2016 South Central Texas Regional Water Plan

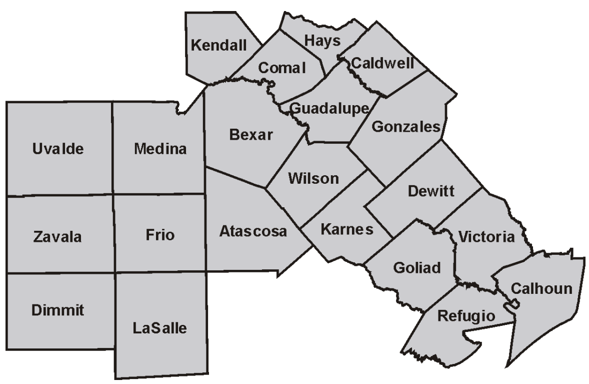
Volume II — Water Management Strategy Evaluations

Prepared by:

South Central Texas Regional Water Planning Group

With administration by:

San Antonio River Authority



With technical assistance by:

HDR Engineering, Inc.
Ximenes and Associates

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5.2.1 Water Conservation (Demand Reduction)

A significant water management strategy is to increase water conservation and thereby reduce freshwater use within the planning area. The general methods to accomplish this objective are to: (1) reduce per capita water use in the municipal water use category; (2) recycle and reuse water and substitute reclaimed water (treated municipal and industrial wastewater) for use in some industries, steam-electric power generation, and mining; and (3) improve irrigation efficiencies to reduce the quantity of water use in agriculture per acre irrigated. Best Management Practices (BMPs) for water conservation, as identified by the Water Conservation Implementation Task Force, will be used in the water conservation water management strategy1. In addition, estimates will be made of the water conservation potentials and associated costs of water conservation for municipal and irrigation water user groups.

5.2.1.1 Municipal Water Conservation

For regional water planning purposes, municipal water use is defined as residential and commercial water use. Municipal water supply is used primarily for drinking, sanitation, cleaning, cooling, fire protection, and landscape watering for residential, commercial, and institutional establishments. Such water is supplied by both public and private utilities, and in areas not served by water utilities, is supplied by individual households. A key parameter of municipal water use within a typical city or water service area is the number of gallons used per person per day (per capita water use). The objective of municipal water conservation programs is to reduce the per capita water use parameter without adversely affecting the quality of life of the people involved. This can be achieved through:

- Use of low flow plumbing fixtures (e.g., toilets, shower heads, and faucets that are designed for low quantities of flow per unit of use);
- The selection and use of more efficient water-using appliances (e.g., clothes washers and dishwashers);
- Modifying and/or installing lawn and landscaping systems to use grass and plants that require less water;
- Repair of plumbing and water-using appliances to reduce leaks; and
- Modification of personal behavior that controls the use of plumbing fixtures, appliances, and lawn watering methods.

With respect to plumbing fixtures, in 1991 the Texas Legislature enacted Senate Bill 587, which established minimum standards for plumbing fixtures sold in Texas[2]. The bill became effective on January 1, 1992, and allowed for wholesalers and retailers to clear existing inventories of pre-standards plumbing fixtures by January 1, 1993. The standards for new plumbing fixtures, as specified by Senate Bill 587, are shown in Table 5.2.1-1. The Texas Commission on Environmental Quality (TCEQ) has promulgated rules requiring the labeling of both plumbing fixtures and water-using appliances sold in

[1] Water Conservation Implementation Task Force, Report to the 79th Legislature, Texas Water Development Board, Special Report, Austin, Texas, November 2004.
[2] Senate Bill 587, Texas Legislature, Regular Session, 1991, Austin, Texas.

Texas. The labels must specify the rates of flow for plumbing fixtures and lawn sprinklers, and the amounts of water used per cycle for clothes washers and dishwashers[3].

In 2009, the Texas Legislature enacted House Bill (HB) 2667 establishing new minimum standards for plumbing fixtures sold in Texas beginning in 2014. HB 2667 clarifies and sets out the national standards of the American Society of Mechanical Engineers and American National Standards Institute by which plumbing fixtures will be produced and tested. This bill establishes a phase-in of high efficiency plumbing fixtures brought into Texas, which will allow manufacturers the time to change their production, at the same time allowing retailers the opportunity to turn over their inventory. HB 2667 creates an exemption for those manufacturers that volunteer to register their products with the United States Environmental Protection Agency's WaterSense Program, which should result in additional water savings. This bill also repeals the Texas Commission on Environmental Quality certification process for plumbing fixtures since the plumbing fixtures must meet national certification and testing procedures.

The Texas Commission on Environmental Quality (TCEQ) has promulgated rules to reflect this new change in law. The 2009 law requires that by January 2014, all toilets use no more than 1.28 gallons per flush (20 percent savings from the 1991 1.6 gallons per flush standard). Based upon an average frequency of per-person toilet use in households of 5.1 and a per-use savings of 0.32 gallons per use the supplementary savings of adopting high-efficiency toilets is 1.63 GPCD. This change is also reflected in Table 5.2.1-1

Table 5.2.1-1 Standards for Pluming Fixtures[1]

Fixture	***Standard***
Toilets*	1.28 gallons per flush
Shower Heads	2.75 gallons per minute at 80 psi
Urinals	0.5 gallon per flush
Faucet Aerators	2.20 gallons per minute at 60 psi
Drinking Water Fountains	Shall be self-closing
*Bill 2667 of the 81st Texas Legislature, 2009	

The TWDB has estimated that the effect of the new plumbing fixtures in dwellings, offices, and public places will be a reduction in per capita water use of approximately 20 gallons per capita per day (gpcd), in comparison to what would have occurred with previous generations of plumbing fixtures[4]. The estimated water conservation effect of 20 gpcd was obtained using the data found in Table 5.2.1-2.

[3] Chapter 290, 30 TAC Sections 290.251, 290.253 - 290.256, 290.260, 290.265, 290.266, Water Hygiene, Texas Register, Page 9935, December 24, 1993.

Table 5.2.1-2 Water Conservation Potentials of Low Flow Plumbing Fixtures

Plumbing Fixture	***Water Savings (gpcd)***
Toilets and Showerheads	16.0
Additional Savings (High Efficiency Toilet)*	1.63
Faucet Aerators – 2.2 gallons per minute	2.0
Urinals – 1.0 gallon per minute	0.3
Drinking Fountains (self-closing)	0.1
Total	20.03 (~20 gpcd)

** TWDB, 2013*

In 2001, the Texas Legislature amended the Texas Water Code to require Regional Water Planning Groups to consider water conservation and drought management measures for each water user group with a need (projected water shortage). The Water Conservation Implementation Task Force has identified and described Water Conservation BMPs and provided a BMP Guide for use by Regional Water Planning Groups in the development of the 2016 Regional Water Plans[5]. The list of BMPs for municipal water users is as follows:

1. System Water Audit and Water Loss;
2. Water Conservation Pricing;
3. Prohibition on Wasting Water;
4. Showerhead, Aerator, and Toilet Flapper Retrofit;
5. Residential Ultra-Low Flow Toilet Replacement Programs;
6. Residential Clothes Washer Incentive Program;
7. School Education;
8. Water Survey for Single-Family and Multi-Family Customers;
9. Landscape Irrigation Conservation and Incentives;
10. Water-Wise Landscape Design and Conversion Programs;
11. Athletic Field Conservation;
12. Golf Course Conservation;
13. Metering of all New Connections and Retrofitting of Existing Connections;
14. Wholesale Agency Assistance Programs;
15. Conservation Coordinator;
16. Reuse of Reclaimed Water;
17. Public Information;

[4] "Water Conservation Impacts on Per Capita Water Use," Water Planning Information, Texas Water Development Board, Austin, Texas, 1992.
[5] Water Conservation Implementation Task Force, Report to the 79th Legislature, Texas Water Development Board, Special Report, Austin, Texas, November 2004.

18. Rainwater Harvesting and Condensate Reuse;
19. New Construction Graywater;
20. Park Conservation; and
21. Conservation Programs for Industrial, Commercial, and Institutional Accounts.

In addition to the list of BMPs, the Water Conservation Implementation Task Force recommends that a standardized methodology be used for determining per capita per day municipal water use in order to allow consistent evaluations of effectiveness of water conservation measures among cities that are located in the different climates and parts of Texas. The Task Force further recommends gpcd targets and goals that should be considered by retail public water suppliers when developing water conservation plans required by the state, as follows:

- "All public water suppliers that are required to prepare and submit water conservation plans should establish targets for water conservation, including specific goals for per capita water use and for water loss programs using appropriate water conservation BMPs.
- "Municipal Water Conservation Plans required by the state shall include per capita water-use goals, with targets and goals established by an entity giving consideration to a minimum annual reduction of one percent in total gpcd, based upon a five-year moving average, until such time as the entity achieves a total gpcd of 140 gpcd or less."
- For the 2016 Regional Water Plan, The South Central Texas Regional Water Planning Group established the municipal water conservation goals, as follows:
- For municipal WUGs with water use of 140 gpcd and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 gpcd is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year for the remainder of the planning period; and
- For municipal WUGs having year 2011 water use of less than 140 gpcd, the goal is to reduce per capita water use by one-fourth percent per year (0.25 percent per year).

In year 2011, in the South Central Texas Water Planning Region, 66 WUGs had per capita water use of less than 140 gpcd (Table 4C.1-3). WUGs with less than 140 gpcd represented 26.1 percent of the population of the Region in year 2011, and used 20.4 percent of the quantity of municipal water used in the Region in year 2011 (Table 4C.1-3). In 2011, 74 percent of the WUGs in the Region had per capita water use of 140 or more gpcd. This group represented 73.9 percent of the region's population in 2011, and accounted for 76.6 percent of the municipal water used in the Region in 2011 (Table 5.2.1-3). These statistics do not include Randolph AFB for which 2011 use data was unavailable.

Table 5.2.1-3 Municipal Water User Group Statistics by Per Capita Water Use

Per Capita Water Use in 2011 (gpcd)	Number of WUGs	Percent of WUGs	Population		Water Use	
			2011 (number)	Percent of Total	2011 (acft)	Percent of Total
Less than 140	66	47.1%	660,166	26.1%	85,475	20.4%
140 and Greater	74	52.9%	1,866,460	73.9%	334,239	79.6%
Totals	140	100.0%	2,526,626	100.0%	419,714	100.0%

The 140 Municipal WUGs of Region L are listed in Table 5.2.1-4, in the order of lowest to highest per capita water use in year 2011 together with projected per capita water use with expected effects of low flow plumbing fixtures upon per capita water use in 2020, 2030, 2040, 2050, 2060, and 2070. This table shows the water conservation effects of low flow plumbing fixtures that were included in the projected water demands for each WUG. The projected municipal water needs (shortages) were calculated for each WUG by subtracting projected municipal water demands from existing municipal water supplies, with the low flow plumbing fixture water conservation effects taken into account.

For purposes of calculating the additional water conservation that needs to be included in the South Central Texas Regional Water Plan, for WUGS having projected needs, the projected per capita water use for municipal WUGs was calculated for the Region L municipal water conservation goals, as stated above, in comparison to the low flow plumbing fixtures per capita water use projections used in calculating municipal water demand. It is important to note that for some WUGs the low flow plumbing fixtures had a greater effect than the Region L goal. For these WUGS, no additional water conservation is considered.

Conservation potentials were calculated for additional plumbing fixtures, clothes washer retrofits and lawn irrigation conservation for each WUG of Region L. The low flow plumbing fixtures effects that are already included in the water demand projections are deducted from the 20 gpcd plumbing fixtures potentials for municipal water demand reduction before additional conservation measures are suggested. The conservation potentials for households in region L were determined using the information in Table 5.2.1-5. In Table 5.2.1-6, the per capita water conservation needed by each WUG to meet the Region L goals are tabulated for indoor (plumbing fixtures and clothes washer retrofits) and outdoor (lawn watering) water conservation.

Table 5.2.1-4 Projected Per Capita Water Conservation Potentials

No.	Water User Group	County	Year 2011 gpcd	Projected Per Capita Water Use with Low Flow Plumbing Fixtures*						Projected Per Capita Water Use with Region L Water Conservation Goals**					
				2020 gpcd	2030 gpcd	2040 gpcd	2050 gpcd	2060 gpcd	2070 gpcd	2020 gpcd	2030 gpcd	2040 gpcd	2050 gpcd	2060 gpcd	2070 gpcd
1	RANDOLPH AFB	BEXAR	60	61	60	60	60	60	60	59	57	56	54	53	52
2	COUNTY LINE WSC	HAYS	71	62	60	60	60	60	60	69	68	66	64	63	61
3	PLUM CREEK WATER COMPANY	HAYS	71	60	60	60	60	60	60	69	68	66	64	63	61
4	PORT O'CONNOR MUD	CALHOUN	79	70	66	63	62	62	62	77	75	73	72	70	68
5	GREEN VALLEY SUD	GUADALUPE	81	70	66	63	62	62	61	79	77	75	73	72	70
6	CALHOUN COUNTY WS	CALHOUN	82	72	68	66	64	64	64	80	78	76	74	73	71
7	CASTLE HILLS	BEXAR	85	74	71	68	66	66	66	83	81	79	77	75	73
8	SPRINGS HILL WSC	GUADALUPE	86	77	73	71	70	69	69	84	82	80	78	76	74
9	EAST MEDINA COUNTY SUD	MEDINA	89	80	76	74	73	73	73	87	85	83	81	79	77
10	KENDALL COUNTY WCID #1	KENDALL	94	85	81	79	78	78	78	92	90	87	85	83	81
11	NIEDERWALD	HAYS	96	88	85	84	83	82	82	94	92	89	87	85	83
12	KYLE	HAYS	97	91	89	89	88	88	88	95	92	90	88	86	84
13	LACOSTE	MEDINA	99	89	84	81	80	80	80	97	94	92	90	88	85
14	MAXWELL WSC	CALDWELL	100	91	87	85	84	84	84	98	95	93	91	88	86
15	KIRBY	BEXAR	102	91	87	84	83	83	83	100	97	95	93	90	88
16	LACKLAND AFB	BEXAR	103	95	91	88	87	86	86	101	98	96	93	91	89
17	BENTON CITY WSC	ATASCOSA	104	97	94	93	92	92	92	102	99	97	94	92	90
18	POINT COMFORT	CALHOUN	104	94	89	86	86	85	86	102	99	97	94	92	90
19	GOFORTH SUD	HAYS	105	96	93	92	91	91	91	103	100	98	95	93	91
20	CONVERSE	BEXAR	106	97	94	93	92	92	92	104	101	99	96	94	91
21	YANCEY WSC	MEDINA	108	100	97	96	95	94	94	106	103	100	98	96	93
22	VON ORMY	BEXAR	109	100	97	94	93	93	93	107	104	101	99	96	94
23	CREEDMOOR-MAHA WSC	CALDWELL	110	100	95	92	91	91	90	108	105	102	100	97	95
24	COUNTY-OTHER	GUADALUPE	111	104	102	101	100	100	100	109	106	103	101	98	96
25	WIMBERLEY WSC	HAYS	111	99	96	96	96	96	96	109	106	103	101	98	96
26	COUNTY-OTHER	LA SALLE	111	136	130	124	121	97	97	109	106	103	101	98	96
27	MOUNTAIN CITY	HAYS	112	108	102	100	98	98	98	110	107	104	102	99	97
28	COUNTY-OTHER	VICTORIA	114	104	100	97	96	96	96	111	109	106	103	101	98
29	COUNTY-OTHER	WILSON	114	106	103	102	101	101	101	111	109	106	103	101	98
30	SOMERSET	BEXAR	115	105	101	98	97	97	97	112	110	107	104	102	99
31	COUNTY-OTHER	CALDWELL	115	106	103	101	100	99	99	112	110	107	104	102	99
32	COUNTY-OTHER	CALHOUN	115	104	100	100	99	99	99	112	110	107	104	102	99
33	COUNTY-OTHER	GONZALES	115	111	103	100	99	98	98	112	110	107	104	102	99

Table 5.2.1-4 (Continued)

No.	Water User Group	County	Year 2011 gpcd	Projected Per Capita Water Use with Low Flow Plumbing Fixtures*						Projected Per Capita Water Use with Region L Water Conservation Goals**					
				2020 gpcd	2030 gpcd	2040 gpcd	2050 gpcd	2060 gpcd	2070 gpcd	2020 gpcd	2030 gpcd	2040 gpcd	2050 gpcd	2060 gpcd	2070 gpcd
34	SANTA CLARA	GUADALUPE	115	106	102	101	100	100	100	112	110	107	104	102	99
35	COUNTY-OTHER	REFUGIO	116	128	112	97	88	97	97	113	111	108	105	103	100
36	S S WSC	WILSON	116	108	105	104	103	103	103	113	111	108	105	103	100
37	COUNTY-OTHER	HAYS	118	110	107	105	104	104	104	115	113	110	107	104	102
38	COUNTY-OTHER	KENDALL	118	109	106	103	102	102	102	115	113	110	107	104	102
39	SAN ANTONIO WATER SYSTEM	BEXAR	119	111	107	105	104	104	104	116	113	111	108	105	103
40	CANYON LAKE WATER SERVICE COMPANY	COMAL	119	112	110	109	109	109	109	116	113	111	108	105	103
41	COUNTY-OTHER	GOLIAD	119	148	143	135	125	102	101	116	113	111	108	105	103
42	MCCOY WSC	ATASCOSA	120	111	107	105	104	104	103	117	114	112	109	106	104
43	POLONIA WSC	CALDWELL	120	111	107	105	104	104	104	117	114	112	109	106	104
44	POTEET	ATASCOSA	121	110	106	103	101	101	101	118	115	113	110	107	104
45	ATASCOSA RURAL WSC	BEXAR	122	113	110	108	108	107	107	119	116	113	111	108	105
46	UHLAND	HAYS	122	115	112	110	110	109	109	119	116	113	111	108	105
47	MARION	GUADALUPE	123	113	108	105	104	104	104	120	117	114	112	109	106
48	COUNTY-OTHER	MEDINA	124	116	113	110	109	109	109	121	118	115	112	110	107
49	COUNTY-OTHER	ATASCOSA	125	115	110	107	106	106	106	122	119	116	113	111	108
50	COUNTY-OTHER	FRIO	127	116	111	111	110	110	110	124	121	118	115	112	110
51	MUSTANG RIDGE	CALDWELL	129	120	116	114	113	112	112	126	123	120	117	114	111
52	MARTINDALE	CALDWELL	131	121	117	115	114	113	113	128	125	122	119	116	113
53	COUNTY-OTHER	DEWITT	131	132	121	111	103	112	112	128	125	122	119	116	113
54	COUNTY-OTHER	DIMMIT	132	157	149	139	132	115	115	129	126	123	120	117	114
55	COUNTY-OTHER	KARNES	134	132	131	128	125	122	122	131	128	125	122	119	116
56	PORT LAVACA	CALHOUN	135	125	121	118	116	116	116	132	129	126	122	119	116
57	EAST CENTRAL SUD	BEXAR	136	126	122	119	117	117	117	133	130	126	123	120	117
58	CIBOLO	GUADALUPE	136	129	127	127	127	127	127	133	130	126	123	120	117
59	ELMENDORF	BEXAR	137	129	127	125	125	125	124	134	131	127	124	121	118
60	BULVERDE	COMAL	137	129	127	125	124	124	124	134	131	127	124	121	118
61	COUNTY-OTHER	UVALDE	137	127	123	120	119	118	118	134	131	127	124	121	118
62	ST. HEDWIG	BEXAR	138	128	124	121	120	120	120	135	132	128	125	122	119
63	LOCKHART	CALDWELL	138	128	124	122	121	121	121	135	132	128	125	122	119
64	LULING	CALDWELL	138	127	123	121	120	119	119	135	132	128	125	122	119
65	CRYSTAL CLEAR WSC	GUADALUPE	138	128	125	122	121	121	121	135	132	128	125	122	119
66	DEVINE	MEDINA	140	131	127	123	122	122	121	137	133	130	127	124	121
67	UNIVERSAL CITY	BEXAR	143	134	130	128	127	126	126	137	133	130	127	124	121
68	BALCONES HEIGHTS	BEXAR	147	137	132	129	128	127	127	138	135	132	128	125	122
69	SAN ANTONIO	BEXAR	147	137	134	131	130	130	130	138	135	132	128	125	122
70	SEGUIN	GUADALUPE	147	137	133	131	130	129	129	138	135	132	128	125	122

Table 5.2.1-4 (Continued)

No.	Water User Group	County	Year 2011 gpcd	Projected Per Capita Water Use with Low Flow Plumbing Fixtures*						Projected Per Capita Water Use with Region L Water Conservation Goals**					
				2020 gpcd	2030 gpcd	2040 gpcd	2050 gpcd	2060 gpcd	2070 gpcd	2020 gpcd	2030 gpcd	2040 gpcd	2050 gpcd	2060 gpcd	2070 gpcd
71	NIXON	GONZALES	148	138	131	125	122	130	130	138	135	132	128	125	122
72	BIG WELLS	DIMMIT	152	182	172	161	153	133	133	139	135	132	129	126	123
73	SCHERTZ	GUADALUPE	152	144	141	140	139	139	139	139	135	132	129	126	123
74	SELMA	BEXAR	153	147	145	145	145	144	144	140	136	133	130	126	123
75	NEW BERLIN	GUADALUPE	153	146	143	142	141	141	141	140	136	133	130	126	123
76	WATER SERVICES INC	BEXAR	154	144	139	136	135	135	135	141	136	133	130	126	123
77	POTH	WILSON	154	143	139	136	135	135	135	141	136	133	130	126	123
78	HELOTES	BEXAR	155	148	146	145	144	144	144	142	136	133	129	126	123
79	SUNKO WSC	WILSON	155	157	153	152	147	138	138	142	136	133	129	126	123
80	AQUA WSC	CALDWELL	156	147	143	141	140	140	140	143	137	134	130	127	124
81	WOODSBORO	REFUGIO	156	175	155	136	125	138	137	143	137	134	130	127	124
82	OAK HILLS WSC	WILSON	158	149	146	145	144	144	143	144	137	133	130	127	124
83	SEADRIFT	CALHOUN	159	149	145	142	140	140	140	145	137	134	131	128	124
84	COUNTY-OTHER	ZAVALA	159	148	143	142	141	141	141	145	137	134	131	128	124
85	COUNTY-OTHER	COMAL	160	151	147	144	142	142	142	146	137	134	131	127	124
86	SAN MARCOS	HAYS	161	149	146	144	144	144	143	147	138	135	131	128	125
87	LEON VALLEY	BEXAR	162	153	148	145	144	144	143	148	138	135	131	128	125
88	WAELDER	GONZALES	162	159	152	146	143	146	146	148	138	135	131	128	125
89	WOODCREEK	HAYS	162	153	150	148	146	146	146	148	138	135	131	128	125
90	CHARLOTTE	ATASCOSA	163	153	148	146	145	144	144	149	138	134	131	128	125
91	NATALIA	MEDINA	163	153	149	146	144	144	144	149	138	134	131	128	125
92	THE OAKS WSC	BEXAR	164	156	153	152	151	151	151	150	139	135	132	129	125
93	WIMBERLEY	HAYS	166	154	149	147	146	146	146	152	139	136	132	129	126
94	LIVE OAK	BEXAR	167	158	155	153	151	151	151	153	139	136	132	129	126
95	YORKTOWN	DEWITT	167	171	157	145	136	148	148	153	139	136	132	129	126
96	BUDA	HAYS	168	161	159	158	157	157	157	153	139	135	132	129	126
97	YOAKUM	DEWITT	169	170	157	145	135	150	150	154	140	136	133	130	126
98	COUNTY-OTHER	BEXAR	175	167	162	160	159	158	158	160	145	137	133	130	127
99	KARNES CITY	KARNES	177	175	172	166	162	158	158	162	146	137	134	131	127
100	REFUGIO	REFUGIO	180	204	182	160	147	161	161	164	149	138	134	131	128
101	LYTLE	ATASCOSA	183	173	169	166	165	164	164	167	151	139	135	132	129
102	PEARSALL	FRIO	186	177	173	171	170	169	169	170	154	139	136	132	129
103	SMILEY	GONZALES	189	188	178	171	169	172	171	173	156	141	137	133	130
104	GOLIAD	GOLIAD	190	243	237	225	209	171	171	174	157	142	136	133	130
105	NEW BRAUNFELS	COMAL	191	182	179	178	177	177	176	174	158	143	137	134	130
106	ASHERTON	DIMMIT	191	230	219	209	200	174	174	174	158	143	137	134	130
107	EL OSO WSC	KARNES	192	191	189	182	178	173	173	175	159	143	137	133	130
108	RUNGE	KARNES	192	191	188	181	178	174	174	175	159	143	137	133	130

Table 5.2.1-4 (Concluded)

No.	Water User Group	County	Year 2011 gpcd	Projected Per Capita Water Use with Low Flow Plumbing Fixtures*						Projected Per Capita Water Use with Region L Water Conservation Goals**					
				2020 gpcd	2030 gpcd	2040 gpcd	2050 gpcd	2060 gpcd	2070 gpcd	2020 gpcd	2030 gpcd	2040 gpcd	2050 gpcd	2060 gpcd	2070 gpcd
109	HONDO	MEDINA	198	189	185	183	181	181	181	181	164	148	138	134	131
110	JOURDANTON	ATASCOSA	199	189	185	182	181	180	180	182	164	149	139	135	132
111	LA VERNIA	WILSON	199	189	186	183	182	182	182	182	164	149	139	135	132
112	STOCKDALE	WILSON	199	188	184	181	180	180	180	182	164	149	139	135	132
113	CRYSTAL CITY	ZAVALA	199	188	184	181	180	180	180	182	164	149	139	135	132
114	BOERNE	KENDALL	201	192	189	188	187	187	187	184	166	150	139	135	132
115	WINDCREST	BEXAR	202	193	188	185	183	183	183	185	167	151	139	135	132
116	PLEASANTON	ATASCOSA	205	195	191	188	187	187	186	187	169	153	140	136	133
117	OLMOS PARK	BEXAR	206	195	191	188	187	186	186	188	170	154	139	136	132
118	FALLS CITY	KARNES	209	205	202	196	191	191	191	191	173	156	141	137	133
119	HILL COUNTRY VILLAGE	BEXAR	213	203	200	196	195	195	195	195	176	159	144	137	134
120	ENCINAL	LA SALLE	215	271	260	249	245	197	196	196	178	161	145	137	134
121	TERRELL HILLS	BEXAR	217	206	203	200	198	198	198	198	179	162	147	138	134
122	CHINA GROVE	BEXAR	218	208	204	200	199	199	199	199	180	163	147	137	134
123	DILLEY	FRIO	220	211	207	205	204	203	203	201	182	164	149	139	135
124	UVALDE	UVALDE	220	210	206	203	201	201	201	201	182	164	149	139	135
125	FLORESVILLE	WILSON	223	212	208	206	205	205	205	204	184	167	151	138	135
126	SABINAL	UVALDE	224	215	210	207	206	205	205	205	185	167	151	139	136
127	GONZALES	GONZALES	231	230	220	212	209	213	213	211	191	173	156	141	137
128	VICTORIA	VICTORIA	235	225	221	218	217	216	216	215	194	176	159	144	137
129	FAIR OAKS RANCH	BEXAR	244	236	234	233	232	232	232	223	202	182	165	149	138
130	CUERO	DEWITT	246	256	239	222	208	227	227	225	203	184	166	150	138
131	CARRIZO SPRINGS	DIMMIT	252	309	297	279	268	233	233	230	208	188	170	154	139
132	GONZALES COUNTY WSC	GONZALES	252	264	253	248	243	236	236	230	208	188	170	154	139
133	ALAMO HEIGHTS	BEXAR	255	244	240	237	236	236	236	233	211	191	172	156	141
134	ZAVALA COUNTY WCID #1	ZAVALA	265	255	251	247	246	246	246	242	219	198	179	162	146
135	CASTROVILLE	MEDINA	272	263	259	255	253	253	253	248	225	203	184	166	150
136	HOLLYWOOD PARK	BEXAR	280	271	267	264	262	261	261	256	231	209	189	171	155
137	COTULLA	LA SALLE	289	369	356	343	336	269	269	264	239	216	195	177	160
138	SHAVANO PARK	BEXAR	290	282	279	277	276	276	276	265	240	217	196	177	160
139	GARDEN RIDGE	COMAL	323	314	311	310	309	309	309	295	267	241	218	197	179
140	KENEDY	KARNES	361	367	366	357	351	342	342	330	298	270	244	221	200

* Water conservation effects as estimated by the TWDB and used in computing municipal water demand for WUGs.

**Region L water conservation goals for municipal WUGs with water use of 140 gpcd and greater in the year 2011 are to reduce per capita water use by 1 percent per year until the level of 140 gpcd is reached, after which the goal is to reduce per capita water use by one-fourth percent per year for the remainder of the planning period. For Municipal WUGs having per capita water use less than 140 gpcd in year 2011, the goal is to reduce per capita water use by one-fourth percent per year.

The water conservation water management strategy for Municipal Water User Groups (WUGs) of Region L is based upon BMPs listed above, and quantities and costs of water conservation measures, as reported in, "Quantifying the Effectiveness of Various Water Conservation Techniques in Texas, Texas Water Development Board, GDS Associates, Austin, Texas, July 2003," and the Water Conservation Implementation Task Force guidelines for water-use targets and goals listed above. The purpose of the municipal water conservation water management strategy is to evaluate the potentials of additional municipal water conservation for inclusion in the Regional Water Plan to meet a part of the projected water needs (shortages) of each WUG for which a need (shortage) is projected.

The calculations for the municipal water conservation water management strategy for municipal WUGs is presented below, and includes both indoor (plumbing fixtures and clothes washers) and outdoor (lawn watering and landscape irrigation) water conservation methods. The underlying methods and assumptions are as follows:

1. Indoor plumbing fixture water conservation potentials are 20 gpcd, a part of which has already been included in the per capita water use projections shown in Table 4C.1-4, and is taken into account in the computations of quantities and costs of the municipal water conservation water management strategy;
2. Outdoor (lawn and landscape) water conservation is used to meet the projected conservation that is needed in order to meet the Region L municipal water goals, as stated above; and
3. Costs of municipal water conservation were obtained from a TWDB study, and are as follows:
   - Plumbing fixture and clothes washer retrofit(Table 5.2.1-5) [6]

     Rural areas………………………………...$ 770 per acre-foot;

     Suburban areas……………………………$ 681 per acre-foot; and

     Urban areas………………………………..$ 600 per acre-foot.
   - Lawn watering and landscape water conservation… $524 per acre-foot.

The per capita municipal water conservation potentials for indoor (plumbing fixtures and clothes washers) and outdoor (lawn and landscape irrigation) were tabulated for each WUG of Region L as a total of 3 parts as follows:

1. Low flow plumbing fixtures water conservation potentials, as provided by TWDB for use in the municipal water demand projections.
2. Additional plumbing fixtures and clothes washer water conservation calculated at 1.0 percent and 0.25 percent per year respectively, as stated in the goals, above.
3. Lawn and landscape irrigation conservation potentials.

[6] GDS Associates, "Quantifying the Effectiveness of Various Water Conservation Techniques in Texas; Appendix VI, Region L," Texas Water Development Board, Austin, Texas, July 2003.

Table 5.2.1-5 Water Conservation Potentials and Costs of Various Water Conservation Techniques and Housing Combinations

*Water Conservation Techniques**	*Life (Years)*	*Discount Factor at 6%*	*Potential Savings for Region L (acft)*	*Number of People Affected*	*Potential Savings (acft per person per year)*	*Total Costs (dollars)*	*Cost per acft of Water Saved Amortized at 6%**
Rural Areas							
SF Toilet Retrofit	25	0.0782	1,536	326,520	0.004705	12,300,668	626
SF Showerheads and Aerators	15	0.1029	805	326,520	0.002464	1,012,996	130
SF Clothes Washer Rebate	13	0.1129	1,843	326,520	0.005646	19,536,354	1,197
MF Toilet Retrofit	25	0.0782	65	11,083	0.005881	338,247	406
MF Showerheads and Aerators	15	0.1029	34	11,083	0.003080	18,040	54
MF Clothes Washer Rebate	8	0.1610	8	11,083	0.000754	39,086	753
Totals **			4,292	337,603	**0.012713**	33,245,391	**$770****
Suburban Areas							
SF Toilet Retrofit	25	0.0782	2,254	279,152	0.008075	16,144,438	560
SF Showerheads and Aerators	15	0.1029	1,181	279,152	0.004230	1,329,542	116
SF Clothes Washer Rebate	13	0.1129	2,705	279,152	0.009690	25,641,167	1,070
MF Toilet Retrofit	25	0.0782	222	37,787	0.005881	1,346,116	474
MF Showerheads and Aerators	15	0.1029	116	37,787	0.003080	71,793	63
MF Clothes Washer Rebate	8	0.1610	33	37,787	0.000880	155,551	753
Totals **			6,512	316,939	**0.020546**	44,688,607	**$681****
Urban Areas							
SF Toilet Retrofit	25	0.0782	4,406	936,489	0.004705	29,225,488	519
SF Showerheads and Aerators	15	0.1029	2,308	936,489	0.002464	2,406,805	107
SF Clothes Washer Rebate	13	0.1129	5,287	936,489	0.005646	46,416,952	991
MF Toilet Retrofit	25	0.0782	1,427	242,646	0.005881	8,420,679	461
MF Showerheads and Aerators	15	0.1029	747	242,646	0.003080	449,103	62
MF Clothes Washer Rebate	8	0.1610	208	242,646	0.000857	973,056	753
Totals **			14,383	1,179,135	**0.012198**	87,892,082	**$600****

* SF is Single Family and MF is Multi-family residential housing. Potentials for Water Conservation in Commercial Sector estimated at zero due to expected poor participation.

** Weighted average of measures included. Used to obtain cost per acre foot of municipal water conservation for use in calculating unit and total costs for water conservation water management strategy for Region L.

Source: "Quantifying the Effectiveness of Various Water Conservation Techniques in Texas," Texas Water Development Board, GDS Associates, Austin, Texas, July 2003.

The estimated quantities of water conservation potential (or water demand reduction) for the WUGs of Region L for which additional water conservation is needed in order to reach the Region L water conservation goals are presented in Table 5.2.1 6 (gpcd) and Table 5.2.10-7(acft/yr).Total projected water demand reduction through water conservation, needed to meet the Region L per capita water use goals is 7,603 acft/yr in 2020, 25,661 acft/yr in 2040, and 96,287 acft/yr in 2070 (Table 5.2.1-7).

The information shown in Table 5.2.1-7 for each of the WUGs for which water conservation estimates have been calculated is illustrated using New Braunfels (Number 105 on the list). For example, with additional water conservation through plumbing fixtures and clothes washers retrofit, the water conservation water management strategy would meet 834 acft/yr of projected need (shortages) in 2030; 896 acft/yr in 2060; and 989 acft/yr in 2070. In order to meet the Region L water conservation goals, additional water conservation through lawn irrigation would provide 1,340 acft/yr in 2030; 6,036 acft/yr in 2060; and 7,357 acft/yr in 2070. The total of which 2,174 acft/yr in 2030; 6,932 acft/yr in 2060; and 8,346 acft/yr in 2070 is shown in Table 5.2.1-7.

The estimated total costs of municipal water conservation for each individual WUG are shown in Table 5.2.1-8. This includes estimates for additional plumbing fixtures, clothes washers retrofit and lawn irrigation. The costs depend upon quantity of water conservation potential, as well as location. For example, San Marcos has a potential of 179 acft/yr in 2020, with a cost $121,953, and a potential of 3,588 acft/yr in 2070 at a cost of $2,443,551 (Table 5.2.1-7and Table 5.2.1-8, respectively).

Total cost for implementation and administration of the municipal water conservation water management strategy to meet the Region L goals of reducing per capita water use at the 1 percent and 0.25 percent rates, as described at the beginning of this analysis, in 2020 is $5,527,643 ($727/acft/yr), increasing to $18.181,695 ($708/acft/yr) in 2040, and to $63,611,975 in 2070 ($661/acft/yr) (Table 5.2.1-8). As the quantity of water conservation (demand reduction) increases, the unit cost decreases from $727 per acre-foot in 2020, to $708 per acre-foot in 2040, and to $660 per acre-foot in 2070.

Based on information obtained from San Antonio Water System, SAWS has a system wide conservation goal of 135 gpcd rather than the region wide goal of 140 gpcd. A table of the decadal savings and costs for SAWS is presented below in Table 5.2.1-9.

Table 5.2.1-6 Projected Municipal Water Demand Reduction from Additional Water Conservation (GPCD)

No.	Water User Group	County	Additional Plumbing Fixtures and Clothes Washers Retrofit Plus Lawn Irrigation Conservation					
			2020 gpcd	2030 gpcd	2040 gpcd	2050 gpcd	2060 gpcd	2070 gpcd
1	RANDOLPH AFB	BEXAR	2	3	5	6	7	8
2	COUNTY LINE WSC	HAYS	0	0	0	0	0	0
3	PLUM CREEK WATER COMPANY	HAYS	0	0	0	0	0	0
4	PORT O'CONNOR MUD	CALHOUN	0	0	0	0	0	0
5	GREEN VALLEY SUD	GUADALUPE	0	0	0	0	0	0
6	CALHOUN COUNTY WS	CALHOUN	0	0	0	0	0	0
7	CASTLE HILLS	BEXAR	0	0	0	0	0	0
8	SPRINGS HILL WSC	GUADALUPE	0	0	0	0	0	0
9	EAST MEDINA COUNTY SUD	MEDINA	0	0	0	0	0	0
10	KENDALL COUNTY WCID #1	KENDALL	0	0	0	0	0	0
11	NIEDERWALD	HAYS	0	0	0	0	0	0
12	KYLE	HAYS	0	0	0	1	3	5
13	LACOSTE	MEDINA	0	0	0	0	0	0
14	MAXWELL WSC	CALDWELL	0	0	0	0	0	0
15	KIRBY	BEXAR	0	0	0	0	0	0
16	LACKLAND AFB	BEXAR	0	0	0	0	0	0
17	BENTON CITY WSC	ATASCOSA	0	0	0	0	0	2
18	POINT COMFORT	CALHOUN	0	0	0	0	0	0
19	GOFORTH SUD	HAYS	0	0	0	0	0	0
20	CONVERSE	BEXAR	0	0	0	0	0	0
21	YANCEY WSC	MEDINA	0	0	0	0	0	1
22	VON ORMY	BEXAR	0	0	0	0	0	0
23	CREEDMOOR-MAHA WSC	CALDWELL	0	0	0	0	0	0
24	COUNTY-OTHER	GUADALUPE	0	0	0	0	2	4
25	WIMBERLEY WSC	HAYS	0	0	0	0	0	0
26	COUNTY-OTHER	LA SALLE	28	24	21	20	0	1
27	MOUNTAIN CITY	HAYS	0	0	0	0	0	1
28	COUNTY-OTHER	VICTORIA	0	0	0	0	0	0
29	COUNTY-OTHER	WILSON	0	0	0	0	0	3
30	SOMERSET	BEXAR	0	0	0	0	0	0
31	COUNTY-OTHER	CALDWELL	0	0	0	0	0	0
32	COUNTY-OTHER	CALHOUN	0	0	0	0	0	0
33	COUNTY-OTHER	GONZALES	0	0	0	0	0	0
34	SANTA CLARA	GUADALUPE	0	0	0	0	0	0
35	COUNTY-OTHER	REFUGIO	14	1	0	0	0	0
36	S S WSC	WILSON	0	0	0	0	0	3
37	COUNTY-OTHER	HAYS	0	0	0	0	0	2
38	COUNTY-OTHER	KENDALL	0	0	0	0	0	0
39	SAN ANTONIO WATER SYSTEM	BEXAR	0	0	0	0	0	1
40	CANYON LAKE WATER SERVICE COMPANY	COMAL	0	0	0	1	3	6
41	COUNTY-OTHER	GOLIAD	32	29	24	17	0	0
42	MCCOY WSC	ATASCOSA	0	0	0	0	0	0
43	POLONIA WSC	CALDWELL	0	0	0	0	0	0
44	POTEET	ATASCOSA	0	0	0	0	0	0
45	ATASCOSA RURAL WSC	BEXAR	0	0	0	0	0	2

No.	Water User Group	County	Additional Plumbing Fixtures and Clothes Washers Retrofit Plus Lawn Irrigation Conservation					
			2020 gpcd	2030 gpcd	2040 gpcd	2050 gpcd	2060 gpcd	2070 gpcd
46	UHLAND	HAYS	0	0	0	0	1	4
47	MARION	GUADALUPE	0	0	0	0	0	0
48	COUNTY-OTHER	MEDINA	0	0	0	0	0	2
49	COUNTY-OTHER	ATASCOSA	0	0	0	0	0	0
50	COUNTY-OTHER	FRIO	0	0	0	0	0	0
51	MUSTANG RIDGE	CALDWELL	0	0	0	0	0	1
52	MARTINDALE	CALDWELL	0	0	0	0	0	0
53	COUNTY-OTHER	DEWITT	4	0	0	0	0	0
54	COUNTY-OTHER	DIMMIT	28	23	16	13	0	1
55	COUNTY-OTHER	KARNES	1	3	3	3	3	6
56	PORT LAVACA	CALHOUN	0	0	0	0	0	0
57	EAST CENTRAL SUD	BEXAR	0	0	0	0	0	0
58	CIBOLO	GUADALUPE	0	0	1	4	7	9
59	ELMENDORF	BEXAR	0	0	0	1	3	6
60	BULVERDE	COMAL	0	0	0	0	3	6
61	COUNTY-OTHER	UVALDE	0	0	0	0	0	0
62	ST. HEDWIG	BEXAR	0	0	0	0	0	1
63	LOCKHART	CALDWELL	0	0	0	0	0	2
64	LULING	CALDWELL	0	0	0	0	0	0
65	CRYSTAL CLEAR WSC	GUADALUPE	0	0	0	0	0	2
66	DEVINE	MEDINA	0	0	0	0	0	1
67	UNIVERSAL CITY	BEXAR	0	0	0	0	3	6
68	BALCONES HEIGHTS	BEXAR	0	0	0	0	2	5
69	SAN ANTONIO	BEXAR	0	0	0	2	4	8
70	SEGUIN	GUADALUPE	0	0	0	1	4	7
71	NIXON	GONZALES	0	0	0	0	5	8
72	BIG WELLS	DIMMIT	43	37	29	24	8	10
73	SCHERTZ	GUADALUPE	5	6	8	11	14	17
74	SELMA	BEXAR	8	9	12	15	18	21
75	NEW BERLIN	GUADALUPE	6	7	9	12	15	17
76	WATER SERVICES INC	BEXAR	3	3	3	6	9	12
77	POTH	WILSON	3	3	4	6	9	12
78	HELOTES	BEXAR	6	10	12	15	18	21
79	SUNKO WSC	WILSON	16	17	19	18	12	15
80	AQUA WSC	CALDWELL	5	6	8	10	13	16
81	WOODSBORO	REFUGIO	33	18	2	0	11	14
82	OAK HILLS WSC	WILSON	5	10	11	14	17	20
83	SEADRIFT	CALHOUN	4	7	8	10	12	15
84	COUNTY-OTHER	ZAVALA	3	5	8	11	14	17
85	COUNTY-OTHER	COMAL	5	10	10	12	15	18
86	SAN MARCOS	HAYS	2	8	10	12	15	18
87	LEON VALLEY	BEXAR	5	10	11	13	16	19
88	WAELDER	GONZALES	11	14	12	12	18	21
89	WOODCREEK	HAYS	5	12	13	15	18	21
90	CHARLOTTE	ATASCOSA	4	11	11	14	16	20
91	NATALIA	MEDINA	4	11	11	13	16	19
92	THE OAKS WSC	BEXAR	6	15	17	20	22	26
93	WIMBERLEY	HAYS	2	10	11	14	17	20
94	LIVE OAK	BEXAR	6	16	17	19	22	25
95	YORKTOWN	DEWITT	18	18	9	4	19	22
96	BUDA	HAYS	8	20	22	25	28	32
97	YOAKUM	DEWITT	16	17	8	2	21	24
98	COUNTY-OTHER	BEXAR	7	17	23	25	28	31
99	KARNES CITY	KARNES	13	26	29	28	27	31
100	REFUGIO	REFUGIO	40	33	23	13	30	33

No.	Water User Group	County	Additional Plumbing Fixtures and Clothes Washers Retrofit Plus Lawn Irrigation Conservation					
			2020 gpcd	2030 gpcd	2040 gpcd	2050 gpcd	2060 gpcd	2070 gpcd
101	LYTLE	ATASCOSA	5	17	27	29	32	36
102	PEARSALL	FRIO	7	20	32	34	37	40
103	SMILEY	GONZALES	15	22	30	33	39	41
104	GOLIAD	GOLIAD	69	80	83	73	38	41
105	NEW BRAUNFELS	COMAL	8	21	35	40	43	46
106	ASHERTON	DIMMIT	55	62	66	63	40	43
107	EL OSO WSC	KARNES	16	30	39	41	40	43
108	RUNGE	KARNES	16	29	38	41	40	43
109	HONDO	MEDINA	8	22	35	44	47	50
110	JOURDANTON	ATASCOSA	7	20	33	42	45	48
111	LA VERNIA	WILSON	7	21	35	44	47	50
112	STOCKDALE	WILSON	6	19	33	41	45	48
113	CRYSTAL CITY	ZAVALA	7	19	32	41	45	48
114	BOERNE	KENDALL	8	23	37	48	51	54
115	WINDCREST	BEXAR	8	22	34	45	48	51
116	PLEASANTON	ATASCOSA	8	21	35	47	50	54
117	OLMOS PARK	BEXAR	7	21	34	48	51	54
118	FALLS CITY	KARNES	14	29	40	50	54	58
119	HILL COUNTRY VILLAGE	BEXAR	9	24	37	51	57	61
120	ENCINAL	LA SALLE	74	82	88	100	59	62
121	TERRELL HILLS	BEXAR	8	24	38	52	60	64
122	CHINA GROVE	BEXAR	9	23	37	52	62	65
123	DILLEY	FRIO	10	25	40	55	65	68
124	UVALDE	UVALDE	9	24	39	53	63	66
125	FLORESVILLE	WILSON	9	24	39	54	66	70
126	SABINAL	UVALDE	10	25	40	54	66	70
127	GONZALES	GONZALES	19	29	40	53	72	76
128	VICTORIA	VICTORIA	11	27	43	58	73	79
129	FAIR OAKS RANCH	BEXAR	13	32	50	67	83	94
130	CUERO	DEWITT	32	36	38	42	77	89
131	CARRIZO SPRINGS	DIMMIT	79	88	91	97	79	94
132	GONZALES COUNTY WSC	GONZALES	34	45	59	73	82	96
133	ALAMO HEIGHTS	BEXAR	11	30	47	64	80	95
134	ZAVALA COUNTY WCID #1	ZAVALA	13	32	49	67	84	99
135	CASTROVILLE	MEDINA	14	34	52	70	87	103
136	HOLLYWOOD PARK	BEXAR	15	35	54	73	90	107
137	COTULLA	LA SALLE	105	118	127	141	92	109
138	SHAVANO PARK	BEXAR	17	39	60	80	99	115
139	GARDEN RIDGE	COMAL	19	44	68	91	112	130
140	KENEDY	KARNES	38	68	88	107	122	143
	Total		1,228	1,880	2,363	2,813	3,068	3,505

Table 5.2.1-7 Projected Municipal Water Demand Reduction from Additional Water Conservation (acft/yr)

No.	Water User Group	County	Additional Plumbing Fixtures and Clothes Washers Retrofit Plus Lawn Irrigation Conservation					
			2020 acft/yr	2030 acft/yr	2040 acft/yr	2050 acft/yr	2060 ac/ft/yr	2070 acft/yr
1	RANDOLPH AFB	BEXAR	3	5	9	13	17	21
2	COUNTY LINE WSC	HAYS	0	0	0	0	0	0
3	PLUM CREEK WATER COMPANY	HAYS	0	0	0	0	0	0
4	PORT O'CONNOR MUD	CALHOUN	0	0	0	0	0	0
5	GREEN VALLEY SUD	GUADALUPE	0	0	0	0	0	0
6	CALHOUN COUNTY WS	CALHOUN	0	0	0	0	0	0
7	CASTLE HILLS	BEXAR	0	0	0	0	0	0
8	SPRINGS HILL WSC	GUADALUPE	0	0	0	0	0	0
9	EAST MEDINA COUNTY SUD	MEDINA	0	0	0	0	0	0
10	KENDALL COUNTY WCID #1	KENDALL	0	0	0	0	0	0
11	NIEDERWALD	HAYS	0	0	0	0	0	0
12	KYLE	HAYS	0	0	0	53	266	480
13	LACOSTE	MEDINA	0	0	0	0	0	0
14	MAXWELL WSC	CALDWELL	0	0	0	0	0	0
15	KIRBY	BEXAR	0	0	0	0	0	0
16	LACKLAND AFB	BEXAR	0	0	0	0	0	0
17	BENTON CITY WSC	ATASCOSA	0	0	0	0	0	57
18	POINT COMFORT	CALHOUN	0	0	0	0	0	0
19	GOFORTH SUD	HAYS	0	0	0	0	0	2
20	CONVERSE	BEXAR	0	0	0	0	0	9
21	YANCEY WSC	MEDINA	0	0	0	0	0	11
22	VON ORMY	BEXAR	0	0	0	0	0	0
23	CREEDMOOR-MAHA WSC	CALDWELL	0	0	0	0	0	0
24	COUNTY-OTHER	GUADALUPE	0	0	0	0	27	79
25	WIMBERLEY WSC	HAYS	0	0	0	0	0	0
26	COUNTY-OTHER	LA SALLE	107	104	100	107	0	5
27	MOUNTAIN CITY	HAYS	0	0	0	0	0	1
28	COUNTY-OTHER	VICTORIA	0	0	0	0	0	0
29	COUNTY-OTHER	WILSON	0	0	0	0	4	73
30	SOMERSET	BEXAR	0	0	0	0	0	0
31	COUNTY-OTHER	CALDWELL	0	0	0	0	0	2
32	COUNTY-OTHER	CALHOUN	0	0	0	0	0	0
33	COUNTY-OTHER	GONZALES	0	0	0	0	0	0
34	SANTA CLARA	GUADALUPE	0	0	0	0	0	1
35	COUNTY-OTHER	REFUGIO	58	5	0	0	0	0
36	S S WSC	WILSON	0	0	0	0	11	104
37	COUNTY-OTHER	HAYS	0	0	0	0	0	354
38	COUNTY-OTHER	KENDALL	0	0	0	0	0	13
39	SAN ANTONIO WATER SYSTEM	BEXAR	0	0	0	0	0	681
40	CANYON LAKE WATER SERVICE COMPANY	COMAL	0	0	0	75	321	638
41	COUNTY-OTHER	GOLIAD	221	232	213	161	0	0
42	MCCOY WSC	ATASCOSA	0	0	0	0	0	0
43	POLONIA WSC	CALDWELL	0	0	0	0	0	4
44	POTEET	ATASCOSA	0	0	0	0	0	0
45	ATASCOSA RURAL WSC	BEXAR	0	0	0	0	0	55

No.	Water User Group	County	Additional Plumbing Fixtures and Clothes Washers Retrofit Plus Lawn Irrigation Conservation					
			2020 acft/yr	2030 acft/yr	2040 acft/yr	2050 acft/yr	2060 ac/ft/yr	2070 acft/yr
46	UHLAND	HAYS	0	0	0	0	5	19
47	MARION	GUADALUPE	0	0	0	0	0	0
48	COUNTY-OTHER	MEDINA	0	0	0	0	0	27
49	COUNTY-OTHER	ATASCOSA	0	0	0	0	0	0
50	COUNTY-OTHER	FRIO	0	0	0	0	0	2
51	MUSTANG RIDGE	CALDWELL	0	0	0	0	0	1
52	MARTINDALE	CALDWELL	0	0	0	0	0	1
53	COUNTY-OTHER	DEWITT	40	0	0	0	0	0
54	COUNTY-OTHER	DIMMIT	109	99	77	64	0	5
55	COUNTY-OTHER	KARNES	7	16	15	17	15	29
56	PORT LAVACA	CALHOUN	0	0	0	0	0	0
57	EAST CENTRAL SUD	BEXAR	0	0	0	0	0	0
58	CIBOLO	GUADALUPE	0	0	48	297	609	975
59	ELMENDORF	BEXAR	0	0	0	2	17	35
60	BULVERDE	COMAL	0	0	0	1	32	71
61	COUNTY-OTHER	UVALDE	0	0	0	0	0	1
62	ST. HEDWIG	BEXAR	0	0	0	0	0	3
63	LOCKHART	CALDWELL	0	0	0	0	0	72
64	LULING	CALDWELL	0	0	0	0	0	3
65	CRYSTAL CLEAR WSC	GUADALUPE	0	0	0	0	0	82
66	DEVINE	MEDINA	0	0	0	0	0	4
67	UNIVERSAL CITY	BEXAR	0	0	0	0	69	143
68	BALCONES HEIGHTS	BEXAR	0	0	0	0	12	32
69	SAN ANTONIO	BEXAR	0	0	0	7,386	22,583	40,300
70	SEGUIN	GUADALUPE	0	0	0	65	257	494
71	NIXON	GONZALES	0	0	0	0	21	37
72	BIG WELLS	DIMMIT	41	38	33	31	8	11
73	SCHERTZ	GUADALUPE	240	370	614	957	1,406	1,935
74	SELMA	BEXAR	60	106	147	194	242	295
75	NEW BERLIN	GUADALUPE	4	6	9	13	19	24
76	WATER SERVICES INC	BEXAR	17	18	22	41	66	95
77	POTH	WILSON	7	9	14	27	44	65
78	HELOTES	BEXAR	67	132	195	276	370	476
79	SUNKO WSC	WILSON	83	107	145	153	112	154
80	AQUA WSC	CALDWELL	9	15	22	33	48	66
81	WOODSBORO	REFUGIO	68	43	6	0	20	26
82	OAK HILLS WSC	WILSON	30	72	100	139	189	244
83	SEADRIFT	CALHOUN	6	14	16	22	31	41
84	COUNTY-OTHER	ZAVALA	10	23	37	55	75	98
85	COUNTY-OTHER	COMAL	133	275	287	335	416	499
86	SAN MARCOS	HAYS	179	778	1,122	1,684	2,507	3,588
87	LEON VALLEY	BEXAR	55	136	149	182	236	294
88	WAELDER	GONZALES	16	22	20	24	33	42
89	WOODCREEK	HAYS	10	25	31	41	57	76
90	CHARLOTTE	ATASCOSA	9	28	33	44	58	74
91	NATALIA	MEDINA	8	22	26	32	42	54
92	THE OAKS WSC	BEXAR	15	42	54	71	90	111
93	WIMBERLEY	HAYS	10	55	78	123	187	272
94	LIVE OAK	BEXAR	94	276	297	333	385	440
95	YORKTOWN	DEWITT	47	51	28	12	51	59
96	BUDA	HAYS	14	48	70	103	144	196
97	YOAKUM	DEWITT	42	51	26	7	56	64
98	COUNTY-OTHER	BEXAR	223	749	1,281	1,807	2,419	3,088
99	KARNES CITY	KARNES	48	95	108	107	100	112
100	REFUGIO	REFUGIO	157	147	112	69	109	120

No.	Water User Group	County	Additional Plumbing Fixtures and Clothes Washers Retrofit Plus Lawn Irrigation Conservation					
			2020 acft/yr	2030 acft/yr	2040 acft/yr	2050 acft/yr	2060 ac/ft/yr	2070 acft/yr
101	LYTLE	ATASCOSA	18	69	120	144	174	207
102	PEARSALL	FRIO	81	247	434	497	573	655
103	SMILEY	GONZALES	11	18	27	33	37	43
104	GOLIAD	GOLIAD	174	228	264	254	120	133
105	NEW BRAUNFELS	COMAL	644	2,174	4,237	5,624	6,932	8,346
106	ASHERTON	DIMMIT	82	101	118	123	65	72
107	EL OSO WSC	KARNES	49	96	126	135	127	137
108	RUNGE	KARNES	19	36	48	52	50	54
109	HONDO	MEDINA	87	258	446	593	669	747
110	JOURDANTON	ATASCOSA	36	119	219	307	360	415
111	LA VERNIA	WILSON	11	39	74	106	128	149
112	STOCKDALE	WILSON	13	49	97	141	168	197
113	CRYSTAL CITY	ZAVALA	60	197	354	497	573	654
114	BOERNE	KENDALL	136	484	985	1,513	1,888	2,294
115	WINDCREST	BEXAR	51	139	228	309	340	372
116	PLEASANTON	ATASCOSA	89	289	531	795	926	1,062
117	OLMOS PARK	BEXAR	21	68	123	188	215	244
118	FALLS CITY	KARNES	10	22	30	38	40	43
119	HILL COUNTRY VILLAGE	BEXAR	10	27	43	58	66	70
120	ENCINAL	LA SALLE	58	72	86	107	58	63
121	TERRELL HILLS	BEXAR	52	148	237	325	379	400
122	CHINA GROVE	BEXAR	13	40	71	107	138	155
123	DILLEY	FRIO	48	136	233	341	425	470
124	UVALDE	UVALDE	178	511	874	1,279	1,612	1,796
125	FLORESVILLE	WILSON	80	272	525	823	1,122	1,288
126	SABINAL	UVALDE	20	57	97	141	184	204
127	GONZALES	GONZALES	183	318	475	695	901	1,035
128	VICTORIA	VICTORIA	809	2,200	3,642	5,158	6,705	7,517
129	FAIR OAKS RANCH	BEXAR	116	331	580	822	1,127	1,407
130	CUERO	DEWITT	270	333	381	452	656	767
131	CARRIZO SPRINGS	DIMMIT	579	715	809	939	629	765
132	GONZALES COUNTY WSC	GONZALES	281	425	620	839	895	1,140
133	ALAMO HEIGHTS	BEXAR	104	280	442	601	755	895
134	ZAVALA COUNTY WCID #1	ZAVALA	24	66	113	168	224	282
135	CASTROVILLE	MEDINA	44	104	159	214	268	319
136	HOLLYWOOD PARK	BEXAR	53	126	198	269	340	407
137	COTULLA	LA SALLE	531	666	798	972	577	721
138	SHAVANO PARK	BEXAR	67	174	296	429	567	709
139	GARDEN RIDGE	COMAL	101	319	625	1,008	1,453	1,941
140	KENEDY	KARNES	145	268	352	437	484	568
	Total		7,603	16,435	25,661	42,687	66,736	96,287

Table 5.2.1-8 Estimated Costs for Projected Municipal Water Conservation

Water User Group	Area	Cost Per Acre Foot	Costs of Water Demand Reduction from Plumbing Fixtures and Clothes Watshers Retrofit Conservation plus Lawn Irrigation Conservation					
			2020 Dollars	2030 Dollars	2040 Dollars	2050 Dollars	2060 Dollars	2070 Dollars
RANDOLPH AFB	Rural	770	2,386	4,235	7,167	10,065	13,116	16,264
COUNTY LINE WSC	Rural	770	0	0	0	0	0	0
PLUM CREEK WATER COMPANY	Rural	770	0	0	0	0	0	0
PORT O'CONNOR MUD	Rural	770	0	0	0	0	0	0
GREEN VALLEY SUD	Rural	770	0	0	0	0	0	0
CALHOUN COUNTY WS	Rural	770	0	0	0	0	0	0
CASTLE HILLS	Suburban	681	0	0	0	0	0	0
SPRINGS HILL WSC	Rural	770	0	0	0	0	0	0
EAST MEDINA COUNTY SUD	Rural	770	0	0	0	0	0	0
KENDALL COUNTY WCID #1	Rural	770	0	0	0	0	0	0
NIEDERWALD	Rural	770	0	0	0	0	0	0
KYLE	suburban	681	0	0	0	35,795	180,934	327,067
LACOSTE	Rural	770	0	0	0	0	0	0
MAXWELL WSC	Rural	770	0	0	0	0	0	0
KIRBY	Rural	770	0	0	0	0	0	0
LACKLAND AFB	Urban	600	0	0	0	0	0	0
BENTON CITY WSC	Rural	770	0	0	0	0	0	43,874
POINT COMFORT	Rural	770	0	0	0	0	0	0
GOFORTH SUD	Rural	770	0	0	0	0	0	1,368
CONVERSE	suburban	681	0	0	0	0	0	6,196
YANCEY WSC	Rural	770	0	0	0	0	0	8,145
VON ORMY	Rural	770	0	0	0	0	0	0
CREEDMOOR-MAHA WSC	Rural	770	0	0	0	0	0	0
COUNTY-OTHER	Rural	770	0	0	0	0	20,992	60,537
WIMBERLEY WSC	Rural	770	0	0	0	0	0	0
COUNTY-OTHER	Rural	770	82,008	79,791	76,690	82,184	0	4,228
MOUNTAIN CITY	Rural	770	0	0	0	0	0	540
COUNTY-OTHER	Rural	770	0	0	0	0	0	0
COUNTY-OTHER	Rural	770	0	0	0	0	2,920	55,957
SOMERSET	Suburban	681	0	0	0	0	0	0
COUNTY-OTHER	Rural	770	0	0	0	0	0	1,436
COUNTY-OTHER	Rural	770	0	0	0	0	0	0
COUNTY-OTHER	Rural	770	0	0	0	0	0	0
SANTA CLARA	Rural	770	0	0	0	0	0	487
COUNTY-OTHER	Rural	770	44,851	3,847	0	0	0	0
S S WSC	Rural	770	0	0	0	0	8,254	79,766
COUNTY-OTHER	Rural	770	0	0	0	0	0	272,643
COUNTY-OTHER	Rural	770	0	0	0	0	0	9,900
SAN ANTONIO WATER SYSTEM	Suburban	681	0	0	0	0	0	463,942
CANYON LAKE WATER SERVICE COMPANY	Rural	770	0	0	0	57,425	246,793	491,637
COUNTY-OTHER	Rural	770	170,121	178,457	164,088	124,053	0	0
MCCOY WSC	Rural	770	0	0	0	0	0	0
POLONIA WSC	Rural	770	0	0	0	0	0	2,860
POTEET	Rural	770	0	0	0	0	0	0
ATASCOSA RURAL WSC	Rural	770	0	0	0	0	0	42,130

Water User Group	Area	Cost Per Acre Foot	Costs of Water Demand Reduction from Plumbing Fixtures and Clothes Watshers Retrofit Conservation plus Lawn Irrigation Conservation					
			2020 Dollars	2030 Dollars	2040 Dollars	2050 Dollars	2060 Dollars	2070 Dollars
UHLAND	Rural	770	0	0	0	0	4,160	14,501
MARION	Rural	770	0	0	0	0	0	0
COUNTY-OTHER	Rural	770	0	0	0	0	0	20,555
COUNTY-OTHER	Rural	770	0	0	0	0	0	0
COUNTY-OTHER	Rural	770	0	0	0	0	0	1,791
MUSTANG RIDGE	Rural	770	0	0	0	0	0	772
MARTINDALE	Rural	770	0	0	0	0	0	397
COUNTY-OTHER	Rural	770	30,709	0	0	0	0	0
COUNTY-OTHER	Rural	770	83,592	76,605	58,977	49,264	0	3,643
COUNTY-OTHER	Rural	770	5,095	12,463	11,791	13,061	11,253	22,148
PORT LAVACA	Rural	770	0	0	0	0	0	0
EAST CENTRAL SUD	Rural	770	0	0	0	0	0	0
CIBOLO	suburban	681	0	0	32,538	202,336	414,507	663,929
ELMENDORF	Suburban	681	0	0	0	1,577	11,616	23,999
BULVERDE	Suburban	681	0	0	0	918	22,089	48,303
COUNTY-OTHER	Rural	770	0	0	0	0	0	1,053
ST. HEDWIG	Rural	770	0	0	0	0	0	2,242
LOCKHART	suburban	681	0	0	0	0	0	49,011
LULING	Rural	770	0	0	0	0	0	2,573
CRYSTAL CLEAR WSC	Rural	770	0	0	0	0	0	63,366
DEVINE	Rural	770	0	0	0	0	0	3,250
UNIVERSAL CITY	suburban	681	0	0	0	0	46,811	97,362
BALCONES HEIGHTS	Suburban	681	0	0	0	0	8,324	21,726
SAN ANTONIO	Urban	600	0	0	0	4,431,856	13,550,060	24,179,745
SEGUIN	Suburban	681	0	0	0	44,492	174,773	336,618
NIXON	Rural	770	0	0	0	0	16,519	28,398
BIG WELLS	Rural	770	31,904	29,638	25,293	23,549	6,142	8,391
SCHERTZ	Suburban	681	163,434	252,087	418,337	651,584	957,561	1,317,526
SELMA	Suburban	681	41,046	71,966	100,203	132,164	165,050	201,177
NEW BERLIN	Rural	770	3,436	4,339	7,124	10,152	14,367	18,647
WATER SERVICES INC	Rural	770	12,740	14,173	16,767	31,250	51,179	73,530
POTH	Rural	770	5,319	6,796	10,973	20,418	34,261	49,711
HELOTES	Suburban	681	45,746	89,643	132,600	187,903	252,278	324,389
SUNKO WSC	Rural	770	63,704	82,538	111,785	117,658	86,304	118,214
AQUA WSC	Rural	770	6,807	11,705	16,900	25,455	36,925	50,677
WOODSBORO	Rural	770	52,192	32,830	4,849	0	15,183	19,741
OAK HILLS WSC	Rural	770	23,205	55,085	77,213	107,232	145,242	187,551
SEADRIFT	Rural	770	4,942	10,868	12,482	17,194	23,821	31,643
COUNTY-OTHER	Rural	770	7,726	17,669	28,144	42,334	57,995	75,404
COUNTY-OTHER	Rural	770	102,259	211,948	220,628	258,321	320,207	384,113
SAN MARCOS	Suburban	681	121,953	529,930	764,316	1,146,686	1,706,984	2,443,551
LEON VALLEY	Suburban	681	37,747	92,726	101,752	124,209	160,390	200,182
WAELDER	Rural	770	12,118	17,002	15,737	18,166	25,460	32,271
WOODCREEK	Suburban	681	6,791	16,810	21,032	28,109	38,780	51,651
CHARLOTTE	Rural	770	6,991	21,461	25,400	33,786	44,643	57,119
NATALIA	Rural	770	6,000	17,299	19,681	24,823	32,604	41,423
THE OAKS WSC	Rural	770	11,732	32,291	41,678	54,738	68,970	85,606
WIMBERLEY	Rural	770	7,628	41,983	59,715	94,409	143,966	209,536
LIVE OAK	Suburban	681	63,818	188,293	202,314	226,909	262,102	299,746
YORKTOWN	Rural	770	36,512	39,650	21,882	9,234	39,042	45,375
BUDA	Rural	770	10,760	37,306	54,283	79,031	111,057	151,206
YOAKUM	Rural	770	32,103	39,184	20,326	5,703	42,990	49,376
COUNTY-OTHER	Rural	770	172,049	576,396	986,256	1,391,124	1,862,891	2,377,630
KARNES CITY	Rural	770	36,731	73,148	83,101	82,126	77,382	86,510
REFUGIO	Rural	770	120,607	113,208	86,598	53,003	83,787	92,717

Water User Group	Area	Cost Per Acre Foot	Costs of Water Demand Reduction from Plumbing Fixtures and Clothes Watshers Retrofit Conservation plus Lawn Irrigation Conservation					
			2020 Dollars	2030 Dollars	2040 Dollars	2050 Dollars	2060 Dollars	2070 Dollars
LYTLE	Suburban	681	12,281	46,811	82,035	98,248	118,816	141,303
PEARSALL	Suburban	681	55,279	168,525	295,294	338,413	390,470	446,287
SMILEY	Rural	770	8,297	13,973	21,159	25,232	28,316	32,898
GOLIAD	Rural	770	133,974	175,423	203,279	195,580	92,270	102,041
NEW BRAUNFELS	Suburban	681	438,597	1,480,654	2,885,069	3,829,607	4,720,620	5,683,862
ASHERTON	Rural	770	63,156	77,600	90,994	94,699	49,878	55,204
EL OSO WSC	Rural	770	37,374	73,562	97,068	103,692	97,632	105,764
RUNGE	Rural	770	14,454	27,702	36,740	40,340	38,492	41,652
HONDO	Rural	770	67,221	198,518	343,739	456,875	515,014	575,301
JOURDANTON	Rural	770	27,831	91,285	168,382	236,383	276,914	319,757
LA VERNIA	Rural	770	8,358	29,646	56,892	81,954	98,368	114,407
STOCKDALE	Rural	770	9,841	37,391	74,541	108,220	129,599	152,014
CRYSTAL CITY	Rural	770	46,295	151,309	272,943	382,840	441,413	503,324
BOERNE	Rural	770	104,744	372,887	758,194	1,165,336	1,454,070	1,766,724
WINDCREST	Suburban	681	34,770	94,877	155,513	210,736	231,295	253,038
PLEASANTON	Suburban	681	60,616	196,898	361,560	541,633	630,511	722,965
OLMOS PARK	Suburban	681	14,298	46,214	83,654	127,764	146,283	166,246
FALLS CITY	Rural	770	7,617	16,623	22,787	29,306	30,870	32,791
HILL COUNTRY VILLAGE	Suburban	681	6,769	18,635	29,106	39,677	44,931	47,591
ENCINAL	Rural	770	45,010	55,451	66,420	82,447	44,384	48,840
TERRELL HILLS	Suburban	681	35,390	100,928	161,426	221,031	257,885	272,469
CHINA GROVE	Suburban	681	8,898	27,460	48,483	72,919	93,878	105,416
DILLEY	Rural	770	36,945	104,880	179,741	262,291	327,456	361,969
UVALDE	Rural	770	137,169	393,130	672,837	985,194	1,241,470	1,382,663
FLORESVILLE	Rural	770	61,446	209,311	403,998	633,905	864,101	992,139
SABINAL	Rural	770	15,783	43,904	75,021	108,793	141,463	157,070
GONZALES	Rural	770	140,645	244,789	365,937	535,160	693,809	797,073
VICTORIA	Urban	600	485,608	1,319,926	2,185,010	3,094,642	4,022,958	4,510,364
FAIR OAKS RANCH	Suburban	681	78,671	225,686	395,247	559,601	767,777	958,175
CUERO	Rural	770	207,927	256,718	293,330	347,757	505,470	590,560
CARRIZO SPRINGS	Rural	770	445,550	550,882	622,607	722,820	484,178	588,857
GONZALES COUNTY WSC	Rural	770	216,285	326,922	477,447	646,305	689,290	877,990
ALAMO HEIGHTS	Suburban	681	70,646	190,887	301,248	409,449	513,948	609,687
ZAVALA COUNTY WCID #1	Rural	770	18,179	50,942	86,666	128,979	172,400	217,088
CASTROVILLE	Rural	770	33,590	80,151	122,411	164,533	206,671	245,424
HOLLYWOOD PARK	Suburban	681	36,332	86,083	134,577	182,882	231,239	277,122
COTULLA	Rural	770	408,504	512,469	614,181	748,749	444,049	555,196
SHAVANO PARK	Suburban	681	45,736	118,440	201,294	291,821	386,415	482,491
GARDEN RIDGE	Suburban	681	68,986	217,018	425,538	686,136	989,613	1,321,586
KENEDY	Rural	770	111,810	206,503	270,705	336,232	373,048	437,655
Total			5,527,643	11,724,387	18,181,695	29,378,476	44,587,949	63,611,975

Table 5.2.1-9 SAWS Water Conservation Goals

	2020	2030	2040	2050	2060	2070
Savings (acft/yr)	15,974	10,704	6,901	7,284	8,004	2,792
Unit Costs($/acft/yr)	$600	$600	$600	$600	$600	$600
Annual Cost ($/yr)	$9,584,276	$6,422,342	$4,140,560	$4,370,335	$4,802,414	$1,675,442

5.2.1.2 Advanced Meter Infrastructure

SAWS is currently planning to adopt Advanced Meter Infastructure (AMI) as a conservation strategy. An AMI fixed network system automates the meter reading process with two way communications from utility to meter. The network collects, delivers, and analyzes data regarding how and when usage takes place. The system will also include a leak sensor to detect loss throughout the line. This strategy is designed to provide the utility with more information to proactively prevent water loss and manage customers and resources. In addition, more information will be available to customers encouraging participation in conservation efforts.

More frequent and precise knowledge of customer use can ensure that information to the customer is accurate and that all water use is appearing on billing statements. Advanced meter infrastructure can promote conservation through improved reporting, reducing demand and increasing the available supply. A 5-7 percent water savings is estimated by SAWS as a byproduct of information being available to customers through the customer service portal.

The leak sensors also contribute to conservation through loss prevention. The 100W ERT module collects data from the Leak Sensor during meter reading operations and stores the data to a web-based drive hosted by Itron. This information can be used to find and repair leaks with greater accuracy, reducing the amount of water the utility either has to pump or buy to meet demands. Two leak detection options are being considered. Option 1 includes Leak detection for the water mains only while Option 2 extends leak detection all the way to the customer services.

Due to improved reporting, additional revenue will be collected by the utility, offsetting the cost of implementation. Based on a study conducted with traditional water meters, an average 304 gallon monthly increase was seen per updated meter[7]. This translates to an average monthly gain in each billing statement of $1.67 or $20.06 annually. Once all 500,000 intended customers are operating under the AMI system approximately 10 million additional dollars will be billed each year. Table 5.2.1-10 shows the progression of additional revenue with meter installation.

Table 5.2.1-10 AMI Estimated Yearly Revenue Gain

Year	*Active Meters*	*Yearly Revenue Gain*
2016	100,000	$ 2,006,000
2017	200,000	$ 4,012,000
2018	300,000	$ 6,018,000
2019	400,000	$ 8,024,000
2020	500,000	$ 10,030,000

[7] Siebert, Steven, “Saws-AMI”, 12 Nov. 2013. Email.

The fixed network and customer portal will be built at the same time and ready as the meters and AMI is installed. Estimated costs for the fixed network, updated meters, customer portal, installation, and integration has been compiled into an "all in cost" of $201/meter. With 100,000 meters installed each year between 2015 and 2020, an annual cost of $20,100,000 is expected during installation and a total cost of approximately 100 million dollars over the 5 year period.

The automatic leak detection will be deployed at the same time as the meters to save on implementation costs. The required network and software will cost $4,723,636 and $1,458,750, respectively. The leak detection equipment costs will depend on the coverage option selected. For planning purposes, SAWS has estimated a total leak detection cost of approximately $16 million including software and network requirements. Over a 5 year implementation period, an annual cost of $24.5 Million is expected. The costs are summarized in Table 5.2.1-11.

Table 5.2.1-11 Estimated Installation Costs

Item	Unit Cost	Units	Total cost	Annual Cost (5 yr install)
AMI Meter/Support	$ 201	500,000	$ 100,500,000	$ 20,100,000
Leak Network	$ 4,723,636	1	$ 4,723,636	$ 944,727
Leak Software	$ 1,458,750	1	$ 1,458,750	$ 291,750
Leak Equipment	----------------	----------	$ 16,000,000	$ 3,200,000
		Total Cost:	**$ 122,682,386**	
			Total Annual Cost:	**$ 24,536,477**

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5.2.2 Drought Management

5.2.2.1 Description of Water Management Strategy

Texas Administrative Code (TAC), Chapter 357 Regional Water Planning Guidelines, states that "Regional water plan development shall include an evaluation of all water management strategies the regional water planning group determines to be potentially feasible, including drought management measures including water demand management [357.7(a)(7)(B)]." As defined here, drought management means the periodic activation of approved drought contingency plans resulting in short-term demand reduction and/or rationing. This reduction in demand is then considered a "supply" source. Using this approach, an entity may make the conscious decision not to develop firm water supplies greater than or equal to projected water demands with the understanding that demands will have to be reduced or go unmet during times of drought. Using this rationale, an economic impact of not meeting projected water demands can be estimated and compared with the costs of other potentially feasible water management strategies in terms of annual unit costs.

Figure 5.2.2-1 shows how water supply planning was done in the 2007 State Water Plan and 2006 Regional Water Plans. For each Water User Group (WUG) with an identified shortage or need during the planning period, a future water supply plan was developed consisting of one or more water management strategies. In each case, the planned future water supply was greater than the projected dry weather demand to allow for drought more severe than the drought of record, uncertainty in water demand projections, and/or available supply from recommended water management strategies. This difference between planned water supply and projected dry weather demand is called management supply in Region L.

Figure 5.2.2-2 illustrates how a drought management water management strategy (WMS) could alter the planning paradigm for WUGs with projected needs. Instead of identifying water management strategies to meet the projected need, planned water supply remains below the projected dry weather water demand. The difference between these two lines represents the drought management WMS. Under this concept, a WUG's water demand would be reduced by activating a drought contingency plan to reduce demands, resulting in unmet needs. This strategy of demand reduction or water rationing could negate the need for water management strategies to meet the full projected need of the WUG. Basically, using this approach, the WUG is planning to manage water shortages through drought contingency plan activation or water rationing if needed. This concept is more fully illustrated in Figure 5.2.2-3, which shows that, in any given year, the actual demand may be above or below the planned supply. During times in which the demand exceeds supply, the WUG would experience shortages and incur associated economic impacts.

Figure 5.2.2-1. Typical Planning in 2011 Regional Water

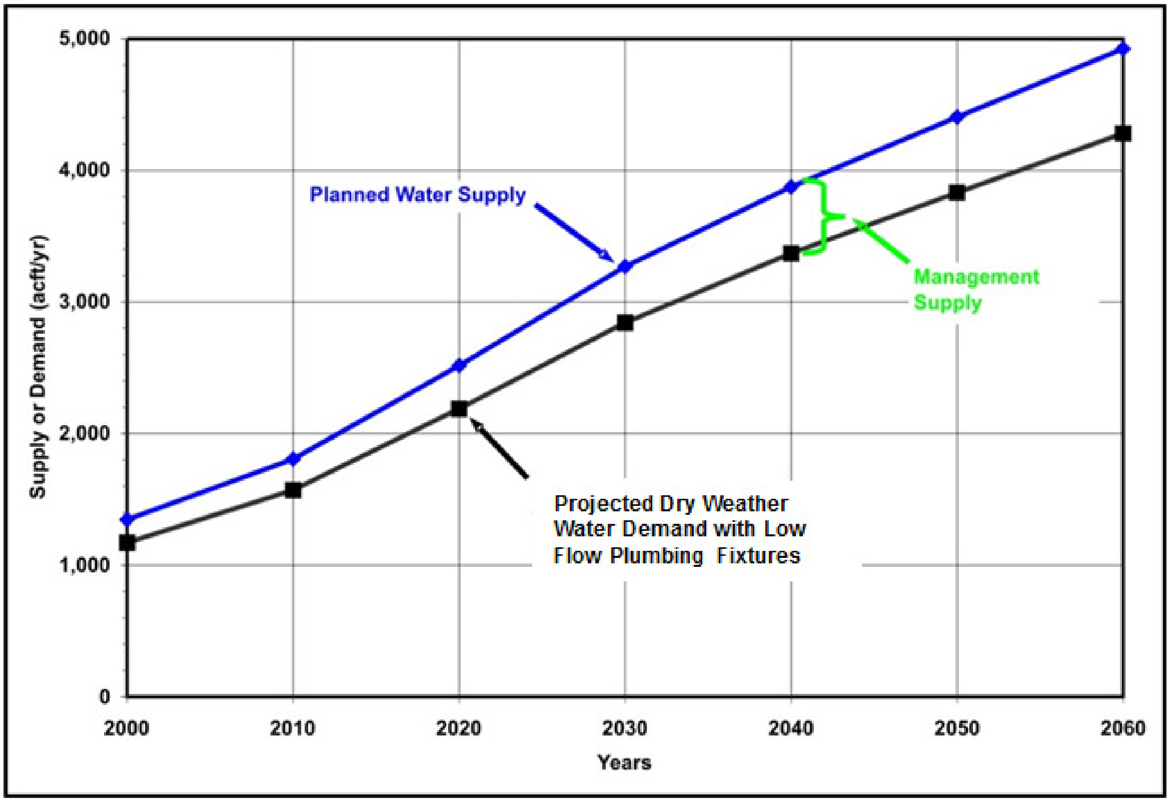


Figure 5.2.2-2. Planning with Drought Management Water Management Strategy

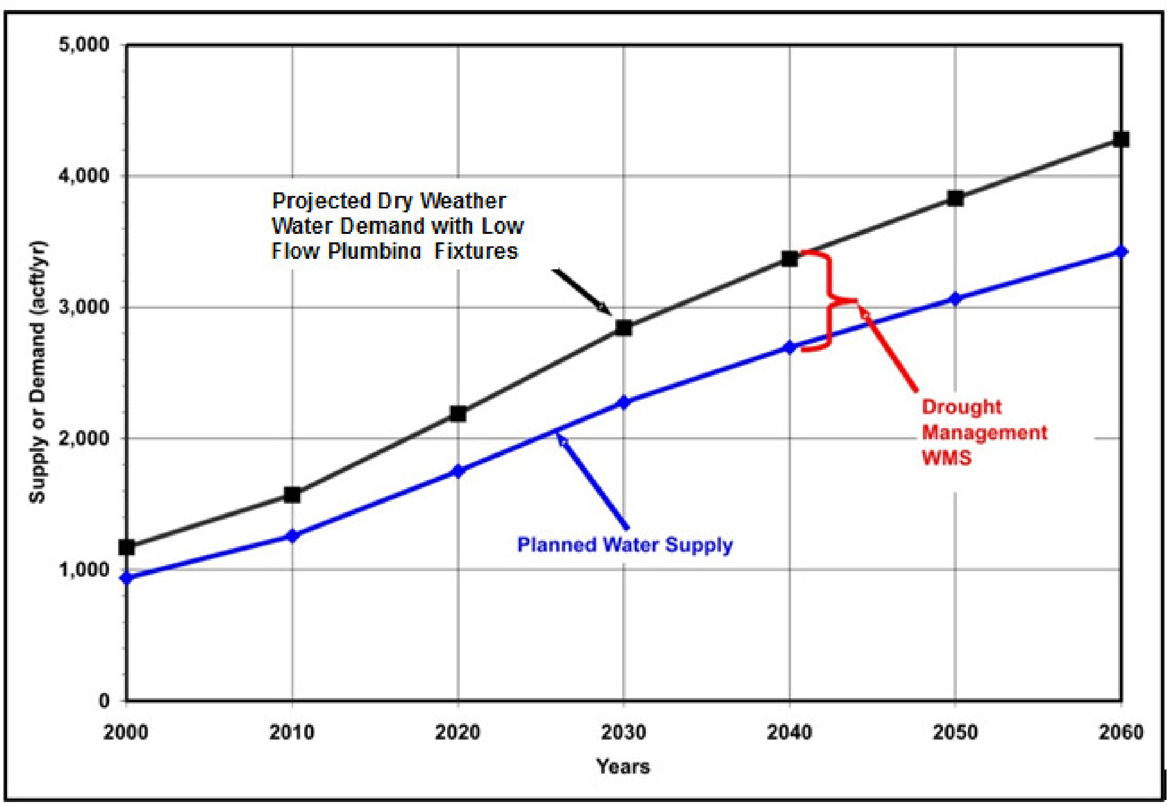
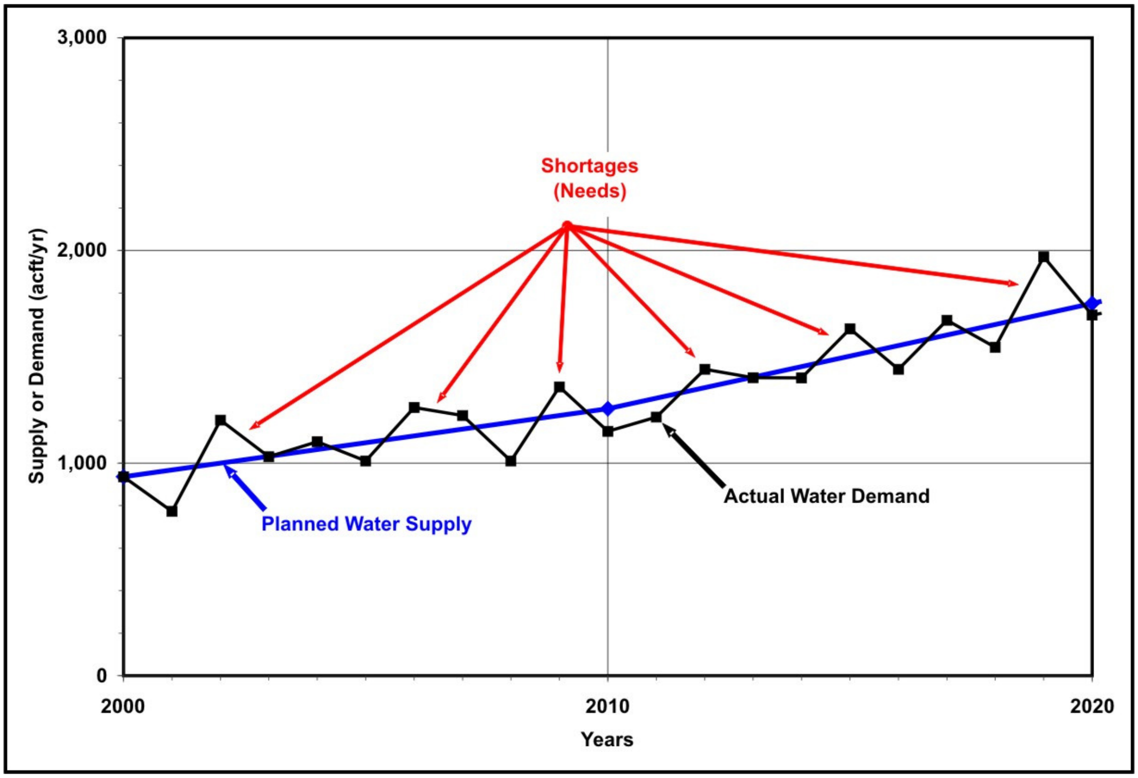


Figure 5.2.2-3. Example Drought Management Water Management Strategy



5.2.2.2 Drought Management Strategy Methodology

As shown in Figure 5.2.2-4, there are a number of incremental steps to calculating a unit cost for this strategy so that it can be compared to other strategies. The first step in the process is to calculate a risk factor for the 5% reduction, 10% reduction, 15% reduction, and 20% reduction cases. Figure 5.2.2-5 illustrates the 5% reduction scenario. The risk factor is defined as the integrated chance of occurrence of potential annual demands in excess of planned supply based on historical per capita variations for each entity. A 5% Drought Management WMS, for example, equates to planned supply that is 95% of projected demand.

The first step in determining the risk factors was to obtain historical annual per capita water use values. These data were obtained from the TWDB for the period 1964 to 2011, if available. From these data, a 5-year moving per capita water use average was calculated in order to limit the effects of trends in per capita water use rates. Next, an annual percentage above or below the 5-year moving average was calculated. These values were then ranked lowest to highest. A frequency curve was then developed using these data with the percentage above or below the 5-year moving average on the y-axis and the percentage of years less than or equal to that value on the x-axis. Finally, this curve was translated so that the year 2011 value was placed at 0 on the y-axis (Figure 5.2.2-5) because year 2011 was used by the TWDB as the basis for demand projections in the 2016 regional water plans.

Figure 5.2.2-4. Methodology Flowchart

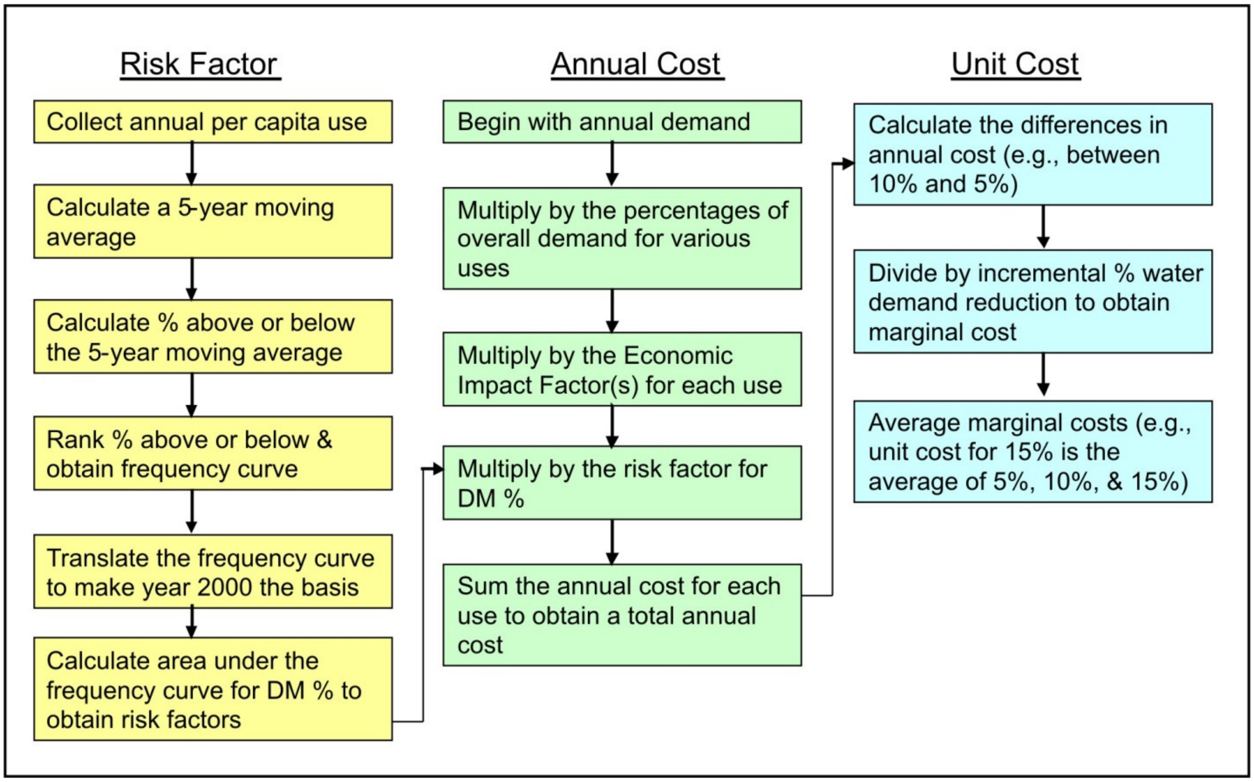
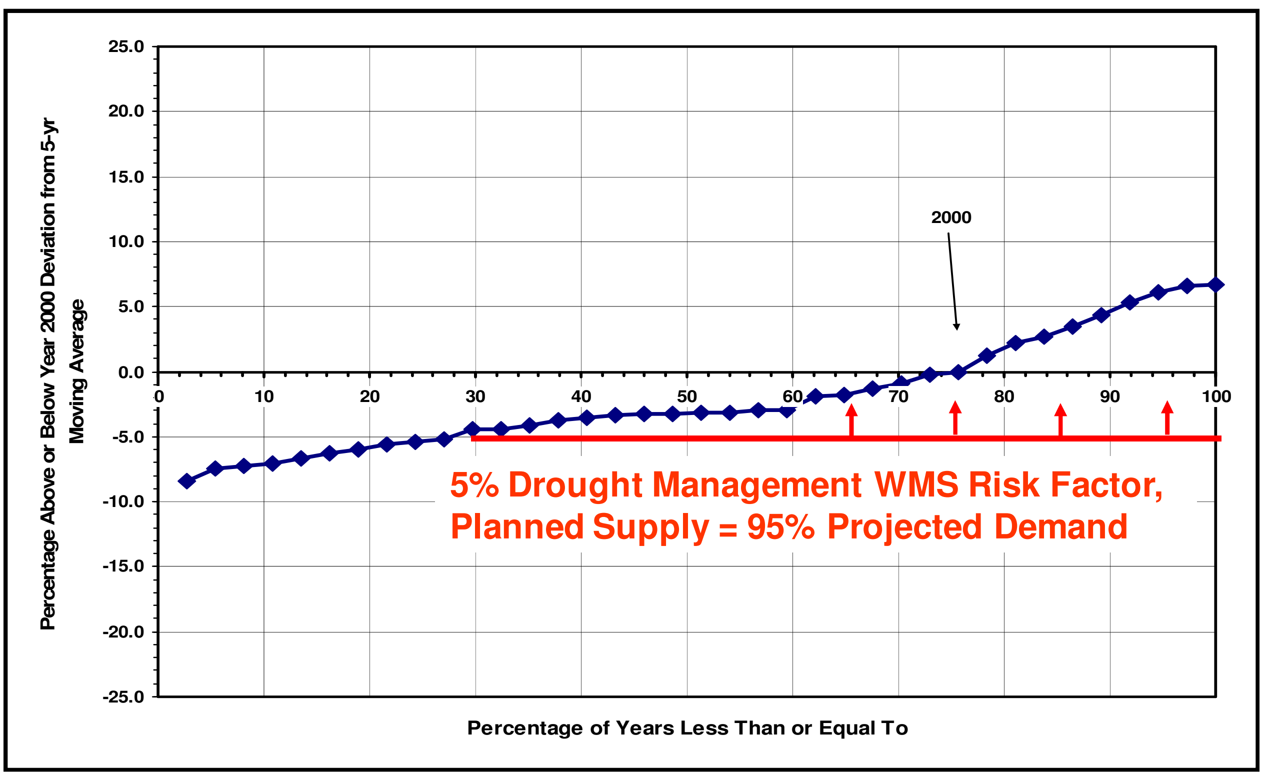


Figure 5.2.2-5. Frequency of Per Capita Water Use Variations



From a plot like Figure 5.2.2-5, the integrated area under the frequency curve was calculated as the risk factor. Using formulas developed in Excel, a chart of risk factors was developed for each WUG for each half percent reduction in water use. Using data supplied by the TWDB which shows the percent of water use for each WUG that is considered to be residential/domestic, the percent reduction in this use type was determined for each of the determined drought management levels (5%, 10%, 15%, and 20%). In other words, reductions in use were focused on residential use first. In this case, all reductions in residential use are attributed to outdoor water use and no reductions in indoor residential water use were assumed to occur. For example, a 10% reduction in overall water use for a WUG may reflect a 12% reduction in residential water use, depending on the amount of water used for other purposes.

Using the chart developed above, the risk factor associated with a 12% reduction in use (10% overall) was determined. If an overall 20% reduction in water use could be obtained without exceeding a 25% reduction in residential use, the use for other water users was not affected. If however, for certain WUGs (Lockhart, Leon Valley, Kirby, Carrizo Springs, Kennedy, Castroville, La Coste, Uvalde and Victoria) this was not the case. For these WUG, residential water use was reduced by 25% with the remaining reduction being split evenly between commercial and industrial use.

After risk factors for each scenario were calculated, an annual cost was then calculated using the following formula:

(Demand) X (%Demand) X (Risk Factor) X ($ Impact Factor) = DM WMS Annual Cost

where:

- Demand (acft/yr) = Projected “dry year” demand from TWDB based on year 2000 per capita use rate (projected demand in year 2010 was used);
- % Demand = Proportion of water demand associated with various use types (i.e., residential, commercial, and manufacturing);
- Risk Factor = Integrated chance of occurrence of potential annual demands in excess of planned supply based on historical per capita use variations for each entity;
- $ Impact Factor ($/acft) = Economic impact factors used by TWDB (see Table 5.2.2-1) to calculate economic impacts of not meeting needs. TWDB factors used include (a) lost sales for water-intensive commercial users; (b) costs to non-water-intensive commercial businesses and households; and (c) lost sales for manufacturing; and
- DM WMS Annual Cost ($/yr) = Typical annual economic impacts of adhering to the Drought Management WMS for that water use type. The annual cost for each use type (i.e., domestic, commercial, and manufacturing) were then summed to obtain a total annual cost.

Table 5.2.2-1. Texas Water Development Board Economic Impact Factors

		RESIDENTIAL/DOMESTIC										NON RESIDENTIAL		DISTRIBUTION BY CATEGORY		
		OUTDOOR				INDOOR										
		% OF TOTAL HOUSEHOLD MONTHLY USE RESTRICTED														
WUG	COUNTY	5%	10%	20%	30%	40%	50%	60%	70%	80%	>90%	COMMERCIAL	INDUSTRIAL (UTILTIY SERVICED)	DOMESTIC %	COMMERCIAL (%)	INDUSTRIAL (UTILTIY SERVICED)
ALAMO HEIGHTS	BEXAR	$994	$1,112	$1,393	$2,300	$6,242	$7,603	$9,666	$13,090	$19,937	$25,996	$51,494	$0	85%	15%	0%
ASHERTON	DIMMIT	$1,156	$1,328	$1,706	$3,132	$9,731	$11,848	$15,023	$20,304	$25,996	$25,996	$24,613	$0	79%	21%	0%
ATASCOSA RURAL WSC	BEXAR	$994	$1,112	$1,393	$2,300	$6,242	$7,603	$9,666	$13,090	$19,937	$25,996	$37,778	$0	100%	0%	0%
CARRIZO SPRINGS	DIMMIT	$994	$1,112	$1,393	$2,300	$6,242	$7,603	$9,666	$13,090	$19,937	$25,996	$24,613	$0	74%	26%	0%
CASTROVILLE	MEDINA	$1,156	$1,328	$1,706	$3,132	$9,731	$11,848	$15,023	$20,304	$25,996	$25,996	$36,223	$58,320	70%	30%	0%
CIBOLO	GUADALUPE	$1,156	$1,328	$1,706	$3,132	$9,731	$11,848	$15,023	$20,304	$25,996	$25,996	$36,223	$58,320	88%	12%	0%
CONVERSE	BEXAR	$1,156	$1,328	$1,706	$3,132	$9,731	$11,848	$15,023	$20,304	$25,996	$25,996	$12,571	$163,480	88%	10%	2%
GARDEN RIDGE	COMAL	$1,156	$1,328	$1,706	$3,132	$9,731	$11,848	$15,023	$20,304	$25,996	$25,996	$14,774	$0	100%	0%	0%
GREEN VALLEY SUD	GUADALUPE	$1,156	$1,328	$1,706	$3,132	$9,731	$11,848	$15,023	$20,304	$25,996	$25,996	$12,571	$163,480	91%	7%	2%
HONDO	MEDINA	$994	$1,112	$1,393	$2,300	$6,242	$7,603	$9,666	$13,090	$19,937	$25,996	$74,909	$437,400	82%	15%	3%
KARNES CITY	KARNES	$1,156	$1,328	$1,706	$3,132	$9,731	$11,848	$15,023	$20,304	$25,996	$25,996	$70,135	$0	95%	5%	0%
KENNEDY	KARNES	$1,156	$1,328	$1,706	$3,132	$9,731	$11,848	$15,023	$20,304	$25,996	$25,996	$24,613	$0	70%	30%	0%
KIRBY	BEXAR	$994	$1,112	$1,393	$2,300	$6,242	$7,603	$9,666	$13,090	$19,937	$25,996	$35,370	$0	60%	40%	0%
LACOSTE	MEDINA	$1,156	$1,328	$1,706	$3,132	$9,731	$11,848	$15,023	$20,304	$25,996	$25,996	$14,494	$0	73%	27%	0%
LEON VALLEY	BEXAR	$1,156	$1,328	$1,706	$3,132	$9,731	$11,848	$15,023	$20,304	$25,996	$25,996	$46,440	$0	73%	27%	0%
LOCKHART	CALDWELL	$994	$1,112	$1,393	$2,300	$6,242	$7,603	$9,666	$13,090	$19,937	$25,996	$38,048	$0	61%	39%	0%
LYTLE	ATASCOSA	$1,156	$1,328	$1,706	$3,132	$9,731	$11,848	$15,023	$20,304	$25,996	$25,996	$47,725	$0	78%	22%	0%
MARTINDALE	CALDWELL	$1,156	$1,328	$1,706	$3,132	$9,731	$11,848	$15,023	$20,304	$25,996	$25,996	$8,176	$0	80%	20%	0%
MOUNTAIN CITY	HAYS	$994	$1,112	$1,393	$2,300	$6,242	$7,603	$9,666	$13,090	$19,937	$25,996	$35,370	$0	100%	0%	0%
NATALIA	MEDINA	$1,156	$1,328	$1,706	$3,132	$9,731	$11,848	$15,023	$20,304	$25,996	$25,996	$24,613	$0	90%	10%	0%
NIEDERWALD	CALDWELL	$1,156	$1,328	$1,706	$3,132	$9,731	$11,848	$15,023	$20,304	$25,996	$25,996	$36,145	$0	90%	10%	0%
SABINAL	UVALDE	$1,156	$1,328	$1,706	$3,132	$9,731	$11,848	$15,023	$20,304	$25,996	$25,996	$39,269	$0	99%	1%	0%
SAN ANTONIO (SAWS)	BEXAR	$886	$983	$1,199	$1,836	$4,525	$5,519	$7,020	$9,526	$14,537	$25,996	$93,182	$290,347	77%	20%	3%
SHAVANO PARK	BEXAR	$1,156	$1,328	$1,706	$3,132	$9,731	$11,848	$15,023	$20,304	$25,996	$25,996	$43,405	$0	100%	0%	0%
UNIVERSAL CITY	BEXAR	$994	$1,112	$1,393	$2,300	$6,242	$7,603	$9,666	$13,090	$19,937	$25,996	$68,148	$0	86%	14%	0%
UVALDE	UVALDE	$994	$1,112	$1,393	$2,300	$6,242	$7,603	$9,666	$13,090	$19,937	$25,996	$56,290	$0	65%	35%	0%
VICTORIA	VICTORIA	$994	$1,112	$1,393	$2,300	$6,242	$7,603	$9,666	$13,090	$19,937	$25,996	$39,269	$0	76%	24%	0%
WINDCREST	BEXAR	$1,156	$1,328	$1,706	$3,132	$9,731	$11,848	$15,023	$20,304	$25,996	$25,996	$39,269	$0	85%	15%	0%
YANCEY WSC	MEDINA	$1,156	$1,328	$1,706	$3,132	$9,731	$11,848	$15,023	$20,304	$25,996	$25,996	$14,494	$0	97%	3%	0%

The final step in this process was to convert the annual cost to a unit cost so that this strategy could be compared to other potentially feasible water management strategies. In order to do this, the difference between the annual cost for each scenario were first calculated (i.e., between 10% and 5%). This value was then divided by a 5% water demand reduction from the year 2010 demand to obtain a marginal cost. Finally, the marginal cost values were averaged to obtain a unit cost (i.e., the unit cost for 15% is the average of 5%, 10%, and 15%).

An example cost calculation for the City of Uvalde is provided in Table 5.2.2-2 and Table 5.2.2-3. Using data supplied by the TWDB (Table 5.2.2-1), the “Share of WUG’s Need Applied to Factor” row is populated. In this case, 65% of the demand is applied to Domestic/Residential use and 15% to Commercial use. There is no demand associated with Manufacturing for the City of Uvalde. Next, the demand associated with each water use is determined by multiplying the total year 2020 demand times the percentage associated with each use type (i.e., 4,052 acft x .65 = 2,634 acft for domestic/residential demand). Using the methodology described above, the risk factor was determined for each scenario. Next, the economic impact factor was determined for each use type using the data supplied by the TWDB and shown in Table 5.2.2-1. These factors are constant from one drought management scenario to the next, with the exception of the factors for Domestic/Residential which were determined by interpolating between the values supplied by the TWDB for the risk factor associated with scenario. For example, for the 5% drought management scenario (a 7.6% reduction in residential/domestic use) for the City of Uvalde, the associated economic impact factor for domestic/residential is $1,053; however, for the 10% reduction scenario (a 15.3% reduction in residential/domestic use), the economic impact factor is $1,267.

Next the total economic impact for each use type is calculated by multiplying the proportional demand times the risk factor times the economic impact factor (i.e., 2,642 acft x 0.1312 x $1,173/acft = $437,627 for the residential sector with a 10% reduction). This same formula was used to determine the economic impact for each use type. Note, that the only WUGs for which commercial and manufacturing water use was reduced are Lockhart, Leon Valley, Kirby, Carrizo Springs, Kennedy, Castroville, La Coste, Uvalde and Victoria. Next, the economic impacts for each use type were summed to obtain a total economic impact (in this case and most cases just for domestic/residential). This type of process was used to determine the total economic impact for each of the drought management scenarios.

Table 5.2.2-2. 5 Percent Drought Management Scenario (City of Uvalde)

	Domestic/ Residential	***Com-mercial***	***Manu-facturing***	***Total/ Combined***
Share of WUG’s Need Applied to Factor (%)	65%	35%	0%	
Proportional Demand (acft)	2,642	1,410	0	
5% DM WMS Risk Factor	0.0744	0	0	
5% Reduction Economic Impact Factor ($/acft)	$1,053	$ 56,290	-	
5% DM WMS - Total Economic Impact ($)	$ 206,377	$ -	$ -	$ 206,377

Table 5.2.2-3. 10 Percent Drought Management Scenario (City of Uvalde)

	Domestic/ Residential	*Com-mercial*	*Manu-facturing*	*Total/ Combined*
Share of WUG's Need Applied to Factor (%)	65%	35%	0%	
Proportional Demand (acft)	2,642	1,410	0	
10% DM WMS Risk Factor	0.1312	0	0	
10% Reduction Economic Impact Factor ($/acft)	$ 1,267	$ 56,290	-	
10% DM WMS - Total Economic Impact ($)	$ 437,627	$ -	$ -	$ 437,627

To determine the unit cost for the 10% drought management scenario for Uvalde, the following steps were completed. First, marginal costs for both the 5% and 10% scenarios were calculated. For the 5% scenario, this is simply the total economic impact divided by 5% of the total year 2010 demand (i.e., $191,091 / 203 acft = $945/acft). For the 10% scenario, a marginal cost must first be calculated. This is calculated as the difference in total economic impact between the 10% and 5% drought management scenarios, divided by 5% of the total year 2010 demand (i.e., ($405,211 - $191,091) / 203 acft = $1,059/acft). To calculate the unit cost for the 10% drought management scenario, the marginal costs of the 5% and the 10% scenario are averaged (i.e., ($945 + $1,059) / 2 = $1,002/acft).

The methodology was presented above for all WUGs showing a need in 2020. San Antonio Water Supply (SAWS), who does not have a need in 2020, also requested to be included in the drought management analysis. SAWS prefers to utilize a multi-decadal approach to drought Management. They are considering a 5% demand reduction for 2020, a 12% demand reduction for 2030, and 16% demand reductions for 2050-2070.

5.2.2.3 Yield from Drought Management Strategy

The yield associated with drought management is simply the year 2020 projected demand times the appropriate percentage depending upon which scenario is used (5%, 10%, 15% or 20%). These values are summarized below in Table 5.2.2-4.

Table 5.2.2-4. Drought Management Yield

	Yield (acft)			
Entity	***5%***	***10%***	***15%***	***20%***
Alamo Heights	111	222	332	443
Asherton	17	34	51	68
Atascosa Rural WSC	80	160	239	319
Carrizo Springs	114	227	341	454

Table 5.2.2-4 (Continued)

Entity	*Yield (acft)*			
	5%	*10%*	*15%*	*20%*
Castroville	40	79	119	159
Cibolo	267	534	801	1,069
Converse	127	254	380	507
Garden Ridge	83	166	249	332
Green Valley SUD	91	182	273	364
Hondo	103	205	308	411
Karnes City	31	63	94	125
Kenedy	71	142	213	284
Kirby	47	94	141	188
LaCoste	6	13	19	25
Leon Valley	93	186	279	372
Lockhart	113	225	338	450
Lytle	29	58	87	115
Martindale	9	19	28	37
Mountain City	1	2	4	5
Natalia	14	28	42	56
Niederwald	4	8	11	15
Sabinal	22	45	67	89
San Antonio/SAWS	55	110	166	221
Shavano Park	160	320	479	639
Universal City	203	405	608	810
Uvalde	856	1,711	2,567	3,422
Victoria	60	120	180	241
Windcrest	33	66	99	132
Yancey WSC	111	222	332	443

5.2.2.4 Drought Management Strategy Costs

For each selected WUG, risk factors for 5%, 10%, 15%, and 20% drought management scenario reductions were calculated (Table 5.2.2-5). For the 5% reduction scenario, the risk factors ranged from 0.0008 for Mountain City, indicating there is very little risk of a higher per capita use rate occurring than what occurred in the year 2011, to 0.7295 for the City of Martindale, indicating a much greater risk of demand being greater than supply. For the 20% scenario, the risk factors ranged from a low of 0.012 for Mountain City to a high of 0.876 for Martindale.

As described above, these risk factors were then used to determine an annual cost for a planned supply less than demand for the year 2020 (Table 5.2.2-6). For the 5% reduction scenario, the annual cost ranged from $17 for Mountain City to a cost of $244, for Leon Valley. For the 20% reduction scenario, the annual cost ranged from $385 for Mountain City to a cost of almost $9 million for Uvalde. The two most important factors driving the annual cost are the risk factor and whether or not that WUG supplies water for commercial and manufacturing purposes (at the 20% reduction level), as these uses have high impact factors.

Finally, the annual cost data were used to calculate a unit cost so that comparisons could be made with other potentially feasible water management strategies (Table 5.2.2-7). For the 5% scenario (supply equal to 95% of dry condition demand), the unit costs ranged from $6/acft/yr for Lytle to a high of $15,038/acft/yr for Martindale. For the 20% scenario (supply equal to 80% of dry condition demand), the unit costs ranged from $75 for Lytle to a high of $10,045 for Uvalde. Again, the high unit costs for Uvalde are primarily due to the high risk factors (i.e., the year 2011 per capita was lower than in many previous years) and the high economic impact factors associated with commercial and manufacturing uses. The decadal percent reductions, yields, and costs for SAWS are presented in Table 5.2.2-8.

Table 5.2.2-5. Risk Factors

Entity	Risk Factors					
	5%	**10%**	**15%**	**20%**	**Commercial**	**Manufacturing**
Alamo Heights	0.0457	0.079	0.123	0.177		
Asherton	0.0010	0.005	0.024	0.055		
Atascosa Rural WSC	0.0262	0.040	0.058	0.079		
Carrizo Springs	0.0720	0.122	0.187	0.231		
Castroville	0.0131	0.024	0.044	0.056	0.015	0.015
Cibolo	0.0312	0.049	0.071	0.109		
Converse	0.0540	0.094	0.140	0.194		
Garden Ridge	0.0126	0.028	0.044	0.066		
Green Valley SUD	0.0912	0.121	0.155	0.193		
Hondo	0.0393	0.078	0.123	0.178		
Karnes City	0.3651	0.414	0.468	0.517		
Kenedy	0.0038	0.014	0.035	0.050		
Kirby	0.0142	0.047	0.115	0.115	0.029	
LaCoste	0.0201	0.042	0.089	0.130	0.016	
Leon Valley	0.1593	0.221	0.282	0.326	0.155	
Lockhart	0.0204	0.060	0.131	0.135	0.037	
Lytle	0.0078	0.027	0.065	0.107		
Martindale	0.7295	0.781	0.829	0.876		
Mountain City	0.0008	0.003	0.007	0.012		
Natalia	0.0357	0.054	0.078	0.111		
Niederwald	0.0687	0.105	0.143	0.182		
Sabinal	0.0162	0.024	0.036	0.053		
Shavano Park	0.0112	0.022	0.037	0.061		
Universal City	0.0173	0.044	0.091	0.143		
Uvalde	0.0744	0.131	0.195	0.213	0.097	
Victoria	0.0010	0.003	0.014	0.041	0.000	
Windcrest	0.0278	0.057	0.103	0.151		
Yancey WSC	0.1768	0.221	0.264	0.309		

Table 5.2.2-6. Total Annual Cost

Entity	*Total Annual Cost*			
	5%	*10%*	*15%*	*20%*
Alamo Heights	$87,612	$172,990	$307,165	$568,763
Asherton	$313	$1,866	$9,958	$33,520
Hondo	$67,015	$154,377	$278,585	$535,657
Karnes City	$235,400	$306,600	$399,868	$525,068
Kenedy	$4,346	$18,771	$62,388	$193,881
Kirby	$8,672	$34,557	$177,313	$507,722
LaCoste	$2,295	$5,661	$14,762	$37,049
Leon Valley	$244,245	$408,575	$628,175	$3,852,331
Lockhart	$29,702	$106,305	$322,078	$1,584,982
Lytle	$4,244	$17,546	$49,259	$132,900
Martindale	$153,755	$192,026	$232,196	$283,990
Mountain City	$17	$77	$195	$385
Natalia	$10,618	$18,571	$31,096	$56,145
Niederwald	$5,441	$9,691	$15,190	$24,515
San Antonio/SAWS	$14,194	$31,787	$62,170	$114,122
Shavano Park	$48,727	$138,993	$333,296	$659,686
Universal City	$206,377	$437,627	$856,946	$8,774,270
Uvalde	$12,788	$49,551	$237,222	$952,662
Victoria	$31,013	$75,775	$157,282	$312,780
Windcrest	$120,620	$175,413	$239,591	$324,504
Yancey WSC	$136,751	$276,602	$516,940	$2,211,819

Table 5.2.2-7. Average Unit Cost

Entity	Average Unit Cost			
	5%	10%	15%	20%
Alamo Heights	$791	$781	$924	$1,283
Cibolo	$595	$558	$617	$944
Converse	$1,032	$1,055	$1,206	$1,684
Garden Ridge	$291	$367	$447	$564
Green Valley SUD	$1,930	$1,490	$1,465	$1,733
Hondo	$653	$752	$905	$1,305
Karnes City	$7,533	$4,906	$4,265	$4,201
Kenedy	$61	$132	$293	$682
Kirby	$184	$367	$1,255	$2,695
LaCoste	$361	$446	$775	$1,459
Leon Valley	$2,626	$2,197	$2,252	$10,356
Lockhart	$264	$472	$954	$3,521
Lytle	$147	$304	$569	$1,152
Martindale	$16,444	$10,269	$8,278	$7,593
Mountain City	$14	$32	$54	$80
Natalia	$756	$661	$738	$999
Niederwald	$1,451	$1,292	$1,350	$1,634
Sabinal	$369	$313	$354	$460
San Antonio/SAWS	$257	$288	$375	$517
Shavano Park	$305	$435	$695	$1,032
Universal City	$1,021	$1,082	$1,413	$10,849
Uvalde	$15	$29	$92	$278
Victoria	$18	$781	$924	$1,283
Windcrest	$520	$444	$484	$553
Yancey WSC	$1,205	$1,219	$1,518	$4,872

Table 5.2.2-8. SAWS Analysis

	2020	2030	2040	2050	2060	2070
% Reduction	5%	5%	5%	5%	5%	5%
Yield (acft)	745	910	1,079	1,253	1,429	1,599
Average Unit Cost	$342	$342	$342	$342	$342	$342

5.2.3 Facilities Expansion

5.2.3.1 Description of Water Management Strategy

Several Water User Groups (WUGs) are interested in projects to expand major components of their existing infrastructure (facilities) so they can continue to provide a safe and reliable water supply to their customers during the planning period. These facilities expansions are considered to be independent of any potential water management strategies to acquire a new water supply, and instead are intended to address expected future improvements to the water system, such as the installation of new water transmission facilities or additional water treatment. Additionally, these facilities expansions could include new transmission facilities designated to move waters from multiple Water Management Strategies throughout an area.

The identification of the facilities expansions is based on responses from WUGs, Wholesale Water Providers (WWPs), and/or representatives of the South Central Texas Regional Water Planning Group only. This water management strategy does not include an environmental assessment, as any environmental issues would likely be localized. Furthermore, cost estimates for each of these facilities expansions are limited and complied herein based on information from the sponsoring entity. Detailed cost estimates will be based on preliminary engineering designs by the entities' engineer.

5.2.3.2 Available Yield

The Facilities Expansions water management strategy (WMS) does not provide additional new firm supply. It is intended to document the expansion of existing facilities for WUGs and WWPs that notified the South Central Texas Regional Planning Group about their plans during the request for information on their future water supply plans. The Facilities Expansions WMS allows these WUGs and WWPs to better utilize their existing supplies and facilitate the implementation of new supplies from other WMSs.

5.2.3.3 Environmental Issues

Facilities expansions typically include adding or expanding water treatment plants, pipelines, pump station, and ground or elevated storage, many of which are on land and easements already owned by the WUG or WWP. In the permitting process some of these facilities expansions may require habitat studies and surveys for protected species and a cultural review. If a significant negative impact appears likely, some modifications to the project may be required. Mitigation may include compensation for net losses of wetlands where impacts are unavoidable.

5.2.3.4 Engineering and Costing

Preliminary engineering and costing have been completed for all facilities expansions not already included in other strategies. Cost estimates were developed using regional planning procedures or information provided by the sponsoring entity. All interconnections are assumed to be made by 12 in. dia. transmission pipelines. The annual costs include debt service for a 20-year loan at 5.5 percent interest and operation and maintenance costs. A description of the facilities expansions requested by each WUG is presented below.

Atascosa Rural WSC

The Atascosa Rural WSC is interested in water transmission facilities for interconnects with San Antonio Water System (SAWS), City of Poteet, City of Jourdanton, and City of Pleasanton. This interconnect would greatly increase the reliability of the utility. While they are not currently working towards these interconnects due to funding, they would also like to explore a connection with Benton City WSC and East Medina in the future. The cost estimate for facilities expansion for the Atascosa Rural WSC includes four 12-inch interconnection transmission pipelines and is summarized in Table 5.2.3-1.

City of Helotes

The City of Helotes is working to integrate their water system with SAWS by installing new 8 in. sanitary sewer service and 12 in water supply line along Highway 16. The project is in its final design phase and cost estimate for facilities expansion were provided by LNV Engineering[1] and are summarized in Table 5.2.3-1.

Gonzales County WSC

The Gonzales County WSC is interested in two facilities expansions. (1) an interconnection with Schertz-Seguin Local Government Corporation, and (2) an interconnection with the Texas Water Alliance. These interconnects would require new pipelines, pump stations, and/or storage facilities. Costs associated with Gonzales County WSC facilities expansion was estimated assuming a 12 in pipe and are included in Table 5.2.3-1.

Springs Hill WSC

Springs Hill WSC is interested in an agreement to utilize Seguin's 90% completed elevated storage tank as well as an emergency Interconnect with the Schertz-Seguin Local Government Corporation Pipeline. These connections would require new pipelines and pump stations, and/or storage facilities. Costs associated with Springs Hill WSC facilities expansion are summarized in Table 5.2.3-1.

Yancey WSC

The Yancey WSC is interested in adding an element to their Local Groundwater WMS that includes an expansion of water treatment and transmission facilities such as new pipelines pump stations, and/or storage facilities. They are also looking to purchase a

[1] Julian Bielawski, Email, December 22, 2014.

new well site for wells, storage and distribution facilities. No cost estimates were prepared for these facilities expansion projects as they are distribution system improvements and not part of the regional planning process.

SAWS

SAWS is looking to build the Water Resources Integration Pipeline, a water pipeline that would convey 75 MGD of potable water from Southern Bexar to Western Bexar 48-inch to 60-inch in diameter. They are also looking into replacing existing filters with new polycellphome units for the Medina Lake Optimization project. SAWS is also considering a direct reuse pipeline from their Dos Rios WWTP to City Public Services (CPS) power plant lake (Calaveras Lake and Lake Braunig). Addition of the pipeline will augment their delivery of recycle contract water to CPS. In order to integrate the water received from the Abengoa Vista Ridge Project, SAWS will be constructing new pipes and retrofit existing infrastructure[2]. Costs associated with these facilities expansions were provided by SAWS[3] and are summarized in Table 5.2.3-1.

Cibolo Creek Municipal Authority (CCMA)

CCMA is a regional wastewater treatment provider, serving several entities in the Cibolo Creek watershed. While CCMA is not a WUG in the SCTRWP, they do supply recycle water to several WUGs within the region. CCMA wishes to expand its recycle program for the decades 2020 through 2070, by expanding their existing WWTP from 6.2 Million Gallons Per Day to 10 Million Gallons per Day in 2016 and building an additional 500,000 gallons per day treatment plant in Middle Cibolo Creek watershed. In addition, other improvements may include new pipelines, pump stations, and/or storage. Construction costs associated with these facilities expansion were provided by CCMA and are summarized in Table 5.2.3-1.

Hays County

Hays County is currently securing water agreements for future supply to meet the needs of the Wimberley/Woodcreek area (Region L), the Dripping Springs area (Region K), and the Hays County-Other category (both Regions L and K). Several water management strategies have been identified to meet the growing needs of the county; however, those strategies deliver water to points along the IH-35 corridor. Hays County is including a Hays County Pipeline Project as a facilities expansion in order to help move these future supplies into and around the county in order to meet the needs over a widespread area. The strategy includes a 36-inch pipeline from the Kyle area, running along FM150 toward Dripping Springs; and a 16-inch spur pipeline running from the FM150-RR3237 split, along RR3237, to the Wimberley area. Costs included in Table 5.2.3-1 represent the cost associated to meet only the needs for the Region L portion of Hays County. It is anticipated that Region K will have a facilities expansion project that will include a spur pipeline off the Region L strategy in order to meet the needs of Region K.

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[2] Steven Siebert, Email, September 29th, 2015.

[3] Steven Siebert, Email, March 5th, 2014.

Guadalupe-Blanco River Authority (GBRA)

GBRA is seeking an expansion of their Western Canyon WTP and transmission facilities, in order to meet future needs in western Comal County. The WTP expansion is expected to increase the treatment capacity of the plant to 16 MGD. Likewise, improvements to transmission pump stations will increase capacity to 16 MGD. Costs associated with these facilities expansion are summarized in Table 5.2.3-1.

5.2.3.5 Implementation Issues

The facilities expansions are not expected to have significant implementation issues.

Table 5.2.3-1. Facilities Expansion Preliminary Costs

WUG	*Description*	*Total Capacity of Facilities Expansion (acft/yr)*	*Project Cost*	*Annual Cost*
Atascosa Rural WSC	(4) 12-in. dia. transmission pipeline connection	11,372	$80,855,000	$7,559,000
Hays County	10.2 mile, 36 in. Diameter Pipe; and an 8.8 mile, 16-in. Diameter Pipe	15,314	$37,432,000	$4,611,000
City of Helotes	12-in. dia. transmission pipeline connection. 8-in. dia. Sewer line.	2,843	$3,597,000	$300,000
GBRA	5 MGD WTP Expansion and Pump Stations	5,600	$13,528,000	$678,000
Gonzales County WSC	(2) 12-in. dia. transmission pipeline connection	5,686	$19,562,000	$861,000
Springs Hill WSC	Expansion of Lake Placid WTP capacity from 1 MGD to 2MGD	1,120	$2,542,000	$806,000
SAWS	Water Integration Pipeline60” diameter pipeline, 48” diameter Pipeline, storage Tanks, Pumps, Delivery Point Facilities.	84,000	$205,000,000	Phased
SAWS	Medina Lake Optimization,	N/A	$4,100,000	$343,085
SAWS	Direct Pipeline from Dos Rios WWTP to Calaveras Lake (CPS)	50,000	$30,000,000	$2,500,000
SAWS	Abengoa Vista Ridge Integration	34,894	$150,000,000	$12,545,000
CCMA	WWTP Expansion (3.8 MGD), New Mid-Cibolo WWTP (0.5 MGD). Distribution Facilities.	4,816	$23,316,500	$4,400,000

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5.2.4 Direct Recycle Programs

5.2.4.1 Description of Water Management Strategy

Recycled Water Programs are defined as projects that utilize treated wastewater effluent as a replacement for potable water supply, reducing the overall demand for fresh water supply. Recycled water typically involves a capital project connecting the treatment plant discharge facilities to an individual area that has a relatively high, localized use that can be met with non-potable water. Examples most frequently include the irrigation of golf courses and other public lands and specific industries or industrial use areas. Few entities, if any, would be capable of utilizing their entire effluent capacity for recycled water at present; long term, it is likely that increased pressure on water supplies will result in increased emphasis on recycled water. Downstream needs, both water rights and environmental instream uses, would have to be met. Any remaining flows after these needs are met could potentially be utilized. Virtually any water supply entity with a wastewater treatment plant could pursue a recycled water alternative, provided that downstream water rights do not have a claim for the entire return flow.

All possible recycled water projects considered for implementation within Region L and described in the following chapter are classified as direct reuse projects. All direct reuse water supply options assume that treated wastewater remains under the control (in pipelines or storage tanks) at all times from treatment to point of use by the entity treating the wastewater and/or supplying recycled water.

Recycled water quality and system design requirements are regulated by Texas Commission on Environmental Quality (TCEQ) by 30 TAC §210. TCEQ allows two types of recycled water as defined by the use of the water and the required water quality:

- Type 1 – Public or food crops generally can come in contact with recycled water; and
- Type 2 – Public or food crops cannot come in contact with recycled water.

Current TCEQ criteria for recycled water are shown in Table 5.2.4-1. Trends across the country indicate that criteria for unrestricted recycled water will likely tend to become more stringent over time. The water quality required for Type 1 recycled water is more stringent with lower requirements for oxygen demand (BOD5 or CBOD5), turbidity, and fecal coliform levels.

A general evaluation of recycled water for multiple water user groups (WUGs) with needs and potential wastewater sources were utilized to evaluate a broad range of potential recycled water supplies.

Table 5.2.4-1 TCEQ Criteria for Recycled Water

Parameter	*Allowable Level*
Type 1 Recycled Water	
BOD_5 or $CBOD_5$	5 mg/L
Turbidity	3 NTU
Fecal Coliform	20 CFU / 100 ml[1]
Fecal Coliform (not to exceed)	75 CFU / 100 ml[2]
Type 2 Recycled Water	
For a system other than a pond system	
BOD_5	20 mg/L
or $CBOD_5$	15 mg/L
Fecal Coliform	200 CFU / 100 ml[1]
Fecal Coliform (not to exceed)	800 CFU / 100 ml[2]
Type 2 Recycled Water	
For a pond system	
BOD_5	30 mg/L
Fecal Coliform	200 CFU / 100 ml[1]
Fecal Coliform (not to exceed)	800 CFU / 100 ml[2]

[1]geometric mean
[2]single grab sample

5.2.4.2 General Evaluation of Direct Reuse Potential for Water User Groups

Potential Recycled Water Needs

A number of water user groups with needs have the potential to utilize recycled water as a water management strategy. These include:

- San Antonio Water System (SAWS);
- City of San Marcos;
- City of Kyle;
- New Braunfels Utilities (NBU), serving City of New Braunfels;
- San Antonio River Authority (SARA); and
- Cibolo Creek Municipal Authority (CCMA).

Recycled Water Programs can help meet the needs of five WUGS in the 2016 South Central Texas Regional Water Plan. Each of the other WUGS could use recycled water to meet the non-potable portion of their needs, however for regional water planning purposes, it is assumed that their needs will be met by other projects. Table 5.2.4-2 lists the water user groups with potential needs for recycled water by decade for 2020 through 2070 and their corresponding possible source of recycled water.

Table 5.2.4-2 Potential Reuse Recipients Needs and Potential Supplier

WUG	***Potential Reuse Supplier***	***2020 need (acft/yr)***	***2030 need (acft/yr)***	***2040 need (acft/yr)***	***2050 need (acft/yr)***	***2060 need (acft/yr)***	***2070 need (acft/yr)***
County Line	City of Kyle	0	0	0	0	180	392
City of Kyle	City of Kyle	0	1,384	2,801	2,787	2,776	2,772
New Braunfels Utilities	New Braunfels	0	1,407	4,803	8,274	11,791	15,196
San Marcos Utilities	San Marcos	0	0	0	1,965	4,576	7,891
Texas State University (San Marcos)	San Marcos	0	140	2,630	3,721	4,831	5,967
SAWS	SAWS	47,016	76,388	106,568	138,258	168,028	195,354

Potential Recycled Water Supply

The supply from recycled water that would be potentially available for any entity would be that portion of their wastewater effluent stream that is over and above any currently planned recycled water and any commitments made to downstream water rights and environmental flows. Of this potential, the amount that can actually be recognized depends on the availability of suitable uses within an economical distance from the treatment plant. If individual high water use industrial plants or open land that benefits from irrigation, such as golf courses, are located relatively close to the plant, then recycled water can provide a substantial benefit to water supplies.

Information regarding each of the water utility districts with an available or projected supply of recycled water is listed in Table 5.2.4-3.

Table 5.2.4-3 Possible Recycled Water Supply

Proximate WW Treatment Facility	2020 Projected Supply (acft/yr)	2030 Projected Supply (acft/yr)	2040 Projected Supply (acft/yr)	2050 Projected Supply (acft/yr)	2060 Projected Supply (acft/yr)	2070 Projected Supply (acft/yr)
CCMA	7,110	10,980	15,840	20,520	23,940	27,270
City of Kyle	2,379	3,641	4,368	4,334	4,222	4,113
New Braunfels Utilities	7,025	7,901	8,568	9,610	10,714	11,709
San Marcos Utilities	2,182	2,887	3,960	5,207	6,656	8,341
SARA	3,192	3,461	3,839	4,549	5,252	6,075
SAWS	5,000	5,000	5,000	15,000	25,000	40,000

CCMA

CCMA currently supplies reuse to five customers: Forum at Olympia Parkway, Mortellaro's Nursery, SCUCISD, Olympia Gold Course and Randolph Air force Base. The combined year 2012 recycled water use for the above entities was 372 acft/yr. In addition, potential demand for recycled water exists for future single-family development as well as existing and future commercial or park development. Developing a recycled water program may provide a cost-effective strategy for meeting current and future water needs. CCMA is currently negotiating additional reclaimed water reservations and is aiming to divert 90 percent of their WWTP effluent, or 27,270 acft/yr, to direct recycle customers by 2070. The project cost for the infrastructure needed to support the projected increase in direct reuse is estimated to be $39,221,000.

City of Kyle

The City of Kyle's parks are presently maintained without supplemental irrigation of landscaping, playgrounds, or athletic fields. The primary demands of recycled water in the City of Kyle (Kyle) are for the irrigation of public and private parks, and public rights-of-way. In addition, potential demand for recycled water exists for future single-family development as well as existing and future commercial development. Potential annual recycled water demand is estimated to exceed 1,300 acft/yr by 2035. Developing a recycled water program may provide a cost-effective strategy for meeting current and future water needs while minimizing the discharge of nutrients to the Plum Creek watershed.

Notably, the current use of potable water for ROW irrigation along Kyle Parkway and cooling makeup water for Seton Medical Center Hays can be replaced with recycled water. Irrigation of Kyle Parkway ROW and cooling make-up water for Seton Medical Center Hays exceeded 21,000,000 gallons in 2011.

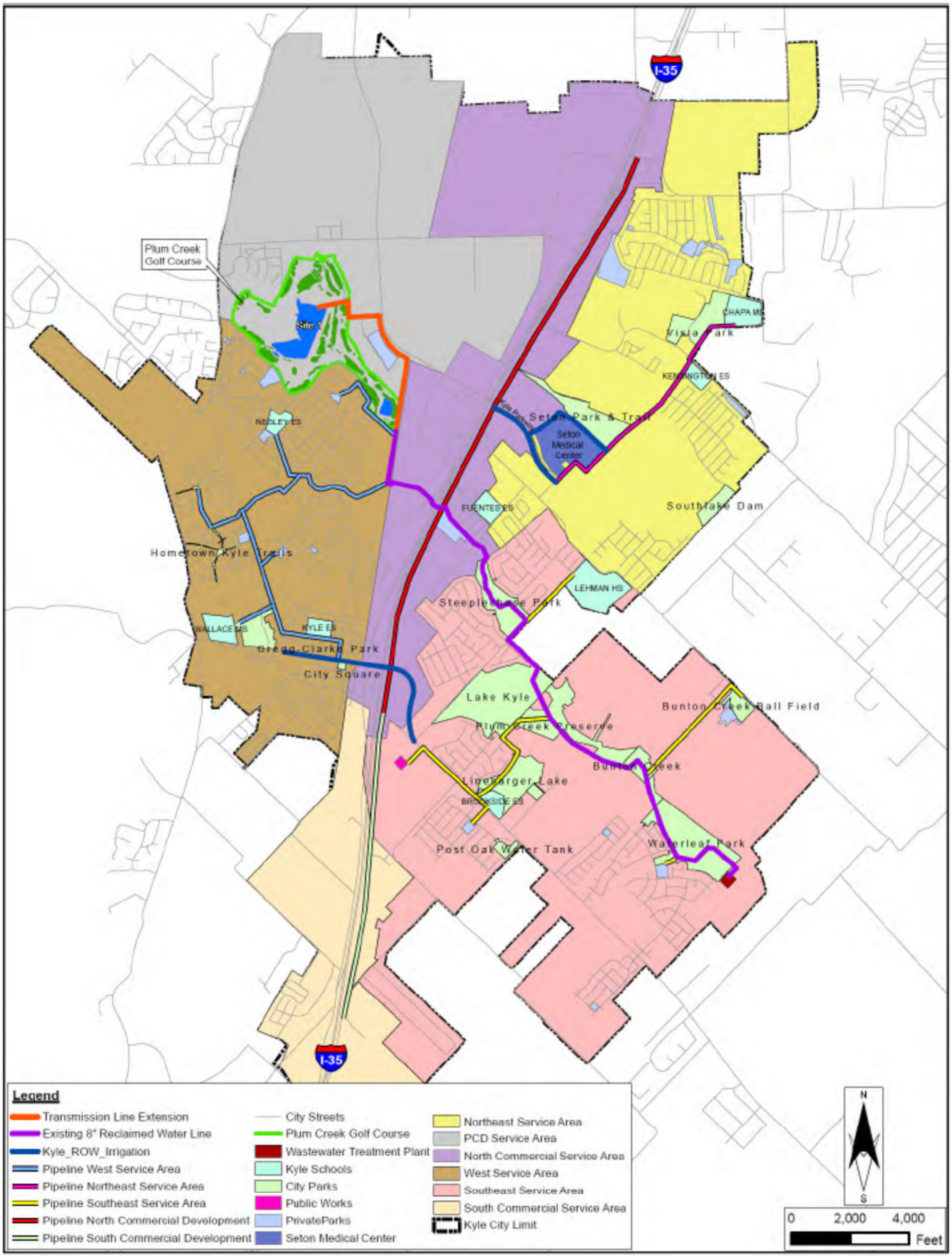
Recycled water has been in use in Kyle for well over a decade. The owners of the Plum Creek Golf Course have operated a recycled water system for golf course irrigation since 1998. However, this privately owned and operated system has a pumping and transmission capacity that is only suitable for the peak demand of the golf course. Furthermore, this system requires frequent maintenance to avoid service interruptions caused by clogged pumps. Expanding the use of recycled water in Kyle in a cost effective manner will likely require replacement of the existing system and operation as a public utility in conjunction with the water and wastewater utilities.

The Kyle WWTP presently discharges approximately 800 million gallons of treated effluent each year. Average wastewater flows are projected to exceed 4 MGD by 2035, providing a source of recycled water that keeps pace with increasing recycled water demand. However, effluent water quality form Kyle WWTP will not meet Type 1 quality standards without additional treatment. To reduce capital and operations costs, additional treatment would be only for the effluent volume intended for the recycled water program. Project costs for the construction of a central supply system and expansion into six service areas are estimated to exceed $32,989,000. The City of Kyle plans to recycle 100 percent of its WWTP discharge by 2070 (Figure 5.2.4-1).

Storage of recycled water in the Plum Creek Site 1 impoundment is feasible under current regulations, but would require applications to amend certain permitted conditions and uses. Under current regulations (30 TAC§210.22e), ponds for storage of recycled water must be located to prevent discharges to waters of the state by diverting runoff away from the pond. Otherwise, the discharge must be permitted through an amendment of the TPDES permit. However, amendment of the city's TPDES permit may be considered a major amendment and could require biomonitoring as part of the application process to identify potential changes in receiving water quality. Access to water stored in the impoundment for irrigation or any other municipal use will require that the water right to the impoundment be obtained by the city and amended to allow the stored water to be used for municipal uses. State highway right-of-way (ROW) crossings will require permits from TxDOT. Crossing railroad ROW will require a permit form the railroad company[1].

[1] RPS Group, Plc., "Kyle Direct Water Reuse Feasibility Study," Final Report for the City of Kyle, December 2012.

Figure 5.2.4-1 Potential recycled water system for Kyle



New Braunfels Utilities

The primary purpose for developing a recycled water program in the City of New Braunfels is to enhance the appeal of the city's parklands and preserve limited water resources as the city's population grows. Approximately 172.8 acres of parkland is presently irrigated, or will be irrigated in the future. A recycled water program designed to meet peak demand during drought conditions is estimated to have a maximum recycled water demand of about 904 acft/yr. Due to limited water resources and restrictions on outdoor irrigation during drought periods, recycled water has the potential to provide an efficient and drought resistant source of water for irrigation needed to preserve and enhance public parks and athletic fields. Park irrigation increases between March and September at the same time that water demand for residential irrigation increases. Currently, water from the Edwards Aquifer is pumped from New Braunfels Utilities' (NBU) wells to supplement surface water supplies and meet seasonal peak demand. However, recycled water may be used for park irrigation and reduce the use of potable water from the Edwards Aquifer. In addition, using wastewater effluent as park irrigation may reduce the nutrient load that would ordinarily be discharged into the Comal and Guadalupe Rivers.

NBU currently operates a recycled water system that provides water to a 29 acre, mixed use development called Sundance Park. Delivery of the recycled water is through approximately 0.75 miles of 10-inch pipeline from the Gruene WWTP. There are three ponds at Sundance Park that store effluent. The NBU contract provides for delivery of up to 2,000,000 gallons per month.

The NBU wastewater system serves more than 18,000 customer connections and has a total treatment capacity of 8.4 MGD associated with three wastewater treatment plants (WWTP). The Gruene WWTP is located in the northeastern quadrant of the city on the Guadalupe River upstream of the confluence with the Comal River. The North and South Kuehler WWTPs are located south of IH 35 on the Guadalupe River below the confluence with the Comal River. Of the three WWTPs operated by BTU, the South Kuehler plant was determined is the most suited as the source of recycled water due to its location and its current production of sufficient volumes (3,140 acft/yr) of high quality effluent. New Braunfels Utilities plans to recycle 100 percent of its WWTP discharge by 2070 (Figure 5.2.4-2).

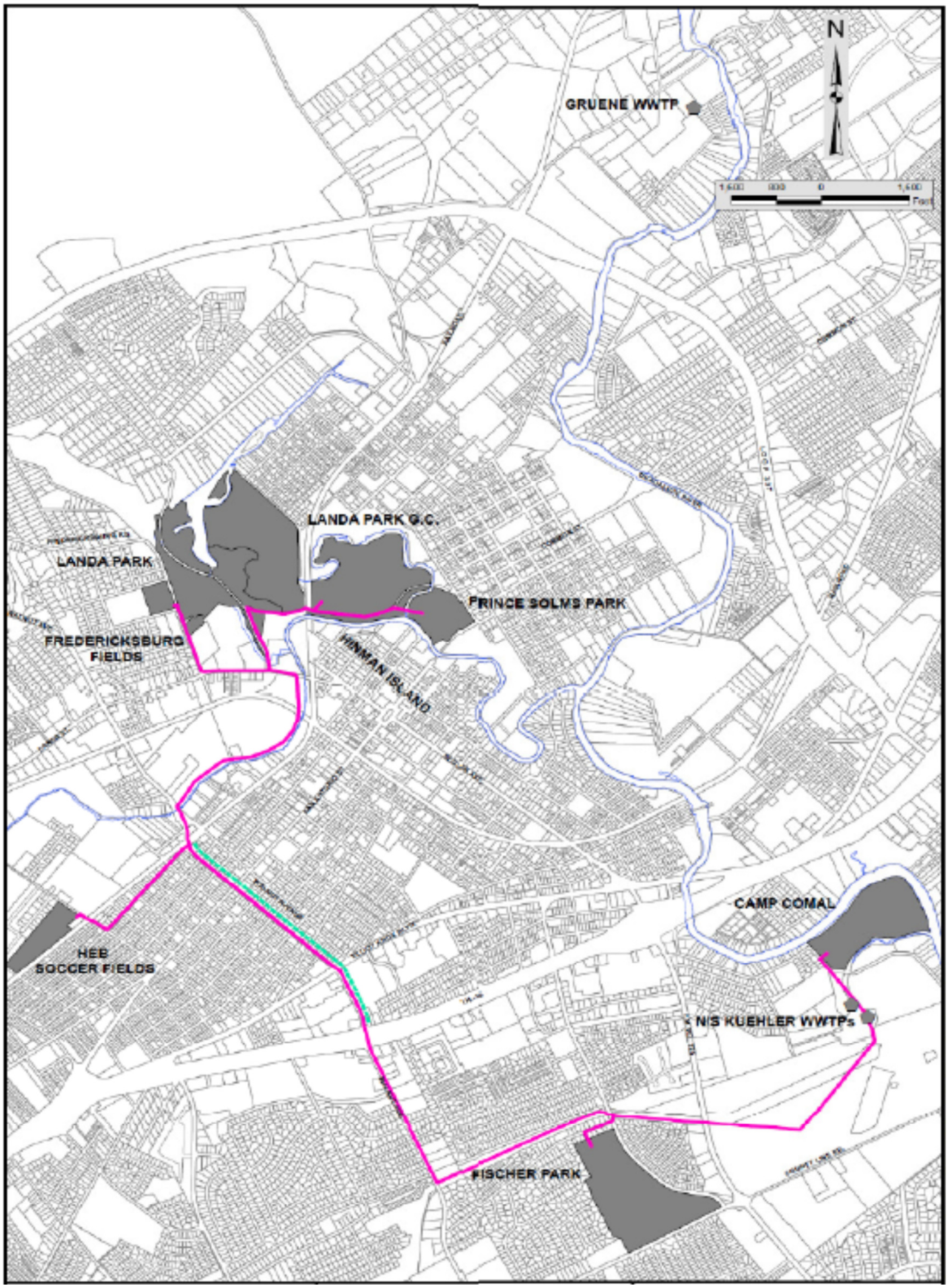
The conceptual recycled water system design developed by Espey Consultants, Inc. for BTU is based on a system pressure of 80 psi at each delivery point. Irrigation of the city's parks occurs during the period from midnight to 6AM. While the supply of recycled water may be pumped during the entire 24-hour period during peak demand, the storage tanks would only be drawn down during the six hours of irrigation. The irrigation demand associated with drought conditions would require two storage tanks of approximately 600,000 gallons and 650,000 gallons.

The capital and operational costs for a recycled water program become less significant as the volume of reclaimed water increases. The project cost is approximately $79 million and the annual cost of operation reaches the current average rate for potable use as park irrigation approaches 506 acft/yr.

State highway right-of-way (ROW) crossings will require permits from TxDOT. Crossing railroad ROW will require a permit form the railroad company. Several isolated wetland areas may exist in Landa Park, the area around the Dry Comal, and in the southern portions of the city. Utility crossings must comply with the terms of Nationwide Permit 12 (NWP-12) relating to activities required for the construction, maintenance, and repair of utility lines and associate facilities in the waters of the United States. Avoidance of wetland areas during construction can be addressed as part of the design process[2].

[2] Espey Consultants, Inc. , "City of New Braunfels Parks Reclaimed Water Irrigation Feasibility Study," Final Report for the City of New Braunfels, July 2011.

Figure 5.2.4-2 Potential recycled water program route from South Kuehler WWTP



City of San Marcos

The existing recycled water conveyance system consists of an 18-inch diameter main from the San Marcos WWTP to a power plant. There is a 12-inch diameter extension to a cement plant and a planned extension to the proposed Paso Robles golf course. Current contracts for recycled water provide a commitment to the power plant, but supply other users only on the basis of available supply. Although much of the City of San Marcos' parklands are maintained without supplemental irrigation, the city's parks along the San Marcos River are the centerpiece of the city's recreational tourist economy. The city's parks department has suggested that irrigating these parklands with recycled water could provide environmental and social benefits by reducing erosion potential along the river and improving the level of service of the local parks.

Planning for expansion of the recycled water system involved identifying potential users along the existing recycled water pipeline and along the route of a proposed pipeline to serve Texas State University's thermal plants. Making recycled water available to the university would reduce demand for San Marcos River water and benefit the areas of critical habitat by allowing increased river flows through the areas of critical habitat. Additional extensions to serve the city's soccer complex and Gary ball fields would reduce potable water demands. Potential industrial users include a concrete products manufacturer and a concrete batch plant.

The San Marcos WWTP is projected to have sufficient average effluent flows to meet future recycled water demand. However, a seasonal storage reservoir would be required so that peak demand would be met during periods of minimum WWTP flows. The recommended peak demand supply alternative is construction of a 105 MG seasonal storage facility adjacent to the WWTP. Average annual recycled water demand is projected to exceed 2,100 acft. The effluent produced by the plant is Type 1 recycled water that should not require significant additional costs for treatment. Project costs for infrastructure are estimated to be about $102,867,000. The City of San Marcos plans to recycle 100 percent of its WWTP discharge by 2070 (Figure 5.2.4-3).

A review of the USFWS National Wetlands Inventory (NWI) revealed that neither digital nor scanned wetlands mapping is available for the study area. To conform with the terms of the Federal Clean Waters Act (CWA), utility crossings must comply with terms of Nationwide Permit 12 (NWP-12) relating to activities required for the construction, maintenance, and repair of utility lines and associated facilities in waters of the United Sates. State highway right-of-way (ROW) crossings will require permits from TxDOT. Crossing railroad ROW will require a permit form the railroad company[3].

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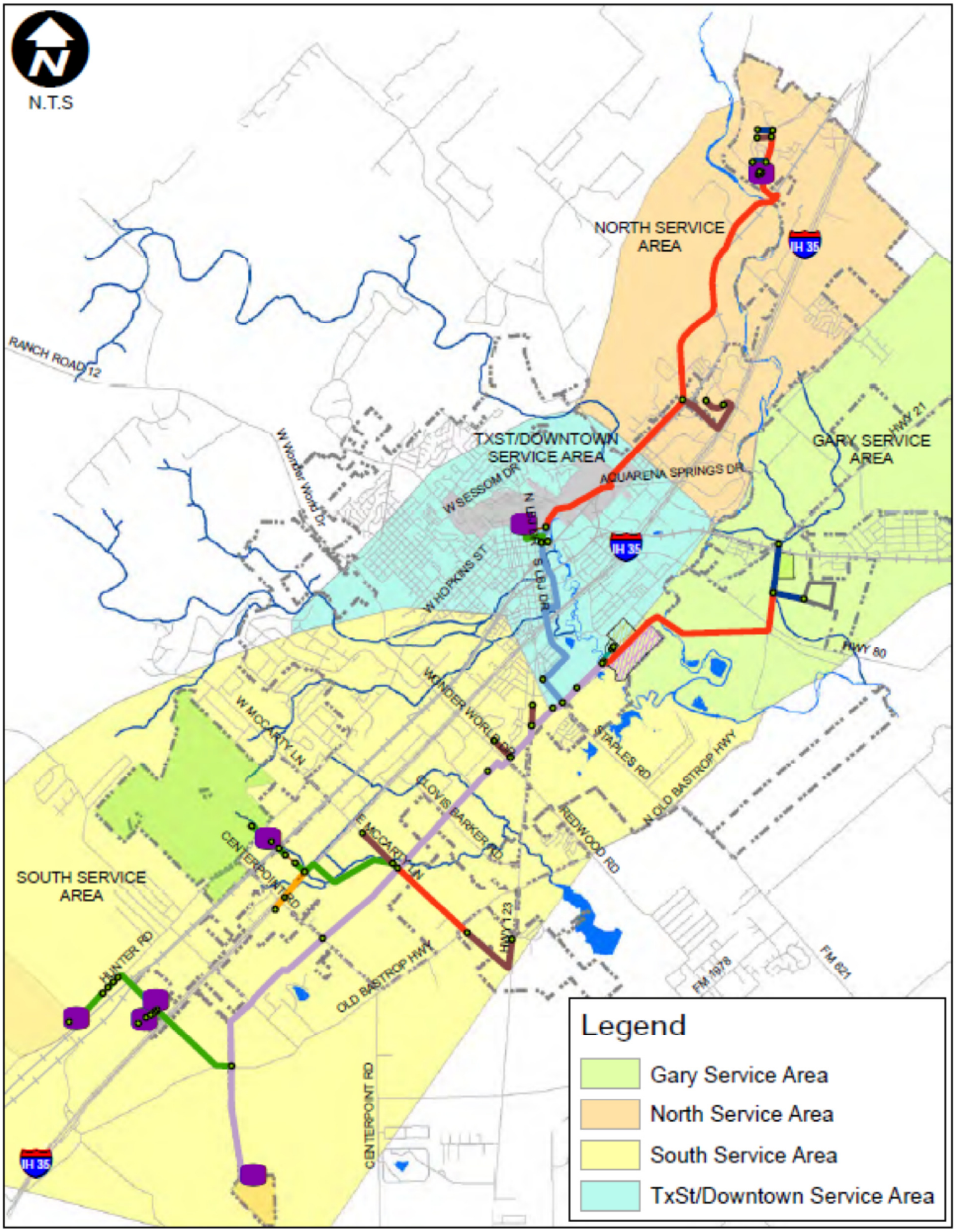
[3] RPS Group, Plc., "San Marcos Direct Water Reuse Expansion Feasibility Study," Draft Report for the City of San Marcos and Texas State University, September 2013.

Figure 5.2.4-3 Potential recycled water system for San Marcos



SARA

SARA has current reuse contracts with three customers: Martinez 1, Salatrillo, and Converse. The combined contracts for the above entities currently total 1,118 acft/yr. In addition, potential demand for recycled water exists for future single-family development as well as existing and future commercial or park development. Developing a recycled water program may provide a cost-effective strategy for meeting current and future water needs. In the future, SARA aims to discharge only the base flow requirement and utilize the rest of the WWTP effluent for direct reuse. According to a previously conducted study by SARA, the base flow requirements for Martinez and Salatrillo creeks total 4,355 acft/yr in 2070 which leaves 6,075 acft/yr for the direct recycle program. The project cost for the infrastructure needed to support the projected increase in direct reuse is estimated to be $108,897,000.

SAWS

SAWS currently supplies reuse from both its west and east systems to industrial and irrigation users. In 2013, the west system had contracts of 3,058 acft for industrial users and 2,003 acft for Irrigation. The east system supported industrial and irrigation customers with 1,018 acft 3,283 acft of recycled water contracts, respectively. The east and west systems are now interconnected in the northern part of the city, allowing for recycle water to be delivered from all three WWTPs. In addition to industrial and irrigation users, potential demand for recycled water exists for future single-family development as well as existing and future commercial development. Developing a recycled water program may provide a cost-effective strategy for meeting current and future water needs.

SAWS currently has an additional future recycle program that is planning to increase its direct reuse to 40,000 acft/yr by 2070. The project cost for the infrastructure needed to support the projected increase in direct reuse is estimated to be $175,965,000.

5.2.4.3 Meeting Demands

The recycled water supply is recommended to meet the projected needs for five WUGs in the region. Utilization of this water is contingent on whether a potential use for the wastewater effluent exists within an economical distance from the treatment plant. Table 5.2.4-4 itemizes the projected supplies to meet the projected demands by decade for each water user group. Additional Reuse supply from SAWS and CCMA is available to meet the needs of additional WUGs at the WWP’s discretion.

Table 5.2.4-4 Recycled Water Allocations

WUG	*Reuse Supplier*	*2020 Supply (acft/yr)*	*2030 Supply (acft/yr)*	*2040 Supply (acft/yr)*	*2050 Supply (acft/yr)*	*2060 Supply (acft/yr)*	*2070 Supply (acft/yr)*
County Line	City of Kyle	50	50	50	50	50	50
City of Kyle	City of Kyle	2,329	3,591	4,318	4,284	4,172	4,063
New Braunfels Utilities	New Braunfels	7,025	7,901	8,568	9,610	10,714	11,709
San Marcos Utilities	San Marcos	1,932	2,637	3,710	4,957	6,406	8,091
Texas State University (San Marcos)	San Marcos	250	250	250	250	250	250

5.2.4.4 Environmental Issues

A summary of environmental issues is presented in Table 5.2.4-5.

Table 5.2.4-5 Environmental Issues: General Recycled Water

Implementation Measures	Development of additional wastewater treatment plant facilities, distribution pipelines, and pump stations. Avoidance of project locations on the Edwards Aquifer recharge zone is desirable.
Environmental Water Needs / Instream Flows	Possible low impact on in-stream flows due to decreased effluent.
Bays and Estuaries	Possible low impact on freshwater inflows during drought due to decreased effluent.
Fish and Wildlife Habitat	Possible impacts depending on changes in volume of effluent and locations of recycled water projects.
Cultural Resources	No impact anticipated.
Threatened and Endangered Species	Possible impacts depending on project location and habitat requirements for listed species.
Comments	Assumes needed infrastructure will be in urbanized areas.

A potential positive effect of the Direct Recycle Program WMS is the potential reduced need for additional groundwater and/or surface water projects that may have greater negative environmental effects through aquifer or stream withdrawals and additional transmission pipelines.

5.2.4.5 Engineering and Costing

The required improvements to implement a recycled water program would be expected to vary considerably between entities based on the upgrades required both in treatment and distribution. Therefore, cost estimates received from participating entities were used when available. While recent reuse reports and costs were obtained for future development from The City of Kyle[4], New Braunfels[5], and San Marcos[6], the reports did not calculate costs for 2070 conditions. The projected project costs and reclaimed water demands in the available reports were updated to September 2013 values and used to develop a unit cost per acft of reuse supply which was then applied to 2070 demands (Table 5.2.4-11). An interest rate of 5.5 percent was assumed for a debt service of 20 years.

While a report from SARA was not readily available, communications[7] with SARA indicated that their most recent direct reuse project had a $1,500 acft/yr unit cost including annual debt service, O&M costs and water charges. SAWS currently has a reuse system in place with a similar capacity to the expected expansion. Costs from the existing system were updated to September 2013 dollars and applied to the planned expansion. Project, annual and unit costs can be found in Table 5.2.4-11 along with expected capacity.

No current information was available for costing the CCMA future reuse system so general cost estimates were used for varying recycled water scenarios as described in Table 5.2.4-6. To provide more flexibility in the types of recycled water applications possible, CCMA was assumed to have a Type 1 wastewater effluent.

Table 5.2.4-6 Recycled Water Scenarios

Scenario #	***Treatment***	***Distribution***
1	Existing WWTP is achieving treatment that meets the Type 1 effluent requirements. Treatment upgrade includes only the addition of chlorine for distribution.	Treated wastewater is supplied to demand location(s) from central WWTP by addition of piping and pump station.
2	Existing WWTP is nearly achieving treatment that meets the Type 1 effluent requirements. Treatment upgrade includes tertiary treatment and chlorine.	Treated wastewater is supplied to demand location(s) from central WWTP by addition of piping and pump station.

Scenarios 1 and 2 include central storage at the wastewater plant with recycled water delivered to demand location on an as needed basis. An alternate delivery option not included here is a more decentralized recycled water system with storage located at the point of use. Providing storage at the point of use may decrease required pipeline and

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[4] "Kyle Direct Water Reuse Feasibility Study.", RPS Espey. Prepared for TWDB. December 7th,2012.

[5] "Parks Reclaimed Water Irrigation Feasibility Study.", Espey Consultants, Inc. Prepared for City of New Braunfels. July 2011.

[6] " Direct Water Reuse Expansion Feasibility Study.", RPS. Prepared for The City of San Marcos and Texas State University. September 2013.

[7] Email. Raabe, Steve. March 6th, 2015.

pump station size because the water can be transported at a more uniform rate to fill storage tanks at the point of use. However, installation of storage tanks at the point of use may be problematic in highly urbanized areas or undesirable near high public use areas.

Cost estimates were developed for each of these scenarios with required facilities for each scenario shown in Table 5.2.4-6. The demand for recycled water used for irrigation of golf courses, parks, schools, crops, or other landscapes will vary seasonally. For planning purposes the application rates in Table 5.2.4-7 are assumed to determine the available project yield for varying sizes of recycled water facilities. Recycled water facilities are sized for the peak usage periods, and consequently, the average annual rate of usage may be considerably lower than the peak usage. For a recycled water system with typical application rates, as shown in Table 5.2.4-8, the annual available project yield is 57 percent of the recycled water system capacity. Available project yield may be higher than 57 percent of maximum capacity for systems supplying a large portion of the recycled water to industrial or other users that have a more uniform recycled water demand.

Table 5.2.4-7 Recycled Water Scenarios 1 and 2 Required Distribution Facilities

Facility	Maximum Capacity (MGD)				Description
	0.5	1	5	10	
Pump Station, HP	127	248	1,209	2,332	Capacity to deliver maximum daily demand in 6 hours
Storage Tank, MG	0.5	1	5	10	Store one days treated recycled water at WWTP
Pipeline, Size in Inches (Length in Miles)	12 (2)	16 (2)	33 (3) 18 (2) 12 (1)	48 (4) 18 (3) 12 (2)	Capacity to deliver maximum daily demand in 6 hours
Available Project Yield, acft/yr (MGD)	319 (0.28)	638 (0.57)	3,193 (2.85)	6,385 (5.7)	Yield is 57 percent of maximum treatment capacity based on seasonal use shown in Table 4C.5-10

Table 5.2.4-8 Recycled Water Application Rate

Use Level	Application Rate	Duration
Peak	1.25 in/week	4 months
Normal	0.75 in/week	3 months
Below Normal	0.25 in/week	5 months
Average	0.71 in/week	weighted
Average/Peak	0.71 / 1.25 = 0.57	

Irrigation water for landscapes such as golf courses and parks will generally be applied during periods when these areas are not being utilized, typically at night. Therefore, the distribution facilities are sized to deliver the total daily demand in a six-hour period. Pumping facilities are sized to provide a residual pressure of 60 psi at the delivery point. Table 5.2.4-9 and Table 5.2.4-10 show the total project capital costs and total operations and maintenance costs for recycled water supplies, respectively. These costs are for general planning purposes and will vary significantly depending on the specific circumstances of an individual water user group.

Table 5.2.4-9 General Recycled Water Total Project Capital Cost ($ per acft)

Scenario	Capacity (MGD)			
	0.5	1	5	10
1	$1,047	$770	$564	$502
2	$2,144	$1,440	$775	$631

Table 5.2.4-10 General Recycled Water Total Operations and Maintenance Cost ($ per acft)

Scenario	Maximum Capacity (MGD)			
	0.5	1	5	10
1	$191	$163	$110	$96
2	$837	$545	$230	$167

CCMA is projected to develop 24MGD of direct recycled water supply by 2070; therefore, a unit cost of $502 was applied using a conservative estimate and Table 5.2.4-9. The projected project annual and Unit cost for CCMA compared to the other reuse strategies is presented in Table 5.2.4-11.

Table 5.2.4-11 Costs for Reuse Projects

Entity	Capacity (acft)	Project Costs	Annual Costs	Unit Costs ($/acft)
CCMA	27,270	$163,595,239	$13,689,540	$502
Kyle	4,368	$37,074,649	$3,102,382	$710
New Braunfels	11,709	$67,279,580	$5,629,910	$481
San Marcos	8,341	$86,664,302	$7,252,011	$869
SARA	6,075	$108,897,000	$9,112,000	$1,500
SAWS	40,000	$170,830,000	$18,316,000	$458

5.2.4.6 Implementation Issues

This water supply option has been compared to the plan development criteria, as shown in Table 5.2.4-12, and the option meets each criterion. Each community that pursues recycled water will need to investigate concerns that would include at a minimum:

- Amount of treated effluent available, taking into consideration downstream water commitments and discharge permit restrictions.
- Potential users, primarily individual large-scale users that could utilize non-potable water (e.g., certain industries) and irrigated lands (e.g., golf courses and park areas).
- Capital costs of constructing needed distribution systems connecting the treatment facilities to the areas of recycled water.

Recycled water requires a TCEQ permit. Requirements specific to pipelines needed to link wastewater treatment facilities to recycled water customers may include:

- U.S. Army Corps of Engineers Section 404 permit(s) for pipeline stream crossings; discharges of fill into wetlands and waters of the United States for construction; and other activities;
- TPDES Storm Water Pollution Prevention Plan; and
- TPWD Sand, Shell, Gravel and Marl permit for construction in state-owned streambeds.

Table 5.2.4-12 Comparison of General Recycled Water Option to Plan Development Criteria

Impact Category	***Comment(s)***
A. Water Supply	
1. Quantity	1. Potentially important source, up to 25 percent of demand
2. Reliability	2. High reliability
3. Cost	3. Reasonable
B. Environmental factors	
1. Environmental Water Needs	1. Produces instream flows—low to moderate impact
2. Habitat	2. Possible low impact
3. Cultural Resources	3. None or low impact
4. Bays and Estuaries	4. None or low impact
5. Threatened and Endangered Species	5. Possible impact
6. Wetlands	6. None or low impact
C. Impact on Other State Water Resources	No apparent negative impacts on state water resources; benefit accrues to demand centers by more efficient use of available water supplies; no effect on navigation
D. Threats to Agriculture and Natural Resources	Generally positive effect to agriculture and natural resources by avoiding need for new supplies
E. Equitable Comparison of Strategies Deemed Feasible	Option is considered to meet municipal and industrial shortages
F. Requirements for Inter-basin Transfers	Not applicable
G. Third Party Social and Economic Impacts from Voluntary Redistribution	Could offset the need for voluntary redistribution of other supplies

5.2.5 Edwards Aquifer Habitat Conservation Plan

5.2.5.1 Description of Water Management Strategy

Pursuant to Senate Bill 3 of the 80th Texas Legislature, the Edwards Aquifer Recovery Implementation Program (EARIP) was established, in part, to facilitate development of an Edwards Aquifer Habitat Conservation Plan (EAHCP)[1]. The EAHCP was approved by the U.S. Fish & Wildlife Service (USFWS) in early 2013 resulting in the issuance of an Incidental Take Permit (ITP) based on implementation of the EAHCP. Recognizing that implementation of the EAHCP is an ongoing, phased process, the SCTRWPG approved the following recommendations during its meeting of March 14, 2013:

> *"The Edwards Aquifer Habitat Conservation Plan (EAHCP) Workgroup recommends that the South Central Texas Regional Water Planning Group include the EAHCP as a recommended Water Management Strategy in the 2016 South Central Texas Regional Water Plan and use the spring flows associated with EAHCP implementation as an hydrologic modeling assumption for computation of existing surface water supplies and technical evaluation of water management strategies. The EAHCP Workgroup further recommends that existing water supplies from the Edwards Aquifer in the 2016 South Central Texas Regional Water Plan be those associated with EAHCP implementation and in specific amounts to be determined in consultation with the Edwards Aquifer Authority."*

Hence, the EAHCP may be described as a water management strategy in implementation in the 2016 South Central Texas Regional Water Plan (SCTRWP). More specifically, this means that the EAHCP is: a) a recommended water management strategy potentially eligible for funding through Texas Water Development Board (TWDB) programs; and b) assumed to be fully implemented with respect to calculation of existing firm water supplies from the Edwards Aquifer and surface water rights below the springs as well as in the technical evaluation of other potentially feasible water management strategies.

5.2.5.2 Available Yield

Senate Bill 3 of the 80th Texas Legislature (SB3) established a maximum annual amount of permitted withdrawals from the Edwards Aquifer of 572,000 acft/yr, specific critical period withdrawal reductions with associated triggers, and the EARIP. The EARIP established springflow magnitude and frequency minima deemed adequate for protection of selected species and described springflow protection measures[2] to be implemented that would meet these minima in a repeat of the drought of record. The four springflow protection measures established in the EARIP and included in the EAHCP that affect water supply are summarized as follows:

[1] RECON Environmental, Inc., Hicks & Company, Zara Environmental LLC, & BIO-WEST, "Edwards Aquifer Recovery Implementation Program Habitat Conservation Plan," Edwards Aquifer Recovery Implementation Program, November 2012

[2] HDR Engineering, Inc., Todd Engineers, & Westward Environmental, Inc., "Evaluation of Water Management Programs and Alternatives for Springflow Protection of Endangered Species at Comal and San Marcos Springs," Edwards Aquifer Recovery Implementation Program, October 2011 (Appendix K of the EAHCP).

1. Voluntary Irrigation Suspension Program (VISPO) – VISPO is a voluntary program open to participation by eligible holders of irrigation water rights issued by the Edwards Aquifer Authority (EAA) who are willing to suspend withdrawals under certain conditions in exchange for financial compensation. Withdrawal suspensions are triggered on January 1 of any year if the water level measured at J-17 (Bexar County monitoring well) was below 635 ft-msl on October 1 of the previous year. The volume goal for the VISPO program in the EAHCP is 40,000 acft/yr, however, enrollment reached 40,951 acft/yr in 2014.
2. Municipal Conservation – Conservation measures include toilet retrofit, replacement of inefficient fixtures, leak detection and repair, large-scale retrofit, and landscape watering savings with a volume reduction goal of 10,067 acft/yr in Edwards Aquifer pumping for municipal uses during non-critical periods.
3. SAWS ASR with Trade-Off – This measure includes tiered acquisition of up to 50,000 acft/yr in irrigation leases to be idled or stored in the existing San Antonio Water System (SAWS) Aquifer Storage & Recovery (ASR) facility for episodic recovery during severe drought to offset SAWS Edwards withdrawals. As of late 2014, only 6,203 acft/yr (37 percent) of the 16,667 acft/yr Tier 1 target volume has been leased.
4. Critical Period Stage V – This measure involves an additional emergency critical period stage including withdrawal reductions of 44 percent from the Initial Regular Permit (IRP) amounts when J-17 falls below 625 ft-msl for the San Antonio pool or J-27 (Uvalde County monitoring well) falls below 840 ft-msl for the Uvalde pool. The EAA has adopted rules implementing this measure.

Accounting for these four key components of the EAHCP in consultation with the EAA results in an existing supply from the Edwards Aquifer of approximately 295,600 acft/yr (including exempt federal and domestic & livestock production) to be used for the 2016 SCTRWP.

Enhanced firm supply from the Edwards Aquifer as a result of EAHCP implementation may be approximated as 50,600 acft/yr by comparison of 295,600 acft/yr to the estimated firm yield of 245,000 acft/yr based on fixed annual withdrawals and a minimum monthly average Comal Springs discharge of 25 cfs interpolated from simulations performed for the EARIP Expert Science Subcommittee by the EAA.[3] Simulated Comal and San Marcos Springs discharges during the drought of record with implementation of the EAHCP exceed 25 cfs and 50 cfs, respectively, and are presented in Chapter 6 (Volume I).

Incremental enhancements to surface water supply during severe drought are also associated with implementation of the EAHCP and concomitant increases in springflow. These enhancements were quantified on a minimum annual diversion basis using the Guadalupe – San Antonio River Basin Water Availability Model (GSA WAM) as part of the EARIP. Increases in minimum annual diversion reported in the EARIP[4] total about

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[3] Edwards Aquifer Area Expert Science Subcommittee, “Analysis of Species Requirements in Relation to Spring Discharge Rates and Associated Withdrawal Reductions and Stages for Critical Period Management of the Edwards Aquifer,” Edwards Aquifer Recovery Implementation Program, December 28, 2009.

[4] Op. cit., HDR Engineering, et al., October 2011.

21,500 acft/yr with about 15,600 acft/yr, 2,700 acft/yr, and 3,200 acft/yr of that total being attributable to municipal, steam-electric/industrial, and irrigation uses, respectively.

5.2.5.3 Environmental Issues

Implementation of the EAHCP would result in the maintenance of continuous springflow during a repeat of the drought of record thereby providing significant protection to eight species federally listed as threatened or endangered. These species include fountain darter, San Marcos salamander, San Marco gambusia, Texas blind salamander, Peck's cave amphipod, Comal Springs dryopid beetle, Comal Spring riffle beetle, and Texas wild rice. Importantly, this protection could be accomplished without construction of new water supply facilities.

5.2.5.4 Engineering and Costing

Estimated annualized implementation costs are summarized in Table 7.1 of the EAHCP and average $17,460,530/yr. These costs include both the springflow protection measures described in Chapter 5.2.5.2 and other measures to reduce the impacts of drought and recreation and enhance the viability of the listed species. Based on an approximate enhanced firm supply from the Edwards Aquifer of 50,600 acft/yr, the annual unit cost of the EAHCP water management strategy is $345/acft/yr.

5.2.5.5 Implementation Issues

Significant progress in implementation of the EAHCP has been made to-date, as documented in the 2014 Annual Report.[5] With respect to regional water planning and springflow protection, recommendations in the 2014 Annual Report indicate that limited participation in the SAWS ASR and Trade-Off measure is an important implementation issue.

[5] Blanton & Associates, Inc., "Edwards Aquifer Habitat Conservation Plan 2014 Annual Report," Edwards Aquifer Habitat Conservation Plan Permittees, Submitted to the U.S. Fish & Wildlife Service March 13, 2015.

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5.2.6 Edwards Transfers

5.2.6.1 Description of Water Management Strategy

The Edwards Aquifer Authority (EAA) was created in 1993 by Senate Bill 1477 of the 73rd Texas Legislature. This bill, which is typically called The Edwards Aquifer Authority Act (The Act), has been amended many times in subsequent legislative sessions. Requirements of the EAA pursuant to The Act include:

a. Issuing permits for all non-exempt wells;

b. Limiting permitted withdrawals to 572,000 acft/yr; and

c. Enforcing water management practices, procedures, and methods to ensure that the continuous minimum springflows of the Comal Springs and the San Marcos Springs are maintained to protect endangered and threatened species to the extent required by federal law (e.g. the Edwards Aquifer Habitat Conservation Plan, EAA critical period rules, etc.).

Since the EAA began to issue Initial Regular Permits (IRPs) for wells, there have been numerous transfers of the water rights associated with these permits among willing buyers and willing sellers. Subject to requirements in The Act and EAA rules related to the base and unrestricted portions of water rights associated with irrigated agriculture, many historical transfers have been from irrigation to municipal use. The Edwards Transfers water management strategy in the 2016 South Central Texas Regional Water Plan (SCTRWP) focuses on the future of such irrigation to municipal transfers as implementation of the Edwards Aquifer Habitat Conservation Plan (EAHCP) described in Chapter 5.2.5 continues.

5.2.6.2 Available Yield

Section 1.15 of The Act provides that the EAA shall manage withdrawals and points of withdrawal from the aquifer by granting permits, and Section 1.34 of The Act specifies the manner in which water rights may be transferred as follows:

a. Water withdrawn from the aquifer must be used within the boundaries of the authority.

b. The authority by rule may establish a procedure by which a person who installs water conservation equipment may sell the water conserved.

c. A permit holder may lease permitted water rights, but a holder of a permit for irrigation use may not lease more than 50 percent of the irrigation water rights initially permitted. The user's remaining irrigation water rights must be used in accordance with the original permit and must pass with transfer of the irrigated land.

In accordance with these and many other provisions of The Act, the EAA has issued Initial Regular Permits (IRPs) for municipal, industrial, and irrigation water use totaling 571,600 acft/yr. Table 5.2.6-1, Column E includes a summary of the geographical and use allocations of these IRPs as of March 22, 2013 and prior to any transfers associated with implementation of the EAHCP. Some years ago, the EAA provided an early summary of permits (totaling 574,234 acft/yr) that is believed to represent geographical and use allocations prior to any transfers (Table 5.2.6-1, Column C). Based on that early summary, unrestricted transfer potential from the irrigation use sector totaled 113,212 acft/yr (Table 5.2.6-1, Column D). Comparing the early and March 22, 2013 permit summaries, it is apparent that about 120,000 acft/yr were transferred to the municipal use sector from the irrigation and industrial use sectors prior to any implementation of the EAHCP (Table 5.2.6-1, Column F). Accounting for to-date and targeted transfers under the EAHCP (Table 5.2.6-1, Columns G-J) and assuming that planned future EAHCP ASR leases will come from unrestricted irrigation, reveals that there will be effectively no remaining unrestricted transfer potential in the irrigation use sector after full implementation of the EAHCP (Table 5.2.6-1, Column K). Therefore, it is anticipated that all recommended Edwards Transfers shown as part of this water management strategy will involve leasing or purchasing Edwards Aquifer rights from major municipal permit holders with surplus supplies.

In the 2016 SCTRWP, Edwards Transfers are included to meet projected needs of 16 municipal water user groups that are currently wholly or largely dependent on the Edwards Aquifer for water supply. Water user groups for which Edwards Transfers are recommended are shown in Table 5.2.6-2 along with their projected needs for additional water supply. In total, these needs grow from 5,972 acft/yr in 2020 to 11,772 acft/yr in 2070. The IRP value of permits needed to obtain these quantities of firm yield increase from 10,179 acft/yr in 2020 to 20,065 acft/yr in 2070.

Table 5.2.6-1 Historical Edwards Transfers, the EAHCP, and Remaining Unrestricted Transfer Potential

A	B	C	D	E	F	G	H	I	J	K
County	*Use Type*	*EAA Initial Estimated Permits (acft/yr)*[1]	*Unrestricted Transfer Potential (acft/yr)*[2]	*EAA Current Regular Permits w/o EAHCP Transfers (acft/yr)*[3]	*Apparent Non-EAHCP Transfers (acft/yr)*[4]	*EAHCP VISPO Base Transfers To-Date (acft/yr)*[5]	*EAHCP VISPO Unrestricted Transfers To-Date (acft/yr)*[6]	*EAHCP ASR Leases To-Date (acft/yr)*[7]	*Planned Future EAHCP ASR Leases (acft/yr)*[8]	*Remaining Unrestricted Transfer Potential (acft/yr)*[9]
Atascosa	Municipal	259	259	259	0					
	Industrial	0	0	0	0					
	Irrigation	2,897	1,449	2,143	(754)	(354)	0	(72)	(693)	(71)
	Subtotal	**3,156**	**1,708**	**2,402**	**(754)**					
Bexar	Municipal	212,006	212,006	320,535	108,529					
	Industrial	55,942	55,942	21,140	(34,802)					
	Irrigation	35,137	17,569	22,902	(12,235)	(2,280)	(177)	(602)	(5,773)	(1,219)
	Subtotal	**303,085**	**285,517**	**364,577**	**61,492**					
Comal	Municipal	8,930	8,930	13,364	4,434					
	Industrial	10,227	10,227	10,436	209					
	Irrigation	1,195	598	843	(352)	0	0	(22)	(208)	16
	Subtotal	**20,352**	**19,755**	**24,643**	**4,291**					
Guadalupe	Municipal	0	0	186	186					
	Industrial	253	253	96	(157)					
	Irrigation	0	0	0	0	0	0	0	0	0
	Subtotal	**253**	**253**	**282**	**29**					
Hays	Municipal	7,265	7,265	9,673	2,408					
	Industrial	2,959	2,959	761	(2,198)					
	Irrigation	845	423	704	(141)	(67)	(57)	(17)	(162)	46
	Subtotal	**11,069**	**10,647**	**11,138**	**69**					
Medina	Municipal	6,126	6,126	9,254	3,128					
	Industrial	1,258	1,258	4,293	3,035					
	Irrigation	88,720	44,360	65,302	(23,418)	(9,072)	(2,454)	(1,694)	(16,257)	537
	Subtotal	**96,104**	**51,744**	**78,849**	**(17,255)**					
Uvalde	Municipal	4,626	4,626	6,061	1,435					
	Industrial	1,959	1,959	516	(1,443)					
	Irrigation	133,630	66,815	83,132	(50,498)	(18,715)	(7,776)	(2,313)	(22,187)	(15,959)
	Subtotal	**140,215**	**73,400**	**89,709**	**(50,506)**					
Edwards Aquifer Area Totals										
	Municipal	**239,212**	**239,212**	**359,332**	**120,120**					
	Industrial	**72,598**	**72,598**	**37,242**	**(35,356)**					
	Irrigation	**262,424**	**131,212**	**175,026**	**(87,398)**	**(30,488)**	**(10,464)**	**(4,720)**	**(45,280)**	**(16,650)**
	Subtotal	**574,234**	**443,022**	**571,600**	**(2,634)**					

Notes:
1. EAA estimated permit values before any transfers.
2. Calculated at 50% of irrigation permits and 100% of municipal and industrial permits.
3. Initial regular permit values as of March 22, 2013. These values account for transfers that have taken place since the initial estimated permit values were provided. EAHCP transfers are not included in these values.
4. Calculated as EAA Current Regular Permits minus EAA Initial Estimated Permits. Negative values indicate a net transfer from that use while a positive value indicates net transfers to that use.
5. Transfers from base permits associated with the EAHCP VISPO through October 7, 2014.
6. Transfers from unrestricted permits associated with the EAHCP VISPO through October 7, 2014. These transfers are included in the Remaining Unrestricted Transfer Potential calculations.
7. EAHCP ASR transfers through December 31, 2013. These transfers are from the unrestricted transfer potential and are included in the Remaining Unrestricted Transfer Potential calculations.
8. Planned future transfers associated with EAHCP ASR. Transfers to date plus planned transfers equal 50,000 acft. These transfers will be from the unrestricted transfer potential and are included in the Remaining Unrestricted Transfer Potential calculations.

Table 5.2.6-2 Firm Supply from Edwards Transfers

Entity	County	Firm Supply from Edwards Transfers by Decade 2020 (acft/yr)	2030 (acft/yr)	2040 (acft/yr)	2050 (acft/yr)	2060 (acft/yr)	2070 (acft/yr)
Lytle	Atascosa	171	257	333	409	484	554
Subtotal		171	257	333	409	484	554
Alamo Heights	Bexar	796	848	820	807	805	805
Atascosa Rural WSC	Bexar	1,167	1,446	1,708	1,970	2,218	2,448
Converse	Bexar	903	1,111	1,297	1,272	1,265	1,264
Kirby	Bexar	137	207	181	172	169	169
Leon Valley	Bexar	97	147	196	254	317	377
Shavano Park	Bexar	425	555	677	797	909	1,013
Windcrest	Bexar	326	343	361	388	420	451
Subtotal		3,851	4,657	5,240	5,660	6,103	6,527
Castroville	Medina	224	217	210	208	211	214
East Medina SUD	Medina	0	0	0	0	11	70
Hondo	Medina	523	680	816	943	1,068	1,180
La Coste	Medina	10	20	28	37	47	56
Natalia	Medina	101	129	153	176	199	220
Yancey WSC	Medina	28	95	154	208	261	309
Subtotal		886	1,141	1,361	1,572	1,797	2,049
Sabinal	Uvalde	121	153	181	212	245	277
Uvalde	Uvalde	943	1,233	1,484	1,772	2,072	2,365
Subtotal		1,064	1,386	1,665	1,984	2,317	2,642
TOTAL Firm Supply		**5,972**	**7,441**	**8,599**	**9,625**	**10,701**	**11,772**
IRP Value Permits Needed*		10,179	12,683	14,657	16,405	18,239	20,065

** Assumes that the IRP amount will be reduced by 41.33% to arrive at a firm supply volume. This is equal to 8 months with a 40% reduction (Stage IV) and 4 months with a 44% reduction (Stage V).*

5.2.6.3 Environmental Issues

There are no major environmental issues associated with this strategy. The transferred water that will be withdrawn from the aquifer is already permitted and only the locations of withdrawals will be changed. As the recommended transfers will generally be from central or eastern urban areas to central or western rural (or suburban) areas, withdrawal centers will be somewhat further from Comal and San Marcos Springs which could result in incremental springflow enhancement. If some Edwards Transfers do come from the irrigation sector, an associated concern would be conversion of irrigated land to dryland crops and/or grassland. A program of converting cropland to native grasses could speed the process of reaching a mature plant community and reduce the opportunity for soil erosion through water and winds. Such a program could provide habitat for native Texas wildlife, including the horned toad, tortoises, deer, hawks, and other desert grassland species. No impacts to cultural resources are anticipated since this strategy does not involve construction.

5.2.6.4 Engineering and Costing

Pursuant to February 6, 2014 discussions with the SCTRWPG, it is assumed for planning purposes that the cost of Edwards Transfers is estimated as the average unit cost of firm, non-Edwards water management strategies recommended for SAWS, New Braunfels Utilities (NBU), and San Marcos plus integration costs ($226/acft/yr) for facility upgrades. In other words, the cost for these transfers is based upon the “replacement cost” of water (i.e., what would it cost a large municipality to construct and operate a project or projects to replace the Edwards water leased to other municipalities). Hence, the assumed unit cost for Edwards Transfers is $1415/acft/yr. Multiplying the projected needs of each water user group for which Edwards Transfers is recommended by $1415/acft/yr results in the estimated annual costs summarized by decade in Table 5.2.6-3.

Table 5.2.6-3 Annual Costs for Edwards Transfers

Entity	County	Annual Cost for Edwards Transfers by Decade** 2020 (acft/yr)	2030 (acft/yr)	2040 (acft/yr)	2050 (acft/yr)	2060 (acft/yr)	2070 (acft/yr)
Lytle	Atascosa	$242,043	$363,772	$471,346	$578,921	$685,080	$784,162
Alamo Heights	Bexar	$1,126,702	$1,200,305	$1,160,673	$1,142,272	$1,139,441	$1,139,441
Atascosa Rural WSC	Bexar	$1,651,835	$2,046,747	$2,417,596	$2,788,445	$3,139,478	$3,465,033
Converse	Bexar	$1,278,155	$1,572,570	$1,835,845	$1,800,458	$1,790,550	$1,789,135
Kirby	Bexar	$193,917	$292,999	$256,197	$243,458	$239,212	$239,212
Leon Valley	Bexar	$137,299	$208,072	$277,429	$359,525	$448,699	$533,626
Shavano Park	Bexar	$601,568	$785,577	$958,263	$1,128,117	$1,286,648	$1,433,855
Windcrest	Bexar	$461,438	$485,501	$510,979	$549,196	$594,491	$638,370
Castroville	Medina	$317,062	$307,154	$297,245	$294,415	$298,661	$302,907
East Medina SUD	Medina	$0	$0	$0	$0	$15,570	$99,082
Hondo	Medina	$740,283	$962,509	$1,155,011	$1,334,774	$1,511,705	$1,670,236
La Coste	Medina	$14,155	$28,309	$39,633	$52,372	$66,526	$79,265
Natalia	Medina	$142,961	$182,594	$216,565	$249,120	$281,675	$311,400
Yancey WSC	Medina	$39,633	$134,468	$217,980	$294,415	$369,434	$437,375
Sabinal	Uvalde	$171,270	$216,565	$256,197	$300,076	$346,786	$392,081
Uvalde	Uvalde	$1,334,774	$1,745,255	$2,100,535	$2,508,185	$2,932,822	$3,347,550
TOTAL Annual Cost		**$8,453,095**	**$10,532,397**	**$12,171,494**	**$13,623,750**	**$15,146,779**	**$16,662,731**
		** SCTRWPG (2/6/2014) - Costs for Edwards Transfers shall be estimated as the average unit cost of firm, non-Edwards water management strategies recommended for SAWS, NBU, and San Marcos (plus integration costs for facility upgrades at $226/acft/yr) times the total firm supply needed.					

5.2.6.5 Implementation Issues

Leasing and purchase of Edwards Aquifer irrigation rights for transfer to municipal and industrial uses are active at the present time. As the existing Edwards Aquifer supply used to quantify needs reported in the 2016 SCTRWP is based on the assumption of full EAHCP implementation, it is assumed that most future Edwards Transfers for non-EAHCP purposes will not be completed as unrestricted transfers from irrigation. Hence, the only remaining transfers available could be leases from municipal users with surplus supplies. The key implementation issues for the Edwards Transfers strategy are expected to be:

a. Willingness of large municipalities to sell or lease Edwards supplies for use by other municipalities (even at replacement cost); and

b. Willingness of rural or suburban communities to buy or lease Edwards supplies at costs substantially greater than previously experienced.

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5.2.7 Local Groundwater

5.2.7.1 Description of Water Management Strategy

Many water utilities for municipalities, Water Supply Corporations (WSC), and Special Utility Districts (SUD), called a Water User Group (WUG), in the South Central Texas Water Planning Region commonly use the local aquifers for their supply. Where local groundwater supplies are available, these utilities have a strong preference for local groundwater because it is: (1) usually readily available at different locations within their distribution system, (2) relatively inexpensive, and (3) often requires minimal treatment. Local groundwater supplies are also used for County-Other and Mining categories.

The purposes of this study for WUGs are to:

- Evaluate aquifers and existing well field(s) for each WUGs as to their ability to meet projected water supply requirements through 2070 in consideration of groundwater supply as estimated by the Modeled Available Groundwater (MAG) and reported well capacity.
- If additional supplies are needed for a WUG, recommend either: (1) identify whether additional wells in the currently used aquifer(s) are the most likely water management strategy, (2) identify alternative aquifers if there is no additional groundwater availability in the current aquifer(s), (3) determine if groundwater permit conversions (typically from irrigation or mining use to municipal use) is possible, or (4) purchase from a wholesale water provider, is recommended.
- If additional wells are needed, identify a reconnaissance level location for new well(s) and cost for system expansion.

The purposes of this study for county-other and mining are to:

- Evaluate aquifers and county-wide estimates of total County-Other and total Mining system capacities as to their ability to meet projected water supply requirements through 2070.
- If additional supplies are needed, prepare a county-wide estimate of target aquifers, number new well(s), and total cost for new or system expansions

The evaluation of Local Groundwater Water Management strategies for each WUG is at a reconnaissance level includes the following steps:

- Compile information prepared for the South Central Texas Regional Water Planning Group on current and TWDB's projected populations and water demands for each of the WUGs.
- Estimate system capacity for each WUG through 2070 by using TCEQ reported system information.
- Compile and summarize publicly available information for each water utility from TCEQ and TWDB.

- If the estimated groundwater supply after adjustments was greater than the estimated required capacity in 2070, the evaluation concludes that the existing water supply is adequate for the planning period.
- If the estimated supply after adjustments was less than the estimated required capacity in the year 2070, the evaluation concluded that an additional water supply is needed during the planning period.
- If new wells are the most feasible water management strategy, identify the target aquifer and estimate when new wells are needed and the cost of adding the new wells to the water system.

The evaluation of Local Groundwater Water Management strategies for County-Other and Mining is similar to WUGs except the evaluation is preformed at a county-wide level instead of at a WUG level.

The selected approach in developing plans for water utilities, county-other and mining that show a projected shortage includes: (1) a reviewing demands and supplies, (2) estimating when shortages occur, (3) preparing reconnaissance level designs, and (4) estimating cost for new wells and associated improvements. It's assumed that water utilities, county-other, and mining that do not have a shortage will continue to utilize the local groundwater supply with their existing wells.

For water utilities entities with shortages, TCEQ water utility data sheets were studied to provide information on the number, depth, and reported capacity of existing wells. This information provided guidance for costing purposes. For the reconnaissance level design, a water demand peaking factor of 2.0 times the average annual water use was used. The pipeline requirements to connect the new wells to a main pipeline within the distribution system was assumed to be one-half mile per well. Other costs such as storage and pump stations are included in a system improvement cost of $200,000 per MGD of peak capacity. For the purposes of estimating well pumping power costs, a total dynamic head is estimated on a case by case basis. An assessment of likely treatment requirements and cost is based on typical water quality data and water treatment requirements in the vicinity of each utility. Land cost for cities is estimated at $20,000 per site. Land cost for WSC and SUDs is based on rural appraisal estimates.

For counties with County-Other shortages, the following assumptions were made:

- The shortages for public water supplies (public facilities such as parks, rural retail centers, and small water utilities) and non-public supplies (rural domestic and landscape irrigation) were distributed on a 25% and 75%, respectively.
- Pumping capacity for public supplies wells were 50 gallons per minute (gpm) and non-public supply wells were 25 gpm.
- Well construction standards vary between public and non-public well use.
- A peaking factor of 2.0 is used.
- System improvements were $5,000 per well.
- Water treatment cost is applied only for water being used for public drinking water.

- Facilities would be constructed on land owned by the entities.
- Power cost is calculated from an estimate of a typical water lift for small wells in the county.

For counties with Mining shortages, the following assumptions were made:

- Pumping capacity is 150 (gpm).
- Well construction standards are consistent with non-potable wells.
- A peaking factor of 2.0 is used.
- System improvements were $5,000 per well.
- No water treatment cost is included.
- Facilities would be constructed on land owned under lease by the operators.
- Power cost is calculated from an estimate of a typical water lift for medium size wells in the county.

All cost estimates were performed by using the 2016 Regional Water Planning criteria. These criteria include estimating the project cost as of September 2013 and amortizing the debt at a 5.5 percent interest rate over a 20-year period. Following the criteria, all wells costs were estimated as of September 2013, even if they are not scheduled to be needed until some time in the future.

5.2.7.2 Carrizo Wilcox Aquifer

The following WUGs utilize the Carrizo-Wilcox Aquifer and are expected to have a water shortage by 2070:

- Asherton
- Benton City WSC
- Carrizo Springs
- Cotulla
- Floresville
- Karnes City (Carrizo/Yegua Jackson)
- Pearsall
- Polonia WSC
- Sunko WSC
- Gonzales
- Gonzales County WSC

Figure 5.2.7 1 shows the general location of these water utilities with projected needs to be met from Local Carrizo-Wilcox Aquifer wells. Table 5.2.7-1 presents the projected needs and number of new wells, by decade, and the capital cost, project cost (including land acquisition, environmental, permitting, and mitigation) for each of these entities as if there is a surplus of groundwater availability. However, in some counties, the TWDB

Modeled Available Groundwater (MAG) is fully committed for the Carrizo-Wilcox Aquifer based on exempt use, existing supplies, and existing permits. Thus, the project yield is set to zero and the annual cost and unit cost are not applicable (N/A) for local supplies coming from the Carrizo-Wilcox Aquifer. As an alternative and if one assumes there is groundwater availability in the Carrizo-Wilcox, Table 5.2.7-2 provides a project yield, annual cost, and unit cost for these water utilities.

This strategy does not include: (1) expenses attributed to regional water level declines that may cause the system operators to lower pumps and to replace old wells, (2) potentially needing to treat the water for high iron and manganese concentrations, and (3) potentially cooling water from deep wells. Disinfection water treatment was included.

Figure 5.2.7-1. Local Carrizo-Wilcox Aquifer Projects

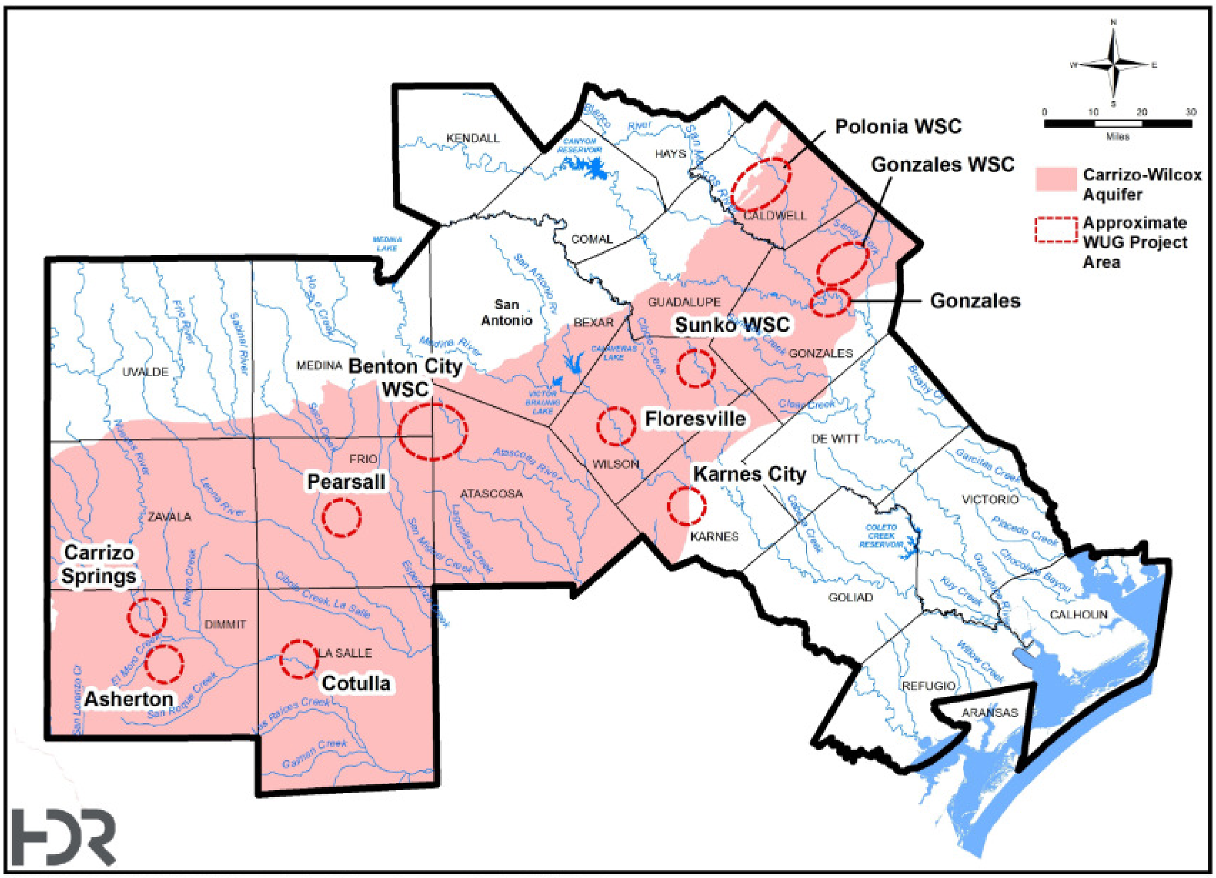

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Table 5.2.7-1 Summary of Schedule and Cost for Local Groundwater Management Strategies for Water User Groups

County	User	Aquifer		Needs						Total Wells	Total Capital Cost	Total Project Cost	Total Annual Cost	Available Project Yield	Annual Unit Cost ($/ac-ft)	Annual Non- Debt Unit Cost($/acft)	Annual Unit Cost ($/1,000 gal)
				2020	2030	2040	2050	2060	2070								
Atascosa	Benton City WSC	Carrizo-Wilcox	Projected Needs	0	0	0	0	0	25	1	$430,000	$659,000	$88,000	0	N/A	N/A	N/A
			New Wells						1								
			Total Wells						1								
Caldwell	Polonica WSC	Carrizo-Wilcox	Projected Needs	0	0	0	88	266	442	2	$1,178,000	$1,683,000	$276,000	0	N/A	N/A	N/A
			New Wells				1		1								
			Total Wells				1	1	2								
Comal	Garden Ridge	Trinity	Projected Needs	1,023	1,599	2,188	2,786	3,383	3,957	8	$8,398,000	$12,186,000	$1,346,000	2,000	$1,346	$326	$4.13
			Local Groundwater	2,000	2,000	2,000	2,000	2,000	2,000								
			Remaining Needs	-977	-401	188	786	1,383	1,957								
			New Wells	8													
			Total Wells	8	8	8	8	8	8								
Dimmit	Asherton	Carrizo-Wilcox	Projected Needs	28	46	61	77	0	0	1	$430,000	$659,000	$88,000	0	N/A	N/A	N/A
			New Wells	1													
			Total Wells	1	1	1	1	1	1								
Dimmit	Carrizo Springs	Carrizo-Wilcox	Projected Needs	267	399	476	578	0	0	1	$1,185,000	$1,713,000	$321,000	600	N/A	N/A	N/A
			New Wells	1													
			Total Wells	1	1	1	1	1	1								
Frio	Pearsall	Carrizo-Wilcox	Projected Needs	0	0	0	0	0	19	1	$708,000	$1,047,000	$103,000	0	N/A	N/A	N/A
			New Wells						1								
			Total Wells						1								
Gonzales	Gonzales	Carrizo-Wilcox	Projected Needs	0	0	0	174	92	310	1	$1,392,000	$2,002,000	$239,000	0	N/A	N/A	N/A
			New Wells				1										
			Total Wells				1	1	1								
Gonzales	Gonzales WSC	Carrizo-Wilcox	Projected Needs	0	0	0	75	0	63	1	$731,000	$1,057,000	$121,000	0	N/A	N/A	N/A
			New Wells				1										
			Total Wells				1	1	1								
Hays	Mountain City	Trinity	Projected Needs	11	17	25	35	47	60	1	$482,000	$731,000	$78,000	60	$1,300	$283	$3.99
			New Wells	1													
			Total Wells	1	1	1	1	1	1								
Hays	Plum Creek Water Company	Trinity	Projected Needs	0	-185	-185	-185	-185	-185	2	$965,000	$1,062,000	$1,597,000	$185	$911	$189	$2.80
			New Wells		2												
			Total Wells		2	2	2	2	2								

County	User	Aquifer		Needs						Total Wells	Total Capital Cost	Total Project Cost	Total Annual Cost	Available Project Yield	Annual Unit Cost ($/ac-ft)	Annual Non- Debt Unit Cost($/acft)	Annual Unit Cost ($/1,000 gal)
				2020	2030	2040	2050	2060	2070								
Karnes	Karnes City	Carrizo-Wilcox	Projected Needs	336	322	298	285	249	249	1	$2,301,000	$3,235,000	$382,000	0	N/A	N/A	N/A
			New Wells														
			Total Wells														
Karnes	Kenedy	Gulf Coast	Projected Needs	161	189	179	178	151	151	1	$2,229,000	$3,172,000	$591,000	190	$3,111	$1,716	$9.54
			New Wells	1													
			Total Wells	1	1	1	1	1	1								
Kendall	Boerne	Trinity	Projected Needs	0	0	337	1,295	2,284	3,258	8	$4,949,000	$7,367,000	$1,635,000	1,000	$1,635	$1,019	$5.02
			Local Groundwater	0	0	337	1,000	1,000	1,000								
			Remaining Needs	0	0	0	295	1,284	2,258								
			New Wells			3	5										
			Total Wells			3	8	8	8								
La Salle	Cotulla	Carrizo-Wilcox	Projected Needs						25	1	$1,569,000	$2,250,000	$294,000	0	N/A	N/A	N/A
			New Wells						1								
			Total Wells						1								
Medina	Castroville	Leona Gravels	Projected Needs	224	217	210	208	211	214	2	$2,444,000	$3,528,000	$644,000	225	$2,862	$1,551	$8.78
			New Wells	2													
			Total Wells	2	2	2	2	2	2								
Medina	East Medina County SUD	Leona Gravels	Projected Needs	0	0	0	0	11	70	1	$1,230,000	$1,737,000	$336,000	75	$4,480	$2,547	$13.75
			New Wells					1									
			Total Wells					1	1								
Medina	La Coste	Leona Gravels	Projected Needs	10	20	28	37	47	56	1	$1,183,000	$1,710,000	$319,000	60	$5,317	$2,933	$16.31
			New Wells	1													
			Total Wells	1	1	1	1	1	1								
Medina	Natalia	Leona Gravels	Projected Needs	101	129	153	176	199	220	2	$2,365,000	$3,418,000	$634,000	225	$2,818	$1,547	$8.65
			New Wells	1	1												
			Total Wells	1	2	2	2	2	2								
Medina	Yancey WSC	Leona Gravels	Projected Needs	28	95	154	208	261	309	3	$3,025,000	$4,278,000	$795,000	310	$2,565	$1,410	$7.87
			New Wells	1		1		1									
			Total Wells	1	1	2	2	3	3								
Wilson	Floresville	Carrizo-Wilcox	Projected Needs	0	8	405	770	1,124	1,445	2	$2,973,000	$4,268,000	$748,000	0	N/A	N/A	N/A
			New Wells			1		1									
			Total Wells			1	1	2	2								
Wilson	Sunko WSC	Carrizo-Wilcox	Projected Needs	0	0	0	0	0	117	1	$603,000	$862,000	$114,000	0	N/A	N/A	N/A
			New Wells						1								
			Total Wells						1								

Table 5.2.7-2 Alternative Carrizo-Wilcox summary of Schedule and Cost for Local Groundwater Management Strategies for Water User Groups

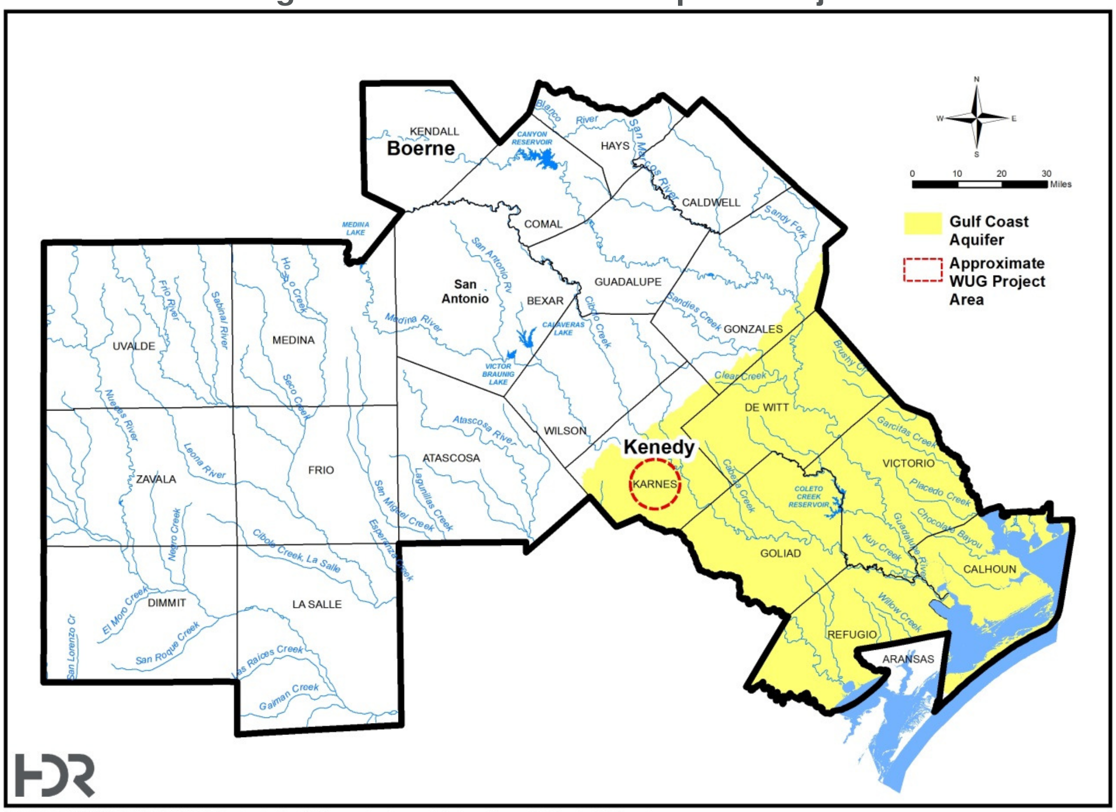
County	User	Aquifer		Needs						Total Wells	Total Capital Cost	Total Project Cost	Total Annual Cost	Available Project Yield	Annual Unit Cost ($/ac-ft)	Annual Non-Debt Unit Cost($/acft)	Annual Unit Cost ($/1,000 gal)
				2020	2030	2040	2050	2060	2070								
Atascosa	Benton City WSC	Carrizo-Wilcox	Projected Needs	0	0	0	0	0	25	1	$430,000	$659,000	$88,000	80	$1,100	$413	$3.38
			New Wells						1								
			Total Wells						1								
Caldwell	Polonica WSC	Carrizo-Wilcox	Projected Needs	0	0	0	88	266	442	2	$1,178,000	$1,683,000	$276,000	450	$613	$300	$1.88
			New Wells				1		1								
			Total Wells				1	1	2								
Dimmit	Asherton	Carrizo-Wilcox	Projected Needs	28	46	61	77	0	0	1	$430,000	$659,000	$88,000	80	$1,100	$413	$3.38
			New Wells	1													
			Total Wells	1	1	1	1	1	1								
Dimmit	Carrizo Springs	Carrizo-Wilcox	Projected Needs	267	399	476	578	0	0	1	$1,185,000	$1,713,000	$321,000	600	$535	$297	$1.64
			New Wells	1													
			Total Wells	1	1	1	1	1	1								
Frio	Pearsall	Carrizo-Wilcox	Projected Needs	0	0	0	0	0	19	1	$708,000	$1,047,000	$103,000	20	$5,150	$750	$15.80
			New Wells						1								
			Total Wells						1								
Gonzales	Gonzales	Carrizo-Wilcox	Projected Needs	0	0	0	174	92	310	1	$1,392,000	$2,002,000	$239,000	310	$771	$232	$2.37
			New Wells				1										
			Total Wells				1	1	1								
Gonzales	Gonzales WSC	Carrizo-Wilcox	Projected Needs	0	0	0	75	0	63	1	$731,000	$1,057,000	$121,000	75	$1,613	$440	$4.95
			New Wells				1	0	0								
			Total Wells				1	1	1								
Karnes	Karnes City	Carrizo-Wilcox	Projected Needs	336	322	298	285	249	249	1	$2,301,000	$3,235,000	$382,000	340	$1,124	$326	$3.45
			New Wells														
			Total Wells														
La Salle	Cotulla	Carrizo-Wilcox	Projected Needs						25	1	$1,569,000	$2,250,000	$294,000	325	$905	$326	$2.78
			New Wells						1								
			Total Wells						1								
Wilson	Floresville	Carrizo-Wilcox	Projected Needs	0	8	405	770	1,124	1,445	2	$2,973,000	$4,268,000	$748,000	1,450	$516	$270	$1.58
			New Wells			1		1									
			Total Wells			1	1	2	2								
Wilson	Sunko WSC	Carrizo-Wilcox	Projected Needs	0	0	0	0	0	117	1	$603,000	$862,000	$114,000	120	$950	$350	$2.92
			New Wells						1								
			Total Wells						1								

5.2.7.3 Gulf Coast Aquifer

The City of Kenedy, in Karnes County, was the only municipal system identified with projected needs that are likely to be met through local development of the Gulf Coast Aquifer (Figure 5.2.7-2). The required number of wells, when they would need to be constructed, and cost estimates are summarized in Table 5.2.7-1.

The current City of Kenedy wells in the Catahoula Formation, which for this part of the Gulf Coast Aquifer. At this vicinity, the Total Dissolved Solids (TDS) concentrations is greater than 1,000 milligrams per liter. Thus, the raw groundwater requires desalination. Current treatment is through a reverse osmosis membrane system. Costs for this advanced treatment were included in cost estimates.

Figure 5.2.7-2. Gulf Coast Aquifer Project



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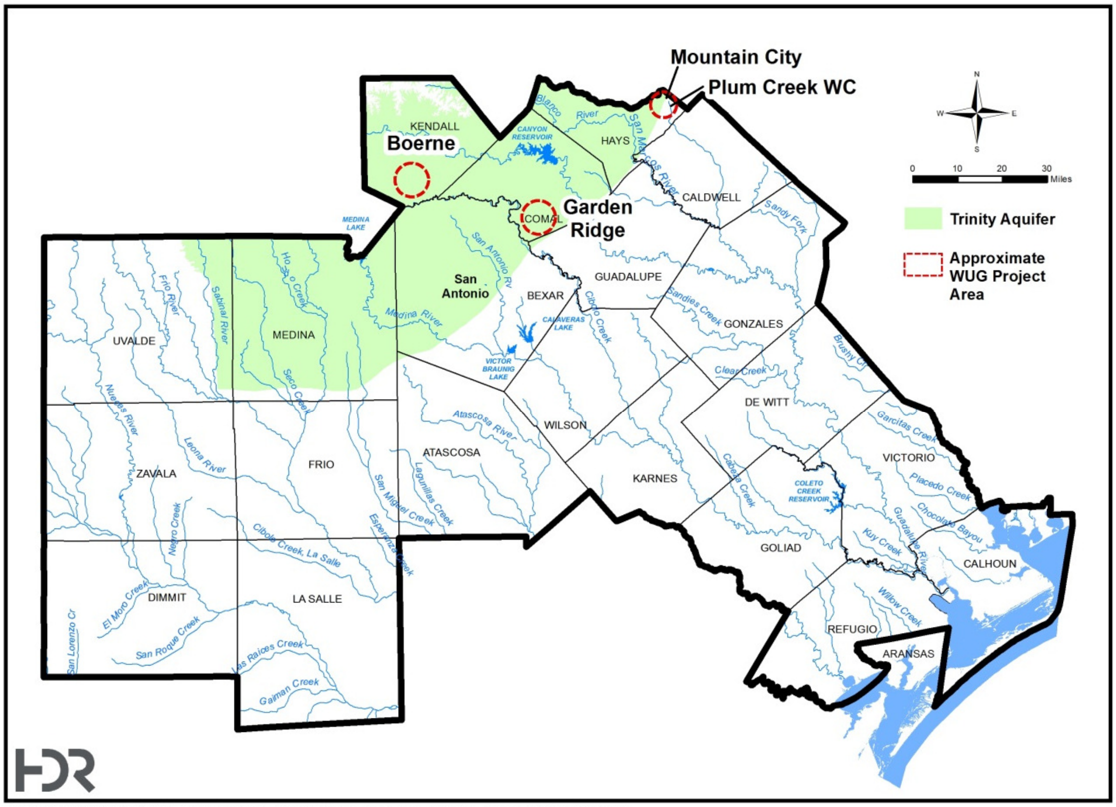
5.2.7.4 Trinity Aquifer

The City of Boerne utilizes the local Trinity Aquifer for a major part of their water supply. The city of Garden Ridge, Plum Creek Water Company and Mountain City have wells in the Edwards Aquifer, which is fully allocated to existing permit holders. The entities overlay the downdip part of the aquifer that has not been developed because of historically abundant water supplies in the overlying Edwards Aquifer. The strategy for these two cities is to add Trinity wells to supplement their water supply. Figure 5.2.7-3 shows the location of these water utilities. Table 5.2.7-1 summarizes the water shortages, number of Trinity wells, and cost estimates. In the cases of Boerne and Garden Ridge, the local Trinity is expected to be capable of producing up to 1,000 acft/yr. Shortages greater than this amount would need to be met with other water sources.

Water quality in the Trinity Aquifer is generally favorable for incorporation into a water supply system with only chlorination as treatment.

Figure 5.2.7-3. Trinity Aquifer Projects



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5.2.7.5 Leona Gravels

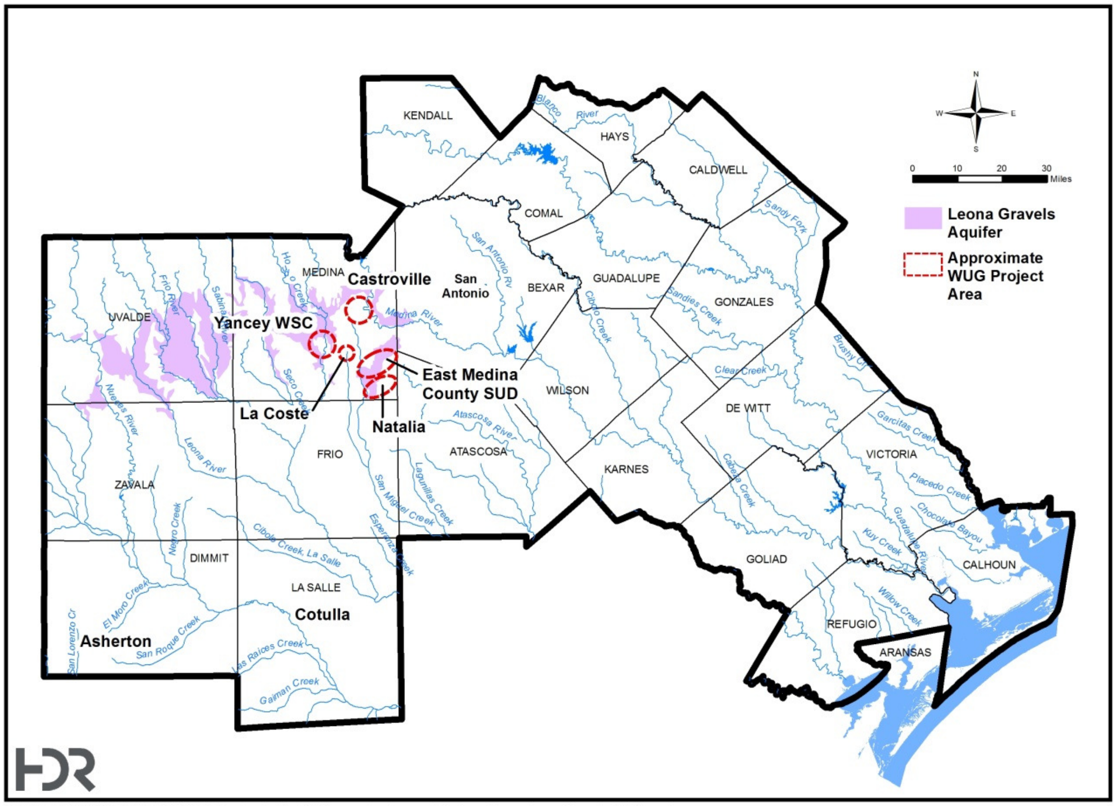
The Leona Gravels in parts of Medina and Uvalde Counties is an aquifer that is mostly utilized for irrigation. However, because the Edwards Aquifer is fully allocated, it is not source for additional water supplies to meet future shortages. Instead, water from the Leona Gravels is a potential source of water for water utilities that have relatively small shortages. Potential WUGs for this water management strategy include:

- Castroville
- East Medina County SUD
- Plum Creek
- La Coste
- Natalia
- Yancey WSC

Figure 5.2.7-4 shows the location of these water utilities. Table 5.2.7-1 summarizes the water shortages, number of Leona Gravel wells, and cost estimates.

Water quality data for Leona Gravel wells in Medina County show the water to be fresh but commonly high in nitrates. This is expected to be attributed to extensive application of fertilizers on irrigated farms. As a result, advanced water treatment is assumed to needed to produce a public drinking water supply. This adds considerable cost to the new water supply and is not nearly offset by relatively shallow Leona Gravel wells instead of the much deeper Edwards wells.

Figure 5.2.7-4. Local Leona Gravels Aquifer Projects



W:\007755\000000000167424_2016_Region_L_Plan\GIS\map_docs\arcmap\Region_l_base_LeonaGravels_WUG.mxd

5.2.7.6 County Other

Future shortages for the County-Other water use category are estimated to occur in Bexar, Dimmit and La Salle counties. The target aquifers are undefined in Bexar County but are expected to include the Trinity, Sparta, Queen City and Carrizo-Wilcox Aquifers. In the other two counties, the target aquifer is expected to be the Carrizo-Wilcox Aquifer.

Table 5.2.7-3 presents the projected needs and number of new wells, by decade, and the capital cost, project cost (including land acquisition, environmental, permitting, and mitigation) all uses in the County-Other Category as if there is a surplus of groundwater availability. However, the TWDB Modeled Available Groundwater (MAG) is fully committed for the Carrizo-Wilcox Aquifer based on exempt use, existing supplies, and existing permits. Thus, the project yield is set to zero and the annual cost and unit cost are not applicable (N/A) for local supplies coming from the Carrizo-Wilcox Aquifer. As an alternative and if one assumes there is groundwater availability in the Carrizo-Wilcox, Table 5.2.7-4 provides a project yield, annual cost, and unit cost for all the users in this category.

Table 5.2.7-3 Summary of Schedule and Cost for Local Groundwater Management Strategies for County-Other Users

County	Users	Aquifer		Needs 2020	2030	2040	2050	2060	2070	Total Wells	Total Capital Cost	Total Project Cost	Total Annual Cost	Available Project Yield	Annual Unit Cost ($/ac-ft)	Annual Unit Cost ($/1,000 gal)
Bexar	Various	Various	Projected Needs				1,898	4,082	6,084	488	$34,231,000	$47,830,000	$7,214,000	6,084	$1,186	$3.64
			New Wells				154	175	159							
			Total Wells				154	329	488							
Dimmit	Various	Carrizo_Wilcox	Projected Needs	297	326	340	362	171	184	30	$2,767,000	$3,866,000	$514,000	0	N/A	N/A
			New Wells	25	3	1	1									
			Total Wells	25	28	29	30	30	30							
La Salle	Various	Carrizo_Wilcox	Projected Needs	22	56	90	133			11	$2,537,000	$3,545,000	$381,000	0	N/A	N/A
			New Wells	2	3	3	3									
			Total Wells	2	5	8	11	11	11							

Table 5.2.7-4 Alternative Carrizo-Wilcox Summary of Schedule and Cost for Local Groundwater Management Strategies for County-Other Users

County	Users	Aquifer		Needs 2020	2030	2040	2050	2060	2070	Total Wells	Total Capital Cost	Total Project Cost	Total Annual Cost	Available Project Yield	Annual Unit Cost ($/ac-ft)	Annual Unit Cost ($/1,000 gal)
Dimmit	Various	Carrizo_Wilcox	Projected Needs	297	326	340	362	171	184	30	$2,767,000	$3,866,000	$514,000	362	$1,420	$4.36
			New Wells	25	3	1	1									
			Total Wells	25	28	29	30	30	30							
La Salle	Various	Carrizo_Wilcox	Projected Needs	22	56	90	133			11	$2,537,000	$3,545,000	$381,000	133	$2,865	$8.79
			New Wells	2	3	3	3									
			Total Wells	2	5	8	11	11	11							

5.2.7.7 Mining

Future shortages for the Mining water use category are estimated to occur in Dimmit, Karnes, Dewitt and La Salle counties. The target aquifer is the Carrizo-Wilcox Aquifers in Dimmit and La Salle Counties. In Karnes and Dewitt Counties, the target aquifer is the Gulf Coast Aquifer.

Cost estimation assumptions were presented earlier. Table 5.2.7-5 summarizes on a county-wide basis the water shortages, number wells, and cost estimates. For the Carrizo-Wilcox Aquifer, the project yield is set to zero because of the lack of groundwater availability. As an alternative and if one assumes there is groundwater availability in the Carrizo-Wilcox, Table 5.2.7-6 provides a project yield, annual cost, and unit cost for all the users in this category.

5.2.7.8 Environmental Issues

In the local groundwater water management strategy, existing municipal, WSC and SUD well fields will be expanded with the addition of new wells. In addition, the expansion of existing distribution systems to connect to the new wells and main pipelines may be required.

Available water level data in the vicinity of the proposed well fields show some of the areas have declining trends. In most all these cases, the declines are expected to continue or to possibly increase. Areas with little or no groundwater level declines in the past may start to experience groundwater declines in the future due to increases in groundwater pumping. Nearby pumping for water supply, recharge from rainfall, and other factors can also affect groundwater levels.

The pumping of groundwater from the Carrizo-Wilcox Aquifer for a local groundwater supply could have a very minor impact on springflow and temporary pools in small streams in the outcrop area, which may be habit for some plant and animal species.

The possible reduction of spring baseflows resulting from a lowering of water levels in aquifers utilized for additional water needs or impacts to wetlands during construction could result in issues associated with potential impacts to species listed as endangered or threatened by the U.S. Fish and Wildlife Service or Texas Parks and Wildlife. Surficial impacts resulting from the addition of new wells and associated distribution pipelines could be minimized if best management practices are utilized and the crossing of streams are avoided as much as feasible.

5.2.7.9 Engineering and Costing

A summary of projected needs and cost estimates for development of local groundwater supply was presented earlier in Table 5.2.7-1 through Table 5.2.7-6.

Table 5.2.7-5 Summary of Schedule and Cost for Local Groundwater Management Strategies for Mining

County	User	Aquifer		Needs						Total Wells	Total Capital Cost	Total Project Cost	Total Annual Cost	Available Project Yield	Annual Unit Cost ($/ac-ft)	Annual Unit Cost ($/1,000 gal)
				2020	2030	2040	2050	2060	2070							
DeWitt	Mining	Gulf Coast	Projected Needs	44	38	16	2	0	0	1	$81,000	$113,000	$20,000	44	$455	$1.39
			New Wells	1												
			Total Wells	1	1	1	1	1	1							
Dimmit	Mining	Carrizo-Wilcox	Projected Needs	4,826	4,908	4,244	2,731	1,222	519	50	$22,680,000	$31,690,000	$3,339,000	0	N/A	N/A
			New Wells	50												
			Total Wells	50	50	50	50	50	50							
Karnes	Mining	Gulf Coast	Projected Needs	1,864	1,292	700	115			19	$1,465,000	$2,071,000	$242,000	1,864	$130	$0.40
			New Wells	19	19	19	19	19	19							
			Total Wells													
La Salle	Mining	Carrizo-Wilcox	Projected Needs	4088	4243	3734	2290	851	147	43	$19,505,000	$27,254,000	$2,735,000	0	N/A	N/A
			New Wells	42	1											
			Total Wells	42	43	43	43	43	43							

Table 5.2.7-6 Alternative Carrizo-Wilcox Summary of Schedule and Cost for Local Groundwater Management Strategies for Mining

County	User	Aquifer		Needs						Total Wells	Total Capital Cost	Total Project Cost	Total Annual Cost	Available Project Yield	Annual Unit Cost ($/ac-ft)	Annual Unit Cost ($/1,000 gal)
				2020	2030	2040	2050	2060	2070							
Dimmit	Mining	Carrizo-Wilcox	Projected Needs	4,826	4,908	4,244	2,731	1,222	519	50	$22,680,000	$31,690,000	$3,339,000	4,908	$680	$2.09
			New Wells	50												
			Total Wells	50	50	50	50	50	50							
La Salle	Mining	Carrizo-Wilcox	Projected Needs	10	20	28	37	47	56	43	$19,505,000	$27,254,000	$2,735,000	4,243	$645	$1.98
			New Wells	42	1											
			Total Wells	42	43	43	43	43	43							

5.2.7.10 Implementation Issues

For each aquifer in the region, the GCDs have adopted desired future conditions (DFCs). In some GCDs, full use of all groundwater supplies (permitted, grandfathered and exempt) may result in non-achievement of the DFCs for an aquifer. To ensure consistency with the DFCs, TWDB currently requires that groundwater availability for each aquifer be limited for planning purposes to the modeled available groundwater (MAG) for the aquifer. This has resulted, for planning purposes only, in adjustments to permit amounts, and a lack of firm water available for future permits in this plan for some areas for certain time periods. This should not be construed as recommending or requiring that GCDs make these adjustments, or deny future permit applications. SCTRWPG recognizes and supports the ability of permit holders to exercise their rights to groundwater use in accordance with their permits and it recognizes and supports the GCDs discretion to issue permits and grandfather historical users for amounts in excess of the MAG. SCTRWPG may not modify groundwater permits that GCDs have already issued or limit future permits that GCDs may issue. If the MAG is increased during or after this planning cycle, SCTRWPG may amend this Plan to adjust groundwater supply numbers that are affected by the new MAG amount.

The amount of water needed by this WMS that exceeds the available water in the District's management plan, or for other reasons is not permitted by the District, cannot be implemented as part of this WMS unless and until all necessary permits are received from the District.

The amount of water needed by this WMS that exceeds the available water in the District's management plan, or for other reasons is not permitted by the District, introduces an added element of uncertainty to reliance upon this WMS and, therefore, additional management supplies may be needed for this WMS.

The development of additional wells and well fields by water utilities may encounter the following issues:

Impact on:

- Endangered and threatened species,
- Water levels in the aquifer,
- Baseflow in streams, and Wetlands.
- Competition with others for groundwater in the area.

5.2.8 Local Carrizo Conversions

5.2.8.1 Description of Water Management Strategy

The Local Carrizo Conversions water management strategy is intended to be used by WUGs where the Local Groundwater WMS is the primary recommended strategy to meet their needs but there is no groundwater availability due to existing permits and limited Modeled Available Groundwater (MAG) estimates. The strategy includes purchasing and/or leasing existing irrigation or mining groundwater permits, and changing the type of use to municipal use. The Local Carrizo Conversions is intended to be use within the same county and between willing sellers and willing buyers.

5.2.8.2 Available Yield

The available supply from the Local Carrizo Conversions water management strategy is limited to the firm supply under existing irrigation or mining groundwater permits within the same county as the municipal WUG seeking to acquire additional supply via use type conversion.

5.2.8.3 Environmental Issues

Environmental issues associated with the Local Carrizo Conversions are anticipated to be limited, if any.

5.2.8.4 Engineering and Costing

The cost associated with the Local Carrizo Conversions water management strategy is limited to the negotiations between willing sellers and willing buyers.

5.2.8.5 Implementation Issues

Implementation would require the ability to execute contractual agreements between the municipal WUG and the irrigators or mining entities, and the ability to amend existing groundwater permits at the groundwater conservation district to add municipal use as a type. If the rules of the groundwater conservation district do not explicitly allow for the conversion of groundwater permits between use types, then such rules would need to be amended.

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5.2.9 ASR for New Braunfels Utilities

5.2.9.1 Description of Water Management Strategy

New Braunfels Utilities (NBU) has several sources of water, including: (1) run-of-the-river water rights from the Guadalupe River, (2) stored water in Canyon Reservoir via a contract with Guadalupe-Blanco River Authority (GBRA), and (3) groundwater from the Edwards Aquifer through permits with the Edwards Aquifer Authority (EAA). NBU is currently (2014) adding groundwater from the Trinity Aquifer to these sources. Table 5.2.9-1 lists the amount of water from these supplies and their reliability. Table 5.2.9-2 lists the capacities of the major components of the NBU water system.

Table 5.2.9-1 NBU Water Supplies

Source	***Supply (acft/yr)***	***Restrictions***
Run-of-the-River Water Rights	6,952	Subject to Prior Appropriation and Special Conditions
Canyon Reservoir	9,720	None. Considered to be Firm
Edwards Aquifer	9,270	Subject to Reductions per Edwards Aquifer Habitat Conservation Plan (EAHCP)
Trinity Aquifer	725	None. Considered to be Firm. Under Development

Table 5.2.9-2 NBU Water System Capacity

System Component (Planning Purposes)	***Capacity (million gallons per day, MGD)***
Water Treatment Plant for Surface Water Supplies	7.5
Edwards Wells	14.3
Trinity Wells (Under Development)	0.65
Total	22.4

NBU is considering adding Aquifer Storage and Recovery (ASR) (dual-purpose wells) to their water system[1]. NBU is expecting an ASR strategy to:

- Provide a long-term supply during drought-of-record (DOR),
- Defer construction of a second Water Treatment Plant (WTP),
- Meet seasonal demands when restrictions are imposed,
- Meet demands at the ends of the distribution system, and

[1] Malcolm-Pirnie/ARCADIS, May 2012, Preliminary Evaluation of Aquifer Storage and Recovery as a Water Supply and Management Strategy, Prepared for New Braunfels Utilities.

- Provide an emergency supply.

The ASR strategy for NBU offers several advantages, including:

- Long-term storage, seasonal peaking, and emergency supplies,
- Opportunity to increase utilization of existing permits, which postpones acquisition of new water supplies,
- Minimize construction of new facilities,
- Extensive use of existing distribution system, and
- Minimize environmental impacts.

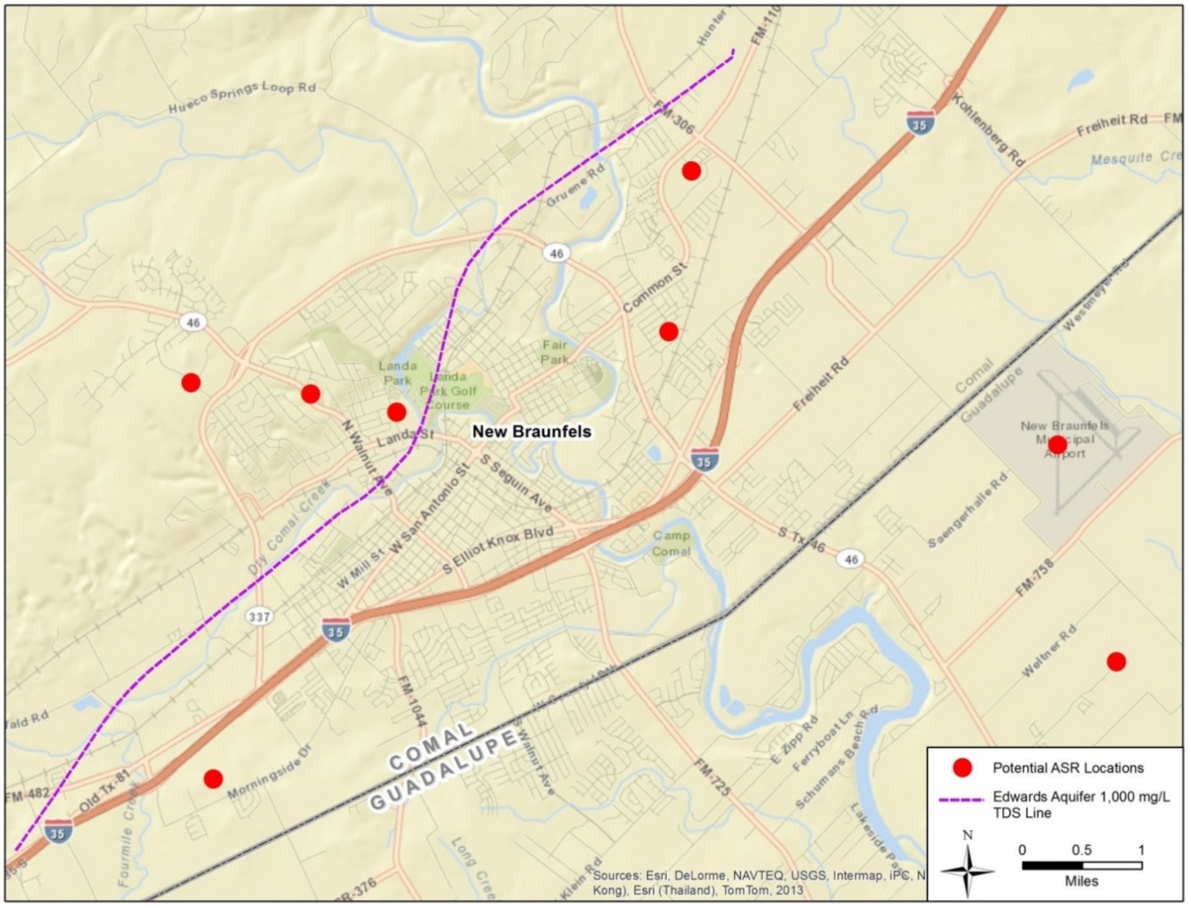
Target aquifers for storage include:

- Trinity
  - Lower Glen Rose and
  - Hosston-Sligo
- Edwards Aquifer (Brackish)

The location of candidate sites for ASR wells, as determined by NBU staff, is shown in Figure 5.2.9-1. These sites are on property owned by the City of New Braunfels (City). Since the project is located on city property and involves injection and recovery of water from other existing sources, it is expected that this water management strategy will have no impacts on agriculture.

Common to most all ASR projects, the concept is to store water during times of plenty and to recover the water during times of shortage. Considering the expectations from NBU, the timeframe would have two components. One is a short-term, seasonal supply when water is stored during winter and spring and recovered during the summer. The second one is a long-term emergency supply for a major drought.

Figure 5.2.9-1 NBU ASR Location Map



5.2.9.2 Available Yield

A NBU water-balance model for the water system was developed to evaluate various planning scenarios. The model operates on a monthly time step and can evaluate strategies of expanding the capacity of the WTP and/or adding an ASR component to the water system. The model utilizes information from the GSA WAM to define the run-of-the-river supply from the Guadalupe River and the Edwards Aquifer MODFLOW model to define Edwards Aquifer permit restrictions. A common period in both models is 1947-1989. For purposes of this study, the new Trinity Aquifer wells were not considered. Results from an application of the model are the maximum firm annual water supply that can meet monthly demands in consideration of the supply constraints.

Development of the NBU water-balance model consisted of:

- Determining the allowable diversions for current run-of-the-river water rights for 1934-1989 hydrologic conditions using the GSA WAM,
- Utilizing the Edwards Aquifer MODFLOW model's results for the adopted EAHCP to determine pumping restrictions on EAA permits for 1947-2000 hydrologic conditions,
- Utilizing a monthly distribution of municipal water demands,

- Estimating recent NBU water demands from 2006-2011 data, as provided by the Texas Water Development Board (TWDB), to the South-Central Regional Water Planning Group (Region L), and
- Utilizing estimated ASR well capacities from the Malcolm-Pirnie/ARCADIS report.

Applications of the NBU water-balance model were made for: (1) an expansion of the WTP only, (2) ASR for the current WTP capacity, and (3) combinations of WTP expansion and ASR. For an expansion of WTP only, the modeling procedure included:

- Model simulations to calculate monthly water balance on the basis of supplies and demands when the water system is constrained by water treatment plant capacities of 10.0, 12.5 and 15.0 MGD. The water system yield was determined by an optimizing procedure of changing the annual water demands and running the model until there was only a small water surplus during the most critical month in the 1947-1989 test period.

For a combination of WTP expansions (includes no expansion) and ASR, the modeling procedure included:

- Optimizing the monthly schedule of surface water diversions and ground water pumping to: (1) utilize as much of the surface water supply and the WTP capacity as possible and (2) maximize the treated water supply during months of high demand.
- Running the model for water treatment plant expansions of 0.0, 2.5, 5.0 and 7.5 MGD with the ASR wells turned ON. For each WTP expansion scenario, the water system yield was determined by an iterative procedure consisting optimizing the maximum annual water demands while always maintaining a positive water balance in ASR throughout the simulation period.
- Determining the number of ASR wells on the basis of system demands and injection and recovery capacities of the wells.

A graphical summary of the results for the scenarios of WTP expansion only and WTP expansion with ASR is presented in Figure 5.2.9-2. Table 5.2.9-3 tabulates these results along with an increase in system capacity that is attributed to the strategy.

As shown in Figure 5.2.9-2 and Table 5.2.9-3, the modeling analysis shows that for every 2.5 MGD of water treatment capacity, the system capacity increases about 2,000 acft/yr. The analysis did not indicate a dimensioning return with the fixed supply of water when the WTP capacity was expanded up to 15.0 MGD. Adding ASR to WTP expansions of 2.5, 5.0 and 7.5 MGD increases the system capacity of 1,700, 2,400 and 2,500 acft/yr. A combination of WTP expansions of 2.5, 5.0 and 7.5 MGD with ASR increases the system capacities by 3,700, 6,300, and 8,300 acft/yr, respectively.

This analysis suggests that: (1) expanding of the WTP and adding ASR wells are about equally effective in increasing the system capacity, (2) adding ASR wells to the current NBU water system only increases the supply by about 800 acft/yr or about 6 percent, and (3) expanding the WTP to 15 MGD and adding ASR would increase the system capacity over 60 percent without acquiring an new water supply.

Figure 5.2.9-2 Water-Balance Model Results for Scenarios with WTP Expansion Only and WTP Expansion with ASR

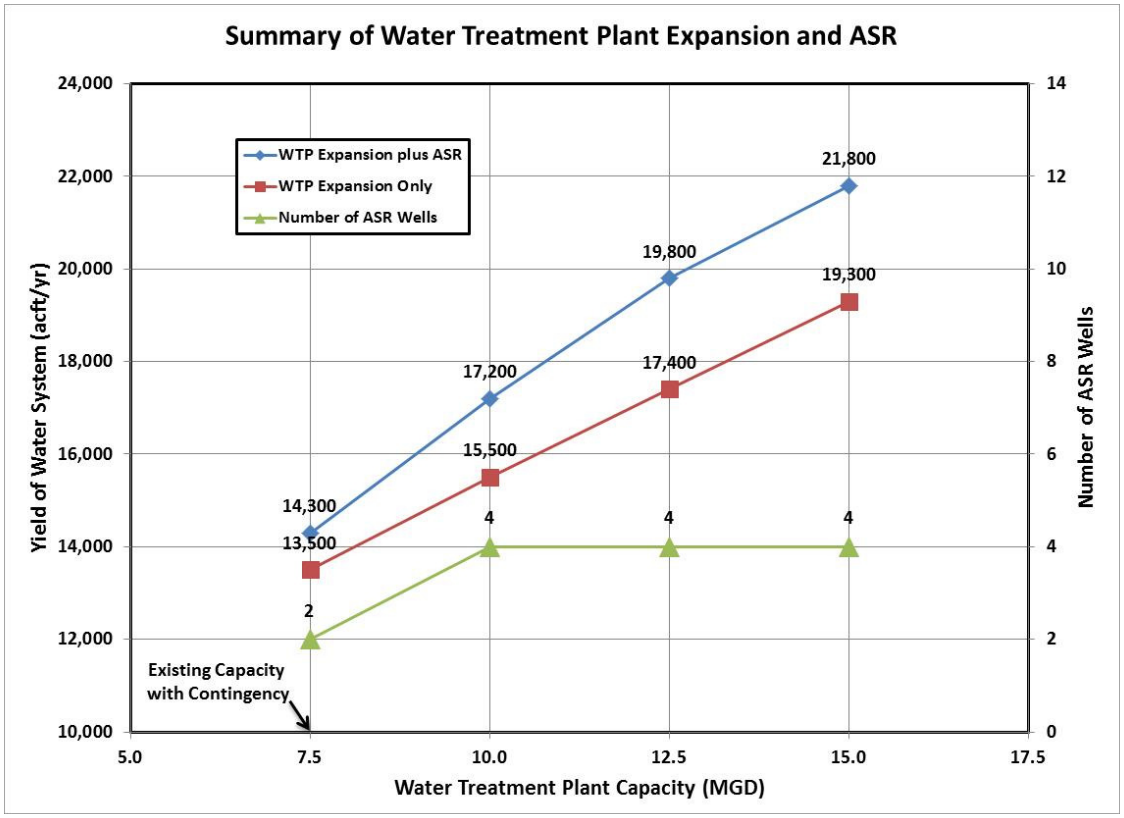


Table 5.2.9-3 Water System Capacities and increases in Capacities for WTP expansion only and WTP expansion with ASR

Capacities			***Capacities with Expansions***		
WTP Capacity (MGD)	***System Capacity without ASR (acft/yr)***	***System Capacity with ASR (acft/yr)***	***Expansion of WTP Capacity (MGD)***	***Increase in System Capacity without ASR (acft/yr)***	***Increase in System Capacity with ASR (acft/yr)***
7.5	13,500	14,300	-	-	800
10	15,500	17,200	2.5	2,000	3,700
12.5	17,400	19,800	5	3,900	6,300
15	19,300	21,800	7.5	5,800	8,300

5.2.9.3 Environmental Issues

The ASR for New Braunfels Utilities water management strategy involves the potential expansion of an existing water treatment plant, the addition of several dual-purpose wells to the water system, and additional pumps, and piping used to transfer water to and from the wells through an existing distribution system. Environmental issues for the proposed ASR for New Braunfels Utilities are described below.

The project area contains parts of both the Edwards Plateau and Blackland Prairie ecoregions[2] and is within portions of the Texan and Balconian biotic provinces.[3] The wells, pipelines and the WTP site are anticipated to have a low negative impact to existing terrestrial habitat. The majority of the project would occur within established urban areas. Vegetation which occurs outside of these areas primarily includes crops; however at lease one potential well site is located within an area identified by Texas Parks and Wildlife (TPWD) as live oak-Ashe juniper woods.

Outside any required maintained right-of-way, land use would not be anticipated to change due to well or pipeline construction. Additional pipeline construction would include a two-way collector pipeline of approximately 500 ft. Impacts to land use would be limited to the removal of existing vegetation and temporary impacts during construction. Herbaceous habitats would recover fastest from construction impacts and would experience low negative impacts. Any impacts to woody vegetation would be permanent within areas of pipeline and WTP maintenance. The proposed wells would have a minimal impact on vegetation within the project area due to limited surface exposure.

The project area lies within an environmentally sensitive area known as the Edwards Aquifer. Numerous enhanced karst features occur within this area, and as a result the Edwards Aquifer is one of the most productive groundwater reservoirs in the country. The project area includes areas within the recharge and transition zones. The recharge zone includes an area where highly faulted and fractured Edwards limestone outcrops occur at the surface, providing a means for large quantities of water to flow into the Edwards Aquifer. The transition zone contains areas where limestones that overlie the aquifer are faulted and fractured and includes caves and sinkholes. Within this area it is possible for surface water to flow into the Edwards limestone below. Recognizing the importance of maintaining water quality within the Edwards Aquifer, the Texas legislature mandated the protection of this aquifer through the Texas Commission on Environmental Quality (TCEQ) under Title 30 Texas Administrative Code (TAC), Chapter 213.

With the construction of the two-way water pipelines, crossings of jurisdictional waters could occur. Perennial waters encountered in the project area include the Guadalupe River, Comal River, and Dry Comal Creek. Avoidance and minimization measures, such as horizontal directional drilling, construction best management practices (BMPs), and avoidance of perennial and /or sensitive aquatic habitats (e.g., the Guadalupe and Comal Rivers, etc.) would reduce the potential impacts from pipelines. Impacts from pipelines to these waters are anticipated to be minor, would be restorable and temporary, and occur during construction. The WTP site and wells are not located within flood hazard areas.

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[2] Gould, F.W. 1975. The Grasses of Texas. Texas A&M University Press. College Station, Texas.

[3] Blair, W.F., “The Biotic Provinces of Texas, “Tex. J. Sci. 2:93-117, 1950.

The TCEQ 2010 Texas Integrated Report for Clean Water Act Section 303(d) lists Dry Comal Creek as a Category 5b water body. This listing indicates Dry Comal Creek is impaired because it "does not meet applicable water quality standards or is threatened for one" and "a review of the water quality standards for this water body will be conducted before a Total Maximum Daily Load (TMDL) is scheduled." Bacteria levels are the parameter on which TCEQ bases this designation. The designation applies to TCEQ Segment ID 1811A, which occurs from the confluence of the Comal River in New Braunfels in Comal County to the upstream perennial portion of the stream southwest of New Braunfels. Any potential impacts to this river segment from the construction of new pipelines would be temporary. Available avoidance and minimization practices could further reduce potential impacts.

Coordination with the U.S. Army Corps of Engineers would be required for construction within waters of the U.S. Impacts from this proposed project resulting in a loss of less than 0.5 acres of waters of the U.S. could be covered under Nationwide Permit #12 for Utility Line Activities unless there are significant impacts to the aquatic environment resulting from other project components.

The TPWD has identified a number of stream segments throughout the state as ecologically significant on the basis of biological function, hydrologic function, riparian conservation, exceptional aquatic life uses, and/or threatened or endangered species. Currently, 21 stream segments in Region L are considered ecologically significant by the TPWD.[4]

The Guadalupe River from the confluence of the Comal River upstream to the Kendall/Kerr County Line, with the exception of Canyon Reservoir is considered to be ecologically significant on the basis of hydrologic function, the existence of a riparian conservation area (Guadalupe River State Park), and high water quality/exceptional aquatic life/high aesthetic value.

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 (Pl96-515), and the Archeological and Historic Preservation Act (PL93-291). Based on the review of available GIS datasets, there are six cemeteries, ten national register properties, and 49 historical markers located near or within the project area.

Based on a review of soils, geology, and aerial photographs, there is a high probability for undocumented significant cultural resources within the alluvial deposits and terrace formations associated with waterways, specifically the perennial aquatic resources. Potential impacts from constructed pipelines increase in areas near waterways and associated landforms.

A review of archaeological resources in the proposed project area should be conducted during the project planning phase. Taking into consideration that the owner or controller of the project will likely be a political subdivision of the State of Texas (i.e. river authority,

[4] TPWD, "Ecologically Significant River and Stream Segments," http://www.tpwd.state.tx.us/landwater/water/environconcerns/water_quality/sigsegs/index.phtml accessed February 6, 2014.

municipality, county, etc.), they will be required to coordinate with the Texas Historical Commission regarding impacts to cultural resources.

The species listed by USFWS, and TPWD, as endangered or threatened with potential habitat in Comal and Guadalupe counties are listed in Table 5.2.9-4. The Texas Natural Diversity Database (TNDD), maintained by TPWD, which documents the occurrence of rare species within the state, was included in this analysis. Listed species recorded within the project area include two endangered species, the fountain darter and the Comal Springs riffle beetle, one federal candidate species, the bracted twistflower, and four species of concern including the mountain plover, Comal Springs salamander, Guadalupe bass, and horseshoe liptooth snail.

The absence of data from the TNDD does not imply the absence of occurrence. The well field, pumps, pipelines, and WTP site expansion include limited potential impacts to listed species.

The project area may provide potential habitat to endangered or threatened species found in Comal, or Guadalupe counties. A survey of the project area may be required prior to pipeline and well construction to determine whether populations of or potential habitats used by listed species occur in the area to be affected. Coordination with TPWD and USFWS regarding threatened and endangered species with the potential to occur in the project area should be initiated early in project planning.

Based on existing habitat types, the following species have potential to occur near or within the project area. The aquatic species are primarily a concern if pipelines cross perennial waters or if project actions negatively impact the Trinity or Edwards Aquifer.

A. Federal and State-Listed Endangered Species

- Comal Springs dryopid beetle (Stygoparnus comalensis), critical habitat established at Comal Springs which occurs within 0.5 mile of potential well location.
- Comal Springs riffle beetle (Heterelmis comalensis), critical habitat established at Comal Springs which occurs within 0.5 mile of potential well location.
- Black-capped vireo (Vireo atricapilla), no confirmed sightings within the project area, however one potential well site occurs within potential habitat area.
- Golden-cheeked warbler (Setophaga chrysoparia), no confirmed sightings within the project area, however one potential well site occurs within potential habitat area.
- Interior least tern (Sterna antillarum athalassos), nests along sand and gravel bars in braided streams. Could occur along the Guadalupe River but no adverse impacts to this species is anticipated to result from the project.
- Pecks's Cave amphipod (*Stygobromus pecki*), is a small aquatic species which lives underground in the Edwards Aquifer. Impacts to the Edwards Aquifer could affect this species.
- Fountain darter (*Etheostoma fonticola*), this small fish is only known from the San Marcos and Comal Rivers. Impacts to this species would not be anticipated from this project.

- Jaguarundi (*Herpailurus yaguarondi*), preferred habitat of thick brushlands near water is not present within the project area. No impacts are anticipated from this project.

B. Federal-Listed Candidate Species

- Golden Orb (*Quadrula aurea*) — The golden orb is a federal candidate for listing and is state threatened. This freshwater mollusk exists in sand, gravel or mud substrates within lake or river systems. The TPWD designates a segment of the Guadalupe River as an Ecologically Significant Stream Segment based on the occurrence of the golden orb. This species could potentially occur in perennial streams, like the Guadalupe River although no impacts are anticipated from the project.
- Texas fatmucket (*Lampsislis bracteata*), this species is a federal candidate for listing in the state and is state threatened. This freshwater mollusk exists in more shallow rivers or streams with substrates of sand, mud and gravel. This species could potentially occur in perennial streams, like the Guadalupe River although no impacts are anticipated from the project.
- Texas pimpleback (*Quadrula petrina*) — The Texas pimpleback is a federal candidate for listing and is state threatened. This freshwater mollusk exists in small to moderate streams and rivers of slow flow rates, as well as moderate size reservoirs with substrates of mixed mud, sand and fine gravel. This species could potentially occur in perennial streams, like the Guadalupe River although no impacts are anticipated from the project.

Table 5.2.9-4 Endangered, Threatened, and Species of Concern for Comal and Guadalupe Counties

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
AMPHIBIANS								
Cascade Caverns salamander	*Eurycea latitans complex*	1	2	2	Endemic subaquatic species found in the Medina and Guadalupe Rivers and Cibolo Creek watersheds within the Edwards Aquifer area.		T	Resident
Comal blind salamander	*Eurycea tridentifera*	1	2	2	Endemic semi-troglobitic species found in springs and waters of caves.		T	Resident
Comal Springs salamander	*Eurycea sp. 8*	1	1	1	Endemic species found in Comal Springs.			Resident
Edwards Plateau spring salamanders	*Eurycea sp. 7*	1	1	1	Endemic species found in springs and caves of the region.			Resident
BIRDS								
American peregrine falcon	*Falco peregrinus anatum*	0	2	0	Migrant and local breeder in West Texas.	DL	T	Possible Migrant
Artic peregrine falcon	*Falco peregrinus tundrius*	0	1	0	Migrant throughout the state.	DL		Possible Migrant
Bald eagle	*Haliaeetus leucocephalus*	0	2	0	Found primarily near rivers and large lakes.	DL	T	Possible Migrant
Black-capped vireo	*Vireo atricapilla*	0	3	0	Oak-juniper woodlands with distinctive patchy, tow-layered aspect.	LE	E	Possible Migrant
Golden-cheeked warbler	*Setophaga chrysoparia*	1	3	3	Juniper-oak woodlands, dependent on mature Ashe juniper for bark.	LE	E	Possible Migrant
Interior least tern	*Sterna antillarum athalassos*	0	3	0	Nests along sand and gravel bars in braided streams	LE	E	Resident
Mountain plover	*Charadrius montanus*	1	1	1	Non-breeding, shortgrass plains and fields			Nesting/ Migrant
Sprague's pipit	*Anthus spragueii*	0	1	0	Migrant in Texas in winter mid Sept. to early April. Strongly tied to native upland prairie.			Possible Migrant

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
Western burrowing owl	*Athene cunicularia hypugaea*	1	1	1	Open grasslands, especially prairie, plains and savanna			Resident
Whooping crane	*Grus americana*	0	3	0	Potential migrant	LE	E	Potential Migrant
Wood stork	*Mycteria americana*	1	2	2	Forages in prairie ponds, ditches, and shallow standing water formerly nested in TX		T	Migrant
Zone-tailed hawk	*Buteo albonotatus*	0	2	0	Located in arid open county, often near watercourses.		T	Resident
CRUSTACEANS								
Ezell's cave amphipod	*Stygobromus flagellates*	0	1	0	Aquatic obligate known only from artesian wells.			Occurs near San Marcos
Long-legged cave amphipod	*Stygobromus longipes*	0	1	0	Subaquatic, subterranean obligate			Resident
Peck's cave amphipod	*Stygobromus pecki*	0	3	0	Small, aquatic species which lives underground in the Edwards Aquifer.	LE	E	Resident
FISHES								
Fountain darter	*Etheostoma fonticola*	1	3	1	Known only from the San Marcos and Comal Rivers.	LE	E	Resident
Guadalupe bass	*Micropterus treculi*	1	1	1	Endemic to perennial streams of the Edwards Plateau region.			Resident
Guadalupe darter	*Percina sciera apristis*	1	1	1	Guadalupe River Basin. Usually found over gravel or gravel and sand raceways of larger streams and rivers.			Resident
INSECTS								
A mayfly	*Campsurus decolaratus*	0	1	0	In Texas and Mexico, possibly clay substrates, found in shoreline vegetation.			Resident
Comal Springs diving beetle	*Comaldessus stygius*	1	1	1	Known only from the outflows at Comal Springs, aquatic.			Resident
Comal Springs dryopid beetle	*Stygoparnus comalensis*	1	3	3	Usually found clinging to objects in a stream.	LE	E	Resident
Comal Springs riffle beetle	*Heterelmis comalensis*	1	3	3	Found in Comal and San Marcos Springs	LE	E	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
Edwards Aquifer diving beetle	*Haideoporus texanus*	0	1	0	Known from an artesian well in Hays County			Potential Resident
Rawson's metalmark	*Calephelis rawsoni*	1	1	1	Found in moist areas in shaded limestone outcrops in central Texas.			Resident
MAMMALS								
Black bear	*Ursus americanus*	0	2	0	Found in bottomland hardwoods and large tracts of inaccessible forested areas.	T/SA; NL	T	Historic Resident
Cave myotis bat	*Myotis velifer*	0	1	0	Roosts colonially in caves, rock crevices			Resident
Jaguarundi	*Herpailurus yaguarondi*	0	3	0	Thick brushlands near water is favored by this species.	LE	E	Resident
Plains spotted skunk	*Spilogale putorius interrupta*	1	1	1	Prefers wooded, brushy areas.			Resident
Red wolf	*Canis rufus*	0	3	0	Extirpated, formerly known throughout the eastern half of Texas.	LE	E	Historic Resident
MOLLUSKS								
Creeper (squawfoot)	*Strophitus undulates*	1	1	1	Small to large streams. Colorado, Guadalupe, and San Antonio River basins.			Resident
False spike mussel	*Quincuncina mitchelli*	1	2	2	Substrates of cobble and mud. Rio Grande, Brazos, Colorado and Guadalupe river basins.		T	Resident
Golden orb	*Quadrula aurea*	1	2	2	Sand and gravel, Guadalupe, San Antonio, Lower San Marcos, and Nueces River basins	C	T	Resident
Horseshoe liptooth snail	*Daedalochila hippocrepis*	1	1	1	Terrestrial snail known only from Landa Park in New Braunfels.			Resident
Texas fatmucket	*Lampsilis bracteata*	1	2	2	Streams and rivers on sand, mud and gravel, Colorado and Guadalupe River basins.	C	T	Resident
Texas pimpleback	*Quadrula petrina*	1	2	2	Mud, gravel and sand substrates, Colorado and Guadalupe river basins	C	T	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
PLANTS								
Big red sage	*Salvia pentstemonoides*	0	1	0	Texas endemic, found in moist to seasonally wet steep limestone outcrops on canyons or along creek banks.			Resident
Bracted twistflower	*Streptanthus bracteatus*	1	1	1	Texas endemic found in oak juniper woodlands.	C		Resident
Comal snakewood	*Colubrina stricta*	0	1	0	Historic in Comal Co., generally found in shrublands.			Historic Resident
Elmendorf's onion	*Allium elmendorfii*	0	1	0	Endemic, in deep sands			Resident
Green beebalm	*Monarda viridissima*	0	1	0	Endemic perennial herb. Found in well-drained sandy soils in opening of post oak woodlands.			Resident
Hill country wild-mercury	*Argthamnia aphoroides*	0	1	0	Texas endemic found primarily in bluestem-grama grasslands associated with plateau live oak woodlands.			Resident
Parks' jointweed	*Polygonella parksii*	0	1	0	Texas endemic, primarily found on deep, loose, sand blowouts in Post Oak Savannas.			Resident
Sandhill woolywhite	*Hymenopappus carrizoanus*	0	1	0	Found south of the Guadalupe River. Prefers dense riparian corridors.			Resident
REPTILES								
Cagle's map turtle	*Graptemys caglei*	1	2	2	Endemic to Guadalupe River System. Found near waters' edge.		T	Resident
Spot-tailed earless lizard	*Holbrookia lacerata*	1	1	1	Moderately open prairie-brushland.			Resident
Texas Garter Snake	*Thamnophis sirtalis annectens*	1	1	1	Wet or moist microhabitats			Resident
Texas Horned Lizard	*Phrynosoma cornutum*	1	2	2	Varied, sparsely vegetated uplands.		T	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
Texas Tortoise	*Gopherus berlandieri*	1	2	2	Open brush w/ grass understory.		T	Resident
Timber/ canebrake rattlesnake	*Crotalus horridus*	1	2	2	Floodplains, upland pine, deciduous woodlands, riparian zones.		T	Resident
TPWD, 2014. Annotated County List of Rare Species – Comal County, revised 10/2/2012. Guadalupe County, revised 8/7/2012. USFWS, 2014. Endangered Species List for Texas. http://www.fws.gov/southwest/es/ES_ListSpecies.cfm accessed online February 24, 2014.								

C. State-Listed Threatened Species

- Cascade Caverns salamander (*Eurycea latitans complex*), a threatened subaquatic species found in the Guadalupe river watershed within the Edwards Aquifer area. Impacts to the Edwards Aquifer could affect this species.
- Comal blind salamander (Eurycean tridentifera), threatened species found in springs and waters of caves. Impacts to the Edwards Aquifer could affect this species.
- Bald eagle (*Haliaeetus leucocephalus*) — The bald eagle is a state-listed threatened species that could occur as a migrant near major aquatic resources. Although they breed primarily in the eastern half of the state, they could potentially occur along rivers or large lakes in this region of Texas during the winter and during migration. This species could potentially occur near perennial waterways.
- Peregrine ralcon (*Falco peregrinus*), including the American peregrine falcon (*F. p. anatum*) subspecies, is a state threatened bird that could be a possible migrant. These birds utilize a wide range of habitats during migration, including urban areas and landscape edges such as lakes or large river shores. No impacts are anticipated from the project.
- Wood stork (*Mycteria americana*), migrant to the area which forages in ponds and ditches. No impacts are anticipated from the project.
- Zone-tailed hawk (*Buteo albonotatus*), found in arid open country near watercourses. No impact to this species is anticipated from the project.
- False spike mussel (*Quadrula mitchelli*) is state threatened freshwater mollusk. The TPWD county list states the species as possibly extirpated in Texas. This species was could potentially occur in the Guadalupe River although no impacts to this species are anticipated.
- Cagle's map turtle (*Graptemys caglei*) is a state threatened reptile which occupies riverine habitat in the Guadalupe-San Antonio river systems. They prefer shallow water with swift to moderate flow and a substrate of gravel or cobble or deeper pools with a slower flow rate and a substrate of silt or mud. The

NDD depicts an approximately 5 mile stretch of recorded Cagle's map turtle observations downstream of the project area along the Guadalupe River. No impacts to this species are anticipated from this project.

- Texas horned lizard (*Phrynosoma cornutum*) is a state threatened reptile present throughout much of the state. They exist in open, arid, and semi-arid regions with sparse vegetation, which includes grass, cactus, scattered brush or scrubby trees. This species could potentially occur in areas with this type of contiguous vegetation although significant impacts are not anticipated from this project.
- Texas tortoise (*Gopherus berlandieri*) is a state threatened reptile that is active in the warmer months of March through November. They occur in open brush with a grass understory and will avoid areas of open grass or bare ground. This species could potentially occur in areas with this type of contiguous vegetation although any impacts are anticipated to be temporary and minor.
- Timber/Canebrake rattlesnake (*Crotalus horridus*) is a state threatened reptile that occurs in swamps, floodplains, upland pine and deciduous woodlands, riparian zones, and abandoned farmland. This species could potentially occur in areas of abandoned farmland or forested riparian areas. Impacts from this project to this species are not anticipated.
- Additional species of concern occur within the project area, including species which are dependent on habitat which is supported by spring flow or aquifer occurrence. Implementation of this project would require field surveys by qualified professionals to document vegetation/habitat types, waters of the U.S. including wetlands and cultural resources that may be impacted. Where impacts to protected species habitat or significant cultural resources cannot be avoided, additional studies would be necessary to evaluate habitat use and/or value, or eligibility for inclusion in the National Register of Historic Places, respectively.

5.2.9.4 Engineering and Costing

Preliminary engineering and costing analyses have been performed for three WTP expansions and four ASR scenarios.

The preliminary design for ASR is to utilize the Trinity Aquifer west of I-35 and to install the wells and facilities on City owned property. As determined by Malcolm-Pirnie/ARCADIS, the Lower Glen Rose and the Hosston-Silago formation are suitable for storage and recovery of treated water. This hydrogeologic setting allows the installation of two ASR wells at one site (one in the relatively shallow Lower Glen Rose and the other in the relatively deep Hosston-Silago), which reduces cost for collector pipelines, treatment of recovered water, and operations. The proposed design is to: (1) select the ASR well sites near a treated water distribution system main, (2) divert the water from the distribution system to the well head through a two-way collector pipeline, (3) utilize system pressure to inject the water into the ASR well, (4) operate the well pump to recover the stored water, (5) disinfect the recovered water at the well head, and (6) pump the water back through the two-way collector pipeline to the distribution system. Based on the Malcolm-Pirnie/ARCADIS report, injection and recovery rates for both formations are estimated to be 500 and 400 gallons per minute (gpm) respectively.

The modeling analyses show that two (2) Trinity wells are needed with the current WTP, and four (4) Trinity wells are needed with WTP expansions up to a total WTP capacity of 15.0 MGD. With two wells per site, one (1) site is required for the current WTP system, and two (2) sites are required for the expansions. The capacity of the two-way collector pipeline and disinfection is 1,000 gpm. For planning purposes, the collector pipeline is assumed to be 500 ft long.

Region L cost estimates for three WTP expansions and four WTP expansion-ASR scenarios are shown in Table 5.2.9-5, and Table 5.2.9-6, respectively. Figure 5.2.9-3 shows the unit cost for three WTP expansions and WTP expansions in combination with four ASR projects. The unit cost of water is least expensive with the ASR only project in $385 per acft/yr, however, the project yield is only 800 acft/yr. The largest project, which has a WTP expansion of 7.5 MGD and supporting ASR system, is next to the least expensive project, has a unit cost of $462 per acft/yr, and yields 8,300 acft/yr. The most expensive project in terms unit cost is a 2.5 MGD expansion of the WTP without ASR. Adding ASR to this project reduces the unit cost by nearly 25 percent.

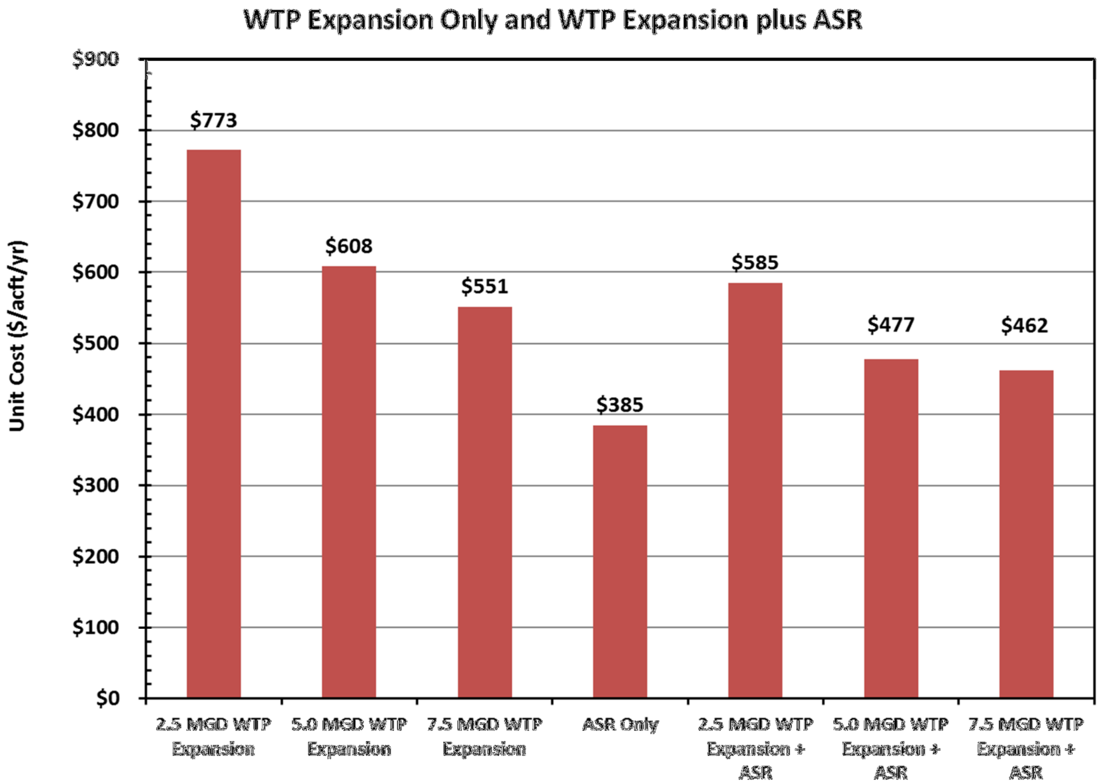
Table 5.2.9-5 Cost Estimate Summary for WTP Only

	2.5 MGD	5.0 MGD	7.5 MGD
Item	**Estimated Costs for Facilities**		
Water Treatment Plant Expansion	$7,129,000	$10,936,000	$14,744,000
TOTAL COST OF FACILITIES	**$7,129,000**	**$10,936,000**	**$14,744,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$2,495,000	$3,828,000	$5,160,000
Interest During Construction (4% for 1 years with a 1% ROI)	$337,000	$517,000	$697,000
TOTAL COST OF PROJECT	**$9,961,000**	**$15,281,000**	**$20,601,000**
ANNUAL COST			
Debt Service (5.5 percent, 20 years)	$833,000	$1,279,000	$1,724,000
Operation and Maintenance			
Water Treatment Plant (2.5% of Cost of Facilities)	$713,000	$1,094,000	$1,474,000
TOTAL ANNUAL COST	**$1,546,000**	**$2,373,000**	**$3,198,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 1	2,000	3,900	5,800
Annual Cost of Water ($ per acft)	$773	$608	$551
Annual Cost of Water ($ per 1,000 gallons)	$2.37	$1.87	$1.69

Table 5.2.9-6 Cost Estimate Summary for Expansion of WTP and ASR

	ASR Only	***2.5 MGD + ASR***	***5.0 MGD + ASR***	***7.5 MGD + ASR***
Item	***Estimated Costs for Facilities***			
Well Fields (Wells, Pumps, and Piping)	$1,902,000	$3,805,000	$3,805,000	$3,805,000
Water Treatment Plant Expansion and Disinfection of Recovered Water	$63,000	$7,247,000	$11,076,000	$14,883,000
Integration, Relocations, & Other	$54,000	$108,000	$108,000	$108,000
TOTAL COST OF FACILITIES	**$2,019,000**	**$11,160,000**	**$14,989,000**	**$18,796,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$707,000	$3,906,000	$5,246,000	$6,579,000
Environmental & Archaeology Studies and Mitigation	$2,000	$5,000	$5,000	$5,000
Interest During Construction (4% for 1 years with a 1% ROI)	$96,000	$528,000	$709,000	$889,000
TOTAL COST OF PROJECT	**$2,824,000**	**$15,599,000**	**$20,949,000**	**$26,269,000**
ANNUAL COST				
Debt Service (5.5 percent, 20 years)	$236,000	$1,305,000	$1,753,000	$2,198,000
Operation and Maintenance				
Intake, Pipeline, Pump Station (1% of Cost of Facilities)	$19,000	$38,000	$38,000	$38,000
Water Treatment Plant (2.5% of Cost of Facilities)	$38,000	$784,000	$1,177,000	$1,558,000
Pumping Energy ($/kwhr)	$15,000	$37,000	$37,000	$37,000
TOTAL ANNUAL COST	**$308,000**	**$2,164,000**	**$3,005,000**	**$3,831,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 1	800	3,700	6,300	8,300
Annual Cost of Water ($ per acft)	$385	$585	$477	$462
Annual Cost of Water ($ per 1,000 gallons)	$1.18	$1.79	$1.46	$1.42

Figure 5.2.9-3 Unit Cost for WTP Expansion and WTP Expansion with ASR



5.2.9.5 Implementation Issues

Implementation of the ASR strategy for NBU will require permits and approvals from Texas Commission on Environmental Quality (TCEQ) and EAA. Requirements by each agency are discussed below.

TCEQ:

- An ASR well is authorized as a Class V injection well. Key requirements for permits to construct and operate a Class V injection well are mechanical integrity of the well, pollution control, and periodic reports.
- Specific to the Edwards Aquifer (Balcones Fault Zone), the source water for injection by an ASR well that transect or terminate in the Edwards Aquifer must be from the Edwards Aquifer.
- The run-of-the-river permits will need to be amended for injection and recovery operations.

EAA:

- Current rules do not address injection and recovery with ASR wells. Instead, ASR rules are based on natural recharge along streams in the Edwards outcrop and recovery from remote water supply wells.

- Source water for recharge is not to include: (1) any surface water unless it is recharged through a "natural recharge feature", and (2) other than the Edwards Aquifer.
- Prior approval is required for submitting a recharge/recovery permit application to EAA.
- Natural recharge must be withdrawn within 12 months. The amount of the recovery must account for losses.
- Separate recharge and recovery permits are required.
- Rules allow for interlocal agreements between EAA and applicants.

This NBU ASR strategy of injecting non-Edwards water into the Trinity ~~Aquiferor~~Aquifer or the brackish zone of the Edwards with ASR wells conflicts with TCEQ and EAA rules and would require waivers. The possibilities or difficulties in getting these waivers are not known.

The hydrogeology of the Trinity Aquifer and brackish Edwards in the vicinity of the City is poorly defined. Of some concern is the influence of the numerous faults in the Balcones Fault Zone that may compartmentalize the aquifer and restrict the aquifer's storage capacity in the vicinity of ASR wells. This lack of definition causes an uncertainty on migration of the stored water and potential losses over a long-term.

There is no local groundwater conservation district to regulate the Trinity Aquifer in Comal County. Thus, local permits and approvals are not required.

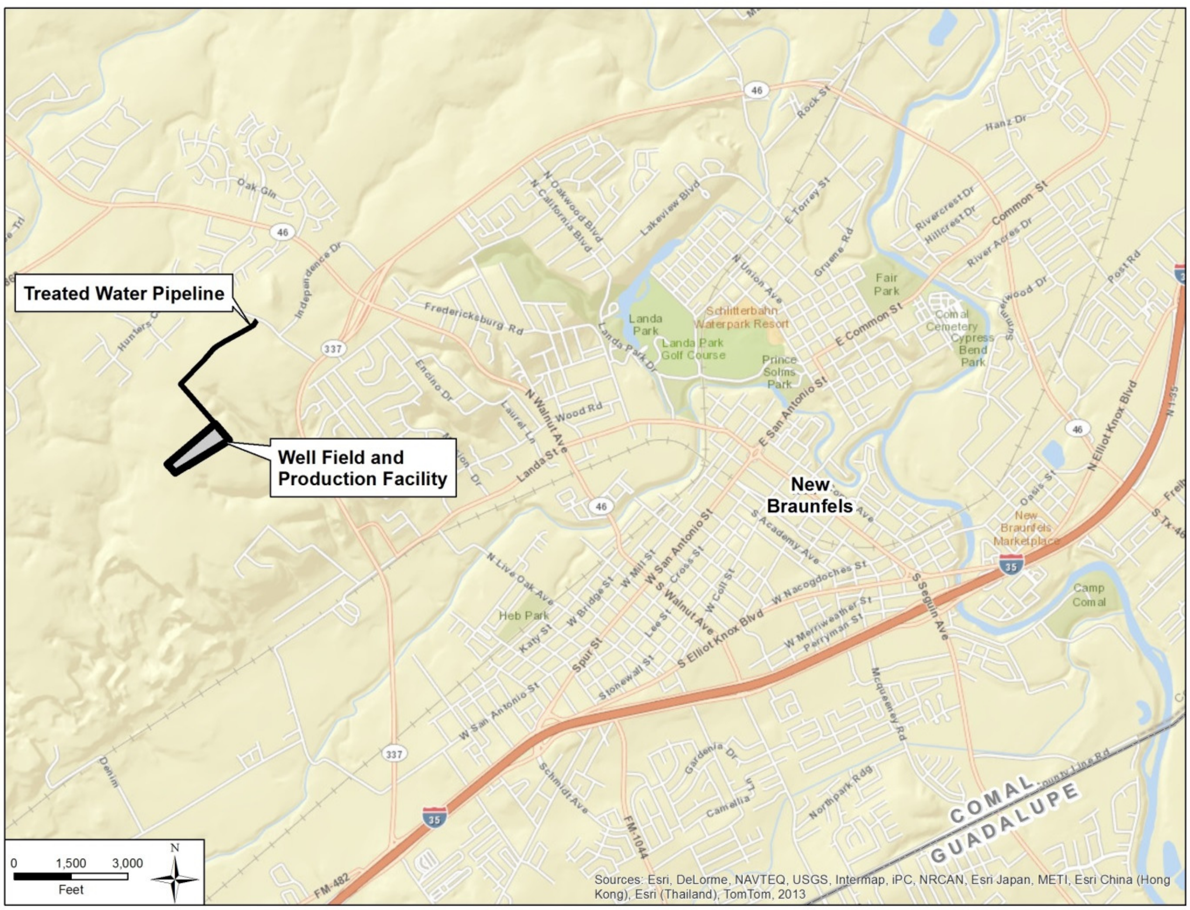
5.2.10 Trinity Groundwater for New Braunfels Utilities

5.2.10.1 Description of Water Management Strategy

New Braunfels Utilities (NBU) has several sources of water, including: (1) run-of-the-river water rights from the Guadalupe River, (2) stored water in Canyon Reservoir under a contract with Guadalupe-Blanco River Authority (GBRA), and (3) groundwater from the Edwards Aquifer through permits with the Edwards Aquifer Authority (EAA). In 2011, NBU began investigating the potential of the Trinity Aquifer as another source water. This investigation has included drilling a test well on the west side of New Braunfels and preparing preliminary designs for a Trinity well field, production facilities, and integration into the current distribution system.

The location of the Trinity Aquifer well field and production facilities being considered is shown in Figure 5.2.10-1.

Figure 5.2.10-1 Potential Location of Trinity Aquifer Project



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5.2.10.2 Available Yield

The NBU preliminary design phase includes two production wells with the possibility of expanding the well field to four wells. With an estimated well yield of 400-500 gallons per minute (gpm), peak production is expected to range between 1.0 and 3.0 million gallons per day (MGD) for the two well field sizes. Before constructing the additional two wells, an estimate of the magnitude of well interference and long-term impact on Trinity Aquifer conditions will be made by analyzing data collected from the initial two Trinity wells.

For purposes of this water management strategy, it is assumed that four wells are feasible and have an average peak production rate of 450 gpm. Assuming one of the wells is for standby or contingency and a peaking factor of 2.0, the project yield is 1,090 acft/yr and has a peak capacity of 1.9 MGD

An assessment of groundwater availability consists of calculating a water balance of the Trinity Aquifer in Comal County between the supply, as determined by from the Modeled Available Groundwater (MAG), and the estimated demands from current users. These calculations suggest that there is sufficient groundwater availability for this project.

5.2.10.3 Environmental Issues

The Trinity Groundwater for New Braunfels Utilities water management strategy involves four new water wells, a collection pipeline, ground storage tank, water treatment plant (WTP), pump station and transmission pipeline. Environmental issues for this water management strategy are described below.

The project area occurs within the Edwards Plateau ecoregion1 and is within portions of the Balconian biotic province.2 The wells, storage tank, pipelines and the WTP site are anticipated to have limited impacts to existing terrestrial habitat. The project area includes some residential single and multifamily structures near the intersection of Hunters Ridge and Oak Run Parkway. The remaining project area is relatively undeveloped. The project area is located within an area identified by Texas Parks and Wildlife Department (TPWD) as live oak-Ashe juniper woods.

Outside any required maintained right-of-way, land use would not be anticipated to change due to the well or pipeline construction. Impacts to land use would be limited to the removal of existing vegetation and temporary impacts during construction. Herbaceous habitats would recover fastest from construction impacts and would experience low negative impacts. Any impacts to woody vegetation would be permanent within areas of pipeline and WTP maintenance. The proposed wells would have a minimal impact on vegetation within the project area due to limited surface exposure.

The project area lies within an environmentally sensitive area known as the Edwards Aquifer. Numerous enhanced karst features occur within this area, and as a result the Edwards Aquifer is one of the most productive groundwater reservoirs in the country. The project area is located within the recharge zone of the Edwards Aquifer. The recharge zone includes an area where highly faulted and fractured Edwards limestone outcrops occur at the surface, providing a means for large quantities of water to flow into the Edwards Aquifer. Recognizing the importance of maintaining water quality within the

[1] Gould, F.W. 1975. The Grasses of Texas. Texas A&M University Press. College Station, Texas.
[2] Blair, W.F., "The Biotic Provinces of Texas, "Tex. J. Sci. 2:93-117, 1950.

Edwards Aquifer, the Texas legislature mandated the protection of this aquifer through the TCEQ under Title 30 Texas Administrative Code (TAC), Chapter 213.

No crossings of jurisdictional waters could occur from this project. Runoff from the project area would enter Dry Comal Creek and ultimately the Guadalupe River. Avoidance and minimization measures, including construction best management practices (BMPs) would reduce the potential impacts from pipelines and other construction activities. The WTP site, pipelines, storage tank and wells are located within Federal Emergency Management Agency (FEMA) floodplain Zone X which does not include flood hazard areas.

The TCEQ 2010 Texas Integrated Report for Clean Water Act Section 303(d) lists Dry Comal Creek as a Category 5b water body. This listing indicates Dry Comal Creek is impaired because it "does not meet applicable water quality standards or is threatened for one" and "a review of the water quality standards for this water body will be conducted before a Total Maximum Daily Load (TMDL) is scheduled." Bacteria levels are the parameter on which TCEQ bases this designation. The designation applies to TCEQ Segment ID 1811A, which occurs from the confluence of the Comal River in New Braunfels in Comal County to the upstream perennial portion of the stream southwest of New Braunfels. Any potential impacts to this river segment from the development of this project would be temporary and avoidable with the use of minimization practices such as BMPs.

The TPWD has identified a number of stream segments throughout the state as ecologically significant on the basis of biological function, hydrologic function, riparian conservation, exceptional aquatic life uses, and/or threatened or endangered species. Currently, twenty one stream segments in Region L are considered ecologically significant by the TPWD.3

The Guadalupe River from the confluence of the Comal River upstream to the Kendall/Kerr County Line, with the exception of Canyon Reservoir is considered to be ecologically significant on the basis of hydrologic function, the existence of a riparian conservation area (Guadalupe River State Park), and high water quality/exceptional aquatic life/high aesthetic value.

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 (Pl96-515), and the Archeological and Historic Preservation Act (PL93-291). Based on the review of available Texas Historical Commission (THC) geographic information system (GIS) datasets, there are no cemeteries, national register properties or districts, or historical markers located near or within the project area. However records from the THC indicate that an archeological testing survey was conducted in the project area.

A review of archaeological resources in the proposed project area should be conducted during the project planning phase. Taking into consideration that the owner or controller of the project will likely be a political subdivision of the State of Texas (i.e. river authority,

[3] TPWD, "Ecologically Significant River and Stream Segments," http://www.tpwd.state.tx.us/landwater/water/environconcerns/water_quality/sigsegs/index.phtml accessed February 6, 2014.

municipality, county, etc.), they will be required to coordinate with the Texas Historical Commission regarding impacts to cultural resources.

The species listed by U.S. Fish and Wildlife Service (USFWS), and TPWD, as endangered or threatened with potential habitat in Comal County are listed in Table 5.2.10-1. Information provided by the Texas Natural Diversity Database (TXDD), which is maintained by TPWD, was included in this analysis. The TXDD documents the occurrence of rare species within Texas. No listed species have been recorded within the project area; however the Texas blind salamander, an endangered species, has been documented less than one mile from the project area, and three plant species of concern including the Texas amorpha, bracted twistflower and buckley tridens occur within the project area. The absence of data from the TNDD does not imply the absence of occurrence for listed species. The well field, pumps, pipelines, and WTP site include limited potential for impacts to listed species.

The project area may provide potential habitat to endangered or threatened species found in Comal County. A survey of the project area may be required prior to pipeline, WTP, storage tank and well construction to determine whether populations of or potential habitats used by listed species occur in the area to be affected. Coordination with TPWD and USFWS regarding threatened and endangered species with the potential to occur in the project area should be initiated early in project planning.

Based on existing habitat types, the following species have potential to occur near or within the project area. The aquatic species are primarily a concern if project actions negatively impact the Edwards or Trinity Aquifers.

A. Federal and State-Listed Endangered Species

- Texas blind salamander (Eurycea rathbuni), recorded occurrence less than one mile from the project area.
- Black-capped vireo (Vireo atricapilla), no confirmed sightings within the project area. Potential for preferred habitat within the project area is low.
- Golden-cheeked warbler (Setophaga chrysoparia), no confirmed sightings within the project area, however potential habitat may occur.
- Whooping Crane (Grus americana) — The Whooping Crane is a federally listed species which occurs in Texas only during migration. Whooping cranes use a variety of habitats during migration, including croplands for feeding and large, marshy palustrine wetlands for roosting.
- Fountain darter (Etheostoma fonticola), this small fish is only known from the San Marcos and Comal Rivers.
- Comal Springs dryopid beetle (Stygoparnus comalensis), critical habitat for this species has been established at Comal Springs which occurs 1.7 mile east of the project area.
- Comal Springs riffle beetle (Heterelmis comalensis), critical habitat for this species has been established at Comal Springs which occurs 1.7 mile east of the project area.

- Jaguarundi (Herpailurus yaguarondi), preferred habitat of thick brushlands near water is not present within the project area.

B. Federal-Listed Candidate Species

- Golden Orb (Quadrula aurea) — The golden orb is a federal candidate for listing and is state threatened. This freshwater mollusk exists in sand, gravel or mud substrates within lake or river systems. The TPWD designates a segment of the Guadalupe River as an
- Ecologically Significant Stream Segment based on the occurrence of the golden orb.
- This species could potentially occur in perennial water sources like the Guadalupe River.
- Texas fatmucket (Lampsislis bracteata), this species is a federal candidate for listing in the state and is state threatened. This freshwater mollusk exists in more shallow rivers or streams with substrates of sand, mud and gravel. This species could potentially occur in perennial streams, like the Guadalupe River.

C. State-Listed Threatened Species

- Cascade Caverns salamander (Eurycea latitans complex), a threatened subaquatic species found in the Guadalupe river watershed within the Edwards Aquifer area. Impacts to the Edwards Aquifer could affect this species.
- Comal blind salamander (Eurycean tridentifera), threatened species found in springs and waters of caves. Impacts to the Edwards Aquifer could affect this species.
- Bald eagle (Haliaeetus leucocephalus) — The bald eagle is a state-listed threatened species that could occur as a migrant near major aquatic resources. Although they breed primarily in the eastern half of the state, they could potentially occur along rivers or large lakes in this region of Texas during the winter and during migration. This species could potentially occur near perennial waterways.
- Peregrine falcon (Falco peregrinus), including the American peregrine falcon (F. p. anatum) subspecies, is a state threatened bird that could be a possible migrant. These birds utilize a wide range of habitats during migration, including urban areas and landscape edges such as lakes or large river shores.
- Zone-tailed hawk (Buteo albonotatus), found in arid open country near watercourses.
- False spike mussel (Quadrula mitchelli) is state threatened freshwater mollusk. The TPWD county list states the species as possibly extirpated in

Texas. This species could potentially occur in perennial water sources like the Guadalupe River.

- Cagle's map turtle (Graptemys caglei) is a state threatened reptile which occupies riverine habitat in the Guadalupe-San Antonio river systems. They prefer shallow water with swift to moderate flow and a substrate of gravel or cobble or deeper pools with a slower flow rate and a substrate of silt or mud.
- Texas horned lizard (Phrynosoma cornutum) is a state threatened reptile present throughout much of the state. They exist in open, arid, and semi-arid regions with sparse vegetation, which includes grass, cactus, scattered brush or scrubby trees. This species could potentially occur in areas with this type of contiguous vegetation.

Additional species of concern occur within the project area, including species which are dependent on habitat which is supported by spring flow or aquifer occurrence. Implementation of this project would require field surveys by qualified professionals to document vegetation/habitat types and cultural resources that may be impacted. Where impacts to protected species habitat or significant cultural resources cannot be avoided, additional studies would be necessary to evaluate habitat use and/or value, or eligibility for inclusion in the National Register of Historic Places, respectively.

Table 5.2.10-1 Endangered, Threatened, and Species of Concern for Comal County

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
AMPHIBIANS								
Cascade Caverns salamander	*Eurycea latitans complex*	1	2	2	Endemic subaquatic species found in the Medina and Guadalupe Rivers and Cibolo Creek watersheds within the Edwards Aquifer area.		T	Resident
Comal blind salamander	*Eurycea tridentifera*	1	2	2	Endemic semi-troglobitic species found in springs and waters of caves.		T	Resident
Comal Springs salamander	*Eurycea sp. 8*	1	1	1	Endemic species found in Comal Springs.			Resident
Edwards Plateau spring salamanders	*Eurycea sp. 7*	1	1	1	Endemic species found in springs and caves of the region.			Resident
Texas blind salamander	*Eurycea rathbuni*	1	3	3	Troglobitic species found in water-filled subterranean caverns.	LE	E	Resident
BIRDS								
American peregrine falcon	*Falco peregrinus anatum*	0	2	0	Migrant and local breeder in West Texas.	DL	T	Possible Migrant

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
Artic peregrine falcon	*Falco peregrinus tundrius*	0	1	0	Migrant throughout the state.	DL		Possible Migrant
Bald eagle	*Haliaeetus leucocephalu s*	0	2	0	Found primarily near rivers and large lakes.	DL	T	Possible Migrant
Black-capped vireo	*Vireo atricapilla*	0	3	0	Oak-juniper woodlands with distinctive patchy, tow-layered aspect.	LE	E	Possible Migrant
Golden-cheeked warbler	*Setophaga chrysoparia*	1	3	3	Juniper-oak woodlands, dependent on mature Ashe juniper for bark.	LE	E	Possible Migrant
Mountain plover	*Charadrius montanus*	1	1	1	Non-breeding, shortgrass plains and fields			Nesting/ Migrant
Sprague's pipit	*Anthus spragueii*	0	1	0	Migrant in Texas in winter mid Sept. to early April. Strongly tied to native upland prairie.			Possible Migrant
Western burrowing owl	*Athene cunicularia hypugaea*	1	1	1	Open grasslands, especially prairie, plains and savanna			Resident
Whooping crane	*Grus americana*	0	3	0	Potential migrant	LE	E	Potential Migrant
Zone-tailed hawk	*Buteo albonotatus*	0	2	0	Located in arid open county, often near watercourses.		T	Resident
CRUSTACEANS								
Ezell's cave amphipod	*Stygobromus flagellates*	0	1	0	Aquatic obligate known only from artesian wells.			Occurs near San Marcos
Long-legged cave amphipod	*Stygobromus longipes*	0	1	0	Subaquatic, subterranean obligate			Resident
Peck's cave amphipod	*Stygobromus pecki*	0	3	0	Small, aquatic species which lives underground in the Edwards Aquifer.	LE	E	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
FISHES								
Fountain darter	*Etheostoma fonticola*	1	3	1	Known only from the San Marcos and Comal Rivers.	LE	E	Resident
Guadalupe bass	*Micropterus treculi*	1	1	1	Endemic to perennial streams of the Edwards Plateau region.			Resident
Guadalupe darter	*Percina sciera apristis*	1	1	1	Guadalupe River Basin. Usually found over gravel or gravel and sand raceways of larger streams and rivers.			Resident
INSECTS								
A mayfly	*Campsurus decolaratus*	0	1	0	In Texas and Mexico, possibly clay substrates, found in shoreline vegetation.			Resident
Comal Springs diving beetle	*Comaldessus stygius*	1	1	1	Known only from the outflows at Comal Springs, aquatic.			Resident
Comal Springs dryopid beetle	*Stygoparnus comalensis*	1	3	3	Usually found clinging to objects in a stream.	LE	E	Resident
Comal Springs riffle beetle	*Heterelmis comalensis*	1	3	3	Found in Comal and San Marcos Springs	LE	E	Resident
Edwards Aquifer diving beetle	*Haideoporus texanus*	0	1	0	Known from an artesian well in Hays County			Potential Resident
Rawson's metalmark	*Calephelis rawsoni*	1	1	1	Found in moist areas in shaded limestone outcrops in central Texas.			Resident
MAMMALS								

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
Black bear	*Ursus americanus*	0	2	0	Found in bottomland hardwoods and large tracts of inaccessible forested areas.	T/SA; NL	T	Historic Resident
Cave myotis bat	*Myotis velifer*	0	1	0	Roosts colonially in caves, rock crevices			Resident
Jaguarundi	*Herpailurus yaguarondi*	0	3	0	Thick brushlands near water is favored by this species.	LE	E	Resident
Plains spotted skunk	*Spilogale putorius interrupta*	1	1	1	Prefers wooded, brushy areas.			Resident
Red wolf	*Canis rufus*	0	3	0	Extirpated, formerly known throughout the eastern half of Texas.	LE	E	Historic Resident
MOLLUSKS								
Creeper (squawfoot)	*Strophitus undulates*	1	1	1	Small to large streams. Colorado, Guadalupe, and San Antonio River basins.			Resident
False spike mussel	*Quincuncina mitchelli*	1	2	2	Substrates of cobble and mud. Rio Grande, Brazos, Colorado and Guadalupe river basins.		T	Resident
Golden orb	*Quadrula aurea*	1	2	2	Sand and gravel, Guadalupe, San Antonio, Lower San Marcos, and Nueces River basins	C	T	Resident
Horseshoe liptooth snail	*Daedalochila hippocrepis*	1	1	1	Terrestrial snail known only from Landa Park in New Braunfels.			Resident
Texas fatmucket	*Lampsilis bracteata*	1	2	2	Streams and rivers on sand, mud and gravel, Colorado and Guadalupe River basins.	C	T	Resident
PLANTS								

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
Bracted twistflower	*Streptanthus bracteatus*	1	1	1	Texas endemic found in oak juniper woodlands.	C		Resident
Comal snakewood	*Colubrina stricta*	0	1	0	Historic in Comal Co., generally found in shrublands.			Historic Resident
Hill country wild-mercury	*Argthamnia aphoroides*	0	1	0	Texas endemic found primarily in bluestem-grama grasslands associated with plateau live oak woodlands.			Resident
Texas mock-orange	*Philadelphus texensis*	0	1	0	Found on limestone outcrops on cliffs and rocky slopes.			Resident
REPTILES								
Cagle's map turtle	*Graptemys caglei*	1	2	2	Endemic to Guadalupe River System. Found near waters' edge.		T	Resident
Spot-tailed earless lizard	*Holbrookia lacerata*	1	1	1	Moderately open prairie-brushland.			Resident
Texas Garter Snake	*Thamnophis sirtalis annectens*	1	1	1	Wet or moist microhabitats			Resident
Texas Horned Lizard	*Phrynosoma cornutum*	1	2	2	Varied, sparsely vegetated uplands.		T	Resident

TPWD, 2014. Annotated County List of Rare Species – Comal County, revised 10/2/2012.
USFWS, 2014. Endangered Species List for Texas. http://www.fws.gov/southwest/es/ES_ListSpecies.cfm accessed online February 24, 2014.

5.2.10.4 Engineering and Costing

The proposed site of the Trinity well field is on the west side of the City of New Braunfels (City). More specifically, it is in the vicinity of Loop 377 and Oak Run Parkway and on property owned by the City. A 10-inch test well has been drilled and tested on this site. The well was 620 ft deep and completed open-hole. A pumping test was conducted at an average rate of 304 gpm for 36 hours. The specific capacity was 23 gpm/ft. Water quality data indicate that the water meets public drinking water standards.

NBU's Trinity Aquifer water management strategy consists of Trinity wells, collection pipelines, a ground storage tank, water treatment facilities, pump station and a treated water transmission pipeline to the existing distribution system at Oak Run Parkway. Well pumps are to deliver the raw groundwater to a ground storage tank at the production facility. Depending on system demands, raw water will be drawn from the ground storage tank, disinfected, and pumped under sufficient pressure to deliver the water into the existing distribution system. Initially, two Trinity wells are planned. Pending the performance of these wells and drawdown interference among the wells, the well field may be expanded to four wells. For purposes of this water management strategy, it is assumed that performance will be satisfactory and four Trinity wells are feasible.

Based on the test well, the Trinity wells are estimated to be about 620 deep and yield an average of 450 gpm. Assuming that production among the wells is rotated so that one of the wells is considered being a standby for contingency purposes, the peak capacity is 1.9 MGD. Assuming the peaking factor of 2.0, the project yield is 1,090 acft/yr.

The engineering and costing analysis for the NBU Trinity Well Project includes all facilities required to deliver treated water to the existing NBU water distribution system. This includes four 620-ft Trinity wells rated at 450 gpm, about 1,400 ft of collector pipeline, a ground storage tank to hold the water from six hours of well production, disinfection water treatment, a high service pump station, a 3,500 ft treated water pipeline, and an interconnect to the existing distribution system.

Cost estimates were computed for capital costs, annual debt service, operation and maintenance, power, land, and environmental mitigation. These costs are summarized in Table 5.2.10-2. The project costs, including capital, are estimated to be $5,947,000. As shown, the annual costs, including debt service, operation and maintenance, power, and groundwater leases, are estimated to be $691,000. This option produces potable water at an estimated cost of $634 per acft ($1.95 per 1,000 gallons).

Table 5.2.10-2 Cost Estimate Summary

Item	*Estimated Costs for Facilities*
CAPITAL COST	
Intake Pump Stations (0 MGD)	$1,169,000
Transmission Pipeline (1 mile)	$145,000
Well Fields (Wells, Pumps, and Piping)	$2,162,000
Storage Tanks (Other Than at Booster Pump Stations)	$412,000
Water Treatment Plant (1.9 MGD)	$106,000
Integration, Relocations, & Other	$250,000
TOTAL COST OF FACILITIES	**$4,244,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$1,478,000
Environmental & Archaeology Studies and Mitigation	$23,000
Interest During Construction (4% for 1 years with a 1% ROI)	$202,000
TOTAL COST OF PROJECT	**$5,947,000**
ANNUAL COST	
Debt Service (5.5 percent, 20 years)	$498,000
Operation and Maintenance	
Intake, Pipeline, Pump Station (1% of Cost of Facilities)	$56,000
Water Treatment Plant (2.5% of Cost of Facilities)	$64,000
Pumping Energy Costs (809,939 kW-hr @ 0.09 $/kW-hr)	$73,000
TOTAL ANNUAL COST	**$691,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 2	1,090
Annual Cost of Water ($ per acft)	$634
Annual Cost of Water ($ per 1,000 gallons)	$1.95

5.2.10.5 Implementation Issues

Implementation of the Trinity strategy for NBU will require permits and approvals from Texas Commission on Environmental Quality (TCEQ) and EAA. Requirements by each agency are discussed below.

TCEQ:

- Review and approval of technical specifications for all new water facility components of the water system.
- Review and approval of facilities and water quality to put the facility into operation.

EAA:

- Review and permit the construction of wells passing through the Edwards Aquifer.

There is no local groundwater conservation district to regulate the Trinity Aquifer in Comal County. Thus, no local permits and approvals are required.

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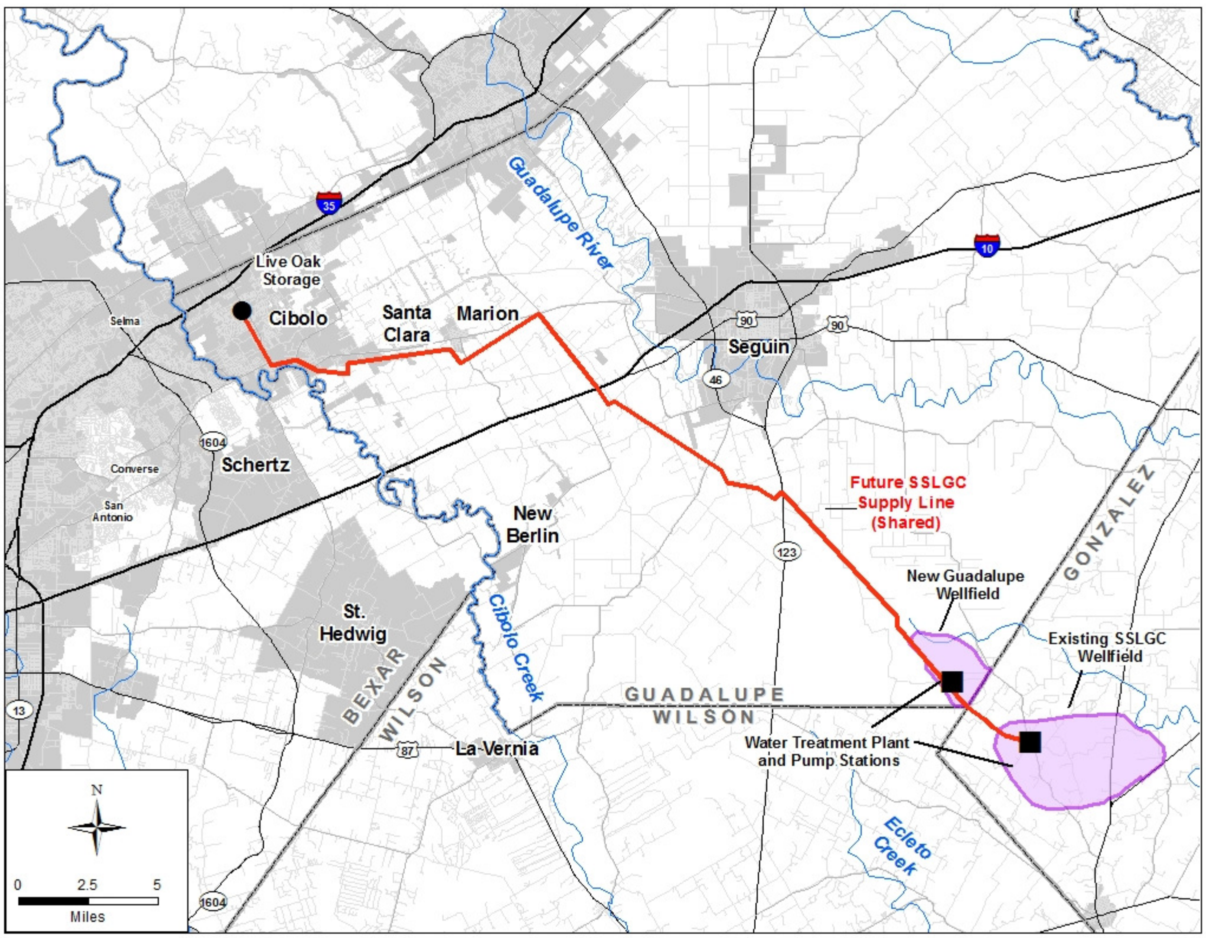
5.2.11 Expanded Carrizo Project for SSLGC

5.2.11.1 Description of Water Management Strategy

The Schertz-Seguin Water Supply Project, owned and operated by Schertz-Seguin Local Government Corp (SSLGC), currently holds permits to pump 19,362 acft/yr of groundwater from the Carrizo Aquifer in western Gonzales County and 3,226 acft/yr from the Carrizo Aquifer in southeastern Guadalupe County. The primary recipients of the water are the cities of Schertz and Seguin. SSLGC also provides some water to the cities of Selma, Universal City, Converse, Springs Hill WSC and SAWS. The project presently consists of eight 1,000-gpm Carrizo wells in western Gonzales County. The expansion into Guadalupe County is planned to increase the total supply by 6,500 acft/yr, leading to a combined Carrizo supply of 19,410 acft/yr. Figure 5.2.11-1 illustrates the existing Schertz-Seguin Water Supply Project system and proposed new wellfield.

Figure 5.2.11-1 Schertz-Seguin Water Supply Project



5.2.11.2 Available Yield

The Carrizo Aquifer in the vicinity of the planned well field is in the confined part of the aquifer and approximately two miles downdip of the outcrop. Hydrogeologic maps of the aquifer in this area suggest that wells would be capable of producing in excess of 500 gpm and would range in depth up to 800 ft deep. The wells are planned to be screened in the Carrizo Sand instead of the Wilcox Group for water quality and depth considerations. Groundwater quality in the planned well field usually has a concentration of total dissolved solids of less than 300 mg/L. However, the water typically has elevated concentrations of iron and manganese that requires removal before being used by the public.

Groundwater supply projects in Guadalupe County are subject to groundwater production, well spacing, and export of groundwater are subject to rules of the Guadalupe County Groundwater Conservation District (GCGCD).

A review of the Modeled Available Groundwater (MAG) and allocated supply (permitted water and exempt use) for Guadalupe County indicates a there is sufficient water available under the MAG to meet the demands of the project.

The project expansion is permitted and is located on lands owned or leased by SSLGC. The water is available under the MAG and, therefore, there are no anticipated impacts to agriculture in Guadalupe County.

5.2.11.3 Environmental Issues

The Expanded Carrizo project for SSLGC includes the construction of a new well field in Guadalupe County which will include eleven wells, installation of a pipeline collection system for the new wellfield, construction of a water treatment plant and pump station and connections to a planned 37 mile SSLGC shared transmission pipeline. This report section discusses the potential impacts to environmental and cultural resources known to exist within the proposed well field and pipeline areas.

The eastern portion of the project area primarily includes land in the Post Oak Savannah vegetational area, with the western portion of the proposed pipeline entering into the Blackland Prairies vegetational area.[1] The Post Oak Savannah vegetation area is now principally composed of rangeland, crops and post-oak woodlands. Common woody species include post oak (*Quercus stellata*), blackjack oak (*Quercus marilandica*), and species of *Carya* (hickory). Grasses of this area commonly include little bluestem (*Schizachyrium scoparium*), indiangrass (*Sorghastrum nutans*) and switchgrass (*Panicum virgatum*).

The Blackland Prairies vegetational area is a rolling and well-dissected area which was historically a luxuriant tallgrass prairie dominated by little bluestem (*Schizachyrium scoparium* var. *frequens*), big bluestem (*Andropogon gerardii*), indiangrass (*Sorghastrum nutans*), and dropseeds (*Sporobolus* sp.). However, during the turn of the 20th century, the majority of the Blackland Prairie was cultivated for crops. Livestock production in this area has increased dramatically since the 1950s and now only about half of this area is

[1] Gould, F.W., “The Grasses of Texas,” Texas A&M University Press, College Station, Texas, 1975.

used for cropland. Common woody species in this area include mesquite (*Prosopis glandulosa*), huisache (*Acacia smallii*), oak (*Quercus sp.*) and elm (*Ulmus sp.*).

Vertebrate fauna typifying these regions include the opossum, raccoon, weasel, skunk, white-tailed deer and bobcat as well as a wide variety of amphibians, reptiles and birds. The coyote and javelina are also common to the area, but are found mainly in brush/shrub areas while the red and gray fox are more common in woodlands.[2]

Plant and animal species listed by the USFWS and TPWD as endangered, threatened or rare in the project area are presented in Table 5.2.11-1. Inclusion in Table 5.2.11-1 does not mean that a species will occur within the project area, but only acknowledges the potential for its occurrence in the project area counties. In addition to the county lists, the Texas Natural Diversity Database (TXNDD) was reviewed for known occurrences of listed species within or near the project area. This database revealed known occurrences of Park's jointweed (Polygonella parksii) and sandhill woolywhite (Hymenopappus carrizoanus), both species of concern, near the project area. Parks jointweed is an endemic species which is usually found in deep, loose sand blowouts in post oak savannas. Sandhill woolywhite normally occurs in disturbed or open areas in grasslands and post oak woodlands on deep sands derived from the Carrizo Sand and similar Eocene formations. Species of concern are considered to be rare, but are not protected by USFWS or TPWD.

Table 5.2.11-1 Endangered, Threatened, Candidate and Species of Concern for Gonzales and Guadalupe Counties

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
BIRDS								
American peregrine falcon	*Falco peregrinus anatum*	0	3	0	Migrant and local breeder in West Texas.	DL	T	Possible Migrant
Arctic peregrine falcon	*Falco peregrinus tundrius*	0	2	0	Migrant throughout the state.	DL	--	Possible Migrant
Bald eagle	*Haliaeetus leucocephalus*	0	2	0	Primarily found near waterbodies.	DL	T	Nesting/ Migrant
Henslow's Sparrow	*Ammodramus henslowii*	0	1	0	Found in weedy fields or cut-over areas.	--	--	Possible Migrant
Interior least tern	*Sterna antillarum athalassos*	0	3	0	Nests along sand and gravel bars in braided streams	LE	E	Resident
Mountain plover	*Charadrius montanus*	1	1	1	Non-breeding, shortgrass plains and fields	--	--	Nesting/ Migrant

[2] Jones, J.K. et al., "Annotated Checklist of Recent Land Mammals of Texas," Occasional Papers of the Museum OP-119, Texas Tech University, 1988.

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
Sprague's pipit	*Anthus spragueii*	0	1	0	Migrant in Texas in winter mid Sept. to early April. Strongly tied to native upland prairie.	C	--	Possible Migrant
Western burrowing owl	*Athene cunicularia hypugaea*	1	1	1	Open grasslands, especially prairie, plains and savanna	--	--	Resident
Whooping crane	*Grus americana*	0	3	0	Potential migrant	LE	E	Potential Migrant
Wood stork	*Mycteria americana*	0	2	0	Forages in prairie ponds, ditches, and shallow standing water formerly nested in TX	--	T	Migrant
FISHES								
Blue sucker	*Cycleptus elongates*	1	2	2	Found in larger portions of major rivers in Texas.	--	T	Resident
Guadalupe bass	*Micropterus treculi*	1	1	1	Endemic to perennial streams of the Edwards Plateau region.	--	--	Resident
Guadalupe darter	*Percina sciera apristis*	0	1	0	Guadalupe River basin.	--	--	Resident
INSECTS								
A mayfly	*Campsurus decoloratus*	0	1	0	Found on clay substrates along shorelines.	--	--	Resident
MAMMALS								
Cave myotis bat	*Myotis velifer*	0	1	0	Roosts colonially in caves, rock crevices	--	--	Resident
Plains spotted skunk	*Spilogale putorius interrupta*	1	1	1	Prefers wooded, brushy areas.	--	--	Resident
Red wolf	*Canis rufus*	0	3	0	Extirpated.	LE	E	Historic Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
MOLLUSKS								
Creeper (squawfoot)	*Strophitus undulates*	1	1	1	Small to large streams. Colorado, Guadalupe, and San Antonio River basins.	--	--	Resident
False spike mussel	*Quincuncina mitchelli*	1	2	2	Substrates of cobble and mud. Rio Grande, Brazos, Colorado and Guadalupe river basins.	--	T	Resident
Golden orb	*Quadrula aurea*	1	2	2	Sand and gravel, Guadalupe, San Antonio, Lower San Marcos, and Nueces River basins	C	T	Resident
Palmetto pill snail	*Euchemotrema leai cheatumi*	0	1	0	Only known from Palmetto State Park	--	--	Resident
Texas fatmucket	*Lampsilis bracteata*	1	2	2	Streams and rivers on sand, mud and gravel, Colorado and Guadalupe River basins.	C	T	Resident
Texas pimpleback	*Quadrula petrina*	1	2	2	Mud, gravel and sand substrates, Colorado and Guadalupe river basins	C	T	Resident
PLANTS								
Big red sage	*Salvia pentstemonoides*	1	1	1	Texas endemic, found in moist to seasonally wet steep limestone outcrops on canyons or along creek banks.	--	--	Resident
Bristle nailwort	*Paronychia setacea*	0	1	0	Plant endemic to eastern south central Texas in sandy soils.	--	--	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
Buckley's spiderwort	*Tradescantia buckleyi*	1	1	1	Occurs on sandy loam or clay soils in grasslands or shrublands.	--	--	Resident
Elmendorf's onion	*Allium elmendorfii*	2	1	2	Endemic, found in deep sands	--	--	Resident
Green beebalm	*Monarda viridissima*	1	1	1	Endemic perennial herb. Found in well-drained sandy soils in opening of post oak woodlands.	--	--	Resident
Parks' jointweed	*Polygonella parksii*	2	1	2	Texas endemic, primarily found on deep, loose, sand blowouts in Post Oak Savannas.	--	--	Resident
Sandhill woolywhite	*Hymenopappus carrizoanus*	2	1	2	Found south of the Guadalupe River. Prefers dense riparian corridors.	--	--	Resident
REPTILES								
Cagle's map turtle	*Graptemys caglei*	1	2	2	Endemic species found in Guadalupe river system.	--	T	Resident
Spot-tailed earless lizard	*Holbrookia lacerata*	1	1	1	Moderately open prairie-brushland.	--	--	Resident
Texas Garter Snake	*Thamnophis sirtalis annectens*	1	1	1	Wet or moist microhabitats	--	--	Resident
Texas Horned Lizard	*Phrynosoma cornutum*	2	2	4	Varied, sparsely vegetated uplands.	--	T	Resident
Texas tortoise	*Gopherus berlandieri*	2	2	4	Open brush w/ grass understory.	--	T	Resident
Timber rattlesnake	*Crotalus horridus*	2	2	4	Floodplains, upland pine, deciduous woodlands, riparian zones.	--	T	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County

LE/LT=Federally Listed Endangered/Threatened
DL=Federally Delisted
C=Candidate for Federal Listing
E, T=State Listed Endangered/Threatened
Blank = Considered rare, but no regulatory listing status

TPWD, 2014. Annotated County List of Rare Species – Guadalupe County, revised 4/28/2014, Gonzales County revised 4/28/2014.
USFWS, 2014. Species List from http://ecos.fws.gov/tess_public/countySearch!speciesByCountyReport.action?fips=48187, accessed September 5, 2014.

After a review of the habitat requirements for each listed species, it is anticipated that this project will have no adverse effect on any federally listed threatened or endangered species, its habitat, or designated habitat, nor would it adversely affect any state endangered species.

Although suitable habitat for several state threatened species including the Texas Horned Lizard (*Phrynosoma cornutum)*, Texas tortoise (*Gopherus berlandieri)*, and timber rattlesnake (*Crotalus horridus)* may exist within the project area, no significant impact to these species is anticipated due to limited area that will be impacted by the project, the abundance of similar habit near the project area and these species ability to relocate to those areas if necessary. The presence or absence of potential habitat does not confirm the presence or absence of a listed species. No species specific surveys were conducted in the project area for this report.

Concerns associated with the development of the new well field area involve water levels in the aquifer and baseflow of the surrounding streams and wetlands. The possibility exists that water levels in the aquifer, affected by the additional wells, could decrease before stabilizing, thus affecting habitat within the area. Waters of the U.S. crossings within the well field area consists of the riverine habitat of Sandies Creek, as well as associated palustrine habitats that are generally composed of narrow bands of wetlands adjacent to this watercourse. Although the USFWS National Wetlands Inventory (NWI) maps identify both temporary and permanent palustrine wetlands adjacent to the well fields, a ground survey wetland delineation will be required to determine which of these and other features would be affected and to what extent. The wetland delineation will document the locations of streambeds, stream widths, quality and type of water bodies, types of aquatic vegetation, presence of special aquatic resources (such as wetlands) and area of jurisdictional Waters of the U.S. likely to be disturbed during construction. A wetland delineation must be conducted on the well pads, access roads and other areas to be disturbed during construction.

Construction of the pipeline, water treatment plant and pump stations would result in disturbance of existing habitat, which would continue in a limited sense during activities associated with the maintenance of these appurtenances. However major construction activities would be temporary and the resulting maintenance activities should have a minimal impact on area species. Stream crossings by the pipeline would be constructed using Best Management Practices to minimize impacts to these areas to the extent practicable.

Field surveys conducted at the appropriate phase of development should be employed to minimize the impacts of construction and operations on sensitive resources. Specific project features, such as well fields, treatment plants and pipelines generally have sufficient design flexibility to avoid most impacts or significantly mitigate potential impacts to geographically limited environmental and cultural resource sites.

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 (Pl96-515), and the Archeological and Historic Preservation Act (PL93-291). A review of the Texas Historical Commission Texas Historic Sites Atlas database indicated that there are no National Register Properties or National Register Districts within one half mile of the proposed pipeline route or wellfield. However three historical markers and four cemeteries do occur within this area. In addition, numerous archeological surveys have occurred adjacent to and within the project area which indicate that a high probability exists for cultural resources to be present. An archeological survey of the project area should be undertaken to more accurately determine actual impacts to cultural resources.

Taking into consideration that the owner or controller of the project will likely be a political subdivision of the State of Texas (i.e., river authority, municipality, county, etc.), they will be required to coordinate with the Texas Historical Commission prior to project construction. If the project will affect waters of the United States or wetlands, the project sponsor will also be required to coordinate with the U.S. Army Corps of Engineers regarding impacts to these resources.

5.2.11.4 Engineering and Costing

The envisioned groundwater project will be developed by constructing eleven new wells, installing a pipeline collection system, and a WTP at the new well field for chlorine disinfection and iron/manganese removal. The treated water will be conveyed with a shared parallel pipeline to the existing SSLGC Pipeline. In addition to the treated groundwater from the proposed well field, the pipeline is sized to convey yield from the SSLGC Brackish Groundwater project and a Carrizo groundwater project for CVLGC. The costs are shared between the three projects.

The SSLGC expansion is planned to provide an additional 6,500 acft/yr above the currently permitted 19,362 acft/yr. When completed, this Regional Carrizo project is to yield 25,862 acft/yr. The major facilities required for this strategy are:

- Wells
- Well field collection pipeline(s)
- Water Treatment Plant
- SSLGC Parallel Pipeline/Pump Station

The Guadalupe County wells were assumed to be 800 feet deep since they are located updip of the existing wells and have a rated capacity of 500 gpm. The water treatment plant and pump station were placed at the proposed intersection of the Cibolo Valley Carrizo project. Power costs for conveyance of the additional 6,500 acft/yr associated with the SSLGC expansion were an equivalent portion of the total pump station costs estimated by calculating the horsepower needed to lift both the Cibolo Valley yield and the effluent from the water treatment plant to City of Schertz-Live Oak Tank while overcoming the pipe friction of an equivalent diameter pipeline. Costs were included for leasing property necessary to obtain groundwater permits, and for anticipated third party well mitigation activities to compensate for lowered pumping levels in existing wells.

Based on these assumptions, and on an assumed yield of 6,500 acft/yr, it is estimated that the water obtained through the water management strategy of SSLGC project expansion will have a unit cost of $1,070/acft, (Table 5.2.11-2).

Table 5.2.11-3 Cost Estimate Summary

Item	*Estimated Costs for Facilities*
Share of Future SSLGC Pipeline and Pump Stations	$28,269,000
Well Fields (Wells, Pumps, and Piping)	$8,007,000
Water Treatment Plant (7.3 MGD)	$2,878,000
TOTAL COST OF FACILITIES	**$39,154,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$12,290,000
Environmental & Archaeology Studies and Mitigation	$134,000
Groundwater Lease Acquisition ($150/acft)	$975,000
Interest During Construction (4% for 1 years with a 1% ROI)	$1,806,000
TOTAL COST OF PROJECT	**$54,359,000**
ANNUAL COST	
Debt Service (5.5 percent, 20 years)	$4,467,000
Operation and Maintenance	
Intake, Pipeline, Pump Station (1% of Cost of Facilities)	$363,000
Water Treatment Plant (2.5% of Cost of Facilities)	$950,000
Pumping Energy Costs (@$0.09/hr)	$800,000
Purchase of Water (6500 acft/yr @ 50 $/acft)	$325,000
Purchase of Water (6500 acft/yr @ 8.15 $/acft)	$53,000
TOTAL ANNUAL COST	**$6,958,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 1.25	6,500
Annual Cost of Water ($ per acft)	$1,070
Annual Cost of Water ($ per 1,000 gallons)	$3.28
Note: One or more cost element has been calculated externally	

5.2.11.5 Implementation Issues

Implementation of the Expanded Carrizo for SSLGC could involve limited conflicts with other Water Management Strategies under consideration, including the Wells Ranch Carrizo project, since both of these will be operating all or in part in common groundwater conservation districts.

This project was evaluated in conformance with the existing rules of the Guadalupe County GCD. Part of the supply developed by this project exceeds the amount of available water identified in the current Guadalupe County GCD management plan. The amount of water needed by the project that exceeds the available water in the management plan cannot be implemented unless and until permits are received from the Guadalupe County GCD. This project does not cause the Guadalupe County GCD management plan to be in conflict with the South Central Texas Regional Water Plan.

The development of groundwater in the Carrizo-Wilcox Aquifer in the South Texas Water Planning Region must address several issues. Major issues include:

- Detailed feasibility evaluation including test drilling and aquifer and water quality testing, followed with more detailed groundwater modeling to confirm results of this preliminary evaluation.
- Impact on:
    - Endangered and threatened wildlife species,
    - Water levels in the aquifer,
    - Baseflow in streams, and
    - Wetlands.
- Competition with others in the area for groundwater.
- Regulations by the Guadalupe County GCD, including the renewal of pumping permits at 5-year intervals.

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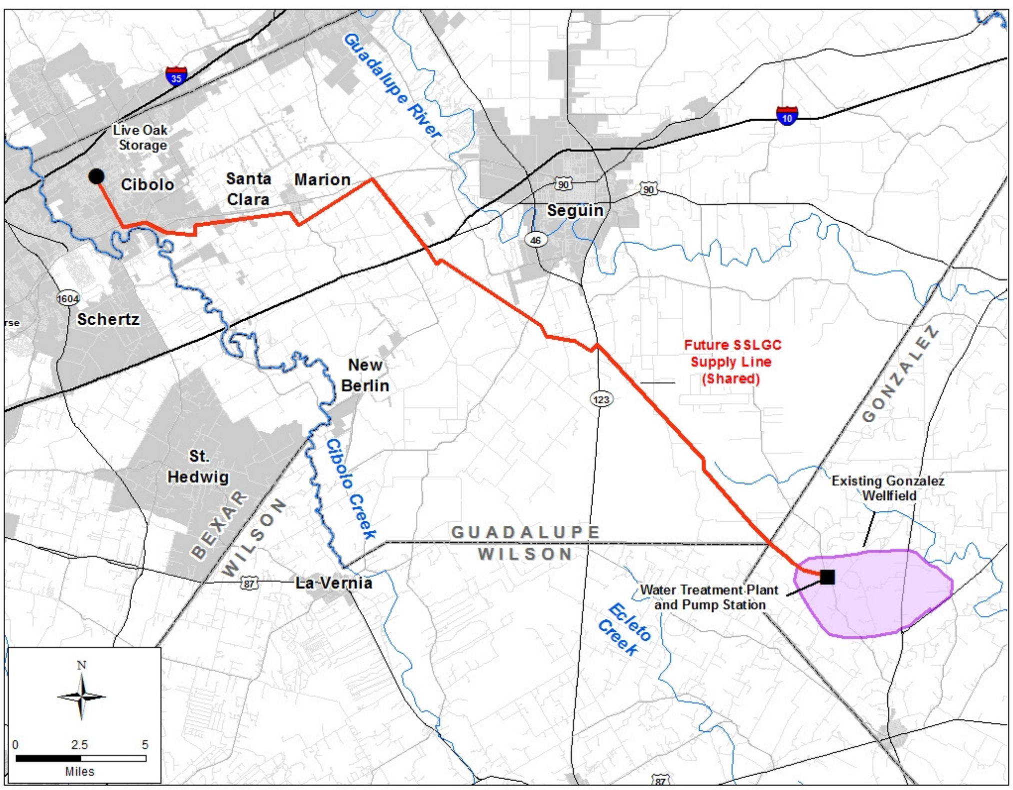
5.2.12 Brackish Wilcox for SSLGC Project Expansion

5.2.12.1 Description of Water Management Strategy

The Schertz-Seguin Water Supply Project, owned and operated by Schertz-Seguin Local Government Corp (SSLGC), currently holds permits to pump 19,362 acft/yr of groundwater from Gonzales County from the Carrizo Aquifer in western Gonzales County and 3,226 acft/yr from the Carrizo Aquifer in southeastern Guadalupe County. The primary recipients of the water are the cities of Schertz and Seguin. SSLGC also provides some water to the cities of Selma and Universal City. The project presently consists of eight 1,000-gpm Carrizo wells in Western Gonzales County. Eleven wells are proposed as a separate WMS in Guadalupe County. The Brackish Wilcox well field expansion is envisioned to provide a total of 5,000 acft/yr of supply out of Gonzales County using wells co-located with their existing freshwater Carrizo wells. The treated yield will be transferred to the distribution system via a new shared pipeline parallel to the existing SSLGC pipeline. Figure 5.2.12-1 illustrates the existing Schertz-Seguin Water Supply Project system.

Figure 5.2.12-1 Schertz-Seguin Water Supply Project



5.2.12.2 Available Yield

The Wilcox Aquifer in the vicinity of the planned well field is in the confined part of the aquifer and approximately twelve miles downdip of the outcrop. Hydrogeologic maps of the aquifer in this area suggest that wells would be capable of producing in excess of 800 gpm and would range in depth from 1,000 to 1600 ft deep. The wells are planned to be screened in the Wilcox Group. Groundwater quality in the planned well field usually has a concentration of total dissolved solids of about 1500 mg/L.

Groundwater supply projects in Gonzales County are subject to groundwater production, well spacing, and export of groundwater are subject to rules of the Gonzales County Underground Water Conservation District (GCUWCD).

A review of the Modeled Available Groundwater (MAG) and allocated water (permitted water and exempt use) for Gonzales County indicates that in the decade of 2030, allocated water exceeds the MAG, thus there is no supply available for new Water Management Strategies (WMS). Therefore, under a MAG-Limited scenario, the firm yield of the Brackish Wilcox for SSLGC WMS is 0 acft/yr. However, if the project was to be developed after the 2030 decade, a MAG-Limited supply of 1,278 acft/yr could be developed.

5.2.12.3 Environmental Issues

The Brackish Wilcox for SSLGC Project Expansion involves the expansion of an existing well field in western Gonzales County and its current water treatment facilities, new well collection pipelines and pumps, a new desalination water treatment plant and a shared transmission pipeline. This report section discusses the potential impacts to environmental and cultural resources known to exist within the proposed project area.

The western portion of the project area includes land primarily in the Blackland Prairies vegetational area, and the eastern end which includes a portion of the pipeline and the existing well field occurs in the Post Oak Savannah vegetational area.[1] The vegetation of this portion of Guadalupe and Gonzales Counties is now primarily composed of rangeland, crops and post-oak woodlands. Common woody species of the Post Oak Savannah vegetational area include post oak (*Quercus stellata*), blackjack oak (*Quercus marilandica*), and species of *Carya* sp. (hickory). Grasses of the area commonly include little bluestem (*Schizachyrium scoparium*), indiangrass (*Sorghastrum nutans*) and switchgrass (*Panicum virgatum*).

The western portion of the transmission pipeline is located in the Blackland Prairies vegetational area in Gonzales County.[2] This rolling and well-dissected vegetational area was historically a luxuriant tallgrass prairie dominated by little bluestem (*Schizachyrium scoparium* var. *frequens*), big bluestem (*Andropogon gerardii*), indiangrass (*Sorghastrum nutans*), and dropseeds (*Sporobolus sp.*). During the turn of the 20th century, the majority of the Blackland Prairie was cultivated for crops. Livestock production within this area has increased dramatically since the 1950s and now only about half of the area is used for cropland. Grazing pressure has caused an increase in grass species such as sideoats grama (*Bouteloua curtipendula*), hairy grama (*B. hirsuta*), Mead's sedge (*Carex meadii*), Texas wintergrass (*Stipa leucotricha*) and buffalograss (*Buchloe dactyloides*).

[1] Gould, F.W., "The Grasses of Texas," Texas A&M University Press, College Station, Texas, 1975.
[2] Ibid.

Common woody species of this area include mesquite, huisache (*Acacia smallii*), oak (*Quercus* sp.) and elm (*Ulmus* sp.). Oak, elm, cottonwood (*Populus* sp.) and native pecan (*Carya* sp.) are common along drainages.

Vertebrate fauna typifying these areas include the opossum, raccoon, weasel, skunk, white-tailed deer and bobcat as well as a wide variety of amphibians, reptiles and birds. The coyote and javelina are also common to the area, but are found mainly in brush/shrub areas while the red and gray fox are more common in woodlands.[3]

Plant and animal species listed by the USFWS and TPWD as endangered, threatened or rare in the project area are presented in Table 5.2.12-1. Inclusion in this table does not mean that a species will occur within the project area, but only acknowledges the potential for its occurrence in the project area counties. In addition to the county lists, the Texas Natural Diversity Database (TXNDD) was reviewed for known occurrences of listed species within or near the project area. This database revealed known occurrences of Park's jointweed (*Polygonella parksii*) and sandhill woolywhite (*Hymenopappus carrizoanus*), both species of concern, near the project area. Parks jointweed is an endemic species which is usually found in deep, loose sand blowouts in post oak savannas. Sandhill woolywhite normally occurs in disturbed or open areas in grasslands and post oak woodlands on deep sands derived from the Carrizo Sand and similar Eocene formations. Species of concern are considered to be rare, but are not protected by USFWS or TPWD.

Although suitable habitat for several state threatened species including the Texas Horned Lizard (*Phrynosoma cornutum)*, Texas tortoise (*Gopherus berlandieri)*, and timber rattlesnake (*Crotalus horridus)* may exist within the project area, no significant impact to these species is anticipated due to limited area that will be impacted by the project, the abundance of similar habit near the project area and these species ability to relocate to those areas if necessary. The presence or absence of potential habitat does not confirm the presence or absence of a listed species. No species specific surveys were conducted in the project area for this report.

After a review of the habitat requirements for each listed species, it is anticipated that this project will have no adverse effect on any federally listed threatened or endangered species, its habitat, or designated habitat, nor would it adversely affect any state endangered species.

Concerns associated with the expansion of the existing well field area involve water levels in the aquifer and baseflow of the surrounding streams and wetlands. The possibility exists that water levels in the aquifer, affected by the additional wells, could decrease before stabilizing, thus affecting habitat within the area. Waters of the U.S. found within the well field area include the salt branch of Sandies Creek, several tributaries of Clear Fork Creek, and the associated palustrine habitats that are generally composed of narrow bands of wetlands adjacent to these watercourses.

[3] Jones, J.K. et al., "Annotated Checklist of Recent Land Mammals of Texas," Occasional Papers of the Museum OP-119, Texas Tech University, 1988.

Table 5.2.12-1 Endangered, Threatened, Candidate and Species of Concern for Gonzales and Guadalupe Counties

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
BIRDS								
American peregrine falcon	*Falco peregrinus anatum*	0	3	0	Migrant and local breeder in West Texas.	DL	T	Possible Migrant
Arctic peregrine falcon	*Falco peregrinus tundrius*	0	2	0	Migrant throughout the state.	DL	--	Possible Migrant
Bald eagle	*Haliaeetus leucocephalus*	0	2	0	Primarily found near waterbodies.	DL	T	Nesting/ Migrant
Henslow's Sparrow	*Ammodramus henslowii*	0	1	0	Wintering migrant found in weedy fields with a key component of bare ground for running and walking	--	--	Migrant
Interior least tern	*Sterna antillarum athalassos*	0	3	0	Nests along sand and gravel bars in braided streams	LE	E	Resident
Mountain plover	*Charadrius montanus*	1	1	1	Non-breeding, shortgrass plains and fields	--	--	Nesting/ Migrant
Sprague's pipit	*Anthus spragueii*	0	1	0	Migrant in Texas in winter mid Sept. to early April. Strongly tied to native upland prairie.	C	--	Possible Migrant
Western burrowing owl	*Athene cunicularia hypugaea*	1	1	1	Open grasslands, especially prairie, plains and savanna	--	--	Resident
Whooping crane	*Grus americana*	0	3	0	Potential migrant	LE	E	Potential Migrant
Wood stork	*Mycteria americana*	0	2	0	Forages in prairie ponds, ditches, and shallow standing water formerly nested in TX	--	T	Migrant
FISHES								
Blue sucker	*Cycleptus elongates*	1	2	2	Found in larger portions of major rivers in Texas.		T	Resident
Guadalupe bass	*Micropterus treculi*	1	1	1	Endemic to perennial streams of the Edwards Plateau region.	--	--	Resident
Guadalupe darter	*Percina sciera apristis*	0	1	0	Guadalupe River basin.	--	--	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
INSECTS								
A mayfly	*Campsurus decoloratus*	0	1	0	Found on clay substrates along shorelines.	--	--	Resident
MAMMALS								
Cave myotis bat	*Myotis velifer*	0	1	0	Roosts colonially in caves, rock crevices	--	--	Resident
Plains spotted skunk	*Spilogale putorius interrupta*	1	1	1	Prefers wooded, brushy areas.	--	--	Resident
Red wolf	*Canis rufus*	0	3	0	Extirpated.	LE	E	Historic Resident
MOLLUSKS								
Creeper (squawfoot)	*Strophitus undulates*	1	1	1	Small to large streams. Colorado, Guadalupe, and San Antonio River basins.	--	--	Resident
False spike mussel	*Quincuncina mitchelli*	1	2	2	Substrates of cobble and mud. Rio Grande, Brazos, Colorado and Guadalupe river basins.	--	T	Resident
Golden orb	*Quadrula aurea*	1	2	2	Sand and gravel, Guadalupe, San Antonio, Lower San Marcos, and Nueces River basins	C	T	Resident
Palmetto pill snail	*Euchemotrema leai cheatumi*	0	1	0	Terrestrial snail known only from Palmetto State Park	--	--	Resident
Texas fatmucket	*Lampsilis bracteata*	1	2	2	Streams and rivers on sand, mud and gravel, Colorado and Guadalupe River basins.	C	T	Resident
Texas pimpleback	*Quadrula petrina*	1	2	2	Mud, gravel and sand substrates, Colorado and Guadalupe river basins	C	T	Resident
PLANTS								

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
Big red sage	Salvia pentstemonoides	1	1	1	Texas endemic, found in moist to seasonally wet steep limestone outcrops on canyons or along creek banks.	--	--	Resident
Bristle nailwort	Paronychia setacea	0	1	0	Flowering vascular plant endemic to eastern southcentral Texas in sandy soils.	--	--	Resident
Buckley's spiderwort	Tradescantia buckleyi	1	1	1	Occurs on sandy loam or clay soils in grasslands or shrublands underlain by the Beaumont Formation.	--	--	Resident
Elmendorf's onion	Allium elmendorfii	2	1	2	Endemic, found in deep sands	--	--	Resident
Green beebalm	Monarda viridissima	1	1	1	Endemic perennial herb. Found in well-drained sandy soils in opening of post oak woodlands.	--	--	Resident
Parks' jointweed	Polygonella parksii	2	1	2	Texas endemic, primarily found on deep, loose, sand blowouts in Post Oak Savannas.	--	--	Resident
Sandhill woolywhite	Hymenopappus carrizoanus	2	1	2	Found south of the Guadalupe River. Prefers dense riparian corridors.	--	--	Resident

LE/LT=Federally Listed Endangered/Threatened
DL=Federally Delisted
C=Candidate for Federal Listing
E, T=State Listed Endangered/Threatened
Blank = Considered rare, but no regulatory listing status

TPWD, 2014. Annotated County List of Rare Species –Guadalupe and Gonzales Counties, revised 4/28/2014.
USFWS, 2014. Species List from http://ecos.fws.gov/tess_public/countySearch!speciesByCountyReport.action?fips=48187, accessed September 5, 2014.

Although the USFWS National Wetlands Inventory (NWI) maps identify wetlands along the shared transmission pipeline and within the well field area, a ground survey wetland delineation will be required to determine which of these and other features would be affected and to what extent. This wetland delineation will document the locations of streambeds, stream widths, quality and type of water bodies, types of aquatic vegetation, presence of special aquatic resources (such as wetlands) and areas of jurisdictional Waters of the U.S. likely to be disturbed during construction.

Construction of the shared transmission pipeline, desalination WTP, new well collection pipeline and pumps, expansion of the existing WTP, new wells, and pump stations would result in disturbance of existing habitat, which would continue in a limited sense during activities associated with the maintenance of these appurtenances. However major construction activities would be temporary and the resulting maintenance activities should have a minimal impact on area species. Stream crossings by the pipeline would be constructed using Best Management Practices to minimize impacts to these areas to the extent practicable.

Field surveys conducted at the appropriate phase of development should be employed to minimize the impacts of construction and operations on sensitive resources. Specific project features, such as well fields, treatment plants and pipelines generally have sufficient design flexibility to avoid most impacts or significantly mitigate potential impacts to geographically limited environmental and cultural resource sites.

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 (Pl96-515), and the Archeological and Historic Preservation Act (PL93-291). A review of the Texas Historical Commission Texas Historic Sites Atlas database indicated that there are no National Register Properties or National Register Districts within one half mile of the proposed pipeline route or wellfield. However three historical markers and four cemeteries do occur within this area. In addition, numerous archeological surveys have occurred adjacent to and within the project area which indicate that a high probability exists for cultural resources to be present. An archeological survey of the project area should be undertaken to more accurately determine actual impacts to cultural resources.

Considering that the owner or controller of the project will likely be a political subdivision of the State of Texas (i.e. river authority, municipality, county, etc.), they will be required to coordinate with the Texas Historical Commission prior to project construction. If the project will affect waters of the United States or wetlands, the project sponsor will also be required to coordinate with the U.S. Army Corps of Engineers regarding impacts to these resources.

5.2.12.4 Engineering and Costing

Brackish Wilcox wells located at the existing well site in Gonzales County were assumed to be 2400 feet deep, with a peak capacity of 800 gpm. The injection well is assumed to need a depth of 5,040 ft and is rated at a capacity of 400 gpm. The TDS of the pumped water is expected to be 1,500 mg/l and 80% of the raw water will be sent to desalination. Brackish Groundwater will be developed by constructing new public supply and injection wells, installing a pipeline collection system, and expanding existing treatment facilities to include an RO plant with 90% efficiency. The envisioned project will include six public supply wells and injection well while the Mag-restricted project will only require three public supply wells. The treated effluent will be transferred using a shared pipeline parallel to the existing SSLGC pipeline. The costs for this pipeline are shared between the three contributing projects; Brackish Wilcox for SSLGC, Carrizo Expansion for SSLGC and Carrizo for CVLGC.

The major facilities required for this strategy are:

- Public Supply and injection Wells
- Well field collection pipeline(s)
- RO Treatment Plant
- Involvement in Parallel pipeline to SSLGC pipeline

The approximate locations of these facilities are displayed in Figure 5.2.12-1.

Power costs for conveyance of the additional 5,000 acft/yr associated with the Brackish Groundwater expansion were an equivalent portion, based on yield ratio, of the total pump station costs for the parallel SSLGC pipeline. These costs were estimated by calculating the horsepower needed to lift both the Cibolo Valley yield and the supply from the water treatment plant to City of Schertz-Live Oak Tank while overcoming the pipe friction of an equivalent diameter pipeline. Costs were included for leasing property necessary to obtain groundwater permits, and for anticipated third party well mitigation activities to compensate for lowered pumping levels in existing wells.

Based on these assumptions, the envisioned project with an assumed yield of 5,000 acft/yr, will have a unit cost of $2,124/acft (Table 5.2.12-2). It is estimated that with a MAG restriction of 1,598 acft/yr and an associated supply yield of 1,278 acft/yr, the project will have a unit cost of $5,032/acft (Table 5.2.12-3).

Table 5.2.12-2 Envisioned Project Cost Estimate Summary

Item	*Estimated Costs for Facilities*
Share of Future SSLGC Pipeline	$28,269,000
Well Fields (Wells, Pumps, and Piping)	$6,711,000
Two Water Treatment Plants (5.6 MGD and 4.9 MGD)	$15,303,000
TOTAL COST OF FACILITIES	**$50,283,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$16,181,000
Environmental & Archaeology Studies and Mitigation	$107,000
Groundwater Lease Acquisition ($150/acft)	$750,000
Interest During Construction (4% for 1 years with a 1% ROI)	$2,330,000
TOTAL COST OF PROJECT	**$69,651,000**
ANNUAL COST	
Debt Service (5.5 percent, 20 years)	$5,766,000
Operation and Maintenance	
Intake, Pipeline, Pump Station (1% of Cost of Facilities)	$350,000
Water Treatment Plant (2.5% of Cost of Facilities)	$3,204,000
Pumping Energy Costs (5,224,836 kW-hr @ 0.09 $/kW-hr)	$846,000
Purchase of Water (5444 acft/yr @ 75 $/acft)	$408,000
Purchase of Water (5444 acft/yr @ 8.12 $/acft)	$44,000
TOTAL ANNUAL COST	**$10,618,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 1.25	5,000
Annual Cost of Water ($ per acft)	$2,124
Annual Cost of Water ($ per 1,000 gallons)	$6.52

Table 5.2.12-3 MAG Restricted Cost Estimate Summary

Item	***Estimated Costs for Facilities***
Share of SSLGC Pipeline	$28,269,000
Well Fields (Wells, Pumps, and Piping)	$6,001,000
Two Water Treatment Plants (1.4 MGD and 1.2 MGD)	$5,346,000
TOTAL COST OF FACILITIES	**$39,616,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$12,450,000
Environmental & Archaeology Studies and Mitigation	$50,000
Groundwater Lease Acquisition ($150/acft)	$192,000
Interest During Construction (4% for 1 years with a 1% ROI)	$1,825,000
TOTAL COST OF PROJECT	**$54,133,000**
ANNUAL COST	
Debt Service (5.5 percent, 20 years)	$4,514,000
Operation and Maintenance	
Intake, Pipeline, Pump Station (1% of Cost of Facilities)	$343,000
Water Treatment Plant (2.5% of Cost of Facilities)	$1,150,000
Pumping Energy Costs (1,349,510 kW-hr @ 0.09 $/kW-hr)	$309,000
Purchase of Water (1,392 acft/yr @ 75 $/acft)	$104,000
Purchase of Water (1,392 acft/yr @ 8.12 $/acft)	$11,000
TOTAL ANNUAL COST	**$6,431,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 1.25	1,278
Annual Cost of Water ($ per acft)	$5,032
Annual Cost of Water ($ per 1,000 gallons)	$15.44

5.2.12.5 Implementation Issues

Implementation of the Brackish Wilcox for SSLGC could involve limited conflicts with other water supply options under consideration due to the limits of the MAG in Gonzales County.

For each aquifer in the region, the GCDs have adopted desired future conditions (DFCs). In some GCDs, full use of all groundwater supplies (permitted, grandfathered and exempt) may result in non-achievement of the DFCs for an aquifer. To ensure consistency with the DFCs, TWDB currently requires that groundwater availability for each aquifer be limited for planning purposes to the modeled available groundwater (MAG) for the aquifer. This has resulted, for planning purposes only, in adjustments to permit amounts, and a lack of firm water available for future permits in this plan for some areas for certain time periods. This should not be construed as recommending or requiring that GCDs make these adjustments, or deny future permit applications. SCTRWPG recognizes and supports the ability of permit holders to exercise their rights to groundwater use in accordance with their permits and it recognizes and supports the GCDs discretion to issue permits and grandfather historical users for amounts in excess of the MAG. SCTRWPG may not modify groundwater permits that GCDs have already issued or limit future permits that GCDs may issue. If the MAG is increased during or after this planning cycle, SCTRWPG may amend this Plan to adjust groundwater supply numbers that are affected by the new MAG amount.

This project was evaluated in conformance with the existing rules of the Gonzales County UWCD.

The development of groundwater in the Carrizo-Wilcox Aquifer in the South Texas Water Planning Region must address several issues. Major issues include:

- Detailed feasibility evaluation including test drilling and aquifer and water quality testing, followed with more detailed groundwater modeling to confirm results of this preliminary evaluation. This has been largely accomplished through the operation of the SSLGC well field since startup in October 2002.
- Impact on:
  - Endangered and threatened wildlife species,
  - Water levels in the aquifer,
  - Baseflow in streams, and
  - Wetlands.
- Competition with others in the area for groundwater.
- Regulations by the Gonzales County UWCD, including the renewal of pumping permits at 5-year intervals.

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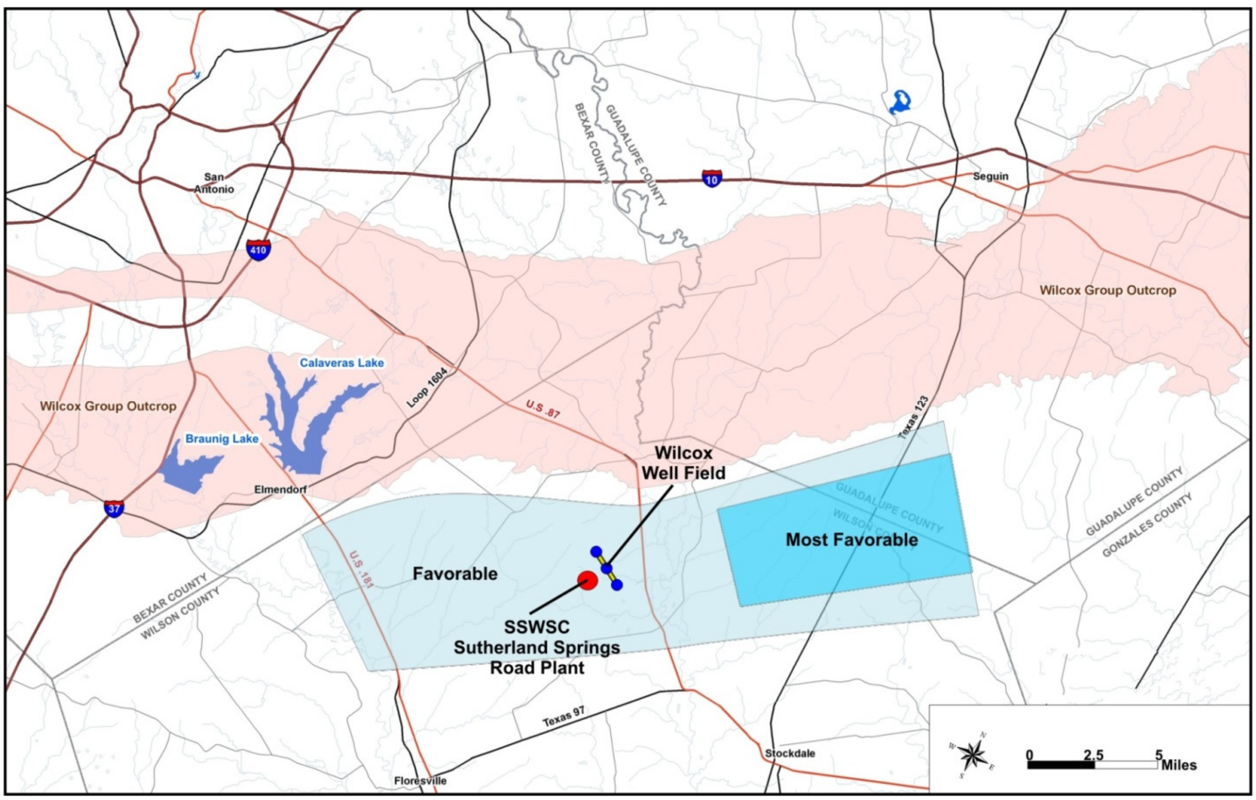
5.2.13 Brackish Wilcox Groundwater for SSWSC

5.2.13.1 Description of Water Management Strategy

The Brackish Wilcox Groundwater for SS Water Supply Corporation (SSWSC) water management strategy includes developing a brackish groundwater supply from the Wilcox Aquifer in Wilson County for the SSWSC. It is designed to produce an average annual water supply of 1.0 MGD and a peak demand of 2.0 MGD. The project's facilities are planned to be located in the vicinity of SSWSC's Sutherland Springs Road Plant, which is located about 3 miles west-northwest of the town of Sutherland Springs. The facilities include Wilcox Aquifer wells to provide a brackish groundwater supply, water treatment plant for pretreatment and desalination, delivery of treated water to the existing distribution system, and concentrate disposal to deep injection wells. The location of the project is shown in Figure 5.2.13-1 and Figure 5.2.13-2.

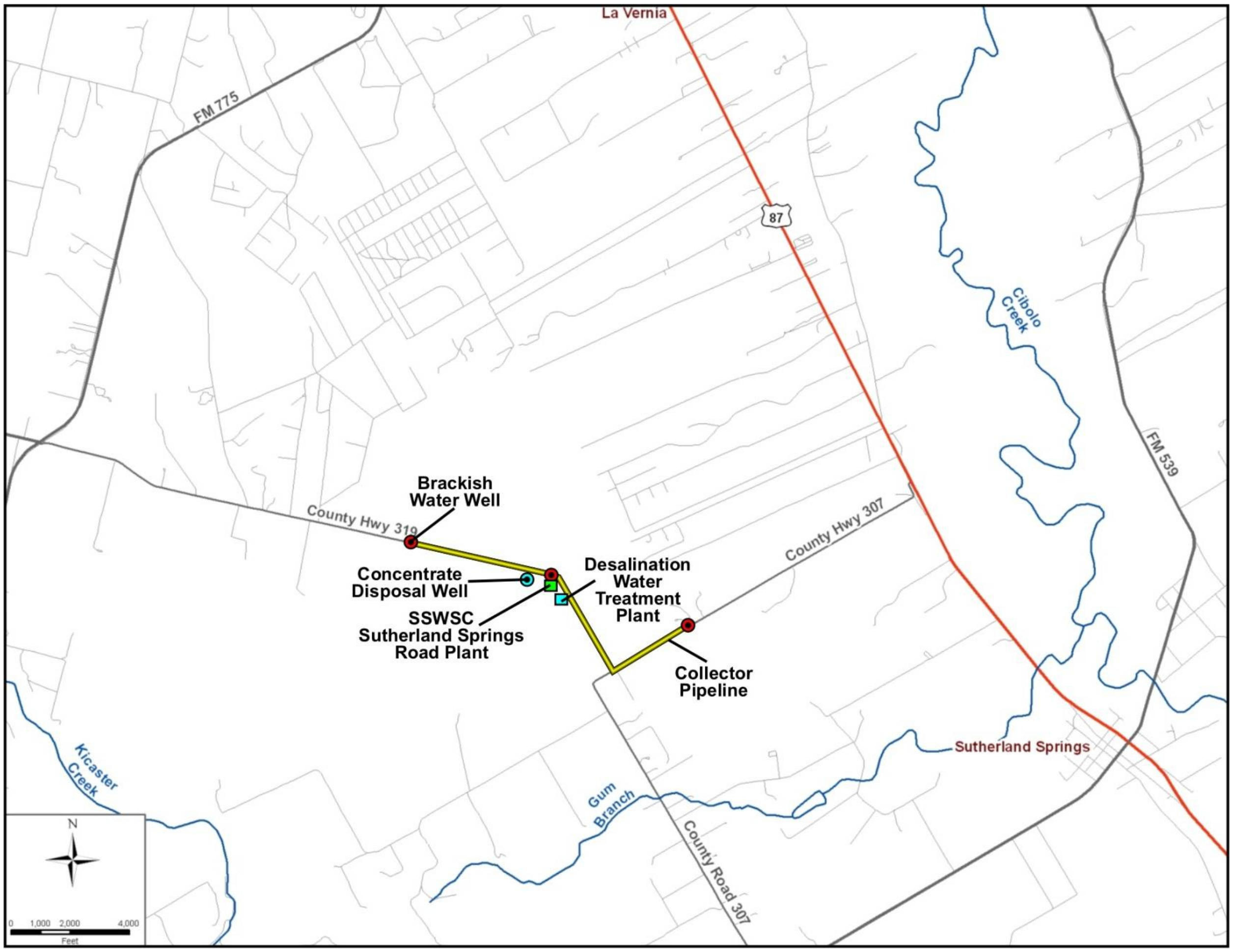
This strategy builds on a preliminary assessment of potential brackish groundwater supplies from the Wilcox Aquifer in a target area that is generally a 10- to 20-mile-wide band that is south of Interstate 10 and between Loop 410 and Seguin[1]. The study and a summary of the findings are briefly discussed in the following section.

Figure 5.2.13-1 Favorable Areas for Brackish Wilcox Groundwater Development



[1] HDR Engineering, Inc, February 2008, Preliminary assessment of potential water supplies from the Wilcox Aquifer in parts of Bexar, Guadalupe, and Wilson Counties: Prepared for San Antonio River Authority.

Figure 5.2.13-2 Brackish Wilcox Groundwater for SSWSC Project Location



5.2.13.2 Available Yield

HDR conducted a study to identify the favorable and most favorable areas for a brackish water wells in the Wilcox Aquifer. More specifically, the study identified trends and patterns of well yields, total dissolved solids, chlorides, and sulfates with well depth in the target area. The study relied on TWDB well data and TCEQ oil and gas well logs.

An analysis of the TCEQ logs identified water-bearing sands and categorized the water quality characteristics into (1) saline, brackish, and fresh, (2) brackish and fresh, or (3) fresh. A summary of the occurrence of water-bearing sands and salinity with depth were delineated into five layers within the Wilcox. In the outcrop area, the layers were 200 ft thick. In the confined section, the data are divided into five evenly divided layers. The sand thicknesses for the three categories of water quality were summed by layer, total thickness, and middle three layers. Finally, all sand layers that were 40 ft or more thick were summed to identify the major water- bearing zones where there is a reasonably good opportunity to develop a high capacity well. In concept, the cumulative thickness of the water-bearing sands should: (1) be thicker in the confined section than the unconfined section, (2) increase with depth in the downdip direction for a limited distance, and (3) begin to thin at great depths where the Wilcox becomes more compact and saline.

An analysis of the TWDB data provided information on well depths, well yields, and several water quality parameters, including total dissolved solids, chlorides, and sulfates from existing Wilcox wells to identify any tendencies and patterns with location and well depth. These data points were largely restricted to the outcrop area of the Wilcox because, in the downdip direction, one can develop a well in the shallower Carrizo and generally get much better, higher quality water. The data suggest that well yields tend to increase with depth. The water quality data show great scatter for relatively shallow wells and more consistent values of the selected properties at moderate and deeper depths. Overall, the Wilcox consists of many strata with a wide range of water bearing and water quality properties, which is reflected in the TWDB data. For shallow, low capacity wells, common decisions of well owners and drillers are to tap the first water-bearing sand. With good luck, this first water-bearing sand was satisfactory and produced a good well with favorable water. Otherwise, the first water-bearing sand probably was relatively poor and resulted in marginal or poor water. For deeper, high capacity wells, the driller probably identified several water-bearing zones and selected the most favorable zone to develop the well. Thus, the data showing more favorable well yields and water quality conditions are believed to be representative of the potential wells where the owner and driller searched for and found a good water-bearing zone(s) rather than using aggressive well development procedures. In general, the chance of developing a good well appears to be better in areas where the potential well depth is greater than 200 ft.

Considering the vertical distribution of the water-bearing sands and salinity, well designs are most likely to focus on the middle part of the aquifer where the water-bearing sands and favorable salinity tend to be more plentiful. A well in the middle part of the Wilcox provided considerable separation from the Carrizo, yet avoids great well depths.

The classification of potential target areas for well fields was divided into most favorable and favorable areas. The classification considers several factors, including: (1) concentration of existing wells in the Wilcox, (2) water quality, (3) potential well yields, (4) expected well depths, and (5) expected future water development by other entities. The concentration of wells in the Wilcox is assumed to generally follow TWDB's inventory of Wilcox wells. Basic water quality conditions are assumed to be represented by TWDB data and estimates of salinity are from interpretations of the TCEQ electric logs of oil and gas test holes.

The classification of potential target areas for well fields was divided into most favorable and favorable areas. The classification considers several factors, including: (1) concentration of existing wells in the Wilcox, (2) water quality, (3) potential well yields, (4) expected well depths, and (5) expected future water development by others. The concentration of wells in the Wilcox is assumed to generally follow TWDB's inventory of Wilcox wells. Basic water quality conditions are assumed to be represented by TWDB data and estimates of salinity are from interpretations of the TCEQ electric logs of oil and gas test holes.

As shown in Figure 5.2.13-1, the favorable and most favorable areas are in a 5- to 8-mile-wide band with the northwest boundary about 1 to 2 miles southeast of the downdip limit of the Wilcox outcrop. This band extends from near the San Antonio River to about 3 miles northeast of the intersection of Texas Highway 123 and the Guadalupe-Wilson County line, which was the extent of the study area. The vicinity of the Guadalupe-Wilson County line and Hwy 123 is in the most favorable area.

Based on the TWDB well data and sand thicknesses, potential well yields in the favorable and most favorable areas are expected to be 500 to 800 and 700 to 1,000 gpm, respectively. The salinity (total dissolved solids) is expected to range between 1,000 and 1,500 mg/L in the favorable area and 800 and 1,200 mg/L for the most favorable area. The Wilcox wells are expected to be between 1,200 and 1,700 ft deep. As shown in Figure 5.2.13-1, the planned location of the Wilcox wells is in the favorable, but near the most favorable areas. At this location, analyses of nearby oil and gas logs suggest: (1) a well depth of about 1,100 ft, (2) 350-375 ft of sands in the middle Wilcox that contain either fresh or brackish water, and (3) well yields of about 750 gpm.

5.2.13.3 Environmental Issues

The Brackish Wilcox Groundwater for SSWSC water management strategy involves the development of wells in the brackish portion of the Wilcox Aquifer in Wilson County, their associated pumps and piping, a water treatment plant, an injection well and a two miles of 12-inch water transmission pipeline connecting to an existing distribution system.

The project area occurs within the Post Oak Savannah vegetational area which contains gently rolling to hilly topography, and elevations which range from 300 to 800 feet.[2] Overstory species found within this area primarily include post oak (*Quercus stellata*), blackjack oak (*Q. marilandica*), and species of hickory (*Carya* ssp.). Climax grasses include yellow indian grass (*Sorghastrum nutans*), switchgrass (*Panicum virgatum*), purpletop tridens (*Tridens flavus*), longspike silver bluestem (*Bothriochloa saccharoides* var. *longipaniculata*), slender woodoats (*Chasmanthium laxum*), and little bluestem (*Schizachyrium scoparium*).

The project area primarily occurs in the Post Oak Woods/Forest vegetational type as described by the Texas Parks and Wildlife Department (TPWD), but also includes a small area to the west that is designated as other.[3]

Vertebrate fauna typical within this region include the opossum, raccoon, weasel, skunk, white-tailed deer and bobcat as well as a wide variety of amphibians, reptiles and birds.[4] The coyote and collared peccary are also common to the area, but are found mainly in brush/shrub areas while the red and gray fox are more common in woodlands.

Plant and animal species listed by U.S. Fish and Wildlife Service (USFWS) and TPWD that may occur within the vicinity of this water management strategy are listed in Table 5.2.13-1. No impacts to federally listed species are anticipated from this project. The Texas Natural Diversity Database (TXNDD), maintained by TPWD, indicates no known occurrences of listed species in the vicinity of the project.

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[2] Gould, F.W., "The Grasses of Texas," Texas A&M University Press, College Station, Texas, 1975.
[3] McMahan, Craig A., Roy G. Frye and Kirby L. Brown. 1984. The Vegetation Types of Texas. Wildlife Division, Texas Parks and Wildlife Department, Austin, Texas.
[4] Davis, William B. and David J. Schmidly. 1994. The Mammals of Texas. Texas Parks and Wildlife Department, Austin, Texas.

Table 5.2.13-1 Endangered, Threatened, Candidate and Species of Concern listed for Wilson County

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
BIRDS								
American peregrine falcon	*Falco peregrinus anatum*	0	3	0	Migrant and local breeder in West Texas.	DL	T	Possible Migrant
Arctic peregrine falcon	*Falco peregrinus tundrius*	0	2	0	Migrant throughout the state.	DL	--	Possible Migrant
Interior least tern	*Sterna antillarum athalassos*	0	3	0	Nests along sand and gravel bars in braided streams	LE	E	Resident
Mountain plover	*Charadrius montanus*	0	1	0	Non-breeding, shortgrass plains and fields	--	--	Nesting/ Migrant
Sprague's pipit	*Anthus spragueii*	0	1	0	Migrant in Texas in winter mid Sept. to early April. Strongly tied to native upland prairie.	C	--	Possible Migrant
Western burrowing owl	*Athene cunicularia hypugaea*	0	1	0	Open grasslands, especially prairie, plains and savanna	--	--	Resident
Whooping crane	*Grus americana*	0	3	0	Potential migrant	LE	E	Potential Migrant
Wood stork	*Mycteria americana*	0	2	0	Forages in prairie ponds, ditches, and shallow standing water formerly nested in TX	--	T	Migrant
INSECTS								
Manfreda giant-skipper	*Stallingsia maculosus*	0	1	0	Larvae feed inside leaf shelter and pupae found in cocoon made of leaves fastened by silk.	--	--	Resident
MAMMALS								
Cave myotis bat	Myotis velifer	0	1	0	Roosts colonially in caves, rock crevices	--	--	Resident
Plains spotted skunk	*Spilogale putorius interrupta*	0	1	0	Prefers wooded, brushy areas.	--	--	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
Red wolf	*Canis rufus*	0	3	0	Extirpated.	LE	E	Historic Resident
MOLLUSKS								
Creeper (squawfoot)	*Strophitus undulates*	0	1	0	Small to large streams. Colorado, Guadalupe, and San Antonio River basins.	--	--	Resident
False spike mussel	*Quincuncina mitchelli*	0	2	0	Substrates of cobble and mud. Rio Grande, Brazos, Colorado and Guadalupe river basins.	--	T	Resident
Golden orb	*Quadrula aurea*	0	2	0	Sand and gravel, Guadalupe, San Antonio, Lower San Marcos, and Nueces River basins	C	T	Resident
Texas pimpleback	*Quadrula petrina*	0	2	0	Mud, gravel and sand substrates, Colorado and Guadalupe river basins	C	T	Resident
PLANTS								
Big red sage	*Salvia pentstemonoides*	0	1	0	Texas endemic, found in moist to seasonally wet steep limestone outcrops on canyons or along creek banks.	--	--	Resident
Bristle nailwort	*Paronychia setacea*	0	1	0	Endemic to south central Texas in sandy soils.	--	--	Resident
Elmendorf's onion	*Allium elmendorfii*	1	1	1	Endemic, found in deep sands	--	--	Resident
Green beebalm	*Monarda viridissima*	0	1	0	Endemic perennial herb. Found in well-drained sandy soils in opening of post oak woodlands.	--	--	Resident
Parks' jointweed	*Polygonella parksii*	0	1	0	Texas endemic, primarily found on deep, loose, sand blowouts in Post Oak Savannas.	--	--	Resident
REPTILES								
Spot-tailed earless lizard	*Holbrookia lacerata*	1	1	1	Moderately open prairie-brushland.	--	--	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
Texas Horned Lizard	*Phrynosoma cornutum*	1	2	2	Varied, sparsely vegetated uplands.	--	T	Resident
Texas indigo snake	*Drymarchon melanurus erebennus*	0	2	0	Grass prairies and sand hills; woodland and mesquite savannah of coastal plain.	--	T	Resident
Texas tortoise	*Gopherus berlandieri*	0	2	0	Open brush w/ grass understory.	--	T	Resident

LE/LT=Federally Listed Endangered/Threatened
DL=Federally Delisted
C=Candidate for Federal Listing
E, T=State Listed Endangered/Threatened
Blank = Considered rare, but no regulatory listing status

TPWD, 2015. Annotated County List of Rare Species –Wilson County, revised 8/7/2012.
USFWS, 2015. Endangered Species List for Texas. http://ecos.fws.gov/tess_public/reports/species-by-current-range-county?fips=48493, accessed online March 4, 2015.

Two reptile species listed as threatened by the state may possibly be affected by the project. These include the spot-tailed earless lizard (*Holbrookia lacerata)*, and Texas horned lizard (*Phrynosoma cornutum)*. Because an abundance of similar habitat areas exist near the project area, and these species have the ability to move into those areas, no significant impacts to these species are anticipated from the project.

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 (PI96-515), and the Archeological and Historic Preservation Act (PL93-291). Based on the review of available records obtained from the Texas Historical Commission, there are no State Historic Sites, National Register Properties or Districts, cemeteries or Historical Markers near the project area. However, because the owner or controller of the project will likely be a political subdivision of the State of Texas (i.e., river authority, municipality, county, etc.), they will be required to coordinate with the Texas Historical Commission prior to project construction.

Field surveys conducted at the appropriate phase of development should be employed to minimize the impacts of construction and operations on sensitive resources. Specific project features, such as well fields, and pipelines generally have sufficient design flexibility to avoid most impacts or significantly mitigate potential impacts to geographically limited environmental and cultural resource sites.

5.2.13.4 Engineering and Costing

Preliminary engineering and costing analyses have been performed for both the production and injection well fields using 2016 Regional Water Planning methods. For Region L, HDR utilized the standard costing procedures and unit costs. The planned site of the facilities is in the vicinity of SSWSC's Sutherland Springs Road Plant. The brackish well field will consist of three wells and be along CR 319 and would be spaced about a mile apart. The desalination water treatment plant would be located at SSWSC's existing water plant. The disposal well for the concentrate would be nearby. A raw water collector pipeline would deliver brackish Wilcox water from the wells to the water treatment plant. Water treatment will consist of pretreatment and desalination. A treated water pipeline and booster pump station would deliver water to the Sutherland Springs Road Plant. A concentrate water pipeline would deliver reject water to a ground storage tank. A small pump and a pipeline will transport the concentrate to a new, deep injection well. The system is designed to provide an annual average 1.0 MGD and a peak demand of 2.0 MGD.

Based on the results from the earlier study and for planning purposes, a typical Wilcox well in this locale is expected to be about 1,100 ft deep, yield about 750 gpm, and produce water with a total dissolved solids (TDS) concentration of about 1,200 mg/L.

The engineering and costing analysis for Brackish Wilcox Groundwater for SSWSC project includes all facilities required for water production from the Wilcox Aquifer, including wells, collector pipeline, water treatment, treated water pipeline and pump stations, and disposal of concentrate to deep injection wells. The well field consists of three brackish water supply wells, two miles of collector pipelines with a diameter of 12 inches. Water treatment will consist of pretreatment and desalination. Pretreatment will include filtration and possibly other processes to remove particulates such as iron or manganese and to condition the water for optimal desalination. Desalination treatment is expected to be by Reverse Osmosis (RO). The treated water facilities consist of a short transmission pipeline with a diameter of 12 inches, a pump station and integration into the existing distribution system. A concentrate disposal well, ground storage tank, pipelines and facilities are planned near the Sutherland Springs Road Plant. The target disposal of the concentration will be deep well injection into depleted or partially depleted oil and gas producing reservoirs (Austin Chalk or Edwards Limestone).

The required secondary Maximum Contaminant Level (MCL) for TDS is 1,000 mg/L. The design of the water treatment facilities is to produce potable water with a TDS concentration of about 400-500 mg/L. The preliminary water treatment design includes: (1) Pretreatment of all raw water, (2) about 60 percent of this water will be sent to the desalination water treatment plant, and (3) the remaining 40 percent will be blended with the desalinated water. The desalination plant recovery rate using conventional RO with raw water having a TDS of about 1,200 mg/L is estimated to be 85 percent, meaning that 85 percent of the water entering the desalination plant becomes purified water and 15 percent of the water remains as concentrated brine. The desalinated water and the treated brackish water are blended to produce a treated water with a TDS of about 480 mg/L. This process converts about 90 percent of the quantity of raw water produced from the well field into potable water. The remaining 10 percent is a concentrate and is discharged to a deep injection well.

Cost estimates were computed for capital costs, annual debt service, operation and maintenance, power, land, and environmental mitigation for seasonal and peak day demands. These costs are summarized in

Table 5.2.13-2. Treatment costs are for removal of iron, manganese, and desalination. The project costs, including capital, are estimated to be $16,864,000. As shown, the annual costs, including debt service, operation and maintenance, power, and groundwater leases, are estimated to be $2,861,000. This option produces potable water at an estimated cost of $2,554/acft/yr.

Table 5.2.13-2 Project Cost Estimate Summary

Item	***Estimated Costs for Facilities***
Transmission Pipeline (12 in dia., 0 miles)	$27,000
Transmission Pump Station(s) & Storage Tank(s)	$439,000
Well Fields (Wells, Pumps, and Piping)	$5,449,000
Two Water Treatment Plants (2.2 MGD and 1.4 MGD)	$5,892,000
Integration, Relocations, & Other	$112,000
TOTAL COST OF FACILITIES	**$11,919,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$4,170,000
Environmental & Archaeology Studies and Mitigation	$57,000
Land Acquisition and Surveying (40 acres)	$147,000
Interest During Construction (4% for 1 years with a 1% ROI)	$571,000
TOTAL COST OF PROJECT	**$16,864,000**
ANNUAL COST	
Debt Service (5.5 percent, 20 years)	$1,411,000
Operation and Maintenance	
Intake, Pipeline, Pump Station (1% of Cost of Facilities)	$62,000
Water Treatment Plant (2.5% of Cost of Facilities)	$1,259,000
Pumping Energy Costs (392273 kW-hr @ 0.09 $/kW-hr)	$35,000
Purchase of Water (1120 acft/yr @ 83.71 $/acft)	$94,000
TOTAL ANNUAL COST	**$2,861,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 2	1,120
Annual Cost of Water ($ per acft)	$2,554
Annual Cost of Water ($ per 1,000 gallons)	$7.84

5.2.13.5 Implementation Issues

For each aquifer in the region, the GCDs have adopted desired future conditions (DFCs). In some GCDs, full use of all groundwater supplies (permitted, grandfathered and exempt) may result in non-achievement of the DFCs for an aquifer. To ensure consistency with the DFCs, TWDB currently requires that groundwater availability for each aquifer be limited for planning purposes to the modeled available groundwater (MAG) for the aquifer. This has resulted, for planning purposes only, in adjustments to permit amounts, and a lack of firm water available for future permits in this plan for some areas for certain time periods. This should not be construed as recommending or requiring that GCDs make these adjustments, or deny future permit applications. SCTRWPG recognizes and supports the ability of permit holders to exercise their rights to groundwater use in accordance with their permits and it recognizes and supports the GCDs discretion to issue permits and grandfather historical users for amounts in excess of the MAG. SCTRWPG may not modify groundwater permits that GCDs have already issued or limit future permits that GCDs may issue. If the MAG is increased during or after this planning cycle, SCTRWPG may amend this Plan to adjust groundwater supply numbers that are affected by the new MAG amount.

Implementation of the Wilcox Aquifer Brackish groundwater strategy includes the following issues:

- Verification of available groundwater quantity and well productivity;
- Verification of water quality for concentrations of dissolved constituents, such as TDS, chloride, sulfate, iron, manganese and hydrogen sulfide;
- Verification of minimal impacts to Carrizo;
- Verification of the potential for deep well injection of concentrate;
- Permitting Class I disposal well for deep well injection of desalination concentrate;
- Regulations by TCEQ;
- Regulations by the Evergreen Underground Water Conservation District;
- Verification that desalinated Wilcox Aquifer water is compatible with other water sources being used by customers and will meet all water quality requirements in the end user's distribution system; and
- Experience in operating and maintaining a desalination water treatment plant.

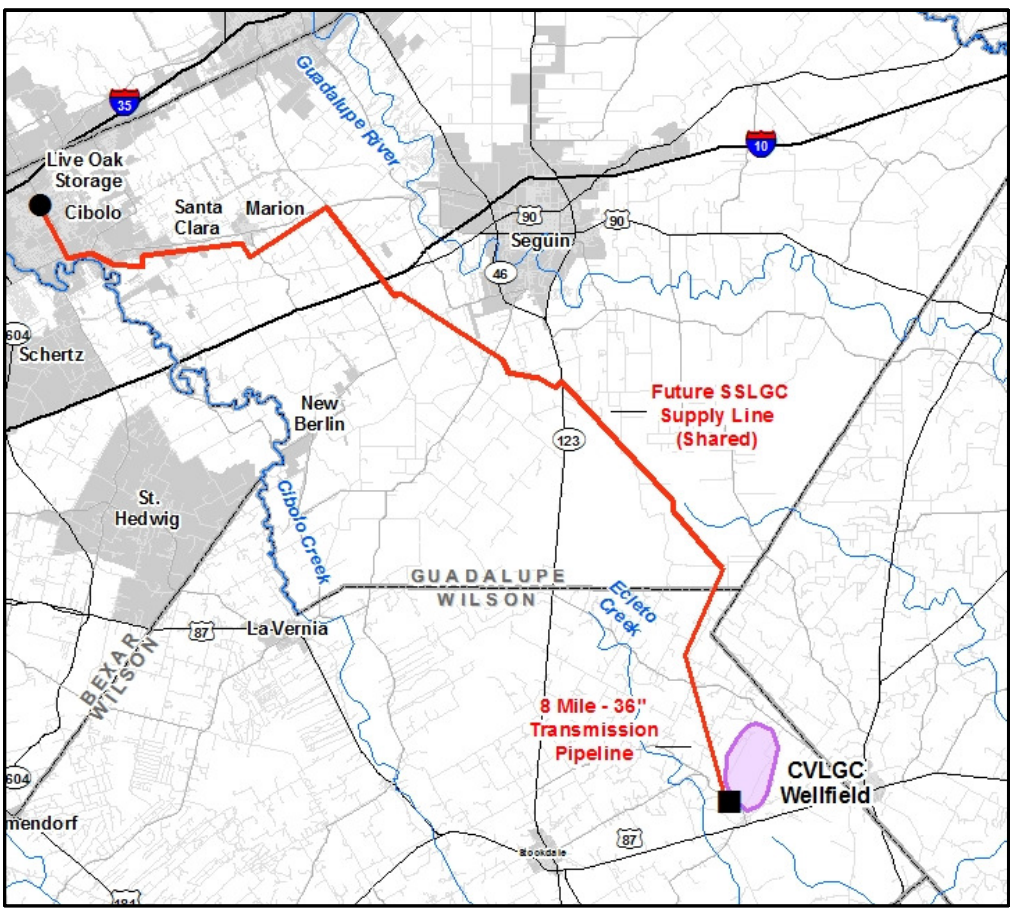
5.2.14 Cibolo Valley Local Government Corporation Carrizo Project

5.2.14.1 Description of Water Management Strategy

The Carrizo-Wilcox Aquifer is one of four major aquifers in the South Central Texas Water Planning Region. Overall, the water quality of the Carrizo-Wilcox Aquifer is suitable for use as a water supply, except for elevated concentrations of iron and manganese in many areas.

Schertz and Cibolo, cities within Cibolo Valley, created the Cibolo Valley Local Government Corporation (CVLGC) and are considering a Carrizo Aquifer well field project in Wilson County. The general location of the planned well field is north of US 87, east of Stockdale. The approximate location is shown on Figure 14-1. Land use and groundwater availability were taken into consideration for selection of the well field. The envisioned project will supply 10,000 acft/year of treated water to the partnering entities.

Figure 14-1 Carrizo for Cibolo Valley Location Map



5.2.14.2 Available Yield

The Carrizo Aquifer in the vicinity of the planned well field is in the confined part of the aquifer and approximately seven miles downdip of the outcrop. Hydrogeologic maps of the aquifer in this area suggest that wells would be capable of producing in excess of 2,000 gpm and would range in depth from 1,000 to 1500 ft deep. The wells are planned to be screened in the Carrizo Sand instead of the Wilcox Group for water quality and depth considerations. Groundwater quality in the planned well field usually has a concentration of total dissolved solids of less than 300 mg/L. However, the water typically has elevated concentrations of iron and manganese that requires removal before being used by the public.

Groundwater supply projects in Wilson County are subject to groundwater production, well spacing, and export of groundwater are subject to rules of the Evergreen Underground Water Conservation District (EUWCD).

A review of the Modeled Available Groundwater (MAG) and groundwater demands for Wilson County, as documented in Task 3, shows a surplus of groundwater from the Carrizo-Wilcox Aquifer to increase from 6,063 acft/yr in 2020 to 22,596 acft/yr in 2070. However, permits in the Carrizo-Wilcox Aquifer in Wilson County total 30,923, thereby exceeding the MAG. Therefore, the MAG-Limited supply from the CVLGC Carrizo Project is zero acft/yr.

5.2.14.3 Environmental Issues

The proposed Cibolo Valley Local Government Corporation Carrizo Project includes a well field in Wilson County, a collection pipeline and pumps, new water treatment plant, transmission pump stations, and a shared transmission pipeline. The transmission pipeline route would originate at the well field located approximately three miles west of the town of Nixon in eastern Wilson County, and travel in a northwest direction crossing IH10, then west along SH78 and finally north, terminating at the Live Oak storage tank in Schertz.

The proposed pipeline route would traverse two of Omernik's[1] ecoregions: the East Central Texas Plains, and the Texas Blackland Prairie. The southern half of the pipeline and the wellfield area occur in the Post Oak Savannah vegetational area while the northern portion of the pipeline lies within the Blackland Prairie.[2] The Post Oak Savannah vegetational area typically includes species such as post oak (*Quercus stellata*), blackjack oak (*Q. marilandica*), and hackberries (*Celtis* spp.). Common native grasses in this area include little bluestem (*Schizachyrium scoparium*), Indiangrass (*Sorghastrum nutans*), and switchgrass (*Panicum virgatum*). The dominant vegetation of the Blackland Prairie includes grasses such as big bluestem (*Andropogon gerardii*), Indiangrass (*Sorghastrum nutans*), switchgrass (*Panicum virgatum*) and Texas wintergrass (*Stipa leucotricha*). This area also includes species such as black willow (*Salix nigra*), oaks (*Quercus* spp.) and pecan (*Carya illinoinensis*) within wooded riparian strips. The land use for the area included in the pipeline route is composed of three major vegetation types as defined by the Texas Parks and Wildlife Department (TPWD).

[1] Omernik, J. M, "Ecoregions of the conterminous United States," Annals of the Association of American Geographers, 77: 118-125, 1987.
[2] Gould, F.W., "The Grasses of Texas," Texas A&M University Press, College Station, Texas, 1975.

The northern section of the pipeline above IH10 is located in an area usually utilized for crop production. The remaining portions of the route are located in alternating bands of Post Oak Woods, Forest and Grassland Mosaic and Post Oak Woods/Forest areas.

Table 14-1 lists the threatened, endangered, candidate or species of concern that may occur in Wilson, or Guadalupe counties according to the U.S. Fish and Wildlife Service (USFWS), and county lists of rare species published by the TPWD online. Inclusion in Table 14-1 does not mean that a species will occur within the project area, but only acknowledges the potential for its occurrence in the project area counties.

In addition to the county lists, the Texas Natural Diversity Database (TXNDD) was reviewed for known occurrences of listed species within or near the project area. This database revealed known occurrences of the sandhill woolywhite (*Hymenopappus carrizoanus*) near the project area. Sandhill woolywhite normally occurs in disturbed or open areas in grasslands and post oak woodlands on deep sands derived from the Carrizo Sand and similar Eocene formations. This plant is a species of concern and considered to be rare, but is not protected by USFWS or TPWD.

After a review of the habitat requirements for each listed species, it is anticipated that this project will have no adverse effect on any federally listed threatened or endangered species, its habitat, or designated habitat, nor would it adversely affect any state endangered species. Although suitable habitat for several state threatened species may exist within the project area, no significant impact to these species is anticipated due to limited area that will be impacted by the project, the abundance of similar habit near the project area and these species ability to relocate to those areas if necessary. The presence or absence of potential habitat does not confirm the presence or absence of a listed species. No species specific surveys were conducted in the project area for this report.

Table 14-1 Endangered, Threatened, Candidate and Species of Concern listed for Guadalupe and Wilson Counties

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
BIRDS								
American peregrine falcon	*Falco peregrinus anatum*	0	3	0	Migrant and local breeder in West Texas.	DL	T	Possible Migrant
Arctic peregrine falcon	*Falco peregrinus tundrius*	0	2	0	Migrant throughout the state.	DL		Possible Migrant
Bald eagle	*Haliaeetus leucocephalus*	0	2	0	Primarily found near waterbodies.	DL	T	Nesting/ Migrant
Interior least tern	*Sterna antillarum athalassos*	0	3	0	Nests along sand and gravel bars in braided streams	LE	E	Resident
Mountain plover	*Charadrius montanus*	2	1	2	Non-breeding, shortgrass plains and fields			Nesting/ Migrant
Sprague's pipit	*Anthus spragueii*	0	1	0	Migrant in Texas in winter mid Sept. to early April. Strongly tied to native upland prairie.	C		Possible Migrant
Western burrowing owl	*Athene cunicularia hypugaea*	1	1	1	Open grasslands, especially prairie, plains and savanna			Resident
Whooping crane	*Grus americana*	0	3	0	Potential migrant	LE	E	Potential Migrant
Wood stork	*Mycteria americana*	0	2	0	Forages in prairie ponds, ditches, and shallow standing water formerly nested in TX		T	Migrant
FISHES								
Guadalupe bass	*Micropterus treculi*	1	1	1	Endemic to perennial streams of the Edwards Plateau region.			Resident
Guadalupe darter	*Percina sciera apristis*	0	1	0	Guadalupe River basin.			Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
INSECTS								
A mayfly	*Campsurus decoloratus*	0	1	0	Found on clay substrates along shorelines.			Resident
MAMMALS								
Cave myotis bat	*Myotis velifer*	0	1	0	Roosts colonially in caves, rock crevices			Resident
Plains spotted skunk	*Spilogale putorius interrupta*	1	1	1	Prefers wooded, brushy areas.			Resident
Red wolf	*Canis rufus*	0	3	0	Extirpated.	LE	E	Historic Resident
MOLLUSKS								
Creeper (squawfoot)	*Strophitus undulates*	0	1	0	Small to large streams. Colorado, Guadalupe, and San Antonio River basins.			Resident
False spike mussel	*Quincuncina mitchelli*	0	2	0	Substrates of cobble and mud. Rio Grande, Brazos, Colorado and Guadalupe river basins.		T	Resident
Golden orb	*Quadrula aurea*	0	2	0	Sand and gravel, Guadalupe, San Antonio, Lower San Marcos, and Nueces River basins	C	T	Resident
Texas fatmucket	*Lampsilis bracteata*	0	2	0	Streams and rivers on sand, mud and gravel, Colorado and Guadalupe River basins.	C	T	Resident
Texas pimpleback	*Quadrula petrina*	0	2	0	Mud, gravel and sand substrates, Colorado and Guadalupe river basins	C	T	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
PLANTS								
Big red sage	*Salvia pentstemonoides*	0	1	0	Texas endemic, found in moist to seasonally wet steep limestone outcrops on canyons or along creek banks.			Resident
Bristle nailwort	*Paronychia setacea*	0	1	0	Endemic to south central Texas in sandy soils.			Resident
Elmendorf's onion	*Allium elmendorfii*	1	1	0	Endemic, found in deep sands			Resident
Green beebalm	*Monarda viridissima*	0	1	0	Endemic perennial herb. Found in well-drained sandy soils in opening of post oak woodlands.			Resident
Parks' jointweed	*Polygonella parksii*	1	1	1	Texas endemic, primarily found on deep, loose, sand blowouts in Post Oak Savannas.			Resident
Sandhill woolywhite	*Hymenopappus carrizoanus*	2	1	2	Found south of the Guadalupe River. Prefers dense riparian corridors.			Resident
REPTILES								
Cagle's map turtle	*Graptemys caglei*	1	2	2	Endemic species found in Guadalupe river system.		T	Resident
Spot-tailed earless lizard	*Holbrookia lacerata*	0	1	0	Moderately open prairie-brushland.			Resident
Texas Garter Snake	*Thamnophis sirtalis annectens*	1	1	1	Wet or moist microhabitats			Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
REPTILES								
Texas Horned Lizard	*Phrynosoma cornutum*	1	2	2	Varied, sparsely vegetated uplands.		T	Resident
Texas indigo snake	*Drymarchon melanurus erebennus*	1	2	2	Grass prairies and sand hills; woodland and mesquite savannah of coastal plain.		T	Resident
Texas tortoise	*Gopherus berlandieri*	1	2	2	Open brush w/ grass understory.		T	Resident
Timber rattlesnake	*Crotalus horridus*	1	2	2	Floodplains, upland pine, deciduous woodlands, riparian zones.		T	Resident

LE/LT=Federally Listed Endangered/Threatened
DL=Federally Delisted
C=Candidate for Federal Listing
E, T=State Listed Endangered/Threatened
Blank = Considered rare, but no regulatory listing status

TPWD, 2014. Annotated County List of Rare Species –Guadalupe County, revised 8/7/2012 and Wilson County, revised 8/7/2012.
USFWS, 2014. Endangered Species List for Texas. http://www.fws.gov/southwest/es/ES_ListSpecies.cfm accessed online June 3, 2014.

Field surveys conducted at the appropriate phase of development should be employed to minimize the impacts of construction and operations on sensitive resources. Specific project features, such as well fields, treatment plants and pipelines generally have sufficient design flexibility to avoid most impacts or significantly mitigate potential impacts to geographically limited environmental and cultural resource sites.

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 (Pl96-515), and the Archeological and Historic Preservation Act (PL93-291). A review of the Texas Historical Commission Texas Historic Sites Atlas database indicated that there are no National Register Properties or National Register Districts within one half mile of the proposed pipeline route or wellfield. However three historical markers and four cemeteries do occur within this area. In addition, numerous archeological surveys have occurred adjacent to and within the project area which indicate that a high probability exists for cultural resources to be present. An archeological survey of the project area should be undertaken to more accurately determine actual impacts to cultural resources.

Taking into consideration that the owner or controller of the project will likely be a political subdivision of the State of Texas (i.e., river authority, municipality, county, etc.), they will be required to coordinate with the Texas Historical Commission prior to project construction. If the project will affect waters of the United States or wetlands, the project sponsor will also be required to coordinate with the U.S. Army Corps of Engineers regarding impacts to these resources.

5.2.14.4 Engineering and Costing

The preliminary engineering analyses have groundwater being developed for a peaking factor of 1.3. For this water management strategy, it is assumed that all facilities would be included in a single phase. A final delivery point has not been selected at this time. For purposes of estimating cost, the delivery point is assumed to be near the city of Cibolo.

As shown in figure 14-1, this project will share a planned SSLGC pipeline and pump station to deliver the water from the current SSLGC water treatment plant and pump station in southeast Guadalupe County.

- The major facilities required for this strategy include:
- 7- 1,100 GPM Wells,
- Well Field Collection Pipelines and Pumps.
- Water Treatment Plant Expansion,
- 36”-8 mile transmission pipeline, and
- Shared Pipeline and Pump Station from SSLGC facilities in southeast Guadalupe County to city of Cibolo.

Cost estimates were developed using regional planning procedures. These costs are summarized in Table 14-2. The estimated project cost is approximately $69.4 million. The annual costs include debt service for a 30-year loan at 5.5 percent interest and operation and maintenance costs, including power. The costs also include a groundwater lease fee of $125/acft and a groundwater district export fee of $8.12/acft. The annual unit cost of water is estimated to be $1,834 acft/yr ($5.63 per 1,000 gallons) for treated water, assuming the envisioned yield of 10,000 acft/yr. The costs presented depict the envisioned yield of 10,000 acft/yr despite the lack of modeled available groundwater. If the project was built and yield was restricted due to MAG Limitations, the project costs would remain the same but a unit cost would be dependent on obtained yield.

Table 14-2 Envisioned Project Cost Estimate Summary

Item	*Envisioned Project*
CAPITAL COST	
Transmission Pipeline	$13,465,000
Pump Station	$3,345,300
Well Fields (Wells, Pumps, and Piping)	$9,682,000
Water Treatment Plants	$21,721,000
Storage Tanks (Other Than at Booster Pump Stations)	$4,758,479
TOTAL COST OF FACILITIES	**$48,213,300**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$15,031,000
Environmental & Archaeology Studies and Mitigation	$433,000
Land Acquisition and Surveying (57 acres)	$212,000
Signing Bonus and Holding Fees ($300/acre)	$3,000,000
Interest During Construction (4% for 1 years with a 1% ROI)	$2,493,000
TOTAL COST OF PROJECT	**$69,382,300**
ANNUAL COST	
Debt Service (5.5 percent, 20 years)	$6,167,000
Operation and Maintenance	
Intake, Pipeline, Pump Station (1% of Cost of Facilities)	$329,000
Water Treatment Plant (2.5% of Cost of Facilities)	$4,344,000
Pumping Energy Costs (10,619,580 kW-hr @ 0.09 $/kW-hr)	$956,000
Fresh Water Production Fee ($125/acre)	$1,250,000
Groundwater District Export Fee($8.12/acre)	$81,000
SSLGC Cost	$5,214,000
TOTAL ANNUAL COST	**$18,341,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 1.3	10,000
Annual Cost of Water ($ per acft)	$1,834
Annual Cost of Water ($ per 1,000 gallons)	$5.63

5.2.14.5 Implementation Issues

Implementation of the Cibolo Valley Local Government Corporation Carrizo Project could involve conflicts with other water supply plans as they will be competing for limited groundwater supplies within Wilson County and the EUWCD. Because the district's permitting process is independent of the regional planning process, potentially competing groundwater management strategies are not prioritized.

For each aquifer in the region, the GCDs have adopted desired future conditions (DFCs). In some GCDs, full use of all groundwater supplies (permitted, grandfathered and exempt) may result in non-achievement of the DFCs for an aquifer. To ensure consistency with the DFCs, TWDB currently requires that groundwater availability for each aquifer be limited for planning purposes to the modeled available groundwater (MAG) for the aquifer. This has resulted, for planning purposes only, in adjustments to permit amounts, and a lack of firm water available for future permits in this plan for some areas for certain time periods. This should not be construed as recommending or requiring that GCDs make these adjustments, or deny future permit applications. SCTRWPG recognizes and supports the ability of permit holders to exercise their rights to groundwater use in accordance with their permits and it recognizes and supports the GCDs discretion to issue permits and grandfather historical users for amounts in excess of the MAG. SCTRWPG may not modify groundwater permits that GCDs have already issued or limit future permits that GCDs may issue. If the MAG is increased during or after this planning cycle, SCTRWPG may amend this Plan to adjust groundwater supply numbers that are affected by the new MAG amount.

The development of groundwater in the Carrizo-Wilcox Aquifer in the South Texas Water Planning Region must address several issues. Major issues include:

- EUWCD permits:
  - Analyses of pumping impacts on groundwater levels;
  - Mitigation of impacts on existing well owners;
  - Drought and Water Conservation Plans; and
  - Needs assessment of the receiving water utilities
- Impacts on:
  - Endangered and threatened species;
  - Water levels in the aquifer, including dewatering of the current artesian part of the aquifer;
  - Baseflow in streams; and
  - Wetlands.
- Competition with others in the area for groundwater; and
- Regulations by the EUWCD, including periodic renewal of permits and potential pumping reductions.

5.2.15 Aquifer Storage and Recovery (ASR) for Uvalde

5.2.15.1 Description of Water Management Strategy

The City of Uvalde is considering an aquifer storage and recovery (ASR) project whereby they would develop new water supply from the Austin Chalk and Buda Limestone Aquifers, treat the water, and store it in the Carrizo Aquifer for subsequent use. Two plans are presented herein. - The first is consistent with City of Uvalde planning, prepared by CDSmuery. It is based on the full envisioned size of the project that the city believes it can achieve through permitting. The second (MAG-Limited) is prepared according to TWDB rules and guidance, and considers the amount of water available from the two aquifers under the current Modeled Available Groundwater (MAG) estimates.

Uvalde's Envisioned Project

The City of Uvalde and Uvalde County have contracted with CDSmuery to prepare an infrastructure plan[1] to: (a) identify and conceptually define alternative groundwater supplies, (b) provide short-term relief from drought restrictions, and (3) provide long-term water resource security. The plan includes additional water for the towns of Knippa and Sabinal.

The City of Uvalde (City) and regional neighbors (including towns of Knippa and Sabinal) rely almost exclusively on groundwater to meet municipal and light industrial demands. Almost all the water supply is from the Edwards Aquifer. The recent multi-year drought has caused low groundwater levels which have triggered very substantial restrictions on Edwards Aquifer water rights. These restrictions have persisted in the Uvalde Pool at a 44 percent reduction from their Initial Regular Permit (IRP).

The draft final plan includes three phases. Phase I consists of installing new wells in a secondary aquifer[2] to provide immediate drought relief. Phase II consists of constructing an Aquifer Storage and Recovery (ASR) facility in the Carrizo Aquifer in Zavala County for long-term water security. Surplus water from the secondary aquifer well field will be source of water for ASR. Water from the Edwards Aquifer is not a viable supply for ASR in Zavala County because the Edwards Aquifer Authority's (EAA) authorization does not allow the export of Edwards water outside their jurisdictional boundary. Phase III consists of installing a regional transmission pipeline to the towns of Knippa and Sabinal.

Phase I of the draft final plan is to install two (2) wells in the Austin Chalk Aquifer in two (2) well fields. The desired annual supply is 4,000 acft/yr. Estimated well capacity is 850 gallons per minute (gpm). One of the wells fields is located near the County Fairgrounds, and the other is located near the City Wastewater Treatment Plant (WWTP). Regulatory jurisdiction for these wells is with the Uvalde County Underground Water Conservation District (UCUWCD). A pipeline from each well field is to deliver the Austin Chalk water to the City's existing treated water distribution system.

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[1] CDS Muery and DNA Geosciences, Inc, April 2014, Uvalde Alternative Groundwater Supply Infrastructure Planning Report (Final Draft), Prepared for City of Uvalde and Uvalde County.

[2] Green, R.T., Bertetti, and P, McGinnis, August 2009, Investigating the Secondary Aquifrs of the Uvalde County Underground Water Conservation District, Final Report, Revison 1, Prepared by Geosciences and Engineering Division of Southwest Research Institute, Prepared for Uvalde County Underground Water Conservation District.

Phase II of the draft final plan is to interconnect the two Austin Chalk well fields, install an ASR well field in the Carrizo Aquifer south of La Pryor, build a two-way pipeline to connect the Austin Chalk well fields with the ASR well field, and to construct an interconnect to the City distribution system. Austin Chalk groundwater will be pumped to the ASR wells and stored ("banked") in the Carrizo during times when there is a surplus supply. During shortages, such as droughts, the "banked water" in the ASR well field will be recovered and pumped to the City's treated water distribution system.

Phase III of the draft final plan is to interconnect the City's treated water distribution systems with the distribution systems for Knippa and Sabinal. Facilities in Phases I and II are sized to accommodate the supplementary water demands of Knippa and Sabinal during drought conditions.

Uvalde's MAG-Limited Project in Region L

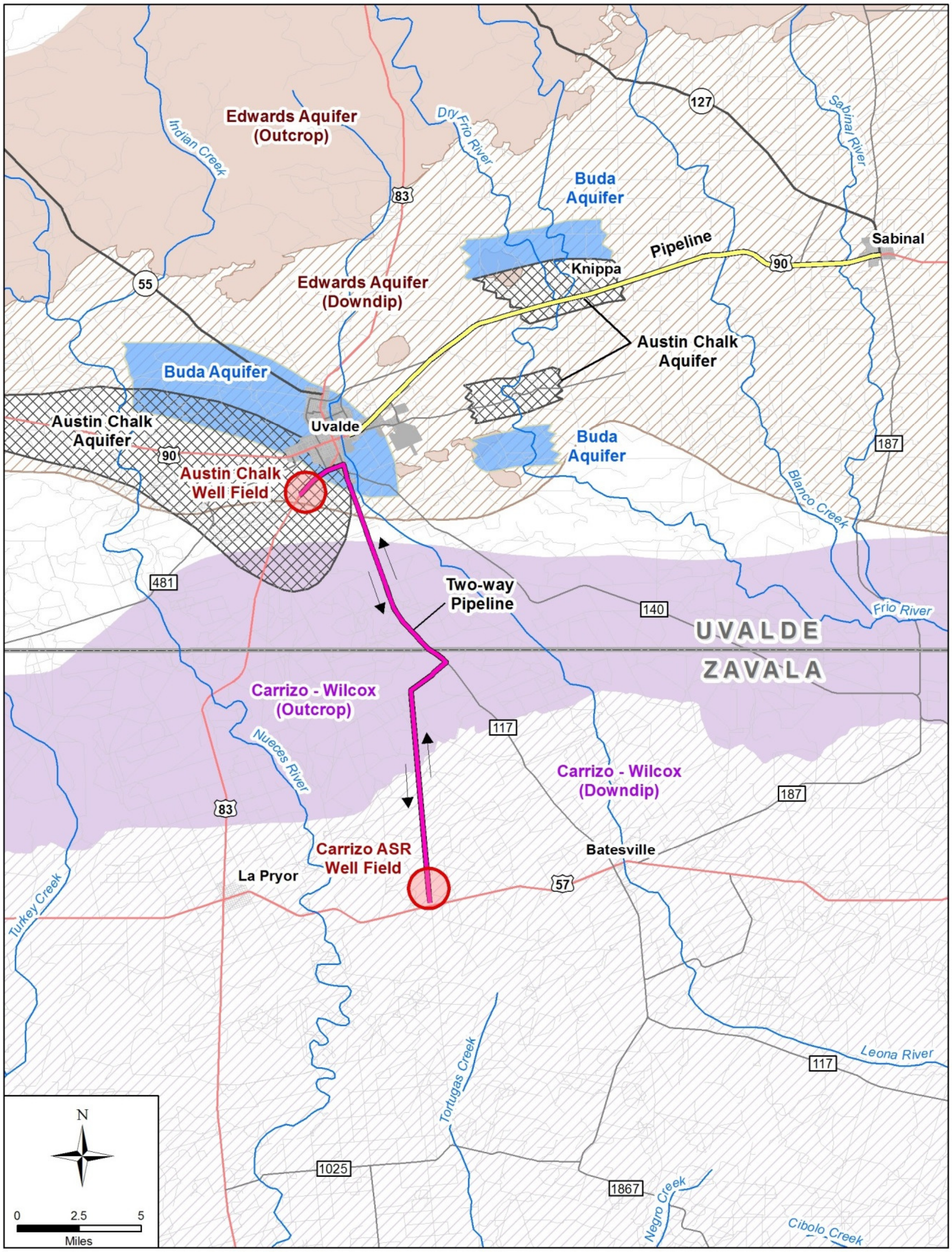
The development of a Region L Water Management Strategy for the City of Uvalde and towns of Knippa and Sabinal considers the estimate of existing water supplies, projected municipal demands, calculation of shortages, and formulation of a plan to meet the shortages. Conceptually similar to the City and County plan that was presented above, the plan is to develop one (1) Austin Chalk well field, pump the supplies either to the City for immediate use or to a Carrizo ASR well field in Zavala County for storage, and recover the stored water in ASR during time of shortage. The location of the facilities for the Region L Uvalde ASR plan is shown in Figure 5.2.15-1.

The City and Sabinal are included in the Region L analysis. For purposes of this study, the water supplies, demands and shortages for Knippa are prorated on the basis of 2010 population estimates for Knippa and Sabinal. Table 5.2.15-1 summarizes the demands, supplies and shortages. As shown the estimated total shortages range from 1,113 acft/yr in 2020 to 2,755 acft/yr in 2070. The supplies are based on Edwards Aquifer permits being restricted to severe (Stage V) drought conditions, i.e., 44 percent restrictions.

One of the constrains in the formulation of a Regional Water Management Plan is adhering to the Texas Water Development Board's (TWDB) Desired Future Conditions (DFC) and Modeled Available Groundwater (MAG). For the Austin Chalk and Buda Aquifers, members of Groundwater Management Area 10 (GMA-10) adopted an allowable regional average drawdown of zero (0) ft for both aquifers. Using this criterion, TWDB estimates the MAG for the Austin Chalk to be 2,935 acft/yr and for the Buda Limestone to be 758 acft/yr. After adjusting from estimates of existing uses, the remaining groundwater availabilities for the Austin Chalk and Buda Limestone are 1,135 and 233 acft/yr. For purposes of this plan, only the Austin Chalk Aquifer is considered for an alternative water supply.

The Region L Plan for Uvalde ASR noticeably differs from City of Uvalde and Uvalde County Final Draft Infrastructure Plan on: (1) the basis of a smaller Austin Chalk well field because of the groundwater availability is constrained by the MAG and (2) a revised location of the ASR well field to shorten the length of the two-way pipeline and avoid construction in and near the town of La Pryor. Operationally, the Region L Plan has the primary supply for the City is water coming from the Edwards Aquifer; the secondary supply coming from Austin Chalk wells; and the tertiary supply coming from ASR. The secondary supply would be brought online when demands exceed Edwards Aquifer supplies or well capacities. If the demands exceed the primary and secondary supplies, then recovery from ASR would be added to the supply. The Carrizo ASR facility would be operated in a “water banking” mode where water is stored for long-term supplies, and not seasonal supplies (summer peaking).

Figure 5.2.15-1 Preliminary Facilities Design for Uvalde ASR Region L Plan



W:\007755\000000000167424_2016_Region_L_Plan\06.00_Project_Engineering_and_Design\WMS Evaluations (PN 208708)\Act 039 - Uvalde ASR\GIS\map_docs\arcmap\Basemap_Pipelines.mxd

Table 5.2.15-1 Water Supply, Demands and Shortages (acre-feet per year)

Water Supplies, Demands and Balance	2020	2030	2040	2050	2060	2070
City of Uvalde						
Edwards IRP	5,552	5,552	5,552	5,552	5,552	5,552
Edwards in Stage V	3,109	3,109	3,109	3,109	3,109	3,109
Demand	4,052	4,342	4,593	4,881	5,181	5,474
Surplus (+)/Shortage (-)	-943	-1,233	-1,484	-1,772	-2,072	-2,365
Town of Knippa						
Edwards IRP	236	236	236	236	236	236
Edwards in Stage V	132	132	132	132	132	132
Demand	181	194	206	218	232	245
Surplus (+)/Shortage (-)	-49	-62	-74	-86	-100	-113
Town of Sabinal						
Edwards IRP	579	579	579	579	579	579
Edwards in Stage V	324	324	324	324	324	324
Demand	445	477	505	536	569	601
Surplus (+)/Shortage (-)	-121	-153	-181	-212	-245	-277
TOTAL: Uvalde, Knippa and Sabinal						
Edwards IRP	6,366	6,366	6,366	6,366	6,366	6,366
Edwards in Stage V	3,565	3,565	3,565	3,565	3,565	3,565
Demand	4,678	5,013	5,304	5,635	5,982	6,320
Surplus (+)/Shortage (-)	-1,113	-1,448	-1,739	-2,070	-2,417	-2,755

5.2.15.2 Available Yield

Groundwater supplies from the Edwards Aquifer for Uvalde, Knippa and Sabinal are defined by permits from the EAA. As with all other EAA permits, allowable pumping is restricted on the basis of groundwater levels at key index wells and discharge from Comal and San Marcos Springs. Restrictions to the Initial Regular Permit (IRP) range up to 44 percent of during Stage V conditions. A review of the UCUWCD rules and management plan did not identify any drought restrictions for the Austin Chalk Aquifer. Thus, for purposes of this study, no pumping restrictions on the Austin Chalk are imposed.

For purposes of this plan, the Edwards IRP for Uvalde, Knippa and Sabinal is estimated to be 6,366 acft/yr; and, an Austin Chalk permit for 1,155 acft/yr can be obtained from the UCUWCD. This provides a supply of 7,521 acft/yr when there is no EAA pumping restrictions. With total demands of 6,320 acft/yr in 2070 (see Table 5.2.15-1), there is a surplus of 1,146 acft/yr. However, when the Edwards Aquifer is in Stage V restrictions, there is shortage of 2,755 acft/yr.

An Uvalde ASR water-balance model for the Uvalde, Knippa and Sabinal water systems was developed to evaluate and formulate a plan of using ASR to meet the shortages when the Edwards pumping restrictions are in effect. The model operates on a monthly time step and can test strategies for operations of Austin Chalk production wells and injection and recovery of Carrizo ASR wells. The model utilizes information from the Edwards Aquifer MODFLOW model[3] to define Edwards Aquifer pumping restrictions for 1947-2000.

Development of the Uvalde ASR water-balance model consisted of:

- Utilizing the Edwards Aquifer MODFLOW model's results for the adopted Edwards Aquifer Habit Conservation Plan (EA-HCP) to determine pumping restrictions on EAA permits for 1947-2000 hydrologic conditions. For modeling purposes, conditions for the period 2016-2069 are a repeat of the 1947-2000 conditions. Conditions during 2070 are a repeat of 1947 conditions,
- Assuming EAA index well J-27 is the controlling well for Edwards pumping restrictions in Uvalde, Knippa and Sabinal,
- Developing a monthly demand that first prorates the decadal Region L projected demands into annual values and then estimates monthly demand from 5-years of San Antonio Water System (SAWS) data,
- Assuming the capacity of the Carrizo ASR well field is 10,000 acft, and.
- Estimating well capacities from Austin Chalk are up to 850 gpm, and Carrizo ASR wells are up to 800 gpm.

For purposes of this study, all water put into ASR storage is assumed to be available for recovery at a later date. If needed, the Uvalde ASR model can be revised to account for losses of stored water.

The Uvalde ASR water-balance model was run for a range of scenarios with a range of Austin Chalk and Carrizo ASR well capacities. Modeling results included charts for:

- Monthly injection into and recovery from Carrizo ASR,
- Cumulative amount of Austin Chalk Aquifer water injected into and recovered from Carrizo ASR at monthly intervals,
- Carrizo ASR water balance at monthly intervals, and
- Distribution of water supplies from Edwards, Austin Chalk and Carrizo ASR.

[3] HDR Engineering, Inc, October 2011, Evaluation of Water Management Program and Alternatives for Springflow Protection of Endangered Species at Comal and San Marcos Springs, Prepared for Edwards Aquifer Recovery Implementation Program.

An annual graphical summary of the distribution of water supplies from Edwards, Austin Chalk and Carrizo ASR is shown in Figure 5.2.15-2. As indicated, the Edwards Aquifer pumping is greatly reduced in the simulated droughts in the 2020s and 2030s, which mimics the actual droughts of the 1950s and 1960s. This causes the Edwards shortages to range from about 1,000 acft/yr in 2020 to about 1,600 in 2036. For 2016-2070, the annual supplies from the Austin Chalk ranges up to 25 percent; and, Carrizo ASR ranges up to 9 percent. Figure 5.2.15-3 shows the balance of water being stored in ASR. The chart show a net storage of about 4,500 acft at the beginning of the drought in 2020 and about 7,000 acft at the beginning of the 2030s drought. For the mid-2030s drought, about 1,600 acft was recovered from ASR.

Figure 5.2.15-2 Distribution of Water Sources for Uvalde, Knippa and Sabinal

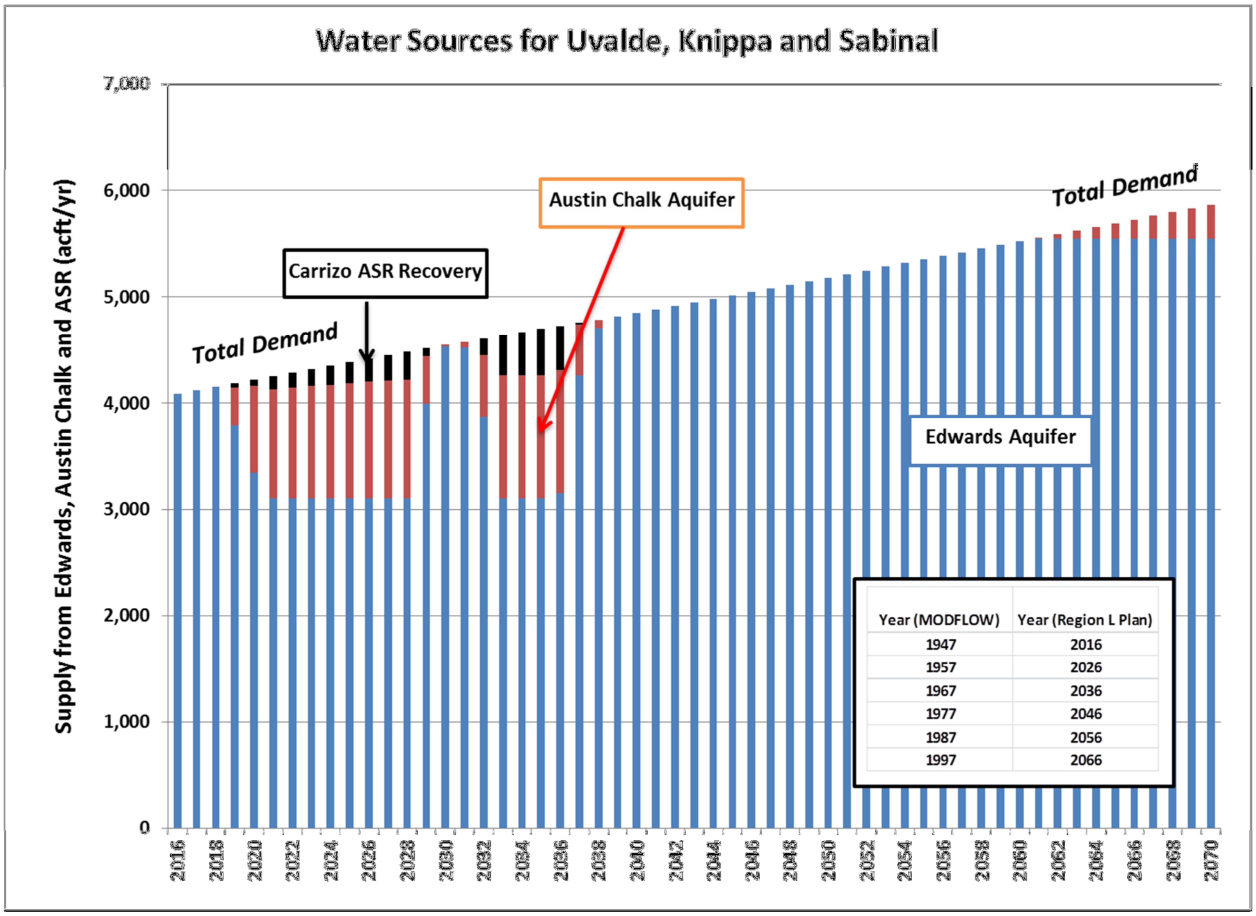
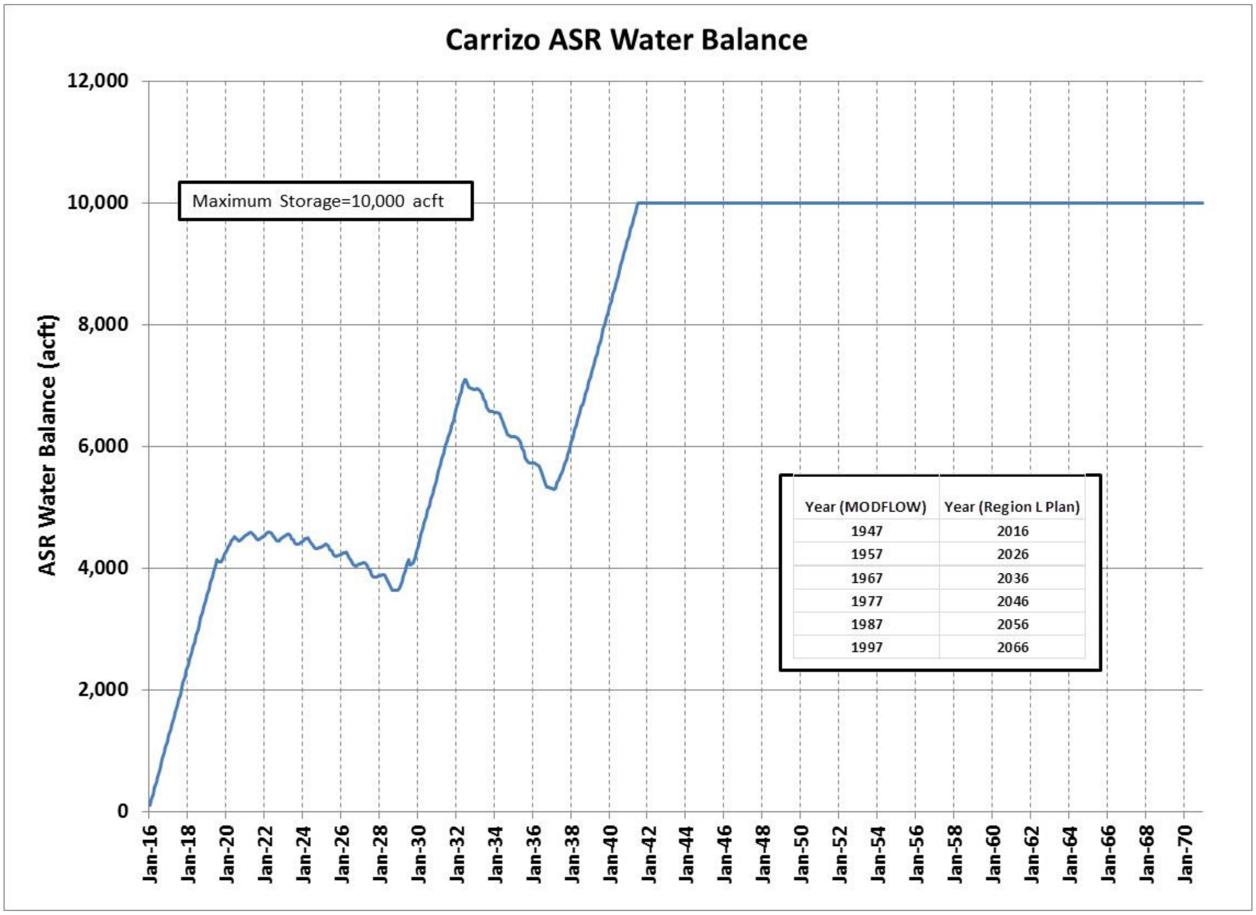


Figure 5.2.15-3 Carrizo ASR Water Balance



5.2.15.3 Environmental Issues

The Uvalde ASR project involves the construction of two wells in the Austin Chalk Aquifer, three Carrizo Aquifer ASR wells and associated pipelines and pump stations to distribute the water to treatment plants and nearby communities. Environmental issues for the Uvalde ASR Region L project are described below.

The project area is located within the South Texas Plains Ecoregion[4] and is within the Tamaulipan biotic province.[5] The project would primarily occur within undeveloped areas of these counties. Vegetation which occurs within the project area primarily includes Mesquite-Blackbrush Brush as identified by the Texas Parks and Wildlife Department (TPWD); however areas of Mesquite-Granjeno Woods and Crops also occur. Because the wells, pipelines and pump stations are located either within undeveloped rangeland or along existing roadways, the project is anticipated to have a low negative impact to existing terrestrial habitat.

Outside any required maintained right-of-way, changes to existing land uses would be minimal due to well or pipeline construction. Impacts to land use from pipeline construction would be limited to the removal of existing vegetation and temporary

[4] Gould, F.W. 1975. The Grasses of Texas. Texas A&M University Press. College Station, Texas.
[5] Blair, W.F., "The Biotic Provinces of Texas, "Tex. J. Sci. 2:93-117, 1950.

impacts during construction. Herbaceous habitats would recover fastest from construction impacts and would experience low negative impacts. Any impacts to woody vegetation would be permanent within areas of pipeline, pump station and well maintenance. The proposed wells would have a minimal impact on vegetation within the project area due to limited surface exposure.

With the construction of the pipelines, crossings of jurisdictional waters would occur. Perennial waters encountered in the project area include the Frio River, Dry Frio River, and Sabinal River. The TCEQ 2012 Texas Integrated Report for Clean Water Act Section 303(d) does not list any of these water bodies. Avoidance and minimization measures, such as horizontal directional drilling, construction best management practices (BMPs), and avoidance of perennial and /or sensitive aquatic habitats (e.g., the Frio and Sabinal Rivers, etc.) would reduce the potential impacts from pipelines. Impacts from pipelines to these waters are anticipated to be minor, would be restorable and temporary, and occur during construction. The pump station sites and wells are not located within flood hazard areas.

The TPWD has identified a number of stream segments throughout the state as ecologically significant on the basis of biological function, hydrologic function, riparian conservation, exceptional aquatic life uses, and/or threatened or endangered species. Currently, twenty one stream segments in Region L are considered ecologically significant by the TPWD.[6]

Significant streams found within the project area include the Sabinal River from the US 90 crossing in Uvalde County near the city of Sabinal upstream to the Uvalde/Bandera County line. This stream segment is considered to be ecologically significant on the basis of biological function, hydrologic function, high water quality/exceptional aquatic life/high aesthetic value and threatened or endangered species/unique communities.

Coordination with the U.S. Army Corps of Engineers would be required for construction within waters of the U.S. Impacts from this proposed project resulting in a loss of less than 0.5 acres of waters of the U.S. could be covered under Nationwide Permit #12 for Utility Line Activities unless there are significant impacts to the aquatic environment resulting from other project components.

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 (Pl96-515), and the Archeological and Historic Preservation Act (PL93-291). Based on the review of available GIS datasets, there is one cemetery, Knippa Cemetery southwest of the City of Knippa, which is located within 100 feet of the project area. No national register properties or districts, and no historical markers occur within the project area.

Based on a review of soils, geology, and aerial photographs, there is a high probability for undocumented significant cultural resources within the alluvial deposits and terrace formations associated with waterways, specifically the perennial aquatic resources. Potential impacts from constructed pipelines increase in areas near waterways and associated landforms.

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[6] TPWD, “Ecologically Significant River and Stream Segments,” http://www.tpwd.state.tx.us/landwater/water/environconcerns/water_quality/sigsegs/index.phtml accessed June 27, 2014.

A review of archaeological resources in the proposed project area should be conducted during the project planning phase. Taking into consideration that the owner or controller of the project will likely be a political subdivision of the State of Texas (i.e. river authority, municipality, county, etc.), they will be required to coordinate with the Texas Historical Commission regarding impacts to cultural resources.

The species listed by U.S. Fish and Wildlife Service (USFWS), and the TPWD as endangered or threatened with potential habitat in Uvalde and Zavala counties are listed in Table 5.2.15-2. Information from the Texas Natural Diversity Database (TNDD), maintained by TPWD, which documents the occurrence of rare species within the state, was included in this analysis. There are no recorded occurrences of any listed species near the project area. However the absence of data from the TNDD does not imply the absence of occurrence. The well fields, pumps, and pipelines include limited potential impacts to listed species.

The project area may provide potential habitat to endangered or threatened species found in Uvalde, or Zavala counties. A survey of the project area may be required prior to pipeline and well construction to determine whether populations of or potential habitats used by listed species occur in the area to be affected. Coordination with TPWD and USFWS regarding threatened and endangered species with the potential to occur in the project area should be initiated early in project planning.

Table 5.2.15-2 Endangered, Threatened, and Species of Concern for Uvalde and Zavala Counties.

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
AMPHIBIANS								
Valdina Farms sinkhole salamander	*Eurycea troglodytes complex*	0	1	0	Found in isolated intermittent pools of subterranean streams and sinkholes in Nueces, Frio, Guadalupe, and Pedernales watersheds within the Edwards Aquifer area.			Resident
BIRDS								
American peregrine falcon	*Falco peregrinus anatum*	0	2	0	Migrant and local breeder in West Texas.	DL	T	Possible Migrant
Artic peregrine falcon	*Falco peregrinus tundrius*	0	1	0	Migrant throughout the state.	DL		Possible Migrant
Baird's sparrow	*Ammodramus bairdii*	0	1	0	Found in shortgrass prairie with scattered low bushes and matted vegetation, migratory in western half of the			Possible Migrant

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
					State.			
Black-capped vireo	*Vireo atricapilla*	0	3	0	Oak-juniper woodlands with distinctive patchy, tow-layered aspect.	LE	E	Possible Migrant
Golden-cheeked warbler	*Setophaga chrysoparia*	0	3	0	Juniper-oak woodlands, dependent on mature Ashe juniper for bark.	LE	E	Possible Migrant
Interior least tern	*Sterna antillarum athalassos*	1	3	3	Nests along sand and gravel bars in braided streams	LE	E	Resident
Mountain plover	*Charadrius montanus*	0	1	0	Non-breeding, shortgrass plains and fields			Nesting/ Migrant
Sennett's Hooded Oriole	*Icterus cucullatus sennetti*	0	1	0	Often builds nest in and of Spanish moss.			Resident
Sprague's pipit	*Anthus spragueii*	0	1	0	Migrant in Texas in winter mid Sept. to early April. Strongly tied to native upland prairie.	C		Possible Migrant
Common Name	**Scientific Name**	**Impact Value**	**Multiplier Based on Status**	**Adjusted Impact**	**Summary of Habitat Preference**	**USFWS Listing**	**TPWD Listing**	**Potential Occurrence in County**
Western burrowing owl	*Athene cunicularia hypugaea*	0	1	0	Open grasslands, especially prairie, plains and savanna			Resident
Zone-tailed hawk	*Buteo albonotatus*	0	2	0	Located in arid open county, often near watercourses.		T	Resident
CRUSTACEANS								
A cave obligate crustacean	*Monodella Texana*	0	1	0	Subaquatic, subterranean obligate in underground freshwater aquifers.			Resident
FISHES								
Blue sucker	*Cycleptus elongates*	0	1	0	Found in major rivers in Texas.			Resident
Edwards Plateau shiner	*Cyprinella lepida*	1	1	1	Edwards Plateau portion of the Nueces basin in mainstem and tributaries of the Nueces, Frio, and			Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
					Sabinal rivers.			
Guadalupe bass	*Micropterus treculi*	0	1	0	Endemic to perennial streams of the Edwards Plateau region.			Resident
Headwater catfish	*Ictalurus lupus*	0	1	0	Currently limited to Rio Grande drainage, including Pecos River basin.			Resident
Nueces River shiner	*Cyprinella sp.2*	0	1	0	Edwards Plateau portion of the Nueces basin in clear, cool, spring-fed headwater creeks.			Resident
Nueces roundnose minnow	*Dionda serena*	1	1	1	Edwards Plateau portion of Nueces basin in the mainstream and tributaries of the Nueces, Frio and Sabinal rivers.			Resident
INSECTS								
A mayfly	*Allenhyphes michaeli*	0	1	0	Tx. Hill country in shoreline vegetation.			Resident
Coahuila giant skipper	*Agathymus remingtoni valverdiensis*	0	1	0	Found with Agave lechuguilla in desert hills and thorn forest.			Resident
INSECTS								
Leonora's dancer damselfly	*Argia leonorae*	1	1	1	South central and western Texas in small streams and seepages.			Resident
Sage sphinx	*Sphinx eremitoides*	0	1	0	Found in desert, grassland, sandy prairie or desert areas with sage.			Resident
MAMMALS								
Black bear	*Ursus americanus*	0	2	0	Found in bottomland hardwoods and large tracts of inaccessible forested areas.	T/SA; NL	T	Historic Resident
Carrizo Springs pocket gopher	*Geomys personatus streckeri*	0	0	0	Burrows underground in sandy soils.			Resident
Cave myotis bat	*Myotis velifer*	0	1	0	Roosts colonially in caves, rock crevices			Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
Frio pocket gopher	*Myotis velifer*	1	1	1	Associated with nearly level Atco soil.			Resident
Gray wolf	*Canis lupus*	0	3	0	Extirpated but formerly known throughout the western two-thirds of the state.	LE	E	Historic Resident
Jaguarundi	*Herpailurus yaguarondi*	1	3	3	Thick brushlands near water is favored by this species.	LE	E	Resident
Ocelot	*Leopardus pardalis*	1	3	3	Dense chaparral thickets.	LE	E	Resident
Red wolf	*Canis rufus*	0	3	0	Extirpated, formerly known throughout the eastern half of Texas.	LE	E	Historic Resident
White-nosed coati	*Nasua narica*	1	2	2	Found in woodlands, riparian corridors and canyons.		T	Resident
PLANTS								
Big red sage	*Salvia pentstemonoides*	0	1	0	Texas endemic, found in moist to seasonally wet steep limestone outcrops on canyons or along creek banks.			Resident
Boerne bean	*Phaseolus tenensis*	0	1	0	Narrowly endemic to rocky canyons in eastern and southern Edwards Plateau.			Resident
Bracted twistflower	*Streptanthus bracteatus*	0	1	0	Texas endemic found in oak juniper woodlands.	C		Resident
Hill country wild-mercury	*Argthamnia aphoroides*	0	1	0	Texas endemic found primarily in bluestem-grama grasslands associated with plateau live oak woodlands.			Resident
Sabinal prairie-clover	*Dalea sabinalis*	0	1	0	Texas endemic probably found in rock soils or on limestone outcrops in sparse grassland openings in juniper-oak woodlands.			Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
Springrun whitehead	*Shinnersia rivularis*	0	1	0	Found in shallow slow-moving water in small spring-fed streams and rivers.			Resident
Texas greasebush	*Flossopetalon texense*	0	1	0	Texas endemic found on dry limestone ledges, chalk bluffs, and limestone outcrops.			Resident
Texas largeseed bittercress	*Cardamine macrocarpa* var *Texana*	1	1	1	Located in seasonally moist, loamy soils in pine-oak woodlands.			Resident
Texas mock-orange	*Philadelphus texensis*	0	1	0	Grows on limestone outcrops of cliffs and rocky slopes and on boulders in mesic canyon bottoms.			Resident
Tobusch fishhook cactus	*Sclerocactus brevihamatus ssp. Tobuschii*	1	3	1	Texas endemic found on shallow, moderately alkaline, stony clay over limestone.	LE	E	Resident
Reticulate collared lizard	*Crotaphytus reticulatus*	1	2	2	Requires open brush-grasslands; thorn-scrub vegetation on well drained soils.		T	Resident
Spot-tailed earless lizard	*Holbrookia lacerata*	1	1	1	Moderately open prairie-brushland.			Resident
Texas Horned Lizard	*Phrynosoma cornutum*	1	2	2	Varied, sparsely vegetated uplands.		T	Resident
Texas indigo snake	*Drymarchon melanurus erebennus*	1	2	2	Found in Tx. South of the Guadalupe river and Balcones Escarpment.		T	Resident
Texas Tortoise	*Gopherus berlandieri*	1	2	2	Open brush w/ grass understory.		T	Resident

TPWD, 2014. Annotated County List of Rare Species – Uvalde County, revised 10/2/2012. Zavala County, revised 12/15/2011.
USFWS, 2014. Endangered Species List for Texas. http://www.fws.gov/southwest/es/ES_ListSpecies.cfm accessed online June 26, 2014.

Based on existing habitat types, the following species have potential to occur near or within the project area.

A. Federal and State-Listed Endangered Species

- Interior least tern (*Sterna antillarum athalassos*) —nests along sand and gravel bars in braided streams. Possible migrant within project area but no impacts to this species is anticipated.
- Jaguarundi (*Herpailurus yaguarondi*) —very limited areas of thick brushlands near water which is this species preferred habitat is present within the project area. No impacts to this species are anticipated from this project.
- Ocelot (*Leopardus pardalis*) — preferred habitat includes dense chaparral thickets which occur within the project area. However the mobility of this species and its elusive habits would allow it to avoid areas during construction of the project. No impacts to this species are anticipated from this project.
- Tobusch fishhook cactus (*Sclerocactus brevihamatus* ssp. *Tobuschii*) —has been reported in Uvalde Co. However this species is generally found in open areas with a thin covering of grasses and other herbaceous species within a woodland or savanna of live oak-juniper woodland which is not a vegetation type present within the project area. No impacts to this species are anticipated from this project.

B. Federal-Listed Candidate Species

- Sprague's pipit (*Anthus spragueii*)—this avian species is a migrant in Texas in the winter and is strongly tied to native upland prairie which is not found within the project area. No impacts to this species are anticipated from this project.
- Bracted twistflower (*Streptanthus bracteatus*)—the bracted twistflower is an endemic species normally found in oak juniper woodlands which do not occur within the project area. No impacts to this species are anticipated from this project.

C. State-Listed Threatened Species

- Zone-tailed hawk (*Buteo albonotatus*) —found in arid open country near watercourses. No impact to this species is anticipated from the project.
- White-nosed coati (*Nasua narica*)—Normally found in woodlands, riparian corridors and canyons. These types of areas are limited within the project area and no impacts to this species are anticipated.
- Reticulate collared lizard (*Crotophytus reticulatus*)—habitat used by this species occurs within the project area. However the close availability of additional areas of this type of vegetation should allow this species to move away from the project area during construction activities. No permanent impacts to this species are anticipated from this project.
- Texas horned lizard (*Phrynosoma cornutum*)—is a state threatened reptile present throughout much of the state. They exist in open, arid, and semi-arid regions with sparse vegetation, which includes grass, cactus, scattered brush or

scrubby trees. This species could potentially occur in areas with this type of contiguous vegetation although significant impacts are not anticipated from this project.

- Texas tortoise (*Gopherus berlandieri*) —is a state threatened reptile that is active in the warmer months of March through November. They occur in open brush with a grass understory and will avoid areas of open grass or bare ground. This species could potentially occur in areas with this type of vegetation although any impacts are anticipated to be temporary and minor.
- Texas indigo snake (*Drymarchon melanurus erebennus*)—found in open brush areas with a grass understory, this reptile may occur within the project area. However the close availability of additional areas of this type of vegetation should allow this species to move away from the project area during construction activities. Impacts from this project to this species are not anticipated.

Additional species of concern occur within the project area and implementation of this project would require field surveys by qualified professionals to document vegetation/habitat types, waters of the U.S. including wetlands and cultural resources that may be impacted. Where impacts to protected species habitat or significant cultural resources cannot be avoided, additional studies would be necessary to evaluate habitat use and/or value, or eligibility for inclusion in the National Register of Historic Places, respectively.

5.2.15.4 Engineering and Costing

City of Uvalde and Uvalde County Final Draft Infrastructure Plan

Preliminary engineering and costing analyses using TWDB regional water planning procedures have been performed for the three phases in the plan. Minor revisions and assumptions were made to accommodate the regional cost estimating model.

Major features of the plan, by phases, include:

- Phase I
  - Two (2) Austin Chalk Aquifer wells in each of two well fields (total of 4 wells). These wells are expected to be about 300 ft deep and produce about 850 gpm. The annual yield is planned to be 4,000 acft/yr. Peaking is to be provided by Edwards Aquifer wells,
  - Disinfection water treatment at the wellhead,
  - Collection pipeline within each well field, and
  - Connector pipeline between well field and existing City distribution system.
- Phase II
  - Connector pipeline between the two well fields,
  - Two-way pipeline between Austin Chalk well fields and Carrizo ASR well field south of LaPryor in Zavala County. The design capacity of the pipeline was defined to be 4,000 acft/yr, or 5.8 million gallons per day (MGD),

  - Five (5) Carrizo Aquifer ASR wells. These wells are expected to be about 700 ft deep and produce about 800 gpm,
  - Pump stations at the ends of the two-way pipeline. No peaking above the average annual supply of 5.8MGD is planned,
  - Disinfection water treatment for recovered water from ASR,
  - Electronic controls to operate wells and pump stations, and
  - Recovered water from ASR will be delivered to the City's treated water distribution system near US 83.
- Phase III
  - Transmission pipeline between Uvalde, Knippa and Sabinal. Capacity is to be 400 acft/yr, or 0.6 MGD. The towns of Knippa and Sabinal will peak with their Edwards wells,
  - Pump station with a capacity of 0.6 MGD. and
  - Interconnects with Uvalde, Knippa and Sabinal water systems.

Region L cost estimates for each of the three phases are presented in Table 5.2.15-4. The project yield for the Infrastructure Plan is 4,000 acft/yr. However, the estimated 2070 total water shortage for the Uvalde, Knippa, and Sabinal. Demand is 2,755 acft/yr (see Table 5.2.15-1). The unit cost of water after the completion of the three phases for the 4,000 acft/yr project is $1,629 per acft/yr.

Table 5.2.15-3 Cost Estimate Summary for City of Uvalde and Uvalde County Final Draft Infrastructure Plan (Envisioned Project)

Item	Estimated Costs Phase 1	Estimated Costs Phase 2	Estimated Costs Phase 3	Estimated Costs All Phases
Pump Stations, Ground Storage and Transmission Pipelines	$698,000	$21,475,000	$5,779,000	$27,952,000
Well Fields (Wells, Pumps, and Piping)	$2,291,000	$4,187,000	$0	$6,478,000
Water Treatment Plants (Chlorination)	$204,000	$183,000	$0	$387,000
TOTAL COST OF FACILITIES	**$3,193,000**	**$31,392,000**	**$6,549,000**	**$41,134,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$1,083,000	$9,913,000	$2,003,000	$12,999,000
Environmental & Archaeology Studies and Mitigation	$157,000	$840,000	$578,000	$1,575,000
Land Acquisition and Surveying	$45,000	$84,000	$308,000	$437,000
Interest During Construction (4% for 2 years with a 1% ROI)	$314,000	$2,957,000	$661,000	$3,932,000
TOTAL COST OF PROJECT	**$4,792,000**	**$45,186,000**	**$10,099,000**	**$60,077,000**
ANNUAL COST				
Debt Service (5.5 percent, 20 years)	$401,000	$3,781,000	$845,000	$5,027,000
Operation and Maintenance				
Pipeline, Storage, Pump Station (1% of Cost of Facilities)	$30,000	$385,000	$77,000	$492,000
Water Treatment Plant (2.5% of Cost of Facilities)	$123,000	$110,000	$0	$233,000
Pumping Energy Costs	$186,000	$559,000	$18,000	$763,000
Purchase of Water	$0	$0	$0	$0
TOTAL ANNUAL COST	**$740,000**	**$4,835,000**	**$940,000**	**$6,515,000**
Available Project Yield (acft/yr)				4,000
Annual Cost of Water ($ per acft)				$1,629
Annual Cost of Water ($ per 1,000 gallons)				$5.00

Region L Plan for Uvalde ASR

Preliminary engineering design is to construct all components of the project as soon as practical.

Major features of the plan include:

- Two (2) Austin Chalk Aquifer wells. These wells are expected to be about 300 ft deep and produce about 725 gpm. The annual yield is planned to be 1,155 acft/yr, which is essentially equal to the remaining groundwater availability of the Austin Chalk. Peaking will be provided by Edwards wells,
- Disinfection water treatment at each well field,
- Connector pipeline between well field and existing City distribution system,
- Three (3) Carrizo Aquifer ASR wells. These wells are expected to be about 700 ft deep and produce about 500 gpm,
- Two-way pipeline between Austin Chalk well field and Carrizo ASR well field west of Batesville in Zavala County. The capacity of the pipeline is planned to be 2.3 million MGD,
- Pump stations at the ends of the two-way pipeline. No peaking above monthly average demands is planned,
- Disinfection water treatment for recovered water from ASR,
- Electronic controls to operate wells and pump stations,
- Pump station and transmission pipeline between Uvalde, Knippa and Sabinal. Capacity is to be 400 acft/yr, or 0.6 MGD. The towns of Knippa and Sabinal will peak with their Edwards wells, and
- Interconnects.

Region L cost estimates for the project are presented in Table 5.2.15-4. The project yield is assumed to be 2070 total water shortage for the Uvalde, Knippa, and Sabinal. The preliminary system design is to accommodate the shortage (2,755 acft/yr) (see Table 5.2.15-1) during the most severe drought conditions. The unit cost of water is $2,803 per acft/yr.

Table 5.2.15-4 Cost Estimate Summary for Expansion of WTP and ASR (MAG-Limited Project)

Item	*Estimated Costs for Facilities*
Pump Stations, Ground Storage and Transmission Pipelines	$17,783,000
Well Fields (Wells, Pumps, and Piping)	$3,079,000
Water Treatment Plants (Chlorination)	$246,000
TOTAL COST OF FACILITIES	**$21,308,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$6,751,000
Environmental & Archaeology Studies and Mitigation	$1,641,000
Land Acquisition and Surveying	$585,000
Interest During Construction (4% for 2 years with a 1% ROI)	$2,120,000
TOTAL COST OF PROJECT	**$32,405,000**
ANNUAL COST	
Debt Service (5.5 percent, 20 years)	$2,712,000
Operation and Maintenance	
Pipeline,Storage,G28 Pump Station (1% of Cost of Facilities)	$259,000
Water Treatment Plant (2.5% of Cost of Facilities)	$148,000
Pumping Energy Costs	$119,000
Purchase of Water	$0
TOTAL ANNUAL COST	**$3,238,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 1	1,155
Annual Cost of Water ($ per acft)	$2,803
Annual Cost of Water ($ per 1,000 gallons)	$8.60

5.2.15.5 Implementation Issues

For each aquifer in the region, the GCDs have adopted desired future conditions (DFCs). In some GCDs, full use of all groundwater supplies (permitted, grandfathered and exempt) may result in non-achievement of the DFCs for an aquifer. To ensure consistency with the DFCs, TWDB currently requires that groundwater availability for each aquifer be limited for planning purposes to the modeled available groundwater (MAG) for the aquifer. This has resulted, for planning purposes only, in adjustments to permit amounts, and a lack of firm water available for future permits in this plan for some areas for certain time periods. This should not be construed as recommending or requiring that GCDs make these adjustments, or deny future permit applications. SCTRWPG recognizes and supports the ability of permit holders to exercise their rights to groundwater use in accordance with their permits and it recognizes and supports the GCDs discretion to issue permits and grandfather historical users for amounts in excess of the MAG. SCTRWPG may not modify groundwater permits that GCDs have already issued or limit future permits that GCDs may issue. If the MAG is increased during or after this planning cycle, SCTRWPG may amend this Plan to adjust groundwater supply numbers that are affected by the new MAG amount.

Implementation of the ASR strategy for Uvalde, Knippa and Sabinal will require permits and approvals from Texas Commission on Environmental Quality (TCEQ), Uvalde County Underground Water Conservation District, and Wintergarden Groundwater Conservation District (WGCD). Requirements by each agency are discussed below.

TCEQ:

- Approval for construction of Austin Chalk Aquifer wells for public water use and approval to connect the wells to Uvalde's water system, and
- ASR wells are classified as Class V injection wells. Key requirements for permits to construct and operate a Class V injection well are mechanical integrity of the well, pollution control, and periodic reports.

UCUWCD:

- Permits to construct two (2) of Austin Chalk wells,
- Operating permits to pump up to 1,155 acft/yr, and
- Permits to export and import water to and from ASR project in Zavala County.

WGCD:

- Obtain permits for the construction and operation of three (3) ASR wells.

The hydrogeology of the Austin Chalk Aquifer and Edwards Aquifer suggests that the two aquifers are interconnected. At this time, this does not appear to be a consideration in the permitting.

Land will have to be purchased or leased for the Austin Chalk wells and Carrizo wells. The willingness of landowners to enter into these transactions is unknown.

5.2.16 CRWA Wells Ranch Project – Phase II

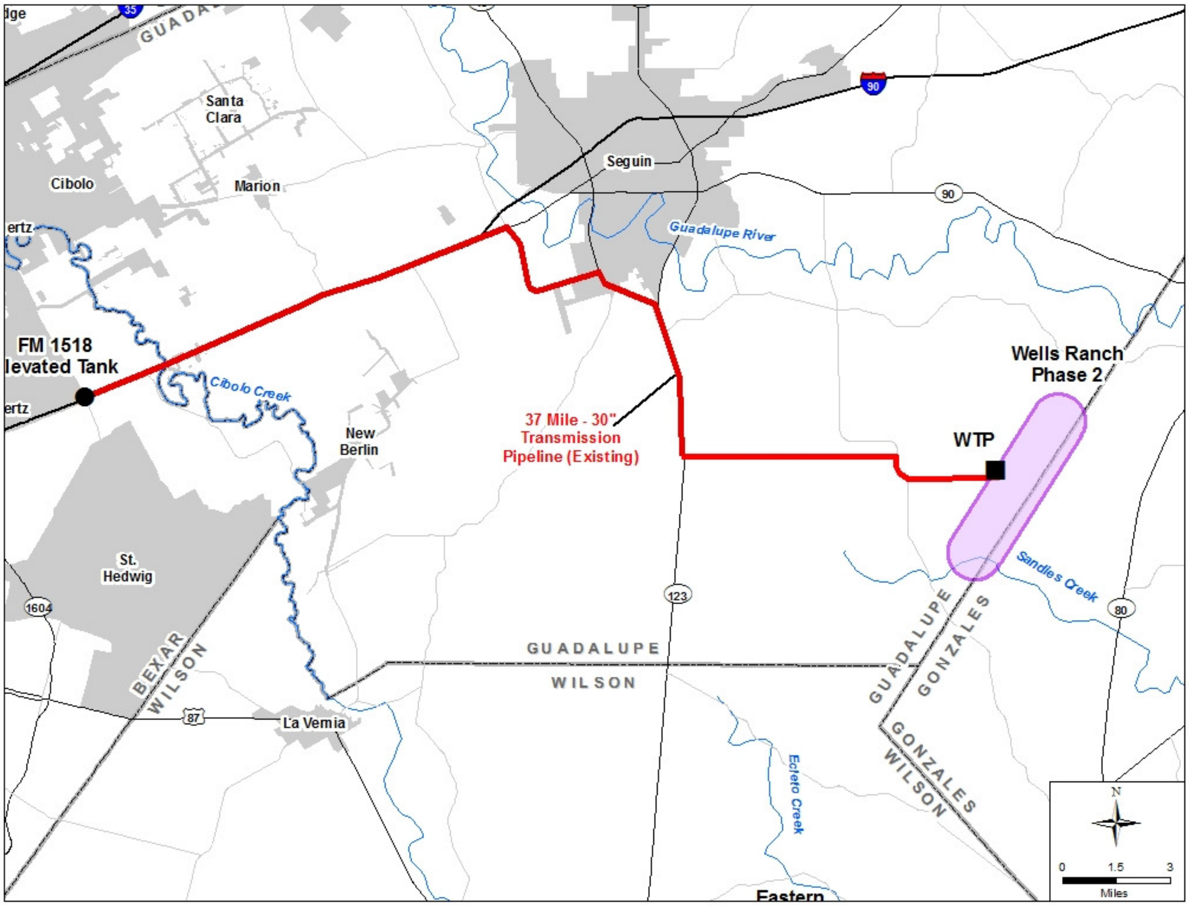
5.2.16.1 Description of Water Management Strategy

The Carrizo-Wilcox Aquifer is one of four major aquifers in the South Central Texas Water Planning Region. In Bastrop, Caldwell, Gonzales, Guadalupe, and Wilson Counties, there has been limited development. Overall, the water quality of the Carrizo-Wilcox Aquifer is suitable for use as a water supply, except for elevated concentrations of iron and manganese in many areas.

Bexar County and other counties along the IH-35 corridor have near-term projected shortages in municipal supply. Several water purveyors in Region L, including SAWS, Schertz-Seguin Local Government Corporation (SSLGC), Canyon Regional Water Authority (CRWA), Hays Caldwell Public Utility Agency (Hays Caldwell), Aqua WSC, and Texas Water Alliance, are evaluating alternative regional projects to import groundwater from the Carrizo-Wilcox to their demand centers.

Canyon Regional Water Authority (CRWA) Wells Branch project has two phases. Phase I has been completed and includes a well field that straddles the border of Guadalupe and Gonzales Counties. Phase I is designed to supply 5,200 acft/yr of water to CRWA customers. Phase II is envisioned to supply an additional 10,629 acft/yr the future. However, the Modeled Available Groundwater (MAG) limits the potential groundwater supply in the target well field to 7,829 acft/yr. To date, CRWA has: (1) conducted test drilling and well performance testing, (2) obtained drilling and production permits for wells from the Gonzales County Underground Water Conservation District (GCUWCD) and Guadalupe County Groundwater Conservation District (GCGCD), and (3) built conveyance infrastructure suitable for transmitting the full 13,000 acft/yr of supply to their distribution system. As such, this water management strategy focuses on the Phase II portion of the project. Figure 5.2.16- shows the location of Phase II of the Wells Ranch well field.

Figure 5.2.16-1 Wells Ranch Project Location Map



An earlier version of this project appeared in the 2006 South Central Texas Regional Water Plan (SCTRWP) as a water management strategy identified as "Wells Ranch Project" and was a joint project between CRWA and Bexar Metropolitan Water District (BMWD). The strategy identified an estimated supply of 9,000 acft/yr in the 2006 plan. The CRWA acquired the Wells Ranch project from BMWD before the 2011 Regional Water Plan (RWP) was released, and Phase I of this plan has subsequently been completed.

5.2.16.2 Water Availability

The Carrizo Aquifer in the vicinity of the planned well field is just downdip of the Carrizo outcrop. Hydrogeologic maps of the aquifer in this area suggest that wells in the area would be capable of producing in excess of 2,000 gpm and would range in depth from 500 to 1,200 ft deep. Most of the wells are planned to be screened in the Carrizo, however, some of the wells in Guadalupe County are to be screened in the Wilcox. Groundwater quality in the planned well field usually has a concentration of total dissolved solids of less than 300 mg/L. However, the water typically has elevated concentrations of iron and manganese that requires removal before being used by the public.

Regional Carrizo projects in this area of Gonzales County include the Shertz-Seguin Local Government Corporation Project Expansion and the Regional Carrizo for San Antonio Water System project. Groundwater production, well spacing, and export of groundwater are subject to rules of the GCUWCD. Regional Carrizo projects in this area of Guadalupe County include the Shertz-Seguin Local Government Corporation Project Expansion.

The effects of the groundwater pumping on groundwater levels and streamflow will be presented in the cumulative effects section of the 2016 SCTRWP.

As stated above, MAG constraint reduces the project yield from 10,629 acft/yr to 7,829 acft/yr.

5.2.16.3 Environmental Issues

The proposed CRWA Wells Ranch Project Phase II facilities include a well field in Gonzales and Guadalupe counties, well collection pipelines and pumps, and expansion of an existing water treatment plant.

The proposed project would occur in the East Central Texas Plains area of Omernik's[1] ecoregions and is located in the Post Oak Savanah vegetational area.[2] The Post Oak Savannah vegetational area is characterized by gently rolling to hilly terrain with an understory that is typically tall grass and an overstory that is primarily post oak *(Quercus stellata)* and blackjack oak *(Q. marilandica)*. The project area includes two major vegetation types as defined by Texas Parks and Wildlife (TPWD), Post Oak Woods/Forest, and Post Oak Woods, Forest and Grassland Mosaic.

Table 5.2.16-1 lists the threatened, endangered, candidate or species of concern that may occur in Wilson, or Guadalupe counties according to the U.S. Fish and Wildlife Service (USFWS), and county lists of rare species published by the TPWD online in the "Annotated County Lists of Rare Species." Inclusion in this table does not mean that a species will occur within the project area, but only acknowledges the potential for its occurrence in the project area counties. In addition to the county lists, the Texas Natural Diversity Database (TXNDD) was reviewed for known occurrences of listed species within or near the project area. This database revealed a known occurrence of the sandhill woolywhite (*Hymenopappus carrizoanus*) within and near the project area. This plant species of concern normally occurs in disturbed or open areas in grasslands and post oak woodlands on deep sands derived from the Carrizo Sand and similar Eocene formations. This species is considered to be rare, but is not protected by the USFWS or TPWD.

After a review of the habitat requirements for each listed species, it is anticipated that this project will have no adverse effect on any federally listed threatened or endangered species, its habitat, or designated habitat, nor would it adversely affect any state endangered species. Although suitable habitat for several state threatened species may exist within the project area, no impact to these species is anticipated due to limited area that will be impacted by the project, the abundance of similar habit near the project area and these species ability to relocate to those areas if necessary. The presence or

[1] Omernik, J. M, "Ecoregions of the conterminous United States," Annals of the Association of American Geographers, 77: 118-125, 1987.
[2] Gould, F.W., "The Grasses of Texas," Texas A&M University Press, College Station, Texas, 1975.

absence of potential habitat does not confirm the presence or absence of a listed species. No species specific surveys were conducted in the project area for this report.

Field surveys conducted at the appropriate phase of development should be employed to minimize the impacts of construction and operations on sensitive resources. Specific project features, such as well fields, treatment plants and pipelines generally have sufficient design flexibility to avoid most impacts or significantly mitigate potential impacts to geographically limited environmental and cultural resource sites.

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 (Pl96-515), and the Archeological and Historic Preservation Act (PL93-291). A review of the Texas Historical Commission Texas Historic Sites Atlas database indicated that there are no historical markers, National Register Properties, National Register Districts or cemeteries within one mile of the proposed pipeline route or wellfield. Taking into consideration that the owner or controller of the project will likely be a political subdivision of the State of Texas (i.e., river authority, municipality, county, etc.), they will be required to coordinate with the Texas Historical Commission prior to project construction. If the project will affect waters of the United States or wetlands, the project sponsor will also be required to coordinate with the U.S. Army Corps of Engineers regarding impacts to these resources.

Table 5.2.16-1 Endangered, Threatened, Candidate and Species of Concern listed for Gonzales and Guadalupe Counties

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
BIRDS								
American peregrine falcon	*Falco peregrinus anatum*	0	3	0	Migrant and local breeder in West Texas.	DL	T	Possible Migrant
Arctic peregrine falcon	*Falco peregrinus tundrius*	0	2	0	Migrant throughout the state.	DL	--	Possible Migrant
Bald eagle	*Haliaeetus leucocephalus*	0	2	0	Primarily found near waterbodies.	DL	T	Nesting/ Migrant
Henslow's sparrow	*Ammodramus henslowii*	0	1	0	Wintering individuals found in weedy fields or cut-over areas.	--	--	Possible Migrant
Interior least tern	*Sterna antillarum athalassos*	0	3	0	Nests along sand and gravel bars in braided streams	LE	E	Resident
Mountain plover	*Charadrius montanus*	0	1	0	Non-breeding, shortgrass plains and fields	--	--	Nesting/ Migrant

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
Sprague's pipit	*Anthus spragueii*	0	1	0	Migrant in Texas in winter mid Sept. to early April. Strongly tied to native upland prairie.	C	--	Possible Migrant
Western burrowing owl	*Athene cunicularia hypugaea*	0	1	0	Open grasslands, especially prairie, plains and savanna	--	--	Resident
Whooping crane	*Grus americana*	0	3	0	Potential migrant	LE	E	Potential Migrant
Wood stork	*Mycteria americana*	0	2	0	Forages in prairie ponds, ditches, and shallow standing water formerly nested in TX	--	T	Migrant
FISHES								
Blue sucker	*Cycleptus elongates*	0	2	0	Found in larger portions of major rivers in Texas	--	T	Resident
Guadalupe bass	*Micropterus treculi*	0	1	0	Endemic to perennial streams of the Edwards Plateau region.	--	--	Resident
Guadalupe darter	*Percina sciera apristis*	0	1	0	Guadalupe River basin.	--	--	Resident
INSECTS								
A mayfly	*Campsurus decoloratus*	0	1	0	Found on clay substrates along shorelines.	--	--	Resident
Manfreda giant-skipper	*Stallingsia maculosus*	0	1	0	Larvae feed inside leaf shelter and pupae found in cocoon made of leaves fastened by silk.	--	--	Resident
MAMMALS								
Cave myotis bat	*Myotis velifer*	0	1	0	Roosts colonially in caves, rock crevices	--	--	Resident
Plains spotted skunk	*Spilogale putorius interrupta*	2	1	2	Prefers wooded, brushy areas.	--	--	Resident
Red wolf	*Canis rufus*	0	3	0	Extirpated.	LE	E	Historic Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
MOLLUSKS								
Creeper (squawfoot)	*Strophitus undulates*	0	1	0	Small to large streams. Colorado, Guadalupe, and San Antonio River basins.	--	--	Resident
False spike mussel	*Quincuncina mitchelli*	0	2	0	Substrates of cobble and mud. Rio Grande, Brazos, Colorado and Guadalupe river basins.	--	T	Resident
Golden orb	*Quadrula aurea*	0	2	0	Sand and gravel, Guadalupe, San Antonio, Lower San Marcos, and Nueces River basins	C	T	Resident
Palmetto pill snail	*Euchemotrema leai cheatumi*	0	1	0	In locations with sand and gravel in Guadalupe, San Antonio, Lower San Marcos, and Nueces River basins.	--	--	Resident
Texas fatmucket	*Lampsilis bracteata*	0	2	0	Streams and rivers on sand, mud and gravel, Colorado and Guadalupe River basins.	C	T	Resident
Texas pimpleback	*Quadrula petrina*	0	2	0	Mud, gravel and sand substrates, Colorado and Guadalupe river basins	C	T	Resident
PLANTS								
Big red sage	*Salvia pentstemonoides*	0	1	0	Texas endemic, found in moist to seasonally wet steep limestone outcrops on canyons or along creek banks.	--	--	Resident
Bristle nailwort	*Paronychia setacea*	0	1	0	Endemic to south central Texas in sandy soils.	--	--	Resident
Buckley's spiderwort	*Tradescantia buckleyi*	0	1	0	Occurs on sandy loam or clay soils in grasslands or shrublands	--	--	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
					underlain by the Beaumount Formation			
Elmendorf's onion	*Allium elmendorfii*	0	1	0	Endemic, found in deep sands	--	--	Resident
Green beebalm	*Monarda viridissima*	0	1	0	Endemic perennial herb. Found in well-drained sandy soils in opening of post oak woodlands.	--	--	Resident
Parks' jointweed	*Polygonella parksii*	2	1	2	Texas endemic, primarily found on deep, loose, sand blowouts in Post Oak Savannas.	--	--	Resident
Sandhill woolywhite	*Hymenopappus carrizoanus*	2	1	2	Found south of the Guadalupe River. Prefers dense riparian corridors.	--	--	Resident
REPTILES								
Cagle's map turtle	*Graptemys caglei*	1	2	2	Endemic species found in Guadalupe river system.	--	T	Resident
Spot-tailed earless lizard	*Holbrookia lacerata*	1	1	1	Moderately open prairie-brushland.	--	--	Resident
Texas Garter Snake	*Thamnophis sirtalis annectens*	1	1	1	Wet or moist microhabitats	--	--	Resident
Texas Horned Lizard	*Phrynosoma cornutum*	1	2	2	Varied, sparsely vegetated uplands.		T	Resident
Texas indigo snake	*Drymarchon melanurus erebennus*	1	2	2	Grass prairies and sand hills; woodland and mesquite savannah of coastal plain.	--	T	Resident
Texas tortoise	*Gopherus berlandieri*	1	2	2	Open brush w/ grass understory.	--	T	Resident
Timber rattlesnake	*Crotalus horridus*	1	2	2	Floodplains, upland pine, deciduous woodlands, riparian zones.	--	T	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
LE/LT=Federally Listed Endangered/Threatened DL=Federally Delisted C=Candidate for Federal Listing E, T=State Listed Endangered/Threatened Blank = Considered rare, but no regulatory listing status TPWD, 2014. Annotated County List of Rare Species –Guadalupe County, revised 4/28/2014 and Wilson County, revised 4/28/2014. USFWS, 2014. Endangered Species List for Texas. http://www.fws.gov/southwest/es/ES_ListSpecies.cfm accessed online April 29, 2014.								

5.2.16.4 Engineering and Costing

The preliminary engineering analyses have groundwater being developed for base load operations (uniform rate). For this water management strategy, it is assumed that facilities for Phase I included the transmission facilities capacities for both Phases I and II. As such, the cost estimate included is for the Phase II expansion only. The existing water pipeline route traverses about 37 miles with a 30-inch diameter pipe from the Wells Ranch well field to the FM18 elevated tank. Water treatment consists of iron and manganese removal.

The major facilities required for this strategy (Phase II) include:

- Production Wells (500 gpm),
- Well Collection Pipelines, and
- Water Treatment Plant Expansion.

Cost estimates were developed for the envisioned project and a MAG limited project using regional planning procedures. The costs for the envisioned project are summarized in Table 5.2.16-2 and for the MAG constrained project in Table 5.2.16-3. The costs also include a groundwater lease fee of $62.50/acft and a groundwater district export fee of $8.71/acft. The cost of water for the envisioned project is estimated to be $835/acft/yr ($2.56 per 1,000 gallons) for treated water. For the MAG constrained project, the costs of water is estimated to be $858/acft/yr ($2.63 per 1,000 gallons) for treated water. These costs do not include any power cost or cost of the transmission (pump stations and pipelines) facilities to deliver the water from the water treatment plant to the customers.

Table 5.2.16-2 Cost Estimate Summary for Envisioned Project

Item	*Phase 2*
CAPITAL COST	
Transmission Pipeline (Production Pipe, Pumps and Crossings)	$4,127,000
Well Fields (Wells, Pumps, and Piping)	$14,191,000
Water Treatment Plants	$18,187,000
TOTAL COST OF FACILITIES	**$36,505,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$12,570,000
Environmental & Archaeology Studies and Mitigation	$457,000
Interest During Construction (4% for 1 years with a 1% ROI)	$1,565,000
TOTAL COST OF PROJECT	**$51,097,000**
ANNUAL COST	
Debt Service (5.5 percent, 20 years)	$3,872,000
Operation and Maintenance	
Intake, Pipeline, Pump Station (1% of Cost of Facilities)	$146,000
Water Treatment Plant (2.5% of Cost of Facilities)	$3,637,000
Pumping Energy Costs (4,765,358 kW-hr @ 0.09 $/kW-hr)	$429,000
Guadalupe Groundwater District Export Fee ($8.71/acft)	$93,000
Water Production Fee ($62.50/acft)	$696,000
TOTAL ANNUAL COST	**$8,873,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 1.3	10,629
Annual Cost of Water ($ per acft)	$835
Annual Cost of Water ($ per 1,000 gallons)	$2.56

Table 5.2.16-3 Cost Estimate Summary for MAG Constrained Project

Item	*Phase 2*
CAPITAL COST	
Transmission Pipeline (Production Pipe, Pumps and Crossings)	$2,883,000
Well Fields (Wells, Pumps, and Piping)	$9,866,000
Water Treatment Plants	$13,894,000
TOTAL COST OF FACILITIES	**$26,643,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$9,181,000
Environmental & Archaeology Studies and Mitigation	$315,000
Interest During Construction (4% for 1 years with a 1% ROI)	$1,153,000
TOTAL COST OF PROJECT	**$37,292,000**
ANNUAL COST	
Debt Service (5.5 percent, 20 years)	$2,852,000
Operation and Maintenance	
Intake, Pipeline, Pump Station (1% of Cost of Facilities)	$103,000
Water Treatment Plant (2.5% of Cost of Facilities)	$2,779,000
Pumping Energy Costs (4,466,262 kW-hr @ 0.09 $/kW-hr)	$402,000
Guadalupe Groundwater District Export Fee ($8.71/acft)	$68,000
Water Production Fee ($62.50/acft)	$513,000
TOTAL ANNUAL COST	**$6,717,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 1.3	7,829
Annual Cost of Water ($ per acft)	$858
Annual Cost of Water ($ per 1,000 gallons)	$2.63

5.2.16.5 Implementation Issues

For each aquifer in the region, the GCDs have adopted desired future conditions (DFCs). In some GCDs, full use of all groundwater supplies (permitted, grandfathered and exempt) may result in non-achievement of the DFCs for an aquifer. To ensure consistency with the DFCs, TWDB currently requires that groundwater availability for each aquifer be limited for planning purposes to the modeled available groundwater (MAG) for the aquifer. This has resulted, for planning purposes only, in adjustments to permit amounts, and a lack of firm water available for future permits in this plan for some areas for certain time periods. This should not be construed as recommending or requiring that GCDs make these adjustments, or deny future permit applications. SCTRWPG recognizes and supports the ability of permit holders to exercise their rights to groundwater use in accordance with their permits and it recognizes and supports the GCDs discretion to issue permits and grandfather historical users for amounts in excess of the MAG. SCTRWPG may not modify groundwater permits that GCDs have already issued or limit future permits that GCDs may issue. If the MAG is increased during or after this planning cycle, SCTRWPG may amend this Plan to adjust groundwater supply numbers that are affected by the new MAG amount.

This project considers existing rules of the GCUWCD with regard to well yield, spacing, and acreage. An assessment has not been conducted of the maximum drawdown criteria, which will be performed in the cumulative effects section of the plan.

Part or all of the water needed by this Water Management Strategy (WMS) is anticipated to be supplied from locations within the jurisdiction of a groundwater conservation district (District).

The development of groundwater in the Carrizo-Wilcox Aquifer in the South Texas Water Planning Region must address several issues. Major issues include:

- GCUWCD permits:
  - Analyses of pumping impacts on groundwater levels;
  - Mitigation of impacts on existing well owners;
  - Drought and Water Conservation Plans; and
  - Needs assessment.
- GCGCD permits:
  - Analyses of pumping impacts on groundwater levels;
  - Mitigation of impacts on existing well owners;
  - Drought and Water Conservation Plans; and
  - Needs assessment.
- Impacts on:
  - Endangered and threatened species;
  - Water levels in the aquifer, including dewatering of the current artesian part of the aquifer;

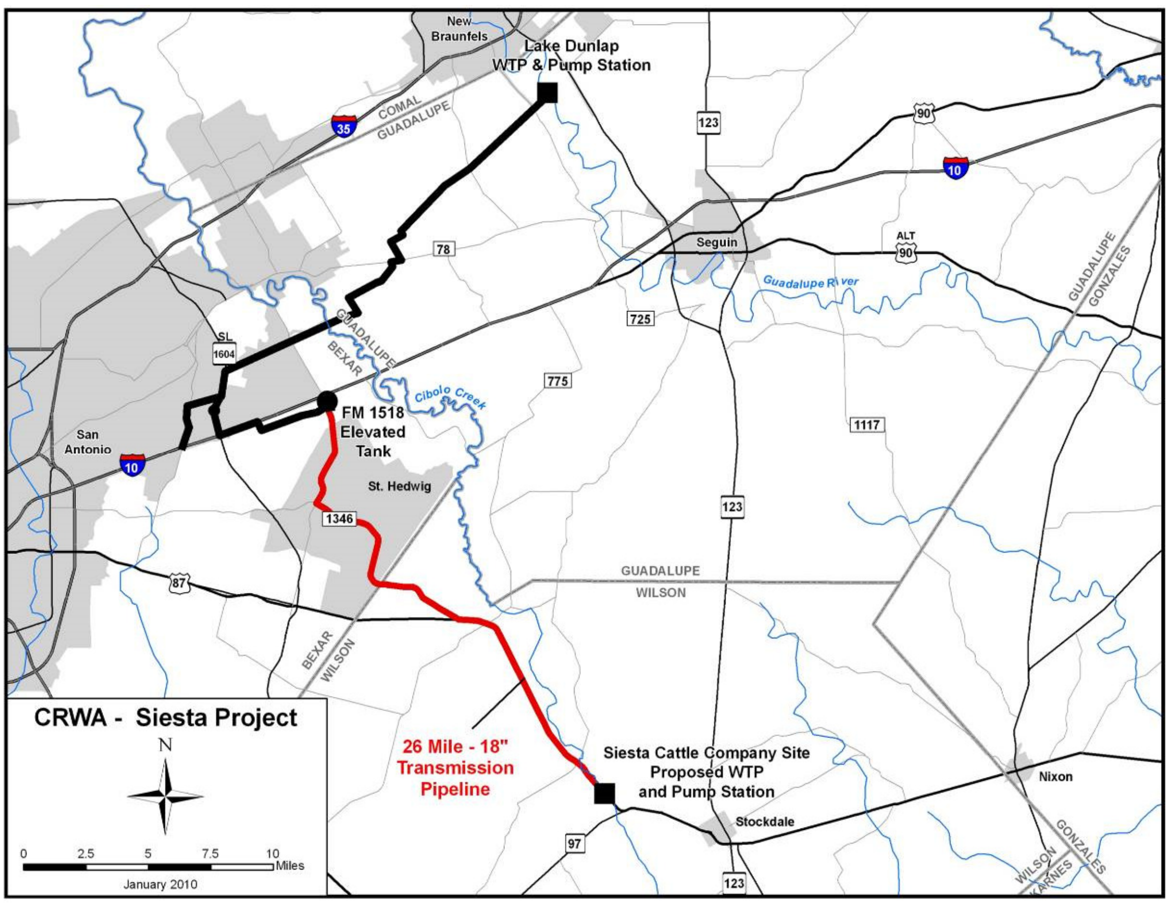
  - Baseflow in streams; and
  - Wetlands.
- Competition with others in the area for groundwater;
- Regulations by the GCUWCD, including periodic renewal of permits and potential pumping reductions; and
- Obtain TCEQ permits.

5.2.17 CRWA Siesta Project

5.2.17.1 Description of Water Management Strategy

The Canyon Regional Water Authority (CRWA) Siesta Project is based on diversions from Cibolo Creek in Wilson County under existing and amended water rights along with treated effluent from wastewater treatment facilities operated by San Antonio River Authority (SARA) and/or Cibolo Creek Municipal Authority (CCMA) as raw water sources for treatment and integration as a new municipal water supply for CRWA members. Should treated effluent from wastewater treatment facilities not be available, the project could include brackish groundwater as an alternate back-up source. The CRWA Siesta Project involves the acquisition/lease of additional water rights and the amendment of a surface water right presently held by CRWA in order to increase authorized diversions from Cibolo Creek by CRWA from 42 acft/yr to 5,042 acft/yr. The firm yield of the CRWA Siesta Project at the Siesta Cattle Company site is to be available to the CRWA members via the existing CRWA Mid-Cities Pipeline (Figure 5.2.17-1).

Figure 5.2.17-1 CRWA Siesta Project Location Map



5.2.17.2 Water Availability

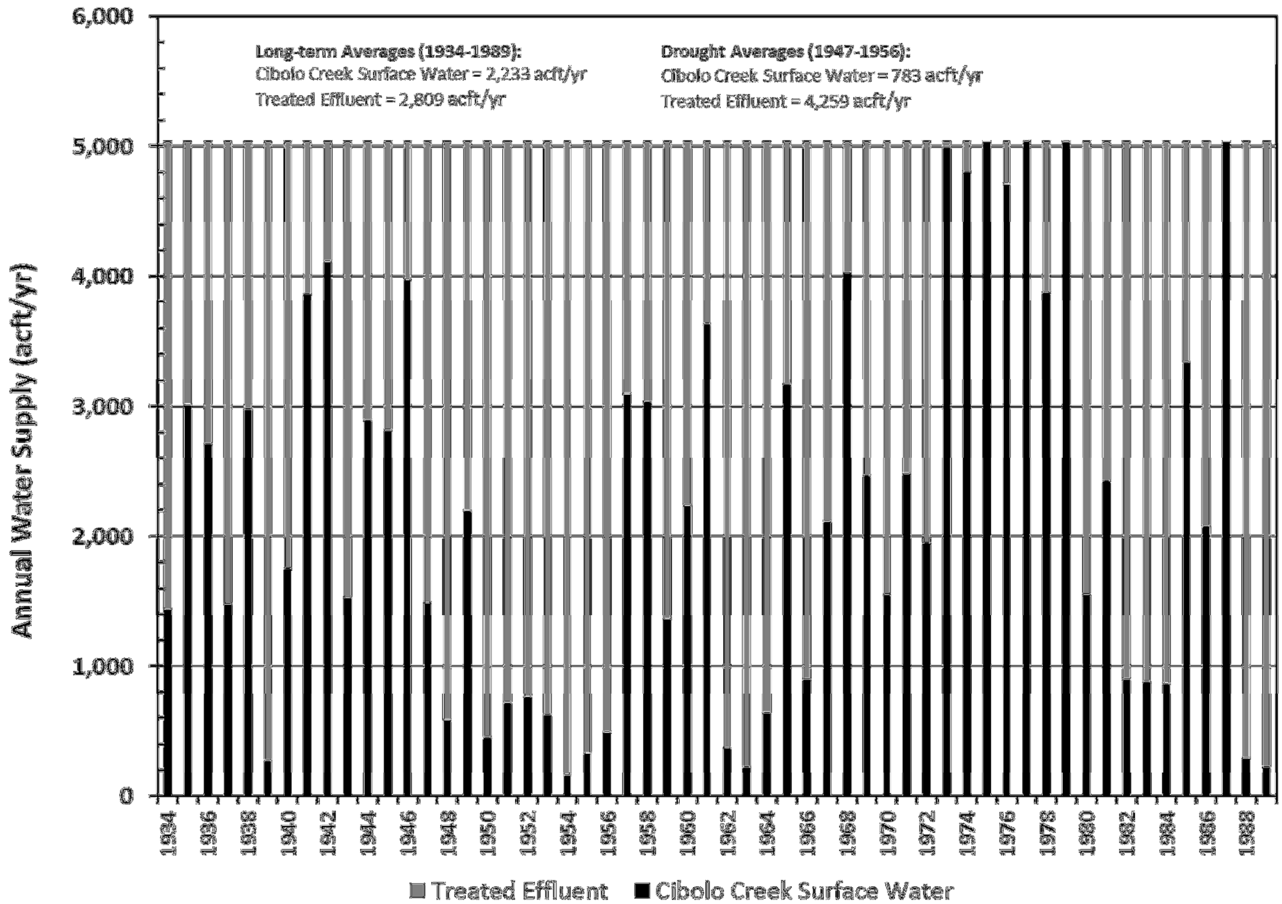
CRWA has acquired two water rights on Cibolo Creek – Certificate of Adjudication (CA) #19-1155 for 42 acft/yr (formerly held by the Siesta Cattle Company) and CA #19-1151 for 86 acft/yr (formerly held by Raymond D Hegwer et ux). CRWA has entered into agreements to lease water from two water rights holders on Cibolo Creek – CA #19-1152 for 35 acft/yr and CA #19-1157 for 117 acft/yr. In addition, CRWA is in negotiations to acquire/lease up to 455 acft/yr of additional water rights to be included in the CRWA Siesta Project. CRWA will be seeking to amend these water rights so that a common diversion point can be utilized at the Siesta Cattle Company site and to increase total authorized diversions at that point to 5,042 acft/yr.

The Guadalupe-San Antonio River Basin Water Availability Model was used to quantify water available for diversion under the existing water rights CRWA has either already acquired/leased or is seeking to acquire/lease. Hydrologic simulations and calculations were performed subject to the Hydrologic Assumptions for approved by TWDB for regional planning.

The GSAWAM was also used to quantify the water available under a proposed amendment to the Siesta water right (CA #19-1155) thereby increasing authorized diversion by 4,307 acft/yr. The proposed amendment to CA #19-1155 was modeled as a new appropriation subject to environmental flow restrictions consistent with TCEQ Environmental Flow Standards.

Water diverted for the CRWA Siesta Project under the various water rights acquisitions, leases, and amendments is shown in Figure 5.2.17-2. In addition, Figure 5.2.17-2 shows the make-up water necessary from SARA and/or CCMA wastewater treatment plants on Martinez Creek to obtain a firm yield of 5,042 acft/yr. The long-term average (1934-1989) diversion from Cibolo Creek under the various water rights is 2,233 acft/yr. The corresponding long-term average make-up water requirement is 2,809 acft/yr.

Figure 5.2.17-2 CRWA Siesta Project – Water Supply Sources



5.2.17.3 Environmental Issues

The CRWA Siesta Project facilities include an intake and pump station, water treatment plant near Cibolo Creek and an approximately 23 mile transmission pipeline leading to the existing FM 1518 elevated tank. The water would then be provided to CRWA members via the existing CRWA Mid-Cities Pipeline. The northern portion of the new project area includes land in the Blackland Prairie vegetational area, with the southern portion of the proposed pipeline entering into the Post Oak Savannah vegetational area.[1] The vegetation of these areas of Bexar and Wilson County is now primarily composed of rangeland, crops and post-oak woodlands. Landforms of the project area are typically nearly level to gently rolling and are slightly-to-moderately dissected by streams which are tributaries of the Guadalupe River.

The Blackland Prairie vegetational area is characterized by prairie grass and forbs. Most of this area is now cultivated in crops, however there are still small pockets of meadowland present which include climax tall grass vegetation. The dominant grass in this area is little bluestem, (*Schizachyrium scoparium* var. *frequens*), with other important grasses including big bluestem (*Andropogon gerardii*), indiangrass (*Sorghastgrum*

[1] Gould, F.W., 1975. "The Grasses of Texas," Texas A&M University Press, College Station, Texas.

nutans), switchgrass (*Panicum virgatum*), and sideoats grama (*Bouteloua curtipendula*).2 During the turn of the 20th century, about 98 percent of the Blackland Prairie was cultivated for crops. Livestock production has increased dramatically since that time, and now only about 50 percent of the area is used for cropland. Common woody plant species in this area include mesquite, huisache (*Acacia smallii*), oak (*Quercus* sp.) and elm (*Ulmus* sp.). Oak, elm, cottonwood (*Populus* sp.) and native pecan (*Carya* sp.) are common along drainages.

The Post Oak Savannah vegetational area includes a gently rolling to hilly topography with elevations ranging from 300 to 800 feet. The original plant community associated with this region included savannah dominated by native bunch grasses and forbs which included scattered clumps of trees. Forested areas within this region are generally found in bottomlands along major rives and creeks, or in areas protected from fire events. Climax grasses found in this area include little bluestem (*Schizachyrium scoparium* var. *frequens*), indiangrass (*Sorghastrum nutans*), switchgrass (*Panicum virgatum*), purpletop tridens (*Tridens flavus*), longspike beardgrass (*Bothriochloa saccharoides* var. *longipaniculata*) and slender woodoats (*Chasmanthium laxum*). Primary trees include post oak (*Quercus stellata*), blackjack oak (*Q. marilandica*) and several species of hickory (*Carya* spp.). Brush and tree densities have increased significantly over time when compared to this area's original condition.

Vertebrate fauna typifying these regions include the opossum, raccoon, weasel, skunk, white-tailed deer and bobcat as well as a wide variety of amphibians, reptiles and birds. The coyote and javelina are also common to the area, but are found mainly in brush/shrub areas while the red and gray fox are more common in woodlands.3

Plant and animal species listed by the USFWS and TPWD as endangered, threatened or rare in the project area are presented in Table 5.2.17-1. Mapped occurrences of the endangered golden-cheeked warbler (*Setophaga chrysoparia*) and black-capped vireo (*Vireo atricapillus*) occur within northern and western Bexar County and not Wilson County.4 Consequently, the presence of these species or their typical nesting habitat, in the vicinity of the proposed pipeline is unlikely.

Several species listed as threatened by the state may occur in the vicinity of the pipeline right of way. These include the Texas indigo snake (*Drymarchon corais erebennus*), Texas horned lizard (*Phrynosoma cornutum*), and Texas tortoise (*Gopherus berlandieri*). The only endangered, threatened species, or species of special concern identified as occurring on or in the vicinity of the proposed pipeline route by the TPWD Natural Diversity Database files include Elmendorf's onion (*Allium elmendorfii*), and Correll's false dragon-head (*Physostegia correllii*). Elmendorf's onion is found in deep sands and Correll's false dragon-head grows in wet soils. These species of concern are considered to be rare, but are not protected by USFWS or TPWD.

[2] Ibid.
[3] Manning, Richard W. et al., "Annotated Checklist of Recent Land Mammals of Texas," Occasional Papers of the Museum Number 278, Texas Tech University, 2008.
[4] Natural Diversity Database. 2014. Texas Parks and Wildlife

Table 5.2.17-1 Endangered, Threatened, and Species of Concern for Bexar and Wilson Counties

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
AMPHIBIANS								
Cascade Caverns salamander	*Eurycea latitans complex*	0	2	0	Endemic, subaquatic in Edwards Aquifer	--	T	Resident
Comal blind salamander	*Eurycea tridentifera*	0	3	0	Endemic and semi-troglobitic, found in springs and waters of caves.	--	T	Resident
Texas salamander	*Eurycea notenes*	0	1	0	Endemic; troglobitic, found in springs, caves and creek headwaters restricted to Helotes and Leon Creek drainages.	--	--	Resident
ARACHNIDS								
Bracken Bat Cave meshweaver	*Cicurina venii*	0	3	0	Small eyeless spider, found in Karst features in western Bexar County.	LE	--	Resident
Cokendolpher cave harvestman	*Texella cokendolpheri*	0	3	0	Small, eyeless spider found in karst features I north and northwest Bexar County.	LE	--	Resident
Government Canyon Bat Cave meshweaver	*Cicurina vespera*	0	3	0	Small eyeless spider in karst features in north and Northwest Bexar county.	LE	--	Resident
Government Canyon Bat Cave spider	*Neoleptoneta microps*	0	3	0	Small eyeless spider in karst features in north and Northwest Bexar county.	LE	--	Resident
Madla Cave meshweaver	*Cicurina madla*	0	3	0	Small eyeless spider in karst features in north and Northwest Bexar county.	LE	--	Resident
Robber Baron Cave meshweaver	*Cicurina baronia*	0	3	0	Small eyeless spider in karst features in north and Northwest Bexar county.	LE	--	Resident
BIRDS								
American peregrine falcon	*Falco peregrinus anatum*	0	3	0	Migrant and local breeder in West Texas.	DL	T	Possible Migrant

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
Artic peregrine falcon	*Falco peregrinus tundrius*	0	2	0	Migrant throughout the state.	DL	--	Possible Migrant
Black-capped vireo	*Vireo atricapillus*	1	3	3	Semi-open broad-leaved shrublands	LE	E	Nesting/ Migrant
Golden-cheeked warbler	*Setophaga chrysoparia*	1	3	3	Woodlands with oaks and old juniper.	LE	E	Nesting/ Migrant
Interior least tern	*Sterna antillarum athalassos*	0	3	0	Nests along sand and gravel bars in braided streams	LE	E	Possible Migrant
Mountain plover	*Charadrius montanus*	0	1	0	Non-breeding, shortgrass plains and fields	--	--	Nesting/ Migrant
Sprague's pipit	*Anthus spragueii*	0	1	0	Migrant in Texas in winter mid Sept. to early April. Strongly tied to native upland prairie.	C	--	Possible Migrant
Western burrowing owl	*Athene cunicularia hypugaea*	1	1	1	Open grasslands, especially prairie, plains and savanna	--	--	Resident
White-faced ibis	*Plegadis chihi*	0	2	0	Prefers freshwater marshes.	--	T	Potential Migrant
Whooping crane	Grus americana	0	3	0	Potential migrant	LE	E	Potential Migrant
Wood stork	*Mycteria americana*	0	2	0	Forages in prairie ponds, ditches, and shallow standing water formerly nested in TX	--	T	Migrant
Zone-tailed hawk	*Buteo albonotatus*	0	2	0	Arid, open country including deciduous or pine-oak woodland.	--	T	Nesting/ migrant
FISHES								
Guadalupe bass	*Micropterus treculi*	1	1	1	Endemic to perennial streams of the Edwards Plateau region.	--	--	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
Toothless blindcat	*Trogloglanis pattersoni*	0	2	0	Troglobitic; blind catfish endemic to the San Antonio pool of the Edwards Aquifer.	--	T	Resident
Widemouth blindcat	*Satan eurystomus*	0	1	0	Troglobitic, blind catfish endemic to the San Antonio pool of the Edwards Aquifer.	--	T	Resident
INSECTS								
A ground beetle	*Rhadine exilis*	0	3	0	Eyeless beetle found in karst features in northern Bexar county.	LE	--	Resident
A ground beetle	*Rhadine infernalis*	0	3	0	Small eyeless ground beetle found in karst features in northern and western Bexar County.	LE	--	Resident
Helotes mold beetle	*Bastrisodes venyivi*	0	3	0	Small, essentially eyeless mold beetle found in karst features in north and northwest Bexar County.	LE	--	Resident
Manfreda giant-skipper	*Stallingsia maculosus*	0	1	0	Larvae feed inside leaf shelter and pupae found in cocoon made of leaves fastened by silk.	--	--	Resident
Rawson's metalmark	*Calephelis rawsoni*	0	1	0	Moist areas in shaded limestone outcrops.	--	--	Resident
MAMMALS								
Black bear	*Ursus americanus*	0	2	0	Mountains, broken county in brushlands and forests.	T/SA; NL	T	Resident
Cave myotis bat	*Myotis velifer*	0	1	0	Roosts colonially in caves, rock crevices	--	--	Resident
Ghost-faced bat	*Mormoops megalophylla*	0	1	0	Roosts in caves, crevices and buildings.	--	--	Resident
Gray wolf	*Canis lupus*	0	3	0	Extirpated.	LE	E	Extinct
Plains spotted skunk	*Spilogale putorius interrupta*	1	1	1	Prefers wooded, brushy areas.	--	--	Resident
Red wolf	*Canis rufus*	0	3	0	Extirpated.	LE	E	Historic Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
MOLLUSKS								
Creeper (squawfoot)	*Strophitus undulates*	0	1	0	Small to large streams. Colorado, Guadalupe, and San Antonio River basins.	--	--	Resident
False spike mussel	*Quincuncina mitchelli*	0	2	0	Substrates of cobble and mud. Rio Grande, Brazos, Colorado and Guadalupe river basins.	--	T	Resident
Golden orb	*Quadrula aurea*	0	2	0	Sand and gravel, Guadalupe, San Antonio, Lower San Marcos, and Nueces River basins	C	T	Resident
Mimic cavesnail	*Phreatodrobia imitata*	0	1	0	Subaquatic found in wells in Edwards Aquifer.	--	--	Resident
Texas fatmucket	*Lampsilis bracteata*	0	2	0	Streams and rivers on sand, mud and gravel, Colorado and Guadalupe River basins.	C	T	Resident
Texas pimpleback	*Quadrula petrina*	0	2	0	Mud, gravel and sand substrates, Colorado and Guadalupe river basins	C	T	Resident
PLANTS								
Big red sage	*Salvia pentstemonoides*	1	1	1	Texas endemic, found in moist to seasonally wet steep limestone outcrops on canyons or along creek banks.	--	--	Resident
Bracted twistflower	*Steptanthus bracteatus*	0	2	0	Endemic; shallow clay soils over limestone rocky slopes.	C	--	Resident
Bristle nailwort	*Paronychia setacea*	0	1	0	Endemic to south central Texas in sandy soils.	--	--	Resident
Correll's false dragon-head	*Physostegia correllii*	2	1	2	Wet soils.	--	--	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
Elmendorf's onion	*Allium elmendorfii*	2	1	2	Endemic, found in deep sands	--	--	Resident
Green beebalm	*Monarda viridissima*	0	1	0	Endemic perennial herb. Found in well-drained sandy soils in opening of post oak woodlands.	--	--	Resident
Hill country wild-mercury	*Argythamnia aphoroides*	0	1	0	Endemic; found in grasslands associated with oak woodlands.	--	--	Resident
Parks' jointweed	*Polygonella parksii*	2	1	2	Texas endemic, primarily found on deep, loose, sand blowouts in Post Oak Savannas.	--	--	Resident
Sandhill woolywhite	*Hymenopappus carrizoanus*	2	1	2	Found south of the Guadalupe River. Prefers dense riparian corridors.	--	--	Resident
REPTILES								
Spot-tailed earless lizard	*Holbrookia lacerata*	1	1	1	Moderately open prairie-brushland.	--	--	Resident
Texas Garter Snake	*Thamnophis sirtalis annectens*	1	1	1	Wet or moist microhabitats	--	--	Resident
Texas Horned Lizard	*Phrynosoma cornutum*	1	2	2	Varied, sparsely vegetated uplands.	--	T	Resident
Texas indigo snake	*Drymarchon melanurus erebennus*	1	2	2	Grass prairies and sand hills; woodland and mesquite savannah of coastal plain.	--	T	Resident
Texas Tortoise	*Gopherus berlandieri*	1	2	2	Open brush w/ grass understory.	--	T	Resident
Timber/ canebrake rattlesnake	*Crotalus horridus*	1	2	2	Floodplains, upland pine, deciduous woodlands, riparian zones.	--	T	Resident

LE/LT=Federally Listed Endangered/Threatened
DL=Federally Delisted
C=Candidate for Federal Listing
E, T=State Listed Endangered/Threatened
Blank = Considered rare, but no regulatory listing status

TPWD, 2014. Annotated County List of Rare Species – Bexar County, revised 10/2/2012, and Wilson County, revised 8/7/2012.
USFWS, 2014. Endangered Species List for Texas. http://www.fws.gov/southwest/es/ES_ListSpecies.cfm accessed online February 17, 2014.

Field surveys conducted at the appropriate phase of development should be employed to minimize the impacts of construction and operations on sensitive resources. Specific project features, such as well fields, pipelines, and off-channel reservoirs generally have sufficient design flexibility to avoid most impacts or significantly mitigate potential impacts to geographically limited environmental and cultural resource sites.

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 (P196-515), and the Archeological and Historic Preservation Act (PL93-291). Based on the review of available records housed at the Texas Archeological Research Laboratory in Austin, seventeen cultural resource sites, nine historical markers and two cemeteries occur within a one-mile corridor of the proposed project area. Taking into consideration that the owner or controller of the project will likely be a political subdivision of the State of Texas (i.e., river authority, municipality, county, etc.), they will be required to coordinate with the Texas Historical Commission prior to project construction. If the project will affect waters of the United States or wetlands, the project sponsor will also be required to coordinate with the U.S. Army Corps of Engineers regarding impacts to these resources.

5.2.17.4 Engineering and Costing

Facilities for the CRWA Siesta Project include a raw water intake and pump station and a water treatment plant at the Siesta Cattle Company site as well as a 23-mile 20-inch treated water transmission pipeline to the existing FM 1518 elevated tank, part of the existing CRWA Mid-Cities Pipeline. Facilities have been sized with a 1.5 peaking factor to meet peak month demands. For costing purposes only, it is assumed that the entire 5,042 acft/yr would be delivered to the FM 1518 elevated tank. Cost estimates were developed in accordance the TWDB Costing Tool methodology.

As suggested by CRWA, water rights acquisition costs are based on a one-time cost of $500/acft and lease costs are based on an annual cost of $75/acft/yr. Table 5.2.17-2 contains the cost estimate for the CRWA Siesta Project. The capital cost for the facilities of the CRWA Siesta Project, including $292,000 for the acquisition of 583 acft/yr in water rights, is $47,915,000. With the inclusion of other project costs (contingencies, environmental, land acquisition, etc.), the total project cost is $68,798,000. The annual cost for the CRWA Siesta Project, including amortization and O&M, is $9,507,000, yielding a unit cost of water of $1,886/acft/yr.

Table 5.2.17-2 Cost Estimate Summary

Item	*Estimated Costs for Facilities*
Intake Pump Stations (6.8 MGD)	$6,780,000
Transmission Pipeline (20 in dia., 23 miles)	$13,343,000
Transmission Pump Station(s) & Storage Tank(s)	$3,690,000
Water Treatment Plant (7 MGD)	$23,602,000
Integration, Relocations, & Other	$500,000
TOTAL COST OF FACILITIES	**$47,915,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$16,103,000
Environmental & Archaeology Studies and Mitigation	$658,000
Land Acquisition and Surveying (296 acres)	$1,795,000
Interest During Construction (4% for 1 years with a 1% ROI)	$2,327,000
TOTAL COST OF PROJECT	**$68,798,000**
ANNUAL COST	
Debt Service (5.5 percent, 20 years)	$5,757,000
Operation and Maintenance	
Intake, Pipeline, Pump Station (1% of Cost of Facilities)	$387,000
Water Treatment Plant (2.5% of Cost of Facilities)	$2,360,000
Pumping Energy Costs (5,980,207 kW-hr @ 0.09 $/kW-hr)	$538,000
Purchase of Water (6,198 acft/yr @ $75/acft)	$465,000
TOTAL ANNUAL COST	**$9,507,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 1.5	5,042
Annual Cost of Water ($ per acft)	$1,886
Annual Cost of Water ($ per 1,000 gallons)	$5.79

5.2.17.5 Implementation Issues

Potential issues or challenges associated with implementation of the CRWA Siesta Project could include:

- Purchase or lease agreements with water rights holders on Cibolo Creek.
- Permit amendments for each of the water rights to be purchased or leased in order to allow diversion from a common point at the Siesta Cattle Company site.
- Permit amendment for the Siesta water right (CA #19-1155) to authorize increased diversions.
- Agreement between CRWA and SARA and/or CCMA for the purchase and use of treated effluent from the SARA wastewater treatment plants on Martinez Creek.
- SARA and/or CCMA to obtain an authorization for the bed and banks transfer of treated effluent from the discharge points along Martinez Creek to the Siesta Cattle Company site.

5.2.18 Brackish Wilcox Groundwater for Canyon Regional Water Authority

5.2.18.1 Description of Water Management Strategy

The Canyon Regional Water Authority (CRWA) Brackish Wilcox Project includes developing a brackish groundwater supply from the Wilcox Aquifer in Guadalupe and Wilson Counties for members of the Canyon Regional Water Alliance with service areas in Bexar, Guadalupe, and Wilson Counties. The envisioned project is designed to produce an annual water supply of 14,700 acft/yr (13.1 MGD) with a peak demand of 17.1 MGD. The well field is planned for northern Wilson County and southern Guadalupe County along Hwy 123. The water treatment plant and site of concentrate disposal is in the vicinity of the well field. The water will be transferred to the Liessner Booster Station for distribution to participating water utilities. The location of the project is shown in Figure 5.2.18-1Figure 5.2.18-1.

While the envisioned project is based on 14,700 acft/yr, analysis of the Modeled Available Groundwater for the Carrizo-Wilcox in Guadalupe and Wilson Counties indicate that only 4,138 acft/yr of pumpage is available for the project. When considering losses associated with the concentrate disposal, the firm yield of the project is 3,839 acft/yr.

This strategy builds on a preliminary assessment of potential brackish groundwater supplies from the Wilcox Aquifer in a target area that is generally a 10- to 20-mile-wide band that is south of Interstate 10 and between Loop 410 and Seguin[1]. The study and a summary of the findings are briefly discussed in the following section.

5.2.18.2 Available Yield

HDR conducted a study to identify the *favorable* and *most favorable* areas for brackish water wells in the Wilcox Aquifer. More specifically, the study identified trends and patterns of well yields, total dissolved solids, chlorides, and sulfates with well depth in the target area. The study relied on TWDB well data and TCEQ oil and gas well logs.

An analysis of the TCEQ logs identified water-bearing sands and categorized the water quality characteristics into (1) saline, brackish, and fresh, (2) brackish and fresh, or (3) fresh. A summary of the occurrence of water-bearing sands and salinity with depth were delineated into five layers within the Wilcox. In the outcrop area, the layers were 200 ft thick. In the confined section, the data are divided into five evenly divided layers. The sand thicknesses for the three categories of water quality were summed by layer, total thickness, and middle three layers. Finally, all sand layers that were 40 ft or more thick were summed to identify the major water-bearing zones where there is a reasonably good opportunity to develop a high capacity well. In concept, the cumulative thickness of the water-bearing sands should: (1) be thicker in the confined section than the unconfined section, (2) increase with depth in the downdip direction for a limited distance, and (3) begin to thin at great depths where the Wilcox becomes more compact and saline.

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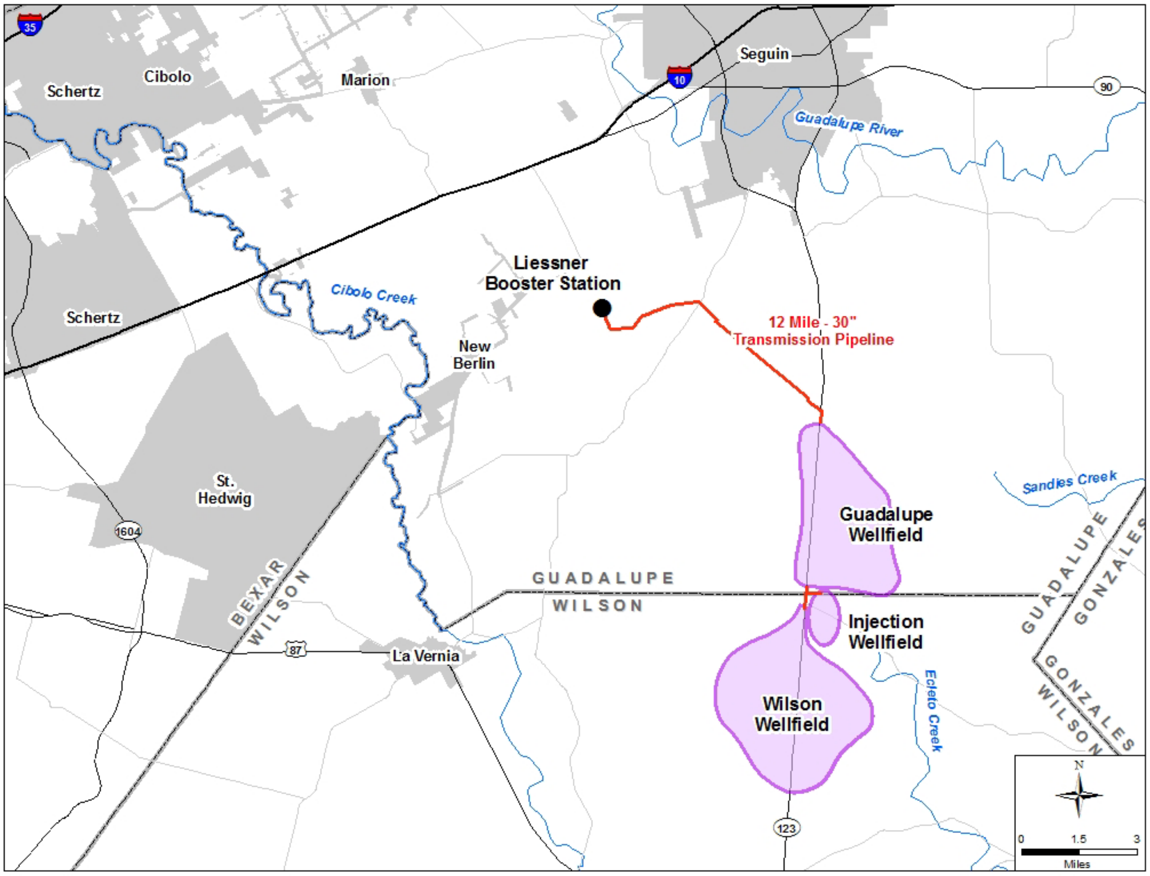
[1] HDR Engineering, Inc, February 2008, Preliminary assessment of potential water supplies from the Wilcox Aquifer in parts of Bexar, Guadalupe, and Wilson Counties: Prepared for San Antonio River Authority.

Figure 5.2.18-1 Project Location



An analysis of the TWDB data provided information on well depths, well yields, and several water quality parameters, including total dissolved solids, chlorides, and sulfates from existing Wilcox wells to identify any tendencies and patterns with location and well depth. These data points were largely restricted to the outcrop area of the Wilcox because, in the downdip direction, one can develop a well in the shallower Carrizo and generally get much better, higher quality water. The data suggest that well yields tend to increase with depth. The water quality data show great scatter for relatively shallow wells and more consistent values of the selected properties at moderate and deeper depths. Overall, the Wilcox consists of many strata with a wide range of water bearing and water quality properties, which is reflected in the TWDB data. For shallow, low capacity wells, common decisions of well owners and drillers are to tap the first water-bearing sand. With good luck, this first water-bearing sand was satisfactory and produced a good well with favorable water. Otherwise, the first water-bearing sand probably was relatively poor and resulted in marginal or poor water. For deeper, high capacity wells, the driller probably identified several water-bearing zones and selected the most favorable zone to develop the well. Thus, the data showing more favorable well yields and water quality conditions are believed to be representative of the potential wells where the owner and driller searched for and found a good water-bearing zone(s) rather than using aggressive well development procedures. In general, the chance of developing a good well appears to be better in areas where the potential well depth is greater than 200 ft.

Analyses and interpretations of the TCEQ oil and gas well logs provided information on the thicknesses of water-bearing sands and associated salinity. Graphics and maps were prepared to identify any tendencies and patterns of water-bearing sand thicknesses and salinity with depth. In contrast to the TWDB well data, the TCEQ oil and gas logs were concentrated in the confined section of the Wilcox instead of in the outcrop area. Because the selected logs only included those that fully penetrated the Wilcox, these data provides an opportunity to study the entire vertical section of the Wilcox, except for the upper section (generally about 100 ft) which was cased. In general, the study showed that the middle part of the Wilcox had more water-bearing sands of better quality than the upper and lower parts.

Considering the vertical distribution of the water-bearing sands and salinity, well designs are most likely to focus on the middle part of the aquifer where the water-bearing sands and favorable salinity tend to be more plentiful. A well in the middle part of the Wilcox provided considerable separation from the Carrizo, yet avoids great well depths.

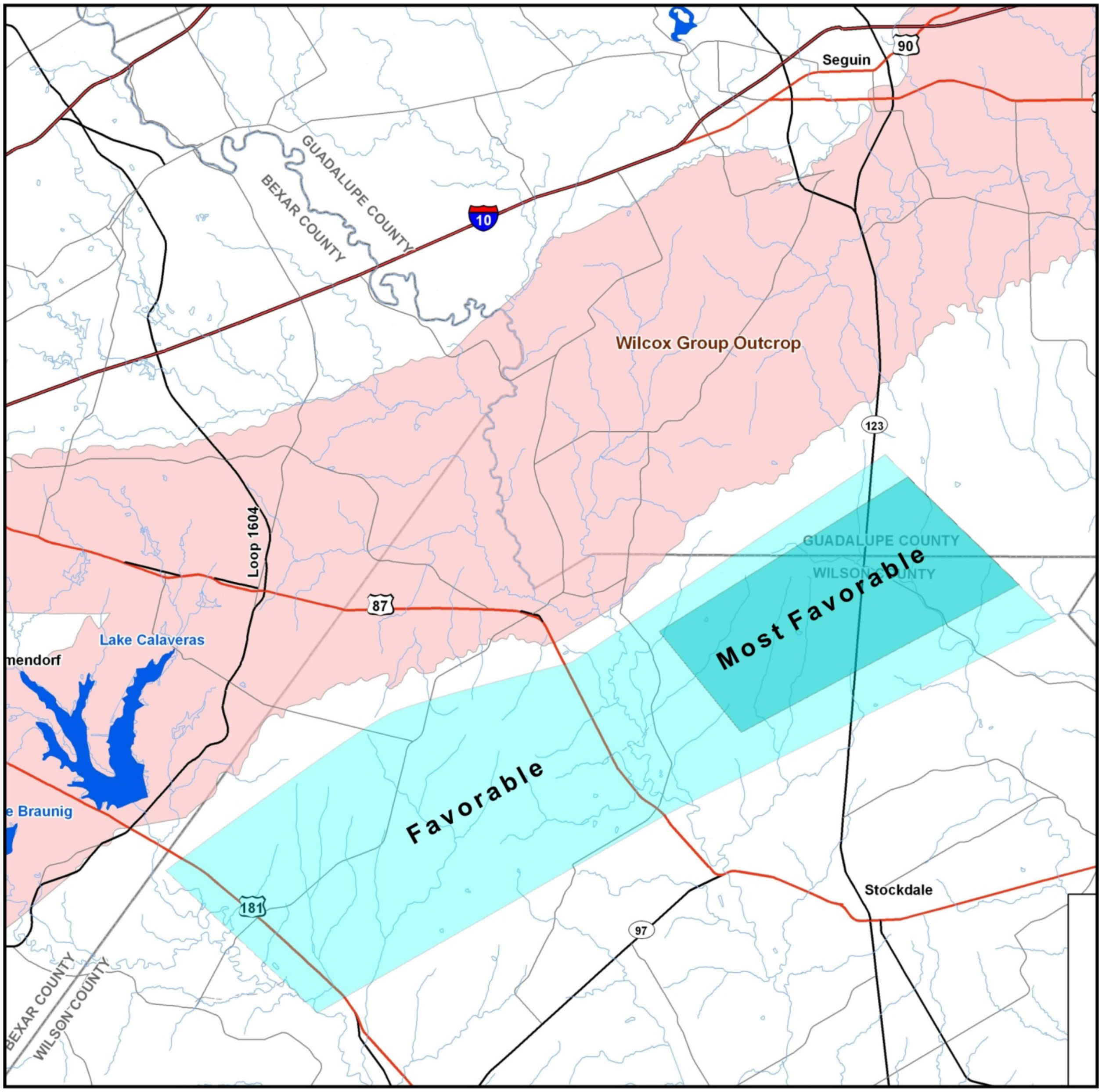
The classification of potential target areas for well fields was divided into *most favorable* and *favorable* areas. The classification considers several factors, including: (1) concentration of existing wells in the Wilcox, (2) water quality, (3) potential well yields, (4) expected well depths, and (5) expected future water development by other entities. The concentration of wells in the Wilcox is assumed to generally follow TWDB's inventory of Wilcox wells. Basic water quality conditions are assumed to be represented by TWDB data and estimates of salinity are from interpretations of the TCEQ electric logs of oil and gas test holes.

As shown in Figure 5.2.18-2, the *favorable* and *most favorable* areas are in a 5- to 8-mile-wide band with the northwest boundary about 1 to 2 miles southeast of the downdip limit of the Wilcox outcrop. This band extends from near the San Antonio River to about 3 miles northeast of the intersection of Texas Highway 123 and the Guadalupe-Wilson County line, which was the extent of the study area. The vicinity of the Guadalupe-Wilson County line and Hwy 123 is in the most favorable area.

Based on the TWDB well data and sand thicknesses, potential well yields in the favorable and most favorable areas are expected to be 500 to 800 and 700 to 1,000 gpm, respectively. The salinity (total dissolved solids) is expected to range between 1,000 and 1,500 mg/L in the favorable area and 800 and 1,200 mg/L for the most favorable area. The Wilcox wells are expected to be between 1,200 and 1,700 ft deep.

Based on analysis of the MAGs, incorporating information regarding existing supplies (allocated water) and other planned projects, there is only 4,138 acft/yr of pumpage available for this project. TWDB rules and guidance requires regional water planning groups to use estimates of MAG in the regional water plans. A determination of the estimated drawdown in the Wilcox and potential leakage from the overlying Carrizo is beyond the scope of this assessment.

Figure 5.2.18-2 Location of Favorable and Most Favorable Areas for Groundwater Development in Wilcox Aquifer



5.2.18.3 Environmental Issues

The primary environmental issues related to the development of the Brackish Wilcox Groundwater for Regional Water Alliance project are the development of the well fields, facilities for brackish water treatment, integration into an existing pipeline system, and the deep well injection of brine concentrate. Raw water from the well field will then be pumped through a collector pipeline to a desalination water treatment plant located in the vicinity of the well field. The finished water will then be pumped through a treated water pipeline to the Liessner Booster Station for distribution to participating water utilities and the concentrate injected into an adjacent disposal wellfield.

The majority of the well field area occurs in the Post Oak Woods/Forest vegetational type as described by the Texas Parks and Wildlife Department (TPWD), with small areas of Post Oak Woods, Forest and Grassland Mosaic also included.[2] The water transmission pipeline also occurs within areas of both of these vegetational types. The injection well field and water treatment plant occur within the Post Oak Woods/Forest vegetational type. The project area is slightly-to-moderately dissected by intermittent streams which are tributaries of the San Antonio and Guadalupe River basins.

Vertebrate fauna typical within this region include the opossum, raccoon, weasel, skunk, white-tailed deer and bobcat as well as a wide variety of amphibians, reptiles and birds.[3] The coyote and collared peccary are also common to the area, but are found mainly in brush/shrub areas while the red and gray fox are more common in woodlands.

lists the 15 state listed endangered and threatened species, and the five federally listed endangered, threatened or candidate species that may occur in Wilson, or Guadalupe Counties, according to county lists of rare species published by the Texas Parks and Wildlife Department (TPWD) online in the “Annotated County Lists of Rare Species.” Inclusion in Table 5.2.18-1 does not mean that a species will occur within the project area, but only acknowledges the potential for its occurrence in the project area counties. In addition to the county lists, the Natural Diversity Database (NDD) was reviewed for known occurrences of listed species within or near the project area.

The only occurrences the NDD documents near the project area are two rare plant species including Parks jointweed (*Polygonella parksii*), and sandhill woolywhite (*Hymenopappus carrizoanus*). Sandhill woolywhite is found south of the Guadalupe River and prefers dense riparian corridors. Parks jointweed is an endemic species which is usually found in deep, loose sand blowouts in post oak savannas. These species of concern are considered to be rare, but are not protected by USFWS or TPWD.

[2] McMahan, Craig A., Roy G. Frye and Kirby L. Brown. 1984. The Vegetation Types of Texas. Wildlife Division, Texas Parks and Wildlife Department, Austin, Texas.
[3] Davis, William B. and David J. Schmidly. 1994. The Mammals of Texas. Texas Parks and Wildlife Department, Austin, Texas.

Table 5.2.18-1 Endangered, Threatened, Candidate and Species of Concern listed for Guadalupe and Wilson Counties

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
BIRDS								
American peregrine falcon	*Falco peregrinus anatum*	0	3	0	Migrant and local breeder in West Texas.	DL	T	Possible Migrant
Arctic peregrine falcon	*Falco peregrinus tundrius*	0	2	0	Migrant throughout the state.	DL	--	Possible Migrant
Bald eagle	*Haliaeetus leucocephalus*	0	2	0	Primarily found near waterbodies.	DL	T	Nesting/ Migrant
Interior least tern	*Sterna antillarum athalassos*	0	3	0	Nests along sand and gravel bars in braided streams	LE	E	Resident
Mountain plover	*Charadrius montanus*	1	1	1	Non-breeding, shortgrass plains and fields	--	--	Nesting/ Migrant
Sprague's pipit	*Anthus spragueii*	0	1	0	Migrant in Texas in winter mid Sept. to early April. Strongly tied to native upland prairie.	C	--	Possible Migrant
Western burrowing owl	*Athene cunicularia hypugaea*	1	1	1	Open grasslands, especially prairie, plains and savanna	--	--	Resident
Whooping crane	*Grus americana*	0	3	0	Potential migrant	LE	E	Potential Migrant
Wood stork	*Mycteria americana*	0	2	0	Forages in prairie ponds, ditches, and shallow standing water formerly nested in TX	--	T	Migrant
FISHES								
Guadalupe bass	*Micropterus treculi*	0	1	0	Endemic to perennial streams of the Edwards Plateau region.	--	--	Resident
Guadalupe darter	*Percina sciera apristis*	0	1	0	Guadalupe River basin.	--	--	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
INSECTS								
A mayfly	*Campsurus decoloratus*	0	1	0	Found on clay substrates along shorelines.	--	--	Resident
Manfreda giant-skipper	*Stallingsia maculosus*	0	1	0	Larvae feed inside leaf shelter and pupae found in cocoon made of leaves fastened by silk.	--	--	Resident
MAMMALS								
Cave myotis bat	*Myotis velifer*	0	1	0	Roosts colonially in caves, rock crevices	--	--	Resident
Plains spotted skunk	*Spilogale putorius interrupta*	2	1	2	Prefers wooded, brushy areas.	--	--	Resident
Red wolf	*Canis rufus*	0	3	0	Extirpated.	LE	E	Historic Resident
MOLLUSKS								
Creeper (squawfoot)	*Strophitus undulates*	0	1	0	Small to large streams. Colorado, Guadalupe, and San Antonio River basins.	--	--	Resident
False spike mussel	*Quincuncina mitchelli*	0	2	0	Substrates of cobble and mud. Rio Grande, Brazos, Colorado and Guadalupe river basins.	--	T	Resident
Golden orb	*Quadrula aurea*	0	2	0	Sand and gravel, Guadalupe, San Antonio, Lower San Marcos, and Nueces River basins	C	T	Resident
Texas fatmucket	*Lampsilis bracteata*	0	2	0	Streams and rivers on sand, mud and gravel, Colorado and Guadalupe River basins.	C	T	Resident
Texas pimpleback	*Quadrula petrina*	0	2	0	Mud, gravel and sand substrates, Colorado and Guadalupe river basins	C	T	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
PLANTS								
Big red sage	*Salvia pentstemonoides*	0	1	0	Texas endemic, found in moist to seasonally wet steep limestone outcrops on canyons or along creek banks.	--	--	Resident
Bristle nailwort	*Paronychia setacea*	0	1	0	Endemic to south central Texas in sandy soils.	--	--	Resident
Elmendorf's onion	*Allium elmendorfii*	0	1	0	Endemic, found in deep sands	--	--	Resident
Green beebalm	*Monarda viridissima*	1	1	1	Endemic perennial herb. Found in well-drained sandy soils in opening of post oak woodlands.	--	--	Resident
Parks' jointweed	*Polygonella parksii*	2	1	2	Texas endemic, primarily found on deep, loose, sand blowouts in Post Oak Savannas.	--	--	Resident
Sandhill woolywhite	*Hymenopappus carrizoanus*	2	1	2	Found south of the Guadalupe River. Prefers dense riparian corridors.	--	--	Resident
REPTILES								
Cagle's map turtle	*Graptemys caglei*	1	2	2	Endemic species found in Guadalupe river system.	--	T	Resident
Spot-tailed earless lizard	*Holbrookia lacerata*	1	1	1	Moderately open prairie-brushland.	--	--	Resident
Texas Garter Snake	*Thamnophis sirtalis annectens*	1	1	1	Wet or moist microhabitats	--	--	Resident
Texas Horned Lizard	*Phrynosoma cornutum*	1	2	2	Varied, sparsely vegetated uplands.	--	T	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
REPTILES								
Texas indigo snake	*Drymarchon melanurus erebennus*	1	2	2	Grass prairies and sand hills; woodland and mesquite savannah of coastal plain.	--	T	Resident
Texas tortoise	*Gopherus berlandieri*	1	2	2	Open brush w/ grass understory.	--	T	Resident
Timber rattlesnake	*Crotalus horridus*	1	2	2	Floodplains, upland pine, deciduous woodlands, riparian zones.	--	T	Resident

LE/LT=Federally Listed Endangered/Threatened
DL=Federally Delisted
C=Candidate for Federal Listing
E, T=State Listed Endangered/Threatened
Blank = Considered rare, but no regulatory listing status

TPWD, 2014. Annotated County List of Rare Species –Guadalupe County, revised 4/28/2014 and Gonzales County, revised 4/28/2014.
USFWS, 2014. Endangered Species List for Texas. http://www.fws.gov/southwest/es/ES_ListSpecies.cfm accessed online April 29, 2014.

After a review of the habitat requirements for each listed species, it is expected that this project will have no adverse effect on any federally listed threatened or endangered species, its habitat, or designated habitat, nor would it adversely affect any state endangered species. Although suitable habitat for several state threatened species may exist within the project area, no impact to these species is anticipated due to the abundance of similar habit near the project area and the species ability to relocate to those areas if necessary. The presence or absence of potential habitat does not confirm the presence or absence of a listed species. No species specific surveys were conducted in the project area for this report.

Field surveys conducted at the appropriate phase of development should be employed to minimize the impacts of construction and operations on sensitive resources. Specific project features, such as well fields, and pipelines generally have sufficient design flexibility to avoid most impacts or significantly mitigate potential impacts to geographically limited environmental and cultural resource sites. Potential wetland impacts are expected to primarily include pipeline stream crossings, which can be minimized by right-of-way selection and appropriate construction methods, including erosion controls and revegetation procedures. Compensation for net losses of wetlands would be required where impacts are unavoidable.

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 (Pl96-515), and the Archeological and Historic Preservation Act (PL93-291). A review of the Texas Historical Commission Texas Historic Sites Atlas database indicated that there are no historical markers, National Register Properties or National Register Districts within one mile of the proposed pipeline route or wellfield. However this database indicates that the Elm Creek cemetery occurs near the proposed pipeline and should be avoided.

5.2.18.4 Engineering and Costing

The planned site of the well field is along the TX Hwy 123 and straddles the Guadalupe-Wilson County line. The wells would be spaced about a mile apart. The desalination water treatment plant, disposal well for the concentrate, and pump station would be located near the intersection of TX Hwy 123 and FM 1681. A raw water collector pipeline would deliver brackish Wilcox water from the wells to the water treatment plant. Water treatment will consist of pretreatment and desalination. A treated water pipeline would deliver water to the Liessner Booster Station and require a pump station at the water treatment plant. A concentrate water pipeline would deliver reject water to a ground storage tank. A small pump and a pipeline will transport the concentrate to a new, deep injection well field near the plant. The system is designed to provide an annual average 13.1MGD and a peak demand of 17.1 MGD.

Based on the results from the earlier study and for planning purposes, a typical Wilcox well in this locale is expected to be about 1,500 ft deep, yield about 800 gpm, and produce water with a total dissolved solids (TDS) concentration of about 1,200 mg/L.

The engineering and costing analysis for both the envisioned and MAG constrained Wilcox Brackish Desalination projects includes all facilities required for water production from the Wilcox Aquifer in Wilson and Guadalupe Counties, including wells, collector pipeline, water treatment, treated water pipeline, pump stations, and disposal of concentrate.

The envisioned well field consists of ten brackish water supply wells in Wilson County (7,000 acft/yr), ten brackish water supply wells in Guadalupe county (7,700 acft/yr), nineteen miles of collector pipelines with diameters ranging from 8 to 30 inches. The MAG constrained well field with a yield of 4,138 acft/yr consists of 4 brackish water supply wells in Guadalupe county, four miles of collector pipelines with diameters ranging from 8 to 18 inches.

Water treatment will consist of pretreatment and desalination. Pretreatment will include filtration and possibly other processes to remove particulates such as iron or manganese and to condition the water for optimal desalination. Desalination treatment is expected to be by Reverse Osmosis (RO). The treated water facilities consists of a 7-mile transmission pipeline which connects to an existing 30” pipeline, a pump station and booster station and a ground storage tank at each station, and integration into the Liessner Booster Station.. A concentrate disposal well, ground storage tank, pipelines and facilities are planned at or near the water treatment plant. The target disposal of the concentration will be deep well injection into depleted or partially depleted oil and gas producing reservoirs (Austin Chalk or Edwards Limestone).

The required secondary Maximum Contaminant Level (MCL) for TDS is 1,000 mg/L. The design of the water treatment facilities is to produce potable water with a TDS concentration of about 400-450 mg/L. The preliminary water treatment design includes: (1) Pretreatment of all raw water, (2) about 70 percent of this water will be sent to the desalination water treatment plant, and (3) the remaining 35 percent of this water will be blended with the desalinated water. The desalination plant recovery rate using conventional RO with raw water having a TDS of about 1,200 mg/Lis 90 percent, meaning that 80 percent of the water entering the desalination plant becomes purified water and 20 percent of the water remains as concentrated brine. The desalinated water and the treated brackish water are blended to produce a treated water with a TDS of about 420 mg/L, which is reasonably consistent with water currently being used by the customers in the area. This process converts about 86 percent of the quantity of raw water produced from the well field into potable water. The remaining 14 percent is a concentrate and is discharged to deep injection wells. The envisioned project requires 7 injection wells and the MAG constrained requires 3 injection wells, including contingencies. Cost estimates were computed for capital costs, annual debt service, operation and maintenance, power, land, and environmental mitigation for seasonal and peak day demands. Costs for the Envisioned project are summarized in Table 5.2.18-2 and costs for the MAG constrained project are shown in Table 5.2.18-3. Treatment costs are for removal of iron, manganese, and desalination.

Table 5.2.18-2 Envisioned Project Cost Estimate Summary

Item	***Envisioned Project***
CAPITAL COST	
Transmission Pipeline (Treated water Pipeline)	$10,918,000
Transmission Pipeline (Concentrate Disposal)	$466,000
Injection Line Pump Station	$2,006,000
Water Treatment Plant Pump Station	$3,637,000
Well Fields (Wells, Pumps, and Piping)	$42,605,000
Storage Tanks (Concentrate)	$4,370,000
Water Treatment Plants	$65,795,000
TOTAL COST OF FACILITIES	**$129,797,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$45,801,000
Environmental & Archaeology Studies and Mitigation	$947,000
Land Acquisition and Surveying	$780,000
Signing Bonus and Holding Fees	$3,089,000
Interest During Construction (4% for 1 years with a 1% ROI)	$6,299,000
TOTAL COST OF PROJECT	**$186,713,000**
ANNUAL COST	
Debt Service (5.5 percent, 30 years)	$15,585,000
Operation and Maintenance	
Intake, Pipeline, Pump Station (1% of Cost of Facilities)	$720,000
Water Treatment Plant (2.5% of Cost of Facilities)	$12,761,000
Pumping Energy Costs (15,243,911 kW-hr @ 0.09 $/kW-hr)	$1,602,000
Brackish Water Production Fee ($75/acft)	$1,545,000
Gonzales Groundwater District Export Fee ($8.12/ acft)	$88,000
TOTAL ANNUAL COST	**$32,301,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 1.3	14,700
Annual Cost of Water ($ per acft)	$2,197
Annual Cost of Water ($ per 1,000 gallons)	$6.74

Table 5.2.18-3 MAG Restricted Project Cost Estimate Summary

Item	*MAG Phase*
CAPITAL COST	
Transmission Pipeline (Treated Water Line)	$5,691,000
Transmission Pipeline (Concentrate Disposal)	$266,000
Injection Line Pump Station	$930,000
Water Treatment Plant Pump Station	$2,306,000
Well Fields (Wells, Pumps, and Piping)	$13,813,000
Storage Tank (Concentrate)	$1,200,000
Water Treatment Plants	$19,480,000
TOTAL COST OF FACILITIES	**$43,686,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$15,129,000
Environmental & Archaeology Studies and Mitigation	$515,000
Land Acquisition and Surveying	$721,000
Signing Bonus and Holding Fees	$621,000
Interest During Construction (4% for 1 years with a 1% ROI)	$2,115,000
TOTAL COST OF PROJECT	**$62,787,000**
ANNUAL COST	
Debt Service (5.5 percent, 30 years)	$5,232,000
Operation and Maintenance	
Intake, Pipeline, Pump Station (1% of Cost of Facilities)	$288,000
Water Treatment Plant (2.5% of Cost of Facilities)	$3,797,000
Pumping Energy Costs (4,268,324 kW-hr @ 0.09 $/kW-hr)	$394,000
Brackish Water Production Fee ($75/acft)	$310,000
Gonzales Groundwater District Export Fee ($8.12/ acft)	$34,000
TOTAL ANNUAL COST	**$10,055,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 1.3	3,839
Annual Cost of Water ($ per acft)	$2,619
Annual Cost of Water ($ per 1,000 gallons)	$8.04

5.2.18.5 Implementation Issues

For each aquifer in the region, the GCDs have adopted desired future conditions (DFCs). In some GCDs, full use of all groundwater supplies (permitted, grandfathered and exempt) may result in non-achievement of the DFCs for an aquifer. To ensure consistency with the DFCs, TWDB currently requires that groundwater availability for each aquifer be limited for planning purposes to the modeled available groundwater (MAG) for the aquifer. This has resulted, for planning purposes only, in adjustments to permit amounts, and a lack of firm water available for future permits in this plan for some areas for certain time periods. This should not be construed as recommending or requiring that GCDs make these adjustments, or deny future permit applications. SCTRWPG recognizes and supports the ability of permit holders to exercise their rights to groundwater use in accordance with their permits and it recognizes and supports the GCDs discretion to issue permits and grandfather historical users for amounts in excess of the MAG. SCTRWPG may not modify groundwater permits that GCDs have already issued or limit future permits that GCDs may issue. If the MAG is increased during or after this planning cycle, SCTRWPG may amend this Plan to adjust groundwater supply numbers that are affected by the new MAG amount.

Implementation of the Wilcox Aquifer Brackish groundwater strategy includes the following issues:

- Verification of available groundwater quantity and well productivity;
- Verification of water quality for concentrations of dissolved constituents, such as TDS, chloride, sulfate, iron, manganese and hydrogen sulfide;
- Verification of minimal impacts to Carrizo;
- Verification of the potential for deep well injection of concentrate;
- Permitting Class I disposal well for deep well injection of desalination concentrate;
- Regulations by TCEQ;
- Regulations by the Evergreen Underground Water Conservation District and Guadalupe County Groundwater Conservation District;
- Verification that desalinated Wilcox Aquifer water is compatible with other water sources being used by customers and will meet all water quality requirements in the end user’s distribution system; and
- Experience in operating and maintaining a desalination water treatment plant.

5.2.19 SAWS Local Brackish Wilcox Groundwater Project

In the Texas Water Development Board's February 2003 report[1], the availability of brackish water in the Carrizo-Wilcox Aquifer in Region L is shown to range from "moderate" to "high" while source water production costs range from "low" to "high." A study completed in July 20042 to evaluate the potential for a brackish groundwater source from the Wilcox Aquifer further defined the water quality and indicated that slightly brackish groundwater was available from the Wilcox Aquifer in Bexar County. A detailed study[3] was completed in October 2008 for San Antonio Water System (SAWS) on the hydrogeology, water quality, water treatment and facilities, disposal of concentrate, permitting, and procurement and financial considerations. A design memorandum4 was prepared in September 2013 for the first phase of the project, providing information on future well locations and transmission lines. Eight of the initial production wells were under construction at the time of the 2013 report.

Based on the findings of these studies, a strategy has been developed in three phases to produce a total of 33,600 acft/yr of potable water. The source of the water would be wells that are screened in the brackish part of the Wilcox Aquifer. Currently, SAWS is planning to divide the project into three phases. The desalination water treatment plant would be located at SAWS' Twin Oaks WTP and pumped to SAWS distribution system either through a new western integration pipeline and/or an existing eastern integration pipeline, or stored in SAWS ASR well field. The production well fields will be located near the future desalination plant. The concentrate injection wells have been placed Wilson County.

While the envisioned project is based on 33,600 acft/yr, a maximum supply of 6,059 acft for pumpage is available under the MAG, when considering other planned projects. With losses due to the concentration water injection, this translates to a firm yield of 5,622 acft/yr.

5.2.19.1 Description of Strategy

The SAWS Local Brackish Wilcox Project is a water management strategy based on the development of brackish groundwater in the Wilcox Aquifer (Figure 5.2.19-1). The desalination water treatment plant is to be adjacent to the Twin Oaks WTP.

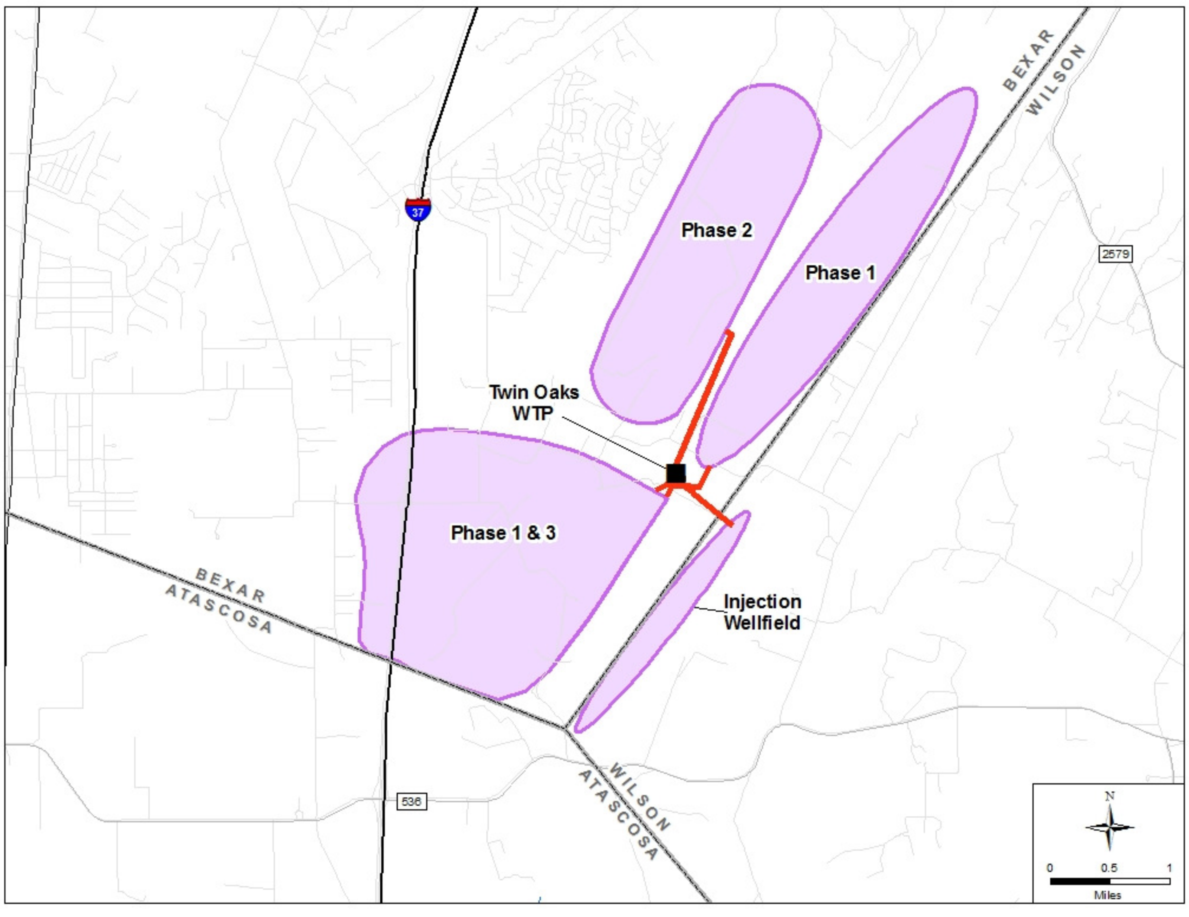
The envisioned strategy consists of three phases. All phases will have the raw water treated with a desalination water treatment plant in the vicinity of the Twin Oaks WTP. The product water would be pumped along with water recovery from the ASR well field to the SAWS distribution system through a planned west pipeline and/or the existing east pipeline. The project includes concentrate disposal injection into Edwards Limestone near the WTP in Wilson County. The strategy is to be designed to produce water at a uniform (base load) rate. The location of the major project components are shown in

[1] LBG-Guyton Associates, "Brackish Groundwater Manual for Texas Regional Water Planning Groups," prepared for the Texas Water Development Board, February 2003.
[2] HDR Engineering, Inc., "Water Quality Characteristics of the Wilcox Aquifer in the Vicinity of San Antonio, TX," prepared for San Antonio Water System, July 2004.
[3] R.W. Beck, "Brackish Groundwater Desalination Feasibility Assessment Report," prepared for SAWS, October 2008.
[4] LBG-Guyton Associates, "Basis of Design Memorandum for Production Wells BGD 9-13," prepared for the Texas Black & Veatch, September 2013.

Figure 5.2.19-1. The MAG-Limited project wells are contained in the northern Phase I well field.

Phase I is designed to produce 13,440 acft/yr of potable water. Twelve wells are planned within the SAWS property. These wells are expected to produce about 900 gpm, have a depth ranging from 1,200 to 1,800 ft, and average about 1,500 ft deep. With allowance for concentrate produced from the desalination process, about 14,500 acft/yr of raw water would have to be pumped from the Wilcox. Water from the Wilcox at this location is expected to have a total dissolved solids concentration of about 1,300-1,600 mg/L.

Figure 5.2.19-1 Brackish Wilcox Groundwater Desalination Project for SAWS



Phase II will be designed to produce 13,440 acft/yr of potable water with twelve wells within the SAWS property. A raw water demand of 14,500 acft/yr will be needed to allow for concentrate disposal. The third phase is designed to produce 6,720 acft/yr of Potable water with 6 wells. The raw water demand will be 7,243 acft/yr. Due to the proximity to the phase I wells, Phase II and III wells are also expected to produce about 900 gpm, have an average depth of about 1,500 ft and a total dissolved solids concentration of 1,300-1,500 mg/L.

5.2.19.2 Available Yield

A study by R.W. Beck (2008) for SAWS of water well data, geophysical logs from oil and gas exploratory test holes, and test drilling characterized the Wilcox Aquifer as a major source of brackish water in southern Bexar, northern Atascosa, and eastern Wilson Counties. The 2013 study by LBG-Guyton Associates, examined collected data from more existing test holes in the region of the Phase 1 well field. Test drilling and field studies in the area by SAWS have greatly improved and refined the previous characterizations of the Wilcox Aquifer with regard to potential well yields and water quality. According to the Beck report, analysis of geophysical log data indicates the thickness of sand layers to range from about 300 to 500 ft in the favorable areas for well field development.

Aquifer testing from 2012 to 2013 and summarized for 13 wells in the 2013 report indicate a well yield of 700 to 1,000 gpm for a drawdown of about 145 to 333 ft. For costing purposes, an average pumping rate of 900 gpm and average drawdown of 190 ft were used. Because of the dip of the Wilcox toward the Gulf Coast, the top of the sands are shallower to the northwest and deeper to the southeast. The range in the concentration of total dissolved solids typically ranged from about 1,300 to 1,500 mg/L, with an average of around 1400 mg/L. A clear, discernable aquitard between the water-bearing sands in the Carrizo and Wilcox Aquifers was reported to be 200 to 300 ft thick in the study area. Results of groundwater modeling in the Beck 2008 report indicates 2060 drawdown in the Wilcox would be about 250 ft from 15 wells pumping in three well fields for a total of 25 MGD. The modeling analysis also showed drawdown in the Carrizo to be less than 8 ft by 2060. Results from the Beck study suggest that well fields located in this area are suitable for a long-term supply of brackish groundwater. Please note that these long-term simulations only approximately match the preliminary designs of this strategy. Thus, the future drawdown for this strategy may be somewhat different.

In Bexar County, there is not a groundwater conservation district to regulate well spacing and production in the Wilcox Aquifer. According to the TWDB approved Groundwater Availability Model, there is only 6,059 acft/yr of MAG available for this project. TWDB rules and guidance require regional water planning groups to use estimates of MAG in the regional water plans.

5.2.19.3 Environmental Issues

The Brackish Groundwater Desalination for SAWS water management strategy involves the development of well fields in the brackish portion of the Wilcox Aquifer including their associated pumps, wells, and piping, water treatment plant and additional expansions, an intake pump station with expansions, and transmission pipelines used for transmission of brackish water and concentrate disposal.

The project area occurs within the Post Oak Savannah vegetational area which contains gently rolling to hilly topography, and elevations which range from 300 to 800 feet.[5] Overstory species found within this area primarily include post oak (*Quercus stellata*), blackjack oak (*Q. marilandica*), and species of hickory (*Carya* ssp.). Climax grasses include yellow indian grass (*Sorghastrum nutans*), switchgrass (*Panicum virgatum*), purpletop tridens (*Tridens flavus*), longspike silver bluestem (*Bothriochloa saccharoides* var. *longipaniculata*), slender woodoats (*Chasmanthium laxum*), and little bluestem (*Schizachyrium scoparium*).

The Phase 1 well field includes mainly Post Oak Woods/Forest vegetational type as described by the Texas Parks and Wildlife Department (TPWD), with small areas of Post Oak Woods/Forest and Grassland Mosaic also included.[6] The Phase II well field occurs solely within the Post Oak Woods/Forest vegetational type. The Phase III well field and existing WTP occur within Crop and Post Oak Woods/Forest vegetational types. The project area is slightly-to-moderately dissected by streams which are tributaries of the Nueces and San Antonio Rivers.

Vertebrate fauna typical within this region include the opossum, raccoon, weasel, skunk, white-tailed deer and bobcat as well as a wide variety of amphibians, reptiles and birds.[7] The coyote and collared peccary are also common to the area, but are found mainly in brush/shrub areas while the red and gray fox are more common in woodlands.

Plant and animal species listed by U.S. Fish and Wildlife Service (USFWS) and TPWD that may occur within the vicinity of this water management strategy are listed in Table 5.2.19-1. No impacts to federally listed species are anticipated from this project. The ranges of two endangered birds, the golden-cheeked warbler (*Dendroica chrysoparia*) and black-capped vireo (*Vireo atricapillus*) extend into northern and western Bexar County and not Wilson County. Consequently, the presence of these species or their typical nesting habitat, in the vicinity of the proposed pipelines or well fields is unlikely.

The Texas Natural Diversity Database (TXNDD), maintained by TPWD, indicates known occurrences of three rare plants in the vicinity of the project, sandhill woolywhite

[5] Gould, F.W., "The Grasses of Texas," Texas A&M University Press, College Station, Texas, 1975.
[6] McMahan, Craig A., Roy G. Frye and Kirby L. Brown. 1984. The Vegetation Types of Texas. Wildlife Division, Texas Parks and Wildlife Department, Austin, Texas.
[7] Davis, William B. and David J. Schmidly. 1994. The Mammals of Texas. Texas Parks and Wildlife Department, Austin, Texas.

Table 5.2.19-1 Endangered, Threatened, Candidate and Species of Concern listed for Atascosa, Bexar and Wilson Counties

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence
AMPHIBIANS								
Cascade Caverns salamander	*Eurycea latitans complex*	0	2	0	Endemic, subaquatic in Edwards Aquifer		T	Resident
Comal blind salamander	*Eurycea tridentifera*	0	2	0	Endemic and semi-troglobitic, found in springs and waters of caves.		T	Resident
San Marcos salamander	*Erurycea nana*	0	2	0	Occurs only in Spring Lake and an adjacent downstream portion of the upper San Marcos	T	T	Potential Resident
Texas blind salamander	*Typhlomolge rathbuni*	0	3	0	Lives in water-filled caves of the Edwards Aquifer near San Marcos, Texas.	LE	E	Potential Resident
Texas salamander	*Eurycea notenes*	0	1	0	Endemic; troglobitic, found in springs, caves and creek headwaters restricted to Helotes and Leon Creek drainages.			Resident
ARACHNIDS								
Bracken Bat Cave meshweaver	*Cicurina venii*	0	3	0	Small eyeless spider, found in Karst features in western Bexar County.	LE		Resident
Cokendolpher cave harvestman	*Texella cokendolpheri*	0	3	0	Small, eyeless spider found in karst features I north and northwest Bexar County.	LE		Resident
Government Canyon Bat Cave meshweaver	*Cicurina vespera*	0	3	0	Small eyeless spider in karst features in north and Northwest Bexar county.	LE		Resident
Government Canyon Bat Cave spider	*Neoleptoneta microps*	0	3	0	Small eyeless spider in karst features in north and Northwest Bexar county.	LE		Resident
Madla Cave meshweaver	*Cicurina madla*	0	3	0	Small eyeless spider in karst features in north and Northwest Bexar county.	LE		Resident
Robber Baron Cave meshweaver	*Cicurina baronia*	0	3	0	Small eyeless spider in karst features in north and Northwest Bexar county.	LE		Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
BIRDS								
American peregrine falcon	*Falco peregrinus anatum*	0	3	0	Migrant and local breeder in West Texas.	DL	T	Possible Migrant
Arctic peregrine falcon	*Falco peregrinus tundrius*	0	2	0	Migrant throughout the state.	DL		Possible Migrant
Black-capped vireo	*Vireo atricapillla*	1	3	3	Semi-open broad-leaved shrublands	LE	E	Nesting/ Migrant
Golden-cheeked warbler	*Setophaga chrysoparia*	1	3	3	Woodlands with oaks and old juniper.	LE	E	Nesting/ Migrant
Interior least tern	*Sterna antillarum athalassos*	0	3	0	Nests along sand and gravel bars in braided streams	LE	E	Resident
Mountain plover	*Charadrius montanus*	0	1	0	Non-breeding, shortgrass plains and fields			Nesting/ Migrant
Sprague's pipit	*Anthus spragueii*	0	1	0	Migrant in Texas in winter mid Sept. to early April. Strongly tied to native upland prairie.	C		Possible Migrant
Western burrowing owl	*Athene cunicularia hypugaea*	0	1	0	Open grasslands, especially prairie, plains and savanna			Resident
White-faced ibis	*Plegadis chihi*	0	2	0	Prefers freshwater marshes.		T	Potential Migrant
Whooping crane	*Grus americana*	0	3	0	Potential migrant	LE	E	Potential Migrant
Wood stork	*Mycteria americana*	0	2	0	Forages in prairie ponds, ditches, and shallow standing water formerly nested in TX		T	Migrant
Zone-tailed hawk	*Buteo albonotatus*	0	2	0	Arid, open country including deciduous or pine-oak woodland.		T	Nesting/ migrant

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
CRUSTACEANS								
A cave obligate crustacean	*Monodella Texana*	0	1	0	Subaquatic, subterranean obligate found in freshwater aquifers.			Resident
Nueces crayfish	*Procambarus nueces*	0	1	0	Known from only one small sluggish stream tributary to the Nueces River.			Resident
Peck's Cave amphipod	*Stygobromus pecki*	0	3	0	Small, aquatic crustacean; lives underground in the Edwards Aquifer.	LE	E	Potential Resident
Nueces crayfish	*Procambarus nueces*	0	1	0	Known from only one small sluggish stream tributary to the Nueces River.			Resident
Peck's Cave amphipod	*Stygobromus pecki*	0	3	0	Small, aquatic crustacean; lives underground in the Edwards Aquifer.	LE	E	Potential Resident
FISHES								
Fountain darter	*Etheostoma fonticola*	0	3	0	Known only from the San Marcos and Comal rivers.	LE	E	Potential Resident
Guadalupe bass	*Micropterus treculi*	0	1	0	Endemic to perennial streams of the Edwards Plateau region.			Resident
Toothless blindcat	*Trogloglanis pattersoni*	0	2	0	Troglobitic; blind catfish endemic to the San Antonio pool of the Edwards Aquifer.		T	Resident
Widemouth blindcat	*Satan eurystomus*	0	2	0	Troglobitic, blind catfish endemic to the San Antonio pool of the Edwards Aquifer.		T	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
INSECTS								
A ground beetle	*Rhadine exilis*	0	3	0	Eyeless beetle found in karst features in northern Bexar county.	LE		Resident
A ground beetle	*Rhadine infernalis*	0	3	0	Small eyeless ground beetle found in karst features in northern and western Bexar County.	LE		Resident
Comal Springs dryopid beetle	*Stygoparnus comalensis*	0	3	0	Dryopids usually cling to objects in a stream.	LE	E	Potential Resident
Comal Springs riffle beetle	*Heterelmis comalensis*	0	3	0	Comal and San Marcos Springs	LE	E	Potential Resident
Helotes mold beetle	*Bastrisodes venyivi*	0	3	0	Small, essentially eyeless mold beetle found in karst features in north and northwest Bexar County.	LE		Resident
Manfreda giant-skipper	*Stallingsia maculosus*	1	1	1	Larvae feed inside leaf shelter and pupae found in cocoon made of leaves fastened by silk.			Resident
Rawson's metalmark	*Calephelis rawsoni*	1	1	1	Moist areas in shaded limestone outcrops.			Resident
MAMMALS								
Black bear	*Ursus americanus*	0	2	0	Mountains, broken county in brushlands and forests.	T/SA; NL	T	Resident
Cave myotis bat	*Myotis velifer*	0	1	0	Roosts colonially in caves, rock crevices			Resident
Ghost-faced bat	*Mormoops megalophylla*	0	1	0	Roosts in caves, crevices and buildings.			Resident
Gulf Coast jaguarondi	*Herpailurus yagouaroundi*	0	3	0	Thick brushlands near water is favored.	LE	E	Potential Resident
Gray wolf	*Canis lupus*	0	3	0	Extirpated.	LE	E	Extinct
Ocelot	*Leopardus pardalis*	0	3	0	Found in dense chaparral thickets, and live oak mottes, avoiding open areas.	LE	E	Resident
Plains spotted skunk	*Spilogale putorius interrupta*	0	1	0	Prefers wooded, brushy areas.			Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
Red wolf	*Canis rufus*	0	3	0	Extirpated.	LE	E	Historic Resident
MOLLUSKS								
Creeper (squawfoot)	*Strophitus undulates*	0	1	0	Small to large streams. Colorado, Guadalupe, and San Antonio River basins.			Resident
False spike mussel	*Quincuncina mitchelli*	0	2	0	Substrates of cobble and mud. Rio Grande, Brazos, Colorado and Guadalupe river basins.		T	Resident
Golden orb	*Quadrula aurea*	0	2	0	Sand and gravel, Guadalupe, San Antonio, Lower San Marcos, and Nueces River basins	C	T	Resident
Mimic cavesnail	*Phreatodrobia imitata*	0	1	0	Subaquatic found in wells in Edwards Aquifer.			Resident
Texas fatmucket	*Lampsilis bracteata*	0	2	0	Streams and rivers on sand, mud and gravel, Colorado and Guadalupe River basins.	C	T	Resident
Texas pimpleback	*Quadrula petrina*	0	2	0	Mud, gravel and sand substrates, Colorado and Guadalupe river basins	C	T	Resident
PLANTS								
Big red sage	*Salvia penstemonoides*	0	1	0	Texas endemic, found in moist to seasonally wet steep limestone outcrops on canyons or along creek banks.	1		Resident
Bracted twistflower	*Steptanthus bracteatus*	1	2	2	Endemic; shallow clay soils over limestone rocky slopes.	C		Resident
Bristle nailwort	*Paronychia setacea*	0	1	0	Endemic to south central Texas in sandy soils.			Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
PLANTS								
Correll's false dragon-head	*Physostegia correllii*	1	1	1	Wet soils.			Resident
Elmendorf's onion	*Allium elmendorfii*	2	1	2	Endemic, found in deep sands			Resident
Green beebalm	*Monarda viridissima*	1	1	1	Endemic perennial herb. Found in well-drained sandy soils in opening of post oak woodlands.			Resident
Hill country wild-mercury	*Argythamnia aphoroides*	0	1	0	Endemic; found in grasslands associated with oak woodlands.			Resident
Parks' jointweed	*Polygonella parksii*	2	1	2	Texas endemic, primarily found on deep, loose, sand blowouts in Post Oak Savannas.			Resident
Sandhill woolywhite	*Hymenopappus carrizoanus*	2	1	2	Found south of the Guadalupe River. Prefers dense riparian corridors.			Resident
Texas wild-rice	*Zizania Texana*	0	3	0	Found in the San Marcos River.	LE	E	Potential Resident
REPTILES								
Spot-tailed earless lizard	*Holbrookia lacerata*	0	1	0	Moderately open prairie-brushland.			Resident
Texas Garter Snake	*Thamnophis sirtalis annectens*	1	1	1	Wet or moist microhabitats			Resident
Texas Horned Lizard	*Phrynosoma cornutum*	1	2	2	Varied, sparsely vegetated uplands.		T	Resident
Texas indigo snake	*Drymarchon melanurus erebennus*	0	2	0	Grass prairies and sand hills; woodland and mesquite savannah of coastal plain.		T	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
REPTILES								
Texas tortoise	*Gopherus berlandieri*	1	2	2	Open brush w/ grass understory.		T	Resident
Timber rattlesnake	*Crotalus horridus*	1	2	2	Floodplains, upland pine, deciduous woodlands, riparian zones.		T	Resident

LE/LT=Federally Listed Endangered/Threatened
DL=Federally Delisted
C=Candidate for Federal Listing
E, T=State Listed Endangered/Threatened
Blank = Considered rare, but no regulatory listing status

TPWD, 2014. Annotated County List of Rare Species – Bexar County, revised 10/2/2012, Atascosa County, revised 8/7/2012 and Wilson County, revised 8/7/2012.
USFWS, 2014. Endangered Species List for Texas. http://www.fws.gov/southwest/es/ES_ListSpecies.cfm accessed online April 18, 2014.

(*Hymenopappus carrizoanus*), Parks' jointweed (*Polygonella parksii*), and Elmendorf's Onion (*Allium elmendorfi*). Sandhill woolywhite is found south of the Guadalupe River and prefers dense riparian corridors. Parks' jointweed and Elmendorf's onion are Texas endemic species found primarily in deep, loose, sands and blowouts in Post Oak Savannahs. These species of concern are considered to be rare, but are not protected by USFWS or TPWD.

Several species listed as threatened by the state may possibly be affected by the project. These include the indigo snake (*Drymarchon corais erebennus)*, Texas horned lizard (*Phrynosoma cornutum)*, Texas tortoise (*Gopherus berlandieri)*, and timber/canebrake rattlesnake (*Crotalus horridus*). Because an abundance of similar habitat areas exist near the project area, and these species have the ability to move into those areas, no significant impacts to these species are anticipated from the project.

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 (Pl96-515), and the Archeological and Historic Preservation Act (PL93-291). Based on the review of available records obtained from the Texas Historical Commission, there are no State Historic Sites, National Register Properties or National Register Districts, or historical markers within the project area. Four cemeteries occur near or within the project area; the Shelly-Fleming, John Shock Shelly, St. Luke and Oakley. Four archeological projects line surveys and one archeological site survey have been performed within or near the project area. Because the owner or controller of the project will likely be a political subdivision of the State of Texas (i.e., river authority, municipality, county, etc.), they will be required to coordinate with the Texas Historical Commission prior to project construction.

Field surveys conducted at the appropriate phase of development should be employed to minimize the impacts of construction and operations on sensitive resources. Specific project features, such as well fields, and pipelines generally have sufficient design flexibility to avoid most impacts or significantly mitigate potential impacts to geographically limited environmental and cultural resource sites.

Potential wetland impacts, which may include well field areas, WTP locations and pipeline stream crossings, can be minimized by right-of-way selection and appropriate construction methods, including erosion controls and revegetation procedures. Compensation for net losses of wetlands would be required where impacts are unavoidable.

5.2.19.4 Engineering and Costing

Preliminary engineering and costing analyses have been performed for each of the three phases as well as the MAG constricted phase using 2016 Regional Water Planning methods. For Region L, HDR utilized the standard costing procedures and unit costs. Earlier, SAWS had performed preliminary engineering and costing analyses in their feasibility studies. The two analyses include all facilities required for water production, collection, transmission and treatment and concentrate disposal. The well field will require wells and a collector pipeline. Reverse Osmosis technology is planned for the desalination process. Disposal of the concentrate is planned by deep well injection into a depleted oil and gas field in eastern Bexar County. For the Phase I project which is already under construction, the pumps in the wells will be sized to deliver the raw water to the water treatment plant. For Phases II and III, it is also assumed that the well pumps will be sufficient for delivery of the raw water to the water treatment plant at Twin Oaks due to the close proximity. The desalination water treatment plant will be located on the SAWS property and near the Twin Oaks WTP. Treated water will be either delivered to the ASR facility or to a SAWS distribution system by a new west side integration pipeline or the existing east side pipeline.

The preliminary design produces a TDS concentration of the treated water with an average of about 420 mg/L. The required secondary Maximum Contaminant Level (MCL) for TDS is 1,000 mg/L. Pretreatment prior to the desalination process includes cartridge filtration with no additional pretreatment included for removal of particulates such as iron or manganese. The preliminary design has 70% the raw water from the well field being sent to the desalination plant to remove dissolved solids. The desalination plant recovery rate is estimated to be 90% meaning that 90% of the water entering the desalination plant passes through as purified water and 10% of the water remains as concentrated brine that contains the constituents removed from the purified water. The desalinated water is blended back with 30 percent of the pretreated brackish water to produce a blended finished water with a TDS concentration of about 420 mg/L. The TDS concentration of the concentrate is estimated at about 14,000 mg/L.

Phase I is to produce a uniform 12 MGD (13,440 acft/yr) of potable water from Bexar County. Facilities include a well field with 12 wells, including 2 backup wells, and an average production of 12.0 MGD. This initial phase will require construction of a water treatment plant. It will also require the initial construction of the concentrate pump station and pipeline, concentrate storage at the disposal site and 3-500 gpm deep injection wells. The brackish water wells are assumed to be on SAWS property, so groundwater leases are not necessary.

Phase II is to produce a uniform 12.0 MGD (13,440 acft/yr) of potable water. Facilities include: a well field with 12 wells, which includes 2 backup wells, for an average production of 12.0 MGD, expansion of the water treatment plant, expansion of the concentrate pump stations, and two new concentrate injection wells.

Phase III is to produce a uniform 6 MGD (6,720 acft/yr) of potable water from a third well field. Facilities include: a well field with 6 wells, which includes 1 backup well, for an average production of 6.0 MGD, expansion of the water treatment plant, expansion of the concentrate pump stations, and one new concentrate injection wells.

The MAG restricted phase is to produce a uniform 5.41 MGD (6,059 acft/yr) of potable water from a third well field. Facilities include: a well field with 6 wells, which includes 1 backup well, for an average production of 5.41 MGD, expansion of the water treatment plant, expansion of the concentrate pump stations, and one new concentrate injection well.

When complete, the envisioned Brackish Groundwater Desalination Project for SAWS will produce about 30 MGD (33,600 acft/yr) of potable water. It would also produce about 2.5 MGD (2,600 acft/yr) of concentrate. The MAG constricted project will produce 5.41 MGD (6,059 acft/yr) of potable water and 0.42 MGD (470 acft/yr) of concentrate.

Region L cost estimates for all phases of the SAWS local Wilcox desalination project to produce finished water with a TDS concentration of about 420 mg/L at a uniform rate is shown in Table 5.2.19-2. Cost Estimates for the Mag Constricted project are shown in Table 5.2.19-3.

Table 5.2.19-2 Cost Estimate Summary Using Region L Costing Procedures Water Supply Project Option

Item	*Phase I*	*Phase II*	*Phase III*	*All Phases*
CAPITAL COST				
Transmission Pipeline (Concentrate Disposal)	$205,000	$209,000	$88,000	$502,000
Injection Line Pump Station	$1,850,000	$177,000	$41,000	$2,068,000
Well Fields (Wells, Pumps, and Piping)	$49,328,000	$49,178,000	$21,416,000	$119,922,000
Water Treatment Plants	$21,381,000	$15,825,000	$7,417,000	$44,623,000
TOTAL COST OF FACILITIES	**$72,764,000**	**$65,389,000**	**$28,962,000**	**$167,115,000**
Engineering Legal Costs and Contingencies	$24,224,000	$21,646,000	$9,597,000	$55,467,000
Environmental & Archaeology Studies and Mitigation	$269,000	$219,000	$106,000	$594,000
Interest During Construction (3 years)	$10,313,000	$9,262,000	$4,104,000	$23,679,000
TOTAL COST OF PROJECT	**$107,570,000**	**$96,516,000**	**$42,769,000**	**$246,855,000**
ANNUAL COST				
Debt Service (5.5 percent, 30 years)	$9,081,000	$8,156,000	$3,613,000	$20,850,000
Operation and Maintenance				
Intake, Pipeline, Pump Station	$540,000	$450,000	$211,000	$1,201,000
Water Treatment Plant	$4,001,000	$2,961,000	$1,388,000	$8,350,000
Pumping Energy Costs (9,207,327 kW-hr @ 0.09 $/kW-hr)	$1,128,000	$1,193,000	$477,000	$2,798,000
TOTAL ANNUAL COST	**$14,750,000**	**$12,760,000**	**$5,689,000**	**$33,199,000**
Available Project Yield (acft/yr)	13,440	13,440	6,720	33,600
Annual Cost of Water ($ per acft)	$1,097	$949	$847	$988
Annual Cost of Water ($ per 1,000 gallons)	$3.37	$2.91	$2.60	$3.03

Table 5.2.19-3 Cost Estimate Summary Using Region L Costing Procedures Water Supply Project Option- MAG Constrained

Item	*MAG Phase*
CAPITAL COST	
Transmission Pipeline (Concentrate Disposal)	$136,000
Injection Line Pump Station	$967,000
Well Fields (Wells, Pumps, and Piping)	$26,673,000
Water Treatment Plants	$10,647,000
TOTAL COST OF FACILITIES	**$38,423,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$12,774,000
Environmental & Archaeology Studies and Mitigation	$150,000
Interest During Construction (4% for 1 years with a 1% ROI)	$1,815,000
TOTAL COST OF PROJECT	**$53,162,000**
ANNUAL COST	
Debt Service (5.5 percent, 20 years)	$4,489,000
Operation and Maintenance	
Intake, Pipeline, Pump Station (1% of Cost of Facilities)	$291,000
Water Treatment Plant (2.5% of Cost of Facilities)	$1,992,000
Pumping Energy Costs (5,251,443 kW-hr @ 0.09 $/kW-hr)	$473,000
TOTAL ANNUAL COST	**$7,245,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 1	5,622
Annual Cost of Water ($ per acft)	$1,289
Annual Cost of Water ($ per 1,000 gallons)	$3.95

5.2.19.5 Implementation Issues

For each aquifer in the region, the GCDs have adopted desired future conditions (DFCs). In some GCDs, full use of all groundwater supplies (permitted, grandfathered and exempt) may result in non-achievement of the DFCs for an aquifer. To ensure consistency with the DFCs, TWDB currently requires that groundwater availability for each aquifer be limited for planning purposes to the modeled available groundwater (MAG) for the aquifer. This has resulted, for planning purposes only, in adjustments to permit amounts, and a lack of firm water available for future permits in this plan for some areas for certain time periods. This should not be construed as recommending or requiring that GCDs make these adjustments, or deny future permit applications. SCTRWPG recognizes and supports the ability of permit holders to exercise their rights to groundwater use in accordance with their permits and it recognizes and supports the GCDs discretion to issue permits and grandfather historical users for amounts in excess of the MAG. SCTRWPG may not modify groundwater permits that GCDs have already issued or limit future permits that GCDs may issue. If the MAG is increased during or after this planning cycle, SCTRWPG may amend this Plan to adjust groundwater supply numbers that are affected by the new MAG amount.

Implementation of the SAWS Local Wilcox Desalination Project includes the following issues:

- Potential adverse impacts on other aquifers (additional research regarding potential interaction between the Wilcox and Carrizo formations has been suggested);
- Verification that desalinated Wilcox Aquifer water is compatible with other water sources and will meet all water quality requirements in distribution system;
- Permitting Class 1 disposal wells for deep well injection of desalination concentrate (permits have been obtained);
- Experience in operating and maintaining a desalination water treatment plant;
- Brine Disposal Discharge Permits by TCEQ; and
- Possibly having to secure permits from a groundwater district.

5.2.20 SAWS Expanded Brackish Wilcox Groundwater Project

As part of a multi-stage water supply plan, SAWS has identified the Wilcox Aquifer in Wilson County as a potential source of yield for its customers. In the Texas Water Development Board's February 2003 report[1], the availability of brackish water in the Carrizo-Wilcox Aquifer in Region L is shown to range from "moderate" to "high" while source water production costs range from "low" to "high." A study completed in July 2004[2] to evaluate the potential for a brackish groundwater source from the Wilcox Aquifer further defined the water quality and indicated that slightly brackish groundwater was available from the Wilcox Aquifer in Bexar County. A detailed study[3] was completed in October 2008 for San Antonio Water System (SAWS) on the hydrogeology, water quality, water treatment and facilities, disposal of concentrate, permitting, and procurement and financial considerations.

Based on these studies, SAWS has a three phase Brackish Groundwater Desalination project is underway in Bexar County and hired Black and Veatch to develop a concept study[4] in November 2013 to evaluate providing an additional 50,000 acft/yr from two well fields in Wilson County. This section focuses on the proposed Wilson County well fields. The eastern well field would produce around 34,500 acft/yr of raw water to a pump station in the central well field. The yield from the two well fields will be transferred to a desalination facility located at the SAWS' Twin Oaks WTP and pumped to the SAWS distribution system either through a new western integration pipeline and/or an existing eastern integration pipeline, or stored in the SAWS ASR well field. While the envisioned project is based on 50,000 acft/yr, a firm yield of 0 acft of water is available according to TWDB Modeled Available Groundwater (MAG).

5.2.20.1 Description of Strategy

The SAWS Expanded Brackish Wilcox Desalination Project is a water supply strategy based on the development of brackish groundwater in the Wilcox Aquifer in Wilson County (Figure 5.2.20-1). The target locations of the well fields were provided by SAWS and selected primarily on the basis of favorable well yields and water quality, with consideration of property availability.

This strategy includes treatment of the raw water at a desalination water treatment plant in the vicinity of the Twin Oaks WTP. The product water would be pumped with water recovery from the ASR well field to SAWS distribution system through a planned west pipeline and/or the existing east pipeline. Concentrate disposal will be deep well injection into a depleted oil and gas reservoir in Wilson County near the existing SAWS Injection Wells. This strategy is designed to produce water at a uniform (base load) rate. The location of the major project components are shown in Figure 5.2.20-1.

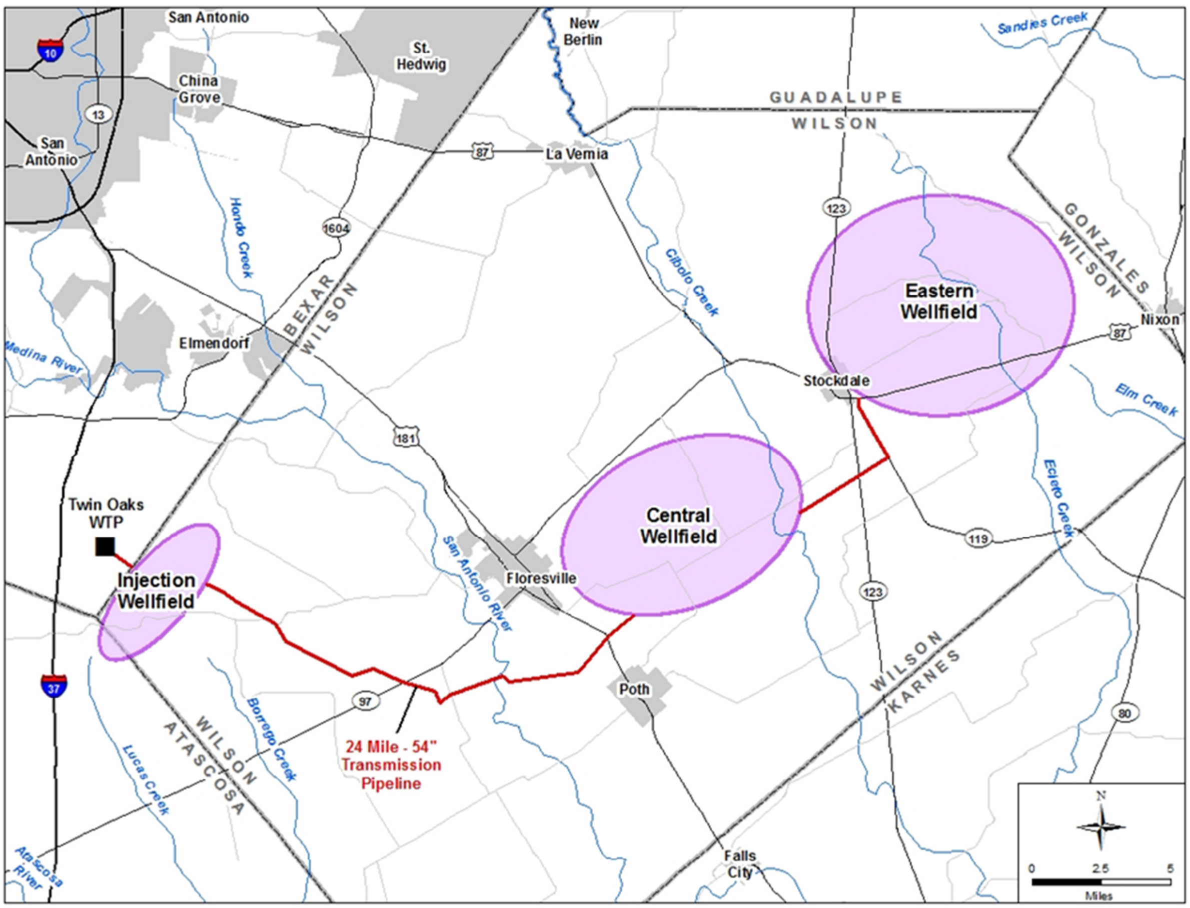
The Eastern Well field is located north east of Stockdale in eastern Wilson County and is designed to produce 32,000 acft/yr of potable water. Thirty-two wells are required

[1] LBG-Guyton Associates, "Brackish Groundwater Manual for Texas Regional Water Planning Groups," prepared for the Texas Water Development Board, February 2003.
[2] HDR Engineering, Inc., "Water Quality Characteristics of the Wilcox Aquifer in the Vicinity of San Antonio, TX," prepared for San Antonio Water System, July 2004.
[3] R.W. Beck, "Brackish Groundwater Desalination Feasibility Assessment Report," prepared for SAWS, October 2008.
[4] Black & Veatch, "Expanded Brackish Groundwater Desalination Project", Prepared for San Antonio Water System. November 2013.

including 5 for contingency. These wells are expected to produce about 800 gpm, and be around 2,300 ft deep. With allowance for concentrate produced from the desalination process, about 34,500 acft/yr of raw water would have to be pumped from the Wilcox. Water from the Wilcox at this location is expected to have a total dissolved solids concentration of about 1,500 mg/L.

The Central Well field is located north east of Floresville in central Wilson County and is designed to produce 18,000 acft/yr of potable water. Nineteen wells are required including 3 for contingency. These wells are expected to produce about 800 gpm, and be around 2,400 ft deep. With allowance for concentrate produced from the desalination process, about 19,400 acft/yr of raw water would have to be pumped from the Wilcox. Water from the Wilcox at this location is expected to have a total dissolved solids concentration of about 1,500 mg/L.

Figure 5.2.20-1 Brackish Wilcox Groundwater Desalination Project for SAWS



5.2.20.2 Available Yield

A study of water well data, geophysical logs from oil and gas exploratory test holes, and test drilling by R.W. Beck (2008) for SAWS characterized the Wilcox Aquifer as a major source of brackish water in Southern Bexar and Eastern Wilson Counties. Test drilling and field studies in the area by SAWS have greatly improved and refined the previous characterizations of the Wilcox Aquifer with regard to potential well yields and water quality. According to the Black and Veatch report (2013), analysis of geophysical log data indicates the thickness of sand layers in the vicinity of the two Wilson County well fields range from about 400 to 500 ft.

Based on previous experience with SAWS Brackish Wells, the 2013 report by LBG-Guyton estimated a well yield between 700 and 1200 gpm each with an average of 800 gpm. Numerical modeling results from the Southern Queen City-Sparta Groundwater Availability Model shows a drawdown of 114 ft. associated with 800 gpm wells in the area of the proposed well fields. Because of the dip of the Wilcox is toward the Gulf Coast, the top of the sands are shallower to the northwest and deeper to the southeast. The range in the concentration of total dissolved solids typically ranged from about 1,200 to 1,700 mg/L. A clear, discernible aquitard between the water-bearing sands in the Carrizo and Wilcox Aquifers was reported to be 200 to 300 ft thick in the study area. Results of groundwater modeling in the Beck 2008 report indicates 2060 drawdown in the Wilcox would be about 250 ft from 15 wells pumping in three well fields for a total of 25 MGD. The modeling analysis also showed drawdown in the Carrizo Aquifer to be less than 8 ft by 2060. Results from the Beck study suggest that well fields located in this area are suitable for a long-term supply of brackish groundwater. Please note that these simulations only approximately match the preliminary designs of this strategy. Thus, the drawdown for this strategy may be somewhat different.

The procedure for obtaining groundwater supplies for the project is dependent on securing groundwater rights from the land owners. In Wilson County well, production, and transportation permits must be obtained from the Evergreen Underground Water Conservation District. According to the District rules, the spacing and production of the wells are dependent on results of a groundwater model, location of the well field, distance to other wells, and the amount of requested water. Analysis of the MAG in Wilson County compared to the amount of allocated water (permitted water and exempt use) indicates that 0 acft/yr of supply is available for this project. TWDB rules and guidance require regional water planning groups to use estimates of MAG in the regional water plans.

5.2.20.3 Environmental Issues

The Brackish Groundwater Desalination-Wilcox Aquifer water management strategy involves the development of well fields in the brackish portion of the Wilcox Aquifer in Bexar and Wilson Counties including their associated pumps, wells, and piping, two water treatment plants, an intake pump station and a 36 miles of raw water transmission pipeline to the desalination WTP.

The project area occurs within the Post Oak Savannah vegetational area which contains gently rolling to hilly topography, and elevations which range from 300 to 800 feet.[5]

[5] Gould, F.W., "The Grasses of Texas," Texas A&M University Press, College Station, Texas, 1975.

Overstory species found within this area primarily include post oak (*Quercus stellata*), blackjack oak (*Q. marilandica*), and species of hickory (*Carya* ssp.). Climax grasses include yellow indian grass (*Sorghastrum nutans*), switchgrass (*Panicum virgatum*), purpletop tridens (*Tridens flavus*), longspike silver bluestem (*Bothriochloa saccharoides* var. *longipaniculata*), slender woodoats (*Chasmanthium laxum*), and little bluestem (*Schizachyrium scoparium*).

The majority of the eastern well field area occurs in the Post Oak Woods, Forest and Grassland Mosaic vegetational type as described by the Texas Parks and Wildlife Department (TPWD), with small areas of Post Oak Woods/Forest and Crops also included.[6] The central well field and water transmission pipeline occur solely within the Crops vegetational type. The injection well field and existing WTP occur within Crop and Post Oak Woods/Forest vegetational types. The project area is slightly-to-moderately dissected by streams which are tributaries of the San Antonio and Guadalupe Rivers.

Vertebrate fauna typical within this region include the opossum, raccoon, weasel, skunk, white-tailed deer and bobcat as well as a wide variety of amphibians, reptiles and birds.[7] The coyote and collared peccary are also common to the area, but are found mainly in brush/shrub areas while the red and gray fox are more common in woodlands.

Plant and animal species listed by U.S. Fish and Wildlife Service (USFWS) and TPWD that may occur within the vicinity of this water management strategy are listed in Table 5.2.20-1. No impacts to federally listed species are anticipated from this project. The ranges of two endangered birds, the golden-cheeked warbler (*Dendroica chrysoparia*) and black-capped vireo (*Vireo atricapillus*) only extend into northern and western Bexar County and not Wilson County. Consequently, the presence of these species or their typical nesting habitat, in the vicinity of the proposed pipeline or well field is unlikely.

The Texas Natural Diversity Database (TXNDD), maintained by TPWD, indicates known occurrences of two rare plants in the vicinity of the project, sandhill woolywhite (*Hymenopappus carrizoanus*), and Elmendorf's Onion (*Allium elmendorfi*). Sandhill woolywhite is found south of the Guadalupe River and prefers dense riparian corridors. Emendorf's onion is an endemic species which is usually found in areas which include deep sands. These species of concern are considered to be rare, but are not protected by USFWS or TPWD.

Several species listed as threatened by the state may possibly be affected by the project. These include the indigo snake (*Drymarchon corais erebennus)*, Texas horned lizard (*Phrynosoma cornutum)*, Texas tortoise (*Gopherus berlandieri)*, and timber/canebrake rattlesnake (*Crotalus horridus*). Because an abundance of similar habitat areas exist near the project area, and these species have the ability to move into those areas, no significant impacts to these species are anticipated from the project.

[6] McMahan, Craig A., Roy G. Frye and Kirby L. Brown. 1984. The Vegetation Types of Texas. Wildlife Division, Texas Parks and Wildlife Department, Austin, Texas.
[7] Davis, William B. and David J. Schmidly. 1994. The Mammals of Texas. Texas Parks and Wildlife Department, Austin, Texas.

Table 5.2.20-1 Endangered, Threatened, Candidate and Species of Concern listed for Atascosa, Bexar and Wilson Counties

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence
AMPHIBIANS								
Cascade Caverns salamander	*Eurycea latitans complex*	0	2	0	Endemic, subaquatic in Edwards Aquifer		T	Resident
Comal blind salamander	*Eurycea tridentifera*	0	2	0	Endemic and semi-troglobitic, found in springs and waters of caves.		T	Resident
San Marcos salamander	*Erurycea nana*	0	2	0	Occurs only in Spring Lake and an adjacent downstream portion of the upper San Marcos	T	T	Potential Resident
Texas blind salamander	*Typhlomolge rathbuni*	0	3	0	Lives in water-filled caves of the Edwards Aquifer near San Marcos, Texas.	LE	E	Potential Resident
Texas salamander	*Eurycea notenes*	0	1	0	Endemic; troglobitic, found in springs, caves and creek headwaters restricted to Helotes and Leon Creek drainages.			Resident
ARACHNIDS								
Bracken Bat Cave meshweaver	*Cicurina venii*	0	3	0	Small eyeless spider, found in Karst features in western Bexar County.	LE		Resident
Cokendolpher cave harvestman	*Texella cokendolpheri*	0	3	0	Small, eyeless spider found in karst features I north and northwest Bexar County.	LE		Resident
Government Canyon Bat Cave meshweaver	*Cicurina vespera*	0	3	0	Small eyeless spider in karst features in north and Northwest Bexar county.	LE		Resident
Government Canyon Bat Cave spider	*Neoleptoneta microps*	0	3	0	Small eyeless spider in karst features in north and Northwest Bexar county.	LE		Resident
Madla Cave meshweaver	*Cicurina madla*	0	3	0	Small eyeless spider in karst features in north and Northwest Bexar county.	LE		Resident
Robber Baron Cave meshweaver	*Cicurina baronia*	0	3	0	Small eyeless spider in karst features in north and Northwest Bexar county.	LE		Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
BIRDS								
American peregrine falcon	*Falco peregrinus anatum*	0	3	0	Migrant and local breeder in West Texas.	DL	T	Possible Migrant
Arctic peregrine falcon	*Falco peregrinus tundrius*	0	2	0	Migrant throughout the state.	DL		Possible Migrant
Black-capped vireo	*Vireo atricapillla*	1	3	3	Semi-open broad-leaved shrublands	LE	E	Nesting/ Migrant
Golden-cheeked warbler	*Setophaga chrysoparia*	1	3	3	Woodlands with oaks and old juniper.	LE	E	Nesting/ Migrant
Interior least tern	*Sterna antillarum athalassos*	0	3	0	Nests along sand and gravel bars in braided streams	LE	E	Resident
Mountain plover	*Charadrius montanus*	0	1	0	Non-breeding, shortgrass plains and fields			Nesting/ Migrant
Sprague's pipit	*Anthus spragueii*	0	1	0	Migrant in Texas in winter mid Sept. to early April. Strongly tied to native upland prairie.	C		Possible Migrant
Western burrowing owl	*Athene cunicularia hypugaea*	0	1	0	Open grasslands, especially prairie, plains and savanna			Resident
White-faced ibis	*Plegadis chihi*	0	2	0	Prefers freshwater marshes.		T	Potential Migrant
Whooping crane	*Grus americana*	0	3	0	Potential migrant	LE	E	Potential Migrant
Wood stork	*Mycteria americana*	0	2	0	Forages in prairie ponds, ditches, and shallow standing water formerly nested in TX		T	Migrant
Zone-tailed hawk	*Buteo albonotatus*	0	2	0	Arid, open country including deciduous or pine-oak woodland.		T	Nesting/ migrant

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
CRUSTACEANS								
A cave obligate crustacean	*Monodella Texana*	0	1	0	Subaquatic, subterranean obligate found in freshwater aquifers.			Resident
Nueces crayfish	*Procambarus nueces*	0	1	0	Known from only one small sluggish stream tributary to the Nueces River.			Resident
Peck's Cave amphipod	*Stygobromus pecki*	0	3	0	Small, aquatic crustacean; lives underground in the Edwards Aquifer.	LE	E	Potential Resident
FISHES								
Fountain darter	*Etheostoma fonticola*	0	3	0	Known only from the San Marcos and Comal rivers.	LE	E	Potential Resident
Guadalupe bass	*Micropterus treculi*	0	1	0	Endemic to perennial streams of the Edwards Plateau region.			Resident
Toothless blindcat	*Trogloglanis pattersoni*	0	2	0	Troglobitic; blind catfish endemic to the San Antonio pool of the Edwards Aquifer.		T	Resident
Widemouth blindcat	*Satan eurystomus*	0	2	0	Troglobitic, blind catfish endemic to the San Antonio pool of the Edwards Aquifer.		T	Resident
INSECTS								
A ground beetle	*Rhadine exilis*	0	3	0	Eyeless beetle found in karst features in northern Bexar county.	LE		Resident
A ground beetle	*Rhadine infernalis*	0	3	0	Small eyeless ground beetle found in karst features in northern and western Bexar County.	LE		Resident
Comal Springs dryopid beetle	*Stygoparnus comalensis*	0	3	0	Dryopids usually cling to objects in a stream.	LE	E	Potential Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
Comal Springs riffle beetle	*Heterelmis comalensis*	0	3	0	Comal and San Marcos Springs	LE	E	Potential Resident
Helotes mold beetle	*Bastrisodes venyivi*	0	3	0	Small, essentially eyeless mold beetle found in karst features in north and northwest Bexar County.	LE		Resident
Manfreda giant-skipper	*Stallingsia maculosus*	0	1	0	Larvae feed inside leaf shelter and pupae found in cocoon made of leaves fastened by silk.			Resident
Rawson's metalmark	*Calephelis rawsoni*	0	1	0	Moist areas in shaded limestone outcrops.			Resident
MAMMALS								
Black bear	*Ursus americanus*	0	2	0	Mountains, broken county in brushlands and forests.	T/SA; NL	T	Resident
Cave myotis bat	*Myotis velifer*	0	1	0	Roosts colonially in caves, rock crevices			Resident
Ghost-faced bat	*Mormoops megalophylla*	0	1	0	Roosts in caves, crevices and buildings.			Resident
Gulf Coast jaguarondi	*Herpailurus yagouaroundi cacomitli*	0	3	0	Thick brushlands near water is favored	LE	E	Potential Resident
Gray wolf	*Canis lupus*	0	3	0	Extirpated.	LE	E	Extinct
Ocelot	*Leopardus pardalis*	0	3	0	Found in dense chaparral thickets, and live oak mottes, avoiding open areas.	LE	E	Resident
Plains spotted skunk	*Spilogale putorius interrupta*	1	1	1	Prefers wooded, brushy areas.			Resident
Red wolf	*Canis rufus*	0	3	0	Extirpated.	LE	E	Historic Resident
MOLLUSKS								
Creeper (squawfoot)	*Strophitus undulates*	0	1	0	Small to large streams. Colorado, Guadalupe, and San Antonio River basins.			Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
False spike mussel	*Quincuncina mitchelli*	0	2	0	Substrates of cobble and mud. Rio Grande, Brazos, Colorado and Guadalupe river basins.		T	Resident
Golden orb	*Quadrula aurea*	0	2	0	Sand and gravel, Guadalupe, San Antonio, Lower San Marcos, and Nueces River basins	C	T	Resident
Mimic cavesnail	*Phreatodrobia imitata*	0	1	0	Subaquatic found in wells in Edwards Aquifer.			Resident
Texas fatmucket	*Lampsilis bracteata*	0	2	0	Streams and rivers on sand, mud and gravel, Colorado and Guadalupe River basins.	C	T	Resident
Texas pimpleback	*Quadrula petrina*	0	2	0	Mud, gravel and sand substrates, Colorado and Guadalupe river basins	C	T	Resident
PLANTS								
Big red sage	*Salvia pentstemonoides*	0	1	0	Texas endemic, found in moist to seasonally wet steep limestone outcrops on canyons or along creek banks.			Resident
Bracted twistflower	*Steptanthus bracteatus*	1	2	2	Endemic; shallow clay soils over limestone rocky slopes.	C		Resident
Bristle nailwort	*Paronychia setacea*	0	1	0	Endemic to south central Texas in sandy soils.			Resident
Correll's false dragon-head	*Physostegia correllii*	1	1	1	Wet soils.			Resident
Elmendorf's onion	*Allium elmendorfii*	2	1	2	Endemic, found in deep sands			Resident
Green beebalm	*Monarda viridissima*	0	1	0	Endemic perennial herb. Found in well-drained sandy soils in opening of post oak woodlands.			Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
Hill country wild-mercury	*Argythamnia aphoroides*	1	1	1	Endemic; found in grasslands associated with oak woodlands.			Resident
Parks' jointweed	*Polygonella parksii*	1	1	1	Texas endemic, primarily found on deep, loose, sand blowouts in Post Oak Savannas.			Resident
Sandhill woolywhite	*Hymenopappus carrizoanus*	2	1	2	Found south of the Guadalupe River. Prefers dense riparian corridors.			Resident
Texas wild-rice	*Zizania Texana*	0	3	0	Found in the San Marcos River.	LE	E	Potential Resident
REPTILES								
Spot-tailed earless lizard	*Holbrookia lacerata*	0	1	0	Moderately open prairie-brushland.			Resident
Texas Garter Snake	*Thamnophis sirtalis annectens*	1	1	1	Wet or moist microhabitats			Resident
Texas Horned Lizard	*Phrynosom a cornutum*	1	2	2	Varied, sparsely vegetated uplands.		T	Resident
Texas indigo snake	*Drymarcho n melanurus erebennus*	0	2	0	Grass prairies and sand hills; woodland and mesquite savannah of coastal plain.		T	Resident
Texas tortoise	*Gopherus berlandieri*	1	2	2	Open brush w/ grass understory.		T	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
Timber rattlesnake	*Crotalus horridus*	1	2	2	Floodplains, upland pine, deciduous woodlands, riparian zones.		T	Resident

LE/LT=Federally Listed Endangered/Threatened
DL=Federally Delisted
C=Candidate for Federal Listing
E, T=State Listed Endangered/Threatened
Blank = Considered rare, but no regulatory listing status

TPWD, 2014. Annotated County List of Rare Species – Bexar County, revised 10/2/2012, Atascosa County, revised 8/7/2012 and Wilson County, revised 8/7/2012.
USFWS, 2014. Endangered Species List for Texas. http://www.fws.gov/southwest/es/ES_ListSpecies.cfm accessed online April 18, 2014.

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 (Pl96-515), and the Archeological and Historic Preservation Act (PL93-291). Based on the review of available records obtained from the Texas Historical Commission, there are no State Historic Sites, National Register Properties or National Register Districts within the project area. Eight cemeteries occur within the project area; three sites within the eastern well field area, two sites within the central well field area, and three sites within the injection well field area. One historical maker is located within the eastern well field area. Four archeological projects reported as line surveys have occurred within the injection well field area. A total of fifty archeological site surveys have been performed within the project area. One site occurs within the injection well field and the other forty nine are located within the eastern well field area. This indicates a high probability of cultural resource sites within this area. Because the owner or controller of the project will likely be a political subdivision of the State of Texas (i.e., river authority, municipality, county, etc.), they will be required to coordinate with the Texas Historical Commission prior to project construction.

Field surveys conducted at the appropriate phase of development should be employed to minimize the impacts of construction and operations on sensitive resources. Specific project features, such as well fields, and pipelines generally have sufficient design flexibility to avoid most impacts or significantly mitigate potential impacts to geographically limited environmental and cultural resource sites.

Potential wetland impacts, which may include well field areas, WTP locations and pipeline stream crossings, can be minimized by right-of-way selection and appropriate construction methods, including erosion controls and revegetation procedures. Compensation for net losses of wetlands would be required where impacts are unavoidable.

5.2.20.4 Engineering and Costing

Preliminary engineering and costing analyses have been performed for both the production and injection well fields using 2016 Regional Water Planning methods. For Region L, HDR utilized the standard costing procedures and unit costs. Earlier, SAWS had performed preliminary engineering and costing analyses in their feasibility studies. The two analyses include all facilities required for water production, collection, transmission and treatment and concentrate disposal. The well fields will require wells and a collector pipeline. Reverse Osmosis technology is planned for the desalination process. Disposal of the concentrate is planned by deep well injection into the Edwards Limestone near the Existing SAWS injection wells. For the Wilson County Project, the pumps in the wells will be sized to deliver the raw water to the Twin Oaks water treatment plant. The desalination water treatment plant will be located on the SAWS property, near the Twin Oaks WTP. The treated water will be delivered via an integration pipeline that would follow the existing Aquifer Storage Recovery (ASR) Integration Pipeline alignment.

The current design produces average treated water with TDS concentrations of about 1,500 mg/L. The required secondary Maximum Contaminant Level (MCL) for TDS is 1,000 mg/L. Pretreatment prior to the desalination process includes iron removal. The preliminary design has 80% of the raw water from the well field being sent to the desalination plant to remove dissolved solids. The desalination plant recovery rate is estimated to be 90% meaning that 90% of the water entering the desalination plant passes through as purified water and 10% of the water remains as concentrated brine that contains the constituents removed from the purified water. The desalinated water is blended back with 30 percent of the pretreated brackish water to produce a blended finished water with a TDS concentration of about 300 mg/L. The TDS concentration of the concentrate is estimated at about 15,000 mg/L.

The Eastern well field will produce a uniform 28.55 MGD (32,000 acft/yr) of potable water from Wilson County. Facilities include a well field with 32 wells, including 5 backup wells, and an average production of 30.77 MGD. This initial phase will require construction of a water treatment plant. It will also require the construction of the concentrate pump station and pipeline; concentrate storage at the disposal site, and six new injection wells. For planning purposes, groundwater leases and groundwater district export fees are assumed to be required.

The Central well field will produce a uniform 16.06 MGD (18,000 acft/yr) of potable water. Facilities include: a well field with 19 wells, which includes 3 backup wells, for an average production of 17.31 MGD, a raw water pump station at the well field, expansion of the water treatment plant, expansion of the concentrate pump stations, and three new concentrate injection wells. For planning purposes, groundwater leases and groundwater district export fees are assumed to be required. When complete, the SAWS Expanded Brackish Wilcox Groundwater Project will produce about 44.6 MGD (50,000 acft/yr) of potable water and about 3.47 MGD (3,890 acft/yr) of concentrate. The blended finished water TDS concentration will be about 450 mg/L. The Region L cost estimates for all phases of the project are shown in Table 5.2.20-2.

Table 5.2.20-2 Envisioned Project Cost Estimate Summary

Item	*Estimated Costs for Facilities*
CAPITAL COST	
Intake Pump Stations (32.4 MGD)	$14,102,000
Transmission Pipeline	$91,495,000
Well Fields (Wells, Pumps, and Piping)	$154,633,000
Two Water Treatment Plants (31.2 MGD and 44.6 MGD)	$127,724,000
Integration, Relocations, & Other	$107,653,000
TOTAL COST OF FACILITIES	**$495,607,000**
PROJECT COST	
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$168,888,000
Environmental & Archaeology Studies and Mitigation	$2,378,000
Signing Bonus and Holding Fees	$7,500,000
Land Acquisition and Surveying (518 acres)	$1,982,000
Interest During Construction (4% for 2 years with a 1% ROI)	$46,820,000
TOTAL COST OF PROJECT	**$723,175,000**
ANNUAL COST	
Debt Service (5.5 percent, 20 years)	$59,887,000
Operation and Maintenance	
Intake, Pipeline, Pump Station (1% of Cost of Facilities)	$3,815,000
Water Treatment Plant (2.5% of Cost of Facilities)	$24,760,000
Pumping Energy Costs (101,325,131 kW-hr @ 0.09 $/kW-hr)	$9,119,000
Groundwater Lease Production Fee ($75/acft)	$4,042,000
Purchase of Water (53889 acft/yr @ 8.12 $/acft)	$438,000
TOTAL ANNUAL COST	**$102,061,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 1	50,000
Annual Cost of Water ($ per acft)	$2,041
Annual Cost of Water ($ per 1,000 gallons)	$6.26

5.2.20.5 Implementation Issues

For each aquifer in the region, the GCDs have adopted desired future conditions (DFCs). In some GCDs, full use of all groundwater supplies (permitted, grandfathered and exempt) may result in non-achievement of the DFCs for an aquifer. To ensure consistency with the DFCs, TWDB currently requires that groundwater availability for each aquifer be limited for planning purposes to the modeled available groundwater (MAG) for the aquifer. This has resulted, for planning purposes only, in adjustments to permit amounts, and a lack of firm water available for future permits in this plan for some areas for certain time periods. This should not be construed as recommending or requiring that GCDs make these adjustments, or deny future permit applications. SCTRWPG recognizes and supports the ability of permit holders to exercise their rights to groundwater use in accordance with their permits and it recognizes and supports the GCDs discretion to issue permits and grandfather historical users for amounts in excess of the MAG. SCTRWPG may not modify groundwater permits that GCDs have already issued or limit future permits that GCDs may issue. If the MAG is increased during or after this planning cycle, SCTRWPG may amend this Plan to adjust groundwater supply numbers that are affected by the new MAG amount.

Implementation of the SAWS Expanded Brackish Wilcox Groundwater Project includes the following issues:

- Potential adverse impacts on other aquifers (additional research regarding potential interaction between the Wilcox and Carrizo formations has been suggested);
- Iron content in the water (This could be a concern especially if the raw water is being transported miles to the plant)
- Potential for differing water qualities/chemical constituents in the water
- Verification that desalinated Wilcox Aquifer water is compatible with other water sources and will meet all water quality requirements in distribution system;
- Permitting Class 1 disposal wells for deep well injection of desalination concentrate through TCEQ General Permit;
- Experience in operating and maintaining a desalination water treatment plant; and
- Securing permits to the Wilcox Aquifer from the Evergreen Underground Water Conservation District.

5.2.21 SAWS Expanded Local Carrizo Project

The San Antonio Water System (SAWS) currently operates a well field producing approximately 9,900 acft/yr of Carrizo Aquifer groundwater, located on SAWS property in South Bexar County and hydrologically upgradient (north, northwest and west) of their Aquifer Storage and Recovery (ASR) well field. The Expanded Local Carrizo Project well field consists of seven production wells that deliver raw groundwater to the Twin Oaks Water Treatment Plant for treatment and delivery to SAWS distribution system.

SAWS is planning to expand their Local Carrizo Project which will provide an additional 30,000 acft/yr of water supply. The proposed wells will either be on SAWS property and in the vicinity of SAWS South Bexar ASR project (Figure 5.2.21-1).

5.2.21.1 Description of Strategy

The SAWS Expanded Local Carrizo Project is a water supply strategy based on the development of fresh groundwater in the Carrizo Sands of the Carrizo-Wilcox Aquifer in southern Bexar County (Figure 5.2.21-1). The target location of the Expanded Local Carrizo well field is outside the existing ASR and Local Carrizo well fields. Some of the wells in the Expanded Local Carrizo Project would be immediately west of the Twin Oaks Water Treatment Plant (WTP), but most would be located northeast of the WTP. Raw water from the wells would be delivered to the WTP for the removal of iron, if needed, and disinfection. Then, the water would be delivered to SAWS distribution system through either the existing east side integration pipeline or a new west side integration pipeline.

The envisioned strategy consists of four phases. The phasing of the project is summarized in Table 5.2.21-1. When fully built out, the project will yield 30,000 acft/yr. Figure 5.2.21-1 shows the general well field location for each phase.

These Carrizo wells are to be designed to produce 1,728 gpm for Phases 1-3. Phase 4 well is to produce 1,400 gpm. They are expected to have a depth ranging from 550 to 600 ft, and average about 575 ft deep. Water from the Carrizo in this area is very low in total dissolved solids, but often is high concentrations of iron and manganese.

Figure 5.2.21-1 Local Carrizo Groundwater Project Location

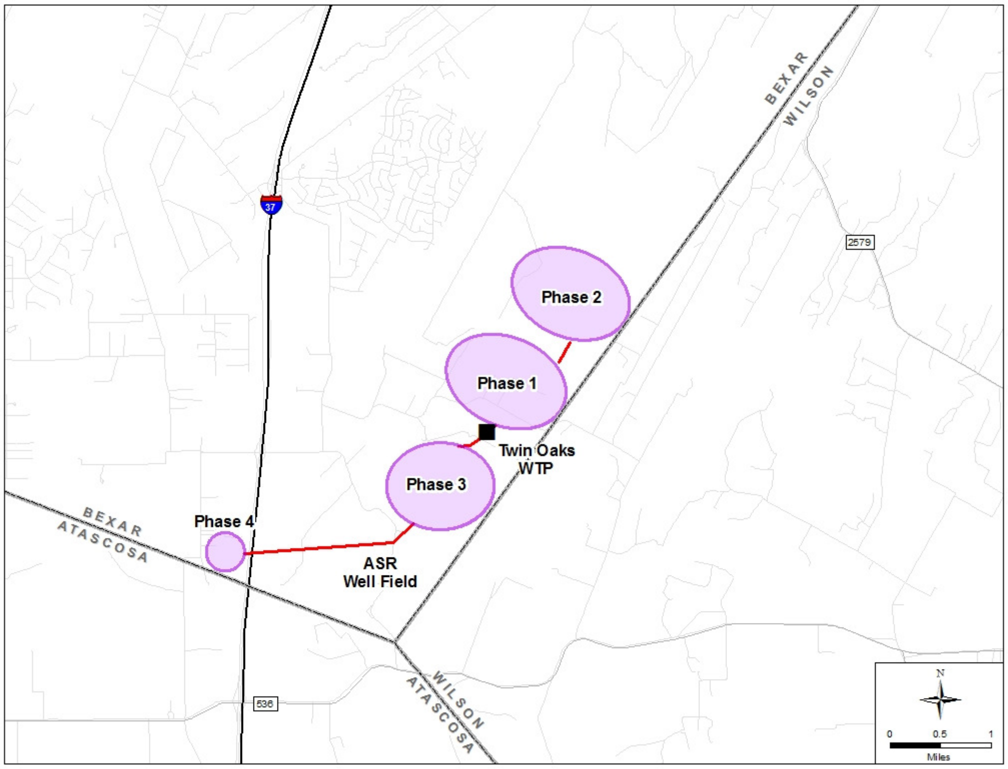


Table 5.2.21-1 Expanded Local Carrizo Project Phases

Phase	Number of Wells	Yield (acft/yr)
1	4	11,152
2	3	8,294
3	4	8,294
4	1	2,260
Total	12	30,000

5.2.21.2 Available Yield

The Carrizo Aquifer in the vicinity of the planned well field is just downdip of the Carrizo outcrop. Hydrogeologic maps of the aquifer in this area suggest that wells in the area would be capable of producing up to 2,000 gpm and would range in depth from 550 to 600 ft. Wells are planned to be screened in the Carrizo. Groundwater quality in this part of Bexar County has a concentration of total dissolved solids of less than 300 mg/L. However, the water typically has elevated concentrations of iron and manganese that requires removal before being integrated into the distribution system.

In the immediate vicinity of the Expanded Local Carrizo Project, SAWS has: (1) a Local Carrizo Project with a yield of 9,900 acft/yr, (2) an ASR project with wells in the Carrizo, and (3) a planned Local Brackish Wilcox Desalination Project. There is no local groundwater conservation district to regulate groundwater production, well spacing, and export of groundwater in Bexar County other than for the Edwards Aquifer.

Desired Future Condition (DFC) has been established for Bexar County by GMA-13. The TWDB has determined that the Modeled Available Groundwater (MAG) for the Carrizo-Wilcox Aquifer in Bexar County is 26,107 acft/yr in 2070. After allowance for existing groundwater production from the Carrizo-Wilcox Aquifer, the MAG-Limited availability is 5,419 acft/yr for the SAWS Expanded Carrizo Project.

The cumulative effects of pumping of existing and planned SAWS wells in the Carrizo and Wilcox and ASR well operations in the Carrizo in South Bexar County and neighboring counties have not been determined.

5.2.21.3 Environmental Issues

SAWS Expanded Local Carrizo Project involves the development of new well fields in the Carrizo Sands of the Carrizo-Wilcox Aquifer in southern Bexar County, and construction of water treatment plant(s), pump station(s), storage tank(s), and transmission pipeline(s).

The project area occurs within the Post Oak Savannah vegetational area which contains gently rolling to hilly topography, and elevations which range from 300 to 800 feet.1 Overstory species found within this area primarily include post oak (*Quercus stellata*), blackjack oak (*Q. marilandica*), and species of hickory (*Carya* ssp.). Climax grasses include yellow indian grass (*Sorghastrum nutans*), switchgrass (*Panicum virgatum*), purpletop tridens (*Tridens flavus*), longspike silver bluestem (*Bothriochloa saccharoides* var. *longipaniculata*), slender woodoats (*Chasmanthium laxum*), and little bluestem (*Schizachyrium scoparium*).

The well field areas of Phase 4, 3, and the southeastern portion of Phase1 occur within the Post Oak Woods, Forest and Grassland Mosaic vegetational type as described by the Texas Parks and Wildlife Department (TPWD). [2] Areas of Post Oak Woods/Forest and Crops are also included in the area of these phases of the project. The Phase 2 well field occurs solely within the Post Oak Woods/Forest vegetational type. The existing WTP includes areas of Post Oak Woods/Forest and Post Oak Woods, and Forest and Grassland Mosaic vegetational types. The project area is slightly dissected by streams which are tributaries of the San Antonio and Nueces Rivers.

Plant and animal species listed by USFWS and TPWD that may occur within the county of this water management strategy are listed in Table 5.2.21-2. Documented occurrences of two endangered birds, the golden-cheeked warbler (*Dendroica chrysoparia*) and black-capped vireo (*Vireo atricapillus*) occur within northern and western Bexar County. However, the presence of these species or their typical nesting habitat, in the vicinity of the proposed pipeline or well fields is unlikely. Reasonable and prudent measures should be taken to avoid and minimize the potential effects of proposed project activities on

[1] Gould, F.W., "The Grasses of Texas," Texas A&M University Press, College Station, Texas, 1975.
[2] McMahan, Craig A., Roy G. Frye and Kirby L. Brown. 1984. The Vegetation Types of Texas. Wildlife Division, Texas Parks and Wildlife Department, Austin, Texas.

threatened and endangered species. Species' locations, activities, and habitat requirements should be considered based on USFWS and TPWD recommendations.

The Texas Natural Diversity Database (TXNDD), maintained by TPWD, includes known occurrences of three rare plants in the vicinity of the project including Parks jointweed (*Polygonella parksii*), sandhill woolywhite (*Hymenopappus carrizoanus*), and Elmendorf's onion (*Allium elmendorfi*). Park's jointweed is a Texas endemic which is primarily found on deep, loose, sand blowouts in post oak savannas. The sandhill woolywhite prefers dense riparian corridors and Emendorf's onion is an endemic species which is usually found in areas which include deep sands. These species of concern are considered to be rare, but are not protected by USFWS or TPWD.

Within the project area several species listed as threatened by the state may possibly be affected by the construction and maintenance of project components. These include the Texas indigo snake (*Drymarchon corais erebennus)*, Texas horned lizard (*Phrynosoma*

Table 5.2.21-2 Endangered, Threatened, and Species of Concern for Bexar County

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence
AMPHIBIANS								
Cascade Caverns salamander	*Eurycea latitans complex*	0	2	0	Endemic, subaquatic in Edwards Aquifer	--	T	Resident
Comal blind salamander	*Eurycea tridentifera*	0	2	0	Endemic and semi-troglobitic, found in springs and waters of caves.	--	T	Resident
Texas salamander	*Eurycea notenes*	0	1	0	Endemic; troglobitic, found in springs, caves and creek headwaters restricted to Helotes and Leon Creek drainages.	--	--	Resident
ARACHNIDS								
Bracken Bat Cave meshweaver	*Cicurina venii*	0	3	0	Small eyeless spider, found in Karst features in western Bexar County.	LE	--	Resident
Cokendolpher cave harvestman	*Texella cokendolpheri*	0	3	0	Small, eyeless spider found in karst features I north and northwest Bexar County.	LE	--	Resident
Government Canyon Bat Cave meshweaver	*Cicurina vespera*	0	3	0	Small eyeless spider in karst features in north and Northwest	LE	--	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence
					Bexar county.			
Government Canyon Bat Cave spider	*Neoleptoneta microps*	0	3	0	Small eyeless spider in karst features in north and Northwest Bexar county.	LE	--	Resident
Madla Cave meshweaver	*Cicurina madla*	0	3	0	Small eyeless spider in karst features in north and Northwest Bexar county.	LE	--	Resident
Robber Baron Cave meshweaver	*Cicurina baronia*	0	3	0	Small eyeless spider in karst features in north and Northwest Bexar county.	LE	--	Resident
BIRDS								
American peregrine falcon	*Falco peregrinus anatum*	0	3	0	Migrant and local breeder in West Texas.	DL	T	Possible Migrant
Arctic peregrine falcon	*Falco peregrinus tundrius*	0	2	0	Migrant throughout the state.	DL		Possible Migrant
Black-capped vireo	*Vireo atricapillla*	1	3	3	Semi-open broad-leaved shrublands	LE	E	Nesting/ Migrant
Golden-cheeked warbler	*Setophaga chrysoparia*	0	3	0	Woodlands with oaks and old juniper.	LE	E	Nesting/ Migrant
Interior least tern	*Sterna antillarum athalassos*	0	3	0	Nests along sand and gravel bars in braided streams	LE	E	Resident
Mountain plover	*Charadrius montanus*	0	1	0	Non-breeding, shortgrass plains and fields			Nesting/ Migrant
Sprague's pipit	*Anthus spragueii*	0	1	0	Migrant in Texas in winter mid Sept. to early April. Strongly tied to native upland prairie.	C		Possible Migrant
Western burrowing owl	*Athene cunicularia hypugaea*	1	1	1	Open grasslands, especially prairie, plains and savanna			Resident
White-faced ibis	*Plegadis chihi*	0	2	0	Prefers freshwater marshes.		T	Potential Migrant
Whooping crane	*Grus americana*	0	3	0	Potential migrant	LE	E	Potential Migrant

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence
Wood stork	*Mycteria americana*	0	2	0	Forages in prairie ponds, ditches, and shallow standing water formerly nested in TX		T	Migrant
Zone-tailed hawk	*Buteo albonotatus*	1	2	2	Arid, open country including deciduous or pine-oak woodland.		T	Nesting/ migrant
CRUSTACEANS								
A cave obligate crustacean	*Monodella Texana*	0	1	0	Subaquatic, subterranean obligate found in freshwater aquifers.			Resident
FISHES								
Guadalupe bass	*Micropterus treculi*	0	1	0	Endemic to perennial streams of the Edwards Plateau region.			Resident
Toothless blindcat	*Trogloglanis pattersoni*	0	2	0	Troglobitic; blind catfish endemic to the San Antonio pool of the Edwards Aquifer.		T	Resident
Widemouth blindcat	*Satan eurystomus*	0	2	0	Troglobitic, blind catfish endemic to the San Antonio pool of the Edwards Aquifer.		T	Resident
INSECTS								
A ground beetle	*Rhadine exilis*	0	3	0	Eyeless beetle found in karst features in northern Bexar county.	LE		Resident
A ground beetle	*Rhadine infernalis*	0	3	0	Small eyeless ground beetle found in karst features in northern and western Bexar County.	LE		Resident
Helotes mold beetle	*Bastrisodes venyivi*	0	3	0	Small, essentially eyeless mold beetle found in karst features in north and northwest Bexar County.	LE		Resident
Manfreda giant-skipper	*Stallingsia maculosus*	0	1	0	Larvae feed inside leaf shelter and pupae found in cocoon made			Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence
					of leaves fastened by silk.			
Rawson's metalmark	*Calephelis rawsoni*	0	1	0	Moist areas in shaded limestone outcrops.			Resident
MAMMALS								
Black bear	*Ursus americanus*	0	2	0	Mountains, broken county in brushlands and forests.	T/SA; NL	T	Resident
Cave myotis bat	*Myotis velifer*	0	1	0	Roosts colonially in caves, rock crevices			Resident
Ghost-faced bat	*Mormoops megalophylla*	0	1	0	Roosts in caves, crevices and buildings.			Resident
Gray wolf	*Canis lupus*	0	3	0	Extirpated.	LE	E	Extinct
Plains spotted skunk	*Spilogale putorius interrupta*	1	1	1	Prefers wooded, brushy areas.			Resident
Red wolf	*Canis rufus*	0	3	0	Extirpated.	LE	E	Historic Resident
MOLLUSKS								
Creeper (squawfoot)	*Strophitus undulates*	0	1	0	Small to large streams. Colorado, Guadalupe, and San Antonio River basins.			Resident
False spike mussel	*Quincuncina mitchelli*	0	2	0	Substrates of cobble and mud. Rio Grande, Brazos, Colorado and Guadalupe river basins.		T	Resident
Golden orb	*Quadrula aurea*	0	2	0	Sand and gravel, Guadalupe, San Antonio, Lower San Marcos, and Nueces River basins	C	T	Resident
Mimic cavesnail	*Phreatodrobia imitata*	0	1	0	Subaquatic found in wells in Edwards Aquifer.			Resident
Texas fatmucket	*Lampsilis bracteata*	0	2	0	Streams and rivers on sand, mud and gravel, Colorado and Guadalupe River	C	T	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence
					basins.			
Texas pimpleback	*Quadrula petrina*	0	2	0	Mud, gravel and sand substrates, Colorado and Guadalupe river basins	C	T	Resident
PLANTS								
Big red sage	*Salvia pentstemonoides*	0	1	0	Texas endemic, found in moist to seasonally wet steep limestone outcrops on canyons or along creek banks.			Resident
Bracted twistflower	*Steptanthus bracteatus*	0	2	0	Endemic; shallow clay soils over limestone rocky slopes.	C		Resident
Correll's false dragon-head	*Physostegia correllii*	0	1	0	Wet soils.			Resident
Elmendorf's onion	*Allium elmendorfii*	1	1	1	Endemic, found in deep sands			Resident
Hill country wild-mercury	*Argythamnia aphoroides*	0	1	0	Endemic; found in grasslands associated with oak woodlands.			Resident
Parks' jointweed	*Polygonella parksii*	1	1	1	Texas endemic, primarily found on deep, loose, sand blowouts in Post Oak Savannas.			Resident
Sandhill woolywhite	*Hymenopappus carrizoanus*	1	1	1	Found south of the Guadalupe River. Prefers dense riparian corridors.			Resident
REPTILES								
Spot-tailed earless lizard	*Holbrookia lacerata*	1	1	1	Moderately open prairie-brushland.			Resident
Texas Garter Snake	*Thamnophis sirtalis annectens*	0	1	0	Wet or moist microhabitats			Resident
Texas Horned Lizard	*Phrynosoma cornutum*	1	2	2	Varied, sparsely vegetated uplands.		T	Resident
Texas indigo snake	*Drymarchon melanurus erebennus*	1	2	2	Grass prairies and sand hills; woodland and mesquite savannah.		T	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence
Texas tortoise	*Gopherus berlandieri*	1	2	2	Open brush w/ grass understory.		T	Resident
Timber rattlesnake	*Crotalus horridus*	1	2	2	Floodplains, upland pine, deciduous woodlands, riparian zones.		T	Resident

LE/LT=Federally Listed Endangered/Threatened
DL=Federally Delisted
C=Candidate for Federal Listing
E, T=State Listed Endangered/Threatened
Blank = Considered rare, but no regulatory listing status

TPWD, 2015. Annotated County List of Rare Species – Bexar County, revised 12/5/2014.
USFWS, 2015. Endangered Species List for Texas. http://www.fws.gov/southwest/es/ES_ListSpecies.cfm accessed online January 12, 2015.

cornutum), Texas tortoise (*Gopherus berlandieri)*, and timber rattlesnake (*Crotalus horridus)*. No significant impacts to these species are anticipated due to the abundance of similar habit near the project area and this species' ability to relocate to those areas if necessary.

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 (Pl96-515), and the Archeological and Historic Preservation Act (PL93-291). Based on the review of publically available Geographic Information System (GIS) records obtained from the Texas Historical Commission, there are no State Historic Sites, National Register Properties or National Register Districts within the project area. Two cemeteries, the Shelly-Fleming and John Shock Shely, occur within the project area between Phases1 and 3.

Field surveys conducted at the appropriate phase of development should be employed to minimize the impacts of construction and operations on cultural and historic resources. Specific project features, such as well fields, and pipelines generally have sufficient design flexibility to avoid most impacts or significantly mitigate potential impacts to geographically limited environmental and cultural resource sites.

Potential wetland impacts, which may include well field areas, WTP locations and pipeline stream crossings, can be minimized by right-of-way selection and appropriate construction methods, including erosion controls and revegetation procedures. Compensation for net losses of wetlands would be required where impacts are unavoidable.

5.2.21.4 Engineering and Costing

Preliminary engineering and costing analyses have been performed for each of the four phases as well as the MAG-Limited project using 2016 Regional Water Planning methods. Project phasing and well locations, number of wells, and well pumping rates were provided by SAWS. . HDR utilized the standard costing procedures and method for calculating unit costs. The costing procedures include all facilities required for water production, collection, transmission and treatment, but did not include the cost of expanding transmission facilities to deliver the treated water from the Twin Oaks WTP to SAWS existing distribution system. The well fields will require wells and a collector pipeline. Water treatment would require standard filtration treatment to remove of iron and manganese and to disinfect the water. Well pumps will be sized to deliver the raw water to the WTP except for Phase IV where a small pump station is needed. Treated water will be either delivered to SAWS distribution system by a new west side integration pipeline or the existing east side pipeline.

Project as Envisioned

Phase 1 of the SAWS Expanded Local Carrizo Project will produce a uniform 10.0 MGD (11,152 acft/yr) of potable water. Facilities include a well field with 4 wells. This initial phase will require an expansion of the existing water treatment. Phases 2 and 3 will each produce a uniform 7.4 MGD (8,292 acft/yr) of potable water. Facilities for each of these two phases include: a well field with 3 wells plus one backup well in Phase 3 and expansion of the water treatment plant. Phase 4 will produce a uniform 2.0 MGD (2,260 acft/yr, which requires one new well and a minor WTP expansion. When complete and without considerations of MAG restrictions, the Expanded Local Carrizo for SAWS project is to produce 26.8 MGD (30,000 acft/yr).

Region L cost estimates for delivering treated water to SAWS South Bexar pump station for each of the four phases is shown in Table 5.2.21-3. Additional cost would be required to transmit the water to SAWS distribution system. Cost estimates were developed using regional planning procedures. The total estimated project cost is $83,080,000. The annual costs include debt service for a 30-year loan at 5.5 percent interest and operation and maintenance costs, including power. Because the wells are located on SAWS property and where there is no groundwater conservation district, the costs do not include a groundwater lease fee or a groundwater district fee. The cost of water is estimated to be $553/acft/yr ($1.70 per 1,000 gallons) for treated water at the ASR facility. Additional cost would be incurred to transport the water to SAWS distribution system.

MAG-Limited Project

The MAG Limited project will produce a uniform 4.84 MGD (5,419 acft/yr acft/yr) of potable water from 3 wells in the Phase 1 well field. Facilities include: a well field, collector pipelines and expansion of the water treatment plant.

Region L cost estimates for the project is shown in Table 5.2.21-4. Cost estimates were developed using regional planning procedures. The total estimated project cost is $19,332,000. The annual costs include debt service for a 30-year loan at 5.5 percent interest and operation and maintenance costs, including power. The cost of water is estimated to be $700/acft/yr ($2.15 per 1,000 gallons) for treated water at SAWS South Bexar pump station. Additional cost would be incurred to transport the water to SAWS distribution system.

Table 5.2.21-3 Cost Estimate Summary (Project as Envisioned)

Item	*Phase I*	*Phase II*	*Phase III*	*Phase IV*	*All Phases*
CAPITAL COST					
Transmission Pipeline (Production Pipe,Pumps and Crossings)	$1,133,000	$861,000	$864,000	$430,000	$3,288,000
Transmission Pump Station(s) & Storage Tank(s)	$0	$0	$0	$899,000	$899,000
Well Fields (Wells, Pumps, and Piping)	$4,826,000	$3,560,000	$4,698,000	$953,000	$14,037,000
Water Treatment Plants	$18,981,000	$9,839,000	$9,819,000	$2,654,000	$41,293,000
TOTAL COST OF FACILITIES	**$24,940,000**	**$14,260,000**	**$15,381,000**	**$4,936,000**	**$59,517,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$8,672,000	$4,948,000	$5,340,000	$1,391,000	$20,351,000
Environmental & Archaeology Studies and Mitigation	$99,000	$123,000	$101,000	$57,000	$380,000
Land Acquisition and Surveying (22 acres)	$0	$0	$0	$49,000	$49,000
Interest During Construction (4% for 1 years with a 1% ROI)	$1,210,000	$646,000	$690,000	$237,000	$2,783,000
TOTAL COST OF PROJECT	**$34,921,000**	**$19,977,000**	**$21,512,000**	**$6,670,000**	**$83,080,000**
ANNUAL COST					
Debt Service (5.5 percent, 30 years)	$2,460,000	$1,313,000	$1,403,000	$480,000	$5,656,000
Operation and Maintenance					
Intake, Pipeline, Pump Station (1% of Cost of Facilities)	$89,000	$37,000	$47,000	$36,000	$209,000
Water Treatment Plant (2.5% of Cost of Facilities)	$3,796,000	$1,968,000	$1,964,000	$531,000	$8,259,000
Pumping Energy Costs (19863211 kW-hr @ 0.09 $/kW-hr)	$1,788,000	$271,000	$303,000	$113,000	$2,475,000
TOTAL ANNUAL COST	**$8,133,000**	**$3,589,000**	**$3,717,000**	**$1,160,000**	**$16,599,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 1	11,152	8,294	8,294	2,260	30,000
Annual Cost of Water ($ per acft)	$729	$433	$448	$513	$553
Annual Cost of Water ($ per 1,000 gallons)	$2.24	$1.33	$1.38	$1.57	$1.70

Table 5.2.21-4 Cost Estimate Summary (MAG Limited)

Item	***MAG Phase***
CAPITAL COST	
Transmission Pipeline (Production Pipe, Pumps and Crossings)	$433,000
Well Fields (Wells, Pumps, and Piping)	$3,274,000
Water Treatment Plants	$10,135,000
TOTAL COST OF FACILITIES	**$13,842,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$4,823,000
Environmental & Archaeology Studies and Mitigation	$30,000
Interest During Construction (4% for 1 years with a 1% ROI)	$637,000
TOTAL COST OF PROJECT	**$19,332,000**
ANNUAL COST	
Debt Service (5.5 percent, 30 years)	$1,295,000
Operation and Maintenance	
Intake, Pipeline, Pump Station (1% of Cost of Facilities)	$33,000
Water Treatment Plant (2.5% of Cost of Facilities)	$2,027,000
Pumping Energy Costs (4,898,989 kW-hr @ 0.09 $/kW-hr)	$441,000
TOTAL ANNUAL COST	**$3,796,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 1	5,419
Annual Cost of Water ($ per acft)	$700
Annual Cost of Water ($ per 1,000 gallons)	$2.15

5.2.21.5 Implementation Issues

For each aquifer in the region, the GCDs have adopted desired future conditions (DFCs). In some GCDs, full use of all groundwater supplies (permitted, grandfathered and exempt) may result in non-achievement of the DFCs for an aquifer. To ensure consistency with the DFCs, TWDB currently requires that groundwater availability for each aquifer be limited for planning purposes to the modeled available groundwater (MAG) for the aquifer. This has resulted, for planning purposes only, in adjustments to permit amounts, and a lack of firm water available for future permits in this plan for some areas for certain time periods. This should not be construed as recommending or requiring that GCDs make these adjustments, or deny future permit applications. SCTRWPG recognizes and supports the ability of permit holders to exercise their rights to groundwater use in accordance with their permits and it recognizes and supports the GCDs discretion to issue permits and grandfather historical users for amounts in excess of the MAG. SCTRWPG may not modify groundwater permits that GCDs have already issued or limit future permits that GCDs may issue. If the MAG is increased during or after this planning cycle, SCTRWPG may amend this Plan to adjust groundwater supply numbers that are affected by the new MAG amount.

Additional development of the Carrizo in the vicinity of SAWS ASR well field is expected to cause the stored water in the vicinity of ASR wells to drift faster and further away from the wells than would occur without the Expanded Local Carrizo Project. This may reduce the efficiency of the recovering the injected water into ASR wells.

The development of groundwater in the Carrizo-Wilcox Aquifer in the South Texas Water Planning Region must address several issues. Major issues include:

- Impacts on:
    - Endangered and threatened species;
    - Water levels in the aquifer, including potential dewatering of the current artesian part of the aquifer;
    - Baseflow in streams; and
    - Wetlands.
- Competition with others in the area for groundwater in the Carrizo Aquifer to include:
    - Private water purveyors,
    - Public water purveyors in Bexar County, and/or
    - Future oil and gas drilling operations.

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5.2.22 Seawater Desalination for SAWS

Desalting seawater from the Gulf of Mexico in the vicinity of San Antonio Bay is a potential source of freshwater supplies for municipal and industrial use. The strategy will be a large-scale desalt plant with finished water capacity of 75 MGD (84,012 acft/yr) drawing saline water from San Antonio Bay with a conveyance system for delivery of treated water to San Antonio Water System distribution facilities.

The desalination treatment plant is located adjacent to San Antonio Bay near the City of Seadrift and the treated water delivery location is south Bexar County as shown in Figure 5.2.22-1.

The desalination process produces a concentrate that is conveyed out to the open Gulf of Mexico for diffusion in deep water. The treatment plant location and concentrate pipeline are shown in Figure 5.2.22-2.

5.2.22.1 Description of Water Management Strategy

General Desalination Background

The commercially available processes that are currently used to desalt seawater and brackish groundwater to produce potable water are:

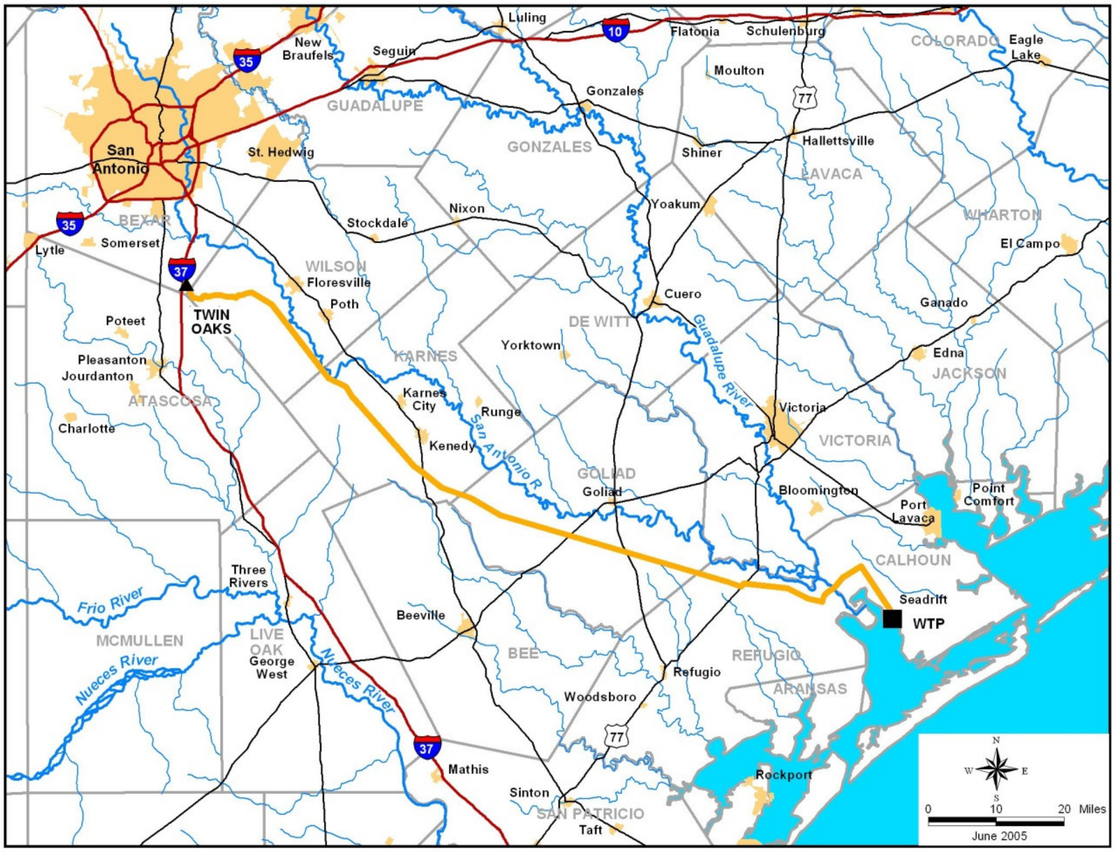
- Distillation (thermal) Processes; and
- Membrane (non-thermal) Processes.

The following sections describe each of these processes and discuss a number of issues that should be considered before selecting a process for desalination of seawater.

Distillation (Thermal) Processes

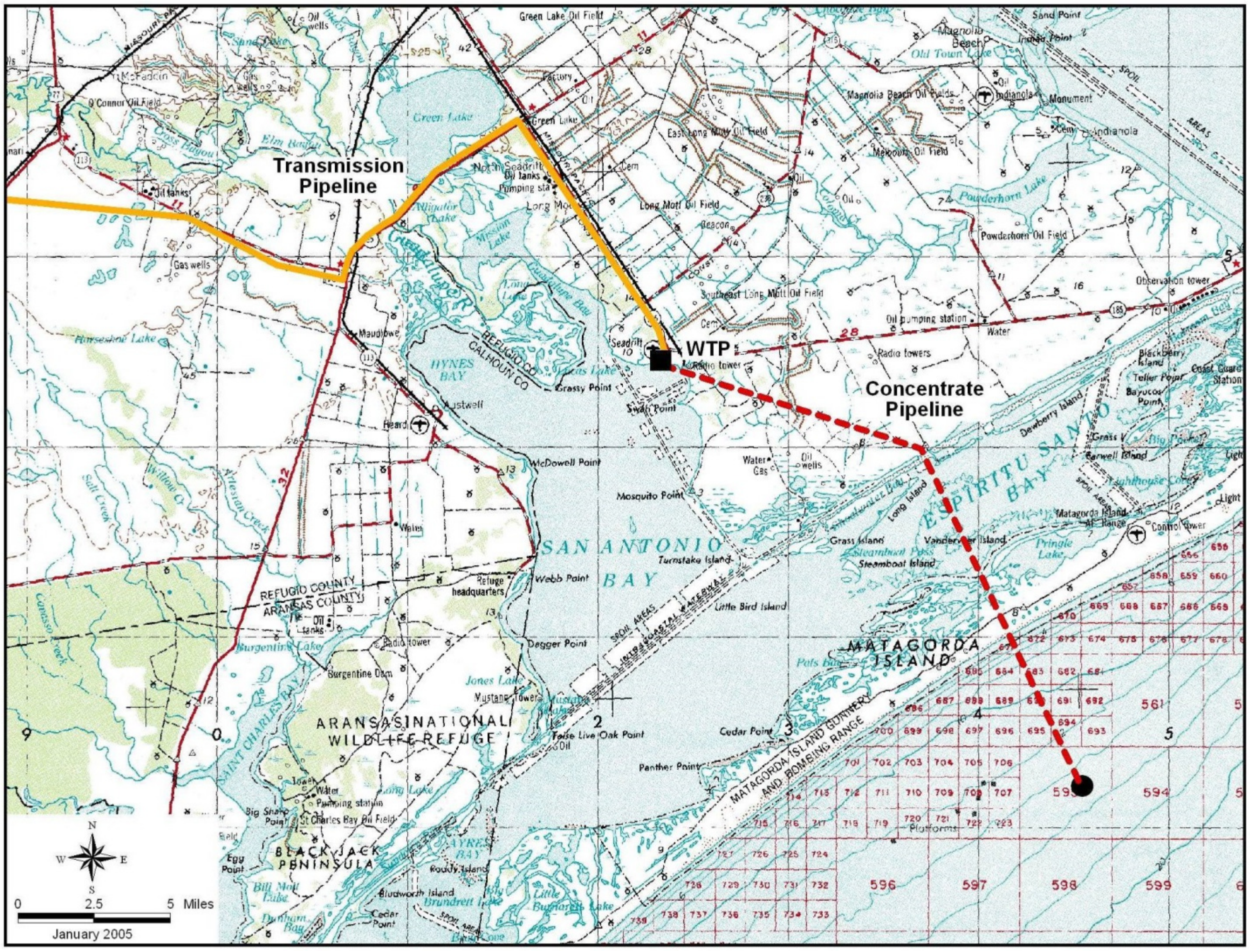
Distillation processes produce purified water by vaporizing a portion of the saline feedstock to form steam. Since the salts dissolved in the feedstock are nonvolatile, they remain unvaporized and the steam formed is captured as a pure condensate. Distillation processes are normally very energy-intensive, quite expensive, and are generally used for large-scale desalination of seawater. Heat is usually supplied by steam produced by boilers or from a turbine power cycle used for electric power generation. Distillation plants are commonly co-sited with power plants.

Figure 5.2.22-1 Seawater Desalination Location Map



In general, for a specific plant capacity, the equipment in distillation plants tends to be much larger than membrane desalination equipment. However, distillation plants do not have the stringent feedwater quality requirements of membrane plants. Due to the relatively high temperatures required to evaporate water, distillation plants have high-energy requirements, making energy a large factor in the overall water cost. The high operating temperatures can result in scaling (precipitation of minerals from the feedwater), which reduces the efficiency of the evaporator processes, because once an evaporator system is constructed, the size of the exchange area and the operating profile are fixed, leaving energy transfer as a function of only the heat transfer coefficient. Therefore, any scale that forms on heat exchanger surfaces reduces heat transfer coefficients. Under normal circumstances, scale can be controlled by chemical inhibitors, which inhibit but do not eliminate scale, and by operating at temperatures of less than 200°F.

Figure 5.2.22-2 Treatment Plant and Concentrate Pipeline Location



Distillation product water recoveries normally range from 15 to 45 percent, depending on the process. The product water from these processes is nearly mineral free, with very low total dissolved solids (TDS) of less than 25 mg/L. However, this product water is extremely aggressive and is too corrosive to meet the Safe Drinking Water Act (SDWA) corrosivity standards without post-treatment. Product water can be stabilized by chemical treatment or by blending with other potable water.

The three main distillation processes in use today are Multistage Flash Evaporation (MSF), Multiple Effect Distillation (MED), and Vapor Compression (VC). All three of these processes utilize an evaporator vessel that vaporizes and condenses the feedstock. The three processes differ in the design of the heat exchangers in the vessels and in the method of heat introduction into the process. Since there are no distillation processes in Texas that can be shown as comparable installations, distillation will not be further considered herein. However, there are membrane desalination operations in Texas, so the following discussion and analyses are based upon information from the use of membrane technology for desalination.

Membrane (Non-thermal) Processes

The two types of membrane processes use either pressure, as in reverse osmosis, or electrical charge, as in electrodialysis reversal, to reduce the mineral content of water. Both processes use semi-permeable membranes that allow selected ions to pass through while other ions are blocked. Electrodialysis reversal (EDR) uses direct electrical current applied across a vessel to attract the dissolved salt ions to their opposite electrical charges. EDR can desalinate brackish water with TDS up to several thousand mg/L, but energy requirements make it economically uncompetitive for seawater, which typically contains approximately 35,000 mg/L TDS. As a result, only reverse osmosis (RO) is used for seawater desalination.

RO utilizes a semi-permeable membrane that limits the passage of salts from the saltwater side to the freshwater side of the membrane. Electric motor driven pumps or steam turbines (in dual-purpose installations) provide the 800 to 1,200 psi pressure to overcome the osmotic pressure and drive the freshwater through the membrane, leaving a waste stream of brine/concentrate. The basic components of an RO plant include pre-treatment, high-pressure pumps, membrane assemblies, and post-treatment. Pretreatment is essential because feedwater must pass through RO membranes during the process and suspended materials, biological growth, and some minerals can foul the RO membrane. As a result, virtually all suspended solids must be removed and the feedwater must be pre-treated so precipitation of minerals or growth of microorganisms does not occur on the membranes. This is normally accomplished by conventional or low pressure membrane (micro or ultra) filtration and the addition of various chemical additives and inhibitors. Post-treatment of product water is usually required prior to distribution to reduce its corrosively and to improve its aesthetic qualities. Specific treatment is dependent on product water composition.

A "single pass" seawater RO plant will produce water with a TDS of 150 to 500 mg/L, most of which is sodium and chloride. The product water will be corrosive, but this may be acceptable, if a source of blending water is available. If not, a dual pass RO system can be installed followed by a post-treatment system to meet the desired TDS levels.

Recovery rates up to 50 percent are common for seawater RO facilities. The recovery rate is dependent on raw water quality and specifically the concentration of dissolved constituents. Higher recovery rates can be obtained for water in a bay or other location that is blended with some freshwater resulting in lower TDS. RO plants, which comprise about 59 percent of the world's desalting capacity, range from a few gallons per day to 130 MGD. The largest RO seawater plant in the United States is the 25-MGD plant in Tampa Bay, Florida. There are several recently completed RO seawater plants mainly in the Middle East with capacities around 85 MGD. RO membranes have been improved significantly over the past two decades with respect to efficiency, longer life, and lower prices.

Examples of Relevant Existing Desalt Projects

Tampa, FL: The water utility, Tampa Bay Water, has constructed a nominal 25 MGD seawater desalt plant. The plant uses RO as the desalt process. The proposal included total capitalization and operations costs for producing high quality drinking water. The total cost to Tampa Bay Water for the 25 MGD seawater desalination plant was $158 million.

Factors listed below may be all or partially responsible for a lower water treatment plant cost:

1. Salinity at the Tampa Bay site ranges from 25,000 to 30,000 mg/L, lower than the more common 35,000 mg/L for seawater. RO cost is sensitive to salinity.
2. The power cost, which is interruptible, is below $0.04 per kilowatt-hour (kWh).
3. Tampa Bay seawater desalination plant used existing power plant canals for intake and concentrate discharge, which lowered capital cost for the plant.
4. Economy of scale at 25 MGD.
5. Amortizing over 30 years.
6. Use of tax-exempt bonds for financing.

San Diego, CA: The San Diego County Water Authority is currently constructing a 50 MGD Carlsbad Desalination Plant. Current cost estimates on the project are roughly $537 million for the water treatment plant alone, with total project costs expected to be in excess of $1 billion. The plant is set to be operational by December 2015.

Large-Scale Demonstration Seawater Desalination in Texas: The Texas Water Development Board (TWDB) funded several studies to evaluate the feasibility of large-scale desalination in Texas. As part of this initiative, the City of Corpus Christi, Freeport, and the Lower Rio Grande Valley-Brownsville were selected as potential locations for large-scale seawater desalination and feasibility studies were conducted for each of these locations. The final feasibility reports were submitted in 2010 to TWDB and indicated that the demonstration seawater desalination projects for the three locations are technically feasible. However, all three draft reports indicate that the estimated total costs for capital and O&M of the proposed projects will exceed the cost of alternative sources of drinking water at these locations[1].

Subsequent to the initial study, the Brownsville Public Utilities Board (BPUB) conducted an 18-month reverse osmosis desalination demonstration study at the Brownsville Ship Channel with the final report completed in October 2008[2]. The study evaluated several pretreatment and reverse osmosis desalination alternatives and presented a cost estimate for implementing a 25 MGD seawater desalination project at Brownsville. Table 5.2.22-2 shows a summary of the capital cost estimate. At the time of the pilot study

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[1] Texas Water Development Board, “The Future of Desalination in Texas Volume I, Biennial Report on Seawater Desalination”, 2010.

[2] NRS, “Final Pilot Study Repot Texas Seawater Demonstration Project”, October 2008.

report BPUB decided that full scale project was not recommended for immediate implementation because there would not be adequate regional water demand and the cost of a 25 MGD seawater desalination project was greater than the cost of other water supply strategies. The study recommended that a 2.5-MGD seawater demonstration project be constructed instead with provisions made in the initial design to expand the facility to 25 MGD by 2050. A study[3] conducted from 2006 to 2009 for Laguna Madre Water District provides site-specific source water data from an open ocean intake and beach wells to determine the cost of a 1-MGD seawater desalination plant.

Table 5.2.22-1. Cost Summary for TWDB Texas Seawater Demonstration Project in Brownsville

Project Component	*Feasibility Estimate (2004)*	*Pilot Study Estimate (2008)*
Capital Costs		
Desalination Plant	$90,167,000	$126,612,000
Concentrate Disposal System	$30,583,000	$21,217,000
Finished Water Transmission System	$9,232,000	$12,180,000
Project Implementation Costs	$21,406,000	$22,400,000
Total Capital Cost	**$151,388,000**	**$182,409,000**

5.2.22.2 Available Yield

Seawater from San Antonio Bay and the Gulf of Mexico is an unlimited quantity within the context of a supply for the South Central Texas Region. For the purpose of developing this strategy in which seawater from the bay is desalinated to develop a significant drinking water supply for the major urban area in the region, it is assumed that the availability of water is unlimited and that its cost is zero prior to extraction from the source.

5.2.22.3 Environmental Issues

Seawater Desalination

The proposed location of the desalination facilities is near Seadrift on San Antonio Bay, which is part of the estuary of the San Antonio and Guadalupe Rivers (Figure 5.2.22-2). The concentrate stream resulting from the desalination process will be discharge into the deep water of the open Gulf of Mexico via a pipeline used for disposal. The treated water delivery location, San Antonio, Texas, will be served by a long water transmission pipeline from the desalination plant.

The location of the desalination plant would take advantage of the lower energy requirement of the desalination process at the lower salinity levels of the upper estuary, although the variable salinity at that location can adversely affect operations at times. Estuaries, which serve as critical habitat and spawning grounds for many marine species

[3] NRS, “Feasibility and Pilot Study: South Padre Island Seawater Desalination Plant”, August 2010.

and migratory birds, are marine environments maintained in a brackish state by the inflow of freshwater from rivers and streams. The high productivity characteristic of estuaries arises from the abundance of nutrient input from the surrounding land, shallow water, and the ability of a few marine species to exploit environments continually stressed by low, variable salinities, temperature extremes, and, on occasion, low dissolved oxygen concentrations.

The potential environmental effects resulting from the construction of a desalination plant in the vicinity of San Antonio Bay will be sensitive to the siting of the plant and its intake location. Construction of either will temporarily disrupt shoreline and benthic habitats in the immediate vicinity, including wetlands and other sensitive areas, and operation of the intake will result in some impingement and entrainment of aquatic organisms. Impingement takes place when organisms are trapped against intake screens by the force of the water passing into the intake structure. Entrainment occurs when organisms are drawn through the water intake structure into the pump and transport system. Organisms that become impinged or entrained are normally relatively small organisms, including early life stages of fish and shellfish. Impingement can result in descaling or other physical damage, and starvation, exhaustion or asphyxiation when the organism cannot escape the intake structure. Entrained organisms are subject to mechanical, thermal, or toxic stress (e.g., biocides or low dissolved oxygen concentrations) as they pass through the system. In the case of either impingement or entrainment, a substantial proportion of the affected individuals will be killed or subjected to significant harm. Minimization of impingement and entrainment by appropriate site selection and through the use of appropriate screening technology must be considered during system design as part of the overall effort to avoid or minimize potential impacts to the estuarine environment.

Since the concentrate discharge point is planned to be located about 13 miles offshore, impacts of this feature on the estuary would be limited to the impacts of pipeline construction on bay bottom habitats. Of particular concern will be potential impacts to *Spartina* marshes and seagrass beds. Discharge structure sites should be selected to avoid areas where organisms tend to concentrate. These include rock outcrops, man-made structures, the vicinities of tidal passes and the surf zone. It can be assumed that the permit process will at some time require a (modeling) demonstration showing that the design of the discharge structure will be adequate to rapidly disperse the concentrate plume to ambient salinities within a relatively small mixing zone in order to minimize the impacts to aquatic species.

A desalination facility using 50 MGD of feedwater would process about 154 acft of bay water per day, or up to 4,800 acft/month. This is a small amount (2.5 percent) compared to historical San Antonio Bay (Guadalupe Estuary) average inflows (195,000 acft/month). Four percent of median inflows (119,000 acft/month), and 1.3 percent of bay volume (360,000 acft). Only during low flow periods would the water withdrawal for desalination be substantial relative to inflows. For example, the 4,800 acft/month would be about 12 percent of monthly inflows during months so dry that they occur only 10 percent of the time, and is roughly equivalent to the lowest monthly inflow recorded for the estuary. Bay volumes, inflows, and tidal exchanges with the Gulf of Mexico are so large relative to this alternative that substantial impacts to overall salinity gradients or to the delivery of nutrients and sediment are not anticipated.

Many migratory birds are dependent on the quality of estuarine environments in order to complete the foraging and nesting activities of their migration. One of the most well known of the migratory birds is the Whooping Crane (*Grus americana)*, which is listed as endangered by both USFWS and TPWD. A growing population of whooping cranes winter in and near the Aransas National Wildlife Refuge located adjacent to Mesquite Bay and the southern and western portions of San Antonio Bay. This wintering population has grown from a low of only 16 birds in 1941 to a current estimate of 250 birds. Detailed research studies by Texas A&M University are underway at this time to identify and better understand factors affecting whooping crane populations. Other migratory birds known to the project area and listed as threatened by TPWD include the Bald eagle (*Haliaeetus leucocephalus*), Sooty tern (*Sterna fuscata*), Reddish egret (*Egretta rufescens*), Wood stork (*Mycteria americana*), and Piping plover (*Charadrius melodus*). The Piping Plover is also listed as threatened by USFWS.

The water transmission pipeline between San Antonio Bay and Bexar County would be approximately 149 miles long. A construction right-of-way of approximately 140-feet wide would affect a total area of approximately 2,528 acres. The construction of the pipeline would include the clearing and removal of woody vegetation. A 40-foot wide right-of-way corridor, free of woody vegetation and maintained for the life of the project, would total 722 acres. The proposed pipeline route would traverse three of Omernik's[4] ecoregions: the Western Gulf Coastal Plains, the East Central Texas Plains, and the westernmost reaches of the Texas Blackland Prairie. In addition, the Guadalupe River is listed by TPWD as an Ecologically Significant River and Stream Segment within the project area.

Surveys for protected species should be conducted within the proposed construction corridors where preliminary evidence indicates their existence. Many of these species, such as the Texas tortoise, the Texas horned lizard, and the indigo snake, are dependent on shrubland or riparian habitat. The timber rattlesnake, a state threatened species, may be found in the riparian woody vegetation of the area.

Destruction of potential habitat can be reduced by selecting a corridor through previously disturbed areas, such as croplands. Selection of a pipeline right-of-way alongside areas of existing habitat could benefit some wildlife by providing edge habitat; however, the majority of these areas are small and fragmented, so care should be taken to ensure minimum impacts.

The TPWD Natural Diversity Database reports the occurrence of endangered, threatened, or rare species near the potential pipeline right-of-way. One endangered species known to historically exist near the pipeline corridor is the Attwater's greater prairie chicken in Goliad and Refugio Counties. The Attwater's greater prairie chicken prefers the coastal prairies grassland in areas with 0 to 24 inches vegetation height. Coastal gay feather (*Liatris bracteata*), plains gumweed (*Grindelia oolepsis*), threeflower broomweed (*Thurovia triflora*) and Welder machaeranthera (*Psilactis heterocarpa*) are all rare plants with reported occurrences within one mile of the desalination plant or pipeline corridor. In addition, the Golden orb (*Quadrula aurea*), a federal species of concern, has been documented near the pipeline route in the San Antonio River. Plant and animal

[4] Omernik, J.M., "Ecoregions of the Conterminous United States," Annals of the Association of American Geographers, 77:118-125, 1987.

species in the project area counties listed by the USFWS, and TPWD as endangered, threatened, candidate or species of concern are presented in Table 5.2.22-3.

Cultural resources that occur on public lands or within the Area of Potential Effect of publicly funded or permitted projects are governed by the Texas Antiquities Code (Title 9, Chapter 191, Texas Natural Resource Code of 1977), the National Historic Preservation Act (PL96-515), and the Archeological and Historic Preservation Act (PL93-291). Based on the review of available GIS datasets provided by the Texas Historical Commission (THC), there are no National Register Properties, State Historic Sites, cemeteries, or historical markers located within the project area. One National Register Districts, the San Antonio river Valley rural Historic District occurs near the pipeline corridor. In addition several cultural resource surveys have been performed near the project area, indicating the potential for additional sites to occur.

Based on the review of available records housed at the Texas Archeological Research Laboratory in Austin, six cultural resource sites appear to occur within the proposed project area. Table 5.2.22-4 lists archeological sites within a one-mile corridor of the Seawater Desalination project area. Because the owner or controller of the project will likely be a political subdivision of the State of Texas (i.e. river authority, municipality, county, etc.), they will be required to coordinate with the Texas Historical Commission regarding potential impacts to cultural resources.

Table 5.2.22-2 Endangered, Threatened, and Species of Concern in Calhoun, Goliad, Karnes, Refugio and Wilson Counties

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County
						USFWS[1]	TPWD[1]	
AMPHIBIANS								
Black-Spotted Newt	*Notophthalmus meridionalis*	1	2	2	Ponds and resacas in south Texas	---	T	Resident
Sheep Frog	*Hypopachus variolosus*	1	2	2	Deep sandy soils of Southeast Texas	---	T	Resident
Southern Crawfish Frog	*Lithobates areolatus areolatus*	1	1	1	Normally found in abandoned crawfish holes and small mammal burrows.	---	---	Resident
BIRDS								
American Peregrine Falcon	*Falco peregrinus anatum*	0	2	0	Open country; cliffs	DL	T	Nesting/ Migrant
Arctic Peregrine Falcon	*Falco peregrinus tundrius*	0	1	0	Open country; cliffs	DL	---	Nesting/Migrant
Attwater's Greater Prairie-Chicken	*Tympanuchus cupido attwateri*	1	3	3	Coastal Prairies of Gulf Coastal Plain	LE	E	Historic Resident
Bald Eagle	*Haliaeetus leucocephalus*	1	2	2	Large Bodies of water with nearby resting sites	DL	T	Nesting/Migrant

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County
						USFWS[1]	TPWD[1]	
Brown Pelican	*Pelecanus occidentalis*	0	1	0	Coastal inlands for nesting, shallow gulf and bays for foraging	DL	---	Nesting/Migrant
Eskimo Curlew	*Numenius borealis*	0	3	0	Grasslands, pastures. Thought to be extinct.	LE	E	Historic Migrant
Henslow's Sparrow	*Ammodramus henslowii*	1	1	1	Weedy fields, cut over areas; bare ground for running and walking	---	---	Nesting/Migrant
Interior Least Tern	*Sterna antillarum athalassos*	1	3	3	Inland river sandbars for nesting and shallow water for foraging	LE	E	Nesting/Migrant
Mountain Plover	*Charadrius montanus*	1	1	1	Non-breeding-shortgrass plains and fields, plowed fields and sandy deserts	---	---	Nesting/Migrant
Northern Aplomado Falcon	*Falco femoralis septentrionalis*	0	3	0	Found in open country, especially savanna and open woodland.	LE	E	Resident
Piping Plover	*Charadrius melodus*	0	2	0	Beaches and flats of Coastal Texas	LT	T	Migrant
Reddish Egret	*Egretta rufescens*	0	2	0	Coastal inlands for nesting, coastal marshes for foraging	---	T	Migrant
Snowy Plover	*Charadrius alexandrinus*	0	1	0	Wintering Migrant on mud flats.	---	---	Migrant
BIRDS								
Sooty Tern	*Sterna fuscata*	1	2	2	Catches small fish.	---	T	Migrant
Southeastern Snowy Plover	*Charadrius alexandrines tenuirostris*	0	1	0	Wintering migrant along the Texas Gulf Coast.	---	---	Migrant
Sprague's Pipit	*Anthus spragueii*	0	1	0	Texas migrant mid Sept. to early April. Strongly tied to native upland prairie.	C	---	Migrant
Western Burrowing Owl	*Athene cunicularia hypugaea*	1	1	1	Open grasslands, especially prairie, plains and savanna	---	---	Resident
Western Snowy Plover	*Charadrius alexandrines nivosus*	0	1	0	Uncommon breeder in the Panhandle, potential migrant that winters along the coast.	---	---	Resident
White-faced Ibis	*Plegadis chihi*	0	2	0	Prefers freshwater marshes.	---	T	Resident
White-tailed Hawk	*Buteo albicaudatus*	1	2	2	Coastal prairies, savannahs and marshes in Gulf coastal plain	---	T	Nesting/Migrant
Whooping Crane	*Grus americana*	1	3	3	Potential migrant	LE	E	Migrant

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County
						USFWS[1]	TPWD[1]	
Wood Stork	*Mycteria americana*	0	2	0	Forages in prairie ponds, ditches, and shallow standing water formerly nested in TX	---	T	Migrant
INSECTS								
Manfreda giant-skipper	*Stallingsia maculosus*	1	1	1	Small butterfly which hold their front and hind wings at different angles.	---	---	Resident
Texas Asaphomyian Tabanid Fly	*Asaphomyia texanus*	1	1	1	Found near slow-moving water, eggs laid on objects near water; larvae are aquatic, adults prefer shady areas; feed on nectar and pollen	---	---	Resident
FISHES								
American Eel	*Anguilla rostrata*	1	1	1	Moist aquatic habitats.	---	---	Resident
Opossum Pipefish	*Microphis brachyurus*	1	2	2	Brooding adults found in fresh or low salinity waters.	---	T	Resident
Smalltooth sawfish	*Pristis pectinata*	1	3	3	Found in bays, estuaries or river mouths.	LE	E	Resident
MAMMALS								
Black Bear	*Usus americanus*	0	2	0	Mountains, broken country, woods, brushlands, forests	T/SA; NL	T	Resident
Cave Myotis Bat	*Myotis velifer*	0	1	0	Roosts colonially in caves.	---	---	Resident
Jaguarundi	*Herpailurus yagouaroundi*	1	3	0	South Texas thick brushlands, favors areas near water	LE	E	Resident
Louisiana Black Bear	*Ursus americanus luteolus*	0	2	0	Within historical range.	LT	T	Historic Resident
Ocelot	*Felis pardalis*	1	3	3	Dense chaparral thickets; mesquite-thorn scrub and live oak mottes	LE	E	Resident
Plains Spotted Skunk	*Spilogale putorius interrupta*	1	1	1	Prefers wooded, brushy areas and tallgrass prairie, fields, prairies, croplands, fence rows, forest edges	---	---	Resident
Red Wolf	*Canis rufus*	0	3	0	Extirpated.	LE	E	Historic Resident
West Indian manatee	*Trichechus manatus*	0	3	0	Gulf and bay systems.	LE	E	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County
						USFWS[1]	TPWD[1]	
White-nosed coati	*Nasua narica*	1	2	2	Found in woodlands, riparian corridors and canyons. Mostly transients from Mexico.	---	T	Resident
MOLLUSKS								
Creeper (squawfoot)	*Stophitus undulates*	0	1	0	Found in small to large streams. Prefers gravel or gravel and mud in flowing water. Colorado, Guadalupe, San Antonio, Neches (historic), and Trinity (historic) River basins.	---	---	Resident
False spike mussel	*Quincuncina mitchelli*	0	2	0	Substrates of cobble and mud with water lilies present. Rio Grande, Brazos, Colorado and Guadalupe river basins.	---	T	Resident
Golden orb	*Quadrula aurea*	0	2	0	Sand and gravel, Guadalupe, San Antonio, and Nueces River basins	C	T	Resident
Texas pimpleback	*Quadrula petrina*	0	2	0	Mud, gravel and sand substrates, Colorado and Guadalupe river basins	C	T	Resident
PLANTS								
Big Red Sage	*Salvia penstemonoides*	1	1	1	Moist Creek and stream bed edges; historic; introduced in native plant nursery trade	---	---	Resident
Black Lace Cactus	*Echinocereus reichenbachii var. albertii*	1	3	3	Grasslands, thorn shrublands, mesquite woodlands on sandy, somewhat saline soils on coastal prairie	LE	E	Resident
Bristle nailwort	*Paronychia setacea*	1	1	1	Occurs in eastern south central Texas in sandy soils.	---	---	
Coastal Gay Feather	*Liatris bracteata*	2	1	2	Black clay soils of midgrass grasslands on coastal prairie remnants.	---	---	Resident
Elmendorf's Onion	*Allium elmendorfii*	1	1	1	Endemic; deep sands derived from Queen City and similar Eocene formations	---	---	Resident
Green beebalm	*Monarda viridissima*	0	1	0	Endemic species found in deep well-drained sandy soils in openings of post oak woodlands.	---	---	

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County
						USFWS[1]	TPWD[1]	
Parks' Jointweed	*Polygonella parksii*	1	1	1	South Texas Plains; subherbaceous annual in deep loose sands, spring-summer	---	---	Resident
Plains Gumweed	*Grindelia oolepsis*	1	1	1	Early successional patches in coastal prairie on heavy clay soils, sometimes in disturbed habitats in urban areas	---	---	Resident
Refugio rain-lily	*Zephyanthes refugiensis*	0	1	0	Occurs on deep heavy black clay soils or sandy loams underlain by the Lissie Formation.	---	---	Resident
Runyon's Water Willow	*Justicia runyonii*	0	1	0	Openings in subtropical woodlands.	---	---	Resident
Shinner's sunflower	*Helianthus occidentalis* ssp. *Plantagineus*	2	1	2	Found on prairies on the Coastal Plain	---	---	Resident
Tharp's rhododon	*Rhododon angulatus*	0	1	0	Deep, sandy soils in dunes.	---	---	Resident
Threeflower broomweed	*Thurovia triflora*	1	1	1	Endemic, black clay soils.	---	---	Resident
Welder Machaeranthera	*Psilactis heterocarpa*	2	1	2	Coastal prairie; Shrub-infested grasslands and open mesquite-huisache woodlands	---	---	Resident
REPTILES								
Atlantic Hawksbill Sea turtle	*Eretmochelys imbricata*	1	3	3	Gulf and bay system.	LE	E	Migrant
Green Sea Turtle	*Chelonia mydat*	1	2	2	Gulf and bay system.	LT	T	Migrant
Gulf Saltmarsh Snake	*Nerodia clarkii*	1	1	1	Brackish to saline coastal waters	---	---	Resident
Kemp's Ridley Sea Turtle	*Lepidochelys kempii*	1	3	3	Gulf and bay system.	LE	E	Migrant
Leatherback Sea Turtle	*Dermochelys coriacea*	1	3	3	Gulf and bay system.	LE	E	Migrant
Loggerhead Sea Turtle	*Caretta caretta*	1	2	2	Gulf and bay system.	LT	T	Migrant
Spot-Tailed Earless Lizard	*Holbrookia lacerata*	1	1	1	Central & southern Texas; oak-juniper woodlands and mesquite-prickly pear	---	---	Resident
Texas Diamondback Terrapin	*Malaclemys terrapin littoralis*	0	1	0	Bays, coastal marshes of the upper two-thirds of Texas Coast	---	---	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County
						USFWS[1]	TPWD[1]	
Texas Horned Lizard	*Phrynosoma cornutum*	1	2	2	Varied, sparsely vegetated uplands, grass, cactus, brush	---	T	Resident
Texas indigo snake	*Drymarchon melanurus erebennus*	1	2	2	Found in Texas south of the Guadalupe river and Balcones Escarpment in thornbush-chaparral woodlands.	---	T	
Texas scarlet snake	*Cemophora coccinea lineri*	1	2	2	Mixed hardwood scrub on sandy soils.	---	T	Resident
Texas Tortoise	*Gopherus berlandieri*	1	2	2	Open brush w/ grass understory; open grass/bare ground avoided; occupies shallow depressions at base of bush or cactus, underground burrows, under objects; active March through November	---	T	Resident
Timber Rattlesnake	*Crotalus horridus*	1	2	2	Floodplains, upland pine, deciduous woodlands, riparian zones, abandoned farms, dense ground cover	---	T	Resident

[1] Source: TPWD, Annotated County List of Rare Species, Wilson 8/7/2012, Karnes 10/10/2011, Goliad 4/28/2014, Refugio 12/11/2014, and Calhoun 12/11/2014 Counties.

LE/LT=Federally Listed Endangered/Threatened

E/SA, T/SA=Federally Listed Endangered/Threatened by Similarity of Appearance

C=Federal Candidate for Listing

DL, PDL=Federally Delisted/Proposed for Delisting

E, T=State Listed Endangered/Threatened

Blank = Rare, but no regulatory listing status

Table 5.2.22-3 Previously Recorded Sites within 1-mile Corridor of the Proposed Seawater Desalination Project Area

Sites	41CL1
	41CL10
	41CL13
	41CL70
	41CL73
	41WN66

5.2.22.4 Engineering and Costing

This water management strategy provides for a major desalination water treatment plant on the Texas coast and the infrastructure for transferring potable water from the coast to existing distribution facilities for SAWS. The entire strategy consists of the intake, water treatment plant, storage tanks, pumping stations and a 126-mile pipeline. The water treatment plant component includes pretreatment necessary to ensure normal life and efficiency of the reverse osmosis membranes and post-treatment for disinfection and distribution system corrosion scale stability.

Desalination treatment cost estimates are based on recent similar desalination treatment plant construction experience and feasibility studies. This approach takes advantage of the development of membrane technology and the resulting reduction in capital and operating costs in comparison to previously available technology. During the past 15 years, the price and operating costs of membranes have declined due to improvements in materials and manufacturing. This contrasts with recent experience with conventional water treatment technology (i.e., costs for conventional water treatment technologies have not been influenced greatly by equipment innovations).

The basic assumptions made to determine the size and characteristics of the components of this seawater desalination strategy are listed in Table 5.2.22-5. A 126-mile pipeline route from the desalination plant adjacent to San Antonio Bay near Seadrift to south Bexar County was assumed. The pumping capacities are equal to the nominal plant capacities, except for the raw water intake, which includes the full raw water quantity that is separated into desalinated finished water and concentrate in the plant. A conveyance line to carry the concentrate offshore is also included in the costs. A concentrate pump station is not included because it is assumed that the residual pressure from the desalination process is utilized to convey the concentrate offshore.

Table 5.2.22-4 Engineering Assumptions for Seawater Desalination

Parameter	***Assumption***	***Description***
Raw water TDS	25,000 mg/L	Intake located near Seadrift
Finished water chlorides	100 mg/L	
Treatment capacities	75 MGD	
Concentrate Pipeline Length	23 miles total (10 miles on land, 13 miles submerged)	Diffused in open Gulf
RO Recovery Rate	60 percent	
Power cost	$0.09 per kWh	Assume interruptible power
Transmission Pipeline dia.	66”	
Booster storage	3.75 MGD	More than 1 hour storage to avoid in-line pumps
Number of booster stations	2	

The treatment and delivery components and respective sizes are summarized in Table 5.2.22-6. The concentrate capacities are based on a recovery rate of 60 percent. This means that of the 100 percent of flow taken from San Antonio Bay at the plant intake, 60 percent is desalinated and 40 percent is returned to the Gulf as concentrate via a route approximately 23 miles long from the plant location through the barrier island. A recovery rate of 60 percent is assumed because the TDS of raw water from the bay is significantly less than pure seawater that is generally around 35,000 mg/l of TDS.

The estimated costs to desalt 75 MGD of seawater is $2,713 per acft (Table 5.2.22-7). The treatment costs include the water treatment plant are for a desalination plant that requires no additional post treatment, a raw water intake, and concentrate discharge to the open Gulf. The pretreatment portion of the plant is essentially a full conventional surface water plant to remove solids from the raw water prior to the RO desalination process. There is some economy of scale in the treatment process with larger processes in the pretreatment and RO desalination components. Also, there are greater economies of scale for components such as the intake and concentrate pump stations and pipelines.

Table 5.2.22-5 Capacities for Seawater Desalination Plant

Item/Facility	***75 MGD***
Intake Pump Station (MGD)	125
Intake Pipeline Diameter (inches)	84
Desalination Water Treatment Plants	
Plant Intake (seawater) (MGD)	125
Desalted Product Water (drinking water) (MGD)	75
Concentrate Discharge (MGD)	50
Concentrate Discharge Pipeline Diameter (inches)	54
Desalted Product Water (MGD)	75
Pump Station at Plant and Each Booster Station (gpm)	52,083
Finished Water Pipeline Diameter (inches)	66
Storage at Booster Pump Stations (MG, each)	3.75

For a conservative cost estimating purposes the salinity of the raw water drawn from San Antonio Bay near Seadrift was assumed to consistently be 25,000 mg/L of total dissolved solids, which is on the upper end of historically observed salinity in this area of the bay. One study of salinity during the period 1968 to 1987 reported mean salinity of 5,640 mg/L in San Antonio Bay near Seadrift[5]. To provide firm yield of desalinated bay water, the desalination facilities should be constructed for the maximum anticipated salinity of 25,000 mg/L. Therefore, the capital costs would not decrease with lower mean salinity. However, if the mean salinity of the raw water delivered to the desalination plant is much less than the maximum, then the operations and maintenance costs may be significantly less than the costs shown in Table 5.2.22-7. The primary cost savings for desalinating lower salinity water is the decrease in electrical power required due to an increase in the RO recovery rate and a decrease in the required pumping pressure to pass the desalinated water through the RO membranes.

[5] Longley, W.L., ed. “Freshwater inflows to Texas bays and estuaries: ecological relationships and methods for determination of needs”, TWDB and TPWD, 1994.

Table 5.2.22-6 Cost Estimate Summary

Item	***Estimated Costs for Facilities***
Intake Pump Stations (75 MGD)	$17,598,000
Transmission Pipeline (66 in dia., 149 miles)	$328,448,000
Concentration Disposal Pipeline (54 in dia., 13 miles)	$81,299,000
Transmission Pump Station(s) & Storage Tank(s)	$30,221,000
FALSE	$520,364,000
Distribution Improvements	$91,834,000
TOTAL COST OF FACILITIES	**$1,069,764,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$353,930,000
Environmental & Archaeology Studies and Mitigation	$9,656,000
Land Acquisition and Surveying (1584 acres)	$6,097,000
Interest During Construction (4% for 3 years with a 1% ROI)	$151,143,000
TOTAL COST OF PROJECT	**$1,590,590,000**
ANNUAL COST	
Debt Service (5.5 percent, 20 years)	$133,100,000
Operation and Maintenance	
Intake, Pipeline, Pump Station (1% of Cost of Facilities)	$5,293,000
Water Treatment Plant (2.5% of Cost of Facilities)	$76,213,000
Pumping Energy Costs (148260246 kW-hr @ 0.09 $/kW-hr)	$13,343,000
Purchase of Water (acft/yr @ $/acft)	$0
TOTAL ANNUAL COST	**$227,949,000**
Available Project Yield (acft/yr)	84,012
Annual Cost of Water ($ per acft)	$2,713
Annual Cost of Water ($ per 1,000 gallons)	$8.33
Conveyance Only	
Total Annual Cost	**$79,562,695**
Available Project Yield (Acft/yr)	$84,012
Annual Cost of Water ($ per acft)	$947
Annual Cost of Water ($ per 1,000 gallons)	$2.91
Treatment Only	
Total Annual Cost	**$148,386,305**
Available Project Yield (Acft/yr)	$84,012
Annual Cost of Water ($ per acft)	$1,766
Annual Cost of Water ($ per 1,000 gallons)	$5.42

5.2.22.5 Implementation Issues

Implementation of this water management strategy requires overcoming several financial, environmental, and technological impediments. The capital cost is likely to be a somewhat serious limitation. The cost estimate shows that while the treatment cost, based on recent Tampa experience and other feasibility studies for a planned 25 MGD desalination facility may be competitive, transferring water from the coast makes the total cost quite high in relation to other water management strategies.

There are several environmental issues that must be considered. The first is the location of the intake in San Antonio Bay. It will be an advantage to take slightly lower salinity water, similar to Tampa, rather than Gulf water. However, to accomplish this means that dilution with freshwater from the San Antonio and Guadalupe Rivers is necessary. Studies will need to be performed to ensure that the removal of the somewhat diluted bay water causes no harmful effects on plant and animal life in San Antonio Bay. Another issue with the desalt plant is the disposal of the concentrate created from the desalination process. Disposal would have to occur at a location and in a manner that also did not disrupt plant or animal life in the Bay or in the Gulf. A further complication is the permitting of a 126-mile pipeline across rivers, highways, and private rural and urban property.

Technological issues include: (1) confirming that desalination as proposed with membranes is the appropriate technology; (2) confirming that blending desalted seawater with the other water sources in the municipal demand distribution system can be successfully accomplished; and (3) obtaining an adequate source of electric power to drive the desalination process using membranes.

Substantial verification of technology would need to be accomplished prior to building this project. Blending differing treated waters is critical for the wellbeing of the customers and the distribution system. The characteristics of the desalted water are likely to be dramatically different from other drinking water in the major municipal demand center of the South Central Texas Region. Considerable investigation would be needed to determine if additional conditioning of the desalinated seawater would be required to make the new water source compatible with existing distribution systems. Conditioning of the desalinated seawater may include addition of alkalinity and hardness to bring the corrosion chemistry closer to existing water sources.

Finally, in spite of recent improvements in membrane technology, desalting seawater will require large amounts of electric power. Normally, this need is met by locating desalination plants near power plants. Future costs of electric power, however, are highly uncertain and represent a very significant component of annual operating costs for this strategy.

Requirements Specific to Water Rights

1. It will be necessary to obtain these permits:
    a. TCEQ Water Right permit.
    b. GLO Sand and Gravel Removal permits.
    c. GLO Easement for use of state-owned land.

   d. Coastal Coordination Council review.
   e. TPWD Sand, Gravel, and Marl permit.
2. Permitting, at a minimum, will require these studies:
   a. Assessment of changes in instream flows and freshwater inflows to bays and estuaries.
   b. Habitat mitigation plan.
   c. Environmental studies.
   d. Cultural resources.
3. Other Considerations:
   a. Water compatibility testing, including biological and chemical characteristics will need to be performed.

Requirements Specific to Pipelines

1. Necessary permits:
   a. USACE Sections 10 and 404 dredge and fill permits for stream crossings.
   b. GLO Sand and Gravel Removal permits.
   c. 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
4. Other utilities

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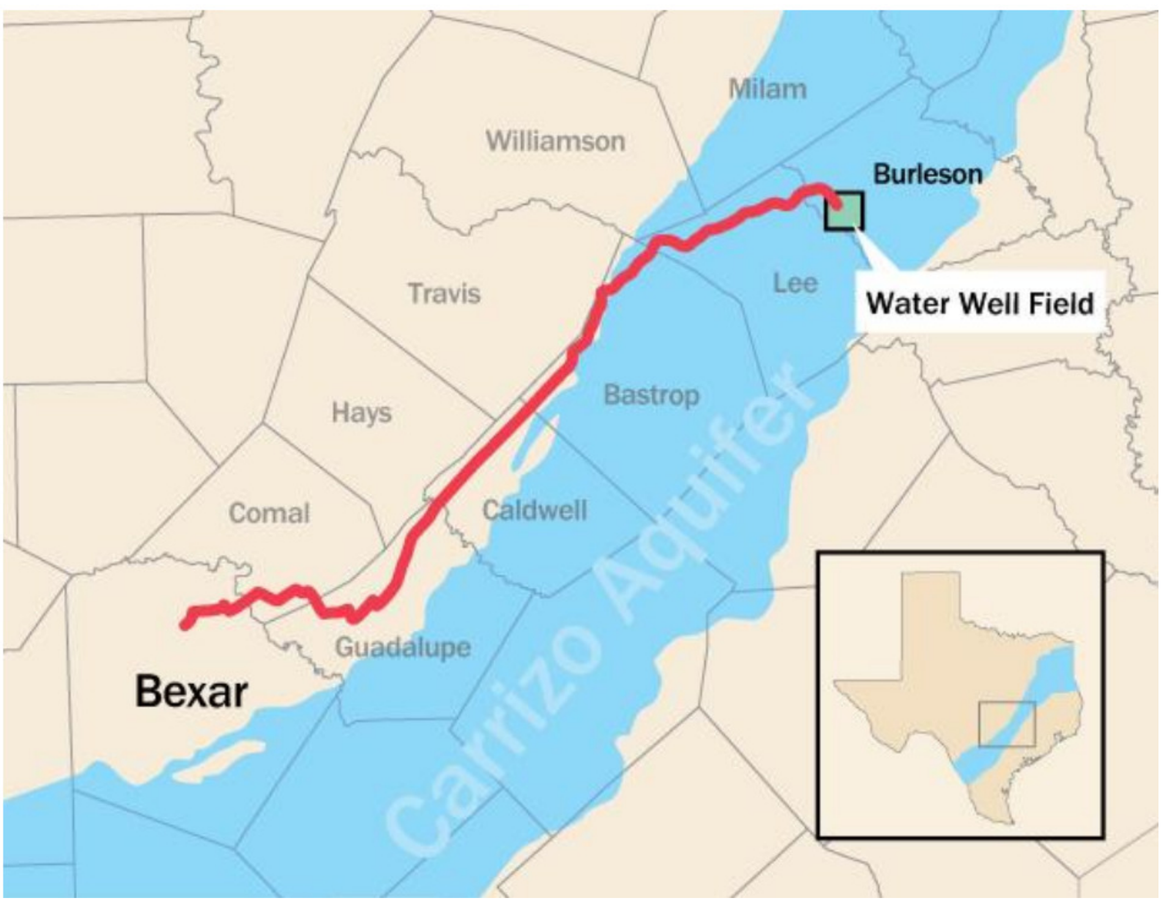
5.2.23 SAWS Vista Ridge Project

5.2.23.1 Description of Water Management Strategy

The San Antonio Water System (SAWS) has contracted with Abengoa Vista Ridge, LLC (AVR) for up to 50,000 acft/yr of groundwater supply from Burleson County, Texas. Vista Ridge holds permits from the Post Oak Savannah Groundwater Conservation District (GCD) for up to 50,993 acft/yr in the Carrizo–Wilcox Aquifer in Burleson County. The project includes a well field, collection system, treatment, and 143 miles of 54-inch and 60-inch transmission facilities, and will deliver water to northern Bexar County for eventual delivery to the SAWS distribution system. The Central Texas Regional Water Supply Corporation (CTR) will provide for easement and permit acquisition, design, construction, and operation of the system. Figure 5.2.23-1 shows the well field location and the proposed pipeline route. In addition, SAWS will be upgrading their integration facilities to accommodate the new water. Costs associated with this integration are not included in this water management strategy, but information can be found in Facilities Expansions.

Figure 5.2.23-1 Vista Ridge Project Location



5.2.23.2 Water Availability

AVR holds permits from the Post Oak Savannah GCD for 50,993 acft/yr of groundwater out of the Carrizo-Wilcox Aquifer in Burleson County. SAWS has contracted for 50,000 acft/yr. The Modeled Available Groundwater (MAG) for the Carrizo-Wilcox Aquifer in Burleson County is limited to 23,249 acft/yr in 2020, growing to 38,701 acft/yr by 2070. Local existing supplies from the are estimated to total 3,807 acft/yr. When accounting for existing supplies, there remains between 19,442 acft/yr (2020) and 34,894 acft/yr (2070) available for new water management strategies. Table 5.2.23-1 illustrates these calculations by decade.

Table 5.2.23-1. Carrizo/Simsboro Aquifer in Burleson County

	2020	2030	2040	2050	2060	2070
Modeled Available Groundwater	**23,249**	**28,047**	**32,518**	**36,492**	**38,701**	**38,701**
Existing Supplies						
Caldwell	2,352	2,352	2,352	2,352	2,352	2,352
Deanville WSC	701	701	701	701	701	701
Milano WSC	0	0	0	0	0	0
Southwest Milam WSC	0	0	0	0	0	0
Burleson County - Other	550	550	550	550	550	550
Burleson County - Irrigation	204	204	204	204	204	204
Existing Supplies (Total)	**3,807**	**3,807**	**3,807**	**3,807**	**3,807**	**3,807**
Remaining for WMSs	**19,442**	**24,240**	**28,711**	**32,685**	**34,894**	**34,894**

The envisioned project size of 50,000 acft/yr of groundwater exceeds the remaining amount of water under the MAG for the Carrizo-Wilcox Aquifer in Burleson County in every decade. Region G (which includes Burleson County) recognizes Vista Ridge's groundwater permits and contract with SAWS. For regional water planning purposes, the remaining amount of water available under the MAG in Burleson County can be utilized by the SAWS Vista Ridge Project. Accordingly, the MAG-Limited (and recommended) size for the Vista Ridge Project is 19,442 acft/yr in 2020, growing to 34,894 acft/yr by 2070.

5.2.23.3 Environmental Issues

Environmental issues for the proposed SAWS Vista Ridge Project which includes portions of Bexar, Bastrop, Burleson, Guadalupe and Lee counties are described below. This project includes the construction of intake pump stations, a 143 mile transmission pipeline, transmission pump station and storage tank, water treatment plant, and well field including pumps, wells and piping. Implementation of this project would require field surveys by qualified professionals to document vegetation/habitat types, waters of the U.S. including wetlands and cultural resources that may be impacted. Where impacts to protected species habitat or significant cultural resources cannot be avoided, additional studies would be necessary to evaluate habitat use and/or value, or eligibility for inclusion in the National Register of Historic Places, respectively. Compensation would be required for unavoidable adverse impacts involving net losses of wetlands.

This water management strategy would obtain groundwater from a well field in Burleson County and transport it to Bexar County through a transmission pipeline. The pipeline traverses from west to east through portions of the Edwards Plateau, Blackland Prairie and Post Oak Savannah ecoregions.[1] The project is located primarily within the Texan biotic province, with a small western portion occurring within the Balconian biotic province and a minor section of the transmission pipeline within the Tamaulipan biotic province to the south.[2] Vegetation within the project area is dominated by a mosaic of vegetation types including, Live Oak-Ashe Juniper-Parks, Live Oak-Mesquite-Ashe Juniper Parks, Post Oak Woods, Forest and Grassland Mosaic, and Post Oak Woods Forest to the east with cropland and urban areas occurring along the western portion of the proposed pipeline.[3]

The majority of terrestrial habitat disruption will result from the transmission pipeline construction. Although a portion of this pipeline as designed will utilize existing right-of-way areas along roadways, the majority of the construction area will be through relatively undeveloped areas. The well field, water treatment plant and pump stations along with storage tanks are anticipated to have minimal impact to existing terrestrial habitat. Herbaceous habitats would recover quickly from the impacts caused by construction with the exception of any required maintained right-of-way. However any impacts to woody vegetation resulting from the construction of pipelines and other project accoutrements would be permanent due to required maintenance.

The proposed pipeline would cross the San Marcos, Colorado and Guadalupe Rivers along with numerous creeks and tributaries. Coordination with the U.S. Army Corps of Engineers would be required for construction within waters of the U.S. Impacts from this proposed project resulting in a loss of less than 0.5 acres of waters of the U.S. could be covered under Nationwide Permit #12 for Utility Line Activities. Impacts to aquatic species would be minimized by utilizing best management practices and drilling under larger waterways to install pipelines.

The Texas Parks & Wildlife Department (TPWD) has identified a number of stream segments throughout the state as ecologically significant on the basis of biological function, hydrologic function, riparian conservation, exceptional aquatic life uses, and/or threatened or endangered species. Currently, 21 stream segments in Region L are considered ecologically significant by the TPWD.[4] The transmission pipeline crosses two ecologically significant stream segments, the San Marcos River and Geronimo Creek.

The project area occurs within an area of karst found in northern Bexar County which includes a number of listed cave species. In addition the transmission pipeline route as currently planned is situated over the recharge zone of the Edwards Aquifer. This sensitive aquatic zone provides habitat for several listed aquatic species.

The species listed by USFWS, and TPWD, as endangered or threatened with potential habitat in the project counties are listed in Table 5.2.23-2. Information provided by the Texas Natural Diversity Database, maintained by TPWD, which documents the occurrence of rare species within the state, was included in this analysis. This data

[1] Gould, F.W. 1975. The Grasses of Texas. Texas A&M University Press. College Station, Texas.
[2] Blair, W.F., "The Biotic Provinces of Texas, "Tex. J. Sci. 2:93-117, 1950.
[3] McMahan, C. A., R. G. Frye and K. L. Brown, " The Vegetation Types of Texas -- Including Cropland," Texas Parks and Wildlife Department – PWD Bulletin 7000-120. 1984.
[4] TPWD, "Ecologically Significant River and Stream Segments," http://www.tpwd.state.tx.us/landwater/water/environconcerns/water_quality/sigsegs/index.phtml accessed February 6, 2014.

showed documented occurrences of a ground beetle, *Rhadine exilis*, which is federally listed as endangered, and the Cascade Caverns salamander a state threatened species, within one mile of the transmission pipeline route. In addition there are documented occurrences of species of concern including the bracted twistflower, hill country wild mercury, mountain plover and Texas salamander within the same area.. Coordination with TPWD and USFWS regarding threatened and endangered species with potential to occur in the project area should be initiated early in project planning.

Table 5.2.23-2 Endangered, Threatened, and Species of Concern for Bastrop, Bexar, Burleson, Caldwell, Guadalupe, and Lee Counties

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
AMPHIBIANS								
Cascade Caverns salamander	*Eurycea latitans complex*	1	2	2	Endemic, subaquatic in Edwards Aquifer	--	T	Resident
Comal blind salamander	*Eurycea tridentifera*	0	3	0	Endemic and semi-troglobitic, found in springs and waters of caves.	--	T	Resident
Houston toad	*Anaxyrus houstonensis*	1	3	3	Endemic species found in sandy substrates, water in pools or stock tanks.	LE	E	Resident
Southern crawfish frog	*Lithobates areolatus areolatus*	0	1	0	Found in abandoned crawfish holes and small mammal burrows.	--	--	Resident
Texas salamander	*Eurycea notenes*	1	1	1	Endemic; troglobitic, found in springs, caves and creek headwaters restricted to Helotes and Leon Creek drainages.	--	--	Resident
ARACHNIDS								
Bracken Bat Cave meshweaver	*Cicurina venii*	0	3	0	Small eyeless spider, found in Karst features in western Bexar County.	LE	--	Resident
Cokendolpher cave harvestman	*Texella cokendolpheri*	1	3	3	Small, eyeless spider found in karst features I north and northwest Bexar County.	LE	--	Resident
Government Canyon Bat Cave	*Cicurina vespera*	1	3	3	Small eyeless spider in karst features in north	LE	--	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
meshweaver					and Northwest Bexar county.			
Government Canyon Bat Cave spider	*Neoleptoneta microps*	1	3	3	Small eyeless spider in karst features in north and Northwest Bexar county.	LE	--	Resident
Madla Cave meshweaver	*Cicurina madla*	1	3	3	Small eyeless spider in karst features in north and Northwest Bexar county.	LE	--	Resident
Robber Baron Cave meshweaver	*Cicurina baronia*	1	3	3	Small eyeless spider in karst features in north and Northwest Bexar county.	LE	--	Resident
BIRDS								
American peregrine falcon	*Falco peregrinus anatum*	0	3	0	Migrant and local breeder in West Texas.	DL	T	Possible Migrant
Artic peregrine falcon	*Falco peregrinus tundrius*	0	2	0	Migrant throughout the state.	DL	--	Possible Migrant
Bald eagle	*Haliaeetus leucocephalus*	0	2	0	Primarily found near rivers and large lakes.	DL	T	Possible Migrant
Black-capped vireo	*Vireo atricapillus*	1	3	3	Semi-open broad-leaved shrublands	LE	E	Nesting/ Migrant
Golden-cheeked warbler	*Setophaga chrysoparia*	1	3	3	Woodlands with oaks and old juniper.	LE	E	Nesting/ Migrant
Henslow’s sparrow	*Ammodramus henslowii*	0	1	0	Wintering individuals found in weedy fields or cut-over areas. Key component is bare ground.	--	--	Possible Migrant
Interior least tern	*Sterna antillarum athalassos*	0	3	0	Nests along sand and gravel bars in braided streams	LE	E	Possible Migrant
Mountain plover	*Charadrius montanus*	2	1	2	Non-breeding, shortgrass plains and fields	--	--	Possible Migrant
Piping plover	*Charadrius melodus*	0	2	0	Small shorebird, migrant.	T	--	Possible Migrant
Sprague’s pipit	*Anthus spragueii*	0	1	0	Migrant in Texas in winter mid Sept. to early April. Strongly tied to native upland prairie.	C	--	Possible Migrant

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
Western burrowing owl	*Athene cunicularia hypugaea*	0	1	0	Open grasslands, especially prairie, plains and savanna	--	--	Resident
White-faced ibis	*Plegadis chihi*	0	2	0	Prefers freshwater marshes.	--	T	Potential Migrant
Whooping crane	Grus americana	0	3	0	Potential migrant	LE	E	Potential Migrant
Wood stork	*Mycteria americana*	0	2	0	Forages in prairie ponds, ditches, and shallow standing water formerly nested in TX	--	T	Migrant
Zone-tailed hawk	*Buteo albonotatus*	0	2	0	Arid, open country including deciduous or pine-oak woodland.	--	T	Nesting/ migrant
CRUSTACEANS								
A cave obligate crustacean	*Monodella Texana*	1	2	2	Subaquatic, subterranean obligate found in underground freshwater aquifers.	--	--	Resident
A crayfish	*Procambarus texanus*	0	1	0	Found in ponds.	--	--	Resident
FISHES								
Blue sucker	*Cycleptus elongatus*	0	2	0	Major rivers in Texas.	--	T	Resident
Guadalupe bass	*Micropterus treculi*	1	1	1	Endemic to perennial streams of the Edwards Plateau region.	--	--	Resident
Guadalupe darter	*Percina sciera apristis*	0	1	0	Guadalupe River Basin. Usually found over gravel or gravel and sand raceways of larger streams and rivers.	--	--	Resident
Sharpnose shiner	*Notropis oxyrhynchus*	0	3	0	Endemic species to Brazos River drainage.	E	--	Resident
Smalleye shiner	*Notropis buccula*	0	3	0	Endemic to upper Brazos River system and its tributaries.	E	--	Resident
Toothless blindcat	*Trogloglanis pattersoni*	1	2	2	Troglobitic; blind catfish endemic to the San	--	T	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
					Antonio pool of the Edwards Aquifer.			
Widemouth blindcat	*Satan eurystomus*	1	2	2	Troglobitic, blind catfish endemic to the San Antonio pool of the Edwards Aquifer.	--	T	Resident
INSECTS								
A mayfly	*Campsurus decolaratus*	0	1	0	In Texas and Mexico, possibly clay substrates, found in shoreline vegetation.	--	--	Potential Resident
A ground beetle	*Rhadine exilis*	2	3	6	Eyeless beetle found in karst features in northern Bexar county.	LE	--	Resident
A ground beetle	*Rhadine infernalis*	1	3	3	Small eyeless ground beetle found in karst features in northern and western Bexar County.	LE	--	Resident
Helotes mold beetle	*Bastrisodes venyivi*	1	3	3	Small, essentially eyeless mold beetle found in karst features in north and northwest Bexar County.	LE	--	Resident
Manfreda giant-skipper	*Stallingsia maculosus*	0	1	0	Larvae feed inside leaf shelter and pupae found in cocoon made of leaves fastened by silk.	--	--	Resident
Rawson's metalmark	*Calephelis rawsoni*	0	1	0	Moist areas in shaded limestone outcrops.	--	--	Resident
MAMMALS								
Black bear	*Ursus americanus*	0	2	0	Mountains, broken county in brushlands and forests.	T/SA; NL	T	Resident
Cave myotis bat	*Myotis velifer*	0	1	0	Roosts colonially in caves, rock crevices	--	--	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
Elliot's short-tailed shrew	*Blarina hylophaga hylophaga*	0	1	0	Found In sandy areas in live oak mottes, and grassy areas.	--	--	Resident
Ghost-faced bat	*Mormoops megalophylla*	0	1	0	Roosts in caves, crevices and buildings.	--	--	Resident
Gray wolf	*Canis lupus*	0	3	0	Extirpated.	LE	E	Extinct
Louisiana black bear	*Ursus americanus luteolus*	0	2	0	Possible as transient, found in bottomland hardwoods and large tracts of inaccessible forested areas.	LT	T	Possible transient
Plains spotted skunk	*Spilogale putorius interrupta*	1	1	1	Prefers wooded, brushy areas.	--	--	Resident
Red wolf	*Canis rufus*	0	3	0	Extirpated.	LE	E	Historic Resident
MOLLUSKS								
Creeper (squawfoot)	*Strophitus undulates*	0	1	0	Small to large streams. Colorado, Guadalupe, and San Antonio River basins.	--	--	Resident
False spike mussel	*Quincuncina mitchelli*	0	2	0	Substrates of cobble and mud. Rio Grande, Brazos, Colorado and Guadalupe river basins.	--	T	Resident
Golden orb	*Quadrula aurea*	0	2	0	Sand and gravel, Guadalupe, San Antonio, Lower San Marcos, and Nueces River basins	C	T	Resident
Mimic cavesnail	*Phreatodrobia imitata*	0	1	0	Subaquatic found in wells in Edwards Aquifer.	--	--	Resident
Smooth pimpleback	*Quadrula houstonensis*	0	2	0	Found in small to moderate streams and rivers and smaller reservoirs.	C	T	Resident
Texas fatmucket	*Lampsilis bracteata*	0	2	0	Streams and rivers on sand, mud and gravel, Colorado and Guadalupe River basins.	C	T	Resident
Texas fawnsfoot	*Truncilla macrodon*	0	2	0	Little known species possibly found in rivers	C	T	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
					and larger streams. intolerant of impoundment.			
Texas pimpleback	*Quadrula petrina*	0	2	0	Mud, gravel and sand substrates, Colorado and Guadalupe river basins	C	T	Resident
PLANTS								
Big red sage	*Salvia pentstemonoides*	0	1	0	Texas endemic, found in moist to seasonally wet steep limestone outcrops on canyons or along creek banks.	--	--	Resident
Bracted twistflower	*Steptanthus bracteatus*	2	2	4	Endemic; shallow clay soils over limestone rocky slopes.	C	--	Resident
Branched gay-feather	*Liatris cymosa*	0	1	0	Texas endemic found in somewhat barren grassland openings in post oak woodlands.	--	--	Resident
Bristle nailwort	*Paronychia setacea*	0	1	0	Endemic to south central Texas in sandy soils.	--	--	Resident
Correll's false dragon-head	*Physostegia correllii*	0	1	0	Wet soils.	--	--	Resident
Elmendorf's onion	*Allium elmendorfii*	0	1	0	Endemic, in deep sands	--	--	Resident
Green beebalm	*Monarda viridissima*	0	1	0	Endemic perennial herb. Found in well-drained sandy soils in opening of post oak woodlands.	--	--	Resident
Hill country wild-mercury	*Argythamnia aphoroides*	2	1	2	Endemic; found in grasslands associated with oak woodlands.	--	--	Resident
Navasota ladies'-tresses	*Spiranthes parksii*	0	3	0	Texas endemic found in openings in post oak woodlands in sandy loams.	LE	E	Resident
Parks' jointweed	*Polygonella parksii*	0	1	0	Texas endemic, primarily found on deep, loose, sand blowouts in Post Oak	--	--	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
					Savannas.			
Sandhill woolywhite	*Hymenopappus carrizoanus*	0	1	0	Found south of the Guadalupe River. Prefers dense riparian corridors.	--	--	Resident
Shinner's sunflower	*Helianthus occidentalis ssp plantagineus.*	0	1	0	Found on prairies on the Coastal Plain.	--	--	Resident
REPTILES								
Alligator snapping turtle	*Macrochelys temminckii*	0	2	0	Found in perennial water bodies.	--	T	Resident
Cagle's map turtle	*Graptemys caglei*	1	2	2	Endemic to Guadalupe River System.	--	T	Resident
Spot-tailed earless lizard	*Holbrookia lacerata*	0	1	0	Moderately open prairie-brushland.	--	--	Resident
Texas Garter Snake	*Thamnophis sirtalis annectens*	1	1	1	Wet or moist microhabitats	--	--	Resident
Texas Horned Lizard	*Phrynosoma cornutum*	1	2	2	Varied, sparsely vegetated uplands.	--	T	Resident
Texas indigo snake	*Drymarchon melanurus erebennus*	0	2	0	Grass prairies and sand hills; woodlands of the coastal plain.	--	T	Resident
Texas Tortoise	*Gopherus berlandieri*	0	2	0	Open brush w/ grass understory.	--	T	Resident
Timber rattlesnake	*Crotalus horridus*	1	2	2	Floodplains, upland pine, deciduous woodlands, riparian zones.	--	T	Resident

LE/LT=Federally Listed Endangered/Threatened
DL=Federally Delisted
C=Candidate for Federal Listing
E, T=State Listed Endangered/Threatened
Blank = Considered rare, but no regulatory listing status

TPWD, 2015. Annotated County List of Rare Species –Bexar Co. revised 12/5/2014, Burleson County, 12/11/2014, Bastrop County 4/28/2014, Caldwell County 4/28/2014, Lee County 4/28/2014, Guadalupe County 4/28/2014.

USFWS, 2015. Endangered Species List for Texas. http://www.fws.gov/endangered/?s8fid=112761032793&s8fid=112762573903&countyName, accessed online March 3, 2015.

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 (Pl96-515), and the Archeological and Historic Preservation Act (PL93-291). Based on the review of publically available Geographic Information System (GIS) records obtained from the Texas Historical Commission, there are no State Historic Sites, National Register Properties, or National Register Districts within 0.5-mile of the project area. However a total of 6 Historical Markers and 18 cemeteries occur within 0.5-mile of the transmission pipeline or within the proposed well field.

Avoidance of these cultural resource areas should be possible by careful selection of the transmission pipeline route, WTP, and areas for well sites and their associated pipelines. A review of archaeological resources in the proposed project area should be conducted during the project planning phase. Because the owner or controller of the project will likely be a political subdivision of the State of Texas (i.e., river authority, municipality, county, etc.), they will be required to coordinate with the Texas Historical Commission prior to project construction

5.2.23.4 Engineering and Costing

Preliminary engineering and costing analyses have been performed for the Envisioned and MAG-Limited project using 2016 Regional Water Planning methods. HDR utilized the standard costing procedures and method for calculating unit costs. The costing procedures include all facilities required for water production, collection, transmission, and treatment, but do not include the cost of integration into SAWS existing distribution system. The well fields will require wells and a collector pipeline. Water treatment would require standard filtration treatment to remove of iron and manganese and to disinfect the water.

Project as Envisioned

The SAWS Vista Ridge Project as envisioned will develop 50,000 acft/yr of new supply and deliver it to northern Bexar County within the SAWS distribution system at a constant rate (peaking factor is 1.0). Facilities include a well field with 9 Simsboro wells (Middle Member of the Wilcox Group) and 9 Carrizo wells, well field collection system, 44.7 MGD of water treatment facilities, 39 miles of 54-inch transmission systems, and 104 miles of 60-inch transmission systems. Region L cost estimates for delivering treated water to SAWS is shown in Table 5.2.23-3. The total estimated project cost is $722 million. The annual costs include debt service for a 30-year loan at 5.5 percent interest and operation and maintenance costs, including power. The cost of water is estimated to be $1,976/acft/yr. Additional cost would be incurred to integrate into SAWS distribution system (see Facilities Expansions).

MAG-Limited Project

The MAG-Limited SAWS Vista Ridge Project will deliver up to 34,894 acft/yr of new supply and deliver it to northern Bexar County within the SAWS distribution system by 2060 at a constant rate. Facilities include a well field with 9 Simsboro wells, well field collection system, 32.8 MGD of water treatment facilities, and 143 miles of 48-inch transmission systems. Region L cost estimates for delivering treated water to SAWS is shown in Table 5.2.23-4. The total estimated project cost is $572 million. The annual costs include debt service for a 30-year loan at 5.5 percent interest and operation and maintenance costs, including power. The cost of water is estimated to be $2,177/acft/yr. Additional cost would be incurred to integrate into SAWS distribution system (see Facilities Expansions).

Table 5.2.23-3 SAWS Vista Ridge Project Cost Estimate – Envisioned

Item	*Estimated Costs for Facilities*
Intake Pump Stations (47 MGD)	$9,885,000
Transmission Pipeline (54 in dia., 143 miles)	$325,197,000
Transmission Pump Station(s) & Storage Tank(s)	$26,884,000
Well Fields (Wells, Pumps, and Piping)	$51,892,000
Water Treatment Plant (44.6 MGD)	$64,979,000
Other	$15,000,000
TOTAL COST OF FACILITIES	**$493,837,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$156,583,000
Environmental & Archaeology Studies and Mitigation	$4,266,000
Land Acquisition and Surveying (1782 acres)	$9,311,000
Interest During Construction (4% for 2.5 years with a 1% ROI)	$58,100,000
TOTAL COST OF PROJECT	**$722,097,000**
ANNUAL COST	
Debt Service (5.5 percent, 20 years)	$60,425,000
Operation and Maintenance	
Intake, Pipeline, Pump Station (1% of Cost of Facilities)	$4,600,000
Water Treatment Plant (2.5% of Cost of Facilities)	$12,996,000
Pumping Energy Costs (156,691,400 kW-hr @ 0.09 $/kW-hr)	$14,102,000
Purchase of Water (50,000 acft/yr @ 125 $/acft)	$6,675,000
TOTAL ANNUAL COST	**$98,798,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 1	50,000
Annual Cost of Water ($ per acft)	$1,976
Annual Cost of Water ($ per 1,000 gallons)	$6.06

Table 5.2.23-4 SAWS Vista Ridge Project Cost Estimate – MAG-Limited

Item	Estimated Costs for Facilities
Intake Pump Stations (32.8 MGD)	$7,242,000
Transmission Pipeline (48 in dia., 143 miles)	$264,379,000
Transmission Pump Station(s) & Storage Tank(s)	$23,328,000
Well Fields (Wells, Pumps, and Piping)	$34,838,000
Water Treatment Plant (32.8 MGD)	$49,308,000
Other	$10,468,000
TOTAL COST OF FACILITIES	**$389,563,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$123,128,000
Environmental & Archaeology Studies and Mitigation	$3,990,000
Land Acquisition and Surveying (1772 acres)	$9,257,000
Interest During Construction (4% for 2.5 years with a 1% ROI)	$46,020,000
TOTAL COST OF PROJECT	**$571,958,000**
ANNUAL COST	
Debt Service (5.5 percent, 20 years)	$47,861,000
Operation and Maintenance	
Intake, Pipeline, Pump Station (1% of Cost of Facilities)	$3,686,000
Water Treatment Plant (2.5% of Cost of Facilities)	$9,862,000
Pumping Energy Costs (110,000,740 kW-hr @ 0.09 $/kW-hr)	$9,900,000
Purchase of Water (34,894 acft/yr @ 125 $/acft)	$4,658,000
TOTAL ANNUAL COST	**$75,967,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 1	34,894
Annual Cost of Water ($ per acft)	$2,177
Annual Cost of Water ($ per 1,000 gallons)	$6.68

5.2.23.5 Implementation Issues

The SAWS Vista Ridge Project, as envisioned, exceeds the available water from the Carrizo-Wilcox Aquifer, as determined to be the balance between the TWDB MAG and estimated groundwater pumping. For each aquifer in the region, the GCDs have adopted desired future conditions (DFCs). Then, the TWDB determines the MAG from the DFC. In some GCDs, full use of all groundwater supplies (permitted, grandfathered and exempt) may result in exceeding the MAG and cause a future non-achievement of the DFCs for an aquifer. To ensure compliance with the DFCs, TWDB currently requires that groundwater availability for each aquifer be limited for planning purposes to the modeled available groundwater (MAG) for the aquifer. This has resulted, for planning purposes only, in adjustments to permit amounts, and a lack of firm water available for future permits in this plan for some areas for certain time periods. This should not be construed as recommending or requiring that GCDs make these adjustments, or deny future permit applications. SCTRWPG recognizes and supports the ability of permit holders to exercise their rights to groundwater use in accordance with their permits and it recognizes and supports the GCDs discretion to issue permits and grandfather historical users for amounts in excess of the MAG. SCTRWPG may not modify groundwater permits that GCDs have already issued or limit future permits that GCDs may issue. If the MAG is increased during or after this planning cycle, SCTRWPG may amend this Plan to adjust groundwater supply numbers that are affected by the new MAG amount.

The development of the SAWS Vista Ridge Project must address several other issues, including:

Impact on:

- Endangered and threatened wildlife species;
- Water levels in the aquifer, including dewatering of the current artesian part of the aquifer;
- Baseflow in streams; and
- Wetlands.

Competition with others in the area for groundwater;

Regulations by Post Oak Savannah, including periodic renewal of permits and potential pumping cutbacks;

Land will need to be acquired through either negotiations or condemnation; and

Relocations for the pipeline and pump station facilities may include:

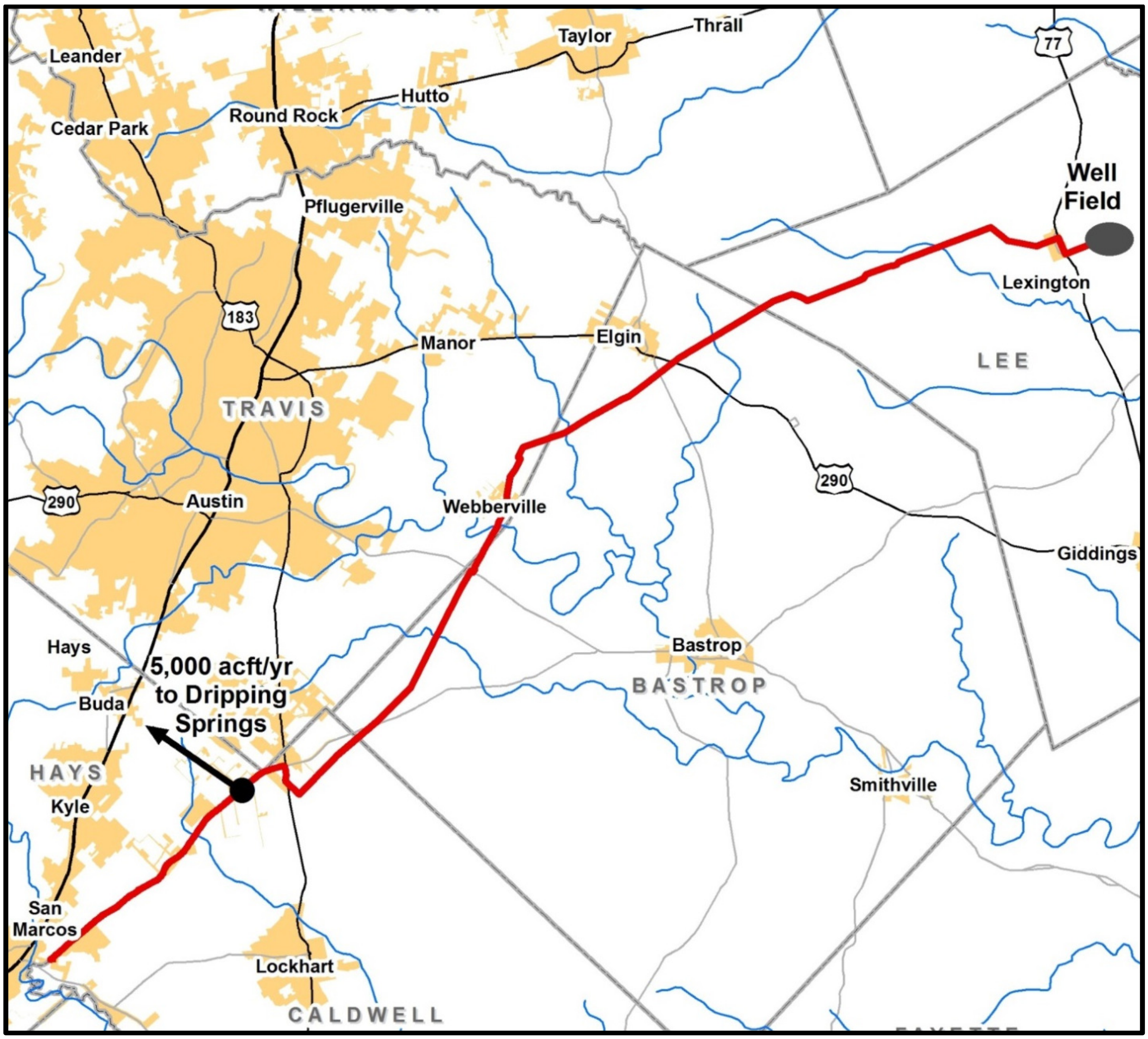
a. County roads;
b. Other utilities;
c. Product transmission pipelines; and
d. Power transmission lines.

5.2.24 Hays County Forestar Project

5.2.24.1 Description of Water Management Strategy

Hays County has contracted with Forestar for up to 45,000 acft/yr of groundwater supply from Lee County, Texas. Forestar holds permits from the Lost Pines Groundwater Conservation District (GCD) for up to 12,000 acft/yr in the Carrizo-Wilcox Aquifer in Lee County, and has applied for the additional 33,000 acft/yr. A legal suit is underway to determine the outcome of their application for the additional 33,000 acft/yr. The project includes a well field, collection system, treatment, and 75 miles of 48-inch transmission facilities, which will deliver water to southern Hays County for potential customers throughout Hays County. Figure 5.2.24-1 shows the well field location and the proposed pipeline route.

Figure 5.2.24-1. Hays County Forestar Project Location



5.2.24.2 Water Availability

Forestar holds permits from the Lost Pines GCD for 12,000 acft/yr of groundwater out of the Carrizo-Wilcox Aquifer in Lee County. Hays County has contracted for 45,000 acft/yr. The Modeled Available Groundwater (MAG) for the Carrizo-Wilcox Aquifer in Lee County ranges from 23,042 acft/yr in 2020 to 27,380 acft/yr in 2070. Local existing supplies from the Carrizo Aquifer total 11,046 acft/yr. When accounting for existing supplies, between 12,356 acft/yr (2020) and 16,334 acft/yr (2070) remain available for new water management strategies.

The envisioned project size of 45,000 acft/yr of groundwater exceeds the remaining amount of water under the MAG for the Carrizo-Wilcox Aquifer in Lee County in every decade. Region G (which includes Lee County) recognizes Forestar's groundwater permits and contract with Hays County. Therefore, the remaining amount of water available under the MAG in Lee County can be utilized by the Hays County Forestar Project. Accordingly, the MAG-Limited (and recommended) size for the Hays County Project is 12,356 acft/yr in 2020, growing to 16,334 acft/yr by 2070.

5.2.24.3 Environmental Issues

Environmental issues for the proposed Hays Forestar Project which includes portions of Bastrop, Caldwell, Hays, Lee and Travis counties are described below. This project includes the construction of intake pump stations, a 75 mile transmission pipeline, storage tanks, water treatment plant, and well field including pumps, wells and piping. Implementation of this project would require field surveys by qualified professionals to document vegetation/habitat types, waters of the U.S. including wetlands and cultural resources that may be impacted. Where impacts to protected species habitat or significant cultural resources cannot be avoided, additional studies would be necessary to evaluate habitat use and/or value, or eligibility for inclusion in the National Register of Historic Places, respectively. Compensation would be required for unavoidable adverse impacts involving net losses of wetlands.

This water management strategy would obtain groundwater from a well field in Lee County and transport it for use in Hays County through a transmission pipeline. The pipeline traverses from west to east through portions of the Edwards Plateau, Blackland Prairie and Post Oak Savannah vegetational areas.[1] The project is located within the Texan biotic province.[2] Vegetation within the project area is dominated by a mosaic of vegetation types including, Post Oak Woods, Forest and Grassland Mosaic, and Post Oak Woods Forest to the east with cropland and other areas occurring generally along the western portion of the proposed pipeline.[3]

The majority of terrestrial habitat disruption will result from the transmission pipeline construction. Although a large portion of this pipeline as designed will utilize existing right-of-way areas along roadways and electric transmission lines, the remainder of the construction will occur through areas of cropland, pasture, or undeveloped areas. The well field, water treatment plant and pump stations along with storage tanks are anticipated to have minimal impact to existing terrestrial habitat. Avoidance of existing

[1] Gould, F.W. 1975. The Grasses of Texas. Texas A&M University Press. College Station, Texas.
[2] Blair, W.F., "The Biotic Provinces of Texas, "Tex. J. Sci. 2:93-117, 1950.
[3] McMahan, C. A., R. G. Frye and K. L. Brown, " The Vegetation Types of Texas -- Including Cropland," Texas Parks and Wildlife Department – PWD Bulletin 7000-120. 1984.

riparian and wooded areas would reduce potential impacts to existing area species. Herbaceous habitats would recover quickly from the impacts caused by construction with the exception of any required maintained right-of-way. However any impacts to woody vegetation resulting from the construction of pipelines and other project accoutrements would be permanent due to required maintenance.

The proposed pipeline would cross the Colorado River and numerous creeks and tributaries within the project area. Coordination with the U.S. Army Corps of Engineers would be required for construction within waters of the U.S. Impacts from this proposed project resulting in a loss of less than 0.5 acres of waters of the U.S. could be covered under Nationwide Permit #12 for Utility Line Activities. Impacts to aquatic species would be minimized by utilizing best management practices and drilling under larger waterways to install pipelines.

The Texas Parks & Wildlife Department (TPWD) has identified a number of stream segments throughout the state as ecologically significant on the basis of biological function, hydrologic function, riparian conservation, exceptional aquatic life uses, and/or threatened or endangered species. Currently, 21 stream segments in Region L are considered ecologically significant by the TPWD.[4] The transmission pipeline does not cross any ecologically significant stream segments.

The species listed by USFWS, and TPWD, as endangered or threatened with potential habitat in the project counties are listed in Table 5.2.24-1. Information provided by the Texas Natural Diversity Database, maintained by TPWD, which documents the occurrence of rare species within the state, was included in this analysis although coverage of the project area was not complete. This data included documented occurrences of Hill Country wild mercury, a species of concern, near the western most terminal of the transmission pipeline. The project area does not occur within any areas of karst geology nor over the Edward’s Aquifer, both which include numerous cave and aquifer dependent species listed for the project counties. Coordination with TPWD and USFWS regarding threatened and endangered species with potential to occur in the project area should be initiated early in project planning.

[4] TPWD, “Ecologically Significant River and Stream Segments,” http://www.tpwd.state.tx.us/landwater/water/environconcerns/water_quality/sigsegs/index.phtml accessed February 6, 2014.

Table 5.2.24-1 Endangered, Threatened, and Species of Concern for Bastrop, Caldwell, Hays, Lee and Travis Counties

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
AMPHIBIANS								
Austin blind salamander	*Eurycea waterlooensis*	*0*	*3*	*0*	Species mostly restricted to subterranean cavities of the Edwards Aquifer.	LE	--	Resident
Barton Springs salamander	*Eurycea sosorum*	*0*	*3*	*0*	Known from Barton Springs and subterranean water-filled caverns.	LE	E	Resident
Blanco blind salamander	*Eurycea robusta*	*0*	*2*	*0*	Troglobitic species found in water-filled subterranean caverns.	--	T	Resident
Blanco River springs salamander	*Eurycea pterophila*	*0*	*1*	*0*	Subaquatic found in springs and caves in the Blanco River drainage.	--	--	Resident
Cascade Caverns salamander	*Eurycea latitans complex*	1	2	2	Endemic, subaquatic in Edwards Aquifer	--	T	Resident
Comal blind salamander	*Eurycea tridentifera*	0	3	0	Endemic and semi-troglobitic, found in springs and waters of caves.	--	T	Resident
Houston toad	*Anaxyrus houstonensis*	1	3	3	Endemic species found in sandy substrates, water in pools or stock tanks.	LE	E	Resident
Jollyville Plateau salamander	*Eurycea tonkawae*	*0*	*2*	*0*	Known from springs and waters of some caves north of the Colorado River.	LT	--	Resident
San Marcos salamander	*Eurycea nana*	*0*	*2*	*0*	Found in headwaters of the San Marcos River.	LT	T	Resident
Southern crawfish frog	*Lithobates areolatus areolatus*	0	1	0	Found in abandoned crawfish holes and small mammal burrows.	--	--	Resident
Texas blind salamander	*Eurycea rathbuni*	*0*	*3*	*0*	Troglobitic species found in water-filled	LE	E	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
					subterranean cavers along a six mile stretch of the San Marcos Spring Fault near San Marcos.			
Texas salamander	*Eurycea notenes*	0	1	0	Endemic; troglobitic, found in springs, caves and creek headwaters restricted to Helotes and Leon Creek drainages.	--	--	Resident
ARACHNIDS								
Bandit cave spider	*Cicurina bandida*	*0*	*1*	*0*	Very small, subterrestrial, subterranean obligate spider.	--	--	Resident
Bee Creek Cave harvestman	*Texella reddilli*	*0*	*3*	*0*	Small blind cave-adapted harvestman endemic to a few caves in Travis and Williamson Counties.	LE	--	Resident
Bone Cave harvestman	*Texella reyesi*	0	3	0	Small blind cave-adapted harvestman endemic to several caves in Travis and Williamson Counties. Weakly differentiated from *Texella reddelli*.	LE	--	Resident
Bracken Bat Cave meshweaver	*Cicurina venii*	0	3	0	Small eyeless spider, found in Karst features in western Bexar County.	LE	--	Resident
Cokendolpher cave harvestman	*Texella cokendolpheri*	0	3	0	Small, eyeless spider found in karst features I north and northwest Bexar County.	LE	--	Resident
Government Canyon Bat Cave meshweaver	*Cicurina vespera*	0	3	0	Small eyeless spider in karst features in north and Northwest Bexar county.	LE	--	Resident
Government Canyon Bat Cave spider	*Neoleptoneta microps*	0	3	0	Small eyeless spider in karst features in north	LE	--	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
					and Northwest Bexar county.			
Madla Cave meshweaver	*Cicurina madla*	0	3	0	Small eyeless spider in karst features in north and Northwest Bexar county.	LE	--	Resident
Robber Baron Cave meshweaver	*Cicurina baronia*	0	3	0	Small eyeless spider in karst features in north and Northwest Bexar county.	LE	--	Resident
Tooth Cave pseudoscorpion	*Tartarocreagris Texana*	0	3	0	Small cave-adapted pseudoscorpion known from small limestone caves of the Edwards Plateau.	LE	--	Resident
Tooth Cave Spider	*Tayshaneta myopica*	0	3	0	Very small, cave-adapted, sedentary spider.	LE	--	Resident
Warton's cave meshweaver	*Cicurina wartoni*	0	1	0	Very small, cave-adapted spider	--	--	Resident
BIRDS								
American peregrine falcon	*Falco peregrinus anatum*	0	3	0	Migrant and local breeder in West Texas.	DL	T	Possible Migrant
Artic peregrine falcon	*Falco peregrinus tundrius*	0	2	0	Migrant throughout the state.	DL	--	Possible Migrant
Bald eagle	*Haliaeetus leucocephalus*	0	2	0	Primarily found near rivers and large lakes.	DL	T	
Black-capped vireo	*Vireo atricapillus*	0	3	0	Semi-open broad-leaved shrublands	LE	E	Nesting/ Migrant
Golden-cheeked warbler	*Setophaga chrysoparia*	0	3	0	Woodlands with oaks and old juniper.	LE	E	Nesting/ Migrant
Henslow's sparrow	*Ammodramus henslowii*	0	1	0	Wintering individuals found in weedy fields or cut-over areas. Key component is bare ground.	--	--	Possible Migrant
Interior least tern	*Sterna antillarum athalassos*	0	3	0	Nests along sand and gravel bars in braided streams	LE	E	Possible Migrant
Mountain plover	*Charadrius montanus*	1	1	1	Non-breeding, shortgrass plains and fields	--	--	Possible Migrant
Piping plover	*Charadrius melodus*	0	2	0	Small shorebird, migrant.	T	--	Possible Migrant
Sprague's pipit	*Anthus spragueii*	0	1	0	Migrant in Texas	C	--	Possible

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
					in winter mid Sept. to early April. Strongly tied to native upland prairie.			Migrant
Western burrowing owl	*Athene cunicularia hypugaea*	1	1	1	Open grasslands, especially prairie, plains and savanna	--	--	Resident
Whooping crane	Grus americana	0	3	0	Potential migrant	LE	E	Potential Migrant
Wood stork	*Mycteria americana*	0	2	0	Forages in prairie ponds, ditches, and shallow standing water formerly nested in TX	--	T	Migrant
Zone-tailed hawk	*Buteo albonotatus*	0	2	0	Arid, open country including deciduous or pine-oak woodland.	--	T	Nesting/ migrant
CRUSTACEANS								
A cave obligate crustacean	*Monodella Texana*	0	2	0	Subaquatic, subterranean obligate found in underground freshwater aquifers.	--	--	Resident
A crayfish	*Procambarus texanus*	0	1	0	Found in ponds.	--	--	Resident
An amphipod	*Stygobromus russelli*	*0*	*1*	*0*	Found in subterranean waters, usually in caves and limestone aquifers.	--	--	Resident
Balcones Cave amphipod	*Stygobromus balconis*	*0*	*1*	*0*	Subaquatic, subterranean obligate amphipod.	--	--	Resident
Bifurcated cave amphipod	*Stygobromus bifurcates*	*0*	*1*	*0*	Found in cave pools.	--	--	Resident
Ezell's cave amphipod	*Stygobromus flagellatus*	*0*	*1*	*0*	Known only from artesian wells.	--	--	Resident
Texas cave shrimp	*Palaemonetes antrorum*	*0*	*1*	*0*	Subterranean species found in sluggish streams and pools.	--	--	Resident
Texas troglobitic water slater	*Lirceolus smithii*	*0*	*1*	*0*	Subaquatic, subterranean obligate species found in aquifers.	--	--	Resident
FISHES								

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
Blue sucker	*Cycleptus elongatus*	0	2	0	Major rivers in Texas.	--	T	Resident
Fountain darter	*Etheostoma fonticola*	0	3	*0*	Known only from the San Marcos and Comal rivers. Found in springs and spring-fed streams in dense beds of aquatic plants.	LE	E	Resident
Guadalupe bass	*Micropterus treculi*	2	1	2	Endemic to perennial streams of the Edwards Plateau region.	--	--	Resident
Guadalupe darter	*Percina sciera apristis*	0	1	0	Guadalupe River Basin. Usually found over gravel or gravel and sand raceways of larger streams and rivers.	--	--	Resident
Ironcolor shiner	*Notropis chalybaeus*	*0*	*1*	*0*	Found in Big Cypress Bayou and Sabine River basin.	--	--	Resident
Smalleye shiner	*Notropis buccula*	*0*	*3*	*0*	Endemic to upper Brazos River system and its tributaries.	LE	--	Resident
San Marcos gambusia	*Gamusia georgei*	*0*	*1*	*0*	Extinct species formerly known from the upper San Marcos River.	LE	E	Historic Resident
INSECTS								
A mayfly	*Campsurus decolaratus*	1	1	1	In Texas and Mexico, possibly clay substrates, found in shoreline vegetation.	--	--	Potential Resident
Comal Springs dryopid beetle	*Stygoparnus comalensis*	*0*	*3*	*0*	These beetles usually cling to objects in streams.	LE	E	Resident
Comal Springs riffle beetle	*Heterelmis comalensis*	*0*	*3*	*0*	Found in Comal and San Marcos Springs.	LE	E	Resident
Edwards Aquifer diving beetle	*Haideoporus texanus*	*0*	*1*	*0*	Habitat poorly known, found in an artesian well in Hays County.	--	--	Resident
Flint's net-	*Cheumatopsyche*	*0*	*1*	*0*	Very poorly	--	--	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
spinning caddisfly	*flinti*				known species with habitat description limited to "a spring".			
Kretschmarr Cave mold beetle	*Texamaurops reddelli*	*0*	*3*	*0*	Small, cave-adapted beetle found under rocks buried in silt; small, Edwards Limestone caves of the Jollyville Plateau.	LE	--	Resident
Leonora's dancer damselfly	*Argia leonorae*	*1*	*1*	*1*	Species found in south central and western Texas in small streams and seepages.	--	--	Resident
Rawson's metalmark	*Calephelis rawsoni*	0	1	0	Moist areas in shaded limestone outcrops.	--	--	Resident
San Marcos saddle-case caddisfly	*Protoptila arca*	*0*	*1*	*0*	Known from an artesian well in Hays County. Very abundant locally.	--	--	Resident
Texas austrotinodes caddisfly	*Austrotinodes texensis*	*0*	*1*	*0*	Thought to be endemic to the karst springs and spring runs of the Edwards Plateau region.	--	--	Resident
Tooth Cave blind rove beetle	*Cylindropsis sp. 1*	*0*	*1*	*0*	One specimen collected from Tooth Cave.	--	--	Resident
Tooth Cave ground beetle	*Rhadine Persephone*	*0*	*3*	*0*	Small cave-adapted beetle found in small Edwards Limestone caves in Travis and Williamson Counties.	LE	--	Resident
MAMMALS								
Cave myotis bat	*Myotis velifer*	0	1	0	Roosts colonially in caves, rock crevices	--	--	Resident
Elliot's short-tailed shrew	*Blarina hylophaga hylophaga*	0	1	0	Found In sandy areas in live oak mottes, and grassy areas.	--	--	Resident
Plains spotted skunk	*Spilogale putorius interrupta*	2	1	2	Prefers wooded, brushy areas.	--	--	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
Red wolf	*Canis rufus*	0	3	0	Extirpated.	LE	E	Historic Resident
MOLLUSKS								
Creeper (squawfoot)	*Strophitus undulates*	1	1	1	Small to large streams. Colorado, Guadalupe, and San Antonio River basins.	--	--	Resident
False spike mussel	*Quincuncina mitchelli*	1	2	2	Substrates of cobble and mud. Rio Grande, Brazos, Colorado and Guadalupe river basins.	--	T	Resident
Golden orb	*Quadrula aurea*	0	2	0	Sand and gravel, Guadalupe, San Antonio, Lower San Marcos, and Nueces River basins	C	T	Resident
Smooth pimpleback	*Quadrula houstonensis*	1	2	2	Found in small to moderate streams and rivers and smaller reservoirs.	C	T	Resident
Texas fatmucket	*Lampsilis bracteata*	1	2	2	Streams and rivers on sand, mud and gravel, Colorado and Guadalupe River basins.	C	T	Resident
Texas fawnsfoot	*Truncilla macrodon*	1	2	2	Little known species possibly found in rivers and larger streams. intolerant of impoundment.	C	T	Resident
Texas pimpleback	*Quadrula petrina*	1	2	2	Mud, gravel and sand substrates, Colorado and Guadalupe river basins	C	T	Resident
PLANTS								
Basin bellflower	*Campanula reverchonii*	0	1	0	Texas endemic found among scattered vegetation on loose gravel and rock outcrops on open slopes.	--	--	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
Big red sage	*Salvia pentstemonoides*	0	1	0	Texas endemic, found in moist to seasonally wet steep limestone outcrops on canyons or along creek banks.	--	--	Resident
Boerne bean	*Phaseolus texensis*	0	1	0	Found in narrowly endemic to rocky canyons in eastern and southern Edwards Plateau.	--	--	Resident
Bracted twistflower	*Steptanthus bracteatus*	0	2	0	Endemic; shallow clay soils over limestone rocky slopes.	C	--	Resident
Branched gay-feather	*Liatris cymosa*	1	1	1	Texas endemic found in somewhat barren grassland openings in post oak woodlands.	--	--	Resident
Bristle nailwort	*Paronychia setacea*	0	1	0	Endemic to south central Texas in sandy soils.	--	--	Resident
Correll's false dragon-head	*Physostegia correllii*	0	1	0	Found in wet, silty clay loams on streamsides or other wet areas.	--	--	Resident
Elmendorf's onion	*Allium elmendorfii*	0	1	0	Endemic, in deep sands	--	--	Resident
Green beebalm	*Monarda viridissima*	0	1	0	Endemic perennial herb. Found in well-drained sandy soils in opening of post oak woodlands.	--	--	Resident
Hill country wild-mercury	*Argythamnia aphoroides*	2	1	2	Endemic; found in grasslands associated with oak woodlands.	--	--	Resident
Navasota ladies'-tresses	*Spiranthes parksii*	0	3	0	Texas endemic found in openings in post oak woodlands in sandy loams.	LE	E	Resident
Parks' jointweed	*Polygonella parksii*	0	1	0	Texas endemic, primarily found on deep, loose, sand blowouts in Post Oak Savannas.	--	--	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
Sandhill woolywhite	*Hymenopappus carrizoanus*	0	1	0	Found south of the Guadalupe River. Prefers dense riparian corridors.	--	--	Resident
Shinner's sunflower	*Helianthus occidentalis ssp plantagineus.*	0	1	0	Found on prairies on the Coastal Plain.	--	--	Resident
Texabama croton	*Croton alabamensis var texensis*	*0*	*1*	*0*	Texas endemic found on loamy clay soils of rocky slopes.	--	--	Resident
Texas wild-rice	*Zizania texana*	*0*	*3*	*0*	Texas endemic found in spring-fed San Marcos River.	LE	E	Resident
Warnock's coral-root	*Hexalectric warnockii*	*0*	*1*	*0*	Found among leaf litter and humus in oak-juniper woodlands on shaded slopes and intermittent, rock creekbeds in canyons.	--	--	Resident
REPTILES								
Cagle's map turtle	*Graptemys caglei*	0	2	0	Endemic to Guadalupe River System. Found near waters' edge.	--	T	Resident
Spot-tailed earless lizard	*Holbrookia lacerata*	0	1	0	Moderately open prairie-brushland.	--	--	Resident
Texas Garter Snake	*Thamnophis sirtalis annectens*	1	1	1	Wet or moist microhabitats	--	--	Resident
Texas Horned Lizard	*Phrynosoma cornutum*	1	2	2	Varied, sparsely vegetated uplands.	--	T	Resident
Texas Tortoise	*Gopherus berlandieri*	0	2	0	Open brush w/ grass understory.	--	T	Resident
Timber rattlesnake	*Crotalus horridus*	1	2	2	Floodplains, upland pine, deciduous woodlands, riparian zones.	--	T	Resident

LE/LT=Federally Listed Endangered/Threatened
DL=Federally Delisted
C=Candidate for Federal Listing
E, T=State Listed Endangered/Threatened
Blank = Considered rare, but no regulatory listing status

TPWD, 2015. Annotated County List of Rare Species –Bastrop County 4/28/2014, Caldwell County 4/28/2014, Hays County 11/3/2014, Lee County 4/28/2014, Travis County 12/5/2014.

USFWS, 2015. Endangered Species List for Texas. http://www.fws.gov/endangered/?s8fid=112761032793&s8fid=112762573903&countyName, accessed online March 5, 2015.

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 (Pl96-515), and the Archeological and Historic Preservation Act (PL93-291). Based on the review of publically available Geographic Information System (GIS) records obtained from the Texas Historical Commission (THC), there are no State Historic Sites, National Register Properties, or National Register Districts within 0.5-mile of the project area. However a total of 10 Historical Markers and 14 cemeteries occur within 0.5-mile of the transmission pipeline or within the proposed well field area.

Avoidance of these cultural resource areas should be possible by careful selection of the transmission pipeline route, WTP, and areas for well sites and their associated pipelines. A review of archaeological resources in the proposed project area should be conducted during the project planning phase. Because the owner or controller of the project will likely be a political subdivision of the State of Texas (i.e., river authority, municipality, county, etc.), they will be required to coordinate with the THC prior to construction.

5.2.24.4 Engineering and Costing

Preliminary engineering and costing analyses have been performed for the Envisioned and MAG-Limited project using 2016 Regional Water Planning methods. HDR utilized the standard costing procedures and method for calculating unit costs. The costing procedures include all facilities required for water production, collection, transmission, and treatment, but do not include the cost of facilities to distribute the water throughout Hays County. The well fields will require wells and a collector pipeline. Water treatment would require standard filtration treatment to remove of iron and manganese and to disinfect the water.

Project as Envisioned

The Hays County Forestar Project as envisioned will develop 45,000 acft/yr of new supply and deliver it to Hays County. Facilities include a well field with 12 Simsboro wells, well field collection system, 40.1 MGD of water treatment facilities, and 75 miles of 48-inch transmission systems. Region L cost estimates for delivering treated water to Hays County is shown in Table 5.2.24-2. The total estimated project cost is $387 million. The annual costs include debt service for a 30-year loan at 5.5 percent interest and operation and maintenance costs, including power. The cost of water is estimated to be $1,331/acft/yr. Additional cost would be incurred to integrate into Hays County (see Facilities Expansions).

MAG-Limited Project

The MAG-Limited Hays County Forestar Project will deliver up to 12,356 acft/yr of new supply and deliver it to Hays County within the SAWS distribution system by 2060. Facilities include a well field with 4 Simsboro wells, well field collection system, 11.0 MGD of water treatment facilities, and 75 miles of 30-inch transmission systems. Region L cost estimates for delivering treated water to Hays County is shown in Table 5.2.24-3. The total estimated project cost is $182 million. The annual costs include debt service for a 30-year loan at 5.5 percent interest and operation and maintenance costs, including power. The cost of water is estimated to be $1,942/acft/yr. Additional cost would be incurred to integrate into Hays County (see Facilities Expansions).

Table 5.2.24-2 Hays County Forestar Project Cost Estimate – Envisioned

Item	*Estimated Costs for Facilities*
Intake Pump Stations (42.3 MGD)	$7,880,000
Transmission Pipeline (48 in dia., 75 miles)	$128,382,000
Transmission Pump Station(s) & Storage Tank(s)	$14,781,000
Well Fields (Wells, Pumps, and Piping)	$42,677,000
Storage Tanks (Other Than at Booster Pump Stations)	$1,902,000
Water Treatment Plant (40.1 MGD)	$59,008,000
Integration, Relocations, & Other	$13,500,000
TOTAL COST OF FACILITIES	**$268,130,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$87,426,000
Environmental & Archaeology Studies and Mitigation	$2,321,000
Land Acquisition and Surveying (948 acres)	$4,124,000
Interest During Construction (4% for 2 years with a 1% ROI)	$25,341,000
TOTAL COST OF PROJECT	**$387,342,000**
ANNUAL COST	
Debt Service (5.5 percent, 20 years)	$32,413,000
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$1,768,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$471,000
Water Treatment Plant	$11,802,000
Pumping Energy Costs (82,463,230 kW-hr @ 0.09 $/kW-hr)	$7,422,000
Purchase of Water (45,000 acft/yr @ 125 $/acft)	$6,008,000
TOTAL ANNUAL COST	**$59,884,000**
Available Project Yield (acft/yr)	45,000
Annual Cost of Water ($ per acft), based on a Peaking Factor of 1	$1,331
Annual Cost of Water ($ per 1,000 gallons), based on a Peaking Factor of 1	$4.08

Table 5.2.24-3 Hays County Forestar Project Cost Estimate – MAG-Limited

Item	*Estimated Costs for Facilities*
Intake Pump Stations (11.6 MGD)	$3,259,000
Transmission Pipeline (30 in dia., 75 miles)	$74,699,000
Transmission Pump Station(s) & Storage Tank(s)	$7,751,000
Well Fields (Wells, Pumps, and Piping)	$13,734,000
Storage Tanks (Other Than at Booster Pump Stations)	$785,000
Water Treatment Plant (11 MGD)	$20,394,000
Integration, Relocations, & Other	$3,707,000
TOTAL COST OF FACILITIES	**$124,329,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$39,780,000
Environmental & Archaeology Studies and Mitigation	$2,058,000
Land Acquisition and Surveying (929 acres)	$4,043,000
Interest During Construction (4% for 2 years with a 1% ROI)	$11,915,000
TOTAL COST OF PROJECT	**$182,125,000**
ANNUAL COST	
Debt Service (5.5 percent, 20 years)	$15,240,000
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$908,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$236,000
Water Treatment Plant	$4,079,000
Pumping Energy Costs (20,918,358 kW-hr @ 0.09 $/kW-hr)	$1,883,000
Purchase of Water (12,356 acft/yr @ 125 $/acft)	$1,650,000
TOTAL ANNUAL COST	**$23,996,000**
Available Project Yield (acft/yr)	12,356
Annual Cost of Water ($ per acft), based on a Peaking Factor of 1	$1,942
Annual Cost of Water ($ per 1,000 gallons), based on a Peaking Factor of 1	$5.96

5.2.24.5 Implementation Issues

The Hays County Forestar Project, as envisioned, exceeds the available water from the Carrizo-Wilcox Aquifer, as determined to be the balance between the TWDB MAG and estimated groundwater pumping. For each aquifer in the region, the GCDs have adopted desired future conditions (DFCs). In some GCDs, full use of all groundwater supplies (permitted, grandfathered and exempt) may result in non-achievement of the DFCs for an aquifer. To ensure consistency with the DFCs, TWDB currently requires that groundwater availability for each aquifer be limited for planning purposes to the modeled available groundwater (MAG) for the aquifer, which was determined from the DFC. This has resulted, for planning purposes only, in adjustments to permit amounts, and a lack of firm water available for future permits in this plan for some areas for certain time periods. This should not be construed as recommending or requiring that GCDs make these adjustments, or deny future permit applications. SCTRWPG recognizes and supports the ability of permit holders to exercise their rights to groundwater use in accordance with their permits and it recognizes and supports the GCDs discretion to issue permits and grandfather historical users for amounts in excess of the MAG. SCTRWPG may not modify groundwater permits that GCDs have already issued or limit future permits that GCDs may issue. If the MAG is increased during or after this planning cycle, SCTRWPG may amend this Plan to adjust groundwater supply numbers that are affected by the new MAG amount.

The development of the Hays County Forestar Project must address several issues, including:

Impact on:

- Endangered and threatened wildlife species;
- Water levels in the aquifer, including dewatering of the current artesian part of the aquifer;
- Baseflow in streams; and
- Wetlands.

Competition with others in the area for groundwater;

Regulations by Lost Pines, including periodic renewal of permits and potential pumping cutbacks;

Land will need to be acquired through either negotiations or condemnation; and

Relocations for the pipeline and pump station facilities may include:

a. County roads;
b. Other utilities;
c. Product transmission pipelines; and
d. Power transmission lines.

5.2.25 Hays/Caldwell PUA Project

5.2.25.1 Description of Strategy

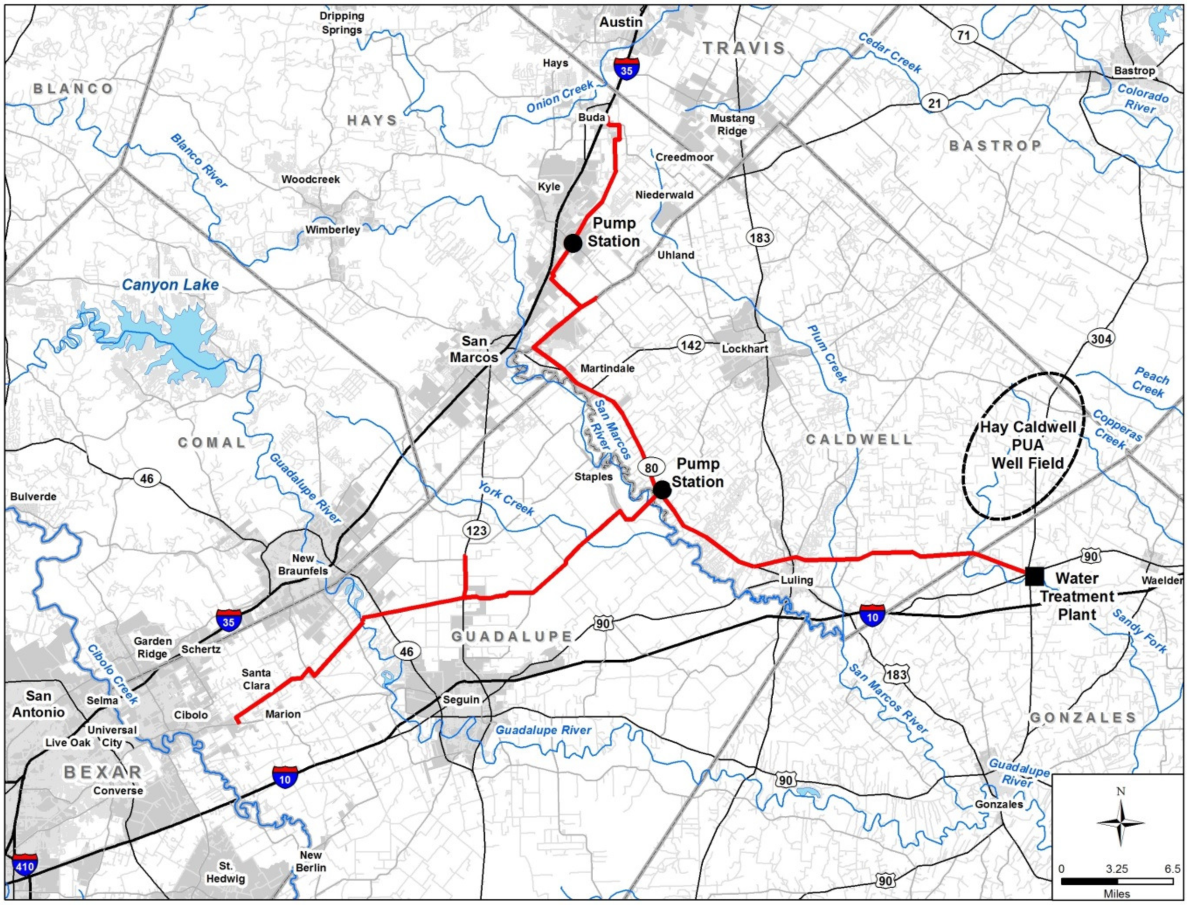
The Carrizo-Wilcox Aquifer is one of four major aquifers in the South Central Texas Water Planning Region. In the Wintergarden area, which is generally considered to be west of the Atascosa-Frio county line, the aquifer has been extensively developed for many decades. In Atascosa County, the aquifer has had moderate development. In Bastrop, Caldwell, Gonzales, Guadalupe, and Wilson Counties, there has been limited development. Overall, the water quality of the Carrizo-Wilcox Aquifer is suitable for use as a municipal water supply, except for elevated concentrations of iron and manganese in many areas.

Along the IH-35 corridor in Region L, there are near-term projected shortages in municipal supplies that could be met using new supplies from the Carrizo-Wilcox Aquifer. The Hays Caldwell Public Utility Agency (HCPUA) was formed in 2007 to resolve long-term water needs for its members which include the cities of San Marcos, Kyle, and Buda and the Canyon Regional Water Authority (CRWA). Several other water purveyors in Region L, including the San Antonio Water System (SAWS), Schertz-Seguin Local Government Corporation (SSLGC), CRWA, Texas Water Alliance, Guadalupe-Blanco River Authority (GBRA), and Aqua WSC, are evaluating regional projects to import groundwater from the Carrizo-Wilcox to their demand centers.

The HCPUA water management strategy has been recommended since the 2006 SCTRWP and involves: (1) pumping groundwater from planned well fields in Caldwell and Gonzales Counties; (2) treating the water near the well field; and (3) conveying the water to participants along the transmission pipelines. The general locations of HCPUA Project facilities are shown in Figure 5.2.25-1.

The HCPUA has secured groundwater leases in Caldwell County and groundwater permits from the Gonzales County Underground Water Conservation District (GCUWCD) to deliver up to 10,300 acft/yr of Carrizo Aquifer groundwater to entities in Caldwell, Guadalupe, and Hays Counties (Figure 5.2.25-1). It is envisioned that the proposed project could deliver up to 35,690 acft/yr.

Figure 5.2.25-1 HCPUA Project Conceptual Layout



W:\007755\000000000167424_2016_Region_L_Plan\06.00_Project_Engineering_and_Design\GIS\map_docs\arcmap\Option2_TWA_HCPUA.mxd

5.2.25.2 Available Yield

The HCPUA has land under lease within the GCUWCD and the Plum Creek Conservation District. According to GCUWCD rules, 1 acft per acre is the allowable production rate and wells of proposed capacity would be subject to a setback of 6,000 feet from existing registered Carrizo wells. The GCUWCD permitted well field is located in eastern Caldwell County.

For each aquifer in the region, the Groundwater Conservation Districts (GCDs) have adopted desired future conditions (DFCs). In some GCDs, full use of all groundwater supplies (permitted, grandfathered, and exempt) may result in non-achievement of the DFCs for an aquifer. To ensure consistency with the DFCs, the Texas Water Development Board (TWDB) currently requires that groundwater availability for each aquifer be limited for planning purposes to the modeled available groundwater (MAG) for the aquifer. This has resulted, for planning purposes only, in the application of project yield limitations for MAG compliance, and a lack of firm water available for future permits in this plan for some areas for certain time periods. Planned withdrawals from the Carrizo-Wilcox Aquifer in Caldwell and Gonzales Counties exceed the MAG and, therefore, the HCPUA envisioned project yield is limited to 21,833 acft/yr so as to not exceed MAG values through 2070.

The HCPUA project is described herein as two water management strategies. The first strategy is the envisioned project yielding a total of 35,690 acft/yr. The second strategy is limited to MAG availability yielding a total of 21,833 acft/yr.

5.2.25.3 Environmental Issues

Environmental issues for the proposed Hays/Caldwell PUA Project are described below. This project includes the development of a well field in Caldwell County, a water treatment plant, additional pump and booster stations, storage tanks, and an approximately ninety-one miles of transmission pipeline. Implementation of this project would require field surveys by qualified professionals to document vegetation/habitat types, waters of the U.S. including wetlands, and cultural resources that may be impacted. Where impacts to protected species habitat or significant cultural resources cannot be avoided, additional studies would be necessary to evaluate habitat use and/or value, or eligibility for inclusion in the National Register of Historic Places, respectively. The project sponsor would also be required to coordinate with the U.S. Army Corps of Engineers regarding impacts to wetland areas and compensation would be required for unavoidable adverse impacts involving net losses of wetlands.

The proposed pipeline would cross the San Marcos and Guadalupe Rivers and their associated tributaries. The Texas Parks & Wildlife Department (TPWD) has identified a number of stream segments throughout the state as ecologically significant on the basis of biological function, hydrologic function, riparian conservation, exceptional aquatic life uses, and/or threatened or endangered species. The transmission pipeline crosses only one of these segments, Geronimo Creek, which is considered ecologically significant due to its high water quality and diverse benthic macroinvertebrate community. Potential impacts to this segment could be avoided by use of horizontal directional drilling for installation of the pipeline stream crossing.

Coordination with the U.S. Army Corps of Engineers would be required for construction within any waters of the U.S. Impacts from this proposed project which result in a loss of less than 0.5 acres of waters of the U.S. could be covered under Nationwide Permit #12 for Utility Line Activities.

The Hays/Caldwell PUA Project involves the construction of approximately 91 miles of pipeline from a well field in Caldwell County to delivery points in Caldwell, Guadalupe, and Hays Counties. The pipeline traverses the East Central Texas Plains and Texas Blackland Prairie Ecoregions[1] and lies within portions of the Texan, and Tamaulipan Biotic Provinces.[2]

Vegetation within the project transmission pipeline area as described by the TPWD[3] primarily includes crops although additional areas of Grassland Mosaic, Post Oak Woods/Forest, and urban areas also occur within the eastern and northern portions of the pipeline.

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[1] Griffith Glenn, Sandy Bryce, James Omernik, and Anne Rogers. 2007. Ecoregions of Texas. Texas Commission on Environmental Quality.
[2] Blair, W. Frank. 1950. The Biotic Provinces of Texas. Texas Journal of Science 2(1):93-117.
[3] McMahan, Craig A., Roy G. Frye and Kirby L. Brown. 1984. The Vegetation Types of Texas. Wildlife Division, Texas Parks and Wildlife Department, Austin, Texas.

Table 5.2.21-1 lists the 26 state listed endangered or threatened species, and the 12 federally listed endangered or threatened species along with species of concern that may occur in Caldwell, Hays, Gonzales, or Guadalupe Counties. This information comes from the county lists of rare species published by the TPWD online in the "Annotated County Lists of Rare Species." Inclusion in this table does not mean that a species will occur within the project area, but only acknowledges the potential for its occurrence in the project area counties.

In addition to the county lists, data received from the Natural Diversity Database (NDD), which is maintained by TPWD, was reviewed for known occurrences of listed species within or near the project area. This database documents occurrences of the Golden orb mussel; a state listed threatened species, in the San Marcos River which is crossed by the pipeline route. Potential impacts to all aquatic species would be minimized if the pipeline is drilled under river crossings. Other species of concern which are documented near the well field or pipeline area include the Guadalupe bass, Shinner's sunflower, mountain plover, bracted twistflower, Texas garter snake, and hill country wild mercury which are all species with no regulatory status. A survey of the project area may be required prior to pipeline construction to determine whether populations of or potential habitats used by listed species occur in the area to be affected. Coordination with TPWD and USFWS regarding threatened and endangered species with potential to occur in the project area should be initiated early in project planning.

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 (Pl96-515), and the Archeological and Historic Preservation Act (PL93-291). Based on the review of publically available Geographic Information System (GIS) records obtained from the Texas Historical Commission, there are no State Historic Sites, National Register Properties, National Register Districts, or Historical Markers within the project area. Two cemeteries, one unnamed and the Delhi Cemetery occur within the area of the well field. Avoidance of these areas should be possible by careful selection of the areas for well sites and their associated pipelines. A review of archaeological resources in the proposed project area should be conducted during the project planning phase. Because the owner or controller of the project will likely be a political subdivision of the State of Texas (i.e., river authority, municipality, water district, etc.), they will be required to coordinate with the Texas Historical Commission prior to project construction.

Table 5.2.25-1 Endangered, Threatened, and Species of Concern for Caldwell, Hays, Gonzales and Guadalupe Counties

Common Name	***Scientific Name***	***Impact Value***	***Multiplier Based on Status***	***Adjusted Impact***	***Summary of Habitat Preference***	***Listing Entity***		***Potential Occurrence in County(s)***
						USFWS	***TPWD***	
AMPHIBIANS								
Barton Springs salamander	*Eurycea sosorum*	*0*	*3*	*0*	Known from Barton Springs and subterranean water-filled caverns.	LE	E	Resident
Blanco blind salamander	*Eurycea robusta*	*0*	*2*	*0*	Troglobitic species found in water-filled subterranean caverns.	--	T	Resident
Blanco River springs salamander	*Eurycea pterophila*	*0*	*1*	*0*	Subaquatic found in springs and caves in the Blanco River drainage.	--	--	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Listing Entity USFWS	Listing Entity TPWD	Potential Occurrence in County(s)
San Marcos salamander	*Eurycea nana*	*0*	*2*	*0*	Found in headwaters of the San Marcos River.	LT	T	Resident
Texas blind salamander	*Eurycea rathbuni*	*0*	*3*	*0*	Troglobitic species found in water-filled subterranean cavers along a six mile stretch of the San Marcos Spring Fault near San Marcos.	LE	E	Resident
ARACHNIDS								
Bandit cave spider	*Cicurina bandida*	*0*	*1*	*0*	Very small, subterrestrial, subterranean obligate spider.	--	--	Resident
BIRDS								
American Peregrine Falcon	*Falco peregrinus anatum*	*0*	*2*	*0*	Resident and local breeder in West Texas. Migrant across the state.	DL	T	Possible Migrant
Arctic peregrine falcon	*Falco peregrinus tundrius*	*0*	*1*	*0*	Migrant throughout the state.	DL	--	Possible Migrant
Bald eagle	*Haliaeetus leucocephalus*	*0*	*2*	*0*	Found primarily near rivers and large lakes, migrant.	DL	T	Possible Migrant
Black-capped Vireo	*Vireo atricapillus*	*0*	*3*	*0*	Oak-juniper woodlands,	LE	E	Resident
Golden-cheeked Warbler	*Setophaga chrysoparia*	*1*	*3*	*3*	Juniper-oak woodlands.	LE	E	Resident
Henslow's Sparrow	*Ammodramus henslowii*	*0*	*1*	*0*	Wintering individuals found in weedy or cut-over areas.	--	--	Possible Migrant
Interior least tern	*Sterna antillarum athalassos*	*0*	*3*	*0*	Nests along sand and gravel bars in braided streams	LE	E	Resident
Mountain Plover	*Charadrius montanus*	*1*	*1*	*1*	Non-breeding, shortgrass plains and fields	--	--	Nesting/Migrant
Sprague's Pipit	*Anthus spragueii*	*0*	*1*	*0*	Migrant in Texas in winter. Strongly tied to native upland prairie.	C	--	Migrant
Western Burrowing Owl	*Athene cunicularia hypugaea*	*0*	*1*	*0*	Open grasslands, especially prairie, plains and savanna	--	--	Resident
Whooping Crane	*Grus americana*	*0*	*3*	*0*	Potential migrant	LE	E	Potential Migrant
Wood Stork	*Mycteria americana*	*0*	*2*	*0*	Forages in prairie ponds, ditches, and shallow standing water formerly nested in TX	--	T	Migrant
Zone-tailed Hawk	*Buteo albonotatus*	*0*	*2*	*0*	Arid open country, often near watercourses	--	T	Resident
CRUSTACEANS								
A cave obligate crustacean	*Monodella Texana*	*0*	*1*	*0*	Subaquatic, subterranean obligate found in underwater freshwater aquifers.	--	--	Resident
Balcones Cave amphipod	*Stygobromus balconis*	*0*	*1*	*0*	Subaquatic, subterranean obligate amphipod.	--	--	Resident
Ezell's cave amphipod	*Stygobromus flagellatus*	*0*	*1*	*0*	Known only from artesian wells.	--	--	Resident
Texas cave shrimp	*Palaemonetes antrorum*	*0*	*1*	*0*	Subterranean species found in sluggish streams and pools.	--	--	Resident
Texas troglobitic water slater	*Lirceolus smithii*	*0*	*1*	*0*	Subaquatic, subterranean obligate species found in aquifers.	--	--	Resident
FISH								
Blue sucker	*Cycleptus elongatus*	0	2	*0*	Found in larger portions of major rivers in Texas.	--	T	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County(s)
						USFWS	TPWD	
Fountain darter	*Etheostoma fonticola*	0	3	*0*	Known only from the San Marcos and Comal rivers. Found in springs and spring-fed streams in dense beds of aquatic plants.	LE	E	Resident
Guadalupe Bass	*Micropterus treculi*	*1*	*1*	*1*	Endemic to perennial streams of the Edwards Plateau region.	--	--	Resident
Guadalupe darter	*Percina sciera apristis*	*1*	*1*	*1*	Guadalupe River basin, found over gravel and sand raceways of larger streams and rivers.	--	--	Resident
Ironcolor shiner	*Notropis chalybaeus*	*0*	*1*	*0*	Found in Big Cypress Bayou and Sabine River basin.	--	--	Resident
San Marcos gambusia	*Gamusia georgei*	*0*	*1*	*0*	Extinct species formerly known from the upper San Marcos River.	--	--	Historic Resident
INSECTS								
A mayfly	*Campurus decolaratus*	*0*	*1*	*0*	Found in Texas and Mexico, possibly in clay substrates.	--	--	Resident
Comal Springs dryopid beetle	*Stygoparnus comalensis*	*0*	*3*	*0*	These beetles usually cling to objects in streams.	LE	E	Resident
Comal Springs riffle beetle	*Heterelmis comalensis*	*0*	*3*	*0*	Found in Comal and San Marcos Springs.	LE	E	Resident
Edwards Aquifer diving beetle	*Haideoporus texanus*	*0*	*1*	*0*	Habitat poorly known, found in an artesian well in Hays County.	--	--	Resident
Flint's net-spinning caddisfly	*Cheumatopsyche flinti*	*0*	*1*	*0*	Very poorly known species with habitat description limited to "a spring".	--	--	Resident
Leonora's dancer damselfly	*Argia leonorae*	*1*	*1*	*1*	Species found in south central and western Texas in small streams and seepages.	--	--	Resident
Rawson's metalmark	*Calephelis rawsoni*	*1*	*1*	*1*	Moist areas in shaded limestone outcrops	--	--	Resident
San Marcos saddle-case caddisfly	*Protoptila arca*	*0*	*1*	*0*	Known from an artesian well in Hays County. Very abundant locally.	--	--	Resident
Texas austrotinodes caddisfly	*Austrotinodes texensis*	*0*	*1*	*0*	Thought to be endemic to the karst springs and spring runs of the Edwards Plateau region.	--	--	Resident
MAMMALS								
Cave Myotis Bat	*Myotis velifer*	0	1	*0*	Roosts colonially in caves, rock crevices	--	--	Resident
Plains Spotted Skunk	*Spilogale putorius interrupta*	1	1	*1*	Prefers wooded, brushy areas.	--	--	Resident
Red Wolf	*Canis rufus*	0	3	*0*	Extirpated.	LE	E	Historic Resident
MOLLUSKS								
Creeper (squawfoot)	*Strophitus undulates*	1	1	*1*	Small to large streams	--	--	Resident
False spike mussel	*Quincuncina mitchelli*	1	2	*2*	Substrates of cobble and mud with water lilies present. Rio Grande, Brazos, Colorado and Guadalupe river basins.	--	T	Resident
Golden orb	*Quadrula aurea*	1	2	*2*	Sand and gravel, Guadalupe, San Antonio, and Nueces	C	T	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County(s)
						USFWS	TPWD	
					River basins			
Palmetto pill snail	*Euchemotrema leai cheatumi*	0	1	*0*	Terrestrial snail known only from Palmetto State Park.	--	--	Resident
Texas fatmucket	*Lampsilis bracteata*	1	2	*2*	Streams and rivers on sand, mud and gravel, Colorado and Guadalupe River basins.	C	T	Resident
Texas pimpleback	*Quadrula petrina*	1	2	*2*	Mud, gravel and sand substrates, Colorado and Guadalupe river basins	C	T	Resident
PLANTS								
Big red sage	*Salvia penstemonoides*	1	1	*1*	Endemic; moist to seasonally wet clay or silt soils in creek beds.	--	--	Resident
Bracted twistflower	*Streptanthus bracteatus*	1	1	*1*	Endemic: found in shallow, well-drained gravelly clays and clay loams over limestone.	C	--	Resident
Bristle nailwort	*Paronychia setacea*	0	1	*0*	Endemic plant found in eastern and southcentral Texas in sandy soils.	--	--	Resident
Buckley's spiderwort	*Tradescantia buckleyi*	0	1	*0*	Occurs on sandy loam or clay soils in grasslands or shrublands underlain by the Beaumont Formation.	--	--	Resident
Elmendorf's onion	*Allium elmendorfii*	1	1	*1*	Endemic, in deep sands	--	--	Resident
Green beebalm	*Monarda viridissima*	0	1	*0*	Endemic perennial herb of Carrizo sands found in openings of post oak woodlands.	--	--	Resident
Hill Country wild-mercury	*Argythamnia aphoroides*	1	1	*1*	Endemic: found in grasslands associated with oak woodlands.	--	--	Resident
Park's jointweed	*Polygonella parksii*	1	1	*1*	Endemic; deep loose sands of Carrizo and similar Eocene formations.	--	--	Resident
Sandhill woolywhite	*Hymenopappus carrizoanus*	1	2	*2*	Found south of the Guadalupe River and the Balcones Escarpment. Prefers dense riparian corridors.	--	--	Resident
Shinner's sunflower	*Helianthus occidentalis ssp.*	1	1	*1*	Found mostly in prairies on the Coastal Plain, Pineywoods and South Texas Brush County.	--	--	Resident
Texas wild-rice	*Zizania texana*	*0*	*3*	0	Texas endemic found in spring-fed San Marcos River.	LE	E	Resident
Warnock's coral-root	*Hexalectric warnockii*	*0*	*1*	0	Found among leaf litter and humus in oak-juniper woodlands on shaded slopes and intermittent, rock creekbeds in canyons.	--	--	Resident
REPTILES								
Cagle's map turtle	*Graptemys caglei*	1	2	*2*	Endemic to the Guadalupe River System. Found in short stretches of shallow water.	--	T	Resident
Spot-tailed earless lizard	*Holbrookia lacerata*	1	1	*1*	Moderately open prairie-brushland.	--	--	Resident
Texas Garter Snake	*Thamnophis sirtalis annectens*	1	1	*1*	Wet or moist microhabitats	--	--	Resident
Texas Horned Lizard	*Phrynosoma cornutum*	1	2	*2*	Varied, sparsely vegetated	--	T	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County(s)
						USFWS	TPWD	
					uplands.			
Texas Tortoise	*Gopherus berlandieri*	1	2	*2*	Open brush w/ grass understory.	--	T	Resident
Timber Rattlesnake	*Crotalus horridus*	1	2	*2*	Floodplains, upland pine, deciduous woodlands, riparian zones.	--	T	Resident

LE/LT=Federally Listed Endangered/Threatened
DL, PDL=Federally Delisted/Proposed for Delisting
T/SA=Listed as Threatened by Similarity of Appearance
E, T=State Listed Endangered/Threatened T*= in process of being listed as threatened by State
Blank= Species of concern, but no regulatory listing status
Source: TPWD, 2014. Annotated County List of Rare Species – Caldwell County. Revised 4/28/2014, Hays County Revised 11/3/2014. Gonzales County Revised 4/28/2014. Guadalupe County, Revised 4/28/2014

5.2.25.4 Engineering and Costing

The envisioned and MAG limited formulations of the HCPUA Project each consist of two phases. Phase I plans for the well field to be located in Caldwell County, to begin producing in about 2018, to have a peaking capacity of 21 MGD, and to produce an average of 15,690 acft/yr. Phase II plans for the well field to be located in Gonzales County, to begin producing in about 2032, to have a peaking capacity of 30.8 MGD for the envisioned option and 8.2 MGD for the MAG Limited option. For each formulation, production wells ranging from 1600 – 2910 gpm in capacity will be used to pump raw groundwater to a water treatment plant near the well field for removal of iron and manganese. Treated water would then be delivered to participants along the 91 mile finished water transmission pipeline. The transmission system will have multiple delivery locations and potential for tie-ins along the route. Table 5.2.25-2 includes summary data for each HCPUA project formulation. Participants and supply volumes for each HCPUA Project formulation are summarized in Table 5.2.25-3. Conceptual planning-level engineering and cost estimates were prepared for the HCPUA envisioned project at 35,690 acft/yr (Table 5.2.25-4) and the MAG Limited project at 21,833 acft/yr (Table 5.2.25-5).

Table 5.2.25-2 Project Data for HCPUA Project Options

	Envisioned	MAG Limited
Project Yield	35,690 acft/yr	21,833 acft/yr
Total Wells	20	12
WTP	47.8 MGD	29.2 MGD

Table 5.2.25-3 Project Participants

	Supplies (acft/yr)	
Participant	**Envisioned Project**	**MAG Limited**
Buda	4,033	2,467
Kyle	6,937	4,244
Maxwell WSC	100	0
County Line SUD	570	570
San Marcos	9,000	5,506
Martindale WSC	50	50
Crystal Clear SUD	5,000	4,498
CRWA	10,000	4,498
Total	35,690	21,833

The transmission system will require two booster pump stations and will cross the San Marcos River. The transmission pipeline is assumed to be sized with a 1.5 peaking factor at 54 inch diameter (envisioned) for the segment from the WTP to the first booster pump station. The 36 inch diameter transmission line to the southwest will deliver to CRWA and Crystal Clear SUD (a CRWA member). A 48 inch diameter pipeline continues to the northeast with deliveries to remaining participants. Smaller diameters are used in the transmission system for the MAG-Limited formulation. Other than pump station and WTP storage, the project includes 8 additional storage tanks ranging in capacity from 0.1 MG to 0.6 MG.

Total project costs $415,405,000 and $309,723,000 for the envisioned and MAG limited formulations, respectively. Total annual costs include debt service for the project cost, operation and maintenance costs, power costs, GCUWCD fees estimated at $9.78/acft/yr, and groundwater lease fees estimated at $125/acft/yr (combined minimum and production fees). The total annual unit cost in dollars per acft is the total annual cost divided by the associated dependable, firm water supply.

The annual costs for the envisioned project are $59,381,000 with an annual unit cost of $1,664/acft (Table 5.2.25-4). The MAG limited project has an annual unit cost of $1,926/acft (Table 5.2.25-5).

Table 5.2.25-4 Summary Cost Estimate for Envisioned HCPUA Project

Item	***Estimated Costs for Facilities***
Intake Pump Stations (47.8 MGD)	$18,850,000
Transmission Pipeline (54 in dia., 91 miles)	$120,857,000
Transmission Pump Station(s) & Storage Tank(s)	$5,616,000
Well Fields (Wells, Pumps, and Piping)	$52,718,000
Storage Tanks (Other Than at Booster Pump Stations)	$2,122,000
Water Treatment Plant (47.8 MGD)	$69,225,000
Access Roads	$1,620,000
TOTAL COST OF FACILITIES	**$271,008,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$88,809,000
Advanced Payments for Groundwater	$10,700,000
Test Drilling and Mitigation	$2,301,000
Environmental & Archaeology Studies and Mitigation	$3,255,000
Land Acquisition and Surveying (596 acres)	$12,156,000
Interest During Construction (4% for 2 years with a 1% ROI)	$27,176,000
TOTAL COST OF PROJECT	**$415,405,000**
ANNUAL COST	
Debt Service (5.5 percent, 20 years)	$34,761,000
Operation and Maintenance	
Intake, Pipeline, Pump Station	$2,309,000
Water Treatment Plant (2.5% of Cost of Facilities)	$13,845,000
Pumping Energy Costs (40,623,509 kW-hr @ 0.09 $/kW-hr)	$3,656,000
Purchase of Water (35,690 acft/yr @ 134.78 $/acft)	$4,810,000
TOTAL ANNUAL COST	**$59,381,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 1.5	35,690
Annual Cost of Water ($ per acft)	$1,664
Annual Cost of Water ($ per 1,000 gallons)	$5.11

Table 5.2.25-5 Summary Cost Estimate for MAG-Limited HCPUA Project

Item	Estimated Costs for Facilities
Intake Pump Stations (29.2 MGD)	$14,958,000
Transmission Pipeline (42 in dia., 91 miles)	$90,016,000
Transmission Pump Station(s) & Storage Tank(s)	$6,326,000
Well Fields (Wells, Pumps, and Piping)	$39,583,000
Storage Tanks (Other Than at Booster Pump Stations)	$1,350,000
Water Treatment Plant (29.2 MGD)	$44,598,000
Access Roads	$1,620,000
TOTAL COST OF FACILITIES	**$198,451,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$64,957,000
Advanced Payments for Groundwater	$8,929,000
Test Drilling and Mitigation	$1,909,000
Environmental & Archaeology Studies and Mitigation	$3,129,000
Land Acquisition and Surveying (581 acres)	$12,085,000
Interest During Construction (4% for 2 years with a 1% ROI)	$20,263,000
TOTAL COST OF PROJECT	**$309,723,000**
ANNUAL COST	
Debt Service (5.5 percent, 20 years)	$25,917,000
Operation and Maintenance	
Intake, Pipeline, Pump Station	$1,785,000
Water Treatment Plant (2.5% of Cost of Facilities)	$8,920,000
Pumping Energy Costs (27,607,303 kW-hr @ 0.09 $/kW-hr)	$2,485,000
Purchase of Water (21,833 acft/yr @ 134.78 $/acft)	$2,943,000
TOTAL ANNUAL COST	**$42,050,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 1.5	21,833
Annual Cost of Water ($ per acft)	$1,926
Annual Cost of Water ($ per 1,000 gallons)	$5.91

5.2.25.5 Implementation Issues

Implementation of the HCPUA water management strategy (WMS) could involve conflicts with other water supply plans as they will be competing for limited groundwater supplies within the GCUWCD and the Plum Creek Conservation District. Because the groundwater conservation districts (GCD) permitting processes are largely independent of the regional planning process, potentially competing groundwater management strategies are not prioritized.

For each aquifer in the region, the GCDs have adopted desired future conditions (DFCs). In some GCDs, full use of all groundwater supplies (permitted, grandfathered and exempt) may result in non-achievement of the DFCs for an aquifer. To ensure consistency with the DFCs, TWDB currently requires that groundwater availability for each aquifer be limited for planning purposes to the modeled available groundwater (MAG) for the aquifer. This has resulted, for planning purposes only, in adjustments to permit amounts, and a lack of firm water available for future permits in this plan for some areas for certain time periods. This should not be construed as recommending or requiring that GCDs make these adjustments, or deny future permit applications. SCTRWPG recognizes and supports the ability of permit holders to exercise their rights to groundwater use in accordance with their permits and it recognizes and supports the GCDs discretion to issue permits and grandfather historical users for amounts in excess of the MAG. SCTRWPG may not modify groundwater permits that GCDs have already issued or limit future permits that GCDs may issue. If the MAG is increased during or after this planning cycle, SCTRWPG may amend this Plan to adjust groundwater supply numbers that are affected by the new MAG amount.

There is a possibility that the HCPUA Project could share facilities with other water management strategies in order to realize potential economies of scale. For information regarding these alternatives, please refer to Chapters 5.2.28 and 5.2.29. The HCPUA Project has received its initial groundwater permits from the GCUWCD and has been paying on groundwater leases.

Other implementation issues include:

a. Renewal of GCUWCD 5-year production permits and 30-year export permits for project life; and
b. Additional groundwater development in the region will not have a substantial effect on groundwater levels in the well field areas.

In addition, it will be necessary to obtain the following permits and agreements:

a. USACE Sections 10 and 404 Dredge and Fill Permits for the reservoir and pipelines;
b. GLO Sand and Gravel Removal permits;
c. GLO Easement for use of state-owned land;
d. TPWD Sand, Gravel, and Marl permit; and
e. Private land for construction of facilities to be acquired through either negotiations or condemnation.

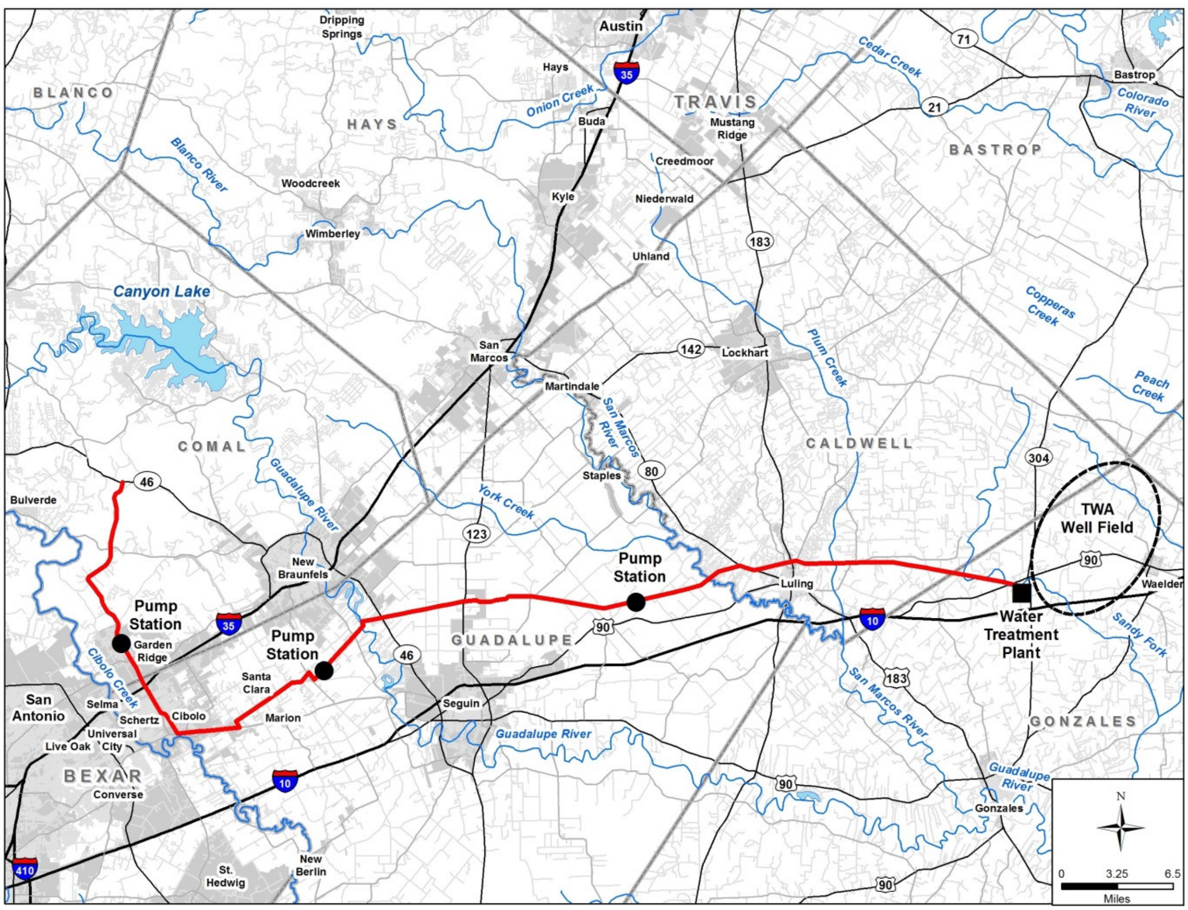
Permitting may require development of a habitat mitigation plan; environmental studies; and/or cultural resource studies and mitigation.

5.2.26 TWA Regional Carrizo

5.2.26.1 Description of Strategy

The Texas Water Alliance (TWA) has secured groundwater leases and permits in northern Gonzales County to deliver up to 15,000 acft/yr of Carrizo Aquifer groundwater to entities in Gonzales, Guadalupe, and Comal Counties (Figure 5.2.26-1). The TWA Regional Carrizo project would deliver 14,500 acft/yr to Springs Hill WSC (3,000 acft/yr) and Canyon Lake Water Service Company (11,500 acft/yr). Another 500 acft/yr would be treated and made available at the water treatment plant (WTP) for Gonzales County WSC. The 75-mile transmission pipeline route illustrated in Figure 5.2.26-1 represents the most advantageous route between the well field and the delivery points.

Figure 5.2.26-1 TWA Regional Carrizo Conceptual Layout



W:\007755\000000000167424_2016_Region_L_Plan\06.00_Project_Engineering_and_Design\GIS\map_docs\arcmap\Option1_TWA.mxd

5.2.26.2 Available Yield

TWA has 42,000 acres under lease and has a groundwater permit from the Gonzales County Underground Water Conservation District (GCUWCD) for 15,000 acft/yr. According to GCUWCD rules, at least 15,000 acres would need to be leased or purchased for the project (i.e., 1 acft per acre allowable production rate) and wells of this capacity would be subject to a setback of 6,000 feet from existing registered Carrizo wells. The proposed well field was selected based on aquifer parameters including depth to water bearing zone, minimizing drawdown interference among wells, and spacing setbacks from existing Carrizo wells in the GCUWCD registered well database.

For each aquifer in the region, the Groundwater Conservation Districts (GCDs) have adopted desired future conditions (DFCs). In some GCDs, full use of all groundwater supplies (permitted, grandfathered, and exempt) may result in non-achievement of the DFCs for an aquifer. To ensure consistency with the DFCs, the Texas Water Development Board (TWDB) currently requires that groundwater availability for each aquifer be limited for planning purposes to the modeled available groundwater (MAG) for the aquifer. This has resulted, for planning purposes only, in the application of project yield limitations for MAG compliance and a lack of firm water available for future permits in this plan for some areas for certain time periods. Currently issued permits from the GCUWCD exceed the MAG. Therefore the firm yield used herein for the TWA Regional Carrizo strategy is limited to 14,680 acft/yr for regional water planning purposes.

5.2.26.3 Environmental Issues

Environmental issues for the proposed groundwater TWA Regional Carrizo water management strategy are described below. This project includes the development of a well field in Gonzales County, an associated water treatment plant, additional pump and booster stations, and an approximately 75 mile transmission pipeline. Implementation of this project would require field surveys by qualified professionals to document vegetation/habitat types, waters of the U.S. including wetlands, and cultural resources that may be impacted. Where impacts to protected species habitat or significant cultural resources cannot be avoided, additional studies would be necessary to evaluate habitat use and/or value, or eligibility for inclusion in the National Register of Historic Places, respectively. Compensation would be required for unavoidable adverse impacts involving net losses of wetlands.

The proposed pipeline would cross the San Marcos and Guadalupe Rivers and their associated tributaries. The Texas Parks & Wildlife Department (TPWD) has identified a number of stream segments throughout the state as ecologically significant on the basis of biological function, hydrologic function, riparian conservation, exceptional aquatic life uses, and/or threatened or endangered species. The transmission pipeline crosses only one of these segments, Geronimo Creek, which is considered ecologically significant due to its high water quality and diverse benthic macroinvertebrate community. Potential impacts to this segment could be avoided by use of horizontal directional drilling for installation of the pipeline stream crossing.

Coordination with the U.S. Army Corps of Engineers would be required for construction within any waters of the U.S. Impacts from this proposed project which result in a loss of less than 0.5 acres of waters of the U.S. could be covered under Nationwide Permit #12 for Utility Line Activities.

The TWA Regional Carrizo water management strategy involves the construction of approximately 75 miles of pipeline from a well field in northern Gonzales County to a delivery point on SH 46 east of Bulverde in Comal County. The pipeline traverses the

East Central Texas Plains, Texas Blackland Prairie, and Edwards Plateau Ecoregions[1] and lies within portions of the Texan, Tamaulipan, and Balconian Biotic Provinces[2].

Vegetation within the project transmission pipeline area near its westernmost point includes a mosaic of Live-Oak Mesquite-Ashe Juniper Parks, Live-Oak Ash Juniper Woods, and Live-Oak Ashe Juniper Parks. The central portion of the pipeline route crosses primarily cropland, and the eastern portion of the transmission pipeline and the well field area includes areas of Post Oak-Wood, Forest, and Grassland Mosaic; and Post Oak Woods/Forest vegetation.[3]

Table 5.2.26-1 lists the 26 state listed endangered or threatened species, and the 10 federally listed endangered or threatened species along with species of concern that may occur in Caldwell, Comal, Gonzales, or Guadalupe Counties. This information comes from the county lists of rare species published by Texas Parks and Wildlife Department (TPWD) online in the “Annotated County Lists of Rare Species.” Inclusion in this table does not mean that a species will occur within the project area, but acknowledges the potential for its occurrence in the project area counties.

In addition to the county lists, data received from the Natural Diversity Database (NDD), which is maintained by TPWD, was reviewed for known occurrences of listed species within or near the project area. This database documents occurrences of the Cagle’s Map Turtle, Cascade Caverns salamander, golden orb, Texas pimpleback, and Comal blind salamander, all state threatened species near the pipeline route. In addition, the endangered Golden-cheeked Warbler, a species listed both by the federal and state governments as endangered, has documented occurrences near the western terminus of the pipeline. Other species of concern which are documented near the well field or pipeline area include the Guadalupe bass, Shinner’s sunflower, mountain plover, and bracted twistflower which are all species of concern, but lacking regulatory status. A survey of the project area may be required prior to pipeline construction to determine whether populations of or potential habitats used by listed species occur in the area to be affected. Coordination with TPWD and the U.S. Fish and Wildlife Service (USFWS) regarding threatened and endangered species with potential to occur in the project area should be initiated early in project planning.

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 (Pl96-515), and the Archeological and Historic Preservation Act (PL93-291). Based on the review of publically available Geographic Information System (GIS) records obtained from the Texas Historical Commission, there are no State Historic Sites, National Register Properties, or National Register Districts within one mile of the transmission pipeline or within the well field area. However, 9 Historical Markers and 21 cemeteries occur within one mile of the transmission pipeline. In addition, two cemeteries occur within the well field area.

[1] Griffith Glenn, Sandy Bryce, James Omernik, and Anne Rogers. 2007. Ecoregions of Texas. Texas Commission on Environmental Quality.
[2] Blair, W. Frank. 1950. The Biotic Provinces of Texas. Texas Journal of Science 2(1):93-117.
[3] McMahan, Craig A., Roy G. Frye and Kirby L. Brown. 1984. The Vegetation Types of Texas. Wildlife Division, Texas Parks and Wildlife Department, Austin, Texas.

Table 5.2.26-1 Endangered, Threatened, and Species of Concern for Caldwell, Comal, Gonzales and Guadalupe Counties

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County
						USFWS	TPWD	
AMPHIBIANS								
Cascade Caverns salamander	*Eurycea latitans complex*	*1*	*2*	*2*	Endemic, subaquatic in Edwards Aquifer Area		T	Resident
Comal blind salamander	*Eurycea tridentifera*	*1*	*2*	*2*	Endemic; springs and waters of caves in Bexar County.		T	Resident
Comal Springs salamander	*Eurycea sp. 8*	*0*	*1*	*0*	Endemic to Comal Springs			Resident
Edwards Plateau spring salamander	*Eurycea sp.7*	*0*	*1*	*0*	Endemic to springs and waters of some caves of this region			Resident
BIRDS								
American Peregrine Falcon	*Falco peregrinus anatum*	*0*	*2*	*0*	Resident and local breeder in West Texas. Migrant across the state.	DL	T	Possible Migrant
Arctic peregrine falcon	*Falco peregrinus tundrius*	*0*	*1*	*0*	Migrant throughout the state.	DL		Possible Migrant
Bald eagle	*Haliaeetus leucocephalus*	*0*	*2*	*0*	Found primarily near rivers and large lakes, migrant.	DL	T	Possible Migrant
Black-capped Vireo	*Vireo atricapillus*	*0*	*3*	*0*	Oak-juniper woodlands,	LE	E	Resident
Golden-cheeked Warbler	*Setophaga chrysoparia*	*1*	*3*	*3*	Juniper-oak woodlands.	LE	E	Resident
Henslow's Sparrow	*Ammodramus henslowii*	*0*	*1*	*0*	Wintering individuals found in weedy or cut-over areas.			Possible Migrant
Interior least tern	*Sterna antillarum athalassos*	*0*	*3*	*0*	Nests along sand and gravel bars in braided streams	LE	E	Resident
Mountain Plover	*Charadrius montanus*	*1*	*1*	*1*	Non-breeding, shortgrass plains and fields			Nesting/Migrant
Sprague’s Pipit						C		
Western Burrowing Owl	*Athene cunicularia hypugaea*	*0*	*1*	*0*	Open grasslands, especially prairie, plains and savanna			Resident
Whooping Crane	*Grus americana*	*0*	*3*	*0*	Potential migrant	LE	E	Potential Migrant
Wood Stork	*Mycteria americana*	*0*	*2*	*0*	Forages in prairie ponds, ditches, and shallow standing water formerly nested in TX		T	Migrant
Zone-tailed Hawk	*Buteo albonotatus*	*0*	*2*	*0*	Arid open country, often near watercourses		T	Resident
CRUSTACEANS								
Ezell's cave amphipod	*Stygobromus flagellatus*	*0*	*1*	*0*	Known only from artesian wells.			Resident
Long-legged cave amphipod	*Stygobromus longipes*	*1*	*1*	*1*	Subaquatic crustacean, subterranean obligate found in subterranean streams			Resident
Peck's cave amphipod	*Stygobromus pecki*	*0*	*1*	*0*	Small aquatic crustacean. Lives underground in the Edwards Aquifer. Collected at Comal and Hueco Springs.	LE	E	Resident
FISH								
Blue sucker	*Cycleptus elongatus*	0	2	*0*	Found in larger portions of major rivers in Texas.		T	Resident
Fountain darter	*Etheostoma fonticola*	0	3	*0*	Known only from the San Marcos and Comal rivers. Found in springs and spring-fed streams in dense beds of aquatic plants.	LE	E	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County
						USFWS	TPWD	
Guadalupe Bass	*Micropterus treculi*	*1*	*1*	*1*	Endemic to perennial streams of the Edwards Plateau region.			Resident
Guadalupe darter	*Percina sciera apristis*	*1*	*1*	*1*	Guadalupe River basin, found over gravel and sand raceways of larger streams and rivers.			Resident
INSECTS								
A mayfly	*Campurus decolaratus*	*0*	*1*	*0*	Found in Texas and Mexico, possibly in clay substrates.			Resident
A mayfly	*Pseudocentroptiloides morihari*	*0*	*1*	*0*	Mayflies are distinguished by an aquatic larval stage. Adults are generally found in shoreline vegetation.			Resident
Comal Springs diving beetle	*Comaldessus stygius*	*0*	*1*	*0*	Known only from the outrlows at Comal Springs.			Resident
Comal Springs dryopid beetle	*Stygoparnus comalensis*	*0*	*3*	*0*	These beetles usally cling to objects in streams.	LE	E	Resident
Comal Springs riffle beetle	*Heterelmis comalensis*	*0*	*3*	*0*	Found in Comal and San Marcos Springs.	LE	E	Resident
Edwards Aquifer diving beetle	*Haideoporus texanus*	*0*	*1*	*0*	Habitat poorly known, found in an artesian well in Hays County.			Resident
Rawson's metalmark	*Calephelis rawsoni*	*1*	*1*	*1*	Moist areas in shaded limestone outcrops			Resident
MAMMALS								
Black Bear	*Ursus americanus*	0	2	*0*	Inhabits bottomland hardwoods	T/SA;NL	T	Historic Resident
Cave Myotis Bat	*Myotis velifer*	0	1	*0*	Roosts colonially in caves, rock crevices			Resident
Jaguarundi	*Herpailurus yaguarondi*	0	3	*0*	Prefers thick brushlands near water.	LE	E	Possible Migrant
Plains Spotted Skunk	*Spilogale putorius interrupta*	1	1	*1*	Prefers wooded, brushy areas.			Resident
Red Wolf	*Canis rufus*	0	3	*0*	Extirpated.	LE	E	Historic Resident
MOLLUSKS								
Creeper (squawfoot)	*Strophitus undulates*	0	1	*0*	Small to large streams			Resident
False spike mussel	*Quincuncina mitchelli*	1	2	*2*	Substrates of cobble and mud with water lilies present. Rio Grande, Brazos, Colorado and Guadalupe river basins.		T	Resident
Golden orb	*Quadrula aurea*	1	2	*2*	Sand and gravel, Guadalupe, San Antonio, and Nueces River basins	C	T	Resident
Horsehoe liptooth snail	*Daedalochila hippocrepis*	0	1	*0*	Terrestrial snail known only from Landa Park in New Braunfels.			Resident
Palmetto pill snail	*Euchemotrema leai cheatumi*	0	1	*0*	Terrestrial snail known only from Palmetto State Park.			Resident
Texas fatmucket	*Lampsilis bracteata*	1	2	*2*	Streams and rivers on sand, mud and gravel, Colorado and Guadalupe River basins.	C	T	Resident
Texas pimpleback	*Quadrula petrina*	1	2	*2*	Mud, gravel and sand substrates, Colorado and Guadalupe river basins.	C	T	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County
						USFWS	TPWD	
PLANTS								
Big red sage	*Salvia penstemonoides*	0	1	*0*	Endemic; moist to seasonally wet clay or silt soils in creek beds.			Resident
Bracted twistflower	*Streptanthus bracteatus*	2	1	*2*	Endemic: found in shallow, well-drained gravelly clays and clay loams over limestone.	C		Resident
Bristle nailwort	*Paronychia setacea*	0	1	*0*	Endemic plant found in eastern and south central Texas in sandy soils.			Resident
Buckley's spiderwort	*Tradescantia buckleyi*	0	1	*0*	Occurs on sandy loam or clay soils in grasslands or shrublands underlain by the Beaumont Formation.			Resident
Comal snakewood	*Colubrina stricta*	0	1	*0*	Found in El Paso County, historic in Comal County.			Historic Resident
Elmendorf's onion	*Allium elmendorfii*	0	1	*0*	Endemic, in deep sands			Resident
Green beebalm	*Monarda viridissima*	0	1	*0*	Endemic perennial herb of Carrizo sands found in openings of post oak woodlands.			Resident
Hill Country wild-mercury	*Argythamnia aphoroides*	1	1	*1*	Endemic: found in grasslands associated with oak woodlands.			Resident
Park's jointweed	*Polygonella parksii*	0	1	*0*	Endemic; deep loose sands of Carrizo and similar Eocene formations.			Resident
Sandhill woolywhite	*Hymenopappus carrizoanus*	0	2	*0*	Found south of the Guadalupe River and the Balcones Escarpment. Prefers dense riparian corridors.			Resident
Shinner's sunflower	*Helianthus occidentalis ssp.*	2	1	*2*	Found mostly in prairies on the Coastal Plain, Pineywoods and South Texas Brush County.			Resident
Texas mock-orange	*Philadelphus texensis*	*0*	*1*	*0*	Found on limestone outcrops on cliffs and rocky slopes.			Resident
REPTILES								
Cagle's map turtle	*Graptemys caglei*	1	2	*2*	Endemic to the Guadalupe River System. Found in short stretches of shallow water.		T	Resident
Spot-tailed earless lizard	*Holbrookia lacerata*	0	1	*0*	Moderately open prairie-brushland.			Resident
Texas Garter Snake	*Thamnophis sirtalis annectens*	1	1	*1*	Wet or moist microhabitats			Resident
Texas Horned Lizard	*Phrynosoma cornutum*	1	2	*2*	Varied, sparsely vegetated uplands.		T	Resident
Texas Tortoise	*Gopherus berlandieri*	1	2	*2*	Open brush w/ grass understory.		T	Resident
Timber Rattlesnake	*Crotalus horridus*	1	2	*2*	Floodplains, upland pine, deciduous woodlands, riparian zones.		T	Resident

LE/LT=Federally Listed Endangered/Threatened, Blank= Species of concern, but no regulatory listing status
DL, PDL=Federally Delisted/Proposed for Delisting
T/SA=Listed as Threatened by Similarity of Appearance
E, T=State Listed Endangered/Threatened T*= in process of being listed as threatened by State
Source: TPWD, 2015. Annotated County List of Rare Species – Caldwell County. Revised 4/28/2014.
Comal County. Revised 10/2/2012. Gonzales County Revised 4/28/2014. Guadalupe County, 4/28/2014.

Avoidance of these cultural resource areas should be possible by careful selection of the areas for well sites and their associated pipelines. A review of archaeological resources in the proposed project area should be conducted during the project planning phase. Because the owner or controller of the project will likely be a political subdivision of the State of Texas (i.e., river authority, municipality, water district, etc.), they will be required to coordinate with the Texas Historical Commission prior to project construction

5.2.26.4 Engineering and Costing

Conceptual planning-level engineering and cost estimates were prepared for the TWA envisioned project at 15,000 acft/yr (Table 5.2.26-2) and the MAG Limited project at 14,680 acft/yr (Table 5.2.26-3).

In either case, the well field is assumed to include 13 - 1073 gpm Carrizo wells and two standby wells. The well field, WTP, and transmission facilities are sized with a 1.5 peaking factor. The transmission pipeline will require three booster pump stations. Pipeline diameters are: 36 inches for the segment from the WTP adjacent well field to the Crystal Clear SUD delivery point, 30 inches from the Crystal Clear SUD delivery point to the CRWA delivery point, and 24 inches from the CRWA delivery point to the Bulverde delivery point.

Total project costs are $279,632,000 for the envisioned or MAG-Limited alternative, but the annual costs are slightly different based on firm yield. The total annual cost includes debt service for the project cost, operation and maintenance costs, power costs, GCUWCD fees estimated at $9.78/acft/yr, and groundwater lease fees estimated at $125/acft/yr (combined minimum and production fees). The total annual unit cost in dollars per acft is the total annual cost divided by the associated dependable, firm water supply.

The annual costs for the envisioned alternative under average conditions are $36,601,000 with a unit cost of $2,440/acft (Table 5.2.26-2). The MAG Limited alternative has a unit cost of $2,490/acft (Table 5.2.26-3).

Table 5.2.26-2 Summary Cost Estimate for TWA Regional Carrizo Envisioned Project (September 2013 Prices)

Item	*Estimated Costs for Facilities*
Primary Pump Stations (20.1 MGD)	$4,655,000
Transmission Pipeline (30 in & 36 in dia., 75 miles)	$89,368,000
Transmission Pump Station(s) & Storage Tank(s)	$17,503,000
Well Fields (Wells, Pumps, and Piping)	$26,680,000
Storage Tanks (Other Than at Booster Pump Stations)	$1,075,000
Water Treatment Plant (20.1 MGD)	$32,455,000
Access Roads	$1,632,000
TOTAL COST OF FACILITIES	**$173,368,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$56,210,000
Advanced Payments for Groundwater	$13,005,000
Test Drilling and Mitigation	$775,000
Environmental & Archaeology Studies and Mitigation	$3,262,000
Land Acquisition and Surveying (550 acres)	$10,512,000
Interest During Construction (4% for 2.5 years with a 1% ROI)	$22,500,000
TOTAL COST OF PROJECT	**$279,632,000**
ANNUAL COST	
Debt Service (5.5 percent, 20 years)	$23,399,000
Operation and Maintenance	
Intake, Pipeline, Pump Station (1% of Cost of Facilities)	$1,688,000
Water Treatment Plant (2.5% of Cost of Facilities)	$6,491,000
Pumping Energy Costs (33,565,694 kW-hr @ 0.09 $/kW-hr)	$3,021,000
Purchase of Water (15,000 acft/yr @ 134.78 $/acft)	$2,022,000
TOTAL ANNUAL COST	**$36,601,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 1.5	15,000
Annual Cost of Water ($ per acft)	$2,440
Annual Cost of Water ($ per 1,000 gallons)	$7.49

Table 5.2.26-3 Summary Cost Estimate for TWA Regional Carrizo MAG-Limited Project (September 2013 Prices)

Item	*Estimated Costs for Facilities*
Primary Pump Stations	$4,655,000
Transmission Pipeline (36 in dia., 75 miles)	$89,368,000
Transmission Pump Station(s) & Storage Tank(s)	$17,503,000
Well Fields (Wells, Pumps, and Piping)	$26,680,000
Storage Tanks (Other Than at Booster Pump Stations)	$1,075,000
Water Treatment Plant (20.1 MGD)	$32,455,000
Access Roads	$1,632,000
TOTAL COST OF FACILITIES	**$173,368,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$56,210,000
Advanced Payments for Groundwater	$13,005,000
Test Drilling and Mitigation	$775,000
Environmental & Archaeology Studies and Mitigation	$3,262,000
Land Acquisition and Surveying (550 acres)	$10,512,000
Interest During Construction (4% for 2.5 years with a 1% ROI)	$22,500,000
TOTAL COST OF PROJECT	**$279,632,000**
ANNUAL COST	
Debt Service (5.5 percent, 20 years)	$23,399,000
Operation and Maintenance	
Intake, Pipeline, Pump Station (1% of Cost of Facilities)	$1,668,000
Water Treatment Plant (2.5% of Cost of Facilities)	$6,491,000
Pumping Energy Costs (33,432,979 kW-hr @ 0.09 $/kW-hr)	$3,009,000
Purchase of Water (14,680 acft/yr @ 134.78 $/acft)	$1,979,000
TOTAL ANNUAL COST	**$36,546,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 1.5	14,680
Annual Cost of Water ($ per acft)	$2,490
Annual Cost of Water ($ per 1,000 gallons)	$7.64

5.2.26.5 Implementation Issues

For each aquifer in the region, the GCDs have adopted desired future conditions (DFCs). In some GCDs, full use of all groundwater supplies (permitted, grandfathered and exempt) may result in non-achievement of the DFCs for an aquifer. To ensure consistency with the DFCs, TWDB currently requires that groundwater availability for each aquifer be limited for planning purposes to the modeled available groundwater (MAG) for the aquifer. This has resulted, for planning purposes only, in adjustments to permit amounts, and a lack of firm water available for future permits in this plan for some areas for certain time periods. This should not be construed as recommending or requiring that GCDs make these adjustments, or deny future permit applications. SCTRWPG recognizes and supports the ability of permit holders to exercise their rights to groundwater use in accordance with their permits and it recognizes and supports the GCDs discretion to issue permits and grandfather historical users for amounts in excess of the MAG. SCTRWPG may not modify groundwater permits that GCDs have already issued or limit future permits that GCDs may issue. If the MAG is increased during or after this planning cycle, SCTRWPG may amend this Plan to adjust groundwater supply numbers that are affected by the new MAG amount.

There is a possibility that TWA could share facilities with other water management strategies in order to realize potential economies of scale. For information regarding these alternatives, please refer to Chapters 5.2.28 and 5.2.29. The TWA well field has received its groundwater permits from the GCUWCD and has been paying on groundwater leases.

Other implementation issues include:

a. Renewal of GCUWCD 5-year production permits and 30-year export permits for project life; and
b. Additional groundwater development in the region will not have a substantial effect on groundwater levels in the well field areas.

In addition, it will be necessary to obtain the following permits and agreements:

a. USACE Sections 10 and 404 Dredge and Fill Permits for the reservoir and pipelines;
b. GLO Sand and Gravel Removal permits;
c. GLO Easement for use of state-owned land;
d. TPWD Sand, Gravel, and Marl permit; and
e. Private land for construction of facilities to be acquired through either negotiations or condemnation.

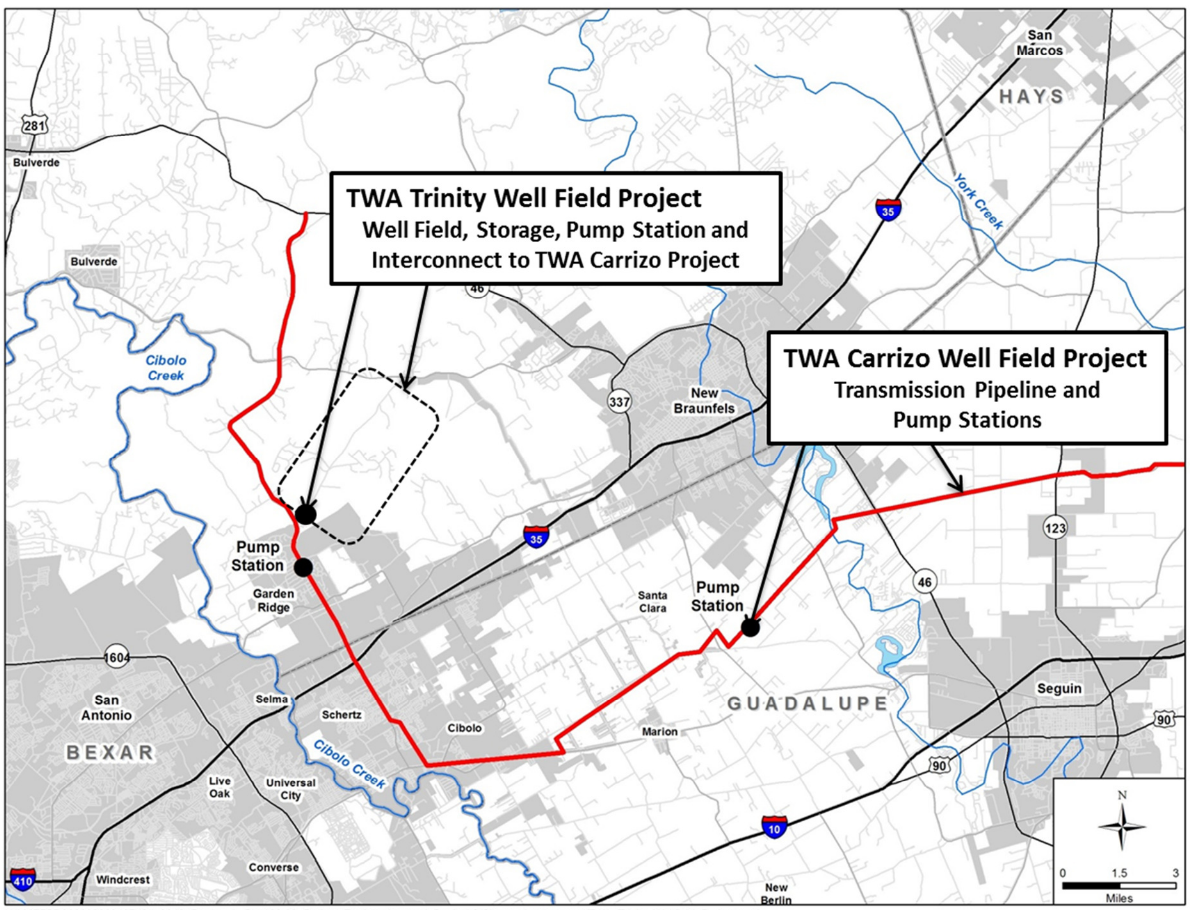
Permitting may require development of an habitat mitigation plan; environmental studies; and/or cultural resource studies and mitigation.

5.2.27 Texas Water Alliance Trinity Well Field Project

5.2.27.1 Description of Strategy

Texas Water Alliance (TWA) has groundwater leases in Northeastern Gonzales County to deliver up to 15,000 acft/yr of Carrizo Aquifer groundwater to entities in Gonzales, Guadalupe and Comal Counties. Figure 5.2.27-1 illustrates the approximate pipeline route from the TWA Carrizo Well Field Project to south-central Comal County. To meet additional water needs in Comal County or to free up some of the water from the Carrizo well field for others in Gonzales, Guadalupe and Comal Counties, a TWA Trinity Well Field Project would pump an additional 5,000 acft/yr from the Trinity Aquifer in southern Comal County. The 71-mile transmission pipeline route illustrated in Figure 5.2.27-1 represents the most advantageous route between the Gonzales Carrizo Aquifer well field and the delivery points. The Trinity Well Field Project would have an interconnect to this pipeline in the vicinity of Garden Ridge.

Figure 5.2.27-1 Potential Location of TWA Trinity Well Field Project



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5.2.27.2 Available Yield

The TWA Trinity Well Field Project's preliminary design includes eight production and two standby wells. With an estimated well yield of 400 gallons per minute (gpm), annual average production is expected be 5,000 acft/yr.

An assessment of groundwater availability consists of calculating a water balance of the Trinity Aquifer in Comal County between the supply, as determined by from the Modeled Available Groundwater (MAG), and the estimated demands from current users. These calculations suggest that there is sufficient groundwater availability from the Trinity Aquifer in Comal County for this project.

5.2.27.3 Environmental Issues

The Trinity Well Field Project for on of TWA's water management strategy involves ten new water wells, a collection pipeline, ground storage tank, water treatment plant (WTP), pump station and interconnect. Environmental issues for this water management strategy are described below.

The project area occurs within the Edwards Plateau ecoregion[1] and is within portions of the Balconian biotic province.[2] The wells, storage tank, pipelines, pump station and the WTP site are anticipated to have limited impacts to existing terrestrial habitat. Part of the project area includes some residential single and multifamily structures immediately west of the City of Garden Ridge. The remaining project area is relatively undeveloped. The project area is located within an area identified by Texas Parks and Wildlife Department (TPWD) as live oak-Ashe juniper woods.

Outside any required maintained right-of-way, land use would not be anticipated to change due to the well or pipeline construction. Impacts to land use would be limited to the removal of existing vegetation and temporary impacts during construction. Herbaceous habitats would recover fastest from construction impacts and would experience low negative impacts. Any impacts to woody vegetation would be permanent within areas of pipeline and WTP maintenance. The proposed wells would have a minimal impact on vegetation within the project area due to limited surface exposure.

The project area lies within an environmentally sensitive area known as the Edwards Aquifer. Numerous enhanced karst features occur within this area, and as a result the Edwards Aquifer is one of the most productive groundwater reservoirs in the country. The project area is located within the recharge zone of the Edwards Aquifer. The recharge zone includes an area where highly faulted and fractured Edwards limestone outcrops occur at the surface, providing a means for large quantities of water to flow into the Edwards Aquifer. Recognizing the importance of maintaining water quality within the Edwards Aquifer, the Texas legislature mandated the protection of this aquifer through the TCEQ under Title 30 Texas Administrative Code (TAC), Chapter 213.

No crossings of jurisdictional waters could occur from this project. Runoff from the project area would enter Dry Comal Creek and ultimately the Guadalupe River. Avoidance and minimization measures, including construction best management practices (BMPs) would reduce the potential impacts from pipelines and other construction activities. The

[1] Gould, F.W. 1975. The Grasses of Texas. Texas A&M University Press. College Station, Texas.
[2] Blair, W.F., "The Biotic Provinces of Texas, "Tex. J. Sci. 2:93-117, 1950.

WTP site, pipelines, storage tank and wells are located within Federal Emergency Management Agency (FEMA) floodplain Zone X which does not include flood hazard areas.

The TCEQ 2010 Texas Integrated Report for Clean Water Act Section 303(d) lists Dry Comal Creek as a Category 5b water body. This listing indicates Dry Comal Creek is impaired because it "does not meet applicable water quality standards or is threatened for one" and "a review of the water quality standards for this water body will be conducted before a Total Maximum Daily Load (TMDL) is scheduled." Bacteria levels are the parameter on which TCEQ bases this designation. The designation applies to TCEQ Segment ID 1811A, which occurs from the confluence of the Comal River in New Braunfels in Comal County to the upstream perennial portion of the stream southwest of New Braunfels. Any potential impacts to this river segment from the development of this project would be temporary and avoidable with the use of minimization practices such as BMPs.

The TPWD has identified a number of stream segments throughout the state as ecologically significant on the basis of biological function, hydrologic function, riparian conservation, exceptional aquatic life uses, and/or threatened or endangered species. Currently, twenty one stream segments in Region L are considered ecologically significant by the TPWD.[3]

The Guadalupe River from the confluence of the Comal River upstream to the Kendall/Kerr County Line, with the exception of Canyon Reservoir is considered to be ecologically significant on the basis of hydrologic function, the existence of a riparian conservation area (Guadalupe River State Park), and high water quality/exceptional aquatic life/high aesthetic value.

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 (Pl96-515), and the Archeological and Historic Preservation Act (PL93-291). Based on the review of available Texas Historical Commission (THC) geographic information system (GIS) datasets, there are no cemeteries, national register properties or districts, or historical markers located near or within the project area. However records from the THC indicate that an archeological testing survey was conducted in the project area.

A review of archaeological resources in the proposed project area should be conducted during the project planning phase. Taking into consideration that the owner or controller of the project will likely be a political subdivision of the State of Texas (i.e. river authority, municipality, county, etc.), they will be required to coordinate with the Texas Historical Commission regarding impacts to cultural resources.

The species listed by U.S. Fish and Wildlife Service (USFWS), and TPWD, as endangered or threatened with potential habitat in Comal County are listed in Table 5.2.27-1. Information provided by the Texas Natural Diversity Database (TXDD), which is maintained by TPWD, was included in this analysis. The TXDD documents the occurrence of rare species within Texas. No listed species have been recorded within the

[3] TPWD, "Ecologically Significant River and Stream Segments," http://www.tpwd.state.tx.us/landwater/water/environconcerns/water_quality/sigsegs/index.phtml accessed February 6, 2014.

project area; however the Texas blind salamander, an endangered species, has been documented less than one mile from the project area, and three plant species of concern including the Texas amorpha, bracted twistflower and buckley tridens occur within the project area. The absence of data from the TNDD does not imply the absence of occurrence for listed species. The well field, pumps, pipelines, and WTP site include limited potential for impacts to listed species. The project area may provide potential habitat to endangered or threatened species found in Comal County. A survey of the project area may be required prior to pipeline, WTP, storage tank and well construction to determine whether populations of or potential habitats used by listed species occur in the area to be affected. Coordination with TPWD and USFWS regarding threatened and endangered species with the potential to occur in the project area should be initiated early in project planning.

Based on existing habitat types, the following species have potential to occur near or within the project area. The aquatic species are primarily a concern if project actions negatively impact the Edwards or Trinity Aquifers.

A. Federal and State-Listed Endangered Species

- Texas blind salamander (*Eurycea rathbuni*), recorded occurrence less than one mile from the project area.
- Black-capped vireo (*Vireo atricapilla*), no confirmed sightings within the project area. Potential for preferred habitat within the project area is low.
- Golden-cheeked warbler (*Setophaga chrysoparia*), no confirmed sightings within the project area, however potential habitat may occur.
- Whooping Crane (*Grus americana*) — The Whooping Crane is a federally listed species which occurs in Texas only during migration. Whooping cranes use a variety of habitats during migration, including croplands for feeding and large, marshy palustrine wetlands for roosting.
- Fountain darter (*Etheostoma fonticola*), this small fish is only known from the San Marcos and Comal Rivers.
- Comal Springs dryopid beetle (*Stygoparnus comalensis*), critical habitat for this species has been established at Comal Springs which occurs 1.7 mile east of the project area.
- Comal Springs riffle beetle (*Heterelmis comalensis*), critical habitat for this species has been established at Comal Springs which occurs 1.7 mile east of the project area.
- Jaguarundi (*Herpailurus yaguarondi*), preferred habitat of thick brushlands near water is not present within the project area.

B. Federal-Listed Candidate Species

- Golden Orb (*Quadrula aurea*) — The golden orb is a federal candidate for listing and is state threatened. This freshwater mollusk exists in sand, gravel or mud substrates within lake or river systems. The TPWD designates a segment of the Guadalupe River as an Ecologically Significant Stream Segment based on the occurrence of the golden orb. This species could potentially occur in perennial water sources like the Guadalupe River.
- Texas fatmucket (*Lampsislis bracteata*), this species is a federal candidate for listing in the state and is state threatened. This freshwater mollusk exists in more shallow rivers or streams with substrates of sand, mud and gravel. This species could potentially occur in perennial streams, like the Guadalupe River.

C. State-Listed Threatened Species

- Cascade Caverns salamander (*Eurycea latitans complex*), a threatened subaquatic species found in the Guadalupe river watershed within the Edwards Aquifer area. Impacts to the Edwards Aquifer could affect this species.
- Comal blind salamander (*Eurycean tridentifera*), threatened species found in springs and waters of caves. Impacts to the Edwards Aquifer could affect this species.
- Bald eagle (*Haliaeetus leucocephalus*) — The bald eagle is a state-listed threatened species that could occur as a migrant near major aquatic resources. Although they breed primarily in the eastern half of the state, they could potentially occur along rivers or large lakes in this region of Texas during the winter and during migration. This species could potentially occur near perennial waterways.
- Peregrine falcon (*Falco peregrinus*), including the American peregrine falcon (*F. p. anatum*) subspecies, is a state threatened bird that could be a possible migrant. These birds utilize a wide range of habitats during migration, including urban areas and landscape edges such as lakes or large river shores.
- Zone-tailed hawk (*Buteo albonotatus*), found in arid open country near watercourses.
- False spike mussel (*Quadrula mitchelli*) is state threatened freshwater mollusk. The TPWD county list states the species as possibly extirpated in Texas. This species could potentially occur in perennial water sources like the Guadalupe River.
- Cagle's map turtle (*Graptemys caglei*) is a state threatened reptile which occupies riverine habitat in the Guadalupe-San Antonio river systems. They prefer shallow water with swift to moderate flow and a substrate of gravel or cobble or deeper pools with a slower flow rate and a substrate of silt or mud.

- Texas horned lizard (*Phrynosoma cornutum*) is a state threatened reptile present throughout much of the state. They exist in open, arid, and semi-arid regions with sparse vegetation, which includes grass, cactus, scattered brush or scrubby trees. This species could potentially occur in areas with this type of contiguous vegetation.

Additional species of concern occur within the project area, including species which are dependent on habitat which is supported by spring flow or aquifer occurrence. Implementation of this project would require field surveys by qualified professionals to document vegetation/habitat types and cultural resources that may be impacted. Where impacts to protected species habitat or significant cultural resources cannot be avoided, additional studies would be necessary to evaluate habitat use and/or value, or eligibility for inclusion in the National Register of Historic Places, respectively.

Table 5.2.27-1 Endangered, Threatened, and Species of Concern for Comal County

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
AMPHIBIANS								
Cascade Caverns salamander	*Eurycea latitans complex*	1	2	2	Endemic subaquatic species found in the Medina and Guadalupe Rivers and Cibolo Creek watersheds within the Edwards Aquifer area.		T	Resident
Comal blind salamander	*Eurycea tridentifera*	1	2	2	Endemic semi-troglobitic species found in springs and waters of caves.		T	Resident
Comal Springs salamander	*Eurycea sp. 8*	1	1	1	Endemic species found in Comal Springs.			Resident
Edwards Plateau spring salamanders	*Eurycea sp. 7*	1	1	1	Endemic species found in springs and caves of the region.			Resident
Texas blind salamander	*Eurycea rathbuni*	1	3	3	Troglobitic species found in water-filled subterranean caverns.	LE	E	Resident
BIRDS								
American peregrine falcon	*Falco peregrinus anatum*	0	2	0	Migrant and local breeder in West Texas.	DL	T	Possible Migrant
Artic peregrine falcon	*Falco peregrinus tundrius*	0	1	0	Migrant throughout the state.	DL		Possible Migrant
Bald eagle	*Haliaeetus leucocephalus*	0	2	0	Found primarily near rivers and large lakes.	DL	T	Possible Migrant
Black-capped vireo	*Vireo atricapilla*	0	3	0	Oak-juniper woodlands with distinctive patchy, tow-layered aspect.	LE	E	Possible Migrant
Golden-cheeked warbler	*Setophaga chrysoparia*	1	3	3	Juniper-oak woodlands, dependent on mature Ashe juniper for bark.	LE	E	Possible Migrant
Mountain plover	*Charadrius montanus*	1	1	1	Non-breeding, shortgrass plains and fields			Nesting/ Migrant
Sprague's pipit	*Anthus spragueii*	0	1	0	Migrant in Texas in winter mid Sept. to early April. Strongly tied to native upland prairie.			Possible Migrant

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
Western burrowing owl	*Athene cunicularia hypugaea*	1	1	1	Open grasslands, especially prairie, plains and savanna			Resident
Whooping crane	*Grus americana*	0	3	0	Potential migrant	LE	E	Potential Migrant
Zone-tailed hawk	*Buteo albonotatus*	0	2	0	Located in arid open county, often near watercourses.		T	Resident
CRUSTACEANS								
Ezell's cave amphipod	*Stygobromus flagellates*	0	1	0	Aquatic obligate known only from artesian wells.			Occurs near San Marcos
Long-legged cave amphipod	*Stygobromus longipes*	0	1	0	Subaquatic, subterranean obligate			Resident
Peck's cave amphipod	*Stygobromus pecki*	0	3	0	Small, aquatic species which lives underground in the Edwards Aquifer.	LE	E	Resident
FISHES								
Fountain darter	*Etheostoma fonticola*	1	3	1	Known only from the San Marcos and Comal Rivers.	LE	E	Resident
Guadalupe bass	*Micropterus treculi*	1	1	1	Endemic to perennial streams of the Edwards Plateau region.			Resident
Guadalupe darter	*Percina sciera apristis*	1	1	1	Guadalupe River Basin. Usually found over gravel or gravel and sand raceways of larger streams and rivers.			Resident
INSECTS								
A mayfly	*Campsurus decolaratus*	0	1	0	In Texas and Mexico, possibly clay substrates, found in shoreline vegetation.			Resident
Comal Springs diving beetle	*Comaldessus stygius*	1	1	1	Known only from the outflows at Comal Springs, aquatic.			Resident
Comal Springs dryopid beetle	*Stygoparnus comalensis*	1	3	3	Usually found clinging to objects in a stream.	LE	E	Resident
Comal Springs riffle beetle	*Heterelmis comalensis*	1	3	3	Found in Comal and San Marcos Springs	LE	E	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
Edwards Aquifer diving beetle	*Haideoporus texanus*	0	1	0	Known from an artesian well in Hays County			Potential Resident
Rawson's metalmark	*Calephelis rawsoni*	1	1	1	Found in moist areas in shaded limestone outcrops in central Texas.			Resident
MAMMALS								
Black bear	*Ursus americanus*	0	2	0	Found in bottomland hardwoods and large tracts of inaccessible forested areas.	T/SA; NL	T	Historic Resident
Cave myotis bat	*Myotis velifer*	0	1	0	Roosts colonially in caves, rock crevices			Resident
Jaguarundi	*Herpailurus yaguarondi*	0	3	0	Thick brushlands near water is favored by this species.	LE	E	Resident
Plains spotted skunk	*Spilogale putorius interrupta*	1	1	1	Prefers wooded, brushy areas.			Resident
Red wolf	*Canis rufus*	0	3	0	Extirpated, formerly known throughout the eastern half of Texas.	LE	E	Historic Resident
MOLLUSKS								
Creeper (squawfoot)	*Strophitus undulates*	1	1	1	Small to large streams. Colorado, Guadalupe, and San Antonio River basins.			Resident
False spike mussel	*Quincuncina mitchelli*	1	2	2	Substrates of cobble and mud. Rio Grande, Brazos, Colorado and Guadalupe river basins.		T	Resident
Golden orb	*Quadrula aurea*	1	2	2	Sand and gravel, Guadalupe, San Antonio, Lower San Marcos, and Nueces River basins	C	T	Resident
Horseshoe liptooth snail	*Daedalochila hippocrepis*	1	1	1	Terrestrial snail known only from Landa Park in New Braunfels.			Resident
Texas fatmucket	*Lampsilis bracteata*	1	2	2	Streams and rivers on sand, mud and gravel, Colorado and Guadalupe River basins.	C	T	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
PLANTS								
Bracted twistflower	*Streptanthus bracteatus*	1	1	1	Texas endemic found in oak juniper woodlands.	C		Resident
Comal snakewood	*Colubrina stricta*	0	1	0	Historic in Comal Co., generally found in shrublands.			Historic Resident
Hill country wild-mercury	*Argthamnia aphoroides*	0	1	0	Texas endemic found primarily in bluestem-grama grasslands associated with plateau live oak woodlands.			Resident
Texas mock-orange	*Philadelphus texensis*	0	1	0	Found on limestone outcrops on cliffs and rocky slopes.			Resident
REPTILES								
Cagle's map turtle	*Graptemys caglei*	1	2	2	Endemic to Guadalupe River System. Found near waters' edge.		T	Resident
Spot-tailed earless lizard	*Holbrookia lacerata*	1	1	1	Moderately open prairie-brushland.			Resident
Texas Garter Snake	*Thamnophis sirtalis annectens*	1	1	1	Wet or moist microhabitats			Resident
Texas Horned Lizard	*Phrynosoma cornutum*	1	2	2	Varied, sparsely vegetated uplands.		T	Resident

TPWD, 2014. Annotated County List of Rare Species – Comal County, revised 10/2/2012.

USFWS, 2014. Endangered Species List for Texas. http://www.fws.gov/southwest/es/ES_ListSpecies.cfm accessed online February 24, 2014.

5.2.27.4 Engineering and Costing

The proposed site of the Trinity well field (for regional planning purposes only) is northwest of the City of Garden Ridge (City). The wells would be about 1,200 ft deep and are expected to produce an average of 400 gpm. Water quality data in the area indicate that the water meets public drinking water standards.

TWA's Trinity Well Field water management strategy consists of Trinity wells, collection pipelines, a ground storage tank, water treatment facilities, pump station and an interconnect to the TWA Carrizo Well Field project. This project is planned to deliver Carrizo groundwater from northwestern Gonzales County to Gonzales, Guadalupe and Comal Counties. Well pumps are to deliver the raw groundwater to a ground storage tank at near the TWA Carrizo transmission pipeline. The water would be run through a disinfection water treatment plant and pumped into the transmission pipeline for ultimate delivery to customers.

The engineering and costing analysis for the TWA Trinity Well Project includes all facilities required to pump and deliver treated water to the planned TWA Carrizo transmission pipeline. This includes 10 1,200-ft Trinity wells rated at 400 gpm, about 5 miles of collector pipeline, a ground storage tank to hold the water from about 24 hours of well production, disinfection water treatment, a high service pump station, and an interconnect to the existing distribution system. Well pumps would deliver the raw groundwater to the ground storage tank. This strategy also includes upsizing of the TWA Carrizo pipeline to convey the additional 5,000 acft/yr of water associated with this strategy.

Cost estimates were computed for capital costs, annual debt service, operation and maintenance, power, land, and environmental mitigation. These costs are summarized in Table 5.2.27-2. The project costs, including capital, are estimated to be $26,087,000. As shown, the annual costs, including debt service, operation and maintenance, power, and groundwater leases, are estimated to be $3,065,000. This option produces potable water at an estimated cost of $613 per acft ($1.88 per 1,000 gallons).

Table 5.2.27-2 Cost Estimate Summary

Item	***Estimated Costs for Facilities***
CAPITAL COST	
New and Upsized Transmission Pipeline	$5,787,000
Transmission Pump Station & Storage Tank	$2,864,000
Well Fields (Wells, Pumps, and Piping)	$9,029,000
Water Treatment Plant (4.5 MGD)	$212,000
Storage, Pump Station and Integration	$250,000
TOTAL COST OF FACILITIES	**$18,142,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$6,349,000
Environmental & Archaeology Studies and Mitigation	$400,000
Interest During Construction (4% for 1 years with a 1% ROI)	$883,000
TOTAL COST OF PROJECT	**$26,087,000**
ANNUAL COST	
Debt Service (5.5 percent, 20 years)	$2,183,000
Operation and Maintenance	
Intake, Pipeline, Pump Station (1% of Cost of Facilities)	$214,000
Water Treatment Plant (2.5% of Cost of Facilities)	$127,000
Pumping Energy Costs (6,015,908 kW-hr @ 0.09 $/kW-hr)	$541,000
TOTAL ANNUAL COST	**$3,065,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 1	5,000
Annual Cost of Water ($ per acft)	$613
Annual Cost of Water ($ per 1,000 gallons)	$1.88

5.2.27.5 Implementation Issues

Implementation of the Trinity strategy for TWA will require permits and approvals from Texas Commission on Environmental Quality (TCEQ) and EAA. Requirements by each agency are discussed below.

TCEQ:

- Review and approval of technical specifications for all new water facility components of the water system.
- Review and approval of facilities and water quality to put the facility into operation.

EAA:

- Review and permit the construction of wells passing through the Edwards Aquifer.

There is no local groundwater conservation district to regulate the Trinity Aquifer in Comal County. Thus, no local permits and approvals are required.

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5.2.28 Hays/Caldwell PUA and TWA Joint Project

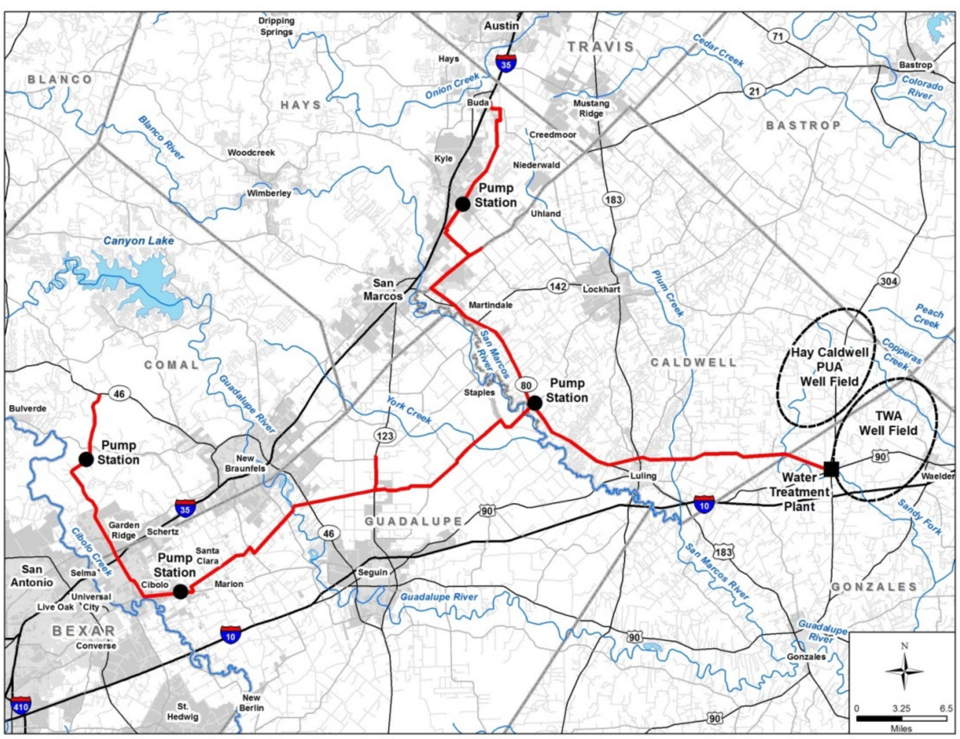
5.2.28.1 Description of Strategy

The Hays Caldwell Public Utility Agency (HCPUA) and the Texas Water Alliance (TWA) both have water management strategies that plan to draw groundwater from the Carrizo Aquifer in Gonzales and Caldwell Counties and deliver it to project participants or customers along the IH 35 corridor. The HCPUA was formed in 2007 to resolve long term water needs for its members who include the cities of San Marcos, Kyle, and Buda and the Canyon Regional Water Authority (CRWA). The TWA project could deliver supplies to Springs Hill WSC, Canyon Lake WSC and Gonzales County WSC.

This HCPUA/TWA Joint Project considers the possibility of combining well field production, and sharing water treatment and transmission facilities for both projects. This strategy could deliver up to 50,690 acft/yr from the two well fields to participants and potential customers. The general locations of the facilities are shown in Figure 5.2.28-1.

Both entities have secured some of the required groundwater permits from the Gonzales County Underground Water Conservation District (GCUWCD). The TWA has secured groundwater leases and permits in northern Gonzales County to deliver up to 15,000 acft/yr of Carrizo groundwater to entities in Gonzales, Guadalupe, and Comal Counties. The HCPUA has secured groundwater leases in Caldwell County and groundwater permits from GCUWCD to deliver up to 10,300 acft/yr of Carrizo Aquifer groundwater to entities in Caldwell, Guadalupe, and Hays Counties.

Figure 5.2.28-1 HCPUA / TWA Joint Project Conceptual Layout



W:\007755\000000000167424_2016_Region_L_Plan\06.00_Project_Engineering_and_Design\GIS\map_docs\arcmap\Option3_TWA_HCPUA.mxd

5.2.28.2 Available Yield

The HCPUA and TWA have land under lease within the GCUWCD and/or the Plum Creek Conservation District. According to GCUWCD rules, 1 acft per acre is the allowable production rate and wells of proposed capacity would be subject to a setback of 6,000 feet from existing registered Carrizo wells.

For each aquifer in the region, the Groundwater Conservation Districts (GCDs) have adopted desired future conditions (DFCs). In some GCDs, full use of all groundwater supplies (permitted, grandfathered, and exempt) may result in non-achievement of the DFCs for an aquifer. To ensure consistency with the DFCs, the Texas Water Development Board (TWDB) currently requires that groundwater availability for each aquifer be limited for planning purposes to the modeled available groundwater (MAG) for the aquifer. This has resulted, for planning purposes only, in the application of project yield limitations for MAG compliance and a lack of firm water available for future permits in this plan for some areas for certain time periods. Planned withdrawals from the Carrizo Wilcox in Caldwell and Gonzales Counties exceed the MAG and, therefore, the HCPUA and TWA supplies are limited to 36,513 acft/yr so as to not exceed MAG values through 2070.

The HCPUA/TWA Joint Project is described herein as two water management strategies. The first strategy is the envisioned project yielding a total of 50,690 acft/yr. The second strategy is limited to MAG availability yielding a total of 36,513 acft/yr.

5.2.28.3 Environmental Issues

Environmental issues for the proposed HCPUA/ TWA Joint Project are described below. This project includes the development of two well fields, one in Caldwell County and a second in Gonzales County, a water treatment plant, additional pump and booster stations, storage tanks and approximately 115 miles of transmission pipeline. Implementation of this project would require field surveys by qualified professionals to document vegetation/habitat types, waters of the U.S. including wetlands, and cultural resources that may be impacted. Where impacts to protected species habitat or significant cultural resources cannot be avoided, additional studies would be necessary to evaluate habitat use and/or value, or eligibility for inclusion in the National Register of Historic Places, respectively. The project sponsors would also be required to coordinate with the U.S. Army Corps of Engineers regarding impacts to wetland areas and compensation would be required for unavoidable adverse impacts involving net losses of wetlands.

The proposed pipeline would cross the San Marcos and Guadalupe Rivers and their associated tributaries. The Texas Parks & Wildlife Department (TPWD) has identified a number of stream segments throughout the state as ecologically significant on the basis of biological function, hydrologic function, riparian conservation, exceptional aquatic life uses, and/or threatened or endangered species. The transmission pipeline crosses only one of these segments, Geronimo Creek, which is considered ecologically significant due to its high water quality and diverse benthic macroinvertebrate community. Potential impacts to this segment could be avoided by use of horizontal directional drilling for installation of the pipeline stream crossing.

The western portion of the transmission pipeline in Comal County passes over the recharge and transition zones of the Edwards Aquifer. Construction within this area would require compliance with the Edwards Aquifer Protection Program and coordination with the Texas Commission on Environmental Quality (TCEQ). Coordination with the U.S. Army Corps of Engineers would be required for construction within any waters of the U.S. Any impacts from this proposed project which would result in a loss of less than 0.5 acres of waters of the U.S. could be covered under Nationwide Permit #12 for Utility Line Activities.

The HCPUA/TWA Joint Project involves the construction of approximately 115 miles of pipeline from the two well fields in Caldwell and Gonzales Counties to delivery points in Caldwell, Comal, Guadalupe, and Hays Counties. The pipeline traverses the Edwards Plateau, East Central Texas Plains, and Texas Blackland Prairie Ecoregions[1] and lies within portions of the Texan, Balconian, and Tamaulipan Biotic Provinces.[2]

Vegetation types within the project transmission pipeline area as described by the TPWD[3] primarily include crops, although additional areas of Grassland Mosaic, Post Oak Woods/Forest, and urban areas also occur within the eastern and central portions of the pipeline. The northwestern portion of the pipeline in Comal County passes through areas of Live Oak-Ashe Juniper Parks, Live Oak-Mesquite-Ashe Juniper Parks, and Live Oak-Ashe Juniper Woods.

Table 5.2.28-1 lists the 31 state listed endangered or threatened species, and the 14 federally listed endangered or threatened species along with species of concern that may occur in Caldwell, Comal, Hays, Gonzales, or Guadalupe Counties. This information comes from the county lists of rare species published by the TPWD online in the “Annotated County Lists of Rare Species.” Inclusion in this table does not mean that a species will occur within the project area, but only acknowledges the potential for its occurrence in the project area counties.

In addition to the county lists, data received from the Natural Diversity Database (NDD), which is maintained by TPWD, was reviewed for known occurrences of listed species within or near the project area. This database documents occurrences of the Golden orb mussel; a state listed threatened species, in the San Marcos River which is crossed by the pipeline route. Potential impacts to all aquatic species would be minimized if the pipeline is installed by horizontal directional drilling under river and larger stream crossings. The Cascade Caverns Salamander and the Comal Blind Salamander, two state threatened species, have been documented from an area west of Cibolo Creek near the northwest portion of the transmission pipeline. This area also includes potential areas of karst which could provide habitat for other listed karst species. In addition, the endangered Golden-cheeked Warbler, a species listed both by the federal and state governments as endangered, has documented occurrences near the northwestern portion of the pipeline route in Comal County.

Species of concern which are documented near the well field or pipeline area include the Guadalupe bass, Shinner’s sunflower, mountain plover, bracted twistflower, Texas garter

[1] Griffith Glenn, Sandy Bryce, James Omernik, and Anne Rogers. 2007. Ecoregions of Texas. Texas Commission on Environmental Quality.
[2] Blair, W. Frank. 1950. The Biotic Provinces of Texas. Texas Journal of Science 2(1):93-117.
[3] McMahan, Craig A., Roy G. Frye and Kirby L. Brown. 1984. The Vegetation Types of Texas. Wildlife Division, Texas Parks and Wildlife Department, Austin, Texas.

snake, and hill country wild mercury which are all species with no regulatory status. A survey of the project area would be required prior to pipeline construction to determine whether populations of or potential habitats used by listed species occur in the area to be affected. Coordination with TPWD and USFWS regarding threatened and endangered species with potential to occur in the project area should be initiated early in project planning.

Table 5.2.28-1 Endangered, Threatened, and Species of Concern for Caldwell, Comal, Hays, Gonzales, and Guadalupe Counties

Common Name	*Scientific Name*	*Impact Value*	*Multiplier Based on Status*	*Adjusted Impact*	*Summary of Habitat Preference*	*Listing Entity*		*Potential Occurrence in County(s)*
						USFWS	*TPWD*	
AMPHIBIANS								
Barton Springs salamander	*Eurycea sosorum*	*0*	*3*	*0*	Known from Barton Springs and subterranean water-filled caverns.	LE	E	Resident
Blanco blind salamander	*Eurycea robusta*	*0*	*2*	*0*	Troglobitic species found in water-filled subterranean caverns.	--	T	Resident
Blanco River springs salamander	*Eurycea pterophila*	*0*	*1*	*0*	Subaquatic found in springs and caves in the Blanco River drainage.	--	--	Resident
Cascade Caverns salamander	*Eurycea latitans complex*	*1*	*2*	*2*	Endemic subaquatic species found in springs and caves in the Medina river, Guadalupe River, and Cibolo Creek watersheds within the Edwards Aquifer Area.	--	T	Resident
Comal blind salamander	*Eurycea tridentifera*	*1*	*2*	*2*	Endemic semi-troglobitic species found in springs and waters of caves.	--	T	Resident
Comal Springs salamander	*Eurycea* sp.8	*0*	*1*	*0*	Endemic species found in Comal Springs	--	--	Resident
Edwards Plateau spring salamander	*Eurycea sp. 7*	*0*	*1*	*0*	Endemic species found in springs and waters of some caves of this region.	--	--	Resident
San Marcos salamander	*Eurycea nana*	*0*	*2*	*0*	Found in headwaters of the San Marcos River.	LT	T	Resident
Texas blind salamander	*Eurycea rathbuni*	*0*	*3*	*0*	Troglobitic species found in water-filled subterranean cavers along a six mile stretch of the San Marcos Spring Fault near San Marcos.	LE	E	Resident
ARACHNIDS								
Bandit cave spider	*Cicurina bandida*	*0*	*1*	*0*	Very small, subterrestrial, subterranean obligate spider.	--	--	Resident
BIRDS								
American Peregrine Falcon	*Falco peregrinus anatum*	*0*	*2*	*0*	Resident and local breeder in West Texas. Migrant across the state.	DL	T	Possible Migrant
Arctic peregrine falcon	*Falco peregrinus tundrius*	*0*	*1*	*0*	Migrant throughout the state.	DL	--	Possible Migrant
Bald eagle	*Haliaeetus leucocephalus*	*0*	*2*	*0*	Found primarily near rivers and large lakes, migrant.	DL	T	Possible Migrant
Black-capped Vireo	*Vireo atricapillus*	*0*	*3*	*0*	Oak-juniper woodlands,	LE	E	Resident
Golden-cheeked Warbler	*Setophaga chrysoparia*	*2*	*3*	*6*	Juniper-oak woodlands.	LE	E	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County(s)
						USFWS	TPWD	
Henslow's Sparrow	*Ammodramus henslowii*	*0*	*1*	*0*	Wintering individuals found in weedy or cut-over areas.	--	--	Possible Migrant
Interior least tern	*Sterna antillarum athalassos*	*0*	*3*	*0*	Nests along sand and gravel bars in braided streams	LE	E	Resident
Mountain Plover	*Charadrius montanus*	*1*	*1*	*1*	Non-breeding, shortgrass plains and fields	--	--	Nesting/ Migrant
Sprague's Pipit	*Anthus spragueii*	*0*	*1*	*0*	Migrant in Texas in winter. Strongly tied to native upland prairie.	C	--	Migrant
Western Burrowing Owl	*Athene cunicularia hypugaea*	*0*	*1*	*0*	Open grasslands, especially prairie, plains and savanna	--	--	Resident
Whooping Crane	*Grus americana*	*0*	*3*	*0*	Potential migrant	LE	E	Potential Migrant
Wood Stork	*Mycteria americana*	*0*	*2*	*0*	Forages in prairie ponds, ditches, and shallow standing water formerly nested in TX	--	T	Migrant
Zone-tailed Hawk	*Buteo albonotatus*	*0*	*2*	*0*	Arid open country, often near watercourses	--	T	Resident
CRUSTACEANS								
A cave obligate crustacean	*Monodella Texana*	*0*	*1*	*0*	Subaquatic, subterranean obligate found in underwater freshwater aquifers.	--	--	Resident
Balcones Cave amphipod	*Stygobromus balconis*	*0*	*1*	*0*	Subaquatic, subterranean obligate amphipod.	--	--	Resident
Ezell's cave amphipod	*Stygobromus flagellatus*	*0*	*1*	*0*	Known only from artesian wells.	--	--	Resident
Long-legged cave amphipod	*Stygobromus longipes*	*0*	*1*	*0*	Subaquatic crustacean that is a subterranean obligate found in subterranean streams.			Resident
Peck's cave amphipod	*Stygobromus pecki*	*0*	*3*	*0*	Small aquatic crustacean that lives underground in the Edwards Aquifer. Collected from Comal and Hueco Springs.	LE	E	Resident
Texas cave shrimp	*Palaemonetes antrorum*	*0*	*1*	*0*	Subterranean species found in sluggish streams and pools.	--	--	Resident
Texas troglobitic water slater	*Lirceolus smithii*	*0*	*1*	*0*	Subaquatic, subterranean obligate species found in aquifers.	--	--	Resident
FISH								
Blue sucker	*Cycleptus elongatus*	0	2	*0*	Found in larger portions of major rivers in Texas.	--	T	Resident
Fountain darter	*Etheostoma fonticola*	0	3	*0*	Known only from the San Marcos and Comal rivers. Found in springs and spring-fed streams in dense beds of aquatic plants.	LE	E	Resident
Guadalupe Bass	*Micropterus treculi*	*1*	*1*	*1*	Endemic to perennial streams of the Edwards Plateau region.	--	--	Resident
Guadalupe darter	*Percina sciera apristis*	*1*	*1*	*1*	Guadalupe River basin, found over gravel and sand raceways of larger streams and rivers.	--	--	Resident
Ironcolor shiner	*Notropis chalybaeus*	*0*	*1*	*0*	Found in Big Cypress Bayou	--	--	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County(s)
						USFWS	TPWD	
					and Sabine River basin.			
San Marcos gambusia	*Gamusia georgei*	*0*	*1*	*0*	Extinct species formerly known from the upper San Marcos River.	--	--	Historic Resident
INSECTS								
A mayfly	*Campurus decolaratus*	*0*	*1*	*0*	Found in Texas and Mexico, possibly in clay substrates.	--	--	Resident
Comal Springs diving beetle	*Comaldessus stygius*	*0*	*1*	*0*	Known only from the outflows at Comal Springs, aquatic.			Resident
Comal Springs dryopid beetle	*Stygoparnus comalensis*	*0*	*3*	*0*	These beetles usually cling to objects in streams.	LE	E	Resident
Comal Springs riffle beetle	*Heterelmis comalensis*	*0*	*3*	*0*	Found in Comal and San Marcos Springs.	LE	E	Resident
Edwards Aquifer diving beetle	*Haideoporus texanus*	*0*	*1*	*0*	Habitat poorly known, found in an artesian well in Hays County.	--	--	Resident
Flint's net-spinning caddisfly	*Cheumatopsyche flinti*	*0*	*1*	*0*	Very poorly known species with habitat description limited to "a spring".	--	--	Resident
Leonora's dancer damselfly	*Argia leonorae*	*1*	*1*	*1*	Species found in south central and western Texas in small streams and seepages.	--	--	Resident
Rawson's metalmark	*Calephelis rawsoni*	*1*	*1*	*1*	Moist areas in shaded limestone outcrops	--	--	Resident
San Marcos saddle-case caddisfly	*Protoptila arca*	*0*	*1*	*0*	Known from an artesian well in Hays County. Very abundant locally.	--	--	Resident
Texas austrotinodes caddisfly	*Austrotinodes texensis*	*0*	*1*	*0*	Thought to be endemic to the karst springs and spring runs of the Edwards Plateau region.	--	--	Resident
MAMMALS								
Black bear	*Ursus americanus*	0	2	*0*	Found in bottomland hardwoods and large tracts of inaccessible forested areas.	T/SA;NL	T	Historic Resident
Cave Myotis Bat	*Myotis velifer*	0	1	*0*	Roosts colonially in caves, rock crevices	--	--	Resident
Jaguarundi	*Herpailurus yaguarondi*	0	3	*0*	Found in thick brushlands, near water favored.	LE	E	Resident
Plains Spotted Skunk	*Spilogale putorius interrupta*	1	1	*1*	Prefers wooded, brushy areas.	--	--	Resident
Red Wolf	*Canis rufus*	0	3	*0*	Extirpated.	LE	E	Historic Resident
MOLLUSKS								
Creeper (squawfoot)	*Strophitus undulates*	1	1	*1*	Small to large streams	--	--	Resident
False spike mussel	*Quincuncina mitchelli*	1	2	*2*	Substrates of cobble and mud with water lilies present. Rio Grande, Brazos, Colorado and Guadalupe river basins.	--	T	Resident
Golden orb	*Quadrula aurea*	2	2	*4*	Sand and gravel, Guadalupe, San Antonio, and Nueces River basins	C	T	Resident
Horseshoe liptooth snail	*Daedalochila hippocrepis*	0	1	*0*	Terrestrial snail known only from Landa Park in New Braunfels.			Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County(s)
						USFWS	TPWD	
Palmetto pill snail	*Euchemotrema leai cheatumi*	0	1	*0*	Terrestrial snail known only from Palmetto State Park.	--	--	Resident
Texas fatmucket	*Lampsilis bracteata*	1	2	*2*	Streams and rivers on sand, mud and gravel, Colorado and Guadalupe River basins.	C	T	Resident
Texas pimpleback	*Quadrula petrina*	1	2	*2*	Mud, gravel and sand substrates, Colorado and Guadalupe river basins	C	T	Resident
PLANTS								
Big red sage	*Salvia penstemonoides*	0	1	*0*	Endemic; moist to seasonally wet clay or silt soils in creek beds.	--	--	Resident
Bracted twistflower	*Streptanthus bracteatus*	1	1	*1*	Endemic: found in shallow, well-drained gravelly clays and clay loams over limestone.	C	--	Resident
Bristle nailwort	*Paronychia setacea*	0	1	*0*	Endemic plant found in eastern and south central Texas in sandy soils.	--	--	Resident
Buckley's spiderwort	*Tradescantia buckleyi*	0	1	*0*	Occurs on sandy loam or clay soils in grasslands or shrublands underlain by the Beaumont Formation.	--	--	Resident
Comal snakewood	*Colubrina stricta*	0	1	*0*	Historic in Comal County record.	--	--	Historic Resident
Elmendorf's onion	*Allium elmendorfii*	0	1	*0*	Endemic, in deep sands	--	--	Resident
Green beebalm	*Monarda viridissima*	0	1	*0*	Endemic perennial herb of Carrizo sands found in openings of post oak woodlands.	--	--	Resident
Hill Country wild-mercury	*Argythamnia aphoroides*	1	1	*1*	Endemic: found in grasslands associated with oak woodlands.	--	--	Resident
Park's jointweed	*Polygonella parksii*	0	1	*0*	Endemic; deep loose sands of Carrizo and similar Eocene formations.	--	--	Resident
Sandhill woolywhite	*Hymenopappus carrizoanus*	0	2	*0*	Found south of the Guadalupe River and the Balcones Escarpment. Prefers dense riparian corridors.	--	--	Resident
Shinner's sunflower	*Helianthus occidentalis ssp.*	2	1	*2*	Found mostly in prairies on the Coastal Plain, Pineywoods and South Texas Brush County.	--	--	Resident
Texas mock-orange	*Philadelphus texensis*	*0*	*1*	*0*	Found on limestone outcrops on cliffs and rocky slopes.			Resident
Texas wild-rice	*Zizania texana*	*0*	*3*	*0*	Texas endemic found in spring-fed San Marcos River.	LE	E	Resident
Warnock's coral-root	*Hexalectric warnockii*	*0*	*1*	*0*	Found among leaf litter and humus in oak-juniper woodlands on shaded slopes and intermittent, rock creekbeds in canyons.	--	--	Resident
REPTILES								
Cagle's map turtle	*Graptemys caglei*	1	2	*2*	Endemic to the Guadalupe River System. Found in short stretches of shallow water.	--	T	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County(s)
						USFWS	TPWD	
Spot-tailed earless lizard	*Holbrookia lacerata*	1	1	*1*	Moderately open prairie-brushland.	--	--	Resident
Texas Garter Snake	*Thamnophis sirtalis annectens*	2	1	*2*	Wet or moist microhabitats	--	--	Resident
Texas Horned Lizard	*Phrynosoma cornutum*	1	2	*2*	Varied, sparsely vegetated uplands.	--	T	Resident
Texas Tortoise	*Gopherus berlandieri*	1	2	*2*	Open brush w/ grass understory.	--	T	Resident
Timber Rattlesnake	*Crotalus horridus*	1	2	*2*	Floodplains, upland pine, deciduous woodlands, riparian zones.	--	T	Resident

LE/LT=Federally Listed Endangered/Threatened
DL, PDL=Federally Delisted/Proposed for Delisting
T/SA=Listed as Threatened by Similarity of Appearance
E, T=State Listed Endangered/Threatened T*= in process of being listed as threatened by State
Blank= Species of concern, but no regulatory listing status
Source: TPWD, 2010. Annotated County List of Rare Species – Caldwell County. Revised 4/28/2014, Hays County Revised 11/3/2014. Gonzales County Revised 4/28/2014. Guadalupe County, Revised 4/28/2014, Comal Co. Revised 10/2/2012.

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 (Pl96-515), and the Archeological and Historic Preservation Act (PL93-291). Based on the review of publically available Geographic Information System (GIS) records obtained from the Texas Historical Commission, there are no State Historic Sites, National Register Properties, or National Register Districts within one mile of the transmission pipeline or within the well field areas. Sixteen Historical Markers and 27 cemeteries occur within one mile of the transmission pipeline. Two cemeteries and one Historical Marker are located within the Caldwell Co. well field. Avoidance of these areas should be possible by careful selection of the areas for well sites and their associated pipelines. A review of archaeological resources in the proposed project area should be conducted during the project planning phase. Because the owner or controller of the project will likely be a political subdivision of the State of Texas (i.e., river authority, municipality, water district, etc.), they will be required to coordinate with the Texas Historical Commission prior to project construction.

5.2.28.4 Engineering and Costing

Table 5.2.28-2 includes summary data for the envisioned and MAG limited formulations of the HCPUA/TWA Joint Project alternative. Project participants and supply volumes for each HCPUA/TWA Joint Project alternative are summarized in Table 5.2.28-3.

Table 5.2.28-2 Project Data for HCPUA/TWA Joint Project Alternatives

	Envisioned	MAG Limited
TWA Supply	15,000 acft/yr	14,680 acft/yr
HCPUA Supply	35,690 acft/yr	21,833 acft/yr
Project Yield	50,690 acft/yr	36,513 acft/yr
Total Wells	35	27
WTP	68 MGD	48.9 MGD

Table 5.2.28-3 Potential Project Participants and Supply Allocations

	Supplies (acft/yr)	
Participant	**Envisioned Project**	**MAG Limited**
Buda	4,033	3,312
Kyle	6,937	5,698
Maxwell WSC	100	0
County Line SUD	570	570
San Marcos	9,000	7,391
Martindale WSC	50	50
Crystal Clear SUD	5,000	4,214
CRWA	15,000	8,074
Canyon Lake WSC	5,000	3,602
WTP	10,000	3,602
Total	50,690	36,513

Conceptual planning-level engineering and cost estimates were prepared for the envisioned HCPUA/TWA Joint Project at 50,690 acft/yr (Table 5.2.288-4) and the MAG Limited project at 36,513 acft/yr (Table 5.2.28-5).

Total project costs for the envisioned and MAG limited alternatives are $623,130,000 and $501,370,000, respectively. The total annual cost includes the debt service for the project cost, operation and maintenance costs, power costs, groundwater district fees estimated at $9.78/acft/yr, and groundwater lease fees estimated at $125/acft/yr (combined minimum and production fees). The total annual unit cost in dollars per acft is the total annual cost divided by the associated dependable, firm water supply.

The annual costs for the envisioned project are $88,009,000 with an annual unit cost of $1,736/acft (Table 5.2.28-4). The MAG Limited project has an annual unit cost of $1,885/acft (Table 5.2.28-5).

Table 5.2.28-4 Summary Cost Estimate for Envisioned HCPUA/TWA Joint Project

Item	*Estimated Costs for Facilities*
Primary Pump Stations (61.2 MGD)	$22,730,000
Transmission Pipeline (60 in dia., 115 miles)	$167,765,000
Transmission Pump Station(s) & Storage Tank(s)	$15,826,000
Well Fields (Wells, Pumps, and Piping)	$79,398,000
Storage Tanks (Other Than at Booster Pump Stations)	$2,424,000
Water Treatment Plant (67.9 MGD)	$95,990,000
Access Roads	$3,252,000
TOTAL COST OF FACILITIES	**$387,385,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$127,196,000
Advanced Payments for Groundwater	$23,705,000
Test Drilling and Mitigation	$3,076,000
Environmental & Archaeology Studies and Mitigation	$5,918,000
Land Acquisition and Surveying (911 acres)	$16,638,000
Interest During Construction (4% for 3 years with a 1% ROI)	$59,212,000
TOTAL COST OF PROJECT	**$623,130,000**
ANNUAL COST	
Debt Service (5.5 percent, 20 years)	$52,143,000
Operation and Maintenance	
Intake, Pipeline, Pump Station	$3,368,000
Water Treatment Plant (2.5% of Cost of Facilities)	$19,198,000
Pumping Energy Costs (71,867,284 kW-hr @ 0.09 $/kW-hr)	$6,468,000
Purchase of Water (50,690 acft/yr @ 134.78 $/acft)	$6,832,000
TOTAL ANNUAL COST	**$88,009,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 1.5	50,690
Annual Cost of Water ($ per acft)	$1,736
Annual Cost of Water ($ per 1,000 gallons)	$5.33

Table 5.2.28-5 Summary Cost Estimate for MAG-Limited HCPUA/TWA Joint Project

Item	*Estimated Costs for Facilities*
Primary Pump Stations (44.1 MGD)	$19,552,000
Transmission Pipeline (48 in dia., 115 miles)	$129,434,000
Transmission Pump Station(s) & Storage Tank(s)	$15,531,000
Well Fields (Wells, Pumps, and Piping)	$66,113,000
Storage Tanks (Other Than at Booster Pump Stations)	$2,424,000
Water Treatment Plant (48.9 MGD)	$70,687,000
Access Roads	$3,252,000
TOTAL COST OF FACILITIES	**$306,993,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$100,976,000
Advanced Payments for Groundwater	$21,048,000
Test Drilling and Mitigation	$2,488,000
Environmental & Archaeology Studies and Mitigation	$5,727,000
Land Acquisition and Surveying (892 acres)	$16,496,000
Interest During Construction (4% for 3 years with a 1% ROI)	$47,642,000
TOTAL COST OF PROJECT	**$501,370,000**
ANNUAL COST	
Debt Service (5.5 percent, 20 years)	$41,954,000
Operation and Maintenance	
Intake, Pipeline, Pump Station	$2,773,000
Water Treatment Plant (2.5% of Cost of Facilities)	$14,137,000
Pumping Energy Costs (56,117,900 kW-hr @ 0.09 $/kW-hr)	$5,051,000
Purchase of Water (36,513 acft/yr @ 134.78 $/acft)	$4,921,000
TOTAL ANNUAL COST	**$68,836,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 1.5	36,513
Annual Cost of Water ($ per acft)	$1,885
Annual Cost of Water ($ per 1,000 gallons)	$5.78

5.2.28.5 Implementation Issues

On an annual unit cost basis, the HCPUA/TWA Joint Project is 2 percent less than the HCPUA Project and 24 percent less than the TWA Regional Carrizo Project.

For each aquifer in the region, the GCDs have adopted desired future conditions (DFCs). In some GCDs, full use of all groundwater supplies (permitted, grandfathered and exempt) may result in non-achievement of the DFCs for an aquifer. To ensure consistency with the DFCs, TWDB currently requires that groundwater availability for each aquifer be limited for planning purposes to the modeled available groundwater (MAG) for the aquifer. This has resulted, for planning purposes only, in adjustments to permit amounts, and a lack of firm water available for future permits in this plan for some areas for certain time periods. This should not be construed as recommending or requiring that GCDs make these adjustments, or deny future permit applications. SCTRWPG recognizes and supports the ability of permit holders to exercise their rights to groundwater use in accordance with their permits and it recognizes and supports the GCDs discretion to issue permits and grandfather historical users for amounts in excess of the MAG. SCTRWPG may not modify groundwater permits that GCDs have already issued or limit future permits that GCDs may issue. If the MAG is increased during or after this planning cycle, SCTRWPG may amend this Plan to adjust groundwater supply numbers that are affected by the new MAG amount.

There is a possibility that HCPUA/TWA Joint Project could share facilities with GBRA's MBWSP – Surface Water with ASR project in order to realize potential economies of scale. For information regarding this alternative, please refer to Chapter 5.2.29.The HCPUA and TWA well fields have received their groundwater permits from the GCUWCD and have been paying on their groundwater leases.

Other implementation issues include:

a. Renewal of GCUWCD 5-year production permits and 30-year export permits for project life; and.

b. Additional groundwater development in the region will not have a substantial effect on groundwater levels in the well field areas.

In addition, it will be necessary to obtain the following permits and agreements:

a. USACE Sections 10 and 404 Dredge and Fill Permits for the reservoir and pipelines;

b. GLO Sand and Gravel Removal permits;

c. GLO Easement for use of state-owned land;

d. TPWD Sand, Gravel, and Marl permit; and

e. Private land for construction of facilities to be acquired through either negotiations or condemnation.

Permitting may require development of a habitat mitigation plan; environmental studies; and/or cultural resource studies and mitigation.

5.2.29 HCPUA, TWA, and GBRA MBWSP Shared Facilities Project

5.2.29.1 Description of Strategy

Projected water needs for Caldwell, Comal, Guadalupe, and Hays counties total almost 78,000 acft/yr in 2070. This water management strategy combines supply strategies for the Hays Caldwell Public Utility Agency (HCPUA), the Texas Water Alliance (TWA), and Guadalupe-Blanco River Authority (GBRA) to deliver up to 86,513 acft/yr to participants and potential customers in these four counties.

The HCPUA and TWA strategies rely upon groundwater from the Carrizo Aquifer in Gonzales and Caldwell Counties. Technical evaluations of the HCPUA, TWA, and HCPUA/TWA Joint strategies are summarized in Chapters 5.2.25, 5.2.26, and 5.2.28, respectively. The GBRA Mid-Basin Water Supply Project (MBWSP) – Surface Water with ASR relies upon surface water from the Guadalupe River made firm with an aquifer storage and recovery (ASR) system in Gonzales County. The technical evaluation of this strategy is summarized in Chapter 5.2.33.

The HCPUA/TWA/GBRA Shared Facilities Project involves combination of the HCPUA and TWA well field production and water treatment facilities and shared transmission facilities with the GBRA MBWSP treated surface water supplies from a joining point near Luling with delivery to participants and customers to the west. The general locations of project facilities are shown in Figure 5.2.29-1.

HCPUA and TWA have secured some of the required groundwater permits. The TWA has secured groundwater leases and permits in northern Gonzales County to deliver up to 15,000 acft/yr of Carrizo groundwater to entities in Gonzales, Guadalupe, and Comal Counties. The HCPUA has secured groundwater leases in Caldwell County and groundwater permits from the Gonzales County Underground Water Conservation District (GCUWCD) to deliver up to 10,300 acft/yr of Carrizo groundwater to entities in Caldwell, Guadalupe, and Hays Counties.

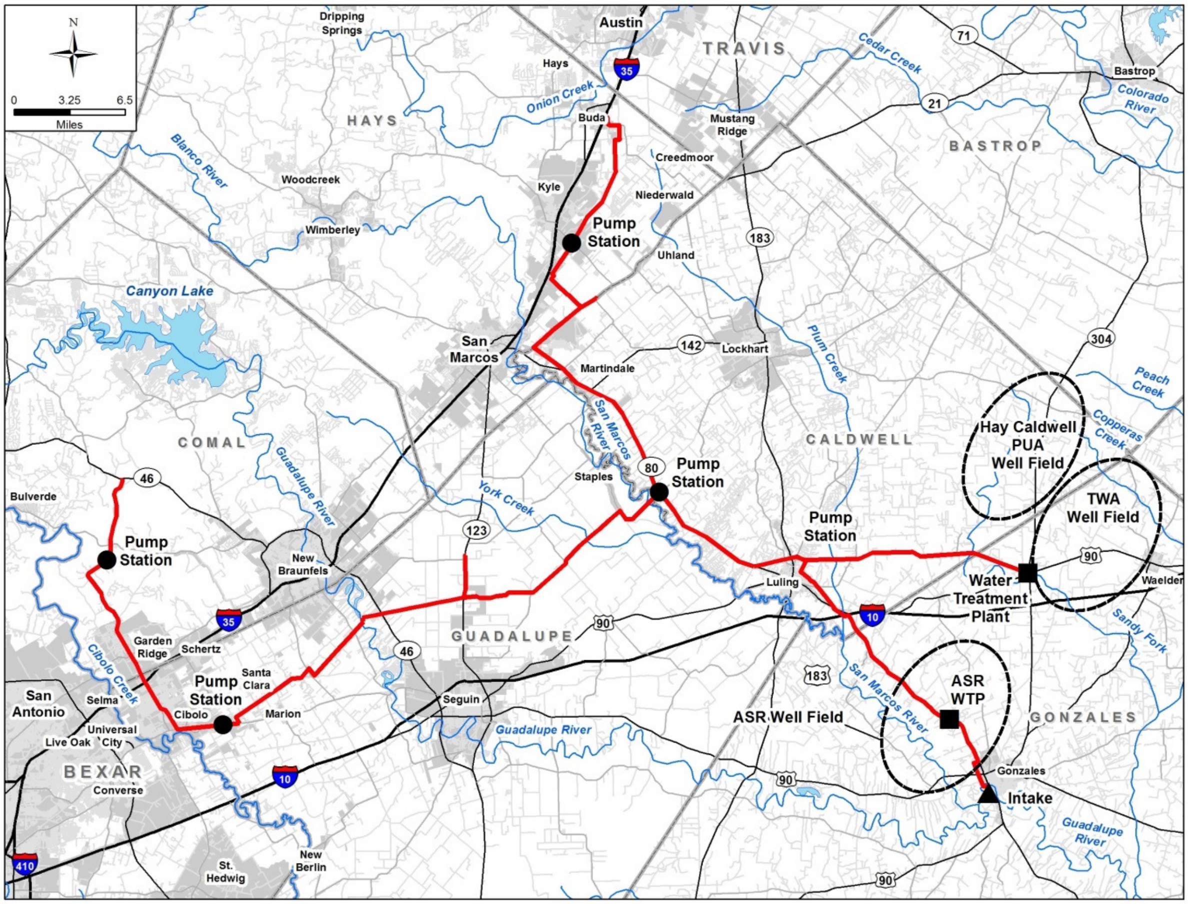
GBRA received a draft permit from TCEQ on July 31, 2013 for diversion of up to 75,000 acft/yr at a maximum rate of 500 cfs from the Guadalupe River in Gonzales County for municipal and industrial uses within the 10-county GBRA statutory district.

5.2.29.2 Available Yield

The HCPUA and TWA have land under lease within the GCUWCD and/or the Plum Creek Conservation District. According to GCUWCD rules, 1 acft per acre is the allowable production rate and wells of proposed capacity would be subject to a setback of 6,000 feet from existing registered Carrizo wells.

For each aquifer in the region, the Groundwater Conservation Districts (GCDs) have adopted desired future conditions (DFCs). In some GCDs, full use of all groundwater supplies (permitted, grandfathered, and exempt) may result in non-achievement of the DFCs for an aquifer. To ensure consistency with the DFCs, the Texas Water Development Board (TWDB) currently requires that groundwater availability for each aquifer be limited for planning purposes to the modeled available groundwater (MAG) for the aquifer. This has resulted, for planning purposes only, in the application of project yield limitations for MAG compliance and a lack of firm water available for future permits in this plan for some areas for certain time periods. Planned withdrawals from the Carrizo Aquifer in Caldwell and Gonzales Counties exceed the MAG and, therefore, the HCPUA and TWA supplies are limited to 36,513 acft/yr so as to not exceed MAG values through 2070.

Figure 5.2.29-1 HCPUA / TWA / MBWSP Shared Facilities Project Conceptual Layout



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The surface water analyses were completed utilizing the Guadalupe-San Antonio River Basin Water Availability Model (GSA-WAM), in conformance with TCEQ Application No. 12378 for surface water rights which has been declared administratively complete by the TCEQ. A firm yield of 50,000 acft/yr can be obtained with a maximum diversion rate at the river and ASR water treatment plant capacity of 140 cfs (90 MGD). For additional information regarding surface water availability, ASR operations, and GBRA MBWSP – Surface Water with ASR firm yield, see Chapter 5.2.33

5.2.29.3 Environmental Issues

Environmental issues for the HCPUA/TWA/GBRA Shared Facilities Project are described below. This project includes the development of two standard well fields, one in Caldwell County and a second in Gonzales County, an Aquifer Storage and Recovery (ASR) well field in Gonzales County, two water treatment plants, additional pump and booster stations, storage tanks, and approximately 134 miles of transmission pipeline. Implementation of this project would require field surveys by qualified professionals to document vegetation/habitat types, waters of the U.S. including wetlands, and cultural resources that may be impacted. Where impacts to protected species habitat or significant cultural resources cannot be avoided, additional studies would be necessary to evaluate habitat use and/or value, or eligibility for inclusion in the National Register of Historic Places, respectively. The project sponsors would also be required to coordinate with the U.S. Army Corps of Engineers (USACE) regarding impacts to wetland areas and compensation would be required for unavoidable adverse impacts involving net losses of wetlands.

The proposed pipeline would cross the San Marcos and Guadalupe Rivers their associated tributaries. The Texas Parks & Wildlife Department (TPWD) has identified a number of stream segments throughout the state as ecologically significant on the basis of biological function, hydrologic function, riparian conservation, exceptional aquatic life uses, and/or threatened or endangered species. The transmission pipeline crosses only one of these segments, Geronimo Creek, which is considered ecologically significant due to its high water quality and diverse benthic macroinvertebrate community. Potential impacts to this segment could be avoided by use of horizontal directional drilling for installation of the pipeline stream crossing. In addition, the section of the Guadalupe River from U.S. 183 (near the Gonzales diversion point) upstream to Lake Gonzales Dam is identified as ecologically significant because it contains two of four known remaining populations of the golden orb, a rare, endemic mollusk.

The western portion of the transmission pipeline in Comal County passes over the recharge and transition zones of the Edwards Aquifer. Construction within this area would require compliance with the Edwards Aquifer Protection Program and coordination with the Texas Commission on Environmental Quality (TCEQ).

Coordination with the USACE would be required for construction within any waters of the U.S. Any impacts from this proposed project which would result in a loss of less than 0.5 acres of waters of the U.S. could be covered under Nationwide Permit #12 for Utility Line Activities.

The HCPUA/TWA/GBRA Shared Facilities Project involves the construction of approximately 134 miles of pipeline from the standard well field in Caldwell County and standard and ASR well fields in Gonzales County to delivery points in Caldwell, Comal, Gonzales, Guadalupe, and Hays Counties. The pipeline traverses the Edwards Plateau, East Central Texas Plains, and Texas Blackland Prairie Ecoregions[1] and lies within portions of the Texan, Balconian, and Tamaulipan Biotic Provinces.[2]

Vegetation types within the project transmission pipeline area as described by the TPWD[3] primarily include crops, although additional areas of Post Oak Woods, Forest and Grassland Mosaic, Post Oak Woods/Forest, and urban areas also occur within the eastern, southern, and central portions of the pipeline. The northwestern portion of the pipeline in Comal County passes through areas of Live Oak-Ashe Juniper Parks, Live

[1] Griffith Glenn, Sandy Bryce, James Omernik, and Anne Rogers. 2007. Ecoregions of Texas. Texas Commission on Environmental Quality.
[2] Blair, W. Frank. 1950. The Biotic Provinces of Texas. Texas Journal of Science 2(1):93-117.
[3] McMahan, Craig A., Roy G. Frye and Kirby L. Brown. 1984. The Vegetation Types of Texas. Wildlife Division, Texas Parks and Wildlife Department, Austin, Texas.

Oak-Mesquite-Ashe Juniper Parks, and Live Oak-Ashe Juniper Woods. The project well fields include Post Oak Woods/Forest, Post Oak Woods, and Forest and Grassland Mosaic areas as well as portions of Pecan Elm vegetation types near the San Marcos River.

Table 5.2.29-1 lists the 31 state listed endangered or threatened species, and the 14 federally listed endangered or threatened species along with species of concern that may occur in Caldwell, Comal, Hays, Gonzales, or Guadalupe Counties. This information comes from the county lists of rare species published by the TPWD online in the "Annotated County Lists of Rare Species." Inclusion in this table does not mean that a species will occur within the project area, but only acknowledges the potential for its occurrence in the project area counties.

In addition to the county lists, data received from the Natural Diversity Database (NDD), which is maintained by TPWD, was reviewed for known occurrences of listed species within or near the project area. This database documents occurrences of three state threatened species in or near the San Marcos River which is crossed by the pipeline route. These include the Golden orb and false spike mussels and the Cagle's map turtle. Careful positioning and construction of the raw water intake on the Guadalupe River and horizontal directional drilling of the pipeline river and larger stream crossings and the diligent use of Better Management Practices (BMPs) would help minimize any potential impacts to aquatic species from project activities.

In addition, the Cascade Caverns Salamander and the Comal Blind Salamander, two state threatened species, have been documented from an area west of Cibolo Creek near the northwest portion of the transmission pipeline. This area also includes potential areas of karst which could provide habitat for additional listed karst species. The Golden-cheeked warbler, a bird species listed both by the federal and state governments as endangered, also has documented occurrences near this portion of the pipeline route.

Species of concern which are documented near the well field or pipeline area include the Guadalupe bass, Shinner's sunflower, mountain plover, bracted twistflower, Texas garter snake, and hill country wild mercury. Species of concern have no regulatory status. A survey of the project area would be required prior to pipeline construction to determine whether populations of or potential habitats used by listed species occur in the area to be affected. Coordination with TPWD and USFWS regarding threatened and endangered species with potential to occur in the project area should be initiated early in project planning.

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 (Pl96-515), and the Archeological and Historic Preservation Act (PL93-291). Based on the review of publically available Geographic Information System (GIS) records obtained from the Texas Historical Commission, there are no State Historic Sites, National Register Properties, or National Register Districts within one mile of the transmission pipeline excluding the section between Luling and Gonzales or within the standard well field areas. However, 16 Historical Markers and 27 cemeteries occur within one mile of this portion of the transmission pipeline. Two cemeteries and one Historical Marker are located within the area of the Caldwell County well field.

Table 5.2.29-1 Endangered, Threatened, and Species of Concern for Caldwell, Comal, Hays, Gonzales, and Guadalupe Counties

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County(s)
						USFWS	TPWD	
AMPHIBIANS								
Barton Springs salamander	*Eurycea sosorum*	0	3	0	Known from Barton Springs and subterranean water-filled caverns.	LE	E	Resident
Blanco blind salamander	*Eurycea robusta*	0	2	0	Troglobitic species found in water-filled subterranean caverns.	--	T	Resident
Blanco River springs salamander	*Eurycea pterophila*	0	1	0	Subaquatic found in springs and caves in the Blanco River drainage.	--	--	Resident
Cascade Caverns salamander	*Eurycea latitans complex*	1	2	2	Endemic subaquatic species found in springs and caves in the Medina river, Guadalupe River, and Cibolo Creek watersheds within the Edwards Aquifer Area.	--	T	Resident
Comal blind salamander	*Eurycea tridentifera*	1	2	2	Endemic semi-troglobitic species found in springs and waters of caves.	--	T	Resident
Comal Springs salamander	*Eurycea* sp.8	0	1	0	Endemic species found in Comal Springs	--	--	Resident
Edwards Plateau spring salamander	*Eurycea sp. 7*	0	1	0	Endemic species found in springs and waters of some caves of this region.	--	--	Resident
San Marcos salamander	*Eurycea nana*	0	2	0	Found in headwaters of the San Marcos River.	LT	T	Resident
Texas blind salamander	*Eurycea rathbuni*	0	3	0	Troglobitic species found in water-filled subterranean cavers along a six mile stretch of the San Marcos Spring Fault near San Marcos.	LE	E	Resident
ARACHNIDS								
Bandit cave spider	*Cicurina bandida*	0	1	0	Very small, subterrestrial, subterranean obligate spider.	--	--	Resident
BIRDS								
American Peregrine Falcon	*Falco peregrinus anatum*	0	2	0	Resident and local breeder in West Texas. Migrant across the state.	DL	T	Possible Migrant
Arctic peregrine falcon	*Falco peregrinus tundrius*	0	1	0	Migrant throughout the state.	DL	--	Possible Migrant
Bald eagle	*Haliaeetus leucocephalus*	0	2	0	Found primarily near rivers and large lakes, migrant.	DL	T	Possible Migrant
Black-capped Vireo	*Vireo atricapillus*	0	3	0	Oak-juniper woodlands,	LE	E	Resident
Golden-cheeked Warbler	*Setophaga chrysoparia*	2	3	6	Juniper-oak woodlands.	LE	E	Resident
Henslow's Sparrow	*Ammodramus henslowii*	0	1	0	Wintering individuals found in weedy or cut-over areas.	--	--	Possible Migrant
Interior least tern	*Sterna antillarum athalassos*	0	3	0	Nests along sand and gravel bars in braided streams	LE	E	Resident
Mountain Plover	*Charadrius montanus*	1	1	1	Non-breeding, shortgrass plains and fields	--	--	Nesting/ Migrant
Sprague's Pipit	*Anthus spragueii*	0	1	0	Migrant in Texas in winter. Strongly tied to native upland prairie.	C	--	Migrant

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County(s)
						USFWS	TPWD	
Western Burrowing Owl	*Athene cunicularia hypugaea*	*0*	*1*	*0*	Open grasslands, especially prairie, plains and savanna	--	--	Resident
Whooping Crane	*Grus americana*	*0*	*3*	*0*	Potential migrant	LE	E	Potential Migrant
Wood Stork	*Mycteria americana*	*0*	*2*	*0*	Forages in prairie ponds, ditches, and shallow standing water formerly nested in TX	--	T	Migrant
Zone-tailed Hawk	*Buteo albonotatus*	*0*	*2*	*0*	Arid open country, often near watercourses	--	T	Resident
CRUSTACEANS								
A cave obligate crustacean	*Monodella Texana*	*0*	*1*	*0*	Subaquatic, subterranean obligate found in underwater freshwater aquifers.	--	--	Resident
Balcones Cave amphipod	*Stygobromus balconis*	*0*	*1*	*0*	Subaquatic, subterranean obligate amphipod.	--	--	Resident
Ezell's cave amphipod	*Stygobromus flagellatus*	*0*	*1*	*0*	Known only from artesian wells.	--	--	Resident
Long-legged cave amphipod	*Stygobromus longipes*	*0*	*1*	*0*	Subaquatic crustacean that is a subterranean obligate found in subterranean streams.			Resident
Peck's cave amphipod	*Stygobromus pecki*	*0*	*3*	*0*	Small aquatic crustacean that lives underground in the Edwards Aquifer. Collected from Comal and Hueco Springs.	LE	E	Resident
Texas cave shrimp	*Palaemonetes antrorum*	*0*	*1*	*0*	Subterranean species found in sluggish streams and pools.	--	--	Resident
Texas troglobitic water slater	*Lirceolus smithii*	*0*	*1*	*0*	Subaquatic, subterranean obligate species found in aquifers.	--	--	Resident
FISH								
Blue sucker	*Cycleptus elongatus*	0	2	*0*	Found in larger portions of major rivers in Texas.	--	T	Resident
Fountain darter	*Etheostoma fonticola*	0	3	*0*	Known only from the San Marcos and Comal rivers. Found in springs and spring-fed streams in dense beds of aquatic plants.	LE	E	Resident
Guadalupe Bass	*Micropterus treculi*	*1*	*1*	*1*	Endemic to perennial streams of the Edwards Plateau region.	--	--	Resident
Guadalupe darter	*Percina sciera apristis*	*1*	*1*	*1*	Guadalupe River basin, found over gravel and sand raceways of larger streams and rivers.	--	--	Resident
Ironcolor shiner	*Notropis chalybaeus*	*0*	*1*	*0*	Found in Big Cypress Bayou and Sabine River basin.	--	--	Resident
San Marcos gambusia	*Gamusia georgei*	*0*	*1*	*0*	Extinct species formerly known from the upper San Marcos River.	--	--	Historic Resident
INSECTS								
A mayfly	*Campurus decolaratus*	*0*	*1*	*0*	Found in Texas and Mexico, possibly in clay substrates.	--	--	Resident
Comal Springs diving beetle	*Comaldessus stygius*	*0*	*1*	*0*	Known only from the outflows at Comal Springs, aquatic.			Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County(s)
						USFWS	TPWD	
Comal Springs dryopid beetle	*Stygoparnus comalensis*	*0*	*3*	*0*	These beetles usually cling to objects in streams.	LE	E	Resident
Comal Springs riffle beetle	*Heterelmis comalensis*	*0*	*3*	*0*	Found in Comal and San Marcos Springs.	LE	E	Resident
Edwards Aquifer diving beetle	*Haideoporus texanus*	*0*	*1*	*0*	Habitat poorly known, found in an artesian well in Hays County.	--	--	Resident
Flint's net-spinning caddisfly	*Cheumatopsyche flinti*	*0*	*1*	*0*	Very poorly known species with habitat description limited to "a spring".	--	--	Resident
Leonora's dancer damselfly	*Argia leonorae*	*1*	*1*	*1*	Species found in south central and western Texas in small streams and seepages.	--	--	Resident
Rawson's metalmark	*Calephelis rawsoni*	*1*	*1*	*1*	Moist areas in shaded limestone outcrops	--	--	Resident
San Marcos saddle-case caddisfly	*Protoptila arca*	*0*	*1*	*0*	Known from an artesian well in Hays County. Very abundant locally.	--	--	Resident
Texas austrotinodes caddisfly	*Austrotinodes texensis*	*0*	*1*	*0*	Thought to be endemic to the karst springs and spring runs of the Edwards Plateau region.	--	--	Resident
MAMMALS								
Black bear	*Ursus americanus*	0	2	*0*	Found in bottomland hardwoods and large tracts of inaccessible forested areas.	T/SA;NL	T	Historic Resident
Cave Myotis Bat	*Myotis velifer*	0	1	*0*	Roosts colonially in caves, rock crevices	--	--	Resident
Jaguarundi	*Herpailurus yaguarondi*	0	3	*0*	Found in thick brushlands, near water favored.	LE	E	Resident
Plains Spotted Skunk	*Spilogale putorius interrupta*	1	1	*1*	Prefers wooded, brushy areas.	--	--	Resident
Red Wolf	*Canis rufus*	0	3	*0*	Extirpated.	LE	E	Historic Resident
MOLLUSKS								
Creeper (squawfoot)	*Strophitus undulates*	1	1	*1*	Small to large streams	--	--	Resident
False spike mussel	*Quincuncina mitchelli*	1	2	*2*	Substrates of cobble and mud with water lilies present. Rio Grande, Brazos, Colorado and Guadalupe river basins.	--	T	Resident
Golden orb	*Quadrula aurea*	2	2	*4*	Sand and gravel, Guadalupe, San Antonio, and Nueces River basins	C	T	Resident
Horseshoe liptooth snail	*Daedalochila hippocrepis*	0	1	*0*	Terrestrial snail known only from Landa Park in New Braunfels.			Resident
Palmetto pill snail	*Euchemotrema leai cheatumi*	0	1	*0*	Terrestrial snail known only from Palmetto State Park.	--	--	Resident
Texas fatmucket	*Lampsilis bracteata*	1	2	*2*	Streams and rivers on sand, mud and gravel, Colorado and Guadalupe River basins.	C	T	Resident
Texas pimpleback	*Quadrula petrina*	1	2	*2*	Mud, gravel and sand substrates, Colorado and Guadalupe river basins	C	T	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County(s)
						USFWS	TPWD	
PLANTS								
Big red sage	*Salvia penstemonoides*	0	1	*0*	Endemic; moist to seasonally wet clay or silt soils in creek beds.	--	--	Resident
Bracted twistflower	*Streptanthus bracteatus*	1	1	*1*	Endemic: found in shallow, well-drained gravelly clays and clay loams over limestone.	C	--	Resident
Bristle nailwort	*Paronychia setacea*	0	1	*0*	Endemic plant found in eastern and south central Texas in sandy soils.	--	--	Resident
Buckley's spiderwort	*Tradescantia buckleyi*	0	1	*0*	Occurs on sandy loam or clay soils in grasslands or shrublands underlain by the Beaumont Formation.	--	--	Resident
Comal snakewood	*Colubrina stricta*	0	1	*0*	Historic in Comal County record.	--	--	Historic Resident
Elmendorf's onion	*Allium elmendorfii*	0	1	*0*	Endemic, in deep sands	--	--	Resident
Green beebalm	*Monarda viridissima*	0	1	*0*	Endemic perennial herb of Carrizo sands found in openings of post oak woodlands.	--	--	Resident
Hill Country wild-mercury	*Argythamnia aphoroides*	1	1	*1*	Endemic: found in grasslands associated with oak woodlands.	--	--	Resident
Park's jointweed	*Polygonella parksii*	0	1	*0*	Endemic; deep loose sands of Carrizo and similar Eocene formations.	--	--	Resident
Sandhill woolywhite	*Hymenopappus carrizoanus*	0	2	*0*	Found south of the Guadalupe River and the Balcones Escarpment. Prefers dense riparian corridors.	--	--	Resident
Shinner's sunflower	*Helianthus occidentalis ssp.*	2	1	*2*	Found mostly in prairies on the Coastal Plain, Pineywoods and South Texas Brush County.	--	--	Resident
Texas mock-orange	*Philadelphus texensis*	*0*	*1*	0	Found on limestone outcrops on cliffs and rocky slopes.			Resident
Texas wild-rice	*Zizania texana*	*0*	*3*	0	Texas endemic found in spring-fed San Marcos River.	LE	E	Resident
Warnock's coral-root	*Hexalectric warnockii*	*0*	*1*	0	Found among leaf litter and humus in oak-juniper woodlands on shaded slopes and intermittent, rock creekbeds in canyons.	--	--	Resident
REPTILES								
Cagle's map turtle	*Graptemys caglei*	1	2	*2*	Endemic to the Guadalupe River System. Found in short stretches of shallow water.	--	T	Resident
Spot-tailed earless lizard	*Holbrookia lacerata*	1	1	*1*	Moderately open prairie-brushland.	--	--	Resident
Texas Garter Snake	*Thamnophis sirtalis annectens*	1	1	*1*	Wet or moist microhabitats	--	--	Resident
Texas Horned Lizard	*Phrynosoma cornutum*	1	2	*2*	Varied, sparsely vegetated uplands.	--	T	Resident
Texas Tortoise	*Gopherus berlandieri*	1	2	*2*	Open brush w/ grass understory.	--	T	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County(s)
						USFWS	TPWD	
Timber Rattlesnake	*Crotalus horridus*	1	2	*2*	Floodplains, upland pine, deciduous woodlands, riparian zones.	--	T	Resident

LE/LT=Federally Listed Endangered/Threatened
DL, PDL=Federally Delisted/Proposed for Delisting
T/SA=Listed as Threatened by Similarity of Appearance
E, T=State Listed Endangered/Threatened T*= in process of being listed as threatened by State
Blank= Species of concern, but no regulatory listing status
Source: TPWD, 2010. Annotated County List of Rare Species – Caldwell County. Revised 4/28/2014, Hays County Revised 11/3/2014. Gonzales County Revised 4/28/2014. Guadalupe County, Revised 4/28/2014, Comal Co. Revised 10/2/2012.

Areas within one mile of the section of the transmission pipeline which occurs between Luling and Gonzales includes 6 National Register Properties, 2 National Register Districts, 10 cemeteries and 58 Historical Markers. The majority of these cultural resource sites occur within the city limits of Luling and Gonzales and are not anticipated to be impacted by project construction activities. The ASR well field area includes four cemeteries, and one Historical Marker. Avoidance of these cultural resource areas should be possible by careful selection of the areas for well sites and their associated pipelines. A review of archaeological resources in the proposed project area should be conducted during the project planning phase. Because the owner or controller of the project will likely be a political subdivision of the State of Texas (i.e., river authority, municipality, water district, etc.), they will be required to coordinate with the Texas Historical Commission prior to project construction

5.2.29.4 Engineering and Costing

For the HCPUA/TWA/GBRA Shared Facilities Project, the HCPUA and TWA combined well fields are assumed to have a capacity of 48.9 MGD (peaking factor of 1.5 times average day) with an annual average production of 36,513 acft/yr. Production wells ranging from 1,600 – 2,910 gpm will be used to pump raw groundwater to a 48.9 MGD water treatment plant near the well field for removal of iron and manganese.

The Guadalupe River intake site is located on the left bank immediately west of U.S. Highway 183, upstream of and within the conservation pool of the existing Gonzales Dam. A 5,600 HP intake pump station is assumed to deliver raw water from the intake to the 67 MGD ASR WTP through a 66-IN diameter, 6 mile pipeline. Available treated water in excess of participant demands is sent to the ASR wellfield for aquifer storage. The 28 dual purpose wells will have a maximum recharge rate of 1,180 gpm and maximum recovery rate of 1,533 gpm. Other treated water is conveyed through a 60 IN diameter, 13 mile pipeline that connects with the treated groundwater supplies from the HCPUA and TWA well fields. Treated surface water and groundwater is then delivered to participants along the potable water transmission pipeline. The transmission system will have multiple delivery locations and potential for tie-ins along the route. Potential project participants and supply volumes for the HCPUA/TWA/GBRA Shared Facilities Project are summarized in Table 5.2.29-2. Participants and supply allocations shown in Table 5.2.29-2 are for illustrative and cost estimating purposes only.

Table 5.2.29-2 Potential Project Participants and Supply Allocations

Participant	Supplies (acft/yr)
Buda	6,833
Kyle	13,606
Maxwell WSC	171
County Line SUD	973
San Marcos	15,360
Martindale WSC	85
Crystal Clear SUD	8,534
CRWA	25,601
Canyon Lake WSC	10,301
WTP	5,000
Total	**86,513**

Conceptual planning-level engineering and cost estimates were prepared for the HCPUA/TWA/GBRA Shared Facilities Project at a MAG limited firm yield of 86,513 acft/yr (Table 5.2.29-3).

The 134 mile transmission system will require four booster pump stations and will cross the San Marcos River and the Guadalupe River. The transmission pipeline is assumed to be sized with a 1.5 peaking factor. Transmission pipeline diameters range from 78-IN to 8-IN. Other than pump station and WTP storage, the project includes 8 additional storage tanks ranging from 0.1 MG to 0.6 MG.

Total project costs are $1,123,541,000. The total annual cost includes the debt service for the project cost, operation and maintenance costs, power costs, groundwater district fees estimated at $9.78/acft/yr, and groundwater lease fees estimated at $125/acft/yr (combined minimum and production fees). The total annual unit cost in dollars per acft is the total annual cost divided by the associated dependable, firm water supply. Annual costs for the project are $150,227,000 with a unit cost of $1,736/acft (Table 5.2.29-3).

Table 5.2.29-3 Cost Estimate for HCPUA/TWA/GBRA Shared Facilities Project

Item	*Estimated Costs for Facilities*
Primary Pump Stations (48.9 MGD)	$47,058,000
Transmission Pipeline (54 in dia., 134 miles)	$238,255,000
Transmission Pump Station(s) & Storage Tank(s)	$44,200,000
Well Fields (Wells, Pumps, and Piping)	$139,182,000
Storage Tanks (Other Than at Booster Pump Stations)	$2,424,000
Two Water Treatment Plants (48.9 MGD and 67 MGD)	$249,533,000
Access Roads	$4,813,000
TOTAL COST OF FACILITIES	**$725,465,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$242,000,000
Advanced Payments for Groundwater	$17,505,000
Test Drilling and Mitigation	$3,185,000
Environmental & Archaeology Studies and Mitigation	$7,979,000
Land Acquisition and Surveying (1,156 acres)	$20,645,000
Interest During Construction (4% for 3 years with a 1% ROI)	$106,762,000
TOTAL COST OF PROJECT	**$1,123,541,000**
ANNUAL COST	
Debt Service (5.5 percent, 20 years)	$94,017,000
Operation and Maintenance	
Intake, Pipeline, Pump Station (1% of Cost of Facilities)	$5,973,000
Water Treatment Plant (2.5% of Cost of Facilities)	$32,022,000
Pumping Energy Costs (140,036,181 kW-hr @ 0.09 $/kW-hr)	$12,603,000
Groundwater Leases and District Fees	$5,612,000
TOTAL ANNUAL COST	**$150,227,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 1.5	86,513
Annual Cost of Water ($ per acft)	$1,736
Annual Cost of Water ($ per 1,000 gallons)	$5.33

5.2.29.5 Implementation Issues

On an annual unit cost basis, the HCPUA/TWA/GBRA Shared Facilities Project is 9 percent less than the HCPUA Project, 30 percent less than the TWA Regional Carrizo Project, and 6 percent more than the GBRA MBWSP – Surface Water with ASR. Furthermore, the HCPUA/TWA/GBRA Shared Facilities Project is 8 percent less than the HCPUA/TWA Joint Project.

For each aquifer in the region, the GCDs have adopted desired future conditions (DFCs). In some GCDs, full use of all groundwater supplies (permitted, grandfathered and exempt) may result in non-achievement of the DFCs for an aquifer. To ensure consistency with the DFCs, TWDB currently requires that groundwater availability for each aquifer be limited for planning purposes to the modeled available groundwater (MAG) for the aquifer. This has resulted, for planning purposes only, in adjustments to permit amounts, and a lack of firm water available for future permits in this plan for some areas for certain time periods. This should not be construed as recommending or requiring that GCDs make these adjustments, or deny future permit applications. SCTRWPG recognizes and supports the ability of permit holders to exercise their rights to groundwater use in accordance with their permits and it recognizes and supports the GCDs discretion to issue permits and grandfather historical users for amounts in excess of the MAG. SCTRWPG may not modify groundwater permits that GCDs have already issued or limit future permits that GCDs may issue. If the MAG is increased during or after this planning cycle, SCTRWPG may amend this Plan to adjust groundwater supply numbers that are affected by the new MAG amount.

Other implementation issues include:

a. Renewal of GCUWCD 5-year production permits and 30-year export permits for project life.

b. Additional groundwater development in the region will not have a substantial effect on groundwater levels in the well field areas.

c. Granting recharge credit for injected water through ASR operations; these credits would be used to increase the allowable groundwater production from given leases.

d. To promote ASR well field viability, the GCUWCD must approve a reduction in the minimum well spacing from 8,000 feet to 4,000 feet (1,800 gpm wells) in recognition of no use of groundwater.

e. Some time is needed to fill an ASR facility; the amount of time is dependent on hydrological conditions in the first years of startup. For this reason, this strategy will not have adequate capacity at startup to meet customer demands without an additional, interim, source of supply (e.g., Carrizo groundwater produced from the remote ASR well field).

In addition it will be necessary to obtain the following permits and agreements:

a. USACE Sections 10 and 404 Dredge and Fill Permits for the reservoir and pipelines;

b. GLO Sand and Gravel Removal permits;

c. GLO Easement for use of state-owned land;

d. TPWD Sand, Gravel, and Marl permit; and

e. Private land for construction of facilities to be acquired through either negotiations or condemnation.

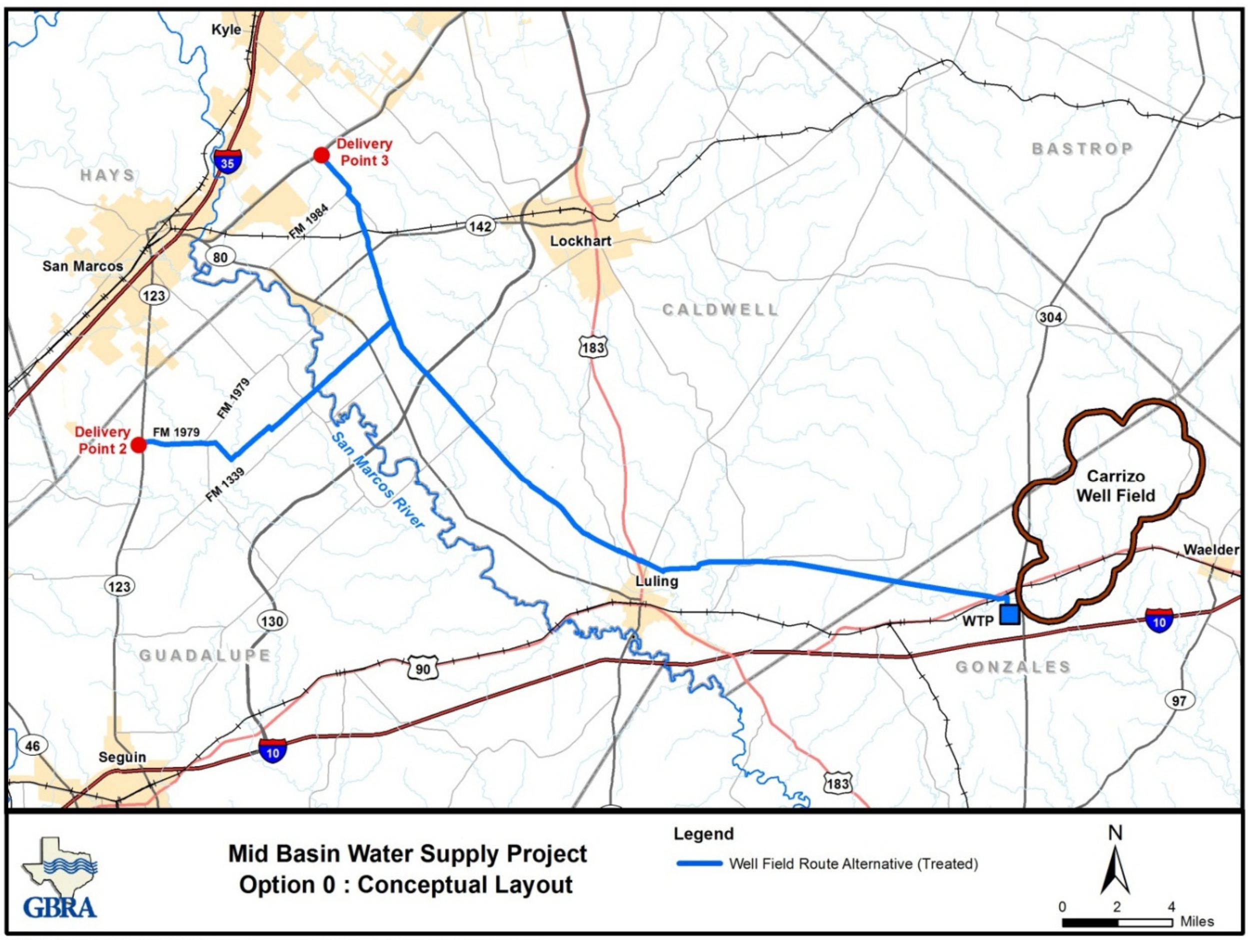
Permitting may require development of a habitat mitigation plan; environmental studies; and/or cultural resource studies and mitigation.

5.2.30. GBRA Mid-Basin Water Supply Project – Carrizo Groundwater

5.2.30.1 Description of Strategy

The Guadalupe-Blanco River Authority (GBRA) Mid-Basin Water Supply Project (MBWSP) Carrizo Groundwater (Option 0) will provide 15,000 acft/yr of Carrizo supplies from the Gonzales County well field area identified by the Texas Water Alliance (TWA) for treatment and delivery to participants. The Carrizo well field is centered on TWA leased property in northern Gonzales and eastern Caldwell County. The overall project map is shown in Figure 5.2.30-1.

Figure 5.2.30-1 MBWSP - Carrizo Groundwater Conceptual Layout



R:\07081-181488_GBRA_MBWSP\GIS\map_docs\arcmap\TM12\Option0_ConceptualLayout_wf.mxd

In the Gonzales/Caldwell County area, TWA has secured groundwater leases has obtained production well permits and transportation permits for 15,000 acft/yr from the Carrizo Aquifer. TWA's application states that the production will come from approximately 17,240 acres of contiguous leases for the well field. In all, TWA has acquired about 40,000 acres of leases. GBRA is in negotiations with TWA to acquire these leases and permits for the MBWSP.

Thirteen production wells are to average approximately 715 gpm for the 15,000 acft/yr project. Depth to bottom of the Carrizo formation in the vicinity of the wells is estimated at 1,500 ft with current static groundwater levels about 60 feet from the land surface. Production would be rotated among the wells to equalize operating time and regional drawdown. Peak production rate is 1,430 gpm from each well. The percent operating time based on the peak for all of the wells is 50%. A total of four monitoring wells (three Carrizo and one Wilcox) are required to monitor water levels and water quality around the well field to comply with GCUWCD rules. Two contingency wells are included to provide backup during peak operating times.

From the Carrizo Well Field, raw groundwater will be conveyed 3.4 miles to a WTP. The raw and treated water transmission lines are sized to deliver peak day supplies at a peaking factor of 2.0 times average day. Finished water supplies are conveyed to two delivery points which would include a meter and two storage tanks with sufficient capacity for 15% of average daily demand. MBWSP participants will be responsible for construction of any facilities required to connect to the delivery locations. Additionally, some treated supply could be made available to customers along the transmission main.

The total finished water route length is 45.6 miles, paralleling existing right of way for nearly 29 miles. Three pump stations are required to deliver supplies along the finished water transmission main. A High Service Pump Station (HSPS) will pump from the clear well at the WTP and provide sufficient head to deliver supplies to the first booster pump station. This pump station will boost pressures to convey supplies to Delivery Point 3 and part way to Delivery Point 2. The second booster pump station will boost pressures to convey supplies to Delivery Point 2.

5.2.30.2 Available Yield

Groundwater availability analyses relied on the Texas Water Development Board (TWDB) Central Groundwater Availability Model (GAM) for the Carrizo-Wilcox Aquifer. Groundwater availability is based on an acceptable level of drawdown in the GCUWCD rules. The maximum acceptable drawdown for the Carrizo and Wilcox aquifers in the artesian zone is 90-100 feet, which is to be measured in monitoring wells that are more than 6,000 feet from the nearest production well in the well field. Withdrawals and resulting drawdowns associated with this water management strategy are consistent with TWDB estimates of modeled available groundwater (MAG) and Groundwater Management Area (GMA) 13 desired future conditions (DFC).

5.2.30.3 Environmental Issues

Potential environmental issues for the proposed GBRA MBWSP - Carrizo Groundwater are described below. Implementation of this project would require field surveys by qualified professionals to document vegetation/habitat types, waters of the U.S. including wetlands, and cultural resources that may be impacted. Where impacts to protected species habitat or significant cultural resources cannot be avoided, additional studies would be necessary to evaluate habitat use and/or value, or eligibility for inclusion in the National Register of Historic Places, respectively. Compensation would be required for unavoidable adverse impacts involving net losses of wetlands.

The GBRA MBWSP Carrizo Groundwater water management strategy involves the construction of a water treatment plant, and an approximately 46 mile finished water pipeline from a well field in northern Gonzales County to two delivery points as shown in Figure 5.2.30-1 The pipeline traverses through both the Blackland Prairie and Post Oak Savannah ecoregions[1] and is within the Texan biotic province[2]. Vegetation within the project area is dominated by a mosaic of post oak woods, forest, and grassland to the east and cropland along the western portion of the pipeline.

The transmission pipelines and WTP are anticipated to have minimal impact on existing terrestrial habitat. Many pipeline segments are co-located along existing rights-of-way, fencerows, and other disturbances, which would reduce their overall vegetative impact. Grassland, cropland, and disturbed habitats make the majority (60–85%) of this area. Habitat consisting of woody species, primarily brush/shrubland, makes up 15–40% of this area, but this habitat is highly fragmented by existing land uses and disturbances (roads, cropland, utility rights-of-way, etc.). Outside the maintained right-of-way, land use would not be anticipated to change due to pipeline construction. Aquatic habitats tend to make up less than 1% of the area and consist mainly of artificial impoundments and ponds. Herbaceous habitats would recover fastest from impacts and would experience low negative impacts. Impacts to woody vegetation would be permanent due to pipeline and WTP maintenance. The proposed well field would have a minimal impact on vegetation within the project area due to limited surface exposure.

With numerous miles of raw and finished water pipelines, crossings of many jurisdictional waters would occur. However, over 90% of these crossings would include small ephemeral and intermittent streams and artificial impoundments. The greatest potential impact would occur from the pipeline crossing of the San Marcos River. Impacts from pipelines would be temporary and occur during construction. Any potential impacts to these areas would be restorable. Due to the prospective number of crossings, pipelines potentially have a medium negative impact on water resources. However, avoidance and minimization measures, such as horizontal directional drilling, construction best management practices (BMPs), and avoiding perennial and/or sensitive aquatic habitats (e.g., San Marcos River, Plum Creek, etc.) would reduce these potential impacts to the area. Wells located in the well field would not affect aquatic resources.

The proposed pipeline would cross the San Marcos River and several creeks and tributaries of the San Marcos and Guadalupe Rivers. Major water resources potentially affected would include Buck and Salt Branches; Callihan, Cottonwood, Dickerson, Long, McNeil, Morrison, Mule, Plum, Seals, and West Fork Plum creeks; Sandy Fork; and the San Marcos River. Plum Creek and the San Marcos River are the only perennial aquatic resources anticipated to be crossed by the pipelines. Cost estimates for these two crossings are based on horizontal directional drilling, thereby avoiding potential construction related stream impacts.

The proposed WTP site has potentially negligible negative impacts to water resources. This site includes one small, potentially jurisdictional ephemeral stream. The WTP site and wells are not within flood hazard areas.

[1] Gould, F.W. 1975. The Grasses of Texas. Texas A&M University Press. College Station, Texas
[2] Blair, W.F., "The Biotic Provinces of Texas, "Tex. J. Sci. 2:93-117, 1950.

Coordination with the U.S. Army Corps of Engineers would be required for construction within waters of the U.S. Impacts from this proposed project resulting in a loss of less than 0.5 acres of waters of the U.S. could be covered under Nationwide Permit #12 for Utility Line Activities unless there are significant impacts to the aquatic environment by other project components.

The Texas Parks & Wildlife Department (TPWD) has identified a number of stream segments throughout the state as ecologically significant on the basis of biological function, hydrologic function, riparian conservation, exceptional aquatic life uses, and/or threatened or endangered species. Currently, 21 stream segments in Region L are considered ecologically significant by the TPWD[3]. Pipelines associated with this water management strategy do not cross any of these stream segments. Long-term groundwater production and associated drawdown could result in incremental reductions in flux from the Carrizo Aquifer to the Lower San Marcos River. This segment is deemed ecologically significant due to the presence of the American eel and golden orb (an endemic freshwater mussel) as well as Palmetto State Park (a riparian conservation area).

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 (Pl96-515), and the Archeological and Historic Preservation Act (PL93-291). Based on the review of available GIS datasets, there are ten cemeteries, four historical markers and one national register property located within a 0.5-mile buffer of the proposed pipeline route. Additionally, there are five cemeteries and four historical markers within the potential well field area.

Based on a review of soils, geology, and aerial photographs, there is a high probability for undocumented significant cultural resources within the alluvial deposits and terrace formations associated with waterways, specifically the intermittent and perennial aquatic resources. The well field collection and transmission pipelines potentially are considered to have low negative impact to cultural resources. For the most part, the pipelines would cross areas of low probability for cultural resources, but those probabilities increase near waterways and associated landforms. However, Thompsonville cemetery is located in the well field near proposed collection piping. The WTP site and wells potentially have negligible negative impacts. No known cultural resource sites occur within these areas, but the components are sited in low probability areas.

A review of archaeological resources in the proposed project area should be conducted during the project planning phase. Taking into consideration that the owner or controller of the project will likely be a political subdivision of the State of Texas (i.e. river authority, municipality, water district, etc.), they will be required to coordinate with the Texas Historical Commission regarding impacts to cultural resources. The project sponsor will also be required to coordinate with the U.S. Army Corps of Engineers regarding any impacts to waters of the United States or wetlands.

The species listed by USFWS, and TPWD, as endangered or threatened with potential habitat in Gonzales, Guadalupe, and Caldwell counties are listed in Table 5.2.30-1. Review of the Texas Natural Diversity Database, maintained by TPWD, which

[3] TPWD, "Ecologically Significant River and Stream Segments," http://www.tpwd.state.tx.us/landwater/water/environconcerns/water_quality/sigsegs/index.phtml accessed February 6, 2014.

documents the occurrence of rare species within the state, was included in this analysis. There are no documented occurrences of threatened or endangered species along or immediately adjacent to the proposed pipeline.

Table 5.2.30-1 Endangered, Threatened, and Species of Concern for Caldwell, Gonzales and Guadalupe Counties

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
BIRDS								
American peregrine falcon	*Falco peregrinus anatum*	0	2	0	Migrant and local breeder in West Texas.	DL	T	Possible Migrant
Artic peregrine falcon	*Falco peregrinus tundrius*	0	1	0	Migrant throughout the state.	DL		Possible Migrant
Bald eagle	*Haliaeetus leucocephalus*	0	2	0	Found primarily near rivers and large lakes.	DL	T	Possible Migrant
Henslow's sparrow	*Ammodramus henslowii*	1	1	1	Found in weedy fields or cut-over areas			Resident
Interior least tern	*Sterna antillarum athalassos*	0	3	0	Nests along sand and gravel bars in braided streams	LE	E	Resident
Mountain plover	*Charadrius montanus*	1	1	1	Non-breeding, shortgrass plains and fields			Nesting/ Migrant
Sprague's pipit	*Anthus spragueii*	0	1	0	Migrant in Texas in winter mid Sept. to early April. Strongly tied to native upland prairie.			Possible Migrant
Western burrowing owl	*Athene cunicularia hypugaea*	1	1	1	Open grasslands, especially prairie, plains and savanna			Resident
Whooping crane	*Grus americana*	0	3	0	Potential migrant	LE	E	Potential Migrant
Wood stork	*Mycteria americana*	1	2	2	Forages in prairie ponds, ditches, and shallow standing water formerly nested in TX		T	Migrant
FISHES								
Blue sucker	*Cycleptus elongatus*	1	2	2	Major rivers in Texas.		T	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
Guadalupe bass	*Micropterus treculi*	1	1	1	Endemic to perennial streams of the Edwards Plateau region.			Resident
Guadalupe darter	*Percina sciera apristis*	1	1	1	Guadalupe River Basin. Usually found over gravel or gravel and sand raceways of larger streams and rivers.			Resident
INSECTS								
A mayfly	*Campsurus decolaratus*	0	1	0	In Texas and Mexico, possibly clay substrates, found in shoreline vegetation.			Potential Resident
MAMMALS								
Cave myotis bat	*Myotis velifer*	0	1	0	Roosts colonially in caves, rock crevices			Resident
Plains spotted skunk	*Spilogale putorius interrupta*	1	1	1	Prefers wooded, brushy areas.			Resident
Red wolf	*Canis rufus*	0	3	0	Extirpated.	LE	E	Historic Resident
MOLLUSKS								
Creeper (squawfoot)	*Strophitus undulates*	1	1	1	Small to large streams. Colorado, Guadalupe, and San Antonio River basins.			Resident
False spike mussel	*Quincuncina mitchelli*	1	2	2	Substrates of cobble and mud. Rio Grande, Brazos, Colorado and Guadalupe river basins.		T	Resident
Golden orb	*Quadrula aurea*	1	2	2	Sand and gravel, Guadalupe, San Antonio, Lower San Marcos, and Nueces River basins	C	T	Resident
Palmetto pill snail	*Euchemostrema leai cheatumi*	0	1	0	Known only from Palmetto State Park.			Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
Texas fatmucket	*Lampsilis bracteata*	1	2	2	Streams and rivers on sand, mud and gravel, Colorado and Guadalupe River basins.	C	T	Resident
Texas pimpleback	*Quadrula petrina*	1	2	2	Mud, gravel and sand substrates, Colorado and Guadalupe river basins		T	Resident
PLANTS								
Big red sage	*Salvia pentstemonoides*	0	1	0	Texas endemic, found in moist to seasonally wet steep limestone outcrops on canyons or along creek banks.			Resident
Bristle nailwort	*Paronychia setacea*	1	1	1	Endemic to south central Texas in sandy soils.			Resident
Buckley's spiderwort	*Tradescantia buckleyi*	1	1	1	Endemic in grassland openings in oak woodlands.			Resident
Green beebalm	*Monarda viridissima*	1	1	1	Endemic perennial herb. Found in well-drained sandy soils in opening of post oak woodlands.			Resident
Elmendorf's onion	*Allium elmendorfii*	1	1	1	Endemic, in deep sands			Resident
Parks' jointweed	*Polygonella parksii*	0	1	0	Texas endemic, primarily found on deep, loose, sand blowouts in Post Oak Savannas.			Resident
Shinner's sunflower	*Helianthus occidentalis ssp.*	1	1	1	Found on prairies on the Coastal Plain.			Resident
Sandhill woolywhite	*Hymenopappus carrizoanus*	1	1	1	Found south of the Guadalupe River. Prefers dense riparian corridors.			Resident
REPTILES								
Cagle's map turtle	*Graptemys caglei*	1	2	2	Endemic to Guadalupe River System. Found near waters' edge.		T	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
Spot-tailed earless lizard	*Holbrookia lacerata*	1	1	1	Moderately open prairie-brushland.			Resident
Texas Garter Snake	*Thamnophis sirtalis annectens*	1	1	1	Wet or moist microhabitats			Resident
Texas Horned Lizard	*Phrynosoma cornutum*	1	2	2	Varied, sparsely vegetated uplands.		T	Resident
Texas Tortoise	*Gopherus berlandieri*	1	2	2	Open brush w/ grass understory.		T	Resident
Timber rattlesnake	*Crotalus horridus*	1	2	2	Floodplains, upland pine, deciduous woodlands, riparian zones.		T	Resident
TPWD, 2014. Annotated County List of Rare Species – Gonzales, Caldwell and Guadalupe counties revised 8/7/2012. USFWS, 2013. Endangered Species List for Texas. http://www.fws.gov/southwest/es/ES_ListSpecies.cfm accessed online February 6, 2013.								

Endangered species including Texas wild-rice, San Marcos gambusia, fountain darter, and the Texas blind salamander; the threatened San Marcos salamander, and the rare Shinner's sunflower have all been documented within five miles of the proposed pipeline route. Many species including Texas wild-rice, the San Marcos gambusia, fountain darter, San Marcos salamander, and Texas blind salamander have a very limited distribution; several are endemic only to the headwaters of the San Marcos River.

The project area may provide potential habitat to endangered or threatened species found in Gonzales, Guadalupe, or Caldwell counties. A survey of the project area may be required prior to pipeline and well field construction to determine whether populations of or potential habitats used by listed species occur in the area to be affected. Coordination with TPWD and USFWS regarding threatened and endangered species with the potential to occur in the project area should be initiated early in project planning.

Available data did not reveal the occurrence of any listed species within the environmental assessment area, but the absence of data does not imply the absence of occurrence. Based on existing habitat types, the following species have potential to occur near project components, but the project is not anticipated to affect any species adversely. The aquatic species are only of concern at locations where pipelines cross perennial waters.

A. Federal-Listed Endangered Species

Whooping Crane (Grus americana) — The Whooping Crane is a federally listed species which would occur in Texas only during migration. Whooping cranes use a variety of habitats during migration, including croplands for feeding and large, marshy palustrine wetlands for roosting. Although large wetlands do not exist within the project area, the Whooping Crane could potentially occur in any surrounding cropland habitat during migration.

B. Federal-Listed Candidate Species

Golden Orb (Quadrula aurea) — The Golden orb is a federal candidate for listing and is state threatened. This freshwater mollusk exists in sand, gravel or mud substrates within lake or river systems. This species could potentially occur in the San Marcos River and perennial streams.

Texas fatmucket (Lampsilis bracteata) — The Texas fatmucket is a federal candidate for listing in the state and is state threatened. This freshwater mollusk exists in more shallow rivers or streams with substrates of sand, mud and gravel. This species could potentially occur in the San Marcos River and perennial streams.

Texas pimpleback (Quadrula petrina) — The Texas pimpleback is a federal candidate for listing in the state, but not in Gonzales and Caldwell counties, and is state threatened. This freshwater mollusk exists in small to moderate streams and rivers of slow flow rates, as well as moderate size reservoirs with substrates of mixed mud, sand and fine gravel. This species was collected during a fall 2011 survey near Gonzales, Texas. This species could potentially occur in the San Marcos River and perennial streams.

C. State-Listed Species

Bald Eagle (Haliaeetus leucocephalus) — The Bald Eagle is a state-listed threatened species that could occur as a migrant near major aquatic resources. Although they breed primarily in the eastern half of the state, they could potentially occur along rivers or large lakes in this region of Texas during the winter and during migration. This species could potentially occur near perennial waterways such as the San Marcos River.

Interior Least Tern (Sterna antillarum athalassos) — The Interior Least Tern is listed as endangered by the USFWS. They prefer to nest on sandbars, islands, salt flats, and bare or sparsely vegetated sand, shell, and gravel beaches that are associated with braided streams, rivers and reservoirs. They could potentially occur within these habitats along the San Marcos River, Plum Creek, Salt Branch, or dry, exposed impoundments.

Peregrine Falcon (Falco peregrinus), including the American peregrine falcon (F. p. anatum) subspecies, is a state threatened bird that could be a possible migrant. They utilize a wide range of habitats during migration, including urban areas and landscape edges such as lakes or large river shores.

Blue sucker (Cycleptus elongatus) is a state threatened fish and exists in large portions of major rivers in Texas. Their preferred habitat includes channels and flowing pools with a moderate current and a bottom of exposed bedrock with hard clay, sand and gravel components.

False spike mussel (Quadrula mitchelli) is state threatened freshwater mollusk. The TPWD county list states the species as possibly extirpated in Texas. A small population was discovered during a fall 2011 survey in the Guadalupe River near Gonzales. This species could potentially occur in the San Marcos River and perennial streams.

Cagle’s map turtle (Graptemys caglei) is a state threatened reptile and occupies riverine habitat in the Guadalupe-San Antonio river systems. They prefer shallow water with swift to moderate flow and a substrate of gravel or cobble or deeper pools with a slower flow rate and a substrate of silt or mud. This turtle will nest on gently sloping sand banks along rivers. This species could potentially occur in the San Marcos River and perennial waterways.

Texas horned lizard (Phrynosoma cornutum) is a state threatened reptile and is present throughout much of the state. They exist in open, arid, and semi-arid regions with sparse vegetation, which includes grass, cactus, scattered brush or scrubby trees. This species could potentially occur in areas with this type of contiguous vegetation.

Texas tortoise (Gopherus berlandieri) is a state threatened reptile that is active in the warmer months of March through November. They occur in open brush with a grass understory and will avoid areas of open grass or bare ground. This species could potentially occur in areas with this type of contiguous vegetation.

Timber/Canebrake rattlesnake (Crotalus horridus) is a state threatened reptile that occurs in swamps, floodplains, upland pine and deciduous woodlands, riparian zones, and abandoned farmland. They could also be present in limestone bluffs, sandy soil or black clay. This species could potentially occur in areas of abandoned farmland or forested riparian areas.

D. Unique or Rare Species

American eel (Anguilla rostrata) is not a listed species, but is part of a unique community designation within the San Marcos River. The NDD has no recorded occurrences of this species in the location of the proposed assessment area, but the species could potentially occur in perennial streams.

Guadalupe bass (Micropterus treculii) is an endemic game fish to Texas, found in the northern and eastern Edwards Plateau including headwaters of the San Antonio River, the Guadalupe River above Gonzales, the Colorado River north of Austin, and portions of the Brazos River drainage. Relatively small populations occur outside of the Edwards Plateau, primarily in the lower Colorado River. Although not a listed species, it is the official state fish and considered rare by TPWD. This species could potentially occur in perennial waters.

The primary impacts that would result from construction of the proposed project would include the conversion of existing habitats and land uses within the pipeline right-of-way, WTP site, and well sites to maintained areas. These impacts are anticipated to be minor. Additional impacts could result from the pipeline crossings of the San Marcos River and other perennial waterways.

5.2.30.4 Engineering and Costing

Costs for the GBRA MBWSP Carrizo Groundwater project are based on the GBRA's MBWSP Engineering Feasibility Study and indexed to September 2013 prices and other TWDB costing assumptions. The project is sized for 15,000 acft/yr annual delivery with a 2.0 peaking factor. Total project and annual costs for this option and each project yield are included in Table 5.2.30-2

These costs are for all facilities including well field facilities, treatment plant, and finished water facilities up to the customer delivery points (i.e. everything shown in Figure). Costs for engineering, legal, and contingencies are estimated as 30 percent of capital costs for the pipeline and 35 percent of capital costs for other facilities (e.g., pump stations). Interest during construction was calculated based on a 3 percent differential between loan payments and earnings with a 2 year construction period. The capital costs for all facilities are $133,395,000 (Table 5.2.30-2). Adding in non-capital costs: engineering/legal/contingencies, environmental, land acquisition and surveying, interest during construction, and groundwater lease payments; the total project cost for all facilities required to provide an annual supply of 15,000 acft/yr is $211,047,000. Annual costs, which include debt service (5.5%, 20 years), operation and maintenance, and energy costs, are $24,982,000, resulting in an annual unit cost of $1,665/acft.

In terms of environmental impacts, the amount and type of impact drives potential surveying, permitting, and mitigation costs. Implementing measures to avoid and limit impacts (e.g., directional drill) to sensitive environmental features and aquatic resources may lessen potential costs. Estimated environmental and archaeological costs (surveying, permitting, and mitigation) are $364,000.

Table 5.2.30-2 Summary Cost Estimate for GBRA MBWSP Carrizo Groundwater

Item	*Estimated Costs for Facilities*
Intake Pump Stations	$14,633,000
Transmission Pipeline	$49,108,000
Well Fields (Wells, Pumps, and Piping)	$29,221,000
Storage Tanks (Other Than at Booster Pump Stations)	$1,675,000
Water Treatment Plant	$37,076,000
Access Roads	$1,682,000
TOTAL COST OF FACILITIES	**$133,395,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$45,008,000
Environmental & Archaeology Studies and Mitigation	$364,000
Land Acquisition and Surveying	$6,369,000
Interest During Construction (4% for 2 years with a 1% ROI)	$12,906,000
Advanced Payments for Groundwater Leases	$13,005,000
TOTAL COST OF PROJECT	**$211,047,000**
ANNUAL COST	
Debt Service (5.5 percent, 20 years)	$17,595,000
Operation and Maintenance	
Intake, Pipeline, Pump Station & Groundwater	$2,968,000
Water Treatment Plant (2.5% of Cost of Facilities)	$2,863,000
Pumping Energy Costs (17,291,667 kW-hr @ 0.09 $/kW-hr)	$1,556,000
TOTAL ANNUAL COST	**$24,982,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 2	15,000
Annual Cost of Water ($ per acft)	$1,665
Annual Cost of Water ($ per 1,000 gallons)	$5.11

Note: Unit costs for Option 0 in GBRA's MBWSP Engineering Feasibility Study were estimated at $1481/acft using March 2012 prices, debt service at 5% for 30 years, and $0.12/kwhr.

5.2.30.5 Implementation Issues

For each aquifer in the region, the GCDs have adopted desired future conditions (DFCs). In some GCDs, full use of all groundwater supplies (permitted, grandfathered and exempt) may result in non-achievement of the DFCs for an aquifer. To ensure consistency with the DFCs, TWDB currently requires that groundwater availability for each aquifer be limited for planning purposes to the modeled available groundwater (MAG) for the aquifer. This has resulted, for planning purposes only, in adjustments to permit amounts, and a lack of firm water available for future permits in this plan for some areas for certain time periods. This should not be construed as recommending or requiring that GCDs make these adjustments, or deny future permit applications. SCTRWPG recognizes and supports the ability of permit holders to exercise their rights to groundwater use in accordance with their permits and it recognizes and supports the GCDs discretion to issue permits and grandfather historical users for amounts in excess of the MAG. SCTRWPG may not modify groundwater permits that GCDs have already issued or limit future permits that GCDs may issue. If the MAG is increased during or after this planning cycle, SCTRWPG may amend this Plan to adjust groundwater supply numbers that are affected by the new MAG amount.

A test drilling program is recommended during the Pre-Design Phase to confirm aquifer properties and support designs of the wells. This yield and operation of this strategy may require modification of or variances from the Gonzales County Underground Water Conservation District (GCUWCD) rules, including:

a. Allowing the maximum production of a well to exceed the average annual production by a factor of 2.0 instead of 1.5; and
b. Modify contiguous acreage requirements to be based on long-term average annual well field production instead of the maximum annual permitted capacity.

Other implementation issues include:

a. An agreement with TWA to acquire their groundwater permits and leases
b. Renewal of GCUWCD 5-year production permits and 30-year export permits for project life; and
c. Effects of additional groundwater development in the region on groundwater levels in the well field areas.

In addition, it will be necessary to obtain the following permits and agreements:

a. USACE Sections 10 and 404 Dredge and Fill Permits for the pipelines;
b. GLO Sand and Gravel Removal permits;
c. GLO Easement for use of state-owned land;
d. TPWD Sand, Gravel, and Marl permit; and
e. Private land for construction of facilities to be acquired through either negotiations or condemnation.

Permitting may require development of an habitat mitigation plan; environmental studies; and/or cultural resource studies and mitigation.

5.2.31 GBRA Mid-Basin Water Supply Project – Surface Water with Off-Channel Reservoir (OCR)

5.2.31.1 Description of Strategy

The Guadalupe-Blanco River Authority (GBRA) Mid-Basin Water Supply Project (MBWSP) Surface Water with Off-Channel Reservoir (Option 2A) can provide a firm yield of up to 40,000 acft/yr.

This strategy would divert run-of-river water from the Guadalupe River below Gonzales backed-up with stored water from an off-channel reservoir in Gonzales County. GBRA has submitted Application No. 12378 for the surface water rights associated with this water management strategy and this application has been declared administratively complete by the Texas Commission on Environmental Quality (TCEQ).

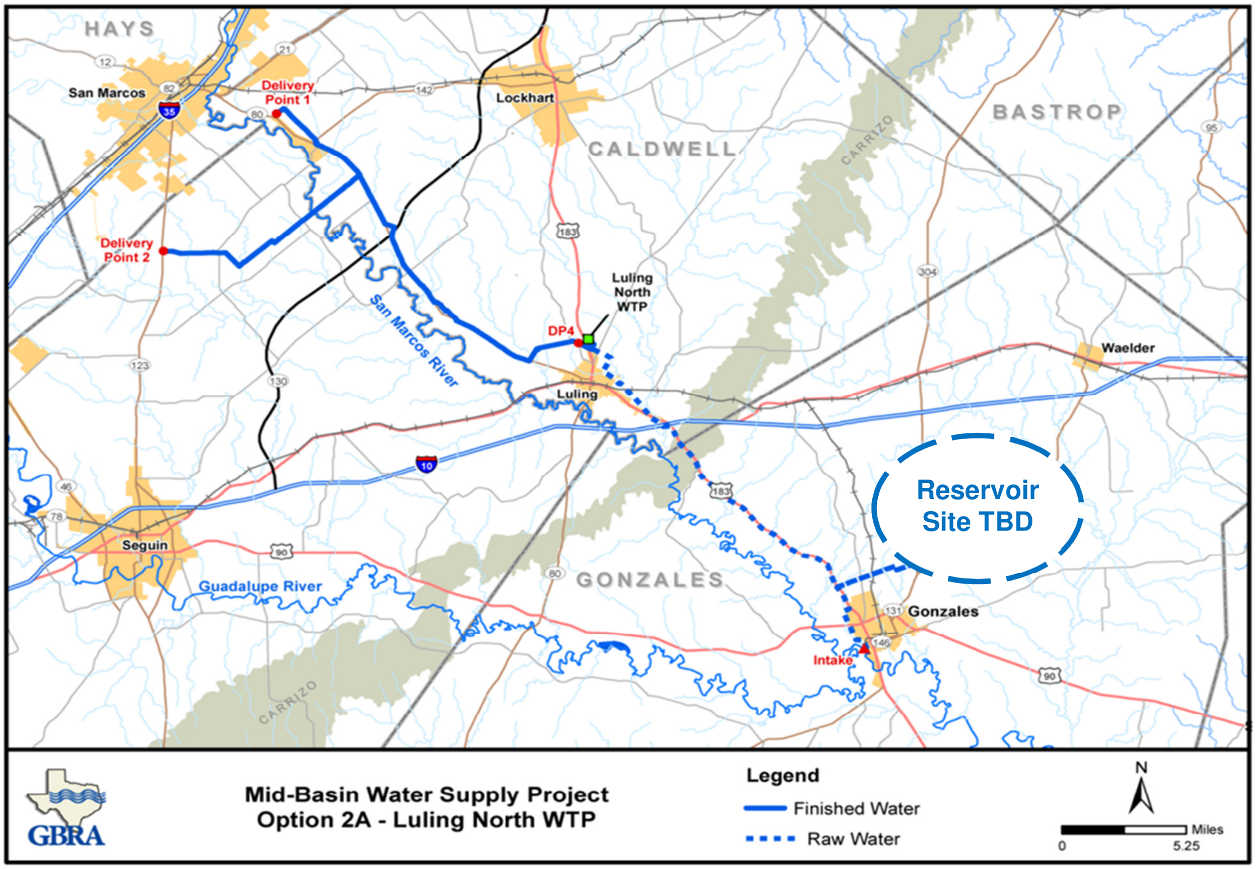
For this alternative, an intake on the Guadalupe River downstream of the confluence of the San Marcos and Guadalupe Rivers and within Gonzales County will divert water under a new appropriation into an off-channel reservoir (OCR) in Gonzales County (Figure 5.2.31-1). The exact location, configuration, and capacity of the OCR have yet to be determined. The raw water transmission pipeline follows US 183 from the OCR intake to a new Water Treatment Plant (WTP) located north of the City of Luling. The treated water pipeline follows SH 80 to customer delivery points near IH-35.

Surface water will be pumped from a 400 cfs intake and pump station on the Guadalupe River at Gonzales for a distance of about 9 miles to the OCR through a 108-IN diameter pipeline. From the OCR, raw water is delivered to the WTP through a 54-IN diameter, 22.4 mile pipeline. All facilities are sized for a 2.0 peaking factor.

Finished water supplies are conveyed to two delivery points which would include a meter and two storage tanks with sufficient capacity for 15% of average daily demand. MBWSP participants will be responsible for construction of any facilities required to connect to the delivery locations. Additionally, some treated supply could be made available to customers along the transmission main.

The total finished water pipeline route length is 45.4 miles. The transmission line is sized to deliver average annual supply with a peaking factor of 2.0. Two pump stations are required to deliver supplies along the finished transmission main. A High Service Pump Station (HSPS) will pump from the clear well located at the WTP and provide sufficient head to deliver supplies to Delivery Point 1 and part way to Delivery Point 2. A booster pump station will boost pressures to convey supplies to Delivery Point 2.

Figure 5.2.31-1 MBWSP – Surface Water Only Conceptual Layout



5.2.31.2 Available Yield

Estimates of surface water available for diversion under a new appropriation from the Guadalupe River at Gonzales were computed subject to senior water rights and environmental flow standards recently adopted by the TCEQ. Surface water availability was computed in conformance with GBRA's Application No. 12378, which includes a maximum annual diversion of 75,000 acft/yr from the Guadalupe River at Gonzales, maximum instantaneous diversion rate of 500 cfs, and off-channel storage of 125,000 acft.

The models used to determine availability and yield include the Guadalupe-San Antonio River Basin Water Availability Model (GSA WAM) and the Flow Regime Application Tool (FRAT).

Modeling Assumptions

Major modeling assumptions in applications of the GSA WAM and FRAT include:

- Water availability computed subject to full use of senior water rights for consumptive uses and environmental flow standards adopted by TCEQ on August 8, 2012.

- Treated effluent discharges were excluded throughout the river basin (similar to TCEQ Run 3), except when specifically addressed in a water right (e.g., INVISTA, Kate O'Connor Trust, etc.).
- Springflows from the Edwards Aquifer were based on aquifer management in accordance with full implementation of the Edwards Aquifer Habitat Conservation Plan (EAHCP) approved by the U.S. Fish and Wildlife Service (USFWS). Two Edwards Aquifer simulation models (GWSIM-IV for the 1934-1946 period and MODFLOW for the 1947-2000 period) were used to estimate springflow.
- Net evaporation depths for off-channel reservoir simulations were obtained from the GSA WAM data files for internal consistency.

Modeling Scenarios

In order to calculate surface water available from the Guadalupe River at Gonzales for the MBWSP, a new water right (junior to all existing water rights) was modeled in the GSA WAM to obtain monthly unappropriated and regulated flows for the Guadalupe River at Gonzales. The portion of streamflow allocated to downstream senior water rights was calculated by subtracting the unappropriated flow from the regulated flow. Monthly regulated flows were then disaggregated to daily values using gaged or estimated daily streamflows for the Guadalupe River at Gonzales. Monthly amounts allocated to downstream senior water rights were then taken uniformly out of the base of the daily hydrograph such that the sum of daily pass-through amounts in each month equals the total monthly amount allocated to downstream senior water rights.

Daily senior water right pass-throughs and daily regulated flows are incorporated into the FRAT model, along with the TCEQ environmental flow standards for the Guadalupe River at Gonzales. These environmental flow standards consist of seasonal subsistence and base flows, two tiers of seasonal pulses, and a pulse exemption provision under which pulses may be excluded if the magnitude of the maximum diversion rate of the water right is less than or equal to 20 percent of the pulse peak. For example, if the maximum diversion rate for the MBWSP is 500 cfs, the Winter, Spring, and Fall Large Pulses and the Spring Small Pulse diversion restrictions would be excluded and the MBWSP would not be required to honor those pulses. Additionally, the environmental flow standard for the Guadalupe River at Gonzales includes a provision for diversions that are made between the base flow and the subsistence flow, such that when streamflow is between the base and subsistence flows, only 50 percent of the difference between the streamflow and the subsistence flow can be diverted.

Surface Water and Off-Channel Reservoir

Using monthly water availability and daily disaggregation procedures described above, FRAT was used to simulate surface water diversions to an off-channel reservoir from which a firm supply of surface water could be delivered to project participants. Simulations indicate that a firm yield of 25,000 acft/yr can be obtained assuming a maximum instantaneous diversion rate of 500 cfs and off-channel storage capacity of 105,000 acft.

5.2.31.3 Environmental Issues

Environmental issues for the proposed MBWSP Surface Water with Off-Channel Reservoir project in Gonzales, Guadalupe, and Caldwell counties are described below. Implementation of this pipeline and OCR would require field surveys by qualified professionals to document vegetation/habitat types, waters of the U.S. including wetlands, and cultural resources that may be impacted. Where impacts to protected species habitat or significant cultural resources cannot be avoided, additional studies would be necessary to evaluate habitat use and/or value, or eligibility for inclusion in the National Register of Historic Places, respectively. Compensation would be required for unavoidable adverse impacts involving net losses of wetlands.

The project involves the construction of approximately 60 miles of pipeline. Water would be diverted from the Guadalupe River near Gonzales and stored in an OCR for delivery to the a WTP near Luling, then to two delivery points as shown in Figure 5.2.31-1. The pipeline traverses both the Blackland Prairie and Post Oak Savannah ecoregions[1] and is within the Texan biotic province[2]. Vegetation within the project area is dominated by a mosaic of post oak woods, forest and grassland to the east and cropland along the western portion of the proposed pipeline[3].

The transmission pipelines and water treatment sites are anticipated to have minimal impact on existing terrestrial habitat. Many pipeline segments are co-located along existing rights-of-way, fencerows, and other disturbances, which would reduce their overall vegetative impact. Grassland, cropland, and disturbed habitats make up the majority (60–85%) of the area planned for these purposes. Existing areas which contain woody species are highly fragmented by existing land uses and disturbances (roads, cropland, utility rights-of-way, etc.). Aquatic habitats are scattered and small and consist mainly of artificial impoundments and ponds. Herbaceous habitats would recover quickly from impacts and would experience low negative impacts. Outside the maintained right-of-way, land use would not be anticipated to change due to pipeline construction. However any impacts to woody vegetation would be permanent due to required pipeline and WTP maintenance.

The proposed OCR construction would result in negative impacts to some species from the inundation of existing terrestrial habitat. However, this impact would be moderated by the creation of additional aquatic habitat which would benefit some species. Habitat within the OCR area consists predominately of woody species which cover 50–61% of the area, and grassland which occurs in 36–44% of the area.

The proposed pipeline would cross the San Marcos River and several creeks and tributaries of the San Marcos and Guadalupe Rivers. In addition, the construction of the OCR would impact existing aquatic resources within that area. Major perennial aquatic resources potentially affected by this strategy include the Guadalupe River, San Marcos River, Artesia Creek, Mule Creek, and Plum Creek. Major intermittent aquatic resources potentially affected by this option include Canoe Creek, Dry Fork, Kerr Creek, and Smith Creek. The proposed water intake located along the Guadalupe River would require placing structures and fill material into the river to construct the facility, resulting in

[1] Gould, F.W. 1975. The Grasses of Texas. Texas A&M University Press. College Station, Texas.
[2] Blair, W.F., “The Biotic Provinces of Texas, “Tex. J. Sci. 2:93-117, 1950.
[3] McMahan, C. A., R. G. Frye and K. L. Brown, “ The Vegetation Types of Texas -- Including Cropland,” Texas Parks and Wildlife Department - PWD Bulletin 7000-120. 1984.

potential impacts to that aquatic resource. Coordination with the U.S. Army Corps of Engineers would be required for construction within waters of the U.S. Impacts from this proposed project resulting in a loss of less than 0.5 acres of waters of the U.S. could be covered under Nationwide Permit #12 for Utility Line Activities.

The Texas Parks & Wildlife Department (TPWD) has identified a number of stream segments throughout the state as ecologically significant on the basis of biological function, hydrologic function, riparian conservation, exceptional aquatic life uses, and/or threatened or endangered species. Currently, 21 stream segments in Region L are considered ecologically significant by the TPWD[4]. Pipelines associated with this water management strategy do not cross any of these stream segments.

The section of the Guadalupe River from U.S. 183 (near the Gonzales diversion point) upstream to Lake Gonzales Dam, however, is listed as ecologically significant as it contains two of four known remaining populations of the golden orb, a rare, endemic mollusk.

The TCEQ 2010 Texas Integrated Report for Clean Water Act Sections 305(b) and 303(d) states that Denton Creek is a Category 5b water which indicates "impairments which may be suitable for development of a Total Maximum Daily Load (TMDL)" and also as having High Aquatic Life Use. Bacteria levels are the parameter for which TCEQ bases this designation. The designation applies to the entire segment (TCEQ Segment ID 1803F and NHD Reach Code 12100202000370), beginning at the confluence with Peach Creek, through OCR 1, to the upper limit of Denton Creek. Installation of a pipeline crossing Denton Creek should have little, if any, effect on bacteria levels.

Riparian woodlands, especially those located within floodplains, are ecological features that contribute to the natural and traditional character of waterways. They also help to protect water quality, wildlife habitat, and aquatic resource functions. Riparian tree species commonly found in the project region include pecan (Carya illinoiensis), American elm (Ulmus americana), bald cypress (Taxodium distichum), black walnut (Juglans nigra), bur oak (Quercus macrocarpa), cedar elm (Ulmus crassifolia), little walnut (Juglans microcarpa), and green ash (Fraxinus pennsylvanica). The largest anticipated impact to existing riparian habitat would result from construction of the OCR and the river intake.

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 (Pl96-515), and the Archeological and Historic Preservation Act (PL93-291). Based on the review of available GIS datasets, there are 17 cemeteries, 29 historical markers, four national register properties and one national register district located within a 0.5-mile buffer of the proposed pipeline route. Additionally, there are three cemeteries within the potential OCR site.

Based on a review of soils, geology, and aerial photographs, there is a high probability for undocumented significant cultural resources within the alluvial deposits and terrace formations associated with waterways. The OCR, river intake, and Luling WTP site are therefore considered to be high probability areas. The transmission pipelines generally

[4] TPWD, "Ecologically Significant River and Stream Segments," http://www.tpwd.state.tx.us/landwater/water/environconcerns/water_quality/sigsegs/index.phtml accessed February 6, 2014.

cross areas of low probability for cultural resources, but those probabilities would increase for areas near waterways and associated landforms.

A review of archaeological resources in the proposed project area should be conducted during the project planning phase. Considering that the owner or controller of the project will likely be a political subdivision of the State of Texas (i.e. river authority, municipality, water district, etc.), they will be required to coordinate with the Texas Historical Commission regarding impacts to cultural resources. The project sponsor will also be required to coordinate with the U.S. Army Corps of Engineers regarding whether the project will affect waters of the United States or wetlands.

The species listed by USFWS, and TPWD, as endangered or threatened with potential habitat in Gonzales, Guadalupe, and Caldwell counties are listed in Table 5.2.31-1.

The Texas Natural Diversity Database, maintained by TPWD, which documents the occurrence of rare species within the state, was included in this analysis. There are no documented occurrences of any endangered species along or immediately adjacent to the proposed pipeline; however, there are documented occurrences of the state threatened Cagle's map turtle, false spike mussel, golden orb, and Texas pimpleback along the Guadalupe River and immediately adjacent to the proposed Gonzales diversion point. Additionally, the western portion of the pipeline route and the San Marcos delivery point site are within an area which includes documented occurrences of Hill Country wild-mercury, a rare plant, and the rare Guadalupe bass has been documented near the proposed diversion point.

Endangered species, including Texas wild-rice, San Marcos gambusia, fountain darter, and the Texas blind salamander; the threatened San Marcos salamander, and the rare Shinner's sunflower have all been documented within 5 miles of one of the proposed delivery points. Many of the species including Texas wild-rice, San Marcos gambusia, fountain darter, San Marcos salamander and the Texas blind salamander have a very limited distribution; several are endemic only to the headwaters of the San Marcos River.

The project area may provide potential habitat to endangered or threatened species found in Gonzales, Guadalupe, or Caldwell counties. A survey of the project area may be required prior to pipeline and OCR construction to determine whether populations of or potential habitats used by listed species occur in the area to be affected. Coordination with TPWD and USFWS regarding threatened and endangered species with potential to occur in the project area should be initiated early in project planning.

Based on existing habitat types, the following species have the potential to occur within or near the OCR area.

Peregrine Falcon (Falco peregrinus), including the American peregrine falcon (F. p. anatum) subspecies — This state threatened species is a possible migrant. They utilize a wide range of habitats during migration, including urban areas and landscape edges such as lakes or large river shores.

Timber/Canebrake rattlesnake (Crotalus horridus) — This is a state threatened species that occurs in swamps, floodplains, upland pine and deciduous woodlands, riparian zones and abandoned farmland. They could also be present in limestone bluffs, sandy soil or black clay. This species could potentially occur in areas of abandoned farmland or forested riparian areas.

Table 5.2.31-1 Endangered, Threatened, and Species of Concern for Caldwell, Gonzales, and Guadalupe Counties

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
BIRDS								
American peregrine falcon	*Falco peregrinus anatum*	0	2	0	Migrant and local breeder in West Texas.	DL	T	Possible Migrant
Artic peregrine falcon	*Falco peregrinus tundrius*	0	1	0	Migrant throughout the state.	DL		Possible Migrant
Bald eagle	*Haliaeetus leucocephalus*	0	2	0	Found primarily near rivers and large lakes.	DL	T	Possible Migrant
Henslow's sparrow	*Ammodramus henslowii*	1	1	1	Found in weedy fields or cut-over areas			Resident
Interior least tern	*Sterna antillarum athalassos*	0	3	0	Nests along sand and gravel bars in braided streams	LE	E	Resident
Mountain plover	*Charadrius montanus*	1	1	1	Non-breeding, shortgrass plains and fields			Nesting/ Migrant
Sprague's pipit	*Anthus spragueii*	0	1	0	Migrant in Texas in winter mid Sept. to early April. Strongly tied to native upland prairie.			Possible Migrant
Western burrowing owl	*Athene cunicularia hypugaea*	1	1	1	Open grasslands, especially prairie, plains and savanna			Resident
Whooping crane	*Grus americana*	0	3	0	Potential migrant	LE	E	Potential Migrant
Wood stork	*Mycteria americana*	1	2	2	Forages in prairie ponds, ditches, and shallow standing water formerly nested in TX		T	Migrant
FISHES								
Blue sucker	*Cycleptus elongatus*	1	2	2	Major rivers in Texas.		T	Resident
Guadalupe bass	*Micropterus treculi*	1	1	1	Endemic to perennial streams of the Edwards Plateau region.			Resident
Guadalupe darter	*Percina sciera apristis*	1	1	1	Guadalupe River Basin. Usually found over gravel or gravel and sand raceways of larger streams and rivers.			Resident
INSECTS								
A mayfly	*Campsurus decolaratus*	0	1	0	In Texas and Mexico, possibly			Potential Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
					clay substrates, found in shoreline vegetation.			
MAMMALS								
Cave myotis bat	*Myotis velifer*	0	1	0	Roosts colonially in caves, rock crevices			Resident
Plains spotted skunk	*Spilogale putorius interrupta*	1	1	1	Prefers wooded, brushy areas.			Resident
Red wolf	*Canis rufus*	0	3	0	Extirpated.	LE	E	Historic Resident
MOLLUSKS								
Creeper (squawfoot)	*Strophitus undulates*	1	1	1	Small to large streams. Colorado, Guadalupe, and San Antonio River basins.			Resident
False spike mussel	*Quincuncina mitchelli*	1	2	2	Substrates of cobble and mud. Rio Grande, Brazos, Colorado and Guadalupe river basins.		T	Resident
Golden orb	*Quadrula aurea*	1	2	2	Sand and gravel, Guadalupe, San Antonio, Lower San Marcos, and Nueces River basins	C	T	Resident
Palmetto pill snail	*Euchemostrema leai cheatumi*	0	1	0	Known only from Palmetto State Park.			Resident
Texas fatmucket	*Lampsilis bracteata*	1	2	2	Streams and rivers on sand, mud and gravel, Colorado and Guadalupe River basins.	C	T	Resident
Texas pimpleback	*Quadrula petrina*	1	2	2	Mud, gravel and sand substrates, Colorado and Guadalupe river basins		T	Resident
PLANTS								
Big red sage	*Salvia pentstemonoides*	0	1	0	Texas endemic, found in moist to seasonally wet steep limestone outcrops on canyons or along creek banks.			Resident
Bristle nailwort	*Paronychia setacea*	1	1	1	Endemic to south central Texas in sandy soils.			Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
Buckley's spiderwort	*Tradescantia buckleyi*	1	1	1	Endemic in grassland openings in oak woodlands.			Resident
Green beebalm	*Monarda viridissima*	1	1	1	Endemic perennial herb. Found in well-drained sandy soils in opening of post oak woodlands.			Resident
Elmendorf's onion	*Allium elmendorfii*	1	1	1	Endemic, in deep sands			Resident
Parks' jointweed	*Polygonella parksii*	0	1	0	Texas endemic, primarily found on deep, loose, sand blowouts in Post Oak Savannas.			Resident
Shinner's sunflower	*Helianthus occidentalis ssp.*	1	1	1	Found on prairies on the Coastal Plain.			Resident
Sandhill woolywhite	*Hymenopapp us carrizoanus*	1	1	1	Found south of the Guadalupe River. Prefers dense riparian corridors.			Resident
REPTILES								
Cagle's map turtle	*Graptemys caglei*	1	2	2	Endemic to Guadalupe River System. Found near waters' edge.		T	Resident
Spot-tailed earless lizard	*Holbrookia lacerata*	1	1	1	Moderately open prairie-brushland.			Resident
Texas Garter Snake	*Thamnophis sirtalis annectens*	1	1	1	Wet or moist microhabitats			Resident
Texas Horned Lizard	*Phrynosoma cornutum*	1	2	2	Varied, sparsely vegetated uplands.		T	Resident
Texas Tortoise	*Gopherus berlandieri*	1	2	2	Open brush w/ grass understory.		T	Resident
Timber/ canebrake rattlesnake	*Crotalus horridus*	1	2	2	Floodplains, upland pine, deciduous woodlands, riparian zones.		T	Resident

TPWD, 2014. Annotated County List of Rare Species – Gonzales, Caldwell and Guadalupe counties revised 8/7/2012.
USFWS, 2013. Endangered Species List for Texas. http://www.fws.gov/southwest/es/ES_ListSpecies.cfm accessed online February 6, 2013.

Whooping Crane (Grus americana) — The Whooping Crane is a federally listed species which would occur in Texas only during migration (USFWS 2012). Whooping cranes use a variety of habitats during migration, including croplands for feeding and large, marshy palustrine wetlands for roosting. Although large wetlands do not exist within the OCR area, the Whooping Crane could potentially occur in any surrounding cropland habitat during migration.

Texas horned lizard (Phrynosoma cornutum) — The Texas horned lizard is a state-listed threatened species and is present throughout much of the state. They exist in open, arid, and semi-arid regions with sparse vegetation, which includes grass, cactus, scattered brush and scrubby trees. This species could potentially occur in areas with this type of contiguous vegetation.

Texas Tortoise (Gopherus berlandieri) — The Texas tortoise is a state-listed threatened species that is active in the warmer months of March through November. They occur in open brush with a grass understory and will avoid areas of open grass or bare ground. This species could potentially occur in areas with this type of vegetation.

Additional species of concern which may occur near the river intake or transmission pipelines, especially those crossing or impacting perennial aquatic resources, include:

Bald Eagle (Haliaeetus leucocephalus) — The Bald Eagle is a state-listed threatened species that could occur as a migrant near major aquatic resources. Although they breed primarily in the eastern half of the state, they could potentially occur in this region of Texas during the winter and during migration along rivers or large lakes. This species could potentially occur near perennial waterways.

Interior Least Tern (Sterna antillarum athalassos) — The Interior Least Tern is listed as endangered by the USFWS (2012). They prefer to nest on sandbars, islands, salt flats, and bare or sparsely vegetated sand, shell, and gravel beaches that are associated with braided streams, rivers and reservoirs. They could potentially occur within these habitats along the Guadalupe River or dry, exposed impoundments.

Guadalupe Bass (Micropterus treculii) — The Guadalupe bass is an endemic game fish native to Texas, found in the northern and eastern Edwards Plateau including headwaters of the San Antonio River, the Guadalupe River above Gonzales, the Colorado River north of Austin, and portions of the Brazos River drainage. Relatively small populations occur outside of the Edwards Plateau, primarily in the lower Colorado River. Although not a federally endangered or threatened species, it is the official state fish and considered rare by TPWD. This species could potentially occur in perennial waterways.

Blue sucker (Cycleptus elongatus) — The Blue sucker is a state-listed threatened species which exists in large portions of major rivers in Texas. Their preferred habitat includes channels and flowing pools with a moderate current and a bottom of exposed bedrock with hard clay, sand and gravel components. This species could potentially occur in perennial waterways.

American eel (Anguilla rostrata) — The American eel is not a listed species but is part of a unique community designation within the San Marcos River. The NDD has no recorded occurrences of these species in the location of the proposed route crossings, but the species could potentially occur in perennial waterways.

Golden Orb (Quadrula aurea) — The Golden orb is a federal candidate for listing and is state threatened. This freshwater mollusk exists in sand, gravel or mud substrates within lake or river systems. The TPWD designates the segment of the Guadalupe River near the intake as an Ecologically Significant Stream Segment. This species was collected during a fall 2011 survey near Gonzales, Texas. This species could potentially occur in perennial waterways.

Texas fatmucket (Lampsilis bracteata) — The Texas fatmucket is a federal candidate for listing and is state threatened. This freshwater mollusk exists in more shallow rivers or streams with substrates of sand, mud and gravel. This species could potentially occur in perennial waterways.

Texas pimpleback (Quadrula petrina) — The Texas pimpleback is a federal candidate for listing and is state threatened. This freshwater mollusk exists in small to moderate streams and rivers of slow flow rates, as well as moderate size reservoirs with substrates of mixed mud, sand and fine gravel. This species was collected during a fall 2011 survey near Gonzales, Texas. This species could potentially occur in perennial waterways.

False spike mussel (Quadrula mitchelli) — The false spike mussel is state threatened. The TPWD county list states the species is possibly extirpated in Texas. However, a small population was discovered during a fall 2011 survey in the Guadalupe River near Gonzales. This species could potentially occur in perennial waterways.

Cagle's map turtle (Graptemys caglei) — The Cagle's map turtle is state threatened and occupies riverine habitat in the Guadalupe-San Antonio river systems. They prefer shallow water with swift to moderate flow and a substrate of gravel or cobble or deeper pools with a slower flow rate and a substrate of silt or mud. This turtle will nest on gently sloping sand banks along rivers. The NDD depicts a ±5 mile stretch of recorded Cagle's map turtle observations downstream of the Gonzales Dam, near the proposed intake. This species could potentially occur in perennial waterways.

The OCR site would likely have a beneficial impact for some species like the bald eagle and whooping crane, by creating additional aquatic habitat. However, the OCR could have a negative impact on terrestrial species like the canebrake rattlesnake, Texas horned lizard, and Texas tortoise, by making the species relocate to less suitable habitat areas or to compete with other species for remaining habitat. The river water intake has the potential to have a negative impact on mollusks and turtle species. The transmission pipelines and Luling WTP site are anticipated to have a low impact to any species.

The primary impacts that would result from construction of the proposed project include the conversion of existing habitats and land uses within the pipeline right-of-way to maintained areas and within the proposed off-channel storage area to open water. Furthermore, potential downstream effects due to modification of the existing flow regime would be possible. Indirect effects of reservoir construction may include land use changes in the area surrounding the reservoir and in mitigation areas that may be converted to alternate uses to compensate for losses of terrestrial habitat. Potential downstream impacts would include modification of the streamflow regime below the Gonzales diversion point, which may impact fish and wildlife species

5.2.31.4 Engineering and Costing

Costs are based on the GBRA's MBWSP Engineering Feasibility Study and indexed to September 2013 prices and other TWDB costing assumptions. The project is sized for 25,000 acft/yr annual delivery with a 2.0 peaking factor. Total project and annual costs for this option and each project yield are included in Table 5.2.31-2.

These costs are for all facilities including raw water intake and pump station, raw water delivery pipelines, treatment plant, and finished water facilities up to the customer delivery points (i.e. everything shown in Figure 5.2.31-1). Costs for engineering, legal, and contingencies are estimated as 30 percent of capital costs for the pipeline and 35 percent of capital costs for other facilities (e.g., pump stations). Interest during construction was calculated based on a 3 percent differential between loan payments and earnings with a 3 year construction period.

The capital costs for all facilities are $405,562,000 (Table 5.2.31 2). Adding in non-capital costs: engineering/legal/contingencies, environmental, land acquisition and surveying, interest during construction, and groundwater lease payments; the total project costs for all facilities required to provide a firm annual supply of 25,000 acft/yr are $661,642,000. Annual costs, which include debt service (5.5%, 20 years for non-reservoir infrastructure and 40 years for reservoirs), operation and maintenance and energy costs, are $64,022,000, resulting in an annual unit cost of $2,561/acft.

In terms of environmental impacts, the amount and type of impact drives potential surveying, permitting, and mitigation costs. Implementing measures to avoid and limit impacts (e.g., directional drill) to sensitive environmental features and aquatic resources may lessen potential costs. Estimated environmental and archaeological costs (surveying, permitting, and mitigation) are $25,816,000.

Table 5.2.31-2 Summary Cost Estimate for MBWSP Surface Water with Off-Channel Reservoir

Item	*Estimated Costs for Facilities*
Off-Channel Storage/Ring Dike	$60,723,000
Intake Pump Stations	$54,432,000
Transmission Pipeline	$134,201,000
Transmission Pump Station(s) & Storage Tank(s)	$11,980,000
Storage Tanks (Other Than at Booster Pump Stations)	$2,457,000
Water Treatment Plant	$116,533,000
Relocations	$25,236,000
TOTAL COST OF FACILITIES	**$405,562,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$135,237,000
Environmental & Archaeology Studies and Mitigation	$25,816,000
Land Acquisition and Surveying	$32,155,000
Interest During Construction (4% for 3 years with a 1% ROI)	$62,872,000
TOTAL COST OF PROJECT	**$661,642,000**
ANNUAL COST	
Debt Service (5.5 percent, 20 years)	$43,432,000
Reservoir Debt Service (5.5 percent, 40 years)	$8,888,000
Operation and Maintenance	
Intake, Pipeline, Pump Station & Groundwater	$3,027,000
Dam and Reservoir (1.5% of Cost of Facilities)	$911,000
Water Treatment Plant (2.5% of Cost of Facilities)	$4,960,000
Pumping Energy Costs (31,158,333 kW-hr @ 0.09 $/kW-hr)	$2,804,000
TOTAL ANNUAL COST	**$64,022,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 2	25,000
Annual Cost of Water ($ per acft)	$2,561
Annual Cost of Water ($ per 1,000 gallons)	$7.86

Note: Unit costs for Option 2A in GBRA's MBWSP Engineering Feasibility Study were estimated at $2,357/acft using March 2012 prices, debt service at 5% for 30 years, and $0.12/kwhr.

5.2.31.5 Implementation Issues

A significant implementation issue for the project is TCEQ approval of GBRA's surface water diversion permit application. In addition it will be necessary to obtain the following permits and agreements:

a. USACE Sections 10 and 404 Dredge and Fill Permits for the reservoir and pipelines;
b. GLO Sand and Gravel Removal permits;
c. GLO Easement for use of state-owned land;
d. TPWD Sand, Gravel, and Marl permit; and
e. Private land for construction of facilities to be acquired through either negotiations or condemnation.

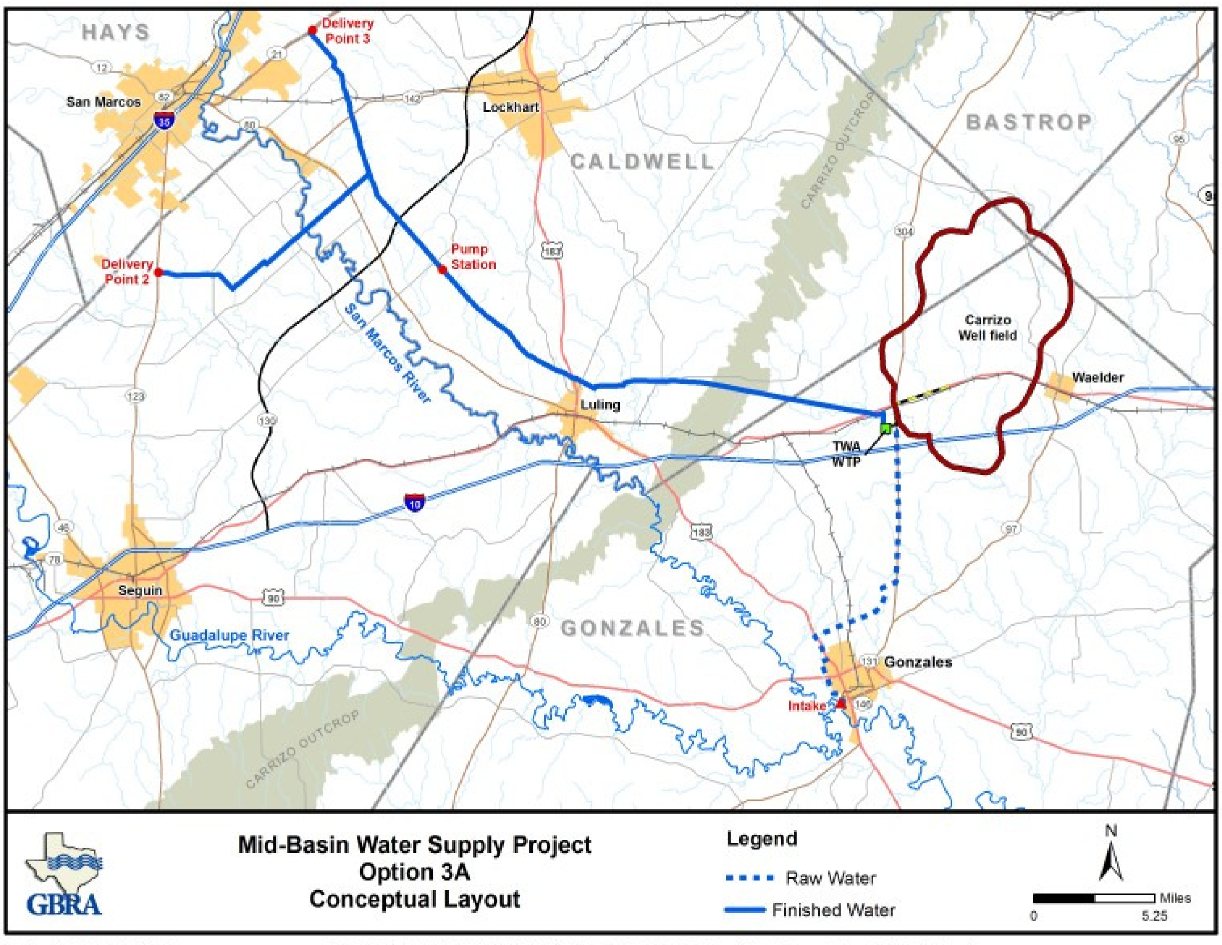
Permitting may require development of an habitat mitigation plan; environmental studies; and/or cultural resource studies and mitigation. Relocations for the off-channel storage facilities may include county roads, product transmission pipelines, power transmission lines, and other utilities.

5.2.32 GBRA Mid-Basin Water Supply Project – Conjunctive Use with ASR

5.2.32.1 Description of Strategy

The Guadalupe-Blanco River Authority (GBRA) Mid-Basin Water Supply Project (MBWSP) Conjunctive Use with Aquifer Storage & Recovery (ASR) strategy (Option 3A) incorporates surface water from the Guadalupe River near Gonzales with a Carrizo well field that produces groundwater and stores treated surface water. The strategy is configured to include an ASR well field that is co-located with the Carrizo well field on Texas Water Alliance (TWA) leased property in northern Gonzales County and eastern Caldwell County. The overall project map is shown in Figure 5.2.32-1.

Figure 5.2.32-1 MBWSP – Conjunctive Use Conceptual Layout



Surface water from the river diversion point near Gonzales is pumped 15.3 miles to a water treatment plant (WTP) located adjacent to the Carrizo well field. Treated surface water will generally be delivered to meet daily participant needs, however, when WTP capacity exceeds daily participant needs, the excess treated water will be injected into the Carrizo using dual-purpose ASR/production wells. This WTP will also treat water produced from the well field because the well field will generally produce a blend of raw Carrizo groundwater and treated surface water. This is necessary because the Carrizo groundwater contains iron and manganese.

Potable water supplies are conveyed to two delivery points which would include a meter and two storage tanks with sufficient capacity for 15% of average daily demand. MBWSP participants will be responsible for construction of any facilities required to connect to the delivery locations. Additionally, some treated supply could be made available to customers along the transmission line.

The total finished water pipeline route length is 45.6 miles, paralleling existing right of way for nearly 29 miles. The transmission line is sized to deliver supply at a peak rate that is 2.0 times that for uniform delivery of annual supply. Three pump stations are required to deliver supplies along the finished transmission main. A High Service Pump Station (HSPS) will pump from the clear well located at the WTP and will provide sufficient head to deliver supplies to the first booster pump station. This pump station will boost pressures to convey supplies to Delivery Point 3 and part way to Delivery Point 2. The second booster pump station will boost pressures to convey supplies to Delivery Point 2.

5.2.32.2 Available Yield

The operational concept for the MBWSP – Conjunctive Use with ASR strategy is summarized as follows: (1) when demands can be met with water rights in the Guadalupe River at Gonzales, the water is treated and delivered directly to participants; (2) when surface water supplies available from the river exceed demands and there is unused capacity in the water treatment plant and delivery system, the excess surface water is treated and stored in the Carrizo Aquifer through ASR wells; and (3) when available surface water supplies cannot meet participant demands, native groundwater or surface water previously stored in the aquifer is produced or recovered to meet the balance of the participant demands. The loss of ASR water is assumed to be zero. The introduction of ASR water adds to the volume of storage and allows for greater withdrawals to stay within GCUWCD drawdown limits. From a quantity perspective, it makes no difference whether the water withdrawn is native groundwater, finished surface water, or a blend of both.

Surface Water Modeling

Estimates of surface water available for diversion under a new appropriation from the Guadalupe River at Gonzales were computed subject to senior water rights and environmental flow standards recently adopted by the TCEQ. Surface water availability was computed in conformance with GBRA's Application No. 12378, which includes a maximum annual diversion of 75,000 acft/yr from the Guadalupe River at Gonzales and maximum instantaneous diversion rate of 500 cfs. The models used to determine availability and yield include the Guadalupe-San Antonio River Basin Water Availability Model (GSA WAM) and the Flow Regime Application Tool (FRAT).

Major modeling assumptions in applications of the GSA WAM and FRAT include:

- Water availability computed subject to full use of senior water rights for consumptive uses and environmental flow standards adopted by TCEQ on August 8, 2012.

- Treated effluent discharges were excluded throughout the river basin (similar to TCEQ Run 3), except when specifically addressed in a water right (e.g., INVISTA, Kate O'Connor Trust, etc.).
- Springflows from the Edwards Aquifer were based on aquifer management in accordance with full implementation of the Edwards Aquifer Habitat Conservation Plan (EAHCP) approved by the U.S. Fish and Wildlife Service (USFWS). Two Edwards Aquifer simulation models (GWSIM-IV for the 1934-1946 period and MODFLOW for the 1947-2000 period) were used to estimate springflow.

In order to calculate surface water available from the Guadalupe River at Gonzales for the MBWSP, a new water right (junior to all existing water rights) was modeled in the GSA WAM to obtain monthly unappropriated and regulated flows for the Guadalupe River at Gonzales. The portion of streamflow allocated to downstream senior water rights was calculated by subtracting the unappropriated flow from the regulated flow. Monthly regulated flows were then disaggregated to daily values using gaged or estimated daily streamflows for the Guadalupe River at Gonzales. Monthly amounts allocated to downstream senior water rights were then taken uniformly out of the base of the daily hydrograph such that the sum of daily pass-through amounts in each month equals the total monthly amount allocated to downstream senior water rights.

Daily senior water right pass-throughs and daily regulated flows are incorporated into the FRAT model, along with the TCEQ environmental flow standards for the Guadalupe River at Gonzales. These environmental flow standards consist of seasonal subsistence and base flows, two tiers of seasonal pulses, and a pulse exemption provision under which pulses may be excluded if the magnitude of the maximum diversion rate of the water right is less than or equal to 20 percent of the pulse peak. For example, if the maximum diversion rate for the MBWSP is 116 cfs, all small and large seasonal pulse diversion restrictions would be excluded and the MBWSP would not be required to honor those pulses. Additionally, the environmental flow standard for the Guadalupe River at Gonzales includes a provision for diversions that are made between the base flow and the subsistence flow, such that when streamflow is between the base and subsistence flows, only 50 percent of the difference between the streamflow and the subsistence flow can be diverted.

Groundwater Modeling

Groundwater availability analyses utilized the Texas Water Development Board (TWDB) Central Groundwater Availability Model (GAM) for the Carrizo-Wilcox Aquifer. Groundwater availability was based on an acceptable level of drawdown in the GCUWCD rules. The assumed maximum acceptable drawdown for the Carrizo and Wilcox aquifers in the artesian zone is 100 feet, which is measured in monitoring wells that are more than 6,000 feet from the nearest production well in the well field.

Surface Water, Groundwater, and ASR

Using monthly water availability and daily disaggregation procedures described above, an accounting model was used to simulate surface water diversions to a WTP and ASR well field as well as groundwater production from which a firm supply of treated water could be delivered to project participants. Simulations indicate that a firm yield of 42,000 acft/yr can be obtained assuming a maximum instantaneous river diversion rate and ASR

WTP capacity of 116 cfs (75 mgd) and maximum long-term drawdown in the Carrizo Aquifer near the well field on the order of 100 feet.

5.2.32.3 Environmental Issues

Environmental issues for the proposed GBRA MBWSP - Conjunctive Use with ASR project are described below. Implementation of this project would require field surveys by qualified professionals to document vegetation/habitat types, waters of the U.S. including wetlands and cultural resources that may be impacted. Where impacts to protected species habitat or significant cultural resources cannot be avoided, additional studies would be necessary to evaluate habitat use and/or value, or eligibility for inclusion in the National Register of Historic Places, respectively. Compensation would be required for unavoidable adverse impacts involving net losses of wetlands.

The GBRA MBWSP- Conjunctive Use with ASR water management strategy involves the construction of an intake on the Guadalupe River with a raw water transmission pipeline to the new TWA WTP site, a well field in Gonzales County, a raw water transmission pipeline from the well field to the TWA WTP, a potable water pipeline to a delivery point near San Marcos through Luling with an additional booster pump station, and a potable water pipeline section to a delivery point near Seguin. The pipelines traverse both the Blackland Prairie and Post Oak Savannah ecoregions[1] and are within the Texan biotic province[2]. Vegetation within the project area is dominated by a mosaic of post oak woods, forest, and grassland to the east and cropland along the western portion of the pipeline.

The Guadalupe River intake has the potential for localized negative ecological impacts as the site area consists of over 90% riparian woodland. Riparian woodlands, especially those located within floodplains, are ecological features that contribute to the natural and traditional character of waterways. These areas help protect water quality, wildlife habitat, and aquatic resource functions and services. However, the well field, transmission pipelines and the TWA WTP site are anticipated to have a low negative impact to terrestrial habitat. Approximately 60-80% of these areas occur within grassland, cropland and disturbed areas. Any remaining habitat which includes woody species within these areas has been highly fragmented by existing land uses and disturbances including roads, utility rights-of-way and cropland. Outside the maintained right-of-way, land use would not be anticipated to change due to pipeline construction. Herbaceous habitats would recover fastest from impacts and would experience low negative impacts. Impacts to woody vegetation would be permanent due to pipeline and WTP maintenance. The proposed well field would have a minimal impact on vegetation within the project area due to limited surface exposure.

The transmission pipelines and water treatment plant site are anticipated to have minimal impact on existing terrestrial habitat. Many pipeline segments are co-located along existing rights-of-way, fencerows, and other disturbances, which would reduce their overall vegetative impact. Pipelines, including collection, raw, and finished water transmission, would require multiple crossing of roads, railroads, and other utilities, as well as being in close proximity to structures, but no adverse effects are expected. The

[1] Gould, F.W. 1975. The Grasses of Texas. Texas A&M University Press. College Station, Texas.
[2] Blair, W.F., "The Biotic Provinces of Texas, "Tex. J. Sci. 2:93-117, 1950.

TWA WTP is located on undeveloped grassland. Impacts to land use would be limited to the removal of existing vegetation and temporary impacts during construction.

With numerous miles of raw and finished water pipelines, crossings of many jurisdictional waters would occur. Intermittent waters, which in this area primarily include streams and impoundments, would occur frequently and make up the majority of the jurisdictional areas crossed. Major intermittent waters potentially affected by this strategy include Buck, Crooked, and Salt branches; Callihan, Cottonwood, Dickerson, Kerr, Long, McNeil, Morrison, Seals, and West Fork Plum creeks; Dry Run; and Sandy Fork. Impacts from pipelines to these waters are anticipated to be minor, would be restorable and temporary, and occur during construction.

Perennial waters are less commonly encountered in the project area and include the Guadalupe River (intake), San Marcos River, Artesia Creek, Mule Creek and Plum Creek. Avoidance and minimization measures, such as horizontal directional drilling, construction best management practices (BMPs), and avoiding perennial and /or sensitive aquatic habitats (e.g., the San Marcos River, Plum Creek, etc.) would reduce the potential impacts from pipelines.

The TCEQ 2010 Texas Integrated Report for Clean Water Act Sections 305(b) and 303(d) lists Sandy Fork as a Category 5b water body. This listing indicates Sandy Fork is impaired because it “does not meet applicable water quality standards or is threatened for one” and “a review of the water quality standards for this water body will be conducted before a Total Maximum Daily Load (TMDL) is scheduled.” Bacteria levels are the parameter on which TCEQ bases this designation. The designation applies to TCEQ Segment ID 1803G_01, which occurs from the confluence with Peach Creek up to the confluence with Scruggs Creek (NHD Reach Code 12100202021868). The raw water transmission line from the well field to the TWA WTP site and the finished water transmission pipeline both cross this designated segment, but the potential negative impact is anticipated to be negligible. Impacts from construction of these project components would be temporary and available avoidance and minimization practices could further reduce potential impacts. The TWA WTP site has limited potential water body impact with one small, potentially jurisdictional ephemeral stream located on the site.

The surface water intake is located along the Guadalupe River within a flood hazard area, and would require the placing of structures and fill material into the river. Impacts resulting from this action would include possible localized impacts to the riparian buffer, bank condition, and possibly instream habitat depending on the final intake design. However the intake is not expected to have an adverse effect on the river’s overall chemical, physical, or biological functions, such as water/sediment transport, access to floodplains, water supply, habitat, and recreation. The WTP site and wells are not located within flood hazard areas.

Coordination with the U.S. Army Corps of Engineers would be required for construction within waters of the U.S. Impacts from this proposed project resulting in a loss of less than 0.5 acres of waters of the U.S. could be covered under Nationwide Permit #12 for Utility Line Activities unless there are significant impacts to the aquatic environment by other project components.

The Texas Parks & Wildlife Department (TPWD) has identified a number of stream segments throughout the state as ecologically significant on the basis of biological function, hydrologic function, riparian conservation, exceptional aquatic life uses, and/or threatened or endangered species. Currently, 21 stream segments in Region L are considered ecologically significant by the TPWD[3]. Pipelines associated with this water management strategy do not cross any of these stream segments. The section of the Guadalupe River from U.S. 183 (near the Gonzales diversion point) upstream to Lake Gonzales Dam, however, is listed as ecologically significant as it contains two of four known remaining populations of the golden orb, a rare, endemic mollusk.

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 (Pl96-515), and the Archeological and Historic Preservation Act (PL93-291). Based on the review of available GIS datasets, there are ten cemeteries, five national register properties, two national district properties, and 42 historical markers located within a 0.5-mile buffer of the proposed pipeline route. Additionally, there are seven cemeteries and four historical markers within the potential well field area.

Based on a review of soils, geology, and aerial photographs, there is a high probability for undocumented significant cultural resources within the alluvial deposits and terrace formations associated with waterways, specifically the intermittent and perennial aquatic resources. The intake has a high potential impact for cultural resources, primarily due to its location in an area with known cultural resources within one-half mile. The well field collection and transmission pipelines potentially are considered to have low negative impact to cultural resources. For the most part, the pipelines would cross areas of low probability for cultural resources, but those probabilities increase near waterways and associated landforms. However, Thompsonville cemetery is located in the well field near proposed collection piping. The WTP site and wells potentially have negligible negative impacts. No known cultural resource sites occur within these areas, but these components are sited in low probability areas.

A review of archaeological resources in the proposed project area should be conducted during the project planning phase. Taking into consideration that the owner or controller of the project will likely be a political subdivision of the State of Texas (i.e. river authority, municipality, county, etc.), they will be required to coordinate with the Texas Historical Commission regarding impacts to cultural resources. The project sponsor will also be required to coordinate with the U.S. Army Corps of Engineers regarding any impacts to waters of the United States or wetlands.

The species listed by USFWS, and TPWD, as endangered or threatened with potential habitat in Gonzales, Caldwell, and Guadalupe counties are listed in Table 5.2.32-1. The Texas Natural Diversity Database, maintained by TPWD, which documents the occurrence of rare species within the state was included in this analysis. Available data did not reveal the occurrence of any listed species within the project area, but the absence of data does not imply the absence of occurrence. Depending on the final design of the intake and resulting impacts to instream habitat, this portion of the project includes potential impacts to federal-candidate/state-listed mollusks and the Cagle's map

[3] TPWD, "Ecologically Significant River and Stream Segments," http://www.tpwd.state.tx.us/landwater/water/environconcerns/water_quality/sigsegs/index.phtml accessed February 6, 2014.

turtle based on known occurrences of these species near the intake site. The well field, pipelines, and WTP site include limited potential impacts to listed species.

Table 5.2.32-1 Endangered, Threatened, and Species of Concern for Caldwell, Gonzales, and Guadalupe Counties

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
BIRDS								
American peregrine falcon	*Falco peregrinus anatum*	0	2	0	Migrant and local breeder in West Texas.	DL	T	Possible Migrant
Artic peregrine falcon	*Falco peregrinus tundrius*	0	1	0	Migrant throughout the state.	DL		Possible Migrant
Bald eagle	*Haliaeetus leucocephalus*	0	2	0	Found primarily near rivers and large lakes.	DL	T	Possible Migrant
Henslow's sparrow	*Ammodramus henslowii*	1	1	1	Found in weedy fields or cut-over areas			Resident
Interior least tern	*Sterna antillarum athalassos*	0	3	0	Nests along sand and gravel bars in braided streams	LE	E	Resident
Mountain plover	*Charadrius montanus*	1	1	1	Non-breeding, shortgrass plains and fields			Nesting/ Migrant
Sprague's pipit	*Anthus spragueii*	0	1	0	Migrant in Texas in winter mid Sept. to early April. Strongly tied to native upland prairie.			Possible Migrant
Western burrowing owl	*Athene cunicularia hypugaea*	1	1	1	Open grasslands, especially prairie, plains and savanna			Resident
Whooping crane	*Grus americana*	0	3	0	Potential migrant	LE	E	Potential Migrant
Wood stork	*Mycteria americana*	1	2	2	Forages in prairie ponds, ditches, and shallow standing water formerly nested in TX		T	Migrant
FISHES								
Blue sucker	*Cycleptus elongatus*	1	2	2	Major rivers in Texas.		T	Resident
Guadalupe bass	*Micropterus treculi*	1	1	1	Endemic to perennial streams of the Edwards Plateau region.			Resident
Guadalupe darter	*Percina sciera apristis*	1	1	1	Guadalupe River Basin. Usually found over gravel or gravel and sand raceways of larger streams and rivers.			Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
INSECTS								
A mayfly	*Campsurus decolaratus*	0	1	0	In Texas and Mexico, possibly clay substrates, found in shoreline vegetation.			Potential Resident
MAMMALS								
Cave myotis bat	*Myotis velifer*	0	1	0	Roosts colonially in caves, rock crevices			Resident
Plains spotted skunk	*Spilogale putorius interrupta*	1	1	1	Prefers wooded, brushy areas.			Resident
Red wolf	*Canis rufus*	0	3	0	Extirpated.	LE	E	Historic Resident
MOLLUSKS								
Creeper (squawfoot)	*Strophitus undulates*	1	1	1	Small to large streams. Colorado, Guadalupe, and San Antonio River basins.			Resident
False spike mussel	*Quincuncina mitchelli*	1	2	2	Substrates of cobble and mud. Rio Grande, Brazos, Colorado and Guadalupe river basins.		T	Resident
Golden orb	*Quadrula aurea*	1	2	2	Sand and gravel, Guadalupe, San Antonio, Lower San Marcos, and Nueces River basins	C	T	Resident
Palmetto pill snail	*Euchemostre ma leai cheatumi*	0	1	0	Known only from Palmetto State Park.			Resident
Texas fatmucket	*Lampsilis bracteata*	1	2	2	Streams and rivers on sand, mud and gravel, Colorado and Guadalupe River basins.	C	T	Resident
Texas pimpleback	*Quadrula petrina*	1	2	2	Mud, gravel and sand substrates, Colorado and Guadalupe river basins		T	Resident
PLANTS								
Big red sage	*Salvia pentstemonoide s*	0	1	0	Texas endemic, found in moist to seasonally wet steep limestone outcrops on canyons or along creek banks.			Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
Bristle nailwort	*Paronychia setacea*	1	1	1	Endemic to south central Texas in sandy soils.			Resident
Buckley's spiderwort	*Tradescantia buckleyi*	1	1	1	Endemic in grassland openings in oak woodlands.			Resident
Green beebalm	*Monarda viridissima*	1	1	1	Endemic perennial herb. Found in well-drained sandy soils in opening of post oak woodlands.			Resident
Elmendorf's onion	*Allium elmendorfii*	1	1	1	Endemic, in deep sands			Resident
Parks' jointweed	*Polygonella parksii*	0	1	0	Texas endemic, primarily found on deep, loose, sand blowouts in Post Oak Savannas.			Resident
Shinner's sunflower	*Helianthus occidentalis ssp.*	1	1	1	Found on prairies on the Coastal Plain.			Resident
Sandhill woolywhite	*Hymenopappus carrizoanus*	1	1	1	Found south of the Guadalupe River. Prefers dense riparian corridors.			Resident
REPTILES								
Cagle's map turtle	*Graptemys caglei*	1	2	2	Endemic to Guadalupe River System. Found near waters' edge.		T	Resident
Spot-tailed earless lizard	*Holbrookia lacerata*	1	1	1	Moderately open prairie-brushland.			Resident
Texas Garter Snake	*Thamnophis sirtalis annectens*	1	1	1	Wet or moist microhabitats			Resident
Texas Horned Lizard	*Phrynosoma cornutum*	1	2	2	Varied, sparsely vegetated uplands.		T	Resident
Texas Tortoise	*Gopherus berlandieri*	1	2	2	Open brush w/ grass understory.		T	Resident
Timber/ canebrake rattlesnake	*Crotalus horridus*	1	2	2	Floodplains, upland pine, deciduous woodlands, riparian zones.		T	Resident

TPWD, 2014. Annotated County List of Rare Species – Gonzales, Guadalupe and Caldwell County revised 8/7/2012.

USFWS, 2013. Endangered Species List for Texas. http://www.fws.gov/southwest/es/ES_ListSpecies.cfm accessed online February 6, 2013.

The project area may provide potential habitat to endangered or threatened species found in Gonzales, Caldwell, or Guadalupe counties. A survey of the project area may be required prior to pipeline and well field construction to determine whether populations of or potential habitats used by listed species occur in the area to be affected. Coordination with TPWD and USFWS regarding threatened and endangered species with the potential to occur in the project area should be initiated early in project planning.

Based on existing habitat types, the following species have potential to occur near project components. The aquatic species are only of concern at river intake or locations where pipelines cross perennial waters.

A. Federal-Listed Endangered Species

Whooping Crane (Grus americana) — The Whooping Crane is a federally listed species which would occur in Texas only during migration. Whooping cranes use a variety of habitats during migration, including croplands for feeding and large, marshy palustrine wetlands for roosting. Although large wetlands do not exist within the project area, the Whooping Crane could potentially occur in any surrounding cropland habitat during migration.

B. Federal-Listed Candidate Species

Golden Orb (Quadrula aurea) — The Golden orb is a federal candidate for listing and is state threatened. This freshwater mollusk exists in sand, gravel or mud substrates within lake or river systems. The TPWD designates a segment of the Guadalupe River near the intake as an Ecologically Significant Stream Segment based on the occurrence of the golden orb. This species was collected during a fall 2011 survey near Gonzales and could potentially occur in perennial streams, like the Guadalupe River, and near the proposed surface water intake.

Texas fatmucket (Lampsilis bracteata) — The Texas fatmucket is a federal candidate for listing in the state and is state threatened. This freshwater mollusk exists in more shallow rivers or streams with substrates of sand, mud and gravel. This species could potentially occur in perennial streams, like the Guadalupe River, and near the proposed surface water intake.

Texas pimpleback (Quadrula petrina) — The Texas pimpleback is a federal candidate for listing in the state, but not in Gonzales and Caldwell counties, and is state threatened. This freshwater mollusk exists in small to moderate streams and rivers of slow flow rates, as well as moderate size reservoirs with substrates of mixed mud, sand and fine gravel. This species was collected during a fall 2011 survey near Gonzales, Texas and could potentially occur in perennial streams, like the Guadalupe River, and near the proposed surface water intake.

C. State-Listed Species

Bald Eagle (Haliaeetus leucocephalus) — The Bald Eagle is a state-listed threatened species that could occur as a migrant near major aquatic resources. Although they breed primarily in the eastern half of the state, they could potentially occur along rivers or large lakes in this region of Texas during the winter and during migration. This species could potentially occur near perennial waterways.

Interior Least Tern (Sterna antillarum athalassos) — The Interior Least Tern is listed as endangered by the USFWS. They prefer to nest on sandbars, islands, salt flats, and bare or sparsely vegetated sand, shell, and gravel beaches that are associated with braided streams, rivers and reservoirs. They could potentially occur within these habitats along the San Marcos River, Plum Creek, Salt Branch, or dry, exposed impoundments.

Peregrine Falcon (Falco peregrinus), including the American peregrine falcon (F. p. anatum) subspecies, is a state threatened bird that could be a possible migrant. They utilize a wide range of habitats during migration, including urban areas and landscape edges such as lakes or large river shores.

Blue sucker (Cycleptus elongatus) is a state threatened fish and exists in large portions of major rivers in Texas. Their preferred habitat includes channels and flowing pools with a moderate current and a bottom of exposed bedrock with hard clay, sand and gravel components.

False spike mussel (Quadrula mitchelli) is state threatened freshwater mollusk. The TPWD county list states the species as possibly extirpated in Texas. This species was collected during a fall 2011 survey near Gonzales, Texas and could potentially occur in perennial streams, like the Guadalupe River, and near the proposed surface water intake.

Cagle's map turtle (Graptemys caglei) is a state threatened reptile and occupies riverine habitat in the Guadalupe-San Antonio river systems. They prefer shallow water with swift to moderate flow and a substrate of gravel or cobble or deeper pools with a slower flow rate and a substrate of silt or mud. This turtle will nest on gently sloping sand banks along rivers. The NDD depicts an approximately 5 mile stretch of recorded Cagle's map turtle observations downstream of the Gonzales Dam, near the intake. This species could potentially occur in perennial waterways.

Texas horned lizard (Phrynosoma cornutum) is a state threatened reptile and is present throughout much of the state. They exist in open, arid, and semi-arid regions with sparse vegetation, which includes grass, cactus, scattered brush or scrubby trees. This species could potentially occur in areas with this type of contiguous vegetation.

Texas tortoise (Gopherus berlandieri) is a state threatened reptile that is active in the warmer months of March through November. They occur in open brush with a grass understory and will avoid areas of open grass or bare ground. This species could potentially occur in areas with this type of contiguous vegetation.

Timber/Canebrake rattlesnake (Crotalus horridus) is a state threatened reptile that occurs in swamps, floodplains, upland pine and deciduous woodlands, riparian zones, and abandoned farmland. They could also be present in limestone bluffs, sandy soil or black clay. This species could potentially occur in areas of abandoned farmland or forested riparian areas.

D. Unique or Rare Species

American eel (Anguilla rostrata) is not a listed species, but is part of a unique community designation within the San Marcos River. The NDD has no recorded occurrences of this species in the location of the proposed assessment area, but the species could potentially occur in perennial streams.

Guadalupe bass (Micropterus treculii) is an endemic game fish to Texas, found in the northern and eastern Edwards Plateau including headwaters of the San Antonio River, the Guadalupe River above Gonzales, the Colorado River north of Austin, and portions of the Brazos River drainage. Relatively small populations occur outside of the Edwards Plateau, primarily in the lower Colorado River. Although not a listed species, it is the official state fish and considered rare by TPWD. This species could potentially occur in perennial waters.

The primary impacts that would result from construction of the proposed project would include the conversion of existing habitats and land uses within the pipeline right-of-way, WTP site, and well sites to maintained areas. These impacts are anticipated to be minor. The surface water intake would require the placing of structures and fill material into the river which may result in possible localized impacts to the riparian buffer, bank condition, and possibly instream habitat depending on the final intake design.

5.2.32.4 Engineering and Costing

Costs are based on the GBRA's MBWSP Engineering Feasibility Study (Option 3A) and indexed to September 2013 prices and other TWDB costing assumptions. The project is sized for 42,000 acft/yr annual delivery with a 2.0 peaking factor. Total project and annual costs for this option at the stated project yield are included in Table 5.2.32-2.These costs are for all facilities including raw water intake and pump station, raw water delivery pipelines, well field facilities, treatment plant, and potable water facilities up to the customer delivery points (i.e. everything shown in Figure 5.2.32-1). Costs for engineering, legal, and contingencies are estimated as 30 percent of capital costs for the pipeline and 35 percent of capital costs for other facilities (e.g., pump stations). Interest during construction was calculated based on a 3 percent differential between loan payments and earnings with a 2.5 year construction period. The capital costs for all facilities are $462,962,000 (Table 5.2.32-2).

Adding in non-capital costs: engineering/legal /contingencies, environmental, land acquisition and surveying, interest during construction, and groundwater lease payments; the total project costs for all facilities required to provide a firm annual supply of 42,000 acft/yr are $700,897,000. Annual costs which include debt service (5.5%, 20 years), operation and maintenance, and energy costs are $77,054,000, resulting in annual unit costs of $1,835/acft.

In terms of environmental impacts, the amount and type of impact drives potential surveying, permitting, and mitigation costs. Implementing measures to avoid and limit impacts (e.g., horizontal directional drilling) to sensitive environmental features and aquatic resources may lessen potential costs. Potential environmental and archaeological costs (surveying, permitting, and mitigation) are estimated at $1,064,000.

Table 5.2.32-2 Summary Cost Estimate for GBRA MBWSP- Conjunctive Use with ASR

Item	Estimated Costs for Facilities
Intake Pump Stations	$16,348,000
Transmission Pipeline	$115,443,000
Transmission Pump Station(s) & Storage Tank(s)	$23,277,000
Well Fields (Wells, Pumps, and Piping)	$87,097,000
Storage Tanks (Other Than at Booster Pump Stations)	$3,675,000
Water Treatment Plant	$212,959,000
Access Roads	$4,163,000
TOTAL COST OF FACILITIES	**$462,962,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$156,684,000
Environmental & Archaeology Studies and Mitigation	$1,064,000
Land Acquisition and Surveying	$9,073,000
Interest During Construction (4% for 2.5 years with a 1% ROI)	$55,070,000
Advanced Payments for Groundwater Leases	$16,044,000
TOTAL COST OF PROJECT	**$700,897,000**
ANNUAL COST	
Debt Service (5.5 percent, 20 years)	$58,615,000
Operation and Maintenance	
Intake, Pipeline, Pump Station & Groundwater	$4,841,000
Water Treatment Plant (2.5% of Cost of Facilities)	$9,418,000
Pumping Energy Costs (46,441,667 kW-hr @ 0.09 $/kW-hr)	$4,180,000
TOTAL ANNUAL COST	**$77,054,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 2	42,000
Annual Cost of Water ($ per acft)	$1,835
Annual Cost of Water ($ per 1,000 gallons)	$5.63

Note: Unit costs for Option 3A in GBRAs MBWSP Engineering Feasibility Study were estimated at $1635/acft using March 2012 prices, debt service at 5% for 30 years, and $0.12/kwhr.

5.2.32.5 Implementation Issues

For each aquifer in the region, the GCDs have adopted desired future conditions (DFCs). In some GCDs, full use of all groundwater supplies (permitted, grandfathered and exempt) may result in non-achievement of the DFCs for an aquifer. To ensure consistency with the DFCs, TWDB currently requires that groundwater availability for each aquifer be limited for planning purposes to the modeled available groundwater (MAG) for the aquifer. This has resulted, for planning purposes only, in adjustments to permit amounts, and a lack of firm water available for future permits in this plan for some areas for certain time periods. This should not be construed as recommending or requiring that GCDs make these adjustments, or deny future permit applications. SCTRWPG recognizes and supports the ability of permit holders to exercise their rights to groundwater use in accordance with their permits and it recognizes and supports the GCDs discretion to issue permits and grandfather historical users for amounts in excess of the MAG. SCTRWPG may not modify groundwater permits that GCDs have already issued or limit future permits that GCDs may issue. If the MAG is increased during or after this planning cycle, SCTRWPG may amend this Plan to adjust groundwater supply numbers that are affected by the new MAG amount.

Significant implementation issues for the project include TCEQ approval of GBRA's surface water diversion permit application and modifications of or variances to rules from the Gonzales County Underground Water Conservation District (GCUWCD) including:

a. Allowing the maximum production of a well to exceed the average annual production by a factor of 2.0 instead of 1.5; and
b. Modify contiguous acreage requirements to be based on long-term average annual well field production instead of the maximum annual permitted capacity; and
c. Granting recharge credit for injected water through ASR operations; these credits would be used to increase the allowable groundwater production from given leases.

Other implementation issues include:

a. Whether an agreement can be reached with TWA to acquire their groundwater leases;
b. Renewal of GCUWCD 5-year production permits and 30-year export permits for project life;
c. Additional groundwater development in the region will not have a substantial effect on groundwater levels in the well field areas;
d. A test drilling program is recommended during a Pre-Design Phase to confirm aquifer properties and support designs of the wells;

In addition it will be necessary to obtain the following permits and agreements:

e. USACE Sections 10 and 404 Dredge and Fill Permits for the reservoir and pipelines;
f. GLO Sand and Gravel Removal permits;

g. GLO Easement for use of state-owned land;
h. TPWD Sand, Gravel, and Marl permit; and
i. Private land for construction of facilities to be acquired through either negotiations or condemnation.

Permitting may require development of habitat mitigation plan, environmental studies, and/or cultural resources studies and mitigation.

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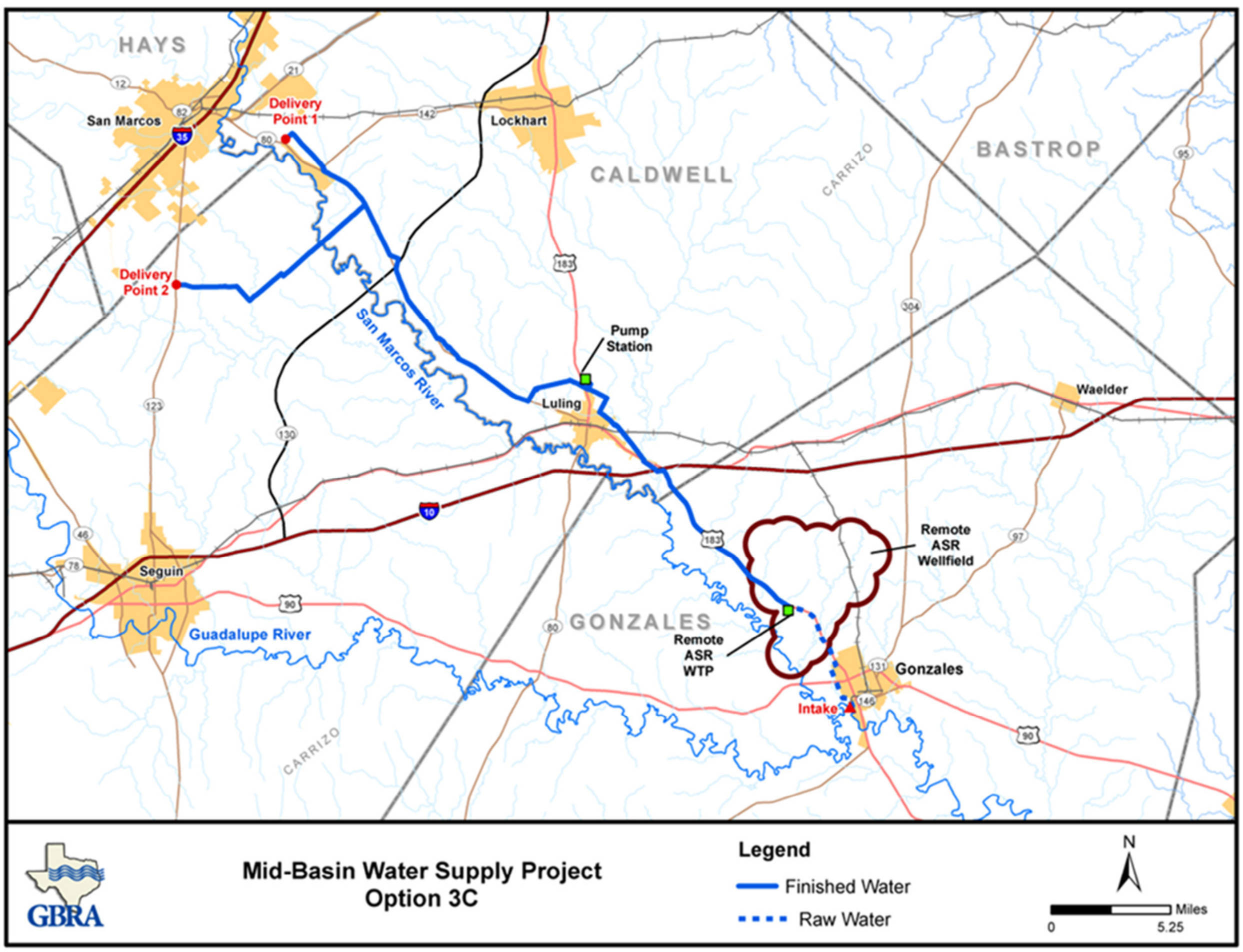
5.2.33 GBRA Mid-Basin Water Supply Project – Surface Water with ASR

5.2.33.1 Description of Strategy

The Guadalupe-Blanco River Authority (GBRA) Mid-Basin Water Supply Project (MBWSP) Surface Water with ASR (Option 3C) relies exclusively on aquifer storage and recovery (ASR) to firm up interruptible diversions from the Guadalupe River. A remote ASR well field located near the San Marcos River is used to store treated surface water. Stored surface water may not need to be retreated upon recovery. The disinfection residual for the recovered water could be restored in the water treatment plant (WTP) clearwell before the water is introduced to the delivery system. The overall project map is shown in Figure 5.2.33-1.

Conceptual designs and cost estimates have been developed for the delivery of 25,000 acft/yr, 35,000 acft/yr, and 50,000 acft/yr in GBRA's MBWSP Engineering Feasibility Study, however, the firm yield of 50,000 acft/yr is recommended in the 2016 SCTRWP.

Figure 5.2.33-1 GBRA MBWSP – Surface Water with ASR Conceptual Layout



The intake site is located on along the western edge of U.S. Highway 183, upstream of and within the conservation pool of the existing Gonzales Dam. A 5,600 HP intake pump station is required to deliver up to 89.2 MGD of raw water from the intake to the remote ASR WTP. Raw water is delivered through a 66-IN diameter, 6 mile pipeline to the WTP.

Characteristics of the ASR well field are summarized in Table 5.2.33-1 for the 50,000 acft/yr project. The ASR "bubble" is expected to remain mostly undisturbed; i.e. no appreciable mixing with native groundwater is expected. Accordingly, the water recovered from storage is expected to require only disinfection with chloramines prior to being delivered to customers. The recommended facilities for the ASR water treatment plant with disinfection of recovered water are: pre-sedimentation basins, rapid mix units, solids contact clarifiers, filters, backwash reclaim basin/sludge lagoons, clearwells, pH adjustment and disinfection, and ASR disinfection.

Table 5.2.33-1 Well Field Characteristics

Feature	50,000 acft/yr Capacity
River Diversion Rates (cfs)	140
Number of Carrizo ASR Wells	40
Average Carrizo ASR Recovery (gpm)	295
Maximum Carrizo ASR Recovery (gpm)	1,533
Average Carrizo ASR Injection (gpm)	370
Maximum Carrizo ASR Injection (gpm)	1,179
Average Production from ASR Recovery (acft/yr)	22,920
Maximum Diversion to ASR (cfs)	105.0
Maximum Storage in ASR (acft)	340,000
Annual Water Loss from ASR (%)	2.0

Potable water supplies are conveyed to two delivery points which would each include a meter and two storage tanks with sufficient capacity for 15% of average daily demand. MBWSP participants will be responsible for construction of any facilities required to connect to the delivery locations. Additionally, some treated supply could be made available to customers along the transmission main.

The total potable water route length is 45.4 miles. The transmission line is sized to deliver average annual supply with a peaking factor of 2.0. Three pump stations are required to deliver supplies along the transmission line. A High Service Pump Station (HSPS) will pump from the clear well located at the WTP and will provide enough head to deliver supplies to the first booster pump station. This pump station will boost pressures to convey supplies to Delivery Point 1 and part way to Delivery Point 2. The second booster pump station will boost pressures to convey supplies to Delivery Point 2.

5.2.33.2 Available Yield

The operational concept for the MBWSP – Surface Water with ASR strategy is summarized as follows: (1) when demands can be met with water rights in the Guadalupe River at Gonzales, the water is treated and delivered directly to participants;

(2) when surface water supplies available from the river exceed demands and there is unused capacity in the water treatment plant and delivery system, the excess surface water is treated and stored in the Carrizo Aquifer through ASR wells; and (3) when available surface water supplies cannot meet participant demands, surface water previously stored in the aquifer is recovered to meet the balance of the participant demands.

Estimates of surface water available for diversion under a new appropriation from the Guadalupe River at Gonzales were computed subject to senior water rights and environmental flow standards recently adopted by the TCEQ. Surface water availability was computed in conformance with GBRA's Application No. 12378, which includes a maximum annual diversion of 75,000 acft/yr from the Guadalupe River at Gonzales and maximum instantaneous diversion rate of 500 cfs. The models used to determine availability and yield include the Guadalupe-San Antonio River Basin Water Availability Model (GSA WAM) and the Flow Regime Application Tool (FRAT).

Modeling Assumptions

Major modeling assumptions in applications of the GSA WAM and FRAT include:

- Water availability computed subject to full use of senior water rights for consumptive uses and environmental flow standards adopted by TCEQ on August 8, 2012.
- Treated effluent discharges were excluded throughout the river basin (similar to TCEQ Run 3), except when specifically addressed in a water right (e.g., INVISTA, Kate O'Connor Trust, etc.).
- Springflows from the Edwards Aquifer were based on aquifer management in accordance with full implementation of the Edwards Aquifer Habitat Conservation Plan (EAHCP) approved by the U.S. Fish and Wildlife Service (USFWS). Two Edwards Aquifer simulation models (GWSIM-IV for the 1934-1946 period and MODFLOW for the 1947-2000 period) were used to estimate springflow.

Modeling Scenarios

In order to calculate surface water available from the Guadalupe River at Gonzales for the MBWSP, a new water right (junior to all existing water rights) was modeled in the GSA WAM to obtain monthly unappropriated and regulated flows for the Guadalupe River at Gonzales. The portion of streamflow allocated to downstream senior water rights was calculated by subtracting the unappropriated flow from the regulated flow. Monthly regulated flows were then disaggregated to daily values using gaged or estimated daily streamflows for the Guadalupe River at Gonzales. Monthly amounts allocated to downstream senior water rights were then taken uniformly out of the base of the daily hydrograph such that the sum of daily pass-through amounts in each month equals the total monthly amount allocated to downstream senior water rights.

Daily senior water right pass-throughs and daily regulated flows are incorporated into the FRAT model, along with the TCEQ environmental flow standards for the Guadalupe River at Gonzales. These environmental flow standards consist of seasonal subsistence and base flows, two tiers of seasonal pulses, and a pulse exemption provision under which pulses may be excluded if the magnitude of the maximum diversion rate of the water right is less than or equal to 20 percent of the pulse peak. For example, if the maximum diversion rate for the MBWSP is 140 cfs, all small and large seasonal pulse diversion restrictions would be excluded and the MBWSP would not be required to honor those pulses. Additionally, the environmental flow standard for the Guadalupe River at Gonzales includes a provision for diversions that are made between the base flow and the subsistence flow, such that when streamflow is between the base and subsistence flows, only 50 percent of the difference between the streamflow and the subsistence flow can be diverted.

Surface Water and ASR

Using monthly water availability and daily disaggregation procedures described above, FRAT was used to simulate surface water diversions to a WTP and ASR well field from which a firm supply of surface water could be delivered to project participants. Simulations indicate that a firm yield of 50,000 acft/yr can be obtained assuming a maximum instantaneous diversion rate and ASR WTP capacity of 140 cfs (90 mgd).

The ASR storage requirements to firm up a surface water supply of 50,000 acft/yr during the drought of record are estimated to be 296,400 acft. After consideration of an annual loss of about 2 percent and other contingencies, ASR operational capacities could need to be about 360,000 acft. Prior to implementation, more detailed analyses of necessary time to bank sufficient treated surface water in the aquifer in advance of drought would need to be performed with due consideration of alternative sources of supply potentially needed during this filling period.

5.2.33.3 Environmental Issues

Environmental issues for the proposed GBRA MBWSP – Surface Water with ASR project are described below. Implementation of this project would require field surveys by qualified professionals to document vegetation/habitat types, waters of the U.S. including wetlands, and cultural resources that may be impacted. Where impacts to protected species habitat or significant cultural resources cannot be avoided, additional studies would be necessary to evaluate habitat use and/or value, or eligibility for inclusion in the National Register of Historic Places, respectively. Compensation would be required for unavoidable adverse impacts involving net losses of wetlands.

The water management strategy involves the construction of an intake on the Guadalupe River with a raw water transmission pipeline to a new WTP, an ASR well field in Gonzales County, a water transmission pipeline connecting the well field to the WTP, a potable water pipeline to San Marcos through Luling with an additional booster pump station, and a potable water pipeline section to a delivery point above Seguin. The pipelines traverse both Blackland Prairie and Post Oak Savannah ecoregions[1] and are within the Texan biotic province[2]. Vegetation within the project area is dominated by a mosaic of post oak woods, forest, and grassland to the east and cropland along the western portion of the pipeline.

The Guadalupe River intake has the potential for localized negative ecological impacts as the site area consists of over 90% riparian woodland. Riparian woodlands, especially

[1] Gould, F.W. 1975. The Grasses of Texas. Texas A&M University Press. College Station, Texas.
[2] Blair, W.F., “The Biotic Provinces of Texas, “Tex. J. Sci. 2:93-117, 1950.

those located within floodplains, are ecological features that contribute to the natural and traditional character of waterways. These areas help protect water quality, wildlife habitat, and aquatic resource functions and services. The transmission pipelines, pump station, and WTP site are anticipated to have a low negative impact to terrestrial habitat. The WTP site includes over 80% brush/shrubland with approximately half of that being sparsely vegetated with woody vegetation. The pump station site near Luling includes over 75% grassland with a small patch of brush and shrubland. Any remaining habitat which includes woody species within these areas has been highly fragmented by existing land uses and disturbances including roads, utility rights-of-way and cropland. Outside the maintained right-of-way, land use would not be anticipated to change due to pipeline construction. Herbaceous habitats would recover fastest from impacts and would experience low negative impacts. Impacts to woody vegetation would be permanent due to pipeline and WTP maintenance. The proposed well field would have a minimal impact on vegetation within the project area due to limited surface exposure. The WTP site also has negligible potential impacts to land use, however this site contains several structures.

Many pipeline segments are co-located along existing rights-of-way, fencerows, and other disturbances, which would reduce their overall vegetative impact. Pipelines, including those for collection, raw, and potable water transmission, would require multiple crossing of roads, railroads, and other utilities, as well as being in close proximity to structures, but no adverse effects are expected. Impacts to land use would be limited to the removal of existing vegetation and temporary impacts during construction.

With numerous miles of raw and potable water pipelines, crossings of many jurisdictional waters would occur. Intermittent waters, which in this area primarily include streams and impoundments, would occur frequently and make up the majority of the jurisdictional areas crossed. Major intermittent waters potentially affected by this option include Buck, and Salt branches; Berry, Callihan, Canoe, Cottonwood, Dickerson, Hemphill, Kerr, Long, Morrison, North Fork Smith, Seals, and Smith creeks; Dry and Sandy Forks; and Dry Run. Impacts from pipelines to these waters are anticipated to be minor, would be restorable and temporary, and occur during construction.

Perennial waters are less commonly encountered in the project area and include the Guadalupe River (intake), San Marcos River, Artesia Creek, Mule Creek and Plum Creek. Avoidance and minimization measures, such as horizontal directional drilling, construction best management practices (BMPs), and avoiding perennial and/or sensitive aquatic habitats (e.g., the San Marcos River, Plum Creek, etc.) would reduce the potential impacts from pipelines.

The WTP site has limited potential water body impact with one small, upland constructed pond that is likely non-jurisdictional. The pump station near Luling does not contain wetlands, but has one small, potentially jurisdictional ephemeral stream located on the site. Well sites would not affect aquatic resources within the project area.

The surface water intake is located along the Guadalupe River within a flood hazard area, and would require the placing of structures and fill material into the river. Impacts resulting from this action would include possible localized impacts to the riparian buffer, bank condition, and possibly instream habitat depending on the final intake design. However, the intake is not expected to have an adverse effect on the river’s overall chemical, physical, or biological functions, such as water/sediment transport, access to floodplains, water supply, habitat, and recreation. The WTP, booster pump site, and wells are not located within flood hazard areas.

Coordination with the U.S. Army Corps of Engineers would be required for construction within waters of the U.S. Impacts from this proposed project resulting in a loss of less than 0.5 acres of waters of the U.S. could be covered under Nationwide Permit #12 for Utility Line Activities unless there are significant impacts to the aquatic environment by other project components.

The Texas Parks & Wildlife Department (TPWD) has identified a number of stream segments throughout the state as ecologically significant on the basis of biological function, hydrologic function, riparian conservation, exceptional aquatic life uses, and/or threatened or endangered species. Currently, 21 stream segments in Region L are considered ecologically significant by the TPWD[3]. Pipelines associated with this water management strategy do not cross any of these stream segments. The section of the Guadalupe River from U.S. 183 (near the Gonzales diversion point) upstream to Lake Gonzales Dam, however, is listed as ecologically significant as it contains two of four known remaining populations of the golden orb, a rare, endemic mollusk.

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 (Pl96-515), and the Archeological and Historic Preservation Act (PL93-291). Based on the review of available GIS datasets, there are 19 cemeteries, six national register properties, two national register district properties, and 45 historical markers located within a 0.5-mile buffer of the proposed pipeline route. An additional cemetery is located near the potential well field area.

Based on a review of soils, geology, and aerial photographs, there is a high probability for undocumented significant cultural resources within the alluvial deposits and terrace formations associated with waterways, specifically the intermittent and perennial aquatic resources. The intake has a high potential impact for cultural resources, primarily due to its location in an area with known cultural resources within one-half mile. The transmission pipelines are considered likely to have low negative impact to cultural resources. For the most part, the pipelines would cross areas of low probability for cultural resources, but those probabilities increase near waterways and associated landforms. The well field location, because it includes several intermittent streams, could include cultural resources. In addition, the McKeller cemetery is located in the well field area and near the proposed pipeline. The WTP site is considered to have low cultural resources impacts.

A review of archaeological resources in the proposed project area should be conducted during the project planning phase. Taking into consideration that the owner or controller of the project will likely be a political subdivision of the State of Texas (i.e. river authority, municipality, water district, etc.), they will be required to coordinate with the Texas Historical Commission regarding impacts to cultural resources. The project sponsor will also be required to coordinate with the U.S. Army Corps of Engineers regarding any impacts to waters of the United States or wetlands.

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[3] TPWD, "Ecologically Significant River and Stream Segments," http://www.tpwd.state.tx.us/landwater/water/environconcerns/water_quality/sigsegs/index.phtml accessed February 6, 2014.

The species listed by USFWS and TPWD, as endangered or threatened with potential habitat in Gonzales, Caldwell, and Guadalupe counties are listed in Table 5.2.33-1. The Texas Natural Diversity Database, maintained by TPWD, which documents the occurrence of rare species within the state was included in this analysis. Available data did not reveal the occurrence of any listed species within the project area, but the absence of data does not imply the absence of occurrence. Depending on the final design of the intake and resulting impacts to instream habitat, this portion of the project includes potential impacts to federal-candidate/state-listed mollusks and the Cagle's map turtle based on known occurrences of these species near the intake site. The well field, pipelines, pump station and WTP site include limited potential impacts to listed species.

Table 5.2.33-2 Endangered, Threatened, and Species of Concern for Caldwell, Gonzales, and Guadalupe Counties

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
BIRDS								
American peregrine falcon	*Falco peregrinus anatum*	0	2	0	Migrant and local breeder in West Texas.	DL	T	Possible Migrant
Artic peregrine falcon	*Falco peregrinus tundrius*	0	1	0	Migrant throughout the state.	DL		Possible Migrant
Bald eagle	*Haliaeetus leucocephalus*	0	2	0	Found primarily near rivers and large lakes.	DL	T	Possible Migrant
Henslow's sparrow	*Ammodramus henslowii*	1	1	1	Found in weedy fields or cut-over areas			Resident
Interior least tern	*Sterna antillarum athalassos*	0	3	0	Nests along sand and gravel bars in braided streams	LE	E	Resident
Mountain plover	*Charadrius montanus*	1	1	1	Non-breeding, shortgrass plains and fields			Nesting/ Migrant
Sprague's pipit	*Anthus spragueii*	0	1	0	Migrant in Texas in winter mid Sept. to early April. Strongly tied to native upland prairie.			Possible Migrant
Western burrowing owl	*Athene cunicularia hypugaea*	1	1	1	Open grasslands, especially prairie, plains and savanna			Resident
Whooping crane	*Grus americana*	0	3	0	Potential migrant	LE	E	Potential Migrant
Wood stork	*Mycteria americana*	1	2	2	Forages in prairie ponds, ditches, and shallow standing water formerly nested in TX		T	Migrant
FISHES								
Blue sucker	*Cycleptus elongatus*	1	2	2	Major rivers in Texas.		T	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
Guadalupe bass	*Micropterus treculi*	1	1	1	Endemic to perennial streams of the Edwards Plateau region.			Resident
Guadalupe darter	*Percina sciera apristis*	1	1	1	Guadalupe River Basin. Usually found over gravel or gravel and sand raceways of larger streams and rivers.			Resident
INSECTS								
A mayfly	*Campsurus decolaratus*	0	1	0	In Texas and Mexico, possibly clay substrates, found in shoreline vegetation.			Potential Resident
MAMMALS								
Cave myotis bat	*Myotis velifer*	0	1	0	Roosts colonially in caves, rock crevices			Resident
Plains spotted skunk	*Spilogale putorius interrupta*	1	1	1	Prefers wooded, brushy areas.			Resident
Red wolf	*Canis rufus*	0	3	0	Extirpated.	LE	E	Historic Resident
MOLLUSKS								
Creeper (squawfoot)	*Strophitus undulates*	1	1	1	Small to large streams. Colorado, Guadalupe, and San Antonio River basins.			Resident
False spike mussel	*Quincuncina mitchelli*	1	2	2	Substrates of cobble and mud. Rio Grande, Brazos, Colorado and Guadalupe river basins.		T	Resident
Golden orb	*Quadrula aurea*	1	2	2	Sand and gravel, Guadalupe, San Antonio, Lower San Marcos, and Nueces River basins	C	T	Resident
Palmetto pill snail	*Euchemostrema leai cheatumi*	0	1	0	Known only from Palmetto State Park.			Resident
Texas fatmucket	*Lampsilis bracteata*	1	2	2	Streams and rivers on sand, mud and gravel, Colorado and Guadalupe River basins.	C	T	Resident
Texas pimpleback	*Quadrula petrina*	1	2	2	Mud, gravel and sand substrates, Colorado and Guadalupe river basins		T	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
PLANTS								
Big red sage	*Salvia pentstemonoides*	0	1	0	Texas endemic, found in moist to seasonally wet steep limestone outcrops on canyons or along creek banks.			Resident
Bristle nailwort	*Paronychia setacea*	1	1	1	Endemic to south central Texas in sandy soils.			Resident
Buckley's spiderwort	*Tradescantia buckleyi*	1	1	1	Endemic in grassland openings in oak woodlands.			Resident
Green beebalm	*Monarda viridissima*	1	1	1	Endemic perennial herb. Found in well-drained sandy soils in opening of post oak woodlands.			Resident
Elmendorf's onion	*Allium elmendorfii*	1	1	1	Endemic, in deep sands			Resident
Parks' jointweed	*Polygonella parksii*	0	1	0	Texas endemic, primarily found on deep, loose, sand blowouts in Post Oak Savannas.			Resident
Shinner's sunflower	*Helianthus occidentalis ssp.*	1	1	1	Found on prairies on the Coastal Plain.			Resident
Sandhill woolywhite	*Hymenopappus carrizoanus*	1	1	1	Found south of the Guadalupe River. Prefers dense riparian corridors.			Resident
REPTILES								
Cagle's map turtle	*Graptemys caglei*	1	2	2	Endemic to Guadalupe River System. Found near waters' edge.		T	Resident
Spot-tailed earless lizard	*Holbrookia lacerata*	1	1	1	Moderately open prairie-brushland.			Resident
Texas Garter Snake	*Thamnophis sirtalis annectens*	1	1	1	Wet or moist microhabitats			Resident
Texas Horned Lizard	*Phrynosoma cornutum*	1	2	2	Varied, sparsely vegetated uplands.		T	Resident
Texas Tortoise	*Gopherus berlandieri*	1	2	2	Open brush w/ grass understory.		T	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence in County
Timber/ canebrake rattlesnake	*Crotalus horridus*	1	2	2	Floodplains, upland pine, deciduous woodlands, riparian zones.		T	Resident
TPWD, 2014. Annotated County List of Rare Species – Gonzales County. Revised 8/7/2012, and Caldwell County. Revised 8/7/2012. USFWS, 2013. Endangered Species List for Texas. http://www.fws.gov/southwest/es/ES_ListSpecies.cfm accessed online February 6, 2013.								

Endangered species, including Texas wild-rice, San Marcos gambusia, fountain darter, the Texas blind salamander, the threatened San Marcos salamander, and the rare Shinner's sunflower have all been documented within five miles of one of the proposed delivery points. Many species including Texas wild-rice, the San Marcos gambusia, fountain darter, San Marcos salamander, and Texas blind salamander have a very limited distribution; several are endemic only to the headwaters of the San Marcos River.

The project area may provide potential habitat to endangered or threatened species found in Gonzales, Guadalupe, or Caldwell counties. A survey of the project area may be required prior to pipeline and well field construction to determine whether populations of or potential habitats used by listed species occur in the area to be affected. Coordination with TPWD and USFWS regarding threatened and endangered species with the potential to occur in the project area should be initiated early in project planning.

Available data did not reveal the occurrence of any listed species within the environmental assessment area, but the absence of data does not imply the absence of occurrence. Based on existing habitat types, the following species have potential to occur near project components, but the project is not anticipated to affect any species adversely. The aquatic species are only of concern at the intake site and locations where pipelines cross perennial waters.

A. Federal-Listed Endangered Species

Whooping Crane (Grus americana) — The Whooping Crane is a federally listed species which would occur in Texas only during migration. Whooping cranes use a variety of habitats during migration, including croplands for feeding and large, marshy palustrine wetlands for roosting. Although large wetlands do not exist within the OCR area, the Whooping Crane could potentially occur in any surrounding cropland habitat during migration.

B. Federal-Listed Candidate Species

Golden Orb (Quadrula aurea) — The Golden orb is a federal candidate for listing and is state threatened. This freshwater mollusk exists in sand, gravel or mud substrates within lake or river systems. This species could potentially occur in the GuadalupeRiver and perennial streams.

Texas fatmucket (Lampsilis bracteata) — The Texas fatmucket is a federal candidate for listing in the state and is state threatened. This freshwater mollusk exists in more shallow rivers or streams with substrates of sand, mud and gravel. This species could potentially occur in the Guadalupe River and perennial streams.

Texas pimpleback (Quadrula petrina) — The Texas pimpleback is a federal candidate for listing in the state, but not in Gonzales and Caldwell counties, and is state threatened. This freshwater mollusk exists in small to moderate streams and rivers of slow flow rates, as well as moderate size reservoirs with substrates of mixed mud, sand and fine gravel. This species was collected during a fall 2011 survey near Gonzales, Texas. This species could potentially occur in the Guadalupe River and perennial streams.

C. State-Listed Species

Bald Eagle (Haliaeetus leucocephalus) — The Bald Eagle is a state-listed threatened species that could occur as a migrant near major aquatic resources. Although they breed primarily in the eastern half of the state, they could potentially occur along rivers or large lakes in this region of Texas during the winter and during migration. This species could potentially occur near perennial waterways such as the Guadalupe River.

Interior Least Tern (Sterna antillarum athalassos) — The Interior Least Tern is listed as endangered by the USFWS. They prefer to nest on sandbars, islands, salt flats, and bare or sparsely vegetated sand, shell, and gravel beaches that are associated with braided streams, rivers and reservoirs. They could potentially occur within these habitats along the Guadalupe River or dry, exposed impoundments.

Peregrine Falcon (Falco peregrinus), including the American peregrine falcon (F. p. anatum) subspecies, is a state threatened bird that could be a possible migrant. They utilize a wide range of habitats during migration, including urban areas and landscape edges such as lakes or large river shores.

Blue sucker (Cycleptus elongatus) is a state threatened fish and exists in large portions of major rivers in Texas. Their preferred habitat includes channels and flowing pools with a moderate current and a bottom of exposed bedrock with hard clay, sand and gravel components.

False spike mussel (Quadrula mitchelli) is state threatened freshwater mollusk. The TPWD county list states the species as possibly extirpated in Texas. A small population was discovered during a fall 2011 survey in the Guadalupe River near Gonzales. This species could potentially occur in perennial streams.

Cagle’s map turtle (Graptemys caglei) is a state threatened reptile and occupies riverine habitat in the Guadalupe-San Antonio river systems. They prefer shallow water with swift to moderate flow and a substrate of gravel or cobble or deeper pools with a slower flow rate and a substrate of silt or mud. This turtle will nest on gently sloping sand banks along rivers. This species could potentially occur in perennial waterways.

Texas horned lizard (Phrynosoma cornutum) is a state threatened reptile and is present throughout much of the state. They exist in open, arid, and semi-arid regions with sparse vegetation, which includes grass, cactus, scattered brush or scrubby trees. This species could potentially occur in areas with this type of contiguous vegetation.

Texas tortoise (Gopherus berlandieri) is a state threatened reptile that is active in the warmer months of March through November. They occur in open brush with a grass understory and will avoid areas of open grass or bare ground. This species could potentially occur in areas with this type of contiguous vegetation.

Timber/Canebrake rattlesnake (Crotalus horridus) is a state threatened reptile that occurs in swamps, floodplains, upland pine and deciduous woodlands, riparian zones, and abandoned farmland. They could also be present in limestone bluffs, sandy soil or black clay. This species could potentially occur in areas of abandoned farmland or forested riparian areas.

D. Unique or Rare Species

American eel (Anguilla rostrata) is not a listed species, but is part of a unique community designation within the San Marcos River. The NDD has no recorded occurrences of this species in the location of the proposed assessment area, but the species could potentially occur in perennial streams.

Guadalupe bass (Micropterus treculii) is an endemic game fish to Texas, found in the northern and eastern Edwards Plateau including headwaters of the San Antonio River, the Guadalupe River above Gonzales, the Colorado River north of Austin, and portions of the Brazos River drainage. Relatively small populations occur outside of the Edwards Plateau, primarily in the lower Colorado River. Although not a listed species, it is the official state fish and considered rare by TPWD. This species could potentially occur in perennial waters.

The primary impacts that would result from construction of the proposed project would include the conversion of existing habitats and land uses within the pipeline right-of-way, WTP site, and well sites to maintained areas. These impacts are anticipated to be minor. Additional impacts could result from the pipeline crossings at the San Marcos River and other perennial waterways.

The primary impacts that would result from construction of the proposed project would include the conversion of existing habitats and land uses within the pipeline right-of-way, WTP site, pump station, and well sites to maintained areas. These impacts are anticipated to be minor. The surface water intake would require the placing of structures and fill material into the river which may result in possible localized impacts to the riparian buffer, bank condition, and possibly instream habitat depending on the final intake design.

5.2.33.4 Engineering and Costing

Costs are based on the GBRA's MBWSP Engineering Feasibility Study (Option 3C) and indexed to September 2013 prices and other TWDB costing assumptions. The project is sized for 50,000 acft/yr annual delivery with a 2.0 peaking factor. Total project and annual costs for this option at the stated project yield are included in Table 5.2.33-3.

These costs are for all facilities including raw water intake and pump station, raw water delivery pipelines, well field facilities, treatment plant, and potable water facilities up to the customer delivery points (i.e. everything shown in Figure 5.2.33-1). Costs for engineering, legal, and contingencies are estimated as 30 percent of capital costs for the pipeline and 35 percent of capital costs for other facilities (e.g., pump stations). Interest during construction was calculated based on a 3 percent differential between loan payments and earnings with a 2.5 year construction period.

The capital costs for all facilities sized for a 2.0 peaking factor are $495,460,000. Adding in non-capital costs: engineering/legal/contingencies, environmental, land acquisition and surveying, interest during construction, and groundwater lease payments; the total project costs for all facilities required to provide a firm annual supply of 50,000 acft/yr are $736,381,000. Annual costs which include debt service (5.5%, 20 years) and operation and maintenance and energy costs are $81,850,000, resulting in an annual unit cost of $1,637/acft.

In terms of environmental impacts, the amount and type of impact drives potential surveying, permitting, and mitigation costs. Implementing measures to avoid and limit impacts (e.g., horizontal directional drilling) to sensitive environmental features and aquatic resources may lessen potential costs. Potential environmental and archaeological costs (surveying, permitting, and mitigation) are estimated at $1,123,000 (Table 5.2.33-3).

Table 5.2.33-3 Summary Cost Estimate for GBRA MBWSP – Surface Water with ASR (Option 3C)

Item	*Estimated Costs for Facilities*
Intake Pump Stations	$20,257,000
Transmission Pipeline	$113,576,000
Transmission Pump Station(s) & Storage Tank(s)	$36,859,000
Storage Tanks (Other Than at Booster Pump Stations)	$4,216,000
Water Treatment Plant	$230,455,000
Access Roads	$2,425,000
TOTAL COST OF FACILITIES	**$495,460,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$167,732,000
Environmental & Archaeology Studies and Mitigation	$1,123,000
Land Acquisition and Surveying	$12,816,000
Interest During Construction (4% for 2.5 years with a 1% ROI)	$59,250,000
TOTAL COST OF PROJECT	**$736,381,000**
ANNUAL COST	
Debt Service (5.5 percent, 20 years)	$61,620,000
Operation and Maintenance	
Intake, Pipeline, Pump Station & Groundwater	$3,733,000
Water Treatment Plant (2.5% of Cost of Facilities)	$11,026,000
Pumping Energy Costs (60,791,667 kW-hr @ 0.09 $/kW-hr)	$5,471,000
TOTAL ANNUAL COST	**$81,850,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 2	50,000
Annual Cost of Water ($ per acft)	$1,637
Annual Cost of Water ($ per 1,000 gallons)	$5.02

Note: Unit costs for Option 3C in GBRA's MBWSP Engineering Feasibility Study were estimated at $1467/acft using March 2012 prices, debt service at 5% for 30 years, and $0.12/kwhr.

5.2.33.5 Implementation Issues

Significant implementation issues includes TCEQ approval of GBRA's surface water diversion permit application and modifications of or variances to rules from the Gonzales County Underground Water Conservation District (GCUWCD) including:

a. Allowing the maximum production of a well to exceed the average annual production by a factor of 2.0 instead of 1.5;
b. Modify contiguous acreage requirements to be based on long-term average annual well field production instead of the maximum annual permitted capacity;
c. Granting recharge credit for injected water through ASR operations; these credits would be used to increase the allowable groundwater production from given leases;
d. To promote ASR well field viability, the GCUWCD could approve a reduction in the minimum well spacing from 8,000 feet to 4,000 feet (1,800 gpm wells) in recognition of no use of groundwater.
e. Some time is needed to fill an ASR facility; the amount of time is dependent on hydrological conditions in the first years of startup. For this reason, this strategy will not have adequate capacity at startup to meet customer demands without an additional, interim, source of supply (e.g., Carrizo groundwater produced from the remote ASR well field).

Other implementation issues include:

a. Renewal of GCUWCD 5-year production permits and 30-year export permits for project life; and
b. Additional groundwater development in the region will not have a substantial effect on groundwater levels in the well field areas.

In addition, it will be necessary to obtain the following permits and agreements:

a. USCE Sections 10 and 404 Dredge and Fill Permits for the reservoir and pipelines;
b. GLO Sand and Gravel Removal permits;
c. GLO Easement for use of state-owned land;
d. TPWD Sand, Gravel, and Marl permit; and
e. Private land for construction of facilities to be acquired through either negotiations or condemnation.

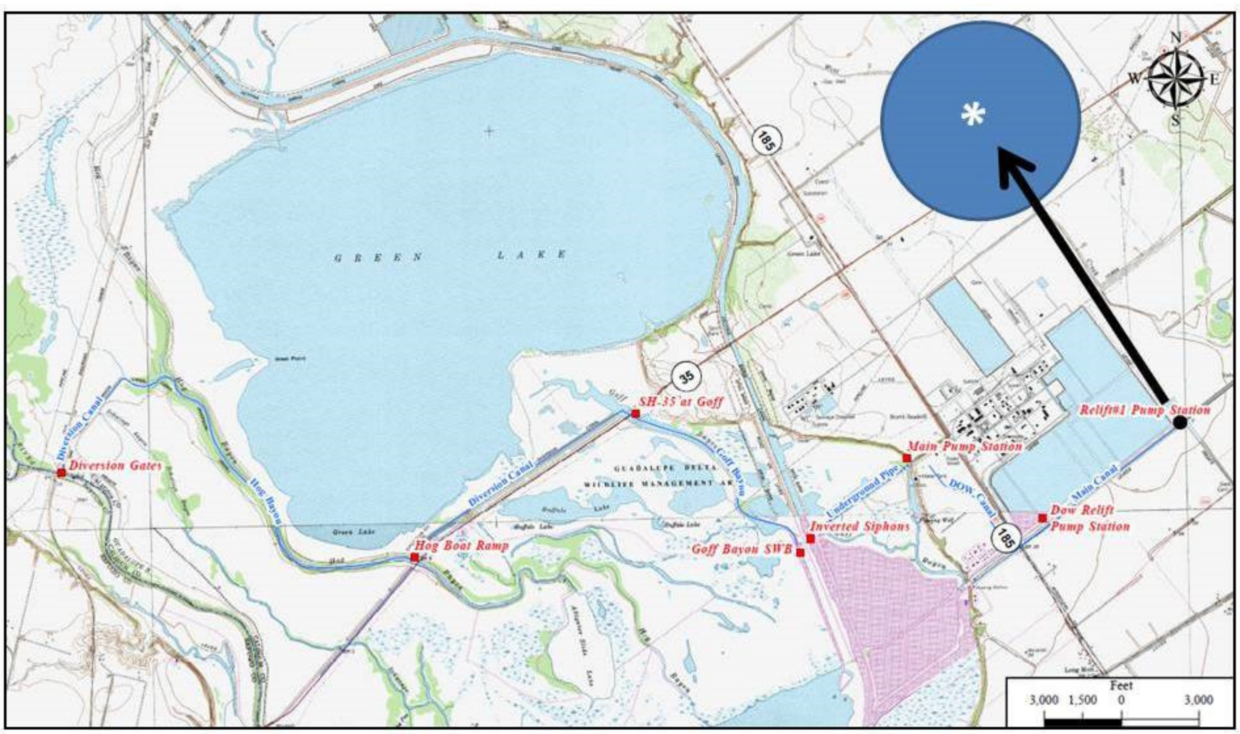
Permitting may require development of habitat mitigation plan, environmental studies, and cultural resources studies and mitigation.

5.2.34 GBRA Lower Basin New Appropriation

5.2.34.1 Description of Water Management Strategy

The Guadalupe-Blanco River Authority (GBRA) is in the planning and permitting stages of a new appropriation for diversion of up to 189,484 acft/yr from the Guadalupe River in Calhoun County using existing gravity-flow diversion facilities located immediately upstream of GBRA's Saltwater Barrier and Diversion Dam at a rate of diversion not to exceed 500 cfs (within the existing 622 cfs maximum authorized diversion rate) and authorization to impound up to 200,000 acft in Calhoun County (Figure 5.2.34-1). The diversion and storage will serve municipal and industrial water users in GBRA's ten-county statutory district and are the subject of Application No. 12482 for surface water rights pending before the Texas Commission on Environmental Quality (TCEQ). Implementation of this water management strategy will help to meet projected demands for current and future GBRA customers through the next 50 years and beyond.

Figure 5.2.34-1 General Project Location



**Location to be determined and size based on 25,000 acft at 25-foot depth*

5.2.34.2 Available Yield

Water Availability Modeling

The GBRA New Appropriation (Lower Basin) water management strategy (WMS) is evaluated using the Guadalupe-San Antonio Basin Water Availability Model (GSAWAM), as modified for regional water planning purposes. This water management strategy is subject to full application of environmental flow standards adopted pursuant to Section 11.1471 of the Texas Water Code. The GSAWAM is a monthly timestep model, however, a series of spreadsheet models, including the Flow Regime Application Tool (FRAT) were used to quantify water availability for a new water right subject to daily flow variations, senior water rights, instantaneous instream flow restrictions, and an instantaneous maximum diversion rate.

Specifically, the GSAWAM was used to determine the regulated flow and unappropriated flow for the San Antonio River and Guadalupe River, separately, just upstream of the confluence of the two rivers. For each river, the regulated and unappropriated flows were disaggregated to daily values, and the daily senior water rights passage volume was determined. Results were imported into separate FRAT models, and the appropriate instream flow standard was incorporated. For the Guadalupe River, the environmental flow standard associated with the Guadalupe River at Victoria was used, adjusted for the additional incremental drainage area to the confluence. For the San Antonio River, the environmental flow standard associated with the San Antonio River at Goliad was used, adjusted for the additional incremental drainage area to the confluence. The FRAT models were then used to determine the amounts of water available to the GBRA Lower Basin New Appropriation water management strategy from each river. Finally, a daily spreadsheet model was used to determine the amount of water used from each river in conjunction with daily reservoir operations and calculate firm yield.

Modeling Results

Firm yield calculations were performed for off-channel reservoir sizes of 25,000 acft, 50,000 acft, 100,000 acft, 150,000 acft, and 200,000 acft. Table 5.2.34-1 shows the results of these calculations at five off-channel reservoir sizes.

Table 5.2.34-1 Lower Basin New Appropriation Firm Yield at Various Off-Channel Reservoir Capacities

Off-Channel Reservoir Size (acft)	Firm Yield (acft/yr)
25,000	20,900
50,000	26,100
100,000	34,300
150,000	42,000
200,000	43,000

With any new project in the Guadalupe-San Antonio River Basin, there is always concern with the effects the project will have on freshwater inflows to the Guadalupe Estuary. Figure 5.2.34-2 and Figure 5.2.34-3 illustrate simulated freshwater inflows to the Guadalupe Estuary with and without implementation of this water management strategy. The data labeled “With GBRA Lower Basin New Application” in Figure 5.2.34-2 and

Figure 5.2.34-3 are from simulations including an 150,000 acft off-channel reservoir and annual diversion of the firm yield as reported in Table 5.2.34-1.

Figure 5.2.34-2 Monthly Median Freshwater Inflows

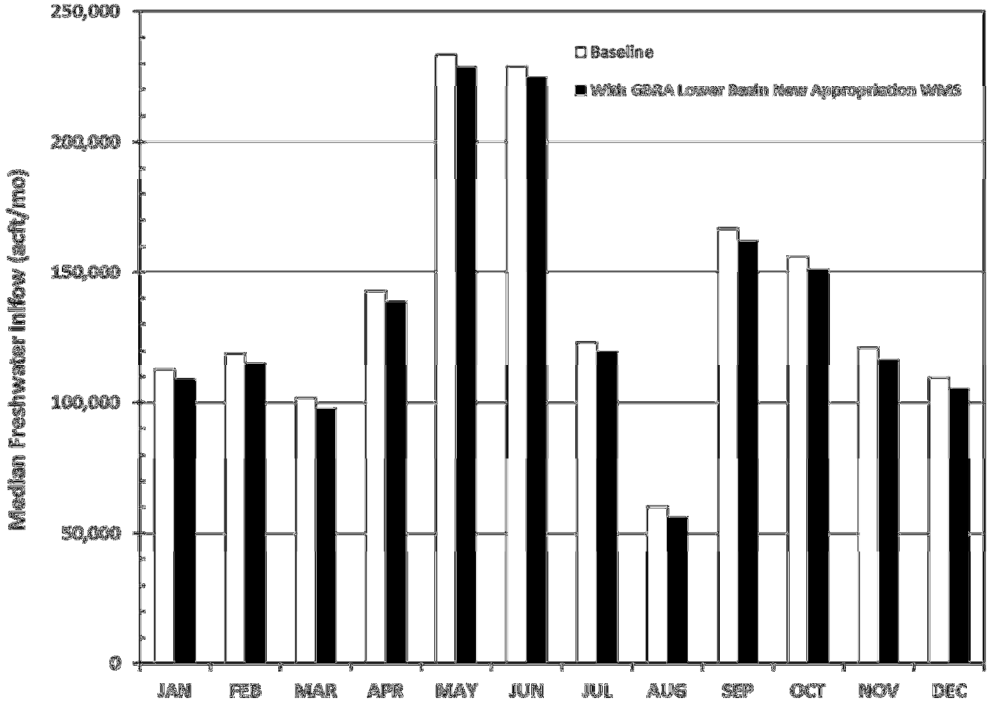
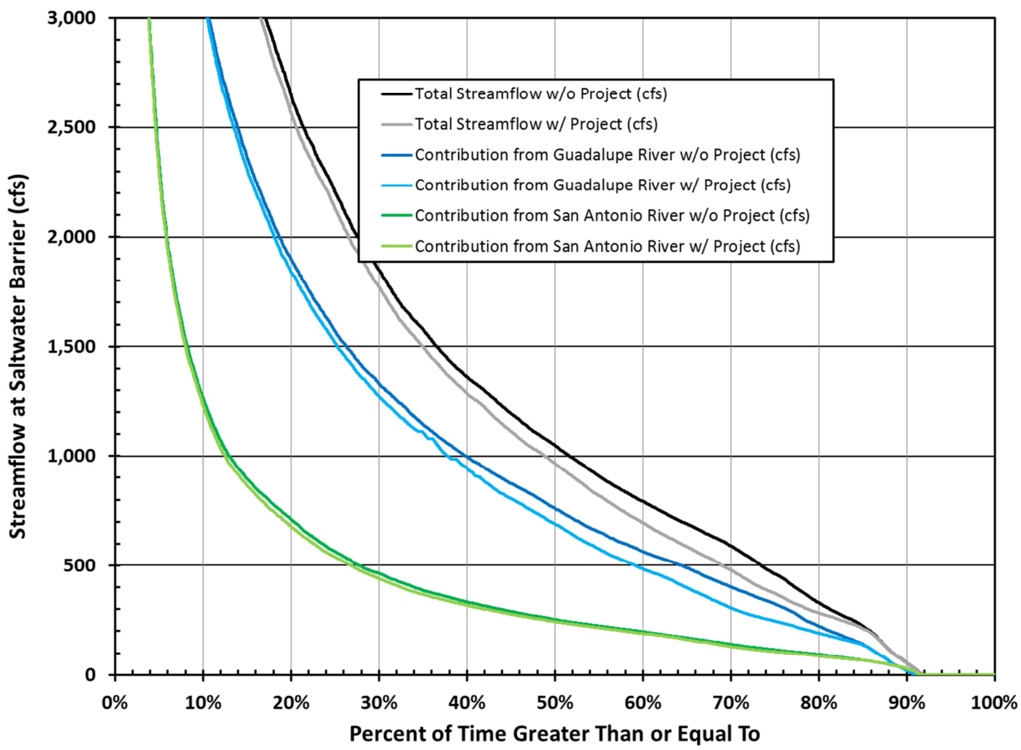


Figure 5.2.34-3 Freshwater Inflow Frequency



5.2.34.3 Environmental Issues

The GBRA New Appropriation (Lower Basin) water management strategy includes the diversion of water from the Guadalupe River via the Calhoun Canal Systems to an off-channel reservoir located east of Green Lake in Calhoun County. The off-channel reservoir will facilitate water storage which will be utilized by municipal and industrial operations. Additional facilities needed for this new water appropriation strategy will include the off-channel reservoir, a new pump station and intake on the GBRA Main Canal, and a water transmission pipeline from the GBRA Main Canal to the off-channel reservoir.

The project area is located in the Gulf Coastal Plains of Texas Physiographic Province, specifically in the subprovince of the Coastal Prairies.[1] This area is locally characterized as a nearly flat prairie composed of deltaic sands and muds which terminates at the Gulf of Mexico and includes topography changes of less than one foot per mile. Elevation levels in the Coastal Prairies range from 0 to 300 feet above mean sea level. Land uses found within the proposed on-site storage area include primarily farm, pasture and range areas.

The off-channel reservoir area is found within the Gulf Prairies and Marshes Vegetational Area.[2] Gulf Prairies have slow surface drainage and elevations that range from sea level to 250 feet. These areas include nearly level and virtually undissected plains. Originally the Gulf Prairies were composed of tallgrass prairie and post oak savannah. However tree species such as honey mesquite (*Prosopis glandulosa*), and acacia (Acacia ssp.), along with other trees and shrubs have increased in this area forming dense thickets in many places. Typical oak species found in this area include live oak (*Quercus virginiana*) and post oak (Q. stellata), in addition to huisache (*Acacia smallii*), black-brush (*A. rigidula*), and a dwarf shrub; bushy sea-ox-eye (*Borrichia frutescens*). Principal climax grasses of the Gulf Prairies include gulf cordgrass (*Spartina spartinae*), indiangrass (*Sorghastrum nutans*), and big bluestem (*Andropogon gerardii* var. *gerardii*). Prickly pear (*Opunita* spp.) are common within this area along with forbs including asters (*Aster* spp.), poppy mallows (*Callirhoe* sp.), bluebonnets (*Lupinus* sp.), and evening primroses (*Oenothera* spp.).

Gulf Marshes range from sea level to a few feet in elevation, and include low, wet marshy coastal areas commonly covered with saline water. These salty areas support numerous species of sedges (*Carex* and *Cyperus* sp.), bulrushes (*Scirpus* sp.), rushes (*Juncus* sp.), and grasses. Aquatic forbs found in these areas generally include pepperweeds (*Lepidium* sp.), smartweeds (*Polygonum* sp.), cattails (*Typha domingensis*) and spiderworts (*Tradescantia* sp.) among others. Upland game and waterfowl find these low marshy areas to be excellent natural wildlife habitat.

The federal Endangered Species Act of 1973, as amended, prohibits the “take” of any threatened or endangered species. The term “take” under the ESA means “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct.” The term “harm” was further defined to include “significant habitat

[1] Bureau of Economic Geology. 1996. Physiographic map of Texas, The University of Texas at Austin, Austin, Texas.
[2] Gould, F. W., 1975. “The Grasses of Texas,” Texas A&M University Press, College Station, Texas,.

modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering." Designation of critical habitat areas has been established for the public knowledge where the publishing of such information would not cause harm to the species. Additional federal protection is extended to migratory birds, and bald and golden eagles under the Migratory Bird Treaty Act (MBTA) as amended, and the Bald and Golden Eagle Protection Act. Protection is also afforded to Texas state-listed species by the Texas Parks and Wildlife Department (TPWD) which enforces the state regulations.

The MBTA protects most bird species, including, but not limited to, cranes, ducks, geese, shorebirds, hawks, and songbirds. Migratory bird pathways, stopover habitats, wintering areas, and breeding areas may occur within and adjacent to the on-site storage area, and may be associated with wetlands, ponds, shorelines, riparian corridors, fallow fields and grasslands, and woodland and forested areas. On-site storage construction activities could disturb migratory bird habitats and/or species' activities.

Reasonable and prudent measures should be taken to avoid and minimize the potential effects of the proposed project activities on threatened and endangered species as well as bald eagles. Species' locations, activities, and habitat requirements should be considered based on U.S. Fish and Wildlife Service (USFWS) and TPWD recommendations.

In Calhoun County, 30 state-listed endangered or threatened species and 15 federally-listed endangered or threatened wildlife species may occur, according to the county lists of rare species published by the TPWD. A list of these species, their preferred habitat and potential occurrence in Calhoun County is provided in Table 5.2.34-1. Inclusion in Table 5.2.34-2 does not imply that a species will occur within the project area, but only acknowledges the potential for its occurrence in Calhoun County. A more intensive field reconnaissance would be necessary to confirm and identify specific suitable habitat that may be present in the project area.

Three bird species federally or state listed as endangered are included in the project area. These include the eskimo curlew (*Numenius borealis*), northern aplomado falcon (*Falco femoralis septentrionalis*), and whooping crane (*Grus americana*). The eskimo curlew is a historic resident of the area, the northern aplomado falcon is a resident species, and the whooping crane is a seasonal migrant which could pass through the project area. The main whooping crane flock nests in Canada and migrates annually to their wintering grounds in and around the Aransas National Wildlife Refuge near Rockport on the Texas coast. Whooping cranes occasionally utilize wetlands as an incidental rest stop during this migration. Habitat elements which are attractive to these bird species may be present on or adjacent to the proposed off-channel reservoir site or pipeline route.

Avian species federally or state listed as threatened include the peregrine falcon (*Falco peregrinus*), reddish egret (*Egretta rufescens*), sooty tern (*Sterna fuscata*), white-faced ibis (*Plegadis chihi*), white-tailed hawk (*Buteo albicaudatus*), wood stork (*Mycteria Americana*), piping plover (*Charadrius melodus*), and bald eagle (*Haliaeetus leucocephalus*). The peregrine falcon includes two subspecies which migrate across the state from more northern breeding areas in the U.S. and Canada to winter along the coast. The majority of nesting bald eagle pairs currently reported are found along major rivers and near reservoirs in Texas. Bald eagles are opportunistic predators, feeding primarily on fish captured in the shallow water of both lakes and streams or scavenged food sources. These birds may utilize tall trees near perennial water as roosting or nesting sites. Bald eagles occur as migrants within south Texas and have been documented as occurring near the project area. The remaining bird species excluding the white-tailed hawk are generally found within marshy or wet areas foraging for food. Development of the off-channel storage site could provide additional habitat for those species which prefer a wet environment.

Table 5.2.34-2 Endangered, Threatened, and Species of Concern for Calhoun County

Common Name	*Scientific Name*	*Impact Value*	*Multiplier Based on Status*	*Adjusted Impact*	*Summary of Habitat Preference*	*Federal Status*	*State Status*	*Potential Occurrence in County*
AMPHIBIANS								
Black-spotted newt	Notophthalmus meridionalis	1	2	2	Found in wet or sometimes wet areas on the Gulf Coastal Plain.	--	T	Resident
Sheep frog	Hypopachus variolosus	1	2	2	Found predominantly in grassland and savanna in moist sites of arid areas.	--	T	Resident
Southern crawfish frog	Lithobates areolatus areolatus	1	1	1	Found in abandoned crawfish holes and small mammal burrows.	--	--	Resident
BIRDS								
Peregrine falcon	*Falco peregrinus anatum* (American)	0	2	0	Open county; cliffs	DL	T	Nesting/ Migrant
	Falco peregrinus tundrius (Arctic)	0	1	0	Open county; cliffs	DL	--	Nesting/ Migrant
Bald eagle	*Haliaeetus leucocephalus*	1	2	2	Large bodies of water with nearby resting sites	DL	T	Nesting/ Migrant
Brown	*Pelecanus*	0	1	0	Coastal	DL	--	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Federal Status	State Status	Potential Occurrence in County
pelican	*occidentalis*				inlands for nesting, shallow gulf and bays for foraging			
Eskimo curlew	*Numenius borealis*	0	3	0	Historic and non-breeding	LE	E	Historic Resident
Henslow's sparrow	*Ammodramus henslowii*	0	1	0	Wintering individuals found in weedy fields or cut-over areas.	--	--	Migrant
Mountain plover	*Charadrius montanus*	0	1	0	Breeding, nesting on shortgrass prairie.	--	--	Resident
Northern Aplomado Falcon	*Falco femoralis septentrionalis*	0	3	0	Found in open country, especially savanna and open woodland.	LE	E	Resident
Piping plover	*Charadrius melodus*	1	2	2	Beaches and flats of coastal Texas	LT	T	Migrant
Red knot	*Clidris canutus rufa*	0	1	0	Migrant, nesting in the arctic and flying to South America during winter.	C	--	Migrant
Reddish egret	*Egretta rufescens*	1	2	2	Coastal inlands for nesting, coastal marshes for foraging	--	T	Resident
Snowy plover	*Charadrius alexandrinus*	1	1	1	Potential migrant, wintering along the coast	--	--	Migrant
Sooty tern	*Sterna fuscata*	1	2	2	Catches small fish as it hovers or flies over water	--	T	Resident
Southeastern snowy plover	*Charadrius alexandrinus tenuirostris*	1	1	1	Wintering migrant along coast.	--	--	Migrant

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Federal Status	State Status	Potential Occurrence in County
Sprague's Pipit	*Anthus spragueii*	1	1	1	Migrant in winter, found in native upland prairie and coastal grasslands.	C	--	Migrant
Western burrowing owl	*Athene cunicularia hypugaea*	1	1	1	Open grasslands, especially prairie.	--	--	Resident
Western snowy plover	*Charadrius alexandrinus nivosus*	0	1	0	Uncommon breeder in Panhandle. Potential migrant.	--	--	Migrant
White-faced ibis	*Plegadis chihi*	1	2	2	Prefers freshwater marshes	--	T	Resident
White-tailed hawk	*Buteo albicaudatus*	0	2	0	Coastal prairies, savannahs and marshes in Gulf Coastal Plain	--	T	Resident
Whooping crane	*Grus Americana*	1	3	3	Winters in coastal marshes	LE	E	Migrant
Wood stork	*Mycteria Americana*	1	2	2	Forages in prairie ponds, ditches and shallow standing water; formerly nested in Texas	--	T	Migrant
FISHES								
American eel	*Anguilla rostrata*	1	1	1	Coastal waterways to Gulf.	--	--	Resident
Opossum pipefish	*Microphis brachyurus*	1	2	2	Brooding adults found in fresh or low salinity waters and young in more saline waters; Southern coastal areas	--	T	Aquatic Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Federal Status	State Status	Potential Occurrence in County
Smalltooth sawfish	*Pristis pectinata*	1	3	3	Found in sheltered bays, on shallow banks and in estuaries or river mouths.	LE	E	Aquatic Resident
MAMMALS								
Black bear	*Ursus americanus*	0	2	0	Possible as transient in bottomland hardwoods and inaccessible forested areas	T/SA; NL	T	Historic
Jaguarundi	*Herpailurus yaguarondi*	1	3	3	Thick brushlands near water.	LE	E	Resident
Louisiana black bear	*Ursus americanus luteolus*	0	2	0	Possible as transient in bottomland hardwoods and inaccessible forested areas	LT	T	Historic
Ocelot	*Leopardus pardalis*	1	3	3	Dense chaparral thickets; mesquite-thorn shrub and live oak stands.	LE	E	Resident
Plains spotted skunk	*Spilogale putorius interrupta*	1	1	1	Open fields, and prairies.	--	--	Resident
Red wolf	*Canis rufus*	0	3	0	Extirpated	LE	E	Historic
West Indian manatee	*Trichechus manatus*	0	3	0	Gulf and bay system; opportunistic, aquatic herbivore	LE	E	Aquatic Resident
MOLLUSKS								
Creeper (squawfoot)	*Strophitus undulates*	1	1	1	Freshwater mussel in Colorado, Guadalupe, San Antonio, Neches, and Trinity River basins.	--	--	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Federal Status	State Status	Potential Occurrence in County
REPTILES								
Atlantic hawksbill sea turtle	*Eretmochelys imbricate*	0	3	0	Gulf and bay systems; warm shallow waters marine environment	LE	E	Aquatic Resident
Green sea turtle	*Chelonia mydas*	0	2	0	Gulf and bay systems	LT	T	Aquatic Resident
Gulf saltmarsh snake	*Nerodia clarkii*	1	1	1	Saline flats and river mouths			Resident
Kemp's Ridley sea turtle	*Lepidochelys kempii*	0	3	0	Gulf and bay systems; shallow waters	LE	E	Aquatic Resident
Leatherback sea turtle	*Dermochelys coriacea*	0	3	0	Gulf and bay systems	LE	E	Aquatic Resident
Loggerhead sea turtle	*Caretta caretta*	0	2	0	Gulf and bay systems	LT	T	Aquatic Resident
Texas diamondback terrapin	*Malaclemys terrapin littoralis*	1	1	1	Coastal marshes and tidal flats.	--	--	Resident
Texas horned lizard	*Phrynosoma cornutum*	1	2	2	Varied; sparsely vegetated uplands	--	T	Resident
Texas scarlet snake	*Cemophora coccinea lineri*	0	2	0	Mixed hardwood scrub	--	T	Resident
Texas tortoise	*Gopherus berlandieri*	1	2	2	Open bush with grass understory	--	T	Resident
Timber rattlesnake	*Crotalus horridus*	1	2	2	Floodplains, riparian zones with dense ground cover	--	T	Resident
PLANTS								
Three-flower broomweed	*Thurovia triflora*	1	1	1	Endemic, remnant grasslands and tidal flats	--	--	Resident

DL = Delisted   T/SA; NL= Threatened by similarity of appearance, not listed
PD = Proposed for Delisting
LE = Federally listed endangered
LT = Federally listed threatened
Blank = Not Federally or State Listed but considered a Species of Concern
E = State Endangered
T = State Threatened

TPWD, 2015. Annotated County List of Rare Species – Calhoun County, revised 12/11/2014.
USFWS, 2015. Endangered Species List for Texas. http://ecos.fws.gov/tess_public/reports/species-by-current-range-county?fips=48057 accessed online February 25, 2015.

Listed reptile species found within Calhoun County, such as the Texas tortoise, Texas scarlet snake, and the Texas horned lizard are dependent on shrubland or riparian habitats which should to be avoided wherever possible. Although suitable habitat for the state threatened Texas horned lizard may exist within the project area, no impact to this species is anticipated due to the abundance of similar habit near the project area and this species' ability to relocate to those areas if necessary. The timber/canebrake rattlesnake, a state-threatened species, may be found in the riparian woody vegetation of the area. Destruction of these potential habitats can be minimized by selecting previously disturbed areas, such as croplands for project construction. Selection of a pipeline right-of-way alongside existing habitat could also be beneficial to some wildlife species by providing edge habitat; however, the majority of these areas within the project area are small and fragmented. Care should be taken to ensure minimum impacts to existing habitat areas.

In addition to the Calhoun County list of rare species, the TPWD Texas Natural Diversity Database (TXNDD) map data was reviewed for known occurrences of listed species within or near the canal, pipeline or proposed on-site storage areas. This information indicated that there were several reported sightings of the state threatened bald eagle (*Haliaeetus leucoephalus*), within the surrounding area. Occurrences of three species of concern, the Texas diamondback terrapin (*Malaclemys terrapin littoralis*), Gulf saltmarsh snake (*Nerodia clarkia*), and threeflower broomweed (*Thurovia triflora*) are documented within 10 miles of the proposed project area. A rookery is located along Hog Bayou on the western side of Green Lake which includes egrets, herons, roseate spoonbill, olivaceous cormorant and anhinga species. No specific sightings of any endangered or threatened species were documented within the proposed diversion canal, pipeline or on-site storage site. The presence or absence of potential habitat within an area does not confirm the presence or absence of a listed species. No species specific surveys were conducted in the project area for this report.

After a review of the habitat requirements for each listed species, it is not anticipated that this project will have any permanent adverse effect on any federally listed threatened or endangered species, its habitat, or designated habitat, nor would it adversely affect any state listed species.

A review of the Texas Historical Commission Texas Historic Sites Atlas database indicated that there is one historical marker, but no National Register Properties, or cemeteries listed within the proposed off-channel storage area or along the canal and pipeline routes.

5.2.34.4 Engineering and Costing

Preliminary engineering and costing analyses have been performed for the GBRA New Appropriation (Lower Basin) WMS using 2016 Regional Water Planning methods. Major facilities required to implement the river diversion option include:

- Main Pump Station and Canal Upgrades (from 355 cfs to 500 cfs);
- New Intake and Pump Station from Main Canal (~250 cfs);
- 10-mile, 96-inch diameter Diversion Pipeline;
- Off-Channel Storage between 25,000 acft and 200,000 acft; and
- Integration.

Cost estimates for each of the five off-channel reservoir sizes are summarized in Table 5.2.34-3. Total project costs for the GBRA New Appropriation (Lower Basin) WMS, assuming a 150,000 acft off-channel reservoir, are estimated at $298,355,000. Annual unit costs are estimated at $591/acft/yr (Table 5.2.34-4). Annual costs are estimated based on debt service for a 20-year loan at 5.5 percent interest for the transmission system, debt service for a 40 year loan at 5.5 percent interest for the reservoir, and operation and maintenance costs, including power. Costs presented in Table 5.2.34-3 and Table 5.2.34 4 are based on raw water at the reservoir plus integration.

Table 5.2.34-3 Project Cost Estimate Summary

	Off-Channel Reservoir Size (acft)				
	25,000	50,000	100,000	150,000	200,000
Cost of Facilities	$109,114,000	$128,965,000	$159,743,000	$189,773,000	$214,250,000
Total Project Cost	$156,788,000	$190,298,000	$245,200,000	$298,355,000	$344,102,000
Annual Cost ($/yr)	$13,918,000	$16,597,000	$20,806,000	$24,839,000	$28,080,000
Firm Yield (acft/yr)	20,900	26,100	34,300	42,000	43,000
Unit Cost ($/acft/yr)	$666	$636	$607	$591	$653

Table 5.2.34-4 Project Cost Estimate for the Recommended Water Management Strategy

Item	***Estimated Costs for Facilities***
Off-Channel Storage/Ring Dike (Conservation Pool 150000 acft, 6000 acres)	$97,675,000
Intake Pump Stations (172.2 MGD)	$15,681,000
Transmission Pipeline (96 in dia., 10 miles)	$40,891,000
Integration, Relocations, & Other	$35,526,000
TOTAL COST OF FACILITIES	**$189,773,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$64,376,000
Environmental & Archaeology Studies and Mitigation	$16,848,000
Land Acquisition and Surveying (6,126 acres)	$17,268,000
Interest During Construction (4% for 1 years with a 1% ROI)	$10,090,000
TOTAL COST OF PROJECT	**$298,355,000**
ANNUAL COST	
Debt Service (5.5 percent, 20 years)	$10,647,000
Reservoir Debt Service (5.5 percent, 40 years)	$10,664,000
Operation and Maintenance	
Intake, Pipeline, Pump Station (1% of Cost of Facilities)	$985,000
Dam and Reservoir (1.5% of Cost of Facilities)	$1,465,000
Pumping Energy Costs (41,313,822 kW-hr @ 0.09 $/kW-hr)	$1,078,000
TOTAL ANNUAL COST	**$24,839,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 1	42,000
Annual Cost of Water ($ per acft)	$591
Annual Cost of Water ($ per 1,000 gallons)	$1.81

5.2.34.5 Implementation Issues

Institutional arrangements may be needed to implement the project.

It will be necessary to obtain the following:

1) TCEQ Diversion and Storage Permits (Application No. 12482, pending);
2) USACE Sections 10 and 404 Dredge and Fill Permits for the reservoir and pipelines;
3) GLO Sand and Gravel Removal permits;
4) GLO Easement for use of state-owned land; and
5) TPWD Sand, Gravel, and Marl permit.

Permitting may require these studies:

1) Habitat mitigation plan;
2) Environmental studies; and
3) Cultural resource studies and mitigation.

Land will need to be acquired through either negotiations or condemnation.

Relocations for the off-channel storage facilities may include:

1) County roads;
2) Other utilities;
3) Product transmission pipelines; and/or
4) Power transmission lines.

5.2.35 GBRA Lower Basin Storage Project

5.2.35.1 Description of Water Management Strategy

The Guadalupe-Blanco River Authority (GBRA) and Dow Chemical Company (Dow), individually and collectively, own surface water rights in the lower Guadalupe – San Antonio River Basin (the GBRA/Dow Water Rights) authorizing diversions from the run-of-river flow of the Guadalupe River totaling 175,501 acre-feet per year (acft/yr). Table 5.2.35-1 lists the individual water rights owned by GBRA and Dow and provides their individual permit number, certificate of adjudication number, priority date, annual diversion, authorized uses, and ownership. Water available for diversion under these rights for use by GBRA or Dow is governed by the complex interactions of natural, anthropogenic, and legal factors including rainfall, runoff, springflow, evaporation, aquifer recharge, diversions by other water right owners, reservoir operations, off-channel storage, treated effluent from municipal and industrial water users, terms and conditions of contracts between GBRA and Dow, terms and conditions of the water rights, and the prior appropriation doctrine as enforced by the South Texas Watermaster of the Texas Commission on Environmental Quality (TCEQ). Given that the GBRA/Dow Water Rights point of diversion near Tivoli is below the San Antonio River confluence and that they are senior in priority to most upstream water rights in both the Guadalupe and San Antonio River Basins, it is recognized that they are quite reliable but not firm.

To firm up the run-of-river supplies of water available under the GBRA/Dow Water Rights, an off-channel reservoir (OCR) near the GBRA Main Canal and Dow Seadrift Operations facilities is considered for implementation. Although final site selection has yet to be completed, the OCR could be located approximately 3 miles east of Green Lake as illustrated in Figure 5.2.35-1. The off-channel reservoir would likely have a water depth of about 25 ft and be capable of impounding approximately 12,500 acft of water. A pressure pipeline would transport water diverted from the GBRA Main Canal to the OCR site and a gravity outlet pipeline would return stored water to the GBRA Main Canal.

Table 5.2.35-1 GBRA/Dow Water Rights in the Lower Guadalupe River Basin

Permit Number	***Certificate of Adjudication***	***Priority Date***	***Annual Diversion (acft/yr)***	***Authorized Uses***	***Ownership***
1319	18-5173	2/3/1941	2,500	Irrigation/Industrial	GBRA/Dow
1362	18-5174	6/15/1944	1,870	Irrigation/Industrial	GBRA/Dow
1564	18-5175	2/13/1951	940	Irrigation/Industrial/ Mining/Livestock	GBRA/Dow
1592	18-5176	6/21/1951	9,944	Irrigation/Industrial/ Municipal	GBRA/Dow
1375	18-5177	1/3/1944	10,000	Irrigation/Industrial/ Municipal	Dow
		1/3/1944	32,615	Irrigation/Industrial/ Municipal	GBRA/Dow
		1/26/1948	8,632	Irrigation/Industrial	GBRA/Dow
1614	18-5178	1/7/1952	106,000	Irrigation/Industrial/ Municipal	GBRA/Dow
1562	18-3863	3/1/1951	3,000	Irrigation/Industrial/ Municipal	GBRA
2120	18-5484	5/15/1964	N/A	Diversion Dam & Salt Water Barrier	GBRA
Total = 175,501 acft/yr					

Figure 5.2.35-1 GBRA Lower Basin Storage Example Off-Channel Site Location

5.2.35.2 Water Availability

Initial water availability calculations were performed using TCEQ's Guadalupe – San Antonio River Basin Water Availability Model (GSA WAM) Run 3. The GSA WAM is a monthly time-step computer model used to estimate regulated streamflow and water available for diversion under existing water rights on a priority basis subject to technical assumptions regarding natural, anthropogenic, and legal factors. General technical assumptions used for the applications of the GSA WAM summarized herein include:

a. Surface water rights modeled at full consumptive amounts per certificates of adjudication and permits.

b. Edwards Aquifer withdrawals, critical period management, and resulting springflows consistent with the approved Habitat Conservation Plan (Phase I) developed through the Edwards Aquifer Recovery Implementation Program.

c. Subordination of all senior Guadalupe River hydropower water rights to Canyon Reservoir.

d. For firm water supply modeling purposes, the total run-of-river supply of water available under the GBRA/Dow Water Rights at any time is assumed to be allocated first to satisfy projected demands for firm water at that time among all present and future GBRA customers and then, to the extent additional run-of-river water is available, to storage in the proposed off-channel reservoir.

e. For firm water supply modeling purposes, projected demands for firm water by all present and future GBRA customers are assumed to be in accordance with current GBRA planning.

f. Two alternative assumptions regarding treated wastewater:

    i. 100% direct re-use of all treated wastewater throughout both the Guadalupe and San Antonio River Basins (unmodified TCEQ WAM Run 3).

    ii. Treated wastewater discharges reported for 2011 adjusted for 2011 direct-reuse commitments.

    Note: For firm water supply modeling purposes, future increases in discharges of treated wastewater above those assumed under alternative ii will result in a firm supply greater than the alternative ii supply.

g. Multiple regulated streamflow extractions from each GSA WAM simulation were necessary to account for the effects of diversions by INVISTA/DuPont (CA# 18-3861) on firm supply available to the GBRA/Dow Water Rights on a daily basis. The only large non-GBRA/Dow water right in either the Guadalupe River Basin or the San Antonio River Basin having a priority date senior to some (and junior to other) GBRA/Dow Water Rights is held by INVISTA/DuPont.

A specially-designed Microsoft Excel workbook was applied to disaggregate monthly regulated streamflow values from the GSA WAM to daily values using historical daily streamflow patterns and obtain estimates of firm water supply available under the GBRA/Dow Water Rights on a daily basis. Historical daily streamflow patterns representative of the Guadalupe River near Tivoli are based on flows for the Guadalupe River at Victoria (USGS# 08176500), Coleto Creek near Victoria (USGS# 08177500), and the San Antonio River at Goliad (USGS# 08188500) obtained from project files for a 1998 study for the 1934 through 1989 period. These daily streamflow values were then used, along with applicable seasonal demand patterns associated with assumed types of use, first to determine the firm supply available under the GBRA/Dow Water Rights on a daily basis without the proposed off-channel reservoir. The firm supplies available from the GBRA/Dow Water Rights without the proposed off-channel reservoir assuming 100% direct reuse of all treated wastewater in the two River Basins and assuming 2011 discharges of treated wastewater are about 15,000 acft/yr and 42,500 acft/yr, respectively. The security of supply of these firm supply figures likely are not truly comparable to firm supplies with the proposed off-channel reservoir because, without the off-channel reservoir, there is no allowance for even short time periods during which the run-of-river flows could drop below those assumed in the modeling. On the other hand, these firm supply figures also do not account for any storage between diversion from the Guadalupe River and ultimate users. Dow, Seadrift Coke, INEOS Nitriles, and the Port Lavaca Water Treatment Plant do, however, have on-site storage that could be drawn upon for short periods during which water from the river is limited or unavailable. Hence, the total firm water supply on a daily basis without the proposed off-channel reservoir may in fact be incrementally lesser or greater than the amounts presented herein.

Firm water supplies available on a daily basis under the GBRA/Dow Water Rights can be enhanced with development and integration of off-channel storage. Analyses of potential enhancement of firm water supplies with off-channel storage are based on:

a. Off-channel reservoir capacity of approximately 12,500 acft;
b. Simplified off-channel reservoir operations simulations assuming maximum and minimum water depths of 25 feet and approximately 3 feet, respectively;
c. Delivery of water into off-channel reservoir at a maximum rate of 50 cfs; and
d. Historical net evaporation from the GSA WAM.

Under the above assumptions, firm water supply could be increased from 15,000 acft/yr to 66,800 acft/yr (51,800 acft/yr increase) with the addition of a 12,500 acft off-channel storage reservoir assuming 100% direct reuse of all treated wastewater in the two River Basins. Assuming 2011 discharges of treated wastewater, firm water supply could be increased from 42,500 acft/yr to 118,000 acft/yr (75,500 acft/yr increase) with the addition of a 12,500 acft off-channel storage reservoir. As indicated above, future increases in discharges of treated wastewater above 2011 discharges would result in a firm supply greater than 118,000 acft/yr. Additionally, the firm supply would also be increased by increasing the rate of delivery of water into the off-channel reservoir above the assumed maximum rate of 50 cfs.

5.2.35.3 Environmental Issues

The GBRA Lower Basin Storage water management strategy includes the diversion of water from the Guadalupe River via the Calhoun Canal System to an off-channel reservoir located east of Green Lake in Calhoun County. The off-channel reservoir will facilitate water storage which will be utilized by municipal and industrial operations. Facilities needed for this new water management strategy will include an off-channel reservoir, a new pump station and intake on the GBRA Main Canal, and piping to and from the off-channel reservoir. It is expected that the off-channel reservoir will inundate or disturb about 600 acres of land that could potentially be used for crops or grazing.

The project area is located in the Gulf Coastal Plains of Texas Physiographic Province, specifically in the subprovince of the Coastal Prairies. This area is locally characterized as a nearly flat prairie composed of deltaic sands and muds which terminates at the Gulf of Mexico and includes topography changes of less than one foot per mile. Elevation levels in the Coastal Prairies range from 0 to 300 feet above mean sea level. Land uses found within the proposed on-site storage area include primarily farm, pasture, and range areas.

The off-channel reservoir area is found within the Gulf Prairies and Marshes Vegetational Area. Gulf Prairies have slow surface drainage and elevations that range from sea level to 250 feet. These areas include nearly level and virtually undissected plains. Originally, the Gulf Prairies were composed of tallgrass prairie and post oak savannah. However, tree species such as honey mesquite (Prosopis glandulosa) and acacia (Acacia ssp.), along with other trees and shrubs, have increased in this area forming dense thickets in many places. Typical oak species found in this area include live oak (Quercus virginiana) and post oak (Q. stellata), in addition to huisache (Acacia smallii), black-brush (A. rigidula), and a dwarf shrub identified as bushy sea-ox-eye (Borrichia frutescens). Principal climax grasses of the Gulf Prairies include gulf cordgrass (Spartina spartinae), indiangrass (Sorghastrum nutans), and big bluestem (Andropogon gerardii var. gerardii). Prickly pear (Opunita spp.) are common within this area along with forbs including asters (Aster sp.), poppy mallows (Callirhoe sp.), bluebonnets (Lupinus sp.), and evening primroses (Oenothera spp.).

Gulf Marshes range from sea level to a few feet in elevation, and include low, wet marshy coastal areas commonly covered with saline water. These salty areas support numerous species of sedges (Carex and Cyperus sp.), bulrushes (Scirpus sp.), rushes (Juncus sp.), and grasses. Aquatic forbs found in these areas generally include pepperweeds (Lepidium sp.), smartweeds (Polygonum sp.), cattails (Typha domingensis) and spiderworts (Tradescantia sp.) among others. Upland game and waterfowl find these low marshy areas to be excellent natural wildlife habitat.

The federal Endangered Species Act of 1973, as amended, prohibits the “take” of any threatened or endangered species. The term “take” under the ESA means “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct.” The term “harm” was further defined to include “significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering.” Designation of critical habitat areas has been established for the public knowledge where the publishing of such information would not cause harm to the species. Additional federal protection is extended to migratory birds, and bald and golden eagles under the Migratory Bird Treaty Act (MBTA) as amended, and the Bald and Golden Eagle Protection Act. Protection is also afforded to Texas state-listed species by the Texas Parks and Wildlife Department (TPWD) through state regulations.

The MBTA protects most bird species, including, but not limited to, cranes, ducks, geese, shorebirds, hawks, and songbirds. Migratory bird pathways, stopover habitats, wintering areas, and breeding areas may occur within and adjacent to the off-channel reservoir area, and may be associated with wetlands, ponds, shorelines, riparian corridors, fallow fields and grasslands, and woodland and forested areas. Reservoir and other construction activities could disturb migratory bird habitats and/or species' activities.

Reasonable and prudent measures should be taken to avoid and minimize the potential effects of the proposed project activities on threatened and endangered species as well as bald eagles. Species' locations, activities, and habitat requirements should be considered based on U.S. Fish and Wildlife Service (USFWS) and TPWD recommendations.

30 state-listed endangered or threatened species and 16 federally-listed endangered or threatened wildlife species may occur in Calhoun County, according to the county lists of rare species published by the TPWD. A list of these species, their preferred habitats, and potential occurrence in Calhoun County is provided in Table 5.2.35-2. Inclusion in Table 5.2.35-2 does not imply that a species will occur within the project area, but only acknowledges the potential for its occurrence in Calhoun County. A more intensive field reconnaissance would be necessary to confirm and identify specific suitable habitat that may be present in the project area.

Table 5.2.35-2 Endangered, Threatened, and Species of Concern for Calhoun County

Common Name	*Scientific Name*	*Impact Value*	*Multiplier Based on Status*	*Adjusted Impact*	*Summary of Habitat Preference*	*Federal Status*	*State Status*	*Potential Occurrence in County*
AMPHIBIANS								
Black-spotted newt	Notophthalmus meridionalis	1	2	2	Found in wet or sometimes wet areas on the Gulf Coastal Plain.	--	T	Resident
Sheep frog	Hypopachus variolosus	1	2	2	Found predominantly in grassland and savanna in moist sites of arid areas.	--	T	Resident
Southern crawfish frog	Lithobates areolatus areolatus	1	1	1	Found in abandoned crawfish holes and small mammal burrows.	--	--	Resident
BIRDS								
Peregrine falcon	*Falco peregrinus anatum*	0	2	0	Open county; cliffs	DL	T	Nesting/ Migrant

Common Name	***Scientific Name***	***Impact Value***	***Multiplier Based on Status***	***Adjusted Impact***	***Summary of Habitat Preference***	***Federal Status***	***State Status***	***Potential Occurrence in County***
	(American)							
	Falco peregrinus tundrius (Arctic)	0	1	0	Open county; cliffs	DL	--	Nesting/ Migrant
Bald eagle	*Haliaeetus leucocephal us*	1	2	2	Large bodies of water with nearby resting sites	DL	T	Nesting/ Migrant
Brown pelican	*Pelecanus occidentalis*	0	1	0	Coastal inlands for nesting, shallow gulf and bays for foraging	DL	--	Resident
Eskimo curlew	*Numenius borealis*	0	3	0	Historic and non-breeding	LE	E	Historic Resident
Henslow's sparrow	*Ammodramu s henslowii*	0	1	0	Wintering individuals found in weedy fields or cut-over areas.	--	--	Migrant
Mountain plover	*Charadrius montanus*	0	1	0	Breeding, nesting on shortgrass prairie.	--	--	Resident
Northern Aplomado Falcon	*Falco femoralis septentrionalis*	0	3	0	Found in open country, especially savanna and open woodland.	LE	E	Resident
Piping plover	*Charadrius melodus*	1	2	2	Beaches and flats of coastal Texas	LT	T	Migrant
Red knot	*Clidris canutus rufa*	0	1	0	Migrant, nesting in the arctic and flying to South America during winter.	C	--	Migrant
Reddish egret	*Egretta rufescens*	1	2	2	Coastal inlands for nesting, coastal marshes for foraging	--	T	Resident
Snowy plover	*Charadrius alexandrinus*	1	1	1	Potential migrant, wintering along the coast	--	--	Migrant
Sooty tern	*Sterna fuscata*	1	2	2	Catches small fish as it hovers or flies over water	--	T	Resident

Common Name	***Scientific Name***	***Impact Value***	***Multiplier Based on Status***	***Adjusted Impact***	***Summary of Habitat Preference***	***Federal Status***	***State Status***	***Potential Occurrence in County***
Southeastern snowy plover	*Charadrius alexandrinus tenuirostris*	1	1	1	Wintering migrant along coast.	--	--	Migrant
Sprague's Pipit	*Anthus spragueii*	1	1	1	Migrant in winter, found in native upland prairie and coastal grasslands.	C	--	Migrant
Western burrowing owl	*Athene cunicularia hypugaea*	1	1	1	Open grasslands, especially prairie.	--	--	Resident
Western snowy plover	*Charadrius alexandrinus nivosus*	0	1	0	Uncommon breeder in Panhandle. Potential migrant.	--	--	Migrant
White-faced ibis	*Plegadis chihi*	1	2	2	Prefers freshwater marshes	--	T	Resident
White-tailed hawk	*Buteo albicaudatus*	0	2	0	Coastal prairies, savannahs and marshes in Gulf Coastal Plain	--	T	Resident
Whooping crane	*Grus Americana*	1	3	3	Winters in coastal marshes	LE	E	Migrant
Wood stork	*Mycteria Americana*	1	2	2	Forages in prairie ponds, ditches and shallow standing water; formerly nested in Texas	--	T	Migrant
FISHES								
American eel	*Anguilla rostrata*	1	1	1	Coastal waterways to Gulf.	--	--	Resident
Opossum pipefish	*Microphis brachyurus*	1	2	2	Brooding adults found in fresh or low salinity waters and young in more saline waters; Southern coastal areas	--	T	Aquatic Resident
Smalltooth sawfish	*Pristis pectinata*	1	3	3	Found in sheltered bays, on shallow banks and in estuaries or	LE	E	Aquatic Resident

Common Name	***Scientific Name***	***Impact Value***	***Multiplier Based on Status***	***Adjusted Impact***	***Summary of Habitat Preference***	***Federal Status***	***State Status***	***Potential Occurrence in County***
					river mouths.			
				MAMMALS				
Black bear	*Ursus americanus*	0	2	0	Possible as transient in bottomland hardwoods and inaccessible forested areas	T/SA; NL	T	Historic
Jaguarundi	*Herpailurus yaguarondi*	1	3	3	Thick brushlands near water.	LE	E	Resident
Louisiana black bear	*Ursus americanus luteolus*	0	2	0	Possible as transient in bottomland hardwoods and inaccessible forested areas	LT	T	Historic
Ocelot	*Leopardus pardalis*	1	3	3	Dense chaparral thickets; mesquite-thorn shrub and live oak stands.	LE	E	Resident
Plains spotted skunk	*Spilogale putorius interrupta*	1	1	1	Open fields, and prairies.	--	--	Resident
Red wolf	*Canis rufus*	0	3	0	Extirpated	LE	E	Historic
West Indian manatee	*Trichechus manatus*	0	3	0	Gulf and bay system; opportunistic, aquatic herbivore	LE	E	Aquatic Resident
				MOLLUSKS				
Creeper (squawfoot)	*Strophitus undulates*	1	1	1	Freshwater mussel in Colorado, Guadalupe, San Antonio, Neches, and Trinity River basins.	--	--	Resident
				REPTILES				
Atlantic hawksbill sea turtle	*Eretmochelys imbricate*	0	3	0	Gulf and bay systems; warm shallow waters in rocky marine environments.	LE	E	Aquatic Resident
Green sea turtle	*Chelonia mydas*	0	2	0	Gulf and bay systems; shallow water	LT	T	Aquatic Resident
Gulf saltmarsh	*Nerodia*	1	1	1	Saline flats	--	--	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Federal Status	State Status	Potential Occurrence in County
snake	*clarkii*				and river mouths			
Kemp's Ridley sea turtle	*Lepidochelys kempii*	0	3	0	Gulf and bay systems; shallow waters	LE	E	Aquatic Resident
Leatherback sea turtle	*Dermochelys coriacea*	0	3	0	Gulf and bay systems	LE	E	Aquatic Resident
Loggerhead sea turtle	*Caretta caretta*	0	2	0	Gulf and bay systems	LT	T	Aquatic Resident
Texas diamondback terrapin	*Malaclemys terrapin littoralis*	1	1	1	Coastal marshes and tidal flats.	--	--	Resident
Texas horned lizard	*Phrynosoma cornutum*	1	2	2	Varied; sparsely vegetated uplands	--	T	Resident
Texas scarlet snake	*Cemophora coccinea lineri*	0	2	0	Mixed hardwood scrub	--	T	Resident
Texas tortoise	*Gopherus berlandieri*	1	2	2	Open bush with grass understory	--	T	Resident
Timber rattlesnake	*Crotalus horridus*	1	2	2	Floodplains, riparian zones with dense ground cover	--	T	Resident
PLANTS								
Three-flower broomweed	*Thurovia triflora*	1	1	1	Endemic, remnant grasslands and tidal flats	--	--	Resident

DL = Delisted T/SA; NL= Threatened by similarity of appearance, not listed
PD = Proposed for Delisting
LE = Federally listed endangered
LT = Federally listed threatened
Blank = Not Federally or State Listed but considered a Species of Concern
E = State Endangered
T = State Threatened
TPWD, 2015. Annotated County List of Rare Species – Calhoun County, revised 12/11/2014.
USFWS, 2015. Endangered Species List for Texas. http://ecos.fws.gov/tess_public/reports/species-by-current-range-county?fips=48057 accessed online February 25, 2015.

Three bird species federally or state listed as endangered are included in the project area. These include the eskimo curlew (Numenius borealis), northern aplomado falcon (Falco femoralis septentrionalis), and whooping crane (Grus americana). The eskimo curlew is a historic resident of the area, the northern aplomado falcon is a resident species, and the whooping crane is a seasonal migrant which could pass through the project area. The main whooping crane flock nests in Canada and migrates annually to their wintering grounds in and around the Aransas National Wildlife Refuge near Rockport on the Texas coast. Whooping cranes occasionally utilize wetlands as an incidental rest stop during this migration. Habitat elements which are attractive to these bird species may be present on or adjacent to the proposed off-channel reservoir site or pipeline route.

Avian species federally or state listed as threatened include the peregrine falcon (Falco peregrinus), reddish egret (Egretta rufescens), sooty tern (Sterna fuscata), white-faced ibis (Plegadis chihi), white-tailed hawk (Buteo albicaudatus), wood stork (Mycteria Americana), piping plover (Charadrius melodus), and bald eagle (Haliaeetus leucocephalus). The peregrine falcon includes two subspecies which migrate across the state from more northern breeding areas in the U.S. and Canada to winter along the coast. The majority of nesting bald eagle pairs currently reported are found along major rivers and near reservoirs in Texas. Bald eagles are opportunistic predators, feeding primarily on fish captured in the shallow water of both reservoirs and streams or scavenged food sources. These birds may utilize tall trees near perennial water as roosting or nesting sites. Bald eagles occur as migrants within south Texas and have been documented as occurring near the project area. The remaining bird species, excluding the white-tailed hawk, are generally found within marshy or wet areas foraging for food. Development of the off-channel reservoir could provide additional habitat for those species which prefer a wet environment.

Listed terrestrial reptile species found within Calhoun County, such as the Texas tortoise, Texas scarlet snake, and the Texas horned lizard are dependent on shrubland or riparian habitats which should to be avoided wherever possible. Although suitable habitat for the state threatened Texas horned lizard may exist within the project area, no impact to this species is anticipated due to the abundance of similar habit near the project area and this species' ability to relocate to those areas if necessary. The timber rattlesnake, a state-threatened species, may be found in the riparian woody vegetation of the area. Destruction of these potential habitats can be minimized by selecting previously disturbed areas, such as croplands for project construction. Selection of a pipeline right-of-way alongside existing habitat could also be beneficial to some wildlife species by providing edge habitat; however, the majority of these areas within the project area are small and fragmented. Care should be taken to ensure minimum impacts to existing habitat areas.

In addition to the Calhoun County list of rare species, the TPWD Texas Natural Diversity Database (TXNDD) map data was reviewed for known occurrences of listed species within or near the canal, pipeline, or proposed reservoir areas. This information indicated that there were several reported sightings of the state threatened bald eagle (Haliaeetus leucoephalus), within the surrounding area. Occurrences of three species of concern, the Texas diamondback terrapin (Malaclemys terrapin littoralis), Gulf saltmarsh snake (Nerodia clarkia), and threeflower broomweed (Thurovia triflora) are documented within 10 miles of the proposed project area. No specific sightings of any endangered or threatened species were documented at the example project site shown in Figure 5.2.35-1. The presence or absence of potential habitat within an area does not confirm the presence or absence of a listed species. No species specific surveys were conducted in the project area for this report.

After a review of the habitat requirements for each listed species, it is not anticipated that this project will have any permanent adverse effect on any federally listed threatened or endangered species, its habitat, or designated habitat, nor would it adversely affect any state listed species.

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 (PI96-515), and the Archeological and Historic Preservation Act (PL93-291). Based on the review of publically available Geographic Information System (GIS) records obtained from the Texas Historical Commission, there are no State Historic Sites, National Register Properties or Districts, cemeteries or Historical Markers within 2.5 miles of the project area.

A review of archaeological resources in the proposed project area should be conducted during the project planning phase. Because the owner or controller of the project will likely be a political subdivision of the State of Texas (i.e., river authority, municipality, county, etc.), they will be required to coordinate with the Texas Historical Commission prior to project construction.

5.2.35.4 Engineering and Costing

Relying in part on an available feasibility study and integrating current TWDB guidance for regional water planning, a cost estimate summary for the GBRA Lower Basin Storage water management strategy has been prepared and is provided as Table 5.2.35-3. Included in the costs for this strategy are the embankment and appurtenant facilities for the off-channel reservoir, a 50 cfs raw water intake and pump station, a 42-inch transmission pipeline, and a 72-inch outlet pipeline. As indicated above, the sizes and capacities of some facilities may be increased to increase the firm supply, thereby resulting in increased costs. Additionally, depending upon the location(s) and type(s) of use for water supplies associated with the strategy, additional facilities and costs could include transmission and treatment facilities for service to project participants and customers.

Based on the above assumptions, the total project and annual costs are $90,543,000 and $7,261,000, respectively, including debt service and operation and maintenance for the 12,500 acft off-channel reservoir and associated facilities. For a firm yield of 51,800 acft/yr (which assumes 100% direct reuse of all treated wastewater in both the Guadalupe and San Antonio River Basins), these annual costs translate to an annual unit cost of $140/acft/yr for raw water at the GBRA Main Canal during the debt service period. For a firm yield of 61,900 acft/yr (which assumes 2011 discharges of treated wastewater), these annual costs translate to an annual unit cost of $117/acft/yr for raw water at the GBRA Main Canal during the debt service period. Some participants or customers may incur additional costs for purchase of water, transmission facilities, treatment, and/or integration.

Table 5.2.35-3 GBRA Lower Basin Storage Cost Estimate

Item	*Estimated Costs for Facilities*
Capital Costs	
Off-Channel Reservoir (12,500 acft Conservation Storage)	$38,210,000
Intake & Pump Station (34 MGD)	$7,883,000
Inlet & Outlet Pipelines (42-in & 72" dia., ~3 mi)	$13,038,000
Inlet, Outlet, & Outfall Structures w/ Flow Control Facilities	$2,516,000
Total Capital Cost	**$61,647,000**
Engineering, Legal, & Contingencies	$20,925,000
Environmental & Archaeology Studies and Mitigation	$1,502,000
Land Acquisition and Surveying (636 acres)[1]	$1,561,000
Interest During Construction (4% for 2 years w/ 1% ROI)	$4,908,000
Total Project Cost	**$90,543,000**
Annual Costs	
Debt Service (5.5 percent, 20 years)	$2,691,000
Reservoir Debt Service (5.5 percent, 40 years)	$3,638,000
Operation and Maintenance	
Intake, Pipeline, Pump Station	$343,000
Off-Channel Reservoir	$573,000
Pumping Energy Costs (181,399 kW-hr @ 0.09 $/kW-hr)	$16,000
Total Annual Cost	**$7,261,000**
Available Project Yield (acft/yr)	51,800
Annual Cost of Water ($ per acft)	$140
Annual Cost of Water ($ per 1,000 gallons)	$0.43

[1] The reservoir is expected to inundate or disturb about 625 acres, with an expected land acquisition cost of $1,503,750.

5.2.35.5 Implementation Issues

An institutional arrangement may be needed to implement this project including financing on a regional basis.

1. It may be necessary to obtain the following permits or authorizations:
   a. TCEQ interbasin transfer, depending upon location(s) of use.
   b. USACE Sections 10 and 404 dredge and fill permits for the reservoir and pipelines.
   c. GLO sand and gravel removal permits.
   d. TPWD sand, gravel, and marl permit.
2. Permitting, at a minimum, will require these studies:
   a. Habitat mitigation plan.
   b. Environmental studies.
   c. Cultural resources survey.
3. Land will need to be acquired through either negotiations or condemnation.

5.2.36 Luling ASR

5.2.36.1 Description of Water Management Strategy

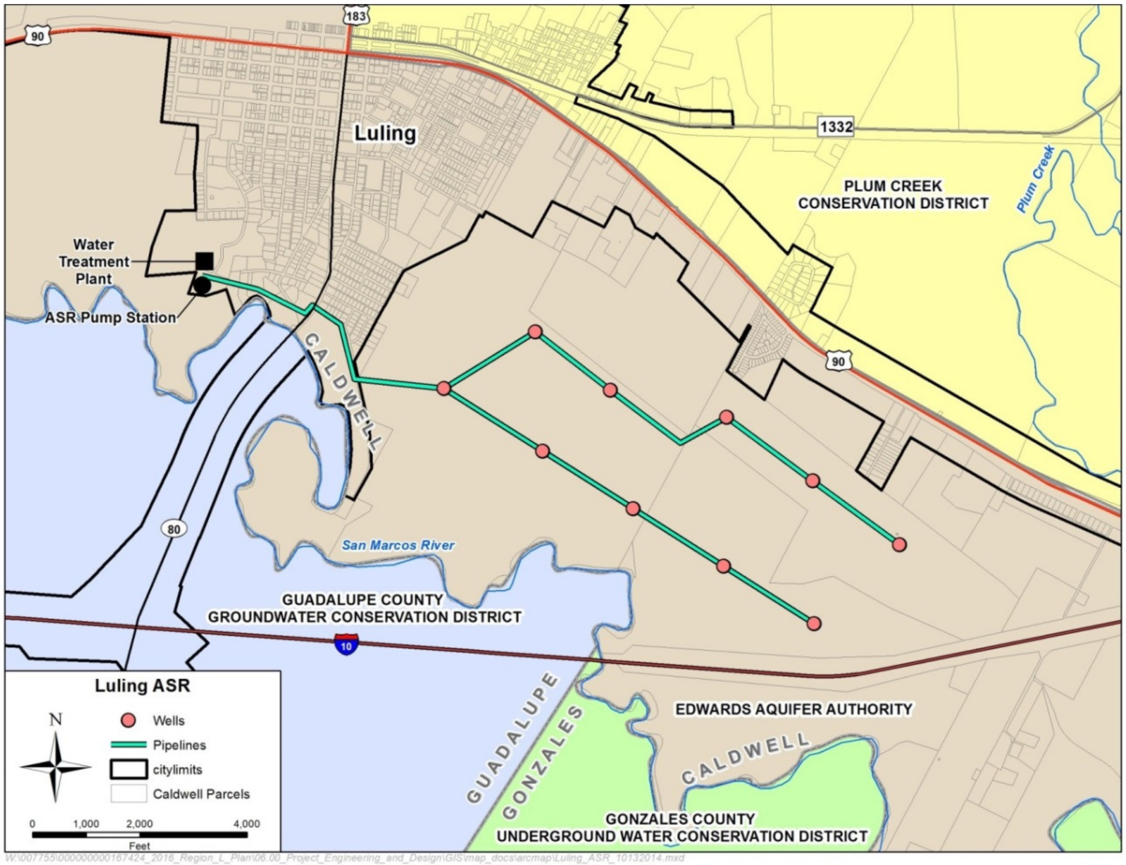
The Luling Aquifer Storage and Recovery (ASR) water management strategy concept is:

- When surface water supply from GBRA's San Marcos water rights exceeds customer demands, water would be treated at the Luling water treatment plant (WTP) and distributed directly to customers.
- When surface water supply exceeds customer demands, and there is unused WTP capacity and available storage capacity in the Wilcox ASR well field, the surplus treated surface water would be diverted to ASR wells for storage.
- When surface water supplies are less than customer demands during moderate droughts, a blend of treated surface water and recovered water from Wilcox ASR wells would be delivered to customers.
- When surface water supplies are not available during severe droughts, water supply would come from Wilcox ASR wells.

The Luling ASR water management strategy is sized to meet all base-load and peak day demands for Luling so that the existing Luling wells can be abandoned. For Lockhart, the strategy is sized for uniform delivery to meet future needs on an annual basis while peaking would be provided by their existing Carrizo wells. The preliminary Luling ASR project design is to provide a firm 4,277 acft/yr (3.82 MGD) supply.

The study area is shown in Figure 5.2.36-1 along with the location of the existing Luling WTP. The target area for the ASR well field is immediately north of the San Marcos River and southeast of the Luling WTP. The preliminary design is to utilize the current location of the Luling WTP for water treatment and distribution to Luling, the Tri-Community area, and Lockhart. Surface water from the San Marcos River would be treated at the WTP, delivered to customers and/or ASR wells, stored in the aquifer, recovered when needed, and delivered back to the WTP for final treatment and distribution.

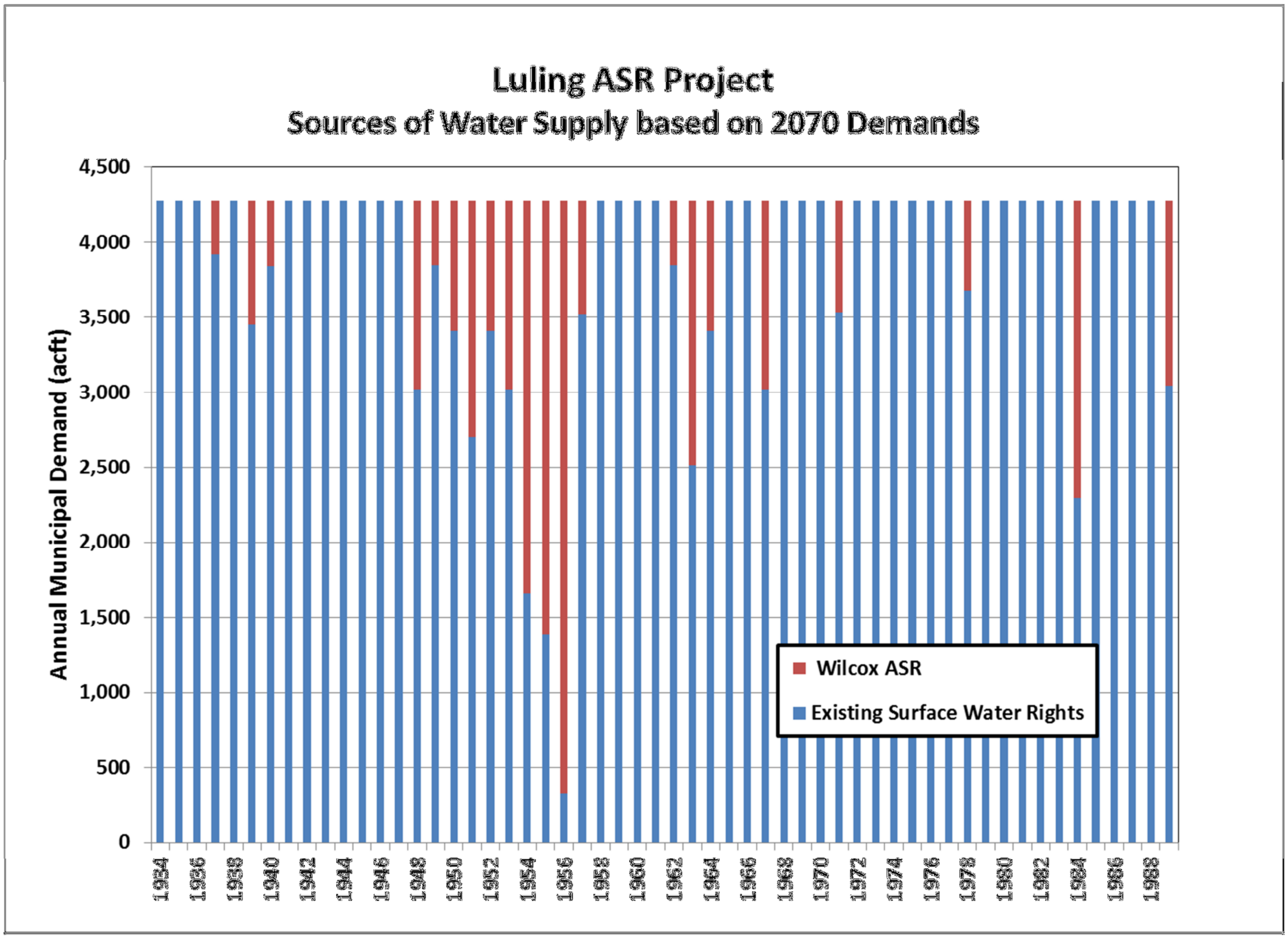
Figure 5.2.36-1 Luling ASR Project



5.2.36.2 Water Availability

GBRA owns or leases three water rights on the San Marcos River that supply water to the Luling WTP. In an attempt to increase supply and reliability beyond these three water rights, the purchase or leasing of additional water rights on the San Marcos River is under consideration by GBRA. However, only the three water rights presently used by GBRA are included as sources of supply for the Luling ASR strategy with a firm yield of 4,277 acft/yr. An analysis of the availability of water under GBRA's existing owned and leased surface water rights for the 1934 to 1989 historical period has been conducted by HDR using the Guadalupe – San Antonio River Basin Water Availability Model (GSA WAM). For purposes of this study, the period from 1934 to 1960, which includes the 1950s drought of record (DOR), was selected for analysis and comparison with monthly municipal water demands. Direct use of surface water supplies and recovery of water stored in the Luling ASR project were calculated assuming: (1) a peak day demand of 5.5 MGD, (2) annual average daily demand equals half of the peak day demand (for Luling only), and (3) a typical long-term average monthly municipal demand pattern. Source components of annual supplies are shown in Figure 5.2.36-2. The direct use of surface water supplies to meet the annual demands ranges from 8 percent in 1956 to 100 percent for about half of the years.

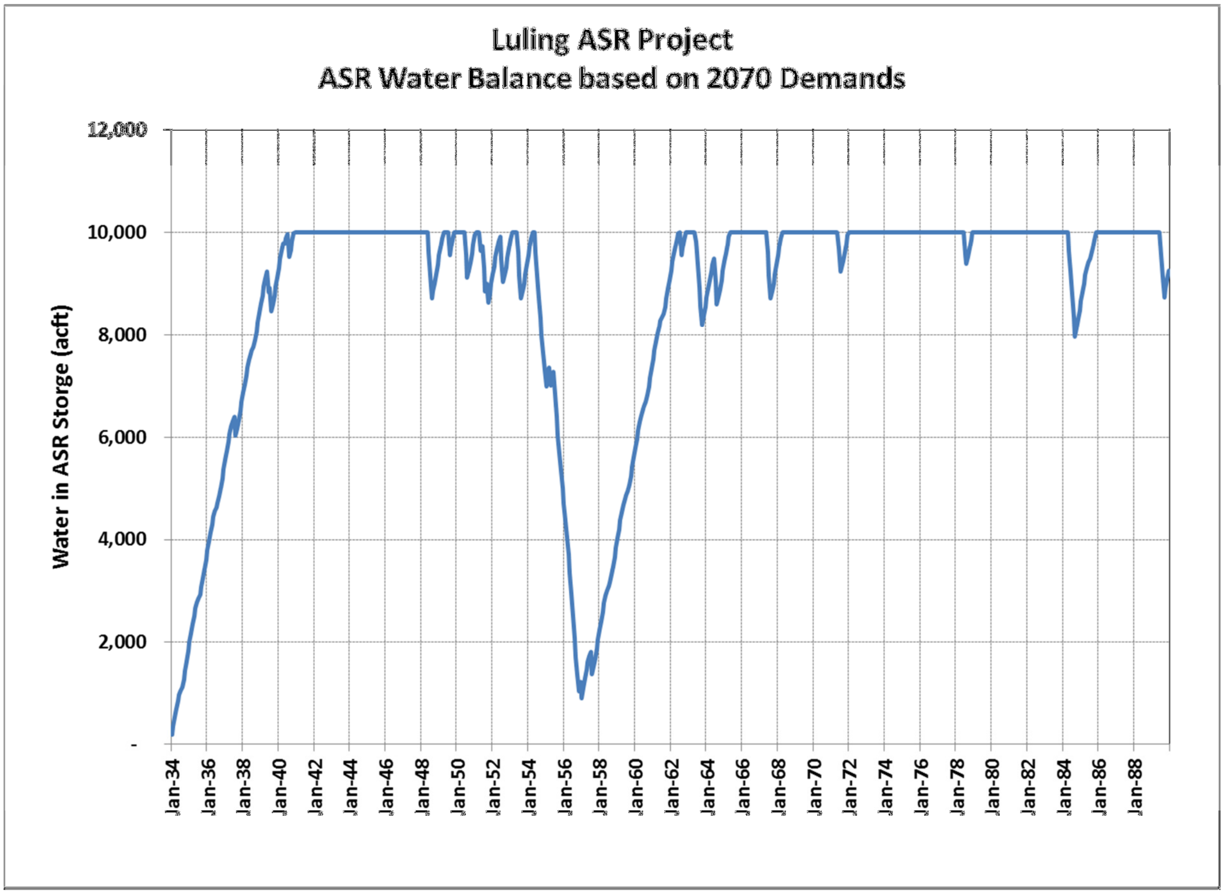
Figure 5.2.36-2 Sources of Water Supplies based on 2070 Demands



Capacity considerations of the Luling ASR project include injection, recovery, and storage limitations. Injection capacity (duration and rates) are largely based on the supply of surplus treated water, its duration, and how quickly the ASR needs to be filled to reach full standby mode. Recovery capacity needs to be sufficient to be able to meet full demands for water during the most intense part of the drought. In the Wilcox Aquifer setting, storage capacity is largely limited by the goal of keeping groundwater levels below ground level, which is strongly influenced by injection rates and durations.

A preliminary analysis of the Luling ASR capacity in the Wilcox Aquifer was conducted by developing and applying an Analytical Well Field Model. This model has a single layer with uniform hydraulic properties (transmissivity and storage coefficient). It allows any number of production and monitoring wells. Aquifer properties were obtained from TWDB Report 12 which includes several aquifer tests using City of Luling water supply wells. An injection capacity of 4.0 MGD was assumed with a monthly loss of 0.1%. Based on these assumptions the water balance in the Wilcox ASR shows that the maximum treated water needed in storage is 10,000 acft and the minimum storage balance at the end of the DOR is about 900 acft, as shown in Figure 5.2.36-3.

Figure 5.2.36-3 ASR Water Balance based on 2070 Demands



5.2.36.3 Environmental Issues

Environmental issues associated with the Luling ASR water management strategy include the construction of a water intake expansion on the San Marcos River, ten ASR wells, pump station(s), WTP expansion, and additional transmission and delivery pipelines.

The project area occurs within the Post Oak Savannah vegetational area which contains gently rolling to hilly topography, and elevations which range from 300 to 800 feet.[1] Overstory species found within this area primarily include post oak (*Quercus stellata*), blackjack oak (*Q. marilandica*), and species of hickory (*Carya* ssp.). Climax grasses include yellow indian grass (*Sorghastrum nutans*), switchgrass (*Panicum virgatum*), purpletop tridens (*Tridens flavus*), longspike silver bluestem (*Bothriochloa saccharoides* var. *longipaniculata*), slender woodoats (*Chasmanthium laxum*), and little bluestem (*Schizachyrium scoparium*).

The project area is included within the Post Oak Woods, Forest and Grassland Mosaic vegetational type as described by the Texas Parks and Wildlife Department (TPWD). [2] However current aerial photography reveals that the majority of the project area is

[1] Gould, F.W., "The Grasses of Texas," Texas A&M University Press, College Station, Texas, 1975.
[2] McMahan, Craig A., Roy G. Frye and Kirby L. Brown. 1984. The Vegetation Types of Texas. Wildlife Division, Texas Parks and Wildlife Department, Austin, Texas.

currently disturbed and used as grassland/pasture. The westernmost portion of the project occurs within an established urban area near the existing WTP and a small amount of wooded area occurs at the eastern end of the proposed wellfield.

Plant and animal species listed by USFWS and TPWD that may occur within the county of this water management strategy are listed in Table 5.2.36-1. The Texas Natural Diversity Database (TXNDD), maintained by TPWD, includes documented occurrences of two federal candidate and state threatened mussels in the San Marcos River adjacent to the project area. These include the Golden orb (*Quadrula aurea*) and the Texas Pimpleback (*Quadrula petrina*). A state threatened species, the Cagle's map turtle (*Graptemys caglei*) and a state species of concern, the Guadalupe bass (*Micropterus teculii*), are also documented in the San Marcos River near the project area. The San Marcos River downstream of the project area is designated by TPWD as an ecologically significant stream segment (TCEQ stream segment 1808) based on the occurrence of threatened or endangered species/unique communities, and is the location of one of only four known populations of the golden orb freshwater mussel.

The disturbed nature of the majority of the project well, pump station, and pipeline areas will minimize potential impacts from the project to area terrestrial species. Reasonable and prudent measures should be taken to avoid and minimize the potential effects of proposed project activities on threatened and endangered species. Species locations, activities, and habitat requirements should be considered based on USFWS and TPWD recommendations.

Within the project area, reptile species listed as threatened by the state may possibly be affected by the construction and maintenance of project components. These include the Texas horned lizard (*Phrynosoma cornutum*), and timber rattlesnake (*Crotalus horridus*). No significant impacts to these species are anticipated due to the abundance of similar habit near the project area and this species' ability to relocate to those areas if necessary.

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 (Pl96-515), and the Archeological and Historic Preservation Act (PL93-291). Based on the review of publically available Geographic Information System (GIS) records obtained from the Texas Historical Commission, there are no State Historic Sites, National Register Properties, National Register Districts, Historical Markers, or cemeteries within the project area. Because the owner or controller of the project will likely be a political subdivision of the State of Texas (i.e., river authority, municipality, county, etc.), they will be required to coordinate with the Texas Historical Commission prior to project construction.

Field surveys conducted at the appropriate phase of development should be employed to minimize the impacts of construction and operations on sensitive resources. Specific project features, such as well fields, and pipelines generally have sufficient design flexibility to avoid most impacts or significantly mitigate potential impacts to geographically limited environmental and cultural resource sites.

Table 5.2.36-1 Endangered, Threatened, and Species of Concern in Caldwell County

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County
						USFWS[1]	TPWD[1]	
BIRDS								
American Peregrine Falcon	*Falco peregrinus anatum*	0	2	0	Open country; cliffs	DL	T	Nesting/ Migrant
Arctic Peregrine Falcon	*Falco peregrinus tundrius*	0	1	0	Open country; cliffs	DL	---	Nesting/Migrant
Bald Eagle	*Haliaeetus leucocephalus*	0	2	0	Large Bodies of water with nearby resting sites	DL	T	Nesting/Migrant
Henslow's Sparrow	*Ammodramus henslowii*	1	1	1	Weedy fields, cut over areas; bare ground for running and walking	---	---	Nesting/Migrant
Mountain Plover	*Charadrius montanus*	1	1	1	Non-breeding-shortgrass plains and fields, plowed fields and sandy deserts	---	---	Nesting/Migrant
Sprague's Pipit	*Anthus spragueii*	0	1	0	Texas migrant mid Sept. to early April. Strongly tied to native upland prairie.	C	---	Migrant
Western Burrowing Owl	*Athene cunicularia hypugaea*	1	1	1	Open grasslands, especially prairie, plains and savanna	---	---	Resident
Whooping Crane	*Grus americana*	0	3	0	Potential migrant	LE	E	Migrant
Wood Stork	*Mycteria americana*	0	2	0	Forages in prairie ponds, ditches, and shallow standing water formerly nested in TX	---	T	Migrant
FISHES								
Blue sucker	*Cycleptus elongates*	1	2	2	Found in larger portions of major rivers.	---	T	Resident
Guadalupe bass	*Micropterus teculii*	1	1	1	Endemic to perennial streams of the Edward's Plateau region. Introduced in Nueces River system.	---	---	Resident
Guadalupe darter	*Percina sciera apristis*	1	1	1	Guadalupe River basin large streams and rivers.	---	---	Resident
MAMMALS								
Cave myotis bat	*Myotis velifer*	0	1	0	Colonial and cave-dwelling bat.	---	---	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County
						USFWS[1]	TPWD[1]	
Plains Spotted Skunk	*Spilogale putorius interrupta*	1	1	1	Prefers wooded, brushy areas and tall grass prairie, fields, prairies, croplands, fence rows, forest edges	---	---	Resident
Red Wolf	*Canis rufus*	0	3	0	Extirpated.	LE	E	Historic Resident
MOLLUSKS								
Creeper (squawfoot)	*Stophitus undulates*	1	1	1	Found in small to large streams. Prefers gravel or gravel and mud in flowing water. Colorado, Guadalupe, San Antonio, Neches (historic), and Trinity (historic) River basins.	---	---	Resident
False spike mussel	*Quincuncina mitchelli*	1	2	2	Substrates of cobble and mud with water lilies present. Rio Grande, Brazos, Colorado and Guadalupe river basins.	---	T	Resident
Golden orb	*Quadrula aurea*	1	2	2	Sand and gravel, Guadalupe, San Antonio, and Nueces River basins	C	T	Resident
Texas fatmucket	*Lampsilis bracteata*	1	2	2	Found in streams and rivers, intolerant of impoundment in Colorado and Guadalupe River basins.	C	T	Resident
Texas pimpleback	*Quadrula petrina*	1	2	2	Mud, gravel and sand substrates, Colorado and Guadalupe river basins	C	T	Resident
REPTILES								
Cagle's map turtle	*Graptemys caglei*	1	1	1	Endemic species found in Guadalupe River System. Generally found near the water's edge.	---	T	Resident
Spot-Tailed Earless Lizard	*Holbrookia lacerata*	0	1	0	Central & southern Texas; oak-juniper woodlands and mesquite-prickly pear	---	---	Resident
Texas garter snake	*Thamnophis sirtalis annectens*	1	1	1	Found in wet or moist microhabitats.	---	---	Resident
Texas Horned Lizard	*Phrynosoma cornutum*	1	2	2	Varied, sparsely vegetated uplands, grass, cactus, brush	---	T	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County
						USFWS[1]	TPWD[1]	
Timber Rattlesnake	*Crotalus horridus*	1	2	2	Floodplains, upland pine, deciduous woodlands, riparian zones, abandoned farms, dense ground cover	---	T	Resident
PLANTS								
Green beebalm	*Monarda viridissima*	1	1	1	Endemic perennial herb of the Carrizo sands found in openings of post oak woodlands.	---	---	Resident
Sandhill woolywhite	*Hymenopappus carrizoanus*	1	1	1	Texas endemic found in disturbed or open areas in grasslands and Post oak woodlands.	---	---	Resident
Shinner's sunflower	*Helianthus occidentalis* ssp. *Plantagineus*	0	1	0	Found on prairies on the Coastal Plain	---	---	Resident

[1] Source: TPWD, Annotated County List of Rare Species, Caldwell County revised 4/28/2014 and USFWS online at http://ecos.fws.gov/tess_public/reports/species-by-current-range-county?fips=48055, accessed January 13, 2015.

LE/LT=Federally Listed Endangered/Threatened

E/SA, T/SA=Federally Listed Endangered/Threatened by Similarity of Appearance

C=Federal Candidate for Listing

DL, PDL=Federally Delisted/Proposed for Delisting

E, T=State Listed Endangered/Threatened

Blank = Rare, but no regulatory listing status

5.2.36.4 Engineering and Costing

An ASR well field capable of recovery at a rate of 5.5 MGD from the Wilcox Aquifer would require nine 500 gpm wells and one contingency well, all with an estimated depth of 500 ft. The well field piping would include diameters ranging between 8 to 16 inches with a total length of 3.8 miles. The delivery pipeline between the well field and the water treatment plant is estimated at 1 mile in length with 20-inch diameter. Well pumps will be sized to deliver the water from the well field to the treatment plant.

The Luling ASR project would require a 4 MGD expansion of the existing WTP to treat raw surface water from the San Marcos River and to disinfect recovered water from the ASR wells, an expanded river intake and pump station, a 348 HP pump station to deliver water from the WTP to the ASR well field, and expansion of the pump station to deliver additional water to Lockhart. After recovery from storage, the water would require additional disinfection treatment prior to distribution. Surface water diversion and treatment for ASR injection would be operated 15 percent of the time on a long-term average; however recovery from ASR storage is estimated at 11 percent of the total demand. Total project costs, including capital costs, are estimated to be $33,308,000. The annual costs, including debt service, operation and maintenance, power, and groundwater fees to property owners are estimated to be $4,646,000. The Luling ASR project produces water at estimated costs of $3.33 per thousand gallons ($1,086 per acft/yr). A summary of the costs is included in Table 5.2.36-2.

Table 5.2.36-2 Cost Estimate Summary

Item	*Estimated Costs for Facilities*
CAPITAL COST	
Intake Pump Stations (3.4 MGD)	$4,398,000
Transmission Pipeline (20 in dia)	$479,000
Well Fields (Wells, Pumps, and Piping)	$6,101,000
Two Water Treatment Plants (5.5 MGD and 5.5 MGD)	$11,951,000
Integration, Relocations, & Other	$250,000
TOTAL COST OF FACILITIES	**$23,179,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$8,088,000
Environmental & Archaeology Studies and Mitigation	$689,000
Interest During Construction (4% for 1 years with a 1% ROI)	$1,127,000
TOTAL COST OF PROJECT	**$33,308,000**
ANNUAL COST	
Debt Service (5.5 percent, 20 years)	$2,787,000
Operation and Maintenance	
Intake, Pipeline, Pump Station (1% of Cost of Facilities)	$176,000
Water Treatment Plant (2.5% of Cost of Facilities)	$1,323,000
Pumping Energy Costs (1,617,759 kW-hr @ 0.09 $/kW-hr)	$146,000
TOTAL ANNUAL COST	**$4,646,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 1.4	4,277
Annual Cost of Water ($ per acft)	$1,086
Annual Cost of Water ($ per 1,000 gallons)	$3.33

5.2.36.5 Implementation Issues

TCEQ:

- Underground Injection Control (UIC), Class V Injection Well Permit
- Public water system reviews and approvals

Groundwater Districts:

- None (Outside of current District boundaries)

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5.2.37 Victoria County Steam Electric

5.2.37.1 Description of Water Management Strategy

To meet Industrial demands for Victoria Steam-Electric (Victoria SE), a reliable supply of raw water is needed in the county. A canal diversion from the GBRA Calhoun Canal system could supply up to 75,000 acft/yr from existing GBRA/Dow Lower Basin Water Rights to Victoria SE. Facilities that would be constructed for the canal diversion include conveyance improvements to existing canals, an expansion of the Main Pump Station, a new pump station on the Main Canal located adjacent to the existing Relift #1 Pump Station, and 18 miles of 90-inch transmission pipeline. Before industrial use, a 101,300 acft cooling reservoir at the site would be needed. A map showing the locations of key components is presented in Figure 5.2.37-1.

GBRA Calhoun Canal System currently supplies water from the Guadalupe River to a Dow Chemical Company (Dow) facility (formerly owned by Union Carbide Corporation), the GBRA Port Lavaca Water Treatment Plant, and various municipal, industrial, and irrigation customers of the GBRA. For this project the existing GBRA Calhoun Canal System will be improved and used to convey raw water from the Guadalupe River at the GBRA Saltwater Barrier to a proposed 121 Pump Station located on the Main Canal adjacent to the existing GBRA Relift#1 Pump Station (Figure 5.2.37-1). Subsequent to diversion from the Main Canal at the proposed pump station, raw water will be delivered to the proposed reservoir via a 90-inch, 18 mile transmission pipeline. Conventional direct-bury/lay construction techniques are suitable for the installation of most of the pipeline along the route; however, horizontal directional drilling (HDD) is recommended (and likely required) at the Victoria Barge Canal and the Guadalupe River. The pipeline terminus is located near the easternmost portion of the proposed cooling reservoir embankment on the Exelon site.

The Gravity Conveyance System (GCS) refers to the gravity flow components of the GBRA Calhoun Canal System. More specifically, the GCS is comprised of two gravity sub-systems, one for conveyance of water diverted from the Guadalupe River to the Goff Bayou Siphon intake adjacent to the Victoria Barge Canal, and the other for conveyance of water from the Main Pump Station discharge structure to the Relift#1 Pump Station site via a canal and conduits on Dow property and the Main Canal. The GCS will be improved to provide the increased capacity necessary to supply water to steam electric facilities in addition to existing customers. The associated work will include the following:

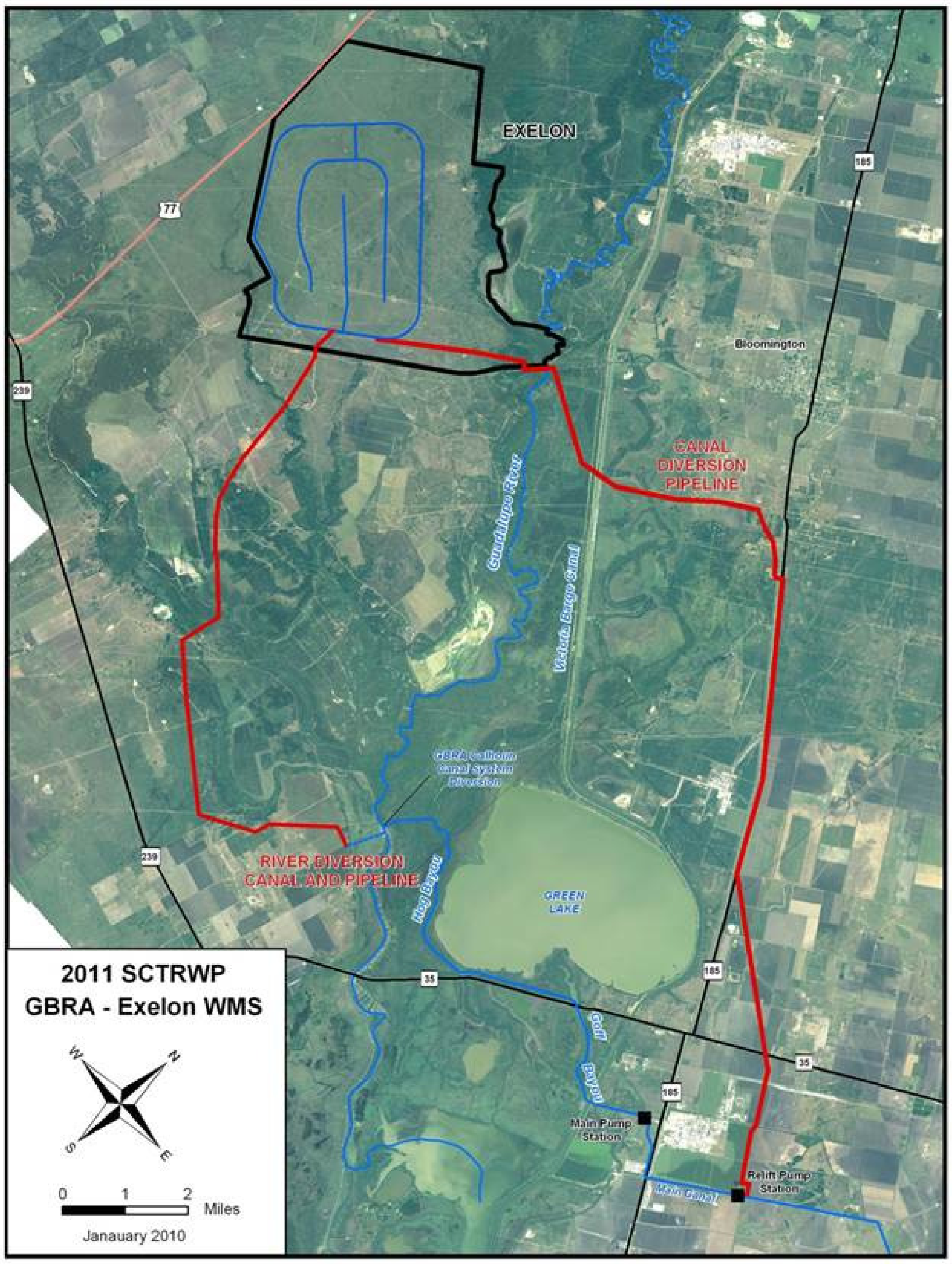
Modification of the existing diversion structure at the Guadalupe River to increase its capacity;

- Construction of two bridges providing access to the north side of the existing diversion canal running between the Guadalupe River and Hog Bayou to allow access for enhanced maintenance (clearing) of the north canal bank;
- Modification to the Green Lake spillway;
- Increasing the height of the levees on the Dow Canal, which is located between the Main Pump Station and the Main Canal;

- Adding capacity to the Main Canal, including excavating a new channel parallel to the existing canal, associated land acquisition, levee construction, and construction of a maintenance access bridge; and
- Upgrading the existing dirt access road to the Relift #1 Pump Station.

In addition to the new pump station, new pipeline, and GCS improvements, the canal diversion option will also require modifications to the existing Main Pump Station to increase its capacity.

Figure 5.2.37-1. Location of Victoria County Steam Electric Project



5.2.37.2 Available Yield

The Guadalupe River Saltwater Barrier was constructed in the early 1960s at a location immediately downstream of the confluence of the Guadalupe and San Antonio Rivers and creates a reservoir pool extending some distance up both rivers. Diversions from this reservoir pool, under existing rights, flow into GBRA's Calhoun Canal System and are dependent upon waters originating in both the Guadalupe and San Antonio Rivers and their respective tributaries.

Maximum reported water use under the GBRA lower basin water rights totaling 175,501 acft/yr at the Guadalupe River Saltwater Barrier did not exceed 63,000 acft/yr during the 1991 through 2006 historical period[1]. It is estimated by GBRA that up to 75,000 acft/yr under one or more of these rights is available for periods of time into the future leaving 100,000 acft/yr available for lower basin uses. Certificate of Adjudication (CA) #18-5178 is the least senior of GBRA's lower basin water rights and it has a priority date of January 7, 1952. Authorized annual diversions under CA# 18-5178 total 106,000 acft for municipal, industrial, and irrigation uses.

The Guadalupe-San Antonio River Basin Water Availability Model (GSAWAM, as modified for regional water planning purposes) was used to quantify water available for diversion under CA# 18-5178. Hydrologic simulations and calculations were performed subject to the General Assumptions for Applications of Hydrologic Models, as adopted by the SCTRWPG for the 2011 Regional Water Plan. Additional assumptions used in the GSA-WAM to quantify water available to Exelon include:

- Supplies are from the most junior portion of CA# 18-5178 and are subordinated to Canyon Reservoir and run-of-river diversions to Coleto Creek Reservoir.
- Water available is not constrained by annual or instantaneous maximum diversion rates in the GSA-WAM. Maximum diversion rate constraints are applied as described below.

Using the total monthly regulated streamflow and historical daily streamflow patterns, the monthly streamflow values from the GSA-WAM were disaggregated to daily values in a specially-designed Microsoft Excel workbook. The historical daily streamflow patterns representative of the Guadalupe River near Tivoli were obtained from project files for a 1998 study[2] for the 1934 through 1989 period. These daily streamflow values were then used, along with the monthly amount of water designated for senior water rights, to determine the daily amount that must be reserved for the senior water rights. This daily senior water right reservation was then subtracted from the daily streamflow to establish maximum daily availability to Exelon under CA# 18-5178. Actual quantities of water available for the project under CA# 18-5178 are limited by an instantaneous maximum diversion rate of 187 cfs.

Available water was computed as described above and limited by the maximum diversion rate of 187 cfs .The firm yield was calculated with and without 2011 effluent

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[1] GBRA, Personal Communication, 2007.

[2] HDR Engineering, Inc., "Guadalupe - San Antonio River Basin Model Modifications & Enhancements," Trans-Texas Water Program, West Central Study Area, Texas Water Development Board, San Antonio River Authority, et.al., March 1998.

and the results of both analysis are shown in Table 5.2.37-1. Water availability is sufficient to support a firm yield of 20,148 acft/yr with 2011 effluent and 29,100 without effluent.

Table 5.2.37-1. Yield Results With and Without 2011 Effluent

	With 2011 Effluent		No Effluent	
	Firm Yield	Water Rights Diversions	Firm Yield	Water Rights Diversions
GBRA Lower Basin Water	---	175,501	---	175,501
Daily Firm Yield	42,544	42,544	15,044	15,044
GBRA Lower Basin Storage	75,457	82,624	51,762	59,093
Total After GBRA Lower Basin Storage	118,001	125,168	66,806	74,137
Water Rights Remaining for Victoria County S-E	---	50,333	---	101,364
Victoria County S-E Daily Firm Yield	20,148*	50,333	29,100**	62,895
GBRA Lower Basin Water Rights Totals	138,149	175,501	98,906	137,032
* Limited by Existing Water Rights ** Limited by Cooling Reservoir Drawdown				

5.2.37.3 Environmental Issues

Construction of the canal diversion pipeline, improvements to the existing GBRA Calhoun Canal System, expansion of the main pump station, installation of a new pump station on the Main Canal adjacent to the existing GBRA Relift#1 Pump Station, and construction of the cooling reservoir are the primary environmental issues related to this option. The approximately 18-mile canal diversion option pipeline for water delivery from the GBRA Calhoun Canal System to the proposed cooling reservoir site is located southwest of the city of Bloomington in southern coastal Texas, within Calhoun, and Victoria Counties. This 90-inch diameter pipeline originates approximately 13-miles southeast of Bloomington and runs in a northwesterly direction, primarily through agricultural areas, with a portion of the route paralleling State Highway 185. Water crossings within this section of the route include Black Bayou and a tributary of Black Bayou. The pipeline then turns to the northwest about two miles northeast of Bloomington and follows the Victoria-Calhoun County line, crossing the Victoria Barge

Canal and the Guadalupe River, and terminating at the proposed cooling reservoir site. Land types within the lower portions of the route include marshy and more heavily vegetated floodplain areas near the canal and river.

The project area is located in the Gulf Coastal Plains of Texas Physiographic Province, specifically in the subprovince of the Coastal Prairies.[3] This area is locally characterized as a nearly flat prairie which terminates at the Gulf of Mexico, and includes topography changes of less than 1 foot per mile. Elevation levels in the project area range from 0 to 100 feet above mean sea level.

The project is located within the Gulf Prairies and Marshes Vegetational Area.[4] Gulf Prairies have slow surface drainage and elevations that range from sea level to 250 feet. These areas include nearly level and virtually undissected plains. Originally, the Gulf Prairies were composed of tallgrass prairie and post oak savannah. However, tree species such as honey mesquite, and acacia, along with other trees and shrubs, have increased in this area forming dense thickets in many places. Typical oak species found in this area include live oak (*Quercus virginiana*) and post oak (*Q. stellata*), in addition to huisache (*Acacia smallii*), black-brush (*A. rigidula*), and a dwarf shrub, bushy sea-ox-eye (*Borrichia frutescens*). Principal climax grasses of the Gulf Prairies include gulf cordgrass (*Spartina spartinae*), indiangrass (*Sorghastrum nutans*), and big bluestem (*Andropogon gerardii* var. *gerardii*). Prickleypear (*Opunita* spp.) are common within this area along with forbs including asters (*Aster* spp.), poppy mallows (*Callirhoe* sp.), bluebonnets (*Lupinus* spp.), and evening primroses (*Oenothera* sp.). Gulf Marshes range from sea level to a few feet in elevation, and include low, wet marshy coast areas commonly covered with saline water. These salty areas support numerous species of sedges (*Carex* and *Cyperus* sp.), bulrushes (*Scirpus* sp.), rushes (*Juncus* sp.), and grasses. Aquatic forbs found in these areas generally include pepperweeds (*Lepidium* sp.), smartweeds (*Polygonum* sp.), cattails (*Typha domingensis*) and spiderworts (*Tradescantia* sp.) among others. Upland game and waterfowl find these low marshy areas to be excellent natural wildlife habitat.

The federal Endangered Species Act (ESA) of 1973, as amended, prohibits the “take” of any threatened or endangered species. The term “take” under the ESA means “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct.” The term “harm” was further defined to include “significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering.” Designation of critical habitat areas has been established for the public knowledge where the publishing of such information would not cause harm to the species. Additional federal protection is extended to migratory birds, and bald and golden eagles under the Migratory Bird Treaty Act (MBTA) as amended, and the Bald and Golden Eagle Protection Act. Protection is also afforded to Texas state-listed species. The TPWD enforces state regulations concerning this act.

The MBTA protects most bird species, including, but not limited to, cranes, ducks, geese, shorebirds, hawks, and songbirds. Migratory bird pathways, stopover habitats, wintering areas, and breeding areas may occur within and adjacent to the pipeline area, and may

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[3] Bureau of Economic Geology. 1996. Physiographic map of Texas., The University of Texas at Austin, Austin, Texas.

[4] Gould, F. W., 1975. “The Grasses of Texas,” Texas A&M University Press, College Station, Texas.

be associated with wetlands, ponds, shorelines, riparian corridors, fallow fields and grasslands, and woodland and forested areas. Pipeline construction activities could disturb migratory bird habitats and/or species' activities.

Reasonable and prudent measures should be taken to avoid and minimize the potential effects of proposed project activities on threatened and endangered species as well as bald eagles. Species' locations, activities, and habitat requirements should be considered based on USFWS and TPWD recommendations.

In Calhoun and Victoria Counties, 37 state-listed endangered or threatened species and 18 federally-listed endangered or threatened wildlife species may occur, according to the county lists of rare species published by TPWD. Two of the species listed as endangered are considered extinct in Texas, the Eskimo curlew (*Numenius borealis*), and red wolf (*Canis rufus*). A list of species, their preferred habitat, and potential occurrence in the two county areas is provided in Table 4C.10-2.

Inclusion in Table 4C.10-2 does not imply that a species will occur within the project area, but only acknowledges the potential for occurrence in the project area counties. A more intensive field reconnaissance is necessary to confirm and identify specific suitable habitat that may be present in the project area. In addition to county lists, the Texas Natural Diversity Database (TXNDD) map data has been reviewed for known occurrences of listed species within or near the proposed pipeline route. This information indicates that there are reported sightings of the bald eagle (*Haliaeetus leucoephalus*) along the pipeline route and in the surrounding area. No other specific sightings of any endangered or threatened species were documented along the pipeline route or within the cooling reservoir area. A plant species of concern, the three-flower broomweed (*Thurovia triflora*) has been recorded north of the proposed pipeline. In addition, the pipeline as planned crosses two documented rookeries. One with a nesting colony of olivaceous cormorants and cattle egrets occurs in a cypress swamp south of the Guadalupe River crossing, the other includes a nesting colony of cattle egrets, great blue heron, great egret, roseate spoonbill, olivaceous cormorant and anhinga located east of Levee Road.

Five bird species federally or state listed as endangered are included in the project area. The Eskimo curlew (*Numenius borealis*) is extinct, but was once a historic resident of this area. The four active endangered bird species include the Attwater's greater prairie chicken (*Tympanuchus cupido attwateri*), northern aplomado falcon (*Falco femoralis septentrionalis*), interior least tern (*Sterna antillarum athalassos*), and whooping crane (*Grus americana*). While the Attwater's greater prairie chicken is a historic resident of the area, the northern aplomado falcon is a current resident. The whooping crane and interior least tern are seasonal migrants which could pass through the project area. The main whooping crane flock nests in Canada and migrates annually to their wintering grounds in and around the Aransas National Wildlife Refuge near Rockport on the Texas coast. Whooping cranes occasionally utilize wetlands as an incidental rest stop during this migration. Habitat elements which are attractive to several of these bird species may be present on or adjacent to the proposed pipeline route or cooling reservoir.

Table 4C.10-2. Endangered, Threatened, and Species of Concern in Calhoun, and Victoria Counties

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County
						USFWS[1]	TPWD[1]	
AMPHIBIANS								
Black-Spotted Newt	*Notophthalmus meridionalis*	2	2	4	Ponds and resacas in south Texas	---	T	Resident
Sheep Frog	*Hypopachus variolosus*	1	2	2	Deep sandy soils of Southeast Texas	---	T	Resident
Southern Crawfish Frog	*Lithobates areolatus areolatus*	1	1	1	Normally found in abandoned crawfish holes and small mammal burrows.	---	---	Resident
BIRDS								
American Peregrine Falcon	*Falco peregrinus anatum*	0	2	0	Open country; cliffs	DL	T	Nesting/ Migrant
Arctic Peregrine Falcon	*Falco peregrinus tundrius*	0	1	0	Open country; cliffs	DL	---	Nesting/Migrant
Attwater's Greater Prairie-Chicken	*Tympanuchus cupido attwateri*	0	3	0	Coastal Prairies of Gulf Coastal Plain	LE	E	Historic Resident
Bald Eagle	*Haliaeetus leucocephalus*	1	2	1	Large Bodies of water with nearby resting sites	DL	T	Nesting/Migrant
Brown Pelican	*Pelecanus occidentalis*	1	1	1	Coastal inlands for nesting, shallow gulf and bays for foraging	DL	---	Nesting/Migrant
Eskimo Curlew	*Numenius borealis*	0	3	0	Grasslands, pastures. Thought to be extinct.	LE	E	Historic Migrant
Henslow's Sparrow	*Ammodramus henslowii*	1	1	1	Weedy fields, cut over areas; bare ground for running and walking	---	---	Nesting/Migrant
Interior Least Tern	*Sterna antillarum athalassos*	1	3	3	Inland river sandbars for nesting and shallow water for foraging	LE	E	Nesting/Migrant
Mountain Plover	*Charadrius montanus*	1	1	1	Non-breeding-shortgrass plains and fields, plowed fields and sandy deserts	---	---	Nesting/Migrant
Northern Aplomado Falcon	*Falco femoralis septentrionalis*	1	3	3	Found in open country, especially savanna and open woodland.	LE	E	Resident
Piping Plover	*Charadrius melodus*	1	2	2	Beaches and flats of Coastal Texas	LT	T	Migrant
Reddish Egret	*Egretta rufescens*	1	2	2	Coastal inlands for nesting, coastal marshes for foraging	---	T	Migrant
Snowy Plover	*Charadrius alexandrinus*	1	1	1	Wintering Migrant on mud flats.	---	---	Migrant

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County
						USFWS[1]	TPWD[1]	
BIRDS								
Sooty Tern	*Sterna fuscata*	1	2	2	Catches small fish.	---	T	Migrant
Southeastern Snowy Plover	*Charadrius alexandrines tenuirostris*	1	1	1	Wintering migrant along the Texas Gulf Coast.	---	---	Migrant
Sprague's Pipit	*Anthus spragueii*	0	1	0	Texas migrant mid Sept. to early April. Strongly tied to native upland prairie.	C	---	Migrant
Western Burrowing Owl	*Athene cunicularia hypugaea*	1	1	1	Open grasslands, especially prairie, plains and savanna	---	---	Resident
Western Snowy Plover	*Charadrius alexandrines nivosus*	0	1	0	Uncommon breeder in the Panhandle, potential migrant that winters along the coast.	---	---	Resident
White-faced Ibis	*Plegadis chihi*	1	2	2	Prefers freshwater marshes.	---	T	Resident
White-tailed Hawk	*Buteo albicaudatus*	1	2	2	Coastal prairies, savannahs and marshes in Gulf coastal plain	---	T	Nesting/Migrant
Whooping Crane	*Grus americana*	1	3	3	Potential migrant	LE	E	Migrant
Wood Stork	*Mycteria americana*	1	2	2	Forages in prairie ponds, ditches, and shallow standing water formerly nested in TX	---	T	Migrant
FISHES								
American Eel	*Anguilla rostrata*	1	1	1	Moist aquatic habitats.	---	---	Resident
Opossum Pipefish	*Microphis brachyurus*	1	2	2	Brooding adults found in fresh or low salinity waters.	---	T	Resident
Smalltooth sawfish	*Pristis pectinata*	1	3	3	Found in bays, estuaries or river mouths.	LE	E	Resident
INSECTS								
A mayfly	*Tortopus circumfluus*	0	1	0	Aquatic larval stage, adult stage generally found in shoreline vegetation.			Resident
Texas Asaphomyian Tabanid Fly	*Asaphomyia texanus*	1	1	1	Found near slow-moving water, eggs laid on objects near water; larvae are aquatic, adults prefer shady areas; feed on nectar and pollen	---	---	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County
						USFWS[1]	TPWD[1]	
MAMMALS								
Black Bear	*Usus americanus*	0	2	0	Mountains, broken country, woods, brushlands, forests	T/SA; NL	T	Resident
Jaguarundi	*Herpailurus yagouaroundi*	1	3	3	South Texas thick brushlands, favors areas near water	LE	E	Resident
Louisiana Black Bear	*Ursus americanus luteolus*	0	2	0	Within historical range.	LT	T	Historic Resident
Ocelot	*Felis pardalis*	1	3	3	Dense chaparral thickets; mesquite-thorn scrub and live oak mottes	LE	E	Resident
Plains Spotted Skunk	*Spilogale putorius interrupta*	2	1	2	Prefers wooded, brushy areas and tall grass prairie, fields, prairies, croplands, fence rows, forest edges	---	---	Resident
Red Wolf	*Canis rufus*	0	3	0	Extirpated.	LE	E	Historic Resident
West Indian manatee	*Trichechus manatus*	0	3	0	Gulf and bay systems.	LE	E	Resident
White-nosed coati	*Nasua narica*	1	2	2	Found in woodlands, riparian corridors and canyons. Mostly transients from Mexico.	---	T	Resident
MOLLUSKS								
Creeper (squawfoot)	*Stophitus undulates*	1	1	1	Found in small to large streams. Prefers gravel or gravel and mud in flowing water. Colorado, Guadalupe, San Antonio, Neches (historic), and Trinity (historic) River basins.	---	---	Resident
False spike mussel	*Quincuncina mitchelli*	1	2	2	Substrates of cobble and mud with water lilies present. Rio Grande, Brazos, Colorado and Guadalupe river basins.	---	T	Resident
Golden orb	*Quadrula aurea*	1	2	2	Sand and gravel, Guadalupe, San Antonio, and Nueces River basins	C	T	Resident
Texas pimpleback	*Quadrula petrina*	1	2	2	Mud, gravel and sand substrates, Colorado and Guadalupe river basins	C	T	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County
						USFWS[1]	TPWD[1]	
REPTILES								
Atlantic Hawksbill Sea turtle	*Eretmochelys imbricata*	0	3	0	Gulf and bay system.	LE	E	Migrant
Cagle's map turtle	*Graptemys caglei*	1	1	1	Endemic species found in Guadalupe River System. Generally found near the water's edge.	---	T	Resident
Green Sea Turtle	*Chelonia mydat*	0	2	0	Gulf and bay system.	LT	T	Migrant
Gulf Saltmarsh Snake	*Nerodia clarkii*	1	1	1	Brackish to saline coastal waters	---	---	Resident
Kemp's Ridley Sea Turtle	*Lepidochelys kempii*	0	3	0	Gulf and bay system.	LE	E	Migrant
Leatherback Sea Turtle	*Dermochelys coriacea*	0	3	0	Gulf and bay system.	LE	E	Migrant
Loggerhead Sea Turtle	*Caretta caretta*	0	2	0	Gulf and bay system.	LT	T	Migrant
Spot-Tailed Earless Lizard	*Holbrookia lacerata*	1	1	1	Central & southern Texas; oak-juniper woodlands and mesquite-prickly pear	---	---	Resident
Texas Diamondback Terrapin	*Malaclemys terrapin littoralis*	2	1	2	Bays, coastal marshes of the upper two-thirds of Texas Coast	---	---	Resident
Texas Horned Lizard	*Phrynosoma cornutum*	1	2	2	Varied, sparsely vegetated uplands, grass, cactus, brush	---	T	Resident
Texas scarlet snake	*Cemophora coccinea lineri*	1	2	2	Mixed hardwood scrub on sandy soils.	---	T	Resident
Texas Tortoise	*Gopherus berlandieri*	1	2	2	Open brush w/ grass understory; open grass/bare ground avoided; occupies shallow depressions at base of bush or cactus, underground burrows, under objects; active March through November	---	T	Resident
Timber Rattlesnake	*Crotalus horridus*	1	2	2	Floodplains, upland pine, deciduous woodlands, riparian zones, abandoned farms, dense ground cover	---	T	Resident
PLANTS								
Shinner's sunflower	*Helianthus occidentalis* ssp. *Plantagineus*	1	1	1	Found on prairies on the Coastal Plain	---	---	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County
						USFWS[1]	TPWD[1]	
Threeflower broomweed	*Thurovia triflora*	2	1	2	Endemic, black clay soils.	---	---	Resident
Welder Machaeranthera	*Psilactis heterocarpa*	2	1	2	Coastal prairie; Shrub-infested grasslands and open mesquite-huisache woodlands	---	---	Resident

[1] Source: TPWD, Annotated County List of Rare Species, Calhoun County revised 12/11/2014 and Victoria County revised 4/28/2014.

LE/LT=Federally Listed Endangered/Threatened

E/SA, T/SA=Federally Listed Endangered/Threatened by Similarity of Appearance

C=Federal Candidate for Listing

DL, PDL=Federally Delisted/Proposed for Delisting

E, T=State Listed Endangered/Threatened

Blank = Rare, but no regulatory listing status

Avian species in the area which are federally or state listed as threatened include the peregrine falcon (*Falco peregrinus*), reddish egret (*Egretta rufescens*), sooty tern (*Sterna fuscata*), white-faced ibis (*Plegadis chihi*), white-tailed hawk (*Buteo albicaudatus*), wood stork (*Mycteria Americana*), piping plover (*Charadrius melodus*), and bald eagle (*Haliaeetus leucocephalus*). The peregrine falcon includes two subspecies which migrate across the state from more northern breeding areas in the U.S. and Canada to winter along the coast. Nesting bald eagle pairs have been documented near the project area. Bald eagles are opportunistic predators, feeding primarily on fish captured in the shallow water of both lakes and streams or scavenged food sources. These birds may utilize tall trees near perennial water as roosting or nesting sites. Bald eagles occur as migrants within south Texas. The remaining bird species excluding the white-tailed hawk prefer marshy or wet habitats.

Three mammal species, the jaguarundi (*Herpailurus yaguarondi*) and ocelot (*Leopardus pardalis*) which are both federal and state listed endangered species, and the white-nosed coati (*Nasua narica*), a state threatened species, may occur within brushy or wooded areas which are found primarily along riparian corridors within the project area.

Reptile species which are state listed as threatened which may occur within the project area include the Texas tortoise (*Gopherus berlandieri*), Cagle's map turtle (*Graptemys caglei*), Texas scarlet snake (*Cemophora coccinea lineri*), timber rattlesnake (*Crotalus horridus*), and the Texas horned lizard (*Phrynosoma cornutum*). Cagle's map turtle is endemic to the Guadalupe River system. The Texas scarlet snake is normally found in areas of mixed hardwood scrub on sandy soils. Although suitable habitat for the state threatened Texas horned lizard may exist within the project area, no impact to this species is anticipated due to the abundance of similar habit near the project area and this species' ability to relocate to those areas if necessary. The Timber rattlesnake may be found in the riparian woody vegetation of the area. The Texas tortoise prefers areas of open brush with grass understories. Destruction of potential habitats for these species can be minimized by selecting a corridor through previously disturbed areas, such as croplands.

Potential wetland impacts are expected to primarily include pipeline river and stream crossings, which can be minimized by right-of-way selection and appropriate construction methods, including erosion controls and revegetation procedures. The pipeline will be bored under its crossings of the Victoria Barge Canal and Guadalupe River, thereby reducing any probable impacts to these water sources. Compensation for net losses of wetland would be required where impacts are unavoidable.

Cultural resources that occur on public lands or within the Area of Potential Effect of publicly funded or permitted projects are governed by the Texas Antiquities Code (Title 9, Chapter 191, Texas Natural Resource Code of 1977), the National Historic Preservation Act (PL96-515), and the Archeological and Historic Preservation Act (PL93-291). Based on the review of available GIS datasets provided by the Texas Historical Commission (THC), there are no historical markers, National Register Properties, National Register Districts, or cemeteries listed along the proposed canal diversion pipeline route or within the boundary of the cooling reservoir site. An archeological survey was completed within the boundary of the cooling reservoir site along with several others near or within the proposed pipeline route indicating the potential for additional sites to occur.

Archeological site records from the Texas Historical Commission's (THC) restricted Texas Archeological Sites Atlas indicate that there is one recorded site along the pipeline route on the Green Lake Quad near West Coloma Creek. This site, according to site descriptions provided, does not occur within 150 feet of the project area. However, there are additional sites recorded within 0.31 miles of the proposed pipeline route, especially on the Green Lake Quad. Site records were not reviewed for the cooling reservoir site. Because the owner or controller of the project will likely be a political subdivision of the State of Texas (i.e. river authority, municipality, county, etc.), they will be required to coordinate with the Texas Historical Commission regarding potential impacts to cultural resources

5.2.37.4 Engineering and Costing

Major facilities required to implement include:

- Gravity conveyance system improvements;
- Expansion of the Main Pump Station;
- New 121 MGD pump station on the Main Canal adjacent to the existing GBRA Relift#1 Pump Station;
- 19-miles of 90-inch transmission pipeline, including two borings; and
- 101,300 acft cooling pond on site.

The estimated costs of the Victoria SE canal diversion WMS with and without 2011 effluent are presented in Table 5.2.37-2 and Table 5.2.37-3 respectively in September 2013 dollars.

Table 5.2.37-2. Cost Estimate Summary with 2011 Effluent

Item	*Estimated Costs for Facilities*
Terminal Storage (Conservation Pool acft, acres)	$114,977,000
Intake Pump Stations (142.8 MGD)	$14,476,000
Transmission Pipeline (90 in dia., 19 miles)	$83,715,000
Main Pump Station and Canal Upgrades	$15,436,000
TOTAL COST OF FACILITIES	**$228,604,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$75,825,000
Environmental & Archaeology Studies and Mitigation	$15,678,000
Land Acquisition and Surveying (5,024 acres)	$15,722,000
Interest During Construction (4% for 2 years with a 1% ROI)	$23,509,000
TOTAL COST OF PROJECT	**$359,338,000**
ANNUAL COST	
Debt Service (5.5 percent, 20 years)	$13,430,000
Reservoir Debt Service (5.5 percent, 40 years)	$12,392,000
Operation and Maintenance	
Intake, Pipeline, Pump Station (1% of Cost of Facilities)	$1,199,000
Dam and Reservoir (1.5% of Cost of Facilities)	$1,725,000
Pumping Energy Costs (5,266,704 kW-hr @ 0.09 $/kW-hr)	$474,000
Purchase of Water (50,333 acft/yr @ 100 $/acft)	$5,033,000
TOTAL ANNUAL COST	**$34,253,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 1.8	20,148
Annual Cost of Water ($ per acft)	$1,700
Annual Cost of Water ($ per 1,000 gallons)	$5.22

Table 5.2.37-3. Cost Estimate Summary without 2011 Effluent

Item	Estimated Costs for Facilities
Terminal Storage (Conservation Pool acft, acres)	$114,977,000
Intake Pump Stations (142.8 MGD)	$14,476,000
Transmission Pipeline (90 in dia., 19 miles)	$83,715,000
Main Pump Station and Canal Upgrades	$15,436,000
TOTAL COST OF FACILITIES	**$228,604,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$75,825,000
Environmental & Archaeology Studies and Mitigation	$15,678,000
Land Acquisition and Surveying (5,024 acres)	$15,722,000
Interest During Construction (4% for 2 years with a 1% ROI)	$23,509,000
TOTAL COST OF PROJECT	**$359,338,000**
ANNUAL COST	
Debt Service (5.5 percent, 20 years)	$13,430,000
Reservoir Debt Service (5.5 percent, 40 years)	$12,392,000
Operation and Maintenance	
Intake, Pipeline, Pump Station (1% of Cost of Facilities)	$1,199,000
Dam and Reservoir (1.5% of Cost of Facilities)	$1,725,000
Pumping Energy Costs (6,706,858 kW-hr @ 0.09 $/kW-hr)	$604,000
Purchase of Water (62,895 acft/yr @ 100 $/acft)	$6,290,000
TOTAL ANNUAL COST	**$35,640,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 1.8	29,100
Annual Cost of Water ($ per acft)	$1,225
Annual Cost of Water ($ per 1,000 gallons)	$3.76

5.2.37.5 Implementation Issues

Institutional arrangements may be needed to implement the project.

1. It will be necessary to obtain the following:
   a. Combined Operating License from Nuclear Regulatory Commission;
   b. Final Water Supply Agreement with GBRA;
   c. TCEQ Storage Permits;
   d. USCE Sections 10 and 404 Dredge and Fill Permits for the reservoir and pipelines;
   e. GLO Sand and Gravel Removal permits;

   f. GLO Easement for use of state-owned land;
   g. Coastal Coordination Council review; and
   h. TPWD Sand, Gravel, and Marl permit.
2. Permitting may require these studies:
   a. Assessment of changes in freshwater inflows to bays and estuaries;
   b. Habitat mitigation plan;
   c. Environmental studies; and
   d. Cultural resource studies and mitigation.
3. Land will need to be acquired through either negotiations or condemnation.
4. Relocations for the off-channel storage facilities may include:
   a. County roads;
   b. Other utilities;
   c. Product transmission pipelines; and
   d. Power transmission lines.

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5.2.38 GBRA Integrated Water Power Project (IWPP)

5.2.38.1 Description of Water Management Strategy

Desalination of seawater from the Gulf of Mexico along the Texas coast is a potential source of freshwater supplies for municipal and industrial use. The GBRA Integrated Water Power Project (IWPP) water management strategy includes a large-scale seawater desalination water treatment plant with a finished water production capacity of 100,000 acft/yr (89.3 MGD). GBRA is currently conducting a feasibility study, performed by MWH Global (MWH) and funded, in part by the Texas General Land Office (GLO) and the Texas Sustainable Energy Research Institute at the University of Texas at San Antonio (UTSA), to determine the best location, operations, and delivery points for a large-scale desalination water treatment plant co-located with a power plant. This feasibility study is in a relatively early phase of its development and the latest information is summarized in an MWH memorandum attached as Attachment A.

For regional water planning purposes recognizing that feasibility studies are on-going, GBRA proposes a preliminary water treatment plant location in Calhoun County and transmission facilities to accommodate potential delivery locations in Calhoun, Victoria, DeWitt, and Gonzales Counties as an example of how the project could develop. As the MWH feasibility study continues, refinement of these preliminary assumptions is expected.

The example IWPP technically evaluated herein includes raw water intake and brine disposal in the Gulf of Mexico, a seawater desalination treatment plant located near Port O'Connor, and treated water transmission facilities terminating near Gonzales as shown in Figure 5.2.38-1. The seawater desalination process produces a brine concentrate that is conveyed out to the open Gulf of Mexico for diffusion in deep water.

General Desalination Background

Commercially available processes used to desalinate seawater and brackish groundwater for production of potable water include:

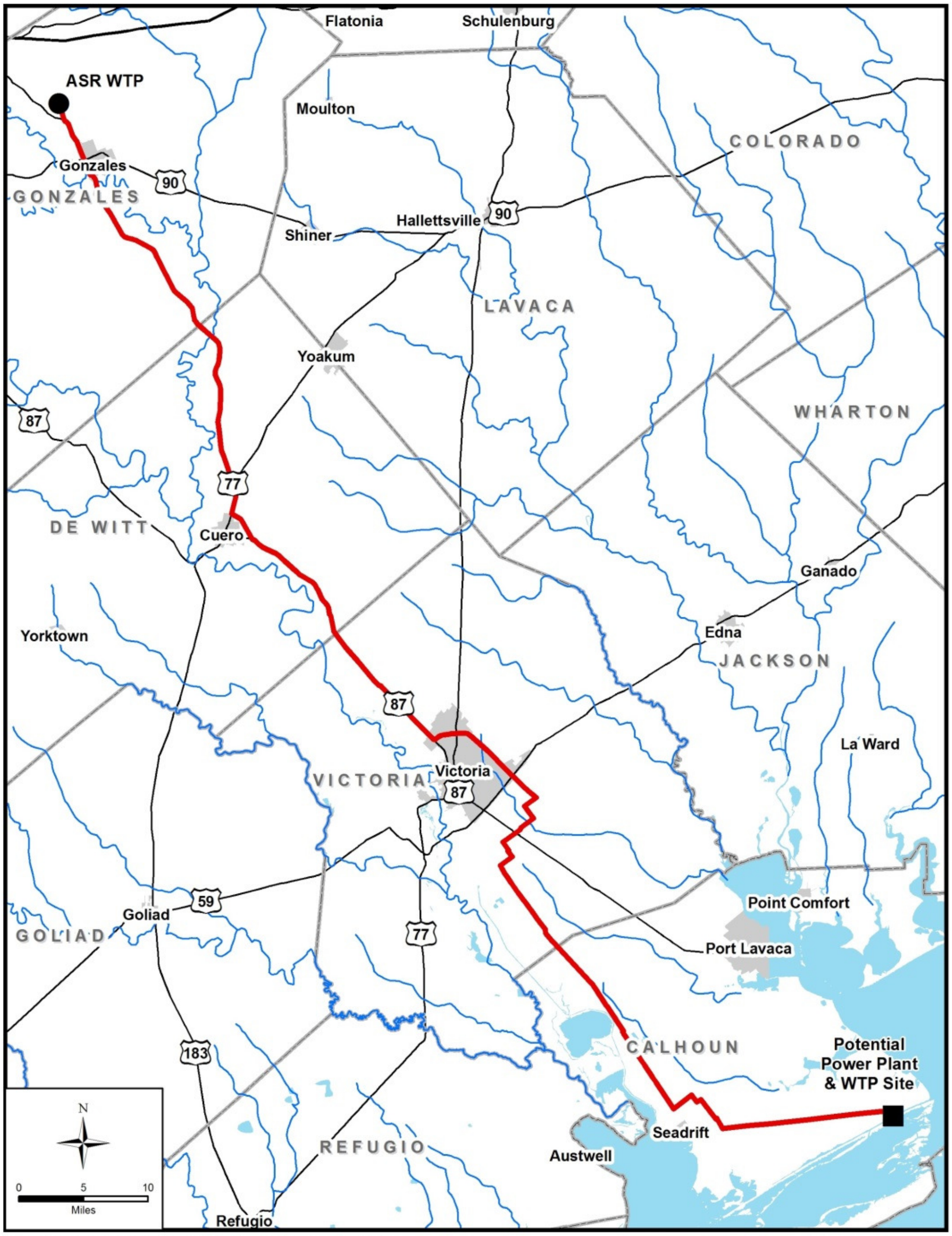
- Distillation (thermal) Processes; and
- Membrane (non-thermal) Processes.

The following sub-sections briefly describe each of these processes and discuss selected issues to be considered before selecting a process for desalination of seawater.

Distillation (Thermal) Processes

Distillation processes produce purified water by vaporizing a portion of the saline feedstock to form steam. Since the salts dissolved in the feedstock are nonvolatile, they remain unvaporized and the steam formed is captured as a pure condensate. Distillation processes are normally energy-intensive, expensive, and used for large-scale desalination of seawater. Heat is usually supplied by steam produced by boilers or from a turbine power cycle used for electric power generation. Distillation plants are commonly co-sited with power plants.

Figure 5.2.38-1 GBRA IWPP Location



In general, for a specific plant capacity, the equipment in distillation plants tends to be much larger than membrane desalination equipment. However, distillation plants do not have the stringent feedwater quality requirements of membrane plants. Due to the relatively high temperatures required to evaporate water, distillation plants have high-energy requirements, making energy a significant factor in the overall water cost. The high operating temperatures can result in scaling (precipitation of minerals from the feedwater), which reduces the efficiency of the evaporator processes, because, once an evaporator system is constructed, the size of the exchange area and the operating profile are fixed, leaving energy transfer as a function of only the heat transfer coefficient. Therefore, any scale that forms on heat exchanger surfaces reduces heat transfer coefficients. Under normal circumstances, scale can be controlled by chemical inhibitors, which inhibit, but do not eliminate, scale and by operating at temperatures of less than 200°F.

Distillation product water recoveries normally range from 15 to 45 percent, depending on the process. The product water from these processes is nearly mineral free, with very low total dissolved solids (TDS) of less than 25 mg/L. However, this product water is extremely aggressive and is too corrosive to meet the Safe Drinking Water Act (SDWA) corrosivity standards without post-treatment. Product water can be stabilized by chemical treatment or by blending with other potable water.

The three main distillation processes in use today are Multistage Flash Evaporation (MSF), Multiple Effect Distillation (MED), and Vapor Compression (VC). All three of these processes utilize an evaporator vessel that vaporizes and condenses the feedstock. The three processes differ in the design of the heat exchangers in the vessels and in the method of heat introduction into the process. Since there are no active, large-scale distillation processes in Texas that can be shown as comparable installations, distillation is not further considered herein. However, there are membrane desalination operations in Texas, so the following discussion and analyses are based upon information from the use of membrane technology for desalination.

Membrane (Non-thermal) Processes

The two types of membrane processes use either pressure, as in reverse osmosis, or electrical charge, as in electrodialysis reversal, to reduce the mineral content of water. Both processes use semi-permeable membranes that allow selected ions to pass through while other ions are blocked. Electrodialysis reversal (EDR) uses direct electrical current applied across a vessel to attract the dissolved salt ions to their opposite electrical charges. EDR can desalinate brackish water with TDS up to several thousand mg/L, but energy requirements make it economically uncompetitive for seawater, which typically contains approximately 35,000 mg/L TDS. As a result, only reverse osmosis (RO) is considered for the example seawater desalination project described herein.

RO utilizes a semi-permeable membrane that limits the passage of salts from the saltwater side to the freshwater side of the membrane. Electric motor driven pumps or steam turbines (in dual-purpose installations) provide the 800 to 1,200 psi pressure necessary to overcome the osmotic pressure and drive the saltwater through the membrane, leaving a waste stream of brine/concentrate. The basic components of an RO plant include pre-treatment, high-pressure pumps, membrane assemblies, and post-treatment. Pretreatment is essential because feedwater must pass through very narrow membrane passages during the process and suspended materials, biological growth, and some minerals can foul the membrane. As a result, virtually all suspended solids must be removed and the feedwater must be pre-treated so precipitation of minerals or growth of microorganisms does not occur on the membranes. This is normally accomplished by various levels of filtration and chemical additives and inhibitors. Post-treatment of product water is usually required prior to distribution to reduce its corrosivity and to improve its aesthetic qualities. Specific treatment requirements are dependent on product water composition.

A "single pass/stage" seawater RO plant will produce water with a TDS of 150 to 500 mg/L, most of which is sodium and chloride. The product water will be corrosive, but this may be acceptable, if a source of blending water is available. If not, and if post-treatment is required, care must be exercised to ensure that post-treatment additives do not cause product water to exceed desired TDS levels.

Recovery rates up to 50 percent are common for seawater RO facilities. The recovery rate is dependent on raw water quality and, specifically, the concentrations of dissolved constituents. Higher recovery rates can be obtained for water drawn from a bay or other location that is blended with freshwater resulting in lower TDS. RO plants, which comprise about 59 percent of world-wide desalination capacity, range from a few gallons per day to 130 MGD. The largest seawater RO plant in the United States is the 25-MGD plant in Tampa, Florida. There are several recently completed seawater RO plants, mainly in the Middle East, with capacities around 85 MGD. The current domestic and worldwide trend is for the adoption of RO when a single purpose seawater desalination plant is to be constructed. RO membranes have improved significantly over the past two decades, particularly with respect to efficiency, longer life, and lower prices.

Table 5.2.38-1 Municipal Use Desalination Plants in Texas (>25,000 gpd and as of 2008)

Location	Source	Total Capacity (MGD)	Desalination Capacity (MGD)	Membrane Type[1]
Abilene, City of	Surface Water	8	8	RO
Bardwell, City of	Groundwater	0.12	0.12	RO
Bayside, City of	Groundwater	0.15	0.15	RO
Brownsville, City of	Groundwater	7.5	7.5	RO
Burleson County MUD 1	Groundwater	0.43	0.43	RO
Country View Estates	Groundwater	0.18	0.18	RO
Dell City, City of	Groundwater	0.11	0.11	EDR
Electra, City of	Groundwater	2.23	2.23	RO
El Paso, City of	Groundwater	27.5	27.5	RO
Ft. Stockton, City of	Groundwater	7.0	6.0	RO
Granbury, City of	Surface Water	0.35	0.35	EDR
Haciendas del Norte (El Paso)	Groundwater	0.23	0.11	RO
Horizon Regional MUD (El Paso)	Groundwater	4	2.2	RO
Kenedy, City of	Groundwater	2.86	0.72	RO
Lake Granbury	Surface Water	10	6	RO
Los Ybanez, City of	Groundwater	0.11	0.11	RO
Oak Trail Shores	Lake Water	1.85	0.79	EDR
Primera, City of	Groundwater	2.5	2	RO
Robinson, City of	Surface Water	2.38	1.8	RO
Seadrift, City of	Groundwater	0.61	0.52	RO
Sherman, City of	Surface Water	10.0	7.5	EDR
Sportsman's World	Surface Water	0.17	0.17	RO
Southmost RWA	Groundwater	7.5	6.75	RO
Windermere Water System	Groundwater	2.88	1	RO

[1] RO = Reverse Osmosis EDR = Electrodialysis Reversal

Examples of Relevant Existing Desalination Projects

Tampa, Florida: Tampa Bay Water has constructed a nominal 25 MGD reverse osmosis (RO) seawater desalination plant. The water treatment plant came online in 2010 at a cost of $158 million, lower than other desalination plants around the world. Some reasons for this might include:

1. Salinity at the Tampa Bay sites ranges from 25,000 to 30,000 mg/L, lower than the more common 35,000 mg/L for seawater. RO cost is sensitive to salinity.
2. The power cost, which is interruptible, is below $0.04 per kilowatt-hour (kWh).
3. Construction cost savings through use of existing power plant canals for intake and concentrate discharge.
4. Economy of scale at 25 MGD.
5. Use of tax-exempt bonds for financing.

The Tampa costs compare with other large-scale desalination projects that have completed construction and become operational in the last several years.

Large-Scale Demonstration Seawater Desalination in Texas: The Texas Water Development Board (TWDB) funded several studies to evaluate the feasibility of large-scale desalination in Texas. As part of this initiative, Corpus Christi, Freeport, and the Lower Rio Grande Valley-Brownsville area were selected as potential locations for large-scale seawater desalination and feasibility studies were conducted for each of these locations. The draft feasibility reports were submitted to TWDB in August 2004 and indicated that the demonstration seawater desalination projects for the three locations are technically feasible. However, all three draft reports indicate that the estimated total costs for capital and O&M of the proposed projects would exceed the cost of alternative sources of drinking water at these locations[1].

Subsequent to the initial study, the Brownsville Public Utilities Board (BPUB) conducted an 18-month reverse osmosis desalination demonstration study at the Brownsville Ship Channel with the final report completed in October 2008[2]. The study evaluated several pretreatment and reverse osmosis desalination alternatives and presented a cost estimate for implementing a 25 MGD seawater desalination project at Brownsville. Table 4C.37-2 shows a summary of the capital cost estimate. At the time of the pilot study report, BPUB decided that full scale project was not recommended for immediate implementation because there would not be adequate regional water demand and the cost of a 25 MGD seawater desalination project was greater than the cost of other water supply strategies. The study recommended that a 2.5-MGD seawater desalination demonstration project be constructed instead with provisions made in the initial design to expand the facility to 25 MGD by 2050.

Table 5.2.38-2 Cost Summary for TWDB Texas Seawater Demonstration Project in Brownsville (Feasibility Estimate from 2004 Compared to Pilot Study Estimate from 2008)

Project Component	***Feasibility Estimate (2004)***	***Pilot Study Estimate (2008)***
Capital Costs		
Desalination Plant	$90,167,000	$126,612,000
Concentrate Disposal System	$30,583,000	$21,217,000
Finished Water Transmission System	$9,232,000	$12,180,000
Project Implementation Costs	$21,406,000	$22,400,000
Total Capital Cost	**$151,388,000**	**$182,409,000**

[1] Texas Water Development Board, “The Future of Desalination in Texas Volume I, Biennial Report on Seawater Desalination,” December 2004.

[2] NRS, “Final Pilot Study Repot Texas Seawater Demonstration Project,” October 2008.

5.2.38.2 Water Availability

Seawater is assumed to be a virtually unlimited potential source of supply for the South Central Texas Region given that the Gulf of Mexico is estimated to contain 643 quadrillion gallons of water (1.973 trillion acft)[3]. Hence, for regional water planning purposes, it is assumed the firm water supply or available yield of the GBRA IWPP is limited only by intake, treatment, and transmission system capacity. The example project firm yield evaluated herein is 100,000 acft/yr (89.3 MGD) and this amount is assumed to be available in all decades of the planning period.

5.2.38.3 Environmental Issues

One potential location of the seawater desalination water treatment plant is in Calhoun County near Port O'Connor a short distance inland from the Gulf Intracoastal Waterway and Espiritu Santo Bay. Source water for the project will be seawater drawn from the Gulf of Mexico. The brine concentrate resulting from the desalination treatment process will be returned to deep waters of the Gulf of Mexico via pipeline for disposal. Potential treated water delivery locations from Calhoun to Gonzales County may be served by a long water transmission pipeline.

Potential environmental effects associated with construction and operation of a seawater desalination plant in Calhoun County will be sensitive to ultimate plant siting and its associated seawater intake and brine disposal transmission pipelines. Construction of the desalination plant will temporarily disrupt habitats in the immediate vicinity. Although the seawater intake is to be located in deep water well offshore, its operations may result in impacts to aquatic organisms. Impingement takes place when organisms are trapped against intake screens by the force of the water passing into the intake structure and entrainment occurs when organisms are drawn through the water intake structure into the pump and transport system. Organisms that become impinged or entrained are normally relatively small organisms, including fish and shellfish in their early life stages. Impingement can result in descaling or other physical damage, and starvation, exhaustion, or asphyxiation when the organism cannot escape the intake structure. Entrained organisms are subject to mechanical, thermal, or toxic stress (e.g., biocides or low dissolved oxygen concentrations) as they pass through the system. In the case of either impingement or entrainment, a substantial proportion of the affected individuals may be killed or subjected to significant harm. Minimization of impingement and entrainment by appropriate site selection and through the use of appropriate screening technology must be considered during the system design as part of the overall effort to avoid or minimize potential impacts to the aquatic environment. In addition, construction of the saltwater intake pipeline may temporarily impact any Spartina marshes and seagrass beds that occur within shallower areas of the gulf.

Brine concentrate disposal is expected to occur a substantial distance offshore in deep waters of the open Gulf of Mexico. Potential associated impacts to aquatic species may result from construction of the brine discharge pipeline on bay bottom habitats, and from increases in salinity in areas near the discharge point. Discharge sites are typically selected to avoid areas where organisms tend to concentrate, including rock outcrops and man-made structures. It is expected that the permitting process will include

[3] http://www.epa.gov/gmpo/about/facts.html

modeling demonstrating that discharge structure design will be adequate to rapidly disperse the concentrate plume to ambient salinities within a relatively small mixing zone in order to minimize impacts to aquatic species.

No changes in instream flows or freshwater inflows are expected from operations of GBRA's IWPP except to the extent that such flows may be increased by the discharge of treated effluent associated with the new water supply. Similarly, no changes in estuarine salinity gradients are expected from operations of the desalination water treatment facilities as seawater diversions and brine discharge are to occur in the Gulf of Mexico well beyond the barrier islands and peninsulas.

Many migratory birds are dependent on the quality of the nearby estuarine environments to support foraging and nesting activities during migration. One of the most well known of the migratory birds is the whooping crane (Grus Americana), which is listed as endangered by both the U.S. Fish and Wildlife Service (USFWS) and the Texas Parks and Wildlife Department (TPWD). A growing population of whooping cranes winter in and near the Aransas National Wildlife Refuge located adjacent to Mesquite Bay and the southern and western portions of San Antonio Bay. This wintering population has grown from a low of only 16 birds in 1941 to more than 300 birds in 2014. Other migratory birds known to occur in the project area and listed as threatened by TPWD include the bald eagle (Haliaeetus leucocephalus), sooty tern (Sterna fuscata), reddish egret (Egretta rufescens), wood stork (Mycteria americana), and the piping plover (Charadrius melodus). The piping plover is also listed as threatened by USFWS.

The treated water transmission pipeline corridor in Calhoun, Victoria, DeWitt, and Gonzales Counties would be approximately 118 miles long. Construction of the pipeline would include the clearing and removal of woody vegetation. A 40-foot wide right-of-way corridor, free of woody vegetation and maintained for the life of the project, would total approximately 572 acres. The proposed pipeline route would traverse three of Omernik's ecoregions[4]: the Western Gulf Coastal Plain, the East Central Texas Plains, and the Texas Blackland Prairie. In addition, the lower Guadalupe River, located within the project area, is listed by TPWD as an Ecologically Significant River and Stream Segment. Surveys for protected species should be conducted within the proposed construction corridors where preliminary evidence indicates their existence. Many of these species, such as the Texas tortoise (Gopherus berlandieri), the Texas horned lizard (Phrynosoma cornutum), and the Texas scarlet snake (Cemophora coccinea lineri), are dependent on shrubland or riparian habitat. The timber rattlesnake (Crotalus horridus), a state threatened species, may be found in the riparian woody vegetation of the area.

Destruction of potential habitat utilized by terrestrial species can be minimized by selecting a corridor through previously disturbed areas, such as croplands. Selection of pipeline right-of-way alongside existing habitat could also be beneficial to some wildlife by providing edge habitat.

The Texas Natural Diversity Database (TXNDD), produced by TPWD, includes known occurrences of endangered, threatened, or rare species near the potential pipeline right-of-way, desalination plant, storage tanks, and pump stations. Due to the limited amount

[4] Omernik, J.M., "Ecoregions of the Conterminous United States," Annals of the Association of American Geographers, 77:118-125, 1987.

of area included around the storage tanks and pump stations, no impact to any listed species is anticipated from this portion of the project. The transmission pipeline corridor and desalination plant contain the most potential to affect aquatic and terrestrial species found within the project area. Careful siting of these components of the project would help minimize impacts to area species.

One endangered species reported by the TXNDD near the transmission pipeline corridor is the Attwater's greater prairie chicken which is found in Victoria County. The Attwater's greater prairie chicken prefers the coastal prairies grassland in areas with 0 to 24 inches vegetation height. In addition, the Cagle's map turtle (Graptemys caglei), a state threatened species, has been documented within one mile of the proposed transmission pipeline route. Several state threatened freshwater mussel species also occur within the project counties, including the Texas pimpleback (Quadrula petrina), Golden orb (Quadrula aurea), and False spike mussel (Quadrula mitchelli). These mussel species could potentially be affected by the pipeline crossings of the Guadalupe River and its tributaries found within the project area. Impacts to these species are not anticipated if appropriate Best Management Practices (BMPs) such as directional drilling at river crossings are utilized during pipeline construction.

Plant and animal species in the project area listed by the USFWS and TPWD as endangered, threatened, or species of concern are presented in Table 4C.37-3. Species included in this table have habitat requirements or preferences that suggest they could be present within the project area.

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 (Pl96-515), and the Archeological and Historic Preservation Act (PL93-291). Based on the review of available GIS datasets from the Texas Historical Commission (THC), there are five National Register Properties, two national Register Districts, twenty eight cemeteries, and seventy three historical markers located within a one-mile buffer of the proposed transmission pipeline route, desalination plant, storage tanks, and pump stations. Additionally, over twenty archeological surveys of both lines and areas have occurred within this one mile buffer.

There is a high probability for undocumented significant cultural resources within the alluvial deposits and terrace formations associated with waterways, specifically the intermittent and perennial aquatic resources. The probability that the transmission pipeline would cross areas which include cultural resources increases near waterways and associated landforms.

A review of archaeological resources in the proposed project area should be conducted during the project planning phase. Taking into consideration that the owner or controller of the project will likely be a political subdivision of the State of Texas (i.e. river authority, municipality, county, etc.), they will be required to coordinate with the Texas Historical Commission regarding impacts to cultural resources. The project sponsor will also be required to coordinate with the U.S. Army Corps of Engineers regarding any impacts to waters of the United States or wetlands.

The water treatment site and transmission pipeline route considered herein do not conflict with the Powderhorn Ranch property acquired recently and intended to be managed by TPWD.

Table 5.2.38-3 Endangered, Threatened, and Species of Concern in Calhoun, DeWitt, Gonzales and Victoria Counties

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County
						USFWS[1]	TPWD[1]	
AMPHIBIANS								
Black-spotted Newt	*Notophthalmus meridionalis*	1	2	2	Ponds and resacas in south Texas		T	Resident
Sheep Frog	*Hypopachus variolosus*	1	2	2	Deep sandy soils of Southeast Texas		T	Resident
BIRDS								
American Peregrine Falcon	*Falco peregrinus anatum*	0	3	0	Open country; cliffs	DL	T	Nesting/ Migrant
Arctic Peregrine Falcon	*Falco peregrinus tundrius*	0	2	0	Open country; cliffs	DL		Nesting/Migrant
Attwater's Greater Prairie-Chicken	*Tympanuchus cupido attwateri*	1	3	3	Coastal Prairies of Gulf Coastal Plain	LE	E	Resident
Bald Eagle	*Haliaeetus leucocephalus*	1	2	2	Large Bodies of water with nearby resting sites	DL	T	Nesting/Migrant
Brown Pelican	*Pelecanus occidentalis*	0	3	0	Coastal inlands for nesting, shallow gulf and bays for foraging	DL		Nesting/Migrant
Eskimo Curlew	*Numenius borealis*	1	3	3	Grasslands, pastures, thought to be extinct.	LE	E	Nonbreeding Resident
Henslow's Sparrow	*Ammodramus henslowii*	1	1	1	Weedy fields, cut over areas; bare ground for running and walking			Nesting/Migrant
Interior Least Tern	*Sterna antillarum athalassos*	1	3	3	Inland river sandbars for nesting and shallow water for foraging	LE	E	Nesting/Migrant
Mountain Plover	*Charadrius montanus*	1	1	1	Non-breeding-shortgrass plains and fields, plowed fields and sandy deserts			Nesting/Migrant
Northern Aplomado Falcon	*Falco femoralis septentrionalis*	0	3	0	Found in open country, especially savanna and open woodland.	LE	E	Resident
Piping Plover	*Charadrius melodus*	1	2	2	Beaches and flats of Coastal Texas	LT	T	Migrant
Reddish Egret	*Egretta rufescens*	1	2	2	Coastal inlands for nesting, coastal marshes for foraging		T	Migrant
Snowy Plover	*Charadrius alexandrinus*	1	1	1	Wintering Migrant on mud flats.			Migrant
Sooty Tern	*Sterna fuscata*	1	2	2	Catches small fish.		T	Resident
Southeastern Snowy Plover	*Charadrius alexandrines tenuirostris*	1	1	1	Wintering migrant along the Texas Gulf Coast.			Migrant
Sprague's Pipit	*Anthus spragueii*	1	1	1	Only in Texas during migration and winter. Strongly tied to native upland prairie.	C		Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County
						USFWS[1]	*TPWD*[1]	
Western Burrowing Owl	*Athene cunicularia hypugaea*	1	1	1	Open grasslands, especially prairie, plains and savanna			Resident
Western Snowy Plover	*Charadrius alexandrines nivosus*	1	1	1	Potential migrant in winter along coast.			Migrant
White-faced Ibis	*Plegadis chihi*	1	2	2	Prefers freshwater marshes.		T	Resident
White-tailed Hawk	*Buteo albicaudatus*	1	2	2	Coastal prairies, savannahs and marshes in Gulf coastal plain		T	Resident
Whooping Crane	*Grus americana*	1	3	3	Potential migrant	LE	E	Migrant
Wood Stork	*Mycteria americana*	1	2	2	Forages in prairie ponds, ditches, and shallow standing water formerly nested in TX		T	Migrant
FISHES								
American Eel	*Anguilla rostrata*	1	1	1	Moist aquatic habitats.			Resident
Blue Sucker	*Cycleptus elongates*	1	2	2	Larger portions of major rivers in Texas.		T	Resident
Guadalupe Bass	*Micropterus teculii*	1	1	1	Endemic to perennial streams of the Edward's Plateau region			Resident
Guadalupe Darter	*Percina sciera apristis*	1	1	1	Guadalupe River basin in raceways of large streams and rivers.			Resident
Opossum Pipefish	*Microphis brachyurus*	1	2	2	Brooding adults found in fresh or low salinity waters.		T	Resident
Smalltooth Sawfish	*Pristis pectinata*	1	3	3	Found in bays, estuaries or river mouths.	LE	E	Resident
INSECTS								
A mayfly	*Tortopus circumfluus*	1	1	1	Mayflies have an aquatic larval stage and adults are generally found in shoreline vegetation.			Resident
Leonora's dancer damselfly	*Argia leonorae*	1	1	1	South central and western Texas in small streams and seepages.			Resident
Texas Asaphomyian Tabanid Fly	*Asaphomyia texanus*	1	1	1	Found near slow-moving water, eggs laid on objects near water; larvae are aquatic, adults prefer shady areas; feed on nectar and pollen			Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County
						USFWS[1]	*TPWD*[1]	
MAMMALS								
Black Bear	*Usus americanus*	0	2	0	Mountains, broken country, woods, brushlands, forests	T/SA; NL	T	Resident
Cave Myotis Bat	*Myotis velifer*	0	1	0	Roosts colonially in caves.			Resident
Jaguarundi	*Herpailurus yaguarondi*	1	3	3	South Texas thick brushlands, favors areas near water	LE	E	Resident
Louisiana Black Bear	*Ursus americanus luteolus*	0	2	0	Within historical range.	LT	T	
Ocelot	*Felis pardalis*	1	3	3	Dense chaparral thickets; mesquite-thorn scrub and live oak mottes	LE	E	Resident
Plains Spotted Skunk	*Spilogale putorius interrupta*	1	1	1	Prefers wooded, brushy areas and tallgrass prairie, fields, prairies, croplands, fence rows, forest edges			Resident
Red Wolf	*Canis rufus*	0	3	0	Extirpated.	LE	E	
West Indian manatee	*Trichechus manatus*	1	3	3	Gulf and bay systems.	LE	E	Resident
White-nosed coati	*Nasua narica*	1	2	2	Found in woodlands, riparian corridors and canyons. Mostly transients from Mexico.		T	Resident
MOLLUSKS								
Creeper (squawfoot)	*Stophitus undulatus*	1	1	1	Small to large streams San Antonio, Neches (historic) and Trinity (historic) River basins.			Resident
False spike mussel	*Quadrula mitchelli*	1	2	2	Possibly extirpated in Texas in medium to large rivers.		T	Possible Resident
Golden orb	*Quadrula aurea*	1	2	2	Found in Guadalupe, San Antonio, Lower San Marcos, and Nueces River Basins.	C	T	Resident
Palmetto pill snail	*Euchemotrema leai cheatumi*	1	1	1	Known from palmetto woodlands of Palmetto State Park.			Resident
Texas fatmucket	*Lampsilis bracteata*	1	2	2	Colorado and Guadalupe river basins.	C	T	Resident
Texas pimpleback	*Quadrula petrina*	1	2	2	Generally in areas with slow flow rates in Colorado and Guadalupe river basins.	C	T	Resident
REPTILES								
Atlantic Hawksbill Sea turtle	*Eretmochelys imbricata*	1	3	3	Gulf and bay system.	LE	E	Migrant
Cagle's map turtle	*Graptemys caglei*	1	2	2	Endemic to Guadalupe River System.		T	Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County
						USFWS[1]	*TPWD*[1]	
Green Sea Turtle	*Chelonia mydat*	1	2	2	Gulf and bay system.	LT	T	Migrant
Gulf Saltmarsh Snake	*Nerodia clarkii*	1	1	1	Brackish to saline coastal waters			Resident
Kemp's Ridley Sea Turtle	*Lepidochelys kempii*	1	3	3	Gulf and bay system.	LE	E	Migrant
Leatherback Sea Turtle	*Dermochelys coriacea*	1	3	3	Gulf and bay system.	LE	E	Migrant
Loggerhead Sea Turtle	*Caretta caretta*	1	2	2	Gulf and bay system.	LT	T	Migrant
Texas Diamondback Terrapin	*Malaclemys terrapin littoralis*	1	1	1	Bays, coastal marshes of the upper two-thirds of Texas Coast			Resident
Texas Horned Lizard	*Phrynosoma cornutum*	1	2	2	Varied, sparsely vegetated uplands, grass, cactus, brush		T	Resident
Texas scarlet snake	*Cemophora coccinea lineri*	1	2	2	Mixed hardwood scrub on sandy soils.		T	Resident
Texas Tortoise	*Gopherus berlandieri*	1	2	2	Open brush w/ grass understory; open grass/bare ground avoided; occupies shallow depressions at base of bush or cactus, underground burrows, under objects; active March through November		T	Resident
Timber Rattlesnake	*Crotalus horridus*	1	2	2	Floodplains, upland pine, deciduous woodlands, riparian zones, abandoned farms, dense ground cover		T	Resident
PLANTS								
Threeflower broomweed	*Thurovia triflora*	1	1	1	Endemic, black clay soils.			Resident
Shinner's sunflower	*Helianthus occidentalis ssp. Plantagineus*	1	1	1	Found on prairies on the Coastal Plain			Resident
Bristle nailwort	*Paronychia setacea*	1	1	1	Endemic to eastern southcentral Texas in sandy soils			Resident
Buckley's spiderwort	*Tradescantia buckleyi*	1	1	1	Occurs on sandy loam or clay soils in grasslands or shrublands.			Resident
Elmendorf's Onion	*Allium elmendorfii*	1	1	1	Endemic; deep sands derived from Queen City and similar Eocene formations			Resident
Green beebalm	*Monarda viridissima*	1	1	1	Endemic perennial herb of the Carrizo Sands.			Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County
						USFWS[1]	*TPWD*[1]	
Sandhill woolywhite	*Hymenopappus carrizoanus*	1	1	1	Texas endemic found in disturbed or open areas in grasslands and post oak woodlands.			Resident
Welder Machaeranthera	*Psilactis heterocarpa*	1	1	1	Coastal prairie; Shrub-infested grasslands and open mesquite-huisache woodlands			Resident

1 Source: TPWD, Annotated County List of Rare Species, Calhoun Co., 4/28/2014, Dewitt Co 4/28/2014, Gonzales Co., 4/28/2014, Victoria Co., 4/28/2014.

LE/LT=Federally Listed Endangered/Threatened
T/SA=Federally Listed Threatened by Similarity of Appearance
C=Federal Candidate for Listing
DL =Federally Delisted
E, T=State Listed Endangered/Threatened
Blank = Rare, but no regulatory listing status

5.2.38.4 Engineering and Costing

This water management strategy provides for a major desalination water treatment plant on the Texas coast and the infrastructure for transferring potable water from the coast to Gonzales County. The entire strategy consists of the offshore intake and brine disposal facilities, water treatment plant, storage tanks, pumping stations, and 138 miles of pipeline (i.e. intake, brine disposal, and treated water transmission). The water treatment plant component includes pretreatment necessary to ensure normal life and efficiency of the reverse osmosis membranes and post-treatment for disinfection and distribution system corrosion scale stability.

Desalination treatment cost estimates are based on recent similar desalination treatment plant construction experience and feasibility studies. This approach takes advantage of the development of membrane technology and the resulting reduction in capital and operating costs in comparison to previously available technology.

The basic assumptions made to determine the size and characteristics of the components of this seawater desalination strategy are listed in Table 5.2.38-4. Considering the RO efficiency of a seawater desalination plant (~60 percent), the GBRA IWPP water treatment plant has been sized at 148.8 MGD in order to produce a potable supply of 89.3 MGD (100,000 acft/yr). A 118-mile pipeline route from the desalination plant adjacent to the Gulf of Mexico to Gonzales County was assumed. A 10-mile conveyance line to carry the concentrate offshore is also included in the costs. A concentrate pump station is not included because it is assumed that the residual pressure from the desalination process is utilized to convey the concentrate offshore.

Table 5.2.38-4 Engineering Assumptions for Seawater Desalination

Parameter	***Assumption***	***Description***
Raw water TDS	35,000 mg/L	Intake located in the Gulf of Mexico
Finished water chlorides	100 mg/L	
Treatment capacity	148.2 MGD	Assumes 60% RO Efficiency
Finished water capacity	89.3 MGD	100,000 acft/yr
Concentrate Pipeline Length	10 miles total	Diffused in open Gulf
RO Recovery Rate	60 percent	
Power cost	$0.09 per kWh	Assume interruptible power
Pipeline diameter	72” and 54”	Treated water
Booster storage	10 percent of flow	More than 1 hour storage to avoid in-line pumps
Number of booster stations	3	

The estimated annual unit cost for the GBRA IWPP as presented herein is $2,393/acft/yr (Table 5.2.38-5). The treatment costs include the water treatment plant (pretreatment, RO desalination, and post-treatment), raw water intake, and offshore concentrate discharge. The pretreatment portion of the plant is essentially a full conventional surface water plant to remove solids from the raw water prior to the RO desalination process. There is some economy of scale in the treatment process with larger processes in the pretreatment and RO desalination components. Also, there are greater economies of scale for components such as the intake and concentrate pump stations and pipelines.

Table 5.2.38-5 GBRA IWPP Cost Estimate

Item	*Estimated Costs for Facilities*
Intake Pump Stations (94 MGD)	$28,159,000
Transmission Pipeline (72 in dia., 118 miles)	$295,874,000
Transmission Pump Station(s) & Storage Tank(s)	$15,960,000
Water Treatment Plant (89.3 MGD)	$599,926,000
Integration, Relocations, & Other	$136,015,000
TOTAL COST OF FACILITIES	**$1,075,934,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$361,783,000
Environmental & Archaeology Studies and Mitigation	$3,600,000
Land Acquisition and Surveying (1,622 acres)	$7,447,000
Interest During Construction (4% for 3 years with a 1% ROI)	$152,121,000
TOTAL COST OF PROJECT	**$1,600,885,000**
ANNUAL COST	
Debt Service (5.5 percent, 20 years)	$133,961,000
Operation and Maintenance	
Intake, Pipeline, Pump Station (1% of Cost of Facilities)	$5,389,000
Water Treatment Plant (2.5% of Cost of Facilities)	$90,017,000
Pumping Energy Costs (110,056,109 kW-hr @ 0.09 $/kW-hr)	$9,905,000
TOTAL ANNUAL COST	**$239,272,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 1	100,000
Annual Cost of Water ($ per acft)	$2,393
Annual Cost of Water ($ per 1,000 gallons)	$7.34

5.2.38.5 Implementation Issues

Implementation of this water management strategy requires addressing several financial, environmental, and technological considerations. The cost estimate shows that, while the treatment cost based on recent Tampa experience and other feasibility studies for a planned 25 MGD desalination facility may be competitive, transferring water from the coast inland is a significant overall cost component.

There are several environmental issues that must be considered. One issue with the desalination plant is the disposal of the concentrate created from the treatment process. Disposal would have to occur at a location and in a manner that does not significantly disrupt plant or animal life in in the Gulf. A further complication is the permitting of a 118-mile pipeline across rivers, highways, water bodies, and private rural and urban property.

Technological issues include: (1) confirming that desalination as proposed with membranes is the appropriate technology; (2) confirming that blending desalted seawater with the other water sources in municipal or industrial customer systems can be successfully accomplished; and (3) obtaining an adequate source of electric power to drive the desalination process using membranes.

Substantial verification of technology would need to be accomplished prior to building this project. Blending differing treated waters is critical for the wellbeing of the customers and their distribution or process systems. Considerable investigation would be needed to determine if additional conditioning of the desalinated seawater would be required to make the new water source compatible with existing distribution systems. Conditioning of the desalinated seawater may include addition of alkalinity and hardness to bring the corrosion chemistry closer to existing water sources.

Requirements Specific to Water Rights

1. It will be necessary to obtain the following:
    a. TCEQ Water Right permit.
    b. GLO Sand and Gravel Removal permits.
    c. GLO Easement for use of state-owned land.
    d. Coastal Coordination Council review.
    e. TPWD Sand, Gravel, and Marl permit.
2. Permitting, at a minimum, will require these studies:
    a. Assessment of changes in instream flows and freshwater inflows to bays and estuaries, if any.
    b. Habitat mitigation plan.
    c. Environmental studies.
    d. Cultural resources.
3. Other Considerations:
    a. Water compatibility testing, including biological and chemical characteristics will need to be performed.

Requirements Specific to Pipelines

1. Necessary permits:
    a. USACE Sections 10 and 404 dredge and fill permits for stream crossings.
    b. GLO Sand and Gravel Removal permits.
    c. 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.
4. Other utilities.

GBRA Integrated Water and Power Project (IWPP)

The Guadalupe-Blanco River Authority (GBRA), in partnership with the State of Texas General Land Office (GLO) and the Texas Sustainable Energy Research Institute at the University of Texas at San Antonio (UTSA), is conducting feasibility study for a potential Integrated Water and Power Project (IWPP) that would involve seawater desalination. Funding is also being provided by the US Bureau of Reclamation through a Title XVI Grant. GBRA recently signed a Memorandum of Understanding (MOU) with the Lower Colorado River Authority (LCRA) to jointly address regional water planning, and an MOU with the City of Corpus Christi that addresses regional water planning including seawater desalination.

The IWPP, as envisioned by GBRA and its partners, presents a regional approach for providing water supply and power generation that will help address the needs of the Coastal Bend and South Central region of Texas. As envisioned, the IWPP would include a desalination plant on the Gulf Coast with a co-located power plant. Facilities would be developed in phases as demands grow. The water treatment plant would be initially constructed to serve a demand of 25 to 50 million gallons per day (mgd), and could be expanded to an ultimate capacity of 250 mgd. The power plant would be sized at an initial capacity of 500 megawatts (MW) and potentially be expanded to 3,000 MW. At full capacity the IWPP could supply enough water for over 350,000 homes and electricity for up to 3 million homes.

The study area encompasses a large region of southeast Texas, extending along the Gulf Coast from north of Freeport southwest to Corpus Christi. The study area also extends inland to include the cities of Austin and San Antonio and the rapidly growing region between these cities, the City of Corpus Christi, and numerous small to mid-size cities (Figure 1). In total, the study area encompasses over 29,000 square miles. It includes 31 counties, three major cities (Austin, San Antonio, and Corpus Christi), several small and mid-sized growing communities including the IH-35, SH 130, and IH10 corridors, several ports, numerous industrial water users, and agricultural water users.

The study area includes all or part of twelve river basins that drain to the Gulf Coast, the most significant of which include the Brazos, Colorado, Lavaca, Guadalupe (and San Antonio), and Nueces. Water demands in the study area will increase in response to rapid municipal and industrial growth. Based on estimates prepared for the 2011 State Water Plan, the combined increase in water demand in the study area is 836 thousand acre feet (TAF) per year by the year 2060. This increase will be driven by municipal, manufacturing, and steam electric use, and includes an over 150 TAF/yr reduction in agricultural demand. In addition, portions of the study area affected by the oil and gas exploration boom related to the Eagle Ford Shale discovery. The Eagle Ford Shale formation stretches across 30 Texas counties and 10 of those counties are located in the study area.

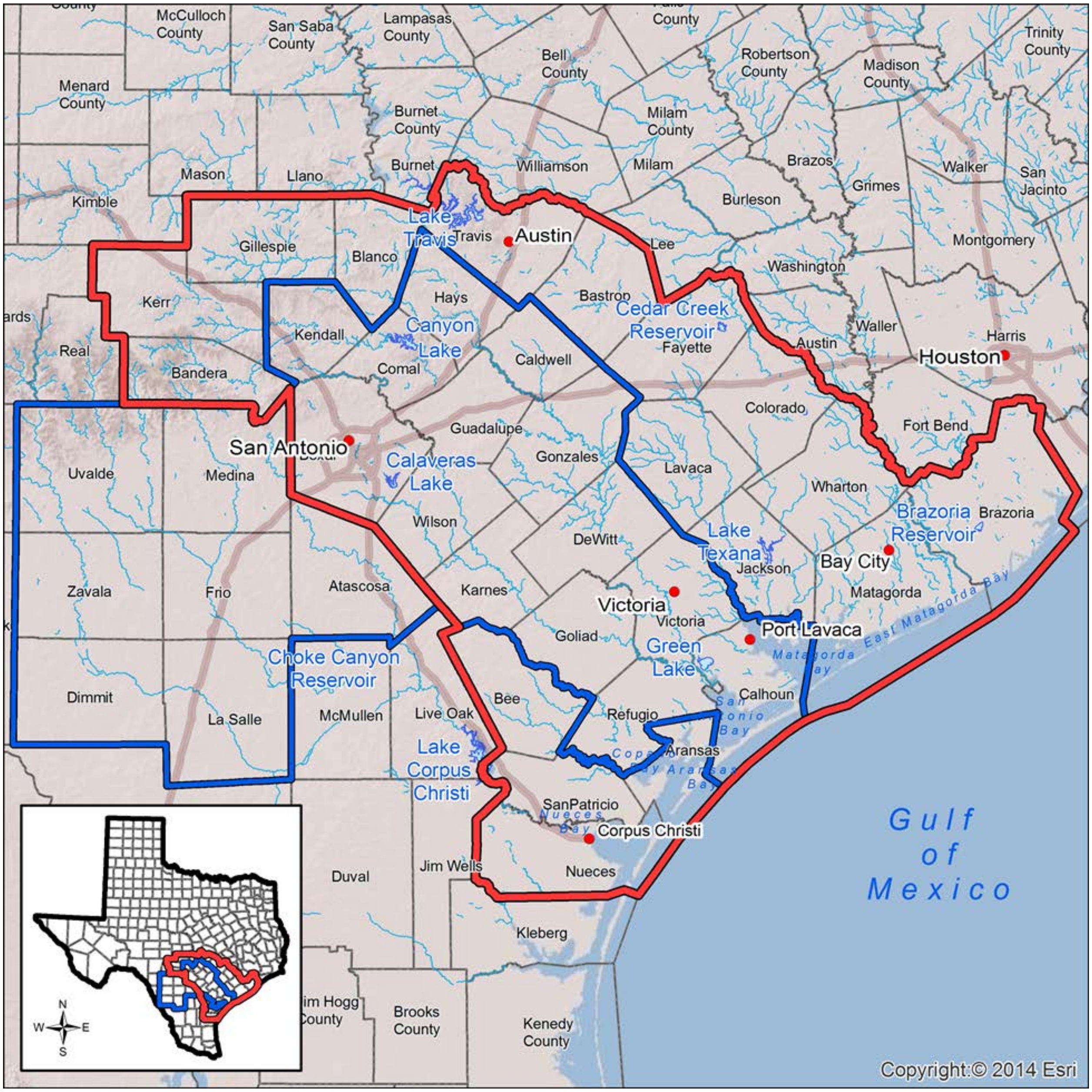


Figure 1 – IWPP Study Area

Seawater Intake and Location

The two primary intake configurations utilized for seawater intakes will be considered; subsurface intakes (beach wells) and open intakes. Subsurface intakes are direct-bury systems that use granular formations as a filter, thereby minimizing aquatic impingement and entrainment. The capacity of subsurface intakes can be limited based on the porosity of the granular material. These facilities also can cause significant environmental impacts during construction.

An open intake configuration would likely be tunneled construction and therefore have less environmental impacts during construction activities. The ease of construction for tunneling compared to open water trenching can provide a more cost-effective process, with capital expenditures roughly one-half to one-fourth of those for comparable capacity beach well intakes. The open intake would be at least 425 feet outside of the littoral zone (the coastal zone extending approximately 600 feet from shoreline, which is influenced by high/low tide levels). A minimal water depth of at least 60 feet for is being considered to minimize impacts to aquatic life. Engineering measures such as fine mesh screens and low intake velocities would be applied to minimize ecological disruption.

Water Treatment and Power Plant Site(s)

Candidate site locations were identified throughout the study area to enable evaluation of alternative water supply and power generation integration strategies. Over 20 site locations in the study area were identified from previous studies, study partner input, and a multi-parameter GIS-based review. Site locations were evaluated using a set of criteria that addressed environmental stewardship, social acceptance, intakes and outfalls, proximity to infrastructure, and general site conditions. Sites were rated for each criterion and ranked based on total scores. The results of the evaluation identified a set of Representative Sites that reflect the geographic distribution of the study area, and support a wide range of potential water supply implementation strategies, including delivery directly to industrial water users, delivery to a regional water conveyance network, or delivery directly to municipal water users. Four representative sites were identified in the evaluation process, one in each of four study area sub-regions, as shown on **Figure 2**. All Representative Sites are large enough for full build-out of water treatment power generation facilities.

Each Representative Site will be evaluated further to better refine desirable characteristics for the purpose of siting a seawater desalination plant, potentially co-located with power generation facilities. Preliminary facility layouts; connecting infrastructure to intakes, outfalls, water delivery points, electrical transmission, and fuel sources; cost; and permit requirements will be some of the many factors taken under consideration during representative site refinement.

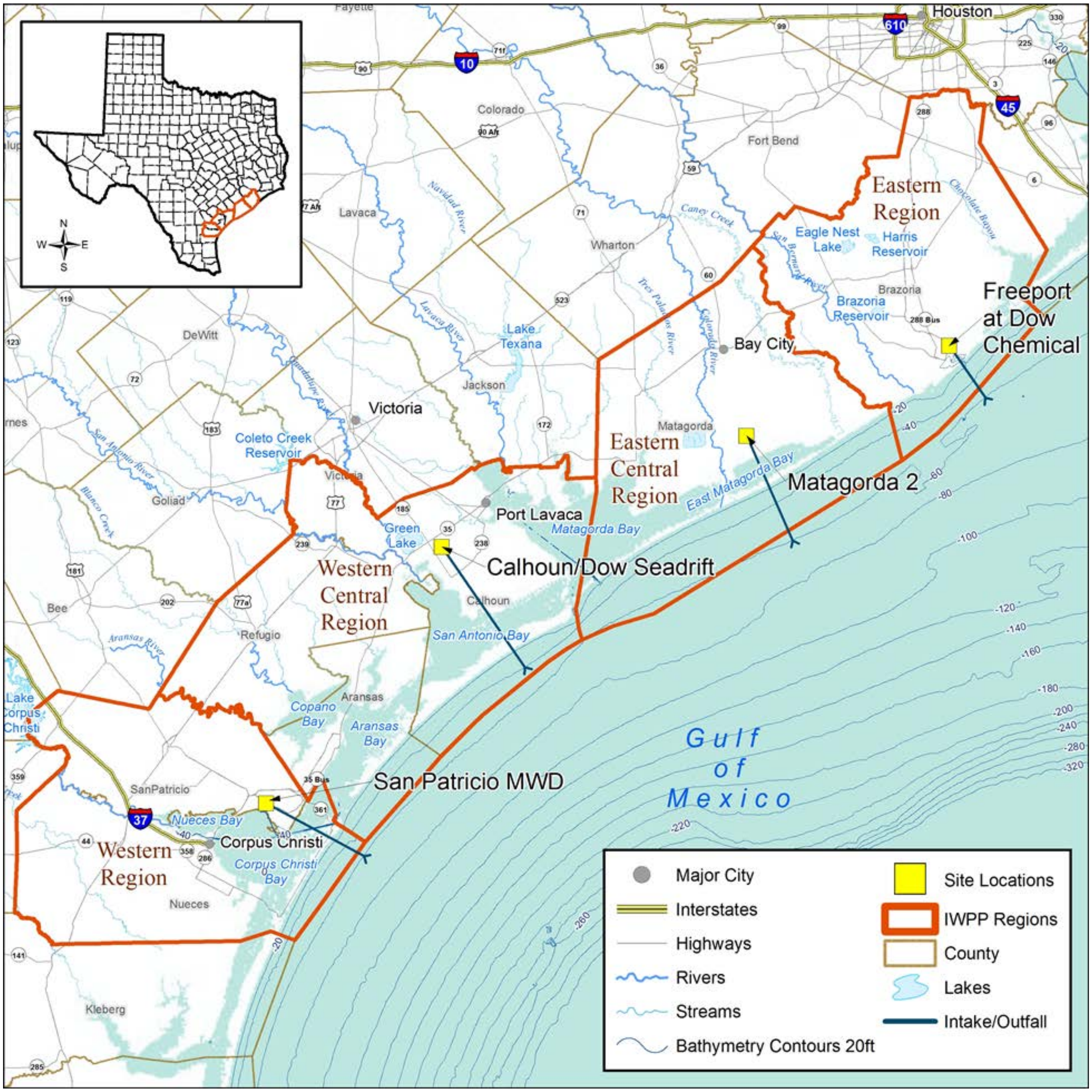


Figure 2 – IWPP Representative Site Regions

Concentrate Handling

Concentrate byproduct is generated during the desalination process. This stream is a derivative of plant recovery, which is typically near fifty percent for the anticipated treatment technology (seawater desalination through high-pressure reverse osmosis). The concentrate stream will have mineral and other constituent ratios roughly 1.5 to 2.5 times greater than that of the source water, and must be safely transported away from areas of consequential environmental impact.

Concentrate handling can be addressed through seawater, deep well injection, or zero-liquid discharge. Seawater return is the most common form of concentrate handling and involves high velocity injection and dispersion back into the ocean. Hydrodynamic mixing characteristics can be modeled to ensure adequate plume dispersion and minimal stratification, thereby reducing or eliminating impacts to surrounding ecosystems. Seawater return also provides an opportunity for combined return of spent cooling water from power generation.

Deep well injection feasibility is dependent on geological conditions in the surrounding area of a final site selection. Injection wells would be constructed in regions of geological confinement to prevent upward migration of concentrate into nearby aquifers. Multiple wells would potentially need to be constructed at various phases of plant expansion to allow for proper pressurization within return lines. Monitoring wells would be constructed adjacent to disposal wells to ensure containment is maintained.

Zero liquid discharge represents a mechanically-induced method of concentrate handling. Here, energy in the form of heat is added to the concentrate stream to crystalize concentrate byproducts. The volume of material remaining after evaporation of residual moisture allows the extraction and potential beneficial use of various minerals such as magnesium compounds, sulphates, and sodium chloride.

At this stage of the study, seawater return is the assumed method for concentrate handling. The majority of the pipeline(s) returning concentrate to the Gulf of Mexico can be constructed and run in parallel with the raw water intake lines. Re-introduction to the ocean and dispersion would occur at a location separate from the intake location to prevent concentrate short-circuiting the dispersion process and returning back to the treatment plant. A distance between intake(s) and outfall(s) of roughly one mile is anticipated at this preliminary planning phase to ensure adequate separation between plant components, with confirmation and adjustment of these distances based on modeling that would be performed in later phases of study.

Treatment Technology

Seawater desalination treatment technology is divided into two major categories: thermal evaporation and membrane separation. Thermal evaporation is an energy intensive method and generally considered economically unfeasible process in the United States due to the power requirements associated with evaporation at such a large scale.

Desalination through reverse osmosis (RO) is a process that utilizes induced pressure to overcome osmotic forces and separate solutions with different concentrations of ions. Initial plant sizing is tentatively scheduled to be 25 mgd (potable water output), expandable to 250 mgd in modular phasing as demand increases. A preliminary flow stream for the desalination of raw seawater is as follows:

- Raw water intake
- Initial screening
- Pretreatment chemical conditioning
- Secondary screening
- RO filtration and subsequent concentrate return
- Finished water chemical conditioning
- Storage and distribution

Planning level details for these items are being developed for layouts at each Representative Site. Various cost-saving measures and Best Engineering Practices (BEPs) will be considered and integrated during detailed planning efforts to maximize the value of construction efforts and minimize the economic impacts on end-customers. The use of energy recovery devices (ERDs) will be considered as a method of capturing and rededicating some of the energy high-pressure feed pumps place on RO feed water. The reuse of pressure will harvest mechanical energy from the membrane concentrate stream that otherwise would be unutilized, and minimize interstage pumping requirements between membrane passes.

The IWPP feasibility study will also consider sizing and phasing of plant components to advance cost-saving measures. Some plant components (such as intake structures, raw water transmission lines, and bulk chemical storage facilities) can be sized for construction beyond what their initial demand would be with no adverse impact to plant performance. The cost savings is realized by simply connecting new equipment as needed during an expansion phase, with no need for disruptive excavations or concrete work. Procedures as simple as obtaining extensive right-of-way for pipeline placement could result in substantial cost and schedule savings.

Plant layout configurations between the seawater desalination facility and the potential power generation facility could be yet another method for cost savings to the overall project. It is assumed that the power generation facility will need substantial amounts of cooling water for their processes. The RO process operates more efficiently at elevated feedwater temperatures, so there is the potential for a symbiotic relationship between the two plants where cooling water is used as RO feedwater to the treatment process. The American Water Works Association (AWWA) has shown that an increase in feedwater temperature from 15oC to 25oC can decrease the feed pressure requirements for the RO process by as much as 100 psi – which provides a substantial cost savings in equipment and power consumption. There is a careful balance that must be maintained during future planning however, as increased water temperatures also hinder the membrane’s ability to screen the contaminant boron from the feed water. A wide array of membrane elements, water temperatures, and flux rates will be considered during modeling efforts to find a safe, efficient, combination of feed conditions.

Firm Yield

Seawater desalination provides a rainfall independent source of potable or raw water. The firm yield of any potential water treatment facility is based on facility capacity and operations. The initial phase of the treatment plant is currently anticipated to provide 25 mgd of treated water. Facilities would be developed in phases as demands grow. The water treatment plant would be initially constructed at a capacity of 25 to 50 million gallons per day (mgd), and could be expanded to an ultimate capacity of 250 mgd.

RO treatment of seawater generally has a recovery rate of approximately fifty percent; therefore a firm yield of 25 mgd would require that initial treatment plant intake and process areas upstream of the finished water streams be sized for no less than 50 mgd. Engineering measures such as oversizing of treatment components (intake, chemical storage facilities, etc) may be utilized to cost-effectively manage construction efforts. Adequate power and process redundancies such as diesel-fueled generators and n+1 pump configurations will also ensure reliable plant performance and delivery capabilities.

Amounts and Delivery Points for Use

Specific delivery points and water demand quantities to each of those points have not yet been finalized and evaluations will continue through project feasibility. Integration of desalinated seawater to regional water supplies in the Coastal Bend area could include numerous approaches. The feasibility study will consider a variety of delivery point options to demonstrate the range of opportunity. The following two scenarios would likely demonstrate the widest range of delivery point scenarios for the representative sites.

The first scenario would deliver all of the water produced by the seawater desalination facility to one industrial customer. The plant site would be located at or adjacent to the industrial facility. And the single customer would be the sole delivery point. Because of the close proximity to the delivery point, minimal transmission lines and no booster stations would be required. Water quality produced by the desalination plant would be sufficient to meet industrial process requirements, and may not be potable. This scenario would allow the industrial customer to expand production within their facility and potentially sell or transfer water rights from current sources to other customers, or some combination.

A second scenario would delivery potable water from a seawater desalination plant to a municipal customer a substantial distance inland. Where possible, existing or planned regional infrastructure facilities, such as the Mary Rhodes Pipeline or the Mid-Basin Project, or right of way associated with these projects would be used. New pipelines and pumping facilities would be constructed, which would involve more intensive permitting, greater capital cost, and greater operating costs.

Average Day, Peak Day, or Intermediate Treatment and Transmission Capabilities

Multiple possible plant operation scenarios are possible, depending on the seasonal and daily demand variation, the amount of storage in the conveyance system, and the role of desalinated water in meeting overall water demands. One treatment scenario commonly used in regions where seawater desalination is used to supplement existing water reservoirs is to only run the treatment plant during periods of high demand (meaning summer and early fall seasons). This plan of operation is based on the assumption that the conventional source water is easier, and therefore more cost effective, to transport and treat than utilizing the RO process, which is an energy intensive process compared to other treatment technologies such as deep bed filtration, flocculation/sedimentation, or low pressure RO. The seawater desalination facility is considered an insurance policy during periods of water scarcity, and ready to be brought online with a few days' notice. The plant should be run, at a minimum, a few days each month regardless of need to exercise mechanical plant processes and prevent the RO membranes from drying out and prematurely degrading.

A second treatment scenario would be to run the plant on a constant basis, but only during hours of off-peak energy demand (i.e. evenings and late nights/early mornings) or run cyclically while ramping up/down depending on peak power periods. This option would have the plant running year-round to meet a constant demand of treated water for municipal and/or industrial use. It would also benefit from power consumption during periods where the electrical grid is not experiencing a high demand from daytime customers.

Once final delivery points are determined through additional planning efforts, an operational analysis study can be performed to determine the most cost effective method for plant runtimes between the two options discussed above, or some combination therein.

Power Plant Water Needs

Power plant water needs are dependent on whether or not a power generation facility is co-located (or constructed in the reasonable vicinity of) the seawater desalination plant. If the power generation facility is removed from consideration, there is obviously zero demand for water and all desalination product water is available for transmission to end-user delivery points. If a power generation facility is constructed in conjunction with the seawater treatment facility, the size, phasing, and selected power generation technology all play factors in determining the water demands.

The most water intensive approach would be once-through cooling of the power plant. Alternate technologies, such as wet cooling towers or air-cooled condensers, represent more efficient options in terms of minimizing water demands at the power generation facility. These advanced technologies, however, potentially come with economic or design tradeoffs that should be considered in subsequent planning efforts. A brief summary of water need for various cooling technologies is show in **Table 1**.

Table 1 IWPP - Power Plant Water Demand Estimates

Nominal Combined Cycle Gas Turbine Power Plant Size	Steam Turbine(s) Size	Heat Rejection Technology	Heat Rejection Cooling (Raw) Water Demand (mgd)	Cycle Make-up Demineralized Water Demand (mgd)	Evaporative Cooling Water Makeup (mgd)	Total Raw Water requirements (mgd)
300 MW (1x1 config)	100 MW	Once-through condenser	158.558	0.028	0.025	158.611
		Wet Cooling Tower	4.683	0.028	0.025	4.736
		Air Cooled Condenser	0	0.028	0.025	0.053
650 MW (2x1 config)	220 MW	Once-through condenser	313.877	0.057	0.050	313.984
		Wet Cooling Tower	9.271	0.057	0.050	9.378
		Air Cooled Condenser	0	0.057	0.050	0.107
1000 MW (3x1 config)	340 MW	Once-through condenser	468.847	0.085	0.075	469.007
		Wet Cooling Tower	13.847	0.085	0.075	14.007
		Air Cooled Condenser	0	0.085	0.075	0.160
2000 MW (Two blocks of 3x1 config)	675 MW	Once-through condenser	937.694	0.170	0.150	938.014
		Wet Cooling Tower	27.694	0.170	0.150	28.014
		Air Cooled Condenser	0	0.170	0.150	0.32
3000 MW (Three blocks of 3x1 config)	1000 MW	Once-through condenser	1406.541	0.255	0.225	1407.021
		Wet Cooling Tower	41.541	0.255	0.225	42.021
		Air Cooled Condenser	0	0.255	0.225	0.48

Other Preliminary Specifications

One of the key components in any planning phase of a project is an understanding of project cost. The seawater desalination component of the project presents fine nuances in that there are few ocean water desalination plants currently online in the US from which to compare. The majority of the world's seawater desalination facilities are in the Middle East or Australia – which are scalable comparisons, but not direct correlations due to regional price differences in construction/operation materials, labor, and energy.

The cost projections for the construction of a seawater desalination facility on the Gulf Coast of Texas are dependent on several factors including, but not limited to, the cost to convey raw water from the intake to the treatment plant, the cost to treat the raw water such that it is suitable for industrial and/or municipal use (this number is comprised of factors such as pre-treatment pumping and conditioning activities, the desalination process itself, and post-treatment polishing and pumping activities). Fixed costs would include structures, pipework, and equipment. Variable costs would include operations and maintenance needs and variable electricity rates. A total cost is expected to range from $1,700 per acre foot to $2,550 per acre foot and should be further refined during pre-design activities.

The IWPP project is currently in the feasibility/planning stage. A reasonable schedule on a path forward to potable water delivery is shown in **Figure 3**.

Develop Water and Power Options	• Q3 2014 to Q1 2015
Formulate and Evaluate Alternatives	• Q4 2014 to Q1 2015
Prepare Feasibility Report	• Q4 2014 to Q2 2015
Planning/Predesign	• Q2 2015 to Q1 2016
Environmental Compliance and Permitting	• Q1 2016 to Q1 2018
Design	• Q1 2016 to Q1 2018
Bid and Award	• Q1 2018 to Q4 2018
Construction	• Q1 2018 to Q3 2020
Startup and Commissioning	• Q2 2020 to Q1 2021

Figure 3 – IWPP Implementation Schedule

The schedule shows that the IWPP could be operational early in the 2020 decade. This schedule is based on estimated durations to accomplish the identified tasks and could be affected by additional time required for decision-making by project partners, securing financing and unforeseen permitting needs. However, it should be possible to accomplish any additional requirements within a timeframe that assures the project could serve water in advance of 2030. For this reason, the decade of need for the project is identified as 2030.

5.2.39 Storage above Canyon Reservoir

5.2.39.1 Description of Water Management Strategy

Water management strategies of the 2016 South Central Texas Regional Water Plan (SCTRWP) are sized and scheduled to meet seasonal and daily variations of demand, but, without storage, some current and proposed supplies may not be fully reliable during extended droughts. Thus, the need for surface reservoirs, large-scale Aquifer Storage and Recovery (ASR) systems, or multipurpose reservoirs, which are adequate in size to store surplus flows of surface water during periods of high streamflows, including flood flows, to be available during extended periods of drought. The Storage above Canyon Reservoir water management strategy involves implementing an ASR facility specifically in the watershed above Canyon Reservoir. For the Storage above Canyon Reservoir water management strategy, the capability of the Trinity Aquifer to store surface water available under a new appropriation in Kendall, County was assessed and the firm supply of this option evaluated. The water management strategy will be used to meet seasonal demands when restrictions are active.

Identification of Aquifer Storage and Recovery Sites

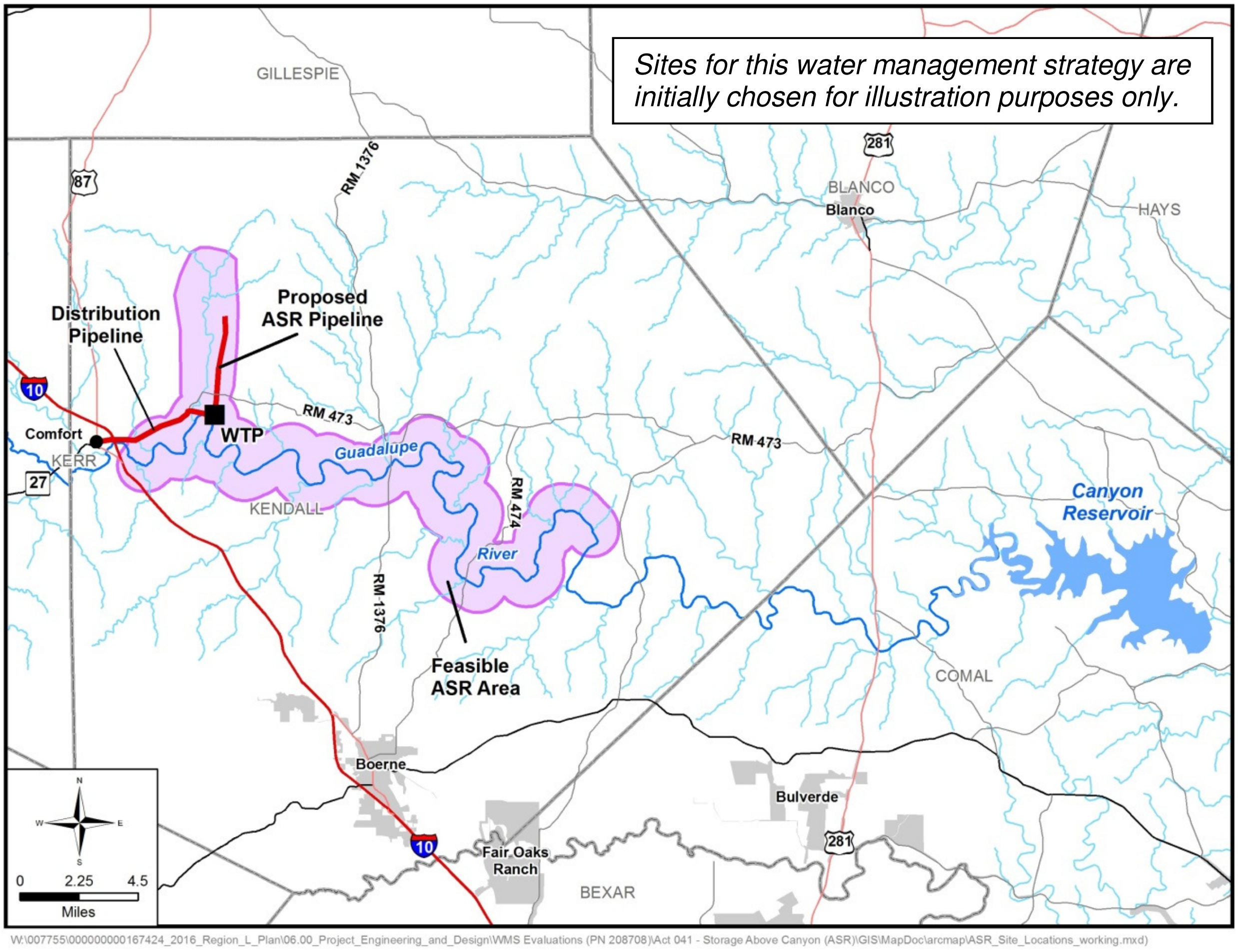
Aquifer Storage and Recovery (ASR), or underground storage of water treated to drinking water standards and subsequent recovery in times of need, could be used to firm-up interruptible run-of-river water available under a new appropriation to meet demands in Kendall and/or Comal Counties. Potential ASR sites above Canyon Reservoir were identified based on proximity to the Guadalupe River and the geology of the area. The area identified for potential ASR implementation shown in Figure 5.2.39-1 was chosen based on an analysis of existing well yields and depth to the Trinity Aquifer in the immediate area and is not meant to exclude other areas that may be identified as potential ASR sites in future studies. The identified area follows the Guadalupe River and Block Creek northeast of Comfort to minimize pumping costs from the Guadalupe River to the ASR well field site.

The basic assumptions made to determine the size and characteristics of the components of the ASR site are listed in Table 5.2.39-1. For the ASR site, an aquifer storage capacity of 12,500 acft for the ASR site and an injection rate of 350 gpm for ten wells were assumed. Facilities would include an intake(s), channel dam and pump station(s) at the Guadalupe River, transmission pipeline to the ASR wells, treatment plant, fifteen ASR wells, and a transmission pipeline to the City of Comfort.

Table 5.2.39-1 Engineering Assumptions for ASR Option

Parameter	*Assumption*	*Description*
Aquifer Storage Capacity	12,500 acft	-
Number of ASR wells	15	Injection and Recovery
Injection Rate	350 gpm	Pumps used to meet demand are turned on automatically for injection when water is available.
Monthly Demand Pattern	Municipal	Municipal demand pattern from GSA Model

Figure 5.2.39-1 Proposed Aquifer Storage and Recovery Area



5.2.39.2 Water Availability

To determine the amount of water available for an ASR system, results from the Guadalupe-San Antonio River Basin Water Availability Model (GSAWAM) estimating monthly total streamflow and unappropriated streamflow available at the Guadalupe River above Canyon Reservoir were used. A subordination agreement with Canyon reservoir was not assumed for diversions rom the ASR site and diversions are subject to prior appropriation and TCEQ environmental flow standards. The firm yield supply of the ASR system of 504 acft/yr was estimated using a spreadsheet-based model that incorporates a municipal demand pattern from the GSAWAM and by first meeting demands before injecting water into the subsurface.

5.2.39.3 Environmental Issues

The Storage above Canyon Reservoir (ASR) water management strategy involves the development of an intake, channel dam and pump station(s) at the Guadalupe River, fifteen ASR wells, transmission pipeline to the ASR wells, water treatment plant and a transmission pipeline to the City of Comfort.

The project area occurs within the Edwards Plateau vegetational area which includes a granitic central area, semi-arid western area and Balcones Escarpment eastern boundary. Vegetation in this area typically includes a tall or mid-grass understory and brush overstory complex which includes live oak (*Quercus virginiana*), shinnery oak (*Q. havardii*), junipers (*Juniperus* spp.) and mesquite (*Prosopis glandulosa*). Climax grasses include yellow Indian grass (*Sorghastrum nutans*), switchgrass (*Panicum virgatum*), and little bluestem (*Schizachyrium scoparium*) among others.

The ASR area includes areas of three different vegetation types as described by the Texas Parks and Wildlife Department (TPWD). These include Live oak-Ashe Juniper Parks, Live oak-Ashe Juniper Woods and Live oak-Mesquite-Ashe juniper Parks. The ASR wells, treatment plant and water transmission pipelines, which are the only portions of the project that would cause surface disturbance, occur primarily within the Live oak-Mesquite-Ashe juniper Parks vegetational type. The project area includes a portion of the Guadalupe River and numerous tributaries to this river. Block Creek and Flat Rock Creek, tributaries to the Guadalupe River, will be crossed by the project pipelines. Impacts to these creeks would be minimized by utilizing best management practices during construction activities.

The Texas Parks & Wildlife Department (TPWD) has identified a number of stream segments throughout the state as ecologically significant on the basis of biological function, hydrologic function, riparian conservation, exceptional aquatic life uses, and/or threatened or endangered species. Currently, 21 stream segments in Region L have been designated as ecologically significant by the Regional Water Planning Group.

The Guadalupe River from its confluence with the Comal River in Comal County upstream to the Kendall/Kerr County line, with the exception of Canyon Reservoir, is considered to be an ecologically significant stream segment. This classification is based on several factors including Hydrologic function in the Edwards Aquifer Zone, a Riparian conservation area in Guadalupe River State Park, High water quality/exceptional aquatic life/high aesthetic values and Overall use.

Vertebrate fauna typical within this region include the opossum, raccoon, weasel, skunk, white-tailed deer and bobcat as well as a wide variety of amphibians, reptiles and birds. The coyote and collared peccary are also common to the area, but are found mainly in brush/shrub areas while the red and gray fox are more common in woodlands.

Plant and animal species listed by U.S. Fish and Wildlife Service (USFWS) and TPWD that may occur within the vicinity of this water management strategy are listed in Table 5.2.39-2.

Table 5.2.39-2. Important Species Having Habitat or Known to Occur in Kendall County

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence
AMPHIBIANS								
Blanco River springs salamander	*Eurycea pterophila*	0	1	0	Subaquatic, found in springs and caves in the Blanco River drainage.			Resident
Cascade Caverns salamander	*Eurycea latitans complex*	0	2	0	Endemic, subaquatic in Edwards Aquifer		T	Resident
Comal blind salamander	*Eurycea tridentifera*	0	2	0	Endemic and semi-troglobitic, found in springs and waters of caves.		T	Resident
Texas salamander	*Eurycea notenes*	0	1	0	Endemic; troglobitic, found in springs, caves and creek headwaters restricted to Helotes and Leon Creek drainages.			Resident
BIRDS								
American peregrine falcon	*Falco peregrinus anatum*	0	3	0	Migrant and local breeder in West Texas.	DL	T	Possible Migrant
Arctic peregrine falcon	*Falco peregrinus tundrius*	0	2	0	Migrant throughout the state.	DL		Possible Migrant
Bald eagle	*Haliaeetus leucocephalus*	0	2	0	Found primarily near rivers and large lakes.	DL	T	Resident
Black-capped vireo	*Vireo atricapillla*	1	3	3	Semi-open broad-leaved shrublands	LE	E	Nesting/ Migrant
Golden-cheeked warbler	*Setophaga chrysoparia*	1	3	3	Woodlands with oaks and old juniper.	LE	E	Nesting/ Migrant
Interior least tern	*Sterna antillarum athalassos*	0	3	0	Nests along sand and gravel bars in braided streams	LE	E	Resident
Mountain plover	*Charadrius montanus*	0	1	0	Non-breeding, shortgrass plains and fields			Nesting/ Migrant
Sprague's pipit	*Anthus spragueii*	0	1	0	Migrant in Texas in winter mid Sept. to early April. Strongly tied to native upland prairie.	C		Possible Migrant

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence
Western burrowing owl	*Athene cunicularia hypugaea*	0	1	0	Open grasslands, especially prairie, plains and savanna			Resident
Whooping crane	*Grus americana*	0	3	0	Potential migrant	LE	E	Potential Migrant
Zone-tailed hawk	*Buteo albonotatus*	0	2	0	Arid, open country including deciduous or pine-oak woodland.		T	Nesting/ migrant
CRUSTACEANS								
Cascade Cave amphipod	*Stygobromus dejectus*	0	1	0	Subaquatic crustacean found in pools.			Resident
Long-legged cave amphipod	*Stygobromus longipes*	0	1	0	Subaquatic crustacean found in subterranean streams.			Resident
FISHES								
Guadalupe bass	*Micropterus treculi*	1	1	1	Endemic to perennial streams of the Edwards Plateau region.			Resident
Guadalupe darter	*Percina sciera apristis*	0	1	0	Guadalupe River basin, over gravel or gavel and sand raceways of large streams and rivers.			Resident
Headwater catfish	*Ictalurus lupus*	0	1	0	Now limited to Rio Grande drainage in clear creeks and small rivers.			Historic Resident
INSECTS								
A mayfly	*Baetodes alleni*	0	1	0	Distinguished by aquatic larval stage and adult stage along shoreline vegetation.			Resident
A mayfly	*Allenhyphes michaeli*	0	1	0	Found in Texas hill country.			Resident
Rawson's metalmark	*Calephelis rawsoni*	0	1	0	Moist areas in shaded limestone outcrops in central Texas.			Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence
MAMMALS								
Black bear	*Ursus americanus*	0	2	0	Mountains, broken county in brushlands and forests.	T/SA; NL	T	Resident
Cave myotis bat	*Myotis velifer*	0	1	0	Roosts colonially in caves, rock crevices			Resident
Gray wolf	*Canis lupus*	0	3	0	Extirpated.	LE	E	Extinct
Plains spotted skunk	*Spilogale putorius interrupta*	1	1	1	Prefers wooded, brushy areas.			Resident
Red wolf	*Canis rufus*	0	3	0	Extirpated.	LE	E	Historic Resident
MOLLUSKS								
Creeper (squawfoot)	*Strophitus undulates*	0	1	0	Small to large streams. Colorado, Guadalupe, and San Antonio River basins.			Resident
False spike mussel	*Quincuncina mitchelli*	0	2	0	Substrates of cobble and mud. Rio Grande, Brazos, Colorado and Guadalupe river basins.		T	Resident
Golden orb	*Quadrula aurea*	0	2	0	Sand and gravel, Guadalupe, San Antonio, Lower San Marcos, and Nueces River basins	C	T	Resident
Texas fatmucket	*Lampsilis bracteata*	0	2	0	Streams and rivers on sand, mud and gravel, Colorado and Guadalupe River basins.	C	T	Resident
Texas pimpleback	*Quadrula petrina*	0	2	0	Mud, gravel and sand substrates, Colorado and Guadalupe river basins	C	T	Resident
PLANTS								
Basin bellflower	*Campanula reverchonii*	1	1	1	Texas endemic found on scattered vegetation on loose gravel on open slopes.			Resident
Big red sage	*Salvia pentstemonoides*	1	1	1	Texas endemic, found in moist to seasonally wet steep limestone outcrops on canyons.			Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	USFWS Listing	TPWD Listing	Potential Occurrence
Boerne bean	*Phaseolus texensis*	0	1	1	Narrowly endemic to rocky canyons in Edwards Plateau.			Resident
Hill country wild-mercury	*Argythamnia aphoroides*	0	1	0	Endemic; found in grasslands associated with oak woodlands.			Resident
Texas mock-orange	*Philadelphus texensis*	0	1	0	Limestone outcrops on cliffs and rocky slopes in shade of mixed evergreen-deciduous slope woodland forest.			Resident
REPTILES								
Cagle's map turtle	*Graptemys caglei*	1	2	2	Endemic to Guadalupe River System, nests on sand banks.		T	Resident
Spot-tailed earless lizard	*Holbrookia lacerata*	0	1	0	Moderately open prairie-brushland.			Resident
Texas Garter Snake	*Thamnophis sirtalis annectens*	1	1	1	Wet or moist microhabitats			Resident
Texas Horned Lizard	*Phrynosoma cornutum*	1	2	2	Varied, sparsely vegetated uplands.		T	Resident

LE/LT=Federally Listed Endangered/Threatened
DL=Federally Delisted
C=Candidate for Federal Listing
E, T=State Listed Endangered/Threatened
Blank = Considered rare, but no regulatory listing status

TPWD, 2014. Annotated County List of Rare Species – Kendall County, revised 8/7/2012.
USFWS, 2014. Endangered Species List for Texas.
http://ecos.fws.gov/tess_public/countySearch!speciesByCountyReport.action?fips=48259 accessed online July 17, 2014.

The four endangered birds listed for Kendall County are all migrants that occur occasionally in the area. No occurrences of the golden-cheeked warbler (*Dendroica chrysoparia*) and black-capped vireo (*Vireo atricapillus*) are documented near the project area. Consequently, the presence of these species in the vicinity of the project is unlikely. The interior least tern (*Sterna antillarum athalassos*) and whooping crane (*Grus Americana*) are species that may occur as migrants within the area. The interior least tern nests along sand and gravel bars in braided streams and the whooping crane prefers marshy areas for feeding. Because of the limited surface disturbance planned for this water management strategy no impacts to either of these species is anticipated.

The two federally endangered mammals, the gray wolf (Canis lupus) and red wolf (Canis rufus) are both considered to be extirpated within the project area, consequently no impacts to these species is anticipated from the project.

Three freshwater mussels, the golden orb (*Quadrula aurea*), Texas fatmucket (*Lampsilis bracteata*), and Texas pimpleback (*Quadrula petrina*) are state listed and federal candidate species. The false spike mussel (*Quincuncia mitchelli*) is only state listed but also occurs in the county. Aquatic species within the project area could potentially be affected by the construction of the intake, channel dam and pump station along the Guadalupe River. Best management practices during construction of these portions of the project would minimize any impacts to these species. Because surplus water would only be diverted from the aquatic habitat during periods of high stream flows, including flood flows, impacts to the normal existing aquatic habitat for the Guadalupe Rive would be anticipated to be minimal. No impacts to these species are anticipated from the proposed project.

The Texas Natural Diversity Database (TXNDD), maintained by TPWD, indicates known occurrences of two rare plants in the vicinity of the project, the basin bellflower (*Campanula reverchonii*), and big red sage (*Salvia pentstemonoides*). The basin bellflower is a Texas endemic which is found in areas of scattered vegetation on loose gravel and open slopes. Big red sage is also a Texas endemic which is usually located in moist to seasonally wet limestone outcrops in canyons or along creek banks. These species of concern are considered to be rare, but are not protected by USFWS or TPWD.

Several species listed as threatened by the state may possibly be affected by the project. These include the Cascade Caverns salamander (*Eurycea latitans complex*), Comal blind salamander (*Eurycea tridentifera*), Cagle's map turtle (*Graptemys caglei*), and Texas horned lizard (*Phrynosoma cornutum*). Because the project will only include water removed during high flow events, and no groundwater will be impacted by the project, no impacts are anticipated to the two subaquatic salamander species.

Ground disturbance associated with the project would be limited to the areas of the intake, pump station, treatment plant, wells and pipelines. Because an abundance of similar habitat areas exist near these project areas, and the Cagle's map turtle and Texas horned lizard have the ability to move into those areas, no significant impacts to these species are anticipated from the project.

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 (Pl96-515), and the Archeological and Historic Preservation Act (PL93-291). Based on the review of available records obtained from the Texas Historical Commission, there are two National Register Properties and one National Register District within the project area. Seven cemeteries occur within the ASR area. Three historical makers are located near the distribution pipeline area. A total of ten archeological site surveys have been performed within the project area. The project location near water sources generally indicates a high probability of cultural resource sites within the area. Because the owner or controller of the project will likely be a political subdivision of the State of Texas (i.e., river authority, municipality, county, etc.), they will be required to coordinate with the Texas Historical Commission prior to project construction.

Field surveys conducted at the appropriate phase of development should be employed to minimize the impacts of construction and operations on sensitive resources. Specific project features, such as water intakes, treatment plants, well fields, and pipelines generally have sufficient design flexibility to avoid most impacts or significantly mitigate potential impacts to geographically limited environmental and cultural resource sites.

Potential wetland impacts, which may include well field areas, treatment plant locations and pipeline stream crossings, can be minimized by right-of-way selection and appropriate construction methods, including erosion controls and re-vegetation procedures. If the project will affect waters of the United States or wetlands, the project sponsor will also be required to coordinate with the U.S. Army Corps of Engineers regarding any impacts to wetland resources. Compensation for net losses of wetlands would be required where impacts are unavoidable.

5.2.39.4 Engineering and Costing

The cost estimates for this water management strategy are shown in Table 5.2.39-1. Included in the costs for ASR is a raw water intake, pump stations, 600 ft intake pipe to WTP, a 5-MGD WTP at intake site in Kendall County, 4-mile ASR pipeline, 5 mile transmission pipeline to the City of Comfort, and 15 wells at a capacity of 350 gpm. Depending upon the location(s) and type(s) of use for water supplies associated with the ASR project, additional facilities and costs could include pipelines to customers. The cost of financing a project for 20 years at 5.5 percent interest is shown in Table 5.2.39 3. The annual cost, including debt service and operation and maintenance is $5,985,000 and the unit cost for a firm yield of 504 acft/yr is $11,875 per acft/yr.

Table 5.2.39-3 Cost Estimate Summary for Storage above Canyon Reservoir

Item	***Estimated Costs for Facilities***
Intake Pump Stations (5 MGD)	$5,725,000
Transmission Pipelines	$1,237,000
Well Fields (Wells, Pumps, and Piping)	$6,281,000
Water Treatment Plant (5 MGD)	$17,349,000
TOTAL COST OF FACILITIES	**$30,592,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$10,645,000
Environmental & Archaeology Studies and Mitigation	$461,000
Land Acquisition and Surveying (69 acres)	$547,000
Interest During Construction (4% for 2 years with a 1% ROI)	$2,958,000
TOTAL COST OF PROJECT	**$45,203,000**
ANNUAL COST	
Debt Service (5.5 percent, 20 years)	$3,782,000
Operation and Maintenance	
Intake, Pipeline, Pump Station (1% of Cost of Facilities)	$218,000
Water Treatment Plant (2.5% of Cost of Facilities)	$1,735,000
Pumping Energy Costs (1,931,779 kW-hr @ 0.09 $/kW-hr)	$174,000
TOTAL ANNUAL COST	**$5,985,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 1	504
Annual Cost of Water ($ per acft)	$11,875
Annual Cost of Water ($ per 1,000 gallons)	$36.44

5.2.39.5 Implementation Issues

This water supply option has been compared to the plan development criteria, as shown in Table 5.2.39-4.

An institutional arrangement may be needed to implement these projects, including financing on a regional basis. Other implementation issues include:

1. It will be necessary to obtain these permits:
    a. TCEQ Water Right and Storage permits.
    b. TCEQ Interbasin Transfer approval depending upon location(s) of use.
    c. USACE Sections 10 and 404 dredge and fill permits for the reservoir and pipelines.
    d. GLO Sand and Gravel Removal permits.
    e. GLO Easement for use of state-owned land.
    f. Coastal Coordination Council review.
    g. TPWD Sand, Gravel, and Marl permit.
2. Permitting, at a minimum, will require these studies:
    a. Assessment of instream flow and bay and estuary inflow changes.
    b. Habitat mitigation plan.
    c. Environmental studies.
    d. Cultural resources.
3. Land will need to be acquired through either negotiations or condemnation.
    a. Relocations for the reservoir may include:
    b. County roads.
    c. Utilities.
    d. Structures of historical significance.
    e. Cemeteries.

Table 5.2.39-4 Comparison of ASR-Canyon Reservoir to Plan Development Criteria

Impact Category	***Comment(s)***
A. Water Supply 1. Quantity 2. Reliability 3. Cost	 1. Low 2. Moderate reliability 3. High
B. Environmental factors 1. Environmental Water Needs 2. Habitat 3. Cultural Resources 4. Bays and Estuaries 5. Threatened and Endangered Species 6. Wetlands	 1. low to moderate impact 2. Possible low impact 3. None or low impact 4. None or low impact 5. Possible impact 6. None or low impact
C. Impact on Other State Water Resources	No apparent negative impacts on state water resources; benefit accrues to demand centers by more efficient use of available water supplies; no effect on navigation
D. Threats to Agriculture and Natural Resources	Generally positive effect to agriculture and natural resources by managing supply more effectively
E. Equitable Comparison of Strategies Deemed Feasible	Option is considered to meet municipal shortages
F. Requirements for Interbasin Transfers	Not applicable
G. Third Party Social and Economic Impacts from Voluntary Redistribution	Could offset the need for voluntary redistribution of other supplies

5.2.39.6 Comments Received Prior to IPP

David Langford, hill country resident and former Region L Planning Group member, submitted the following comments upon presentation of the Storage above Canyon (ASR) water management strategy to the SCTRWPG on February 5, 2015.

My comments are regarding the "Storage above Canyon Reservoir (ARS)." Those comments are as follows:

1. *The site for this strategy was initially chosen for illustration purposes only. As such, it is my understanding is that no science has been done, to date, regarding the feasibility of this strategy on this particular site. Consequently it remains "for illustration only." If this is*

accurate, all communication, including maps, publications, PowerPoints, etc., should reflect this status.

2. *Our family has been living and ranching along Block Creek (this "illustration" site) since 1885. (Please see my book, www.hillingdonranchbook.com for background.) We can testify that injecting 350 gallons per minute into these formations would likely be nearly impossible. It's optimistic, at best, to think such a rate of injection is realistic when, for miles around, only a few gallons per minute can be produced by any wells in this area.*
3. *In my comments of February 19, 2010, regarding this agenda item as it was presented then in the IPP, there was further discussion of the use of eminent domain. Those comments continue to apply, and will always apply. Eminent domain should be justly applied only as an absolute last resort, after bona fide willing-buyer/willing-seller negotiations have failed.*

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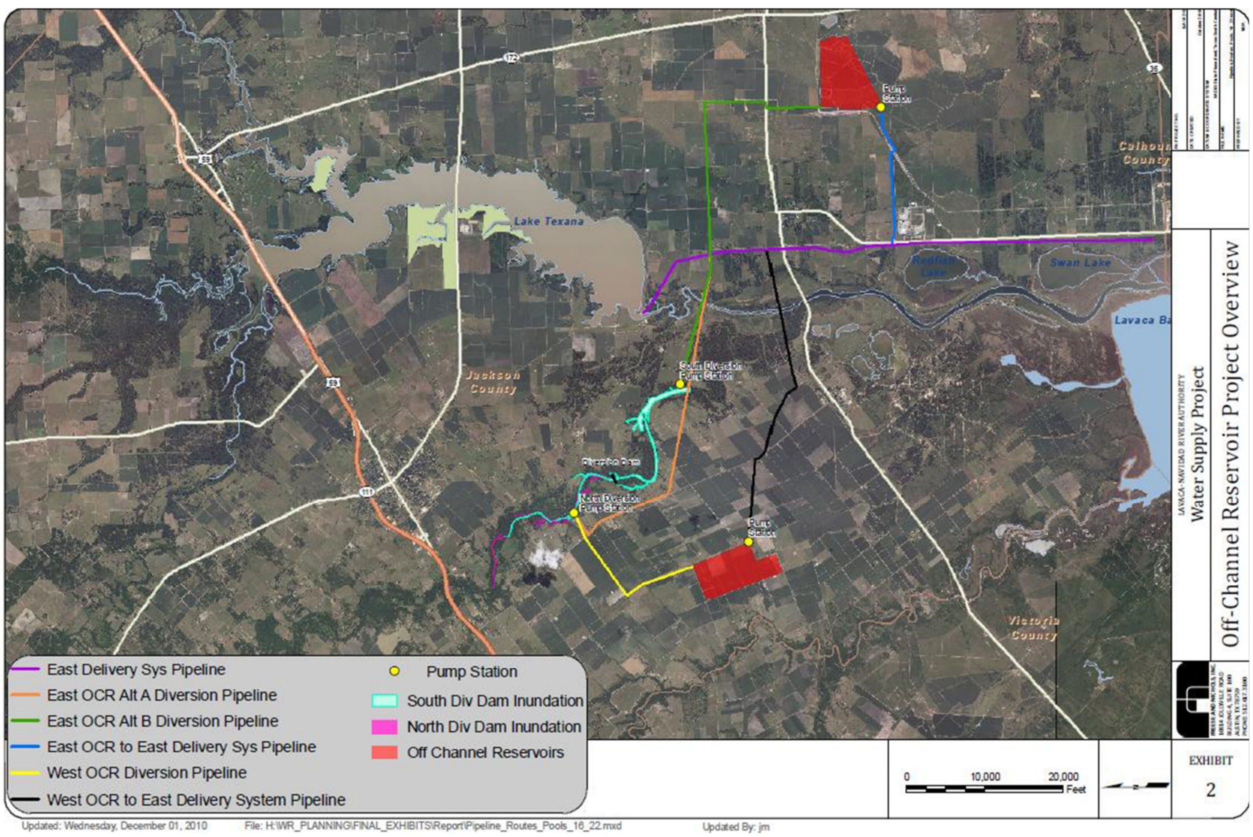
5.2.40 Lavaca River Off-Channel Reservoir

5.2.40.1 Description of Water Management Strategy

The Lavaca-Navidad River Authority (LNRA) has considered multiple scenarios for construction of new reservoir storage, including both on- and off-channel reservoirs. The Lavaca River Water Supply Project Feasibility Study, completed in 2011 by Freese & Nichols, Inc., compared a variety of these configuration options, as shown in Figure 5.2.40-1 below, and recommended the most feasible scenarios for implementation including either the West Off-Channel Reservoir Project or the East Off-Channel Reservoir Project Alternative B. LNRA's Strategic Resource Management Plan (revised 2013) includes the development of an off-channel option as the preferred approach. A summary of the strategy is provided in this Plan. Additional details regarding the strategy scenarios can be found in the above-mentioned Lavaca River Water Supply Project Feasibility Study.

Figure 5.2.40-1 Off-Channel Reservoir Project Overview



In both cases of the West Off-Channel and East Off-Channel B Reservoirs, the minimum facility requirements would include the storage reservoir and associated pump stations to deliver water from the river to the reservoir. Diversion points and conceptual level pipeline alignments are different in each scenario and shown in Figure 5.2.40-1 above. Two pump stations are required for both off-channel alternatives, including a Lavaca River diversion pump station to divert flows and an off-channel reservoir pump station to deliver raw water to the existing LNRA East Delivery System pipeline.

The associated pump station would turn on when there is sufficient storage in the off-channel reservoir and when there is sufficient depth of water covering the inlet pipe. The amount of water pumped is limited primarily to flow conditions in the river and would likely be restricted to short-duration, high flow events. Thus the associated river pump would be required to pump at significantly high rates in order to capture flood flows. A diversion dam to increase the in channel storage and optimize pumping opportunities is also considered in the scenarios in order to increase firm yield. A relatively small amount of in-channel storage could increase the project yield at minimal cost compared to the cost of increasing the size of the off-channel reservoir in order to store more water.

The West Off-Channel Reservoir project includes a diversion dam structure (North Diversion Dam) on the Lavaca River, a raw water diversion pump station on the Lavaca River, a raw water diversion pipeline from the diversion pump station to the off-channel reservoir, the West Off-Channel Reservoir, a raw water delivery pump station at the off-channel reservoir, and a raw water delivery pipeline from the West Off-Channel Reservoir to the existing LNRA East Delivery System pipeline serving customers to the south.

The East Off-Channel Reservoir Alternative B project utilizes an alternative diversion dam on the Lavaca River referred to as the South Diversion, a raw water diversion pump station on the Lavaca River, a raw water diversion pipeline from the diversion pump station to the off-channel reservoir, the East Off- Channel Reservoir, a raw water delivery pump station at the off-channel reservoir, and a raw water delivery pipeline from the East Off-Channel Reservoir to the existing LNRA East Delivery System pipeline serving customers to the south.

5.2.40.2 Available Yield

The firm yield of the Lavaca Off-Channel Reservoir project was analyzed, using an unmodified version of the Lavaca River WAM Run 3, to have no negative impacts to the freshwater inflows to Lavaca Bay, as dictated by the latest TCEQ environmental flow standards, adopted August 2012. Additions and changes to the Base Lavaca WAM to create the strategy analysis are in the Attachment.

The firm yield of the reservoir was determined to be approximately 16,963 ac-ft/yr. This firm yield would increase LNRA's supply as a wholesale water provider. 10,000 acft/yr of the yield is identified to meet existing manufacturing water needs in Region L, Calhoun County. The remaining yield would be available to meet potential water needs for municipal, industrial, or other water users in Region P (Jackson County), Region L, or Region N.

The proposed location of the off-channel reservoir is such that it is downstream of all TCEQ adopted environmental flow standard instream flow measurement points along the Lavaca River. The only TCEQ standard that needs to be met is the Bay and Estuary Freshwater Inflow standards for the Lavaca Bay System. The Standards are identified in Table 5.2.40-1. Projects requiring new water rights permits shall not cause or contribute to an impairment of the inflow regimes described below.

Table 5.2.40-1 Bay and Estuary Freshwater Inflow Standards for the Lavaca Bay System

Inflow Regime	Spring Inflow Quantity (ac-ft)	Fall Inflow Quantity (ac-ft)	Intervening Inflow Quantity (ac-ft)	Annual Strategy Frequency
Subsistence	13,500	9,600	6,900	96%
Base Dry	55,080	39,168	28,152	82%
Base Average	127,980	91,080	65,412	46%
Base Wet	223,650	158,976	114,264	28%

The Lavaca off-channel reservoir project was modeled so that the model incorporating the strategy either met or exceeded the required annual strategy frequency for each seasonal period; or if the Base Lavaca WAM did not meet the required annual strategy frequency, then the strategy model did not decrease it further. The frequency attainment results are shown in Table 5.2.40-2 for the Base WAM and the Strategy WAM, respectively.

Table 5.2.40-2 Base WAM and Lavaca OCR Results

Onset Period	Subsistence		Base Dry		Base Avg.		Base Wet	
	Count	%	Count	%	Count	%	Count	%
Base WAM Results								
Springtime	51	89%	45	79%	38	67%	25	44%
Fall	45	79%	32	56%	19	33%	16	28%
Intervening 6 mo	55	96%	52	91%	45	79%	39	68%
Lavaca OCR Results								
Springtime	51	89%	45	79%	37	65%	24	42%
Fall	45	79%	32	56%	19	33%	16	28%
Intervening 6 mo	55	96%	52	91%	45	79%	38	67%

5.2.40.3 Environmental Issues

The Lavaca OCR project involves the building of an approximately 1,019 acre OCR about six miles southwest of Lake Texana in Jackson County. The purpose of this OCR is to store excess river water which is available during high flow events via an intake and pipeline from the Lavaca River. The stored water would then be transferred via a pipeline from the OCR to the existing LNRA East Delivery System pipeline to serve area needs and stabilize an otherwise interruptible water source.

The proposed Lavaca River OCR and associated pipeline routes are situated within the Western Gulf Coastal Plain Ecoregion, in an area designated as the Northern Humid Gulf Costal Prairies.[1] Deltaic sands, silts, and clays underlie much of this area, which occurs on a gently sloping coastal plain. The original vegetation within this region included primarily grasslands with a few clusters of oaks (*Quercus* spp.) or maritime woodlands. Historically dominant grassland species include little bluestem (*Schizachyrium scoparium*), yellow Indiangrass (*Sorghastrum nutans*), brownseed paspalum (*Paspalum plicatulum*), gulf muhly (*Muhlenbergia capillaris*), and switchgrass (*Panicum virgatum*). The majority of this region is currently utilized as cropland, rangeland, pasture, or urban land, with woodlands occurring only as remnant riparian strips.[2] Construction of the off-channel reservoir is planned within an area normally used for agriculture; however the pipeline and pump station construction may include the clearing and removal of some areas of riparian vegetation along the Lavaca River and areas southwest of Lake Texana. Therefore, the proposed off-channel reservoir would have a marginal impact on local agricultural activities. Siting of the project and inundation of the off-channel reservoir would remove approximately 1,200 acres of agricultural land from production, but would have minimal influence given the large quantity of agricultural land in the area.

The project also occurs within an area known as the Texan Biotic Province.[3] Mammals typical of this province include the Virginia opossum (*Didelphis virginiana*), fox squirrel (*Sciurus niger*), fulvous harvest mouse (*Reithrodontomys fulvescens*), and swamp rabbit (*Sylvilagus aquaticus*). Typical anuran species within this area include the Gulf Coast toad (*Bufo valliceps*), green treefrog (*Hyla cinerea*), bullfrog (*Rana catesbeiana),* and eastern narrowmouth toad (*Microhylla carolinensis*).

In addition, the Lavaca River location where the new diversion pipeline to the Lavaca River OCR originates is listed by the Texas Parks and Wildlife Department (TPWD) as occurring within an Ecologically Significant Stream Segment, a designation which signifies areas of unique ecological value.

Table 5.2.40-3 lists nine federally-listed endangered or threatened wildlife and plant species, 22 state-listed endangered and threatened wildlife and plant species, and additional state and federal species of concern that may occur in Jackson County. Information found within this table originates from the county lists of rare species provided by the TPWD online in their “Annotated County Lists of Rare Species.”

Inclusion in Table 5.2.40-3 does not mean that a species will occur within the project area, but only acknowledges the potential of its occurrence in Jackson County. In addition to the county list, the TPWD Natural Diversity Database (NDD) was reviewed for known occurrences of listed species within or near the project area.

Listed species may have habitat requirements or preferences that suggest they could be present within the project area. However, the presence or absence of potential habitat does not confirm the presence or absence of a listed species. No species specific surveys were conducted in the project area for this report. Surveys for protected species

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[1] Griffith, G.E., Bryce, S.A., Omernik, J.M., Comstock, J.A., Rogers, A.C., Harrison, B., Hatch, S.L., and Bezanson, D., 2004, Ecoregions of Texas (color poster with map, descriptive text, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:2,3000,000).
[2] Gould, F. W., “The Grasses of Texas,” Texas A&M University Press, College Station, Texas, 1975.
[3] Blair, W. Frank, “The Biotic Provinces of Texas,” Texas Journal of Science 2(1):93-117, 1950.

should be conducted within the proposed construction corridors where preliminary evidence reveals preferred habitat or indicates their potential presence.

Table 5.2.40-3 Endangered, Threatened, and Species of Concern for Jackson County

Common Name	***Scientific Name***	***Summary of Habitat Preference***	***Listing Entity***		***Potential Occurrence in County***
			USFWS	***TPWD***	
Birds					
Peregrine Falcon	*Falco peregrinus*	Two subspecies, listing statuses differ; see *anatum* and *tundrius* descriptions below.	DL	T	Possible Migrant
American Peregrine Falcon	*Falco peregrinus anatum*	Resident and local breeder in West Texas. Migrant across the state.	DL	T	Possible Migrant
Arctic Peregrine Falcon	*Falco peregrinus tundrius*	Migrant throughout the state.	DL		Possible Migrant
Bald eagle	*Haliaeetus leucoephalus*	Found primarily near rivers and large lakes.	DL	T	Possible Migrant
Brown pelican	*Pelecanus occidentalis*	*Largely coastal and near shore areas.*	DL		Resident
Henslow's Sparrow	*Ammodramus henslowii*	Found in weedy fields or cut-over areas			Resident
Interior least tern	*Sterna antillarum athalassos*	Nests along sand and gravel bars in braided streams	LE	E	Resident
Mountain Plover	*Charadrius montanus*	Non-breeding, shortgrass plains and fields			Nesting/ Migrant
Reddish Egret	*Egretta rufescens*	Resident of Texas Gulf coast.		T	Resident
Snowy Plover	*Charadrius alexandrines*	Potential migrant, winters along coast			Migrant
Sooty Tern	*Sterna fuscata*	Usually flies or hovers over water.		T	Resident
Southeastern Snowy Plover	*Charadrius alexandrines tenuirostris*	Wintering migrant along the Texas Gulf Coast.			Migrant
Sprague's Pipit	*Anthus spragueii*	Migrant found in Texas only during winter. Strongly tied to native upland prairie, locally common in coastal grasslands.	C		Possible Migrant
Western Burrowing Owl	*Athene cunicularia hypugaea*	Open grasslands, especially prairie, plains and savanna			Resident
White-faced Ibis	*Plegadis chihi*	Prefers freshwater marshes.		T	Resident
White-tailed hawk	*Buteo albicaudatus*	Found near the coast on prairies, cordgrass flats, and scrub-live oak.		T	Resident
Whooping Crane	*Grus americana*	Potential migrant	LE	E	Potential Migrant
Wood Stork	*Mycteria Americana*	Forages in prairie ponds, ditches, and shallow standing water, formerly nested in TX.		T	Migrant
Fishes					

Common Name	Scientific Name	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County
			USFWS	TPWD	
American eel	*Anguilla rostrata*	Coastal waterways below reservoirs to gulf.			Resident
Smalltooth sawfish	*Pristis pectinata*	Young found very close to shore in muddy and sandy bottoms, adults occur in various habitat types.	LE	E	Resident
Mammals					
Louisiana black bear	*Ursus americanus luteolus*	Possible transient; bottomland hardwoods and forested areas.	LT	T	Possible Transient
Plains spotted skunk	*Spilogale putorius interrupta*	Found in open fields, prairies and croplands.			Resident
Red wolf	*Canis rufus*	Extirpated species formerly known throughout the eastern half of Texas.	LE	E	Extirpated
West Indian manatee	*Trichechus manatus*	Aquatic herbivore found in the gulf and bay system	LE	E	Possible Migrant
Mollusks					
Texas fatmucket	*Lampsilis bracteata*	Found in streams and rivers on sand, mud, and gravel substrates in the Colorado and Guadalupe river basins; intolerant of impoundments.	C	T	Resident
Reptiles					
Green sea turtle	*Chelonia mydas*	Gulf and bay systems.	LT	T	Resident
Gulf saltmarsh snake	*Nerodia clarkia*	Found on saline flats.			Resident
Kemp's Ridley sea turtle	*Lepidochelys kempii*	Found in gulf and bay systems.	LE	E	Resident
Loggerhead sea turtle	*Caretta caretta*	Gulf and bay systems for juveniles, ocean for adults.	LT	T	Resident
Texas diamondback terrapin	*Malaclemys terrapin littoralis*	Found in coastal marshes and tidal flats.			Resident
Texas horned lizard	*Phrynosoma cornutum*	Varied, sparsely vegetated uplands.		T	Resident
Texas scarlet snake	*Cemophora coccinea lineri*	Mixed hardwood scrub on sandy soils.		T	Resident
Texas tortoise	*Gopherus berlandieri*	Open brush w/ grass understory.		T	Resident
Timber/Canebrake rattlesnake	*Crotalus horridus*	Floodplains, upland pine, deciduous woodlands, riparian zones.		T	Resident
Plants					
Shinner's sunflower	*Helianthus occidentalis ssp. Plantagineus*	Found on prairies on the Coastal Plain			Resident
Threeflower broomweed	*Thurovia triflora*	Endemic: near coast.			Resident
Welder machaeranthera	*Psilactis heterocarpa*	Texas endemic found on grasslands.			Resident

LE/LT=Federally Listed Endangered/Threatened
DL=Federally Delisted
E, T=State Listed Endangered/Threatened

Common Name	Scientific Name	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County
			USFWS	TPWD	
Blank = Considered rare, but no regulatory listing status					
Source: TPWD, Annotated County List of Rare Species, Jackson County (updated 6/1/2012).					

The Migratory Bird Treaty Act protects most bird species, including, but not limited to, cranes, ducks, geese, shorebirds, hawks, and songbirds. Migratory bird pathways, stopover habitats, wintering areas, and breeding areas may occur within and adjacent to the project area, and may be associated with wetlands, ponds, shorelines, riparian corridors, fallow fields and grasslands areas. Although construction of the proposed off-channel reservoir could remove some habitats utilized by certain migratory bird species, it would create additional habitats for others.

Two bird species federally or state listed as endangered are included in the project area county. These include the interior least tern (*Sterna antillarum athalassos*), and whooping crane (*Grus americana*). The interior least tern and whooping crane are seasonal migrants which could pass through the project area. The interior least tern typically nests on bare or sparsely vegetated areas associated with streams or lakes, such as sand and gravel bars, beaches, islands, and salt flats. The main whooping crane flock nests in Canada and migrates annually to their wintering grounds in and around the Aransas National Wildlife Refuge near Rockport on the Texas coast. Whooping cranes occasionally utilize wetlands as an incidental rest stop during this migration.

Avian species listed by the State of Texas as threatened include the peregrine falcon (*Falco peregrinus*), bald eagle (*Haliaeetus leucocephalus*), reddish egret (*Egretta rufescens*), sooty tern (*Sterna fuscata*), white-faced ibis (*Plegadis chihi*), white-tailed hawk (*Buteo albicaudatus*), and wood stork (*Mycteria Americana*). The reddish egret, sooty tern and white-faced ibis are resident bird species within the project area. The peregrine falcon, bald eagle, snowy plover, southeastern snowy plover, and wood stork are migratory species which may occur infrequently within the project area. The peregrine falcon includes two subspecies which migrate across the state from more northern breeding areas in the U.S. and Canada to winter along the coast. The majority of nesting bald eagle pairs currently reported are found along major rivers and near reservoirs in Texas. Bald eagles are opportunistic predators, feeding primarily on fish captured in the shallow water of both lakes and streams or scavenged food sources. These birds may utilize tall trees near perennial water as roosting or nesting sites. Bald eagles are documented by the NDD in areas near Lake Texana.

Many of the listed species found within the project area, such as the Texas Tortoise (*Gopherus berlandieri*), Texas scarlet snake (*Cemophora coccinea lineri*), and timber/canebrake rattlesnake (*Crotalus horridus* are dependent on shrubland or riparian habitats which should be avoided wherever possible. The NDD indicates that the Texas diamondback terrapin (*Malaclemys terrapin littoralis)* has been documented near the mouth of the Lavaca River where it empties into the Lavaca Bay. This reptilian species of concern prefers a habitat which consists of coastal marshes and tidal flats.

Destruction of potential habitat has been minimized by the selection of an OCR project area which lies within previously disturbed areas of cropland. No designated critical habitat areas occur within the project area.[4] Care should be taken to ensure minimum impacts from construction to the existing riparian and wetland areas located along the Lavaca River and below Lake Texana. It is not anticipated that this project will have any permanent adverse effect on any state or federally listed threatened or endangered species or their designated critical habitat.

Habitat studies and surveys for protected species and cultural resources may need to be conducted at the proposed off channel site, and along the pipeline routes. Specific project features, such as pipelines, and off-channel reservoirs generally have sufficient design flexibility to avoid most impacts or significantly mitigate potential impacts to geographically limited environmental and cultural resource sites. Field surveys conducted at the appropriate phase of development should be employed to minimize the impacts of construction and operation on sensitive resources.

Potential wetland impacts are expected to primarily include the raw water pipeline crossing of the Lavaca River and wetland areas which occur south of Lake Texana. These impacts can be minimized by right-of-way selection and appropriate construction methods, including erosion controls and revegetation procedures. Compensation for net losses of wetlands would be required where impacts are unavoidable.

A review of the Texas Historical Commission Texas Historic Sites Atlas database indicated that there are four small cemeteries and two historical markers which occur within or near the area proposed for the construction of the pipeline routes between the OCR and Lake Texana. Avoidance of these areas should be possible through appropriate siting of the project pipelines.

[4] USFWS. Critical Habitat Portal. Accessed online at http://ecos.fws.gov/crithab/ on January 15, 2014.

5.2.40.4 Engineering and Costing

Costs for the construction of the off-channel reservoir scenarios are provided in Table 5.2.40-4 Costs assumed the more expensive East Off-Channel Alternative B, which is within approximately 10% of the cost of the West Off-Channel scenario. The costs were taken from the Lavaca River Water Supply Project Feasibility Study, and the costs were converted from December 2010 to September 2013. Actual costs could vary significantly due to project implementation requirements. The costs do not include water treatment or raw water purchase.

Table 5.2.40-4 Cost Estimate Summary for Lavaca OCR

Item	***Estimated Costs for Facilities***
CAPITAL COST	
Dam and Reservoir (Conservation Pool acft, acres)	$63,002,000
Pump Stations	$21,454,000
Parallel pipe from Alice to Ben Bolt	$2,928,000
Transmission Pipeline (18 in dia., 2 miles)	$35,829,000
TOTAL COST OF FACILITIES	**$123,213,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$41,470,000
Environmental & Archaeology Studies and Mitigation	$3,523,000
Land Acquisition and Surveying (0 acres)	$3,276,000
Interest During Construction (4% for 1 years with a 1% ROI)	$6,003,000
TOTAL COST OF PROJECT	**$186,564,000**
ANNUAL COST	
Debt Service (5.5 percent, 20 years)	$6,918,000
Reservoir Debt Service (5.5 percent, 40 years)	$5,909,000
Operation and Maintenance	
Intake, Pipeline, Pump Station (1% of Cost of Facilities)	$867,000
Dam and Reservoir (1.5% of Cost of Facilities)	$945,000
Pumping Energy Costs (727,187 kW-hr @ 0.09 $/kW-hr)	$65,000
TOTAL ANNUAL COST	**$14,704,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 1	16,963
Annual Cost of Water ($ per acft)	$867
Annual Cost of Water ($ per 1,000 gallons)	$2.66

5.2.40.5 Implementation Issues

The off-channel reservoir alternatives minimize challenges to implementation as compared to the on-channel scenario. Water rights, land acquisition, and relocation of infrastructure are considerations in the feasibility of this strategy. The evaluation of this strategy assumes that a new water right permit would be obtained for the project. As such, the TCEQ-adopted, Senate Bill 3-developed environmental flow standards, effective August 30, 2012, would need to be met in order for TCEQ to approve the permit.

Water Rights and Permit Modification

Under Certificates of Adjudication No. 16-2095, 16-2095A, 16-2095B, 16-2095C, and 16-2095D, LNRA is authorized to impound and divert water in the Lavaca and Navidad River basins for municipal, industrial, and recreational uses. These permits allow the use of water from two separate reservoirs, one on the Navidad River (existing Palmetto Bend Dam/Lake Texana) and one on the Lavaca River (proposed Palmetto Bend Stage II).

LNRA is authorized to impound up to 170,300 acft of water in Lake Texana on the Navidad River and an additional 93,340 acft in the proposed Palmetto Bend Stage II reservoir on the Lavaca River. LNRA is authorized to divert and use up to 79,000 acft from Lake Texana for municipal and industrial uses and an additional 36,000 acft (not including bay and estuary maintenance flows) from Palmetto Bend Stage II reservoir for municipal and industrial uses. Diversions are currently limited by location to two points on Lake Texana (East and West Delivery System Pump Stations) and by rate to up to 330 cfs total from Lake Texana. The impoundment and diversions of water each have a priority date of May 15, 1972.

In addition to the permit limitations specified above, the impoundment and diversion of water from Lake Texana is further subject to a bay and estuary release schedule. Inflows into Lake Texana are subject to release from Lake Texana as a function of both reservoir capacity and season. The existing permits further specify that prior to commencement of construction of Palmetto Bend Stage II reservoir, or any diversion of water from Stage II reservoir, upon the joint recommendation of LNRA, TWDB, and Texas Parks and Wildlife Department (TPWD), LNRA shall submit an application to the TCEQ to establish a schedule for the release of freshwater inflows from Stage II reservoir. In establishing the Stage II release schedule, the TCEQ may consider the modification to the Lake Texana release schedule. LNRA shall retain the right to withdraw its application at any time prior to any final decision by the TCEQ and upon withdrawal; the Lake Texana release schedule shall remain unchanged.

The existing water rights permits for Lake Texana and Stage II reservoirs would need to be modified to incorporate changes associated with the proposed Lavaca River Off-Channel Reservoir project. These modifications may include an additional diversion point on the Lavaca River, the impoundment of water in an off-channel reservoir as opposed to the currently permitted on-channel Stage II reservoir, likely changes in the amounts and distribution currently permitted for industrial and municipal uses, potential addition of agricultural use, and a proposed bay and estuary (i.e., pass through) schedule for the proposed Lavaca River Off-Channel Reservoir project.

It should be noted that these changes in conditions to the existing permit would likely require a major permit modification and require public notification. In addition, it should also be noted that any of these permit modifications, and specifically the required bay and estuary release schedule, could potentially reduce the project yield from the existing Lake Texana and/or the proposed Lavaca River Off-Channel Reservoir project.

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5.2.41 Purchase from Wholesale Water Provider

5.2.41.1 Description of Water Management Strategy

The Purchase from Wholesale Water Provider (WWP) water management strategy allows Water User Groups (WUGs) to plan for contractual commitments of new water from entities developing large, regional projects. In partnering with WWPs on large-scale projects, WUGs can participate in projects having economy of scale, potentially resulting in a lower unit cost of water than that for a smaller project.

TWDB defines a WWP as a "person or entity, including river authorities and irrigation districts, that had contracts to sell more than 1,000 acft/yr of water wholesale in any one year of the five years immediately preceding the adoption of the last RWP." Region L has expanded upon this definition to include entities that will be selling more than 1,000 acft/yr of water on a wholesale basis within the near-term of the current plan. For the 2016 SCTRWP, Region L has identified eight WWPs (Table 5.2.41-1).

5.2.41.2 Available Yield

Water available from WWPs in the 2016 SCTRWP includes both existing supplies and water from water management strategies developed by the WWP within the planning horizon. Table 5.2.41-1 shows the planned amount of new supply from water management strategies to be developed by each of the WWPs by 2070.

Table 5.2.41-1 Potential 2070 supply from recommended WWP strategies

Wholesale Water Provider	Potential New Supply by 2070 (acft/yr)
Canyon Regional Water Authority	23,454
Cibolo Valley Local Government Corporation	10,000
Guadalupe-Blanco River Authority	272,900
Hays-Caldwell Public Utility Agency	21,833
San Antonio Water System	290,940
Schertz-Seguin Local Government Corporation	7,112
Springs Hill Water Supply Corporation	0
Texas Water Alliance	20,000

5.2.41.3 Environmental Issues

There are no additional environmental impacts associated with the Purchase from Wholesale Water Provider water management strategy. There is a benefit, in that there would be fewer small water management strategies required to meet needs. A greater number of small water management strategies would likely require additional transmission facilities which could increase the environmental impacts of the Plan.

5.2.41.4 Engineering and Costing

The costs of purchasing supplies from a Wholesale Water Provider are approximated by a weighted system cost to the WWP associated with developing new supplies through phased implementation of one or more water management strategies.

5.2.41.5 Implementation Issues

In addition to the implementation issues associated with water management strategy development by the WWPs, implementation of this Purchase from Wholesale Water Provider strategy is predicated on the ability to negotiate and execute contractual agreements between WUGs and WWPs.

5.2.42 Surface Water Rights

5.2.42.1 Description of Water Management Strategy

The Surface Water Rights water management strategy is included to explicitly recognize that use of water supplies made available under existing water rights by lease or purchase agreements between willing buyers and willing sellers is an activity consistent with the 2016 SCTRWP. The additions of diversion points or types and places of use for existing surface water rights are also activities consistent with the 2016 Regional Water Plan, if necessary authorizations are obtained pursuant to Texas Commission on Environmental Quality (TCEQ) rules and applicable law. Specifically, this strategy is to develop or enhance water supplies through lease or purchase of existing right(s) having consumptive use and/or impoundment authorizations. Diversion point(s), use type(s), and/or place(s) of use may be amended as long as there is no associated adverse impact on other water rights or the environment greater than that with full use prior to amendment (the “No Injury” rule).

It is important to note that this water management strategy is intended to address existing water rights (within currently authorized annual and instantaneous maximum diversion rates) and not applications for new surface water appropriations. Furthermore, this strategy focuses on maximizing beneficial use of existing run-of-river water rights as opposed to the development of new major reservoirs. As described in Chapter 3.2, existing firm supplies from major reservoirs are either committed to current steam-electric power generation uses (Coleto Creek Reservoir and Braunig and Calaveras Lakes) or contracted for multiple uses (Canyon Reservoir).

Key applicable water law regarding amendment of existing water rights to facilitate lease/purchase agreements is found in Section 11.122 of the Texas Water Code which requires water rights holders to obtain authorization from TCEQ to *“change the place of use, purpose of use, point of diversion, rate of diversion, acreage to be irrigated, or otherwise alter a water right.”* Section 11.122 further provides that *“an amendment, except an amendment to a water right that increases the amount of water authorized to be diverted or the authorized rate of diversion, shall be authorized if the requested change will not cause adverse impact on other water right holders or the environment on the stream of greater magnitude than under circumstances in which the permit, certified filing, or certificate of adjudication that is sought to be amended was fully exercised according to its terms and conditions as they existed before the requested amendment.”* This section is identified in the TCEQ rules as the “No Injury” Rule. Pursuant to the “No Injury” Rule, restrictions may be placed upon a right for which amendment is being sought in order to protect senior water rights. An example of such restrictions is subordination of an amended right to water rights situated between the existing and amended diversion locations.

5.2.42.2 Available Yield

Available yield of run-of-river surface water rights, whether before or after lease/purchase under the Surface Water Rights water management strategy, is determined using the applicable water availability model (WAM). The Guadalupe – San Antonio River Basin

WAM[1] and the Nueces River Basin WAM[2] are the primary tools applicable for consideration of water rights in the South Central Texas Regional Water Planning Area (Region L). These WAMs perform the complex calculations accounting for relative seniority, authorized annual diversion, type(s) of use, maximum diversion rate, instream flow requirements, physical location, and authorized storage associated with a particular water right, in the context of historical hydrology, as necessary to quantify firm diversion or available yield subject to drought of record conditions. Information regarding current surface water rights in Region L is summarized in Appendix C of Volume I.

Example entities that have acquired existing surface water rights and/or are considering acquiring existing surface water rights in the future include:

- Canyon Regional Water Authority
- City of Victoria
- Guadalupe-Blanco River Authority
- San Antonio River Authority
- San Antonio Water System

5.2.42.3 Environmental Issues

Potential environmental issues associated with implementation of the Surface Water Rights water management strategy are somewhat limited compared to other strategies because the source of water is existing water rights having prior authorizations for consumptive use. If an amendment to an existing water right is necessary to implement the strategy, Section 11.122 of the Texas Water Code indicates that only adverse impacts on the environment on the stream of greater magnitude than under circumstances in which the right sought to be amended was fully exercised prior to the amendment need be addressed. Environmental effects associated with new diversion, storage, transmission, treatment, and/or integration facilities necessary to use water available under existing rights must be addressed in accordance with applicable state and federal requirements.

5.2.42.4 Engineering and Costing

Estimated costs for purchase or lease of existing surface water rights are highly variable depending upon location, reliability, and negotiations between willing buyers and sellers. Future acquisitions of specific water rights are not addressed herein.

5.2.42.5 Implementation Issues

Potentially significant implementation issues associated with the Surface Water Rights water management strategy include the following:

[1] HDR Engineering, Inc., “Water Availability in the Guadalupe – San Antonio River Basin,” Texas Natural Resource Conservation Commission, December 1999.
[2] HDR Engineering, Inc., “Water Availability in the Nueces River Basin,” Texas Natural Resource Conservation Commission, October 1999.

- Quantification and consideration of any potential effects on other water rights, streamflows, and freshwater inflows to bays and estuaries to the extent required by TCEQ rules and applicable state and federal law.
- Changes in the point of diversion may necessitate subordination of an amended right to water rights situated between the existing and amended diversion locations.
- Interbasin transfer of water made available under existing surface water rights may involve additional regulatory requirements to amend place of use and may introduce changes in relative priority and inflow passage for environmental flow needs.
- Run-of-river water rights often require storage and/or groundwater to firm up supply for municipal water use.

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5.2.43 Balancing Storage

5.2.43.1 Description of Water Management Strategy

Water management strategies of the 2016 South Central Texas Regional Water Plan are sized and scheduled to meet seasonal and daily variations of demand, but, without storage, some current and proposed supplies may not be fully reliable during extended droughts. Several recommended strategies involve long distance pipelines of more than 125 miles in length that will be supplied from a combination of run-of-river diversions and groundwater. Thus, the need for surface reservoirs, large scale Aquifer Storage and Recovery (ASR) systems, or multipurpose reservoirs that are adequate in size to store surplus flows of surface water during periods of high streamflows, including flood flows, to be available during extended periods of drought. The Balancing Storage water management strategy involves implementing such ASR and/or surface storage facilities.

The Balancing Storage water management strategy is recommended to explicitly recognize that storage is needed to: a) firm up supplies from run-of-river diversions or interruptible groundwater sources; and b) to ensure that supplies delivered through long distance conveyance facilities are available to meet daily and seasonal demands. The addition of balancing storage on the surface or underground (ASR) is consistent with the 2016 Region L Water Plan if necessary authorizations are obtained pursuant to TCEQ and/or groundwater conservation district rules and applicable law.

Examples include:

- Develop or enhance water supplies through off-channel or underground (ASR) storage authorizations.
- Off-channel or underground (ASR) storage may be added through amendment of existing surface water rights as long as there is no associated adverse impact on other water rights or the environment greater than that with full use prior to amendment (the “No Injury” rule). Additional regulatory requirements may apply.

For example, the City of Victoria is currently studying the best way to integrate their existing gravel pits into the city’s water supply plans to add balancing storage to enhance existing water supplies.

5.2.43.2 Available Yield

Available yield associated with balancing storage is typically determined using the applicable surface water availability model (WAM) to simulate operations of the respective water management strategies. The Guadalupe – San Antonio River Basin WAM[1], the Nueces River Basin WAM[2], the Flow Regime Application Tool (FRAT), the Groundwater Availability Models (GAMs), and spreadsheet models are the primary tools applicable for consideration of surface and groundwater flows in the South Central Texas Regional Water Planning Area (Region L).

[1] HDR Engineering, Inc., “Water Availability in the Guadalupe – San Antonio River Basin,” Texas Natural Resource Conservation Commission, December 1999.
[2] HDR Engineering, Inc., “Water Availability in the Nueces River Basin,” Texas Natural Resource Conservation Commission, October 1999.

5.2.43.3 Environmental Issues

Potential environmental issues associated with implementation of the Balancing Storage water management strategy are limited to terrestrial habitat, as surface water or groundwater rights are existing and authorized for use and storage is off-channel or underground.

5.2.43.4 Engineering and Costing

Estimated costs for development of balancing storage are highly variable depending on location, source water reliability, availability of embankment construction materials, and/or aquifer characteristics.

5.2.43.5 Implementation Issues

Potentially significant implementation issues associated with the Balancing Storage water management strategy include the following:

- Quantification and consideration of any potential effects on water rights, streamflows, and freshwater inflows to bays and estuaries to the extent required by TCEQ rules and applicable state and federal law.
- Run-of-river water rights often require surface storage and/or groundwater to firm up supply for municipal water use and a determination as to the most economically feasible of these is necessary.
- Acquisition of State, Federal, and Local permits.
- Environmental studies.
- Relocations of affected roads, railroads, utilities, and cultural resources.

5.2.44 Brush Management

5.2.44.1 Description of Water Management Strategy

The interest in brush management as a means to increase water supply has its roots in (1) the observation that Texas rangelands changed after settlement and use by Europeans from predominantly open grasslands to increasing domination of brush, and (2) the significantly greater interception of water by brush than grasses. The former suggests that the "natural" character of Texas rangelands would be grasslands. The latter suggests the possibility of increasing aquifer recharge and streamflow by controlling and limiting growth of brush and trees in areas where grasslands would have naturally dominated. For this brush management water management strategy, brush management methods will be described, and estimates of cost and potential water supply effects will be presented.

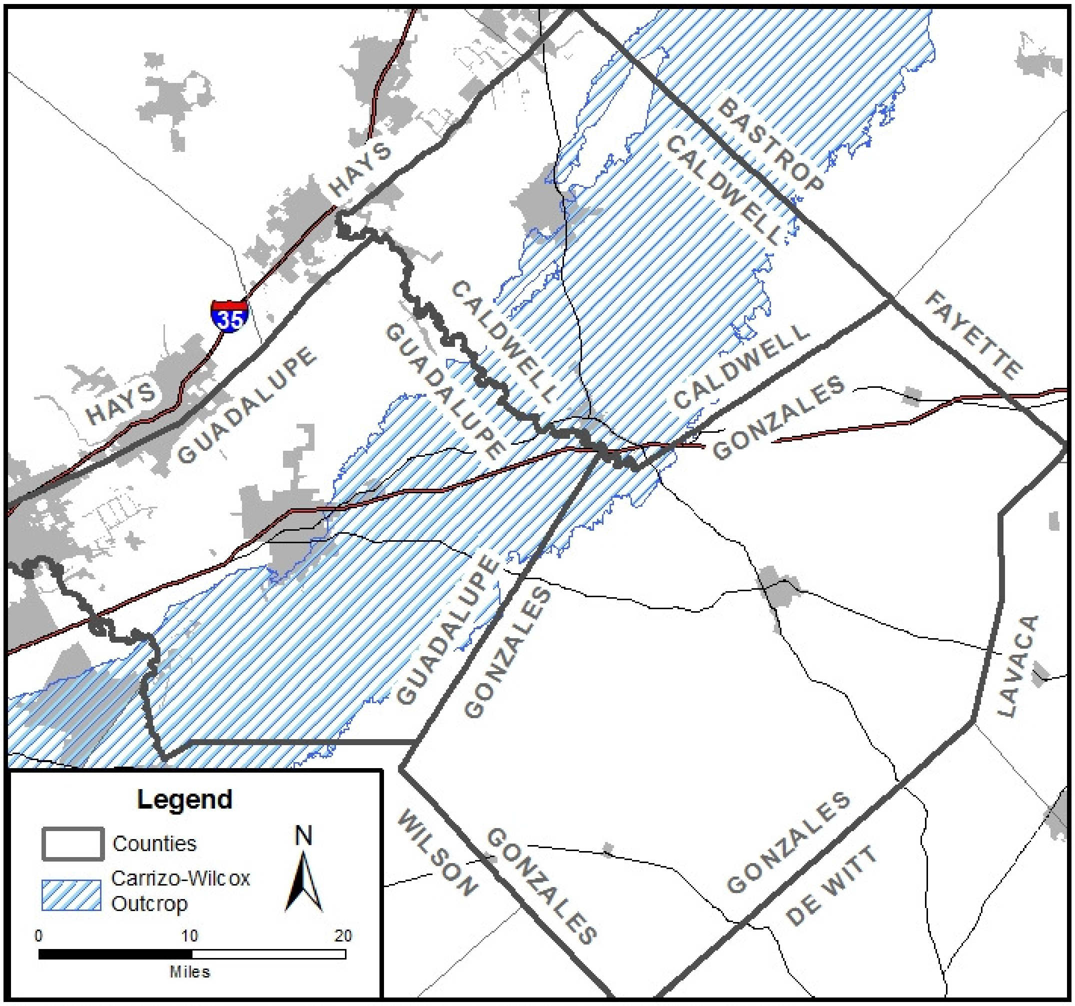
The Texas State Soil and Water Conservation Board's (TSSWCB) Water Supply Enhancement Program (WSEP) seeks to manage brush management in all areas of the state where brush is contributing to a substantial water conservation problem. The TSSWCB commissioned Texas Tech University to apply the Ecological Dynamics Simulation (EDYS) model to various watersheds in the State of Texas. The EDYS model incorporates precipitation, depth of groundwater, topography, soils, and vegetation in order to complete a water balance tracking rainfall, soil moisture, evapo-transpiration, runoff of surface water, and recharge of groundwater.

In 2012, Texas Tech completed a study in Gonzales County, TX[1] investigating target areas for brush control in order to enhance water yield. The study looked at 44 sub-watersheds within the county over a 10 year period from 2002-2011. A water management strategy was conceptualized for areas of the Carrizo-Wilcox Aquifer outcrop in Gonzales County. Information from the Texas Tech study was used to approximate recharge to the aquifer in the areas that could potentially increase pumping in the Carrizo-Wilcox Aquifer in Gonzales County. These areas include the Carrizo-Wilcox outcrop in Guadalupe, Gonzales, and Caldwell Counties (Figure 5.2.44-1).

In the current planning cycle, the SCTRWPG has determined that the Carrizo-Wilcox Aquifer in Gonzales County is fully allocated, as usage and permitted pumpage are greater than the MAG in at least one decade during the planning period. Increasing the recharge to the Carrizo-Wilcox Aquifer by implementing brush management over the outcrop in Guadalupe, Gonzales, and Caldwell Counties could lead to a larger MAG, while still adhering to the Desired Future Condition (DFC) prescribed by the local Groundwater Management Area (GMA 13).

[1] McLendon, Terry, Cindy R Pappas, Cade L Coldren, Ernest B Fish, Micah J Beierle, Annette E Hernandez, Kenneth A Rainwater, and Richard E Zartman, "Application of the EDYS Decision Tool for Modeling of Target Sites [in Gonzales County] for Water Yield Enhancement Through Brush Control," Texas State Soil and Water Conservation Board, September 2012.

Figure 5.2.44-1 Location of Study Area



5.2.44.2 Water Availability

TSSWCB, HDR, and SARA laid out a procedure to determine the increase in the MAG due to the enhanced recharge from brush management. The steps include:

1. Using available data, approximate the recharge over the Carrizo-Wilcox outcrop in three counties (Guadalupe, Gonzales, and Caldwell)
2. Estimate the recharge for a 61-year period (including the drought of record) using the 10-year period in the Texas Tech study
3. Incorporate the enhanced recharge estimates into the appropriate Groundwater Availability Model (GAM)
4. Perform iterative simulations of the GAM in order to determine the increase pumpage (above the current MAG estimates) from the Carrizo-Wilcox Aquifer in Gonzales County, while adhering to the DFC (as set be GMA 13) at the end of the simulation period

The calculations and results of this procedure are described herein.

Recharge Enhancement Estimation

The Texas Tech EDYS study provided good information about the sub-watersheds within Gonzales County over a 10-year period (2002-2011). In order to increase the recharge to the Carrizo-Wilcox Aquifer, it would be necessary to concentrate brush management over the outcrop, where fresh water (via precipitation) enters the aquifer. Furthermore, as shown in Figure 5.2.44-1, the Carrizo-Wilcox Aquifer outcrop covers a small part of the northwestern edge of the county.

For a water management strategy to be viable, the project sponsor would likely wish to implement brush management over the length of the outcrop that affects water availability all across Gonzales County. Additionally, in order to conform with Texas Water Development Board (TWDB) rules and guidance for evaluating water management strategies, one must prove the reliability of the firm supply of the project through a repeat of the drought of record. For this part of Texas, the drought of record is the drought of the 1950s.

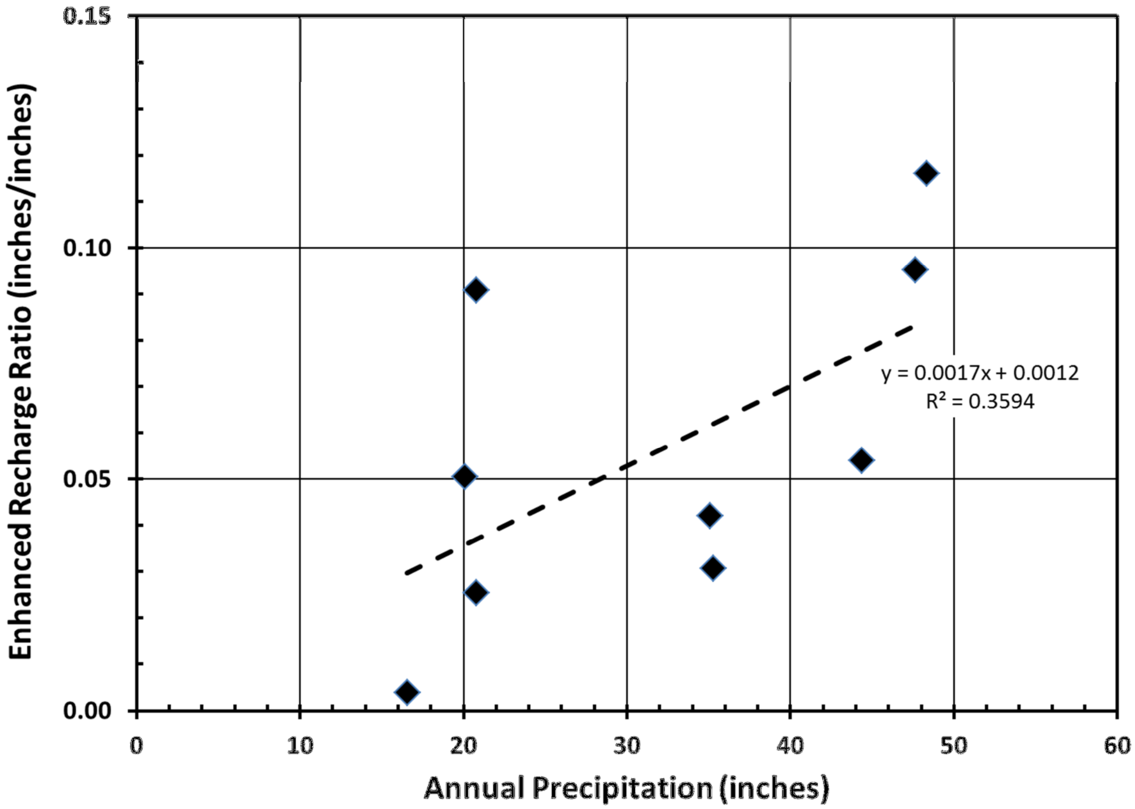
Using data and modeling performed for the TSSWCB in the Gonzales EDYS study by Texas Tech University, linear regression analyses were performed to attempt to correlate the amount of enhanced, recharge that could be expected. In order to extrapolate the results of the Texas Tech study from a 10-year period to the full 61-year period, a common data point was necessary. Measured precipitation for the area (specifically the precipitation associated with the TWDB's Quad 810 data) was used as this correlation data set as precipitation is an independent variable and the force that drives the hydrologic cycle. Ultimately, annual enhanced recharge for a given area was best correlated with annual precipitation as shown in the in Figure 5.2.44-2. Note that Figure 5.2.44-2 includes an Enhanced Recharge Ratio, which is simply the ratio of enhanced recharge to the annual precipitation. Therefore, the equation to determine enhanced recharge as a function of annual precipitation can be simplified as shown in Equation 1 below.

$$\boldsymbol{Enhanced\ Recharge} = \boldsymbol{Average\ Annual\ Precipitation^2} \times \mathbf{0.00117} \qquad \textbf{Eq. 1}$$

This equation was used to calculate enhanced recharge for a 1950-2013 model simulation. Average annual rainfall in the equation is derived from TWDB quad 810 database[2]. This quad covers most all of the outcrop area of the Carrizo-Wilcox aquifers in the study area. These precipitation data show rainfall ranged from 14.5 to 50.4 in/yr and averaged 34.4 in/yr. Enhanced recharge in the equation is the long-term average annual enhanced recharge amount. These calculations resulted in an enhanced recharge of 2.16 in/yr for the simulation period if 100 percent of landowners participated in brush management program. The enhanced recharge was applied to each of the model cells in the outcrop of the Carrizo, Middle Wilcox, and Lower Wilcox model layers. The potential enhanced recharge by landowner participation levels of 10, 30, 50, and 100 percent are shown in Table 5.2.44-1.While 100 percent participation is not feasible, the full implementation was analyzed to examine the maximum amount of recharge possible.

[2] http://www.twdb.texas.gov/surfacewater/conditions/evaporation/

Figure 5.2.44-2 Enhanced recharge ratios at various annual precipitations



(Units: in/yr)

Table 5.2.44-1 Enhanced Recharge by Landowner Participation

Percent of Landowner Participation	Enhanced Recharge (in/yr)
10%	0.22
30%	0.65
50%	1.08
100%	2.16

The potential enhanced recharge was applied to a series of modeling simulations using the Southern Queen City and Sparta Aquifers[3] Groundwater Availability Model (GAM); this model also includes the Carrizo and Wilcox aquifers. Five simulations were conduced, including: baseline (no enhanced recharge), 10, 30, 50 and 100 percent landowner participation. The pumping amounts vary throughout the DFC simulation; however the recharge values are constant for each stress period. The potential enhanced recharge was applied only to the Carrizo (model layer 5), middle Wilcox (layer 7), and the lower Wilcox (layer 8) of the GAM model in Guadalupe, Caldwell, and Gonzales Counties. The recharge in all other counties and aquifers was unchanged.

Approach

The conceptual modeling approach to estimate the increase in MAG that can be attributed to brush management included adding enhanced recharge to the selected

[3] Kelley, V., Deeds, N., Fryar, D., Nicot, J. Groundwater Availability Models for Queen City and Sparta Aquifers. Texas Water Development Board. October 2004.

model layers and running the model in an iterative process of increasing pumping until the water levels from the model run *with* enhanced recharge (scenario) nearly matched the model run *without* enhanced recharge (baseline). The amount of pumping needed to drawdown the water levels to the baseline levels is the potential increase in MAG due to enhanced recharge, i.e. brush management. Pumping wells to capture the enhanced recharge were added in the most productive part of the aquifer. The baseline and modeled recharge by aquifer, county, and scenario is shown in Table 5.2.44-2 and Figures 5.2.44-3 through 5.2.44-5.

Table 5.2.44-2 Average Modeled Recharge by Scenario, County, and Aquifer (in/yr)

Scenario	Aquifer	Caldwell County			Gonzales County			Guadalupe County		
		Baseline	Enhanced Recharge	Total Modeled Recharge	Baseline	Enhanced Recharge	Total Modeled Recharge	Baseline	Enhanced Recharge	Total Modeled Recharge
Baseline (Scenario 4)	Carrizo	2.53	0.00	2.53	1.88	0.00	1.88	1.83	0.00	1.83
	Middle Wilcox	0.58	0.00	0.58	0.57	0.00	0.57	0.61	0.00	0.61
	Lower Wilcox	0.71	0.00	0.71	-	-	-	0.76	0.00	0.76
10% Participation	Carrizo	2.53	0.22	2.74	1.88	0.22	2.10	1.83	0.22	2.04
	Middle Wilcox	0.58	0.22	0.80	0.57	0.22	0.79	0.61	0.22	0.83
	Lower Wilcox	0.71	0.22	0.92	-	-	-	0.76	0.22	0.98
30% Participation	Carrizo	2.53	0.65	3.18	1.88	0.65	2.53	1.83	0.65	2.47
	Middle Wilcox	0.58	0.65	1.23	0.57	0.65	1.22	0.61	0.65	1.26
	Lower Wilcox	0.71	0.65	1.36	-	-	-	0.76	0.65	1.41
50% Participation	Carrizo	2.53	1.08	3.61	1.88	1.08	2.96	1.83	1.08	2.91
	Middle Wilcox	0.58	1.08	1.67	0.57	1.08	1.65	0.61	1.08	1.70
	Lower Wilcox	0.71	1.08	1.79	-	-	-	0.76	1.08	1.85
100% Participation	Carrizo	2.53	2.16	4.69	1.88	2.16	4.05	1.83	2.16	3.99
	Middle Wilcox	0.58	2.16	2.75	0.57	2.16	2.73	0.61	2.16	2.78
	Lower Wilcox	0.71	2.16	2.87	-	-	-	0.76	2.16	2.93

Figure 5.2.44-3 Carrizo Baseline and Enhanced Recharge by County/Scenario

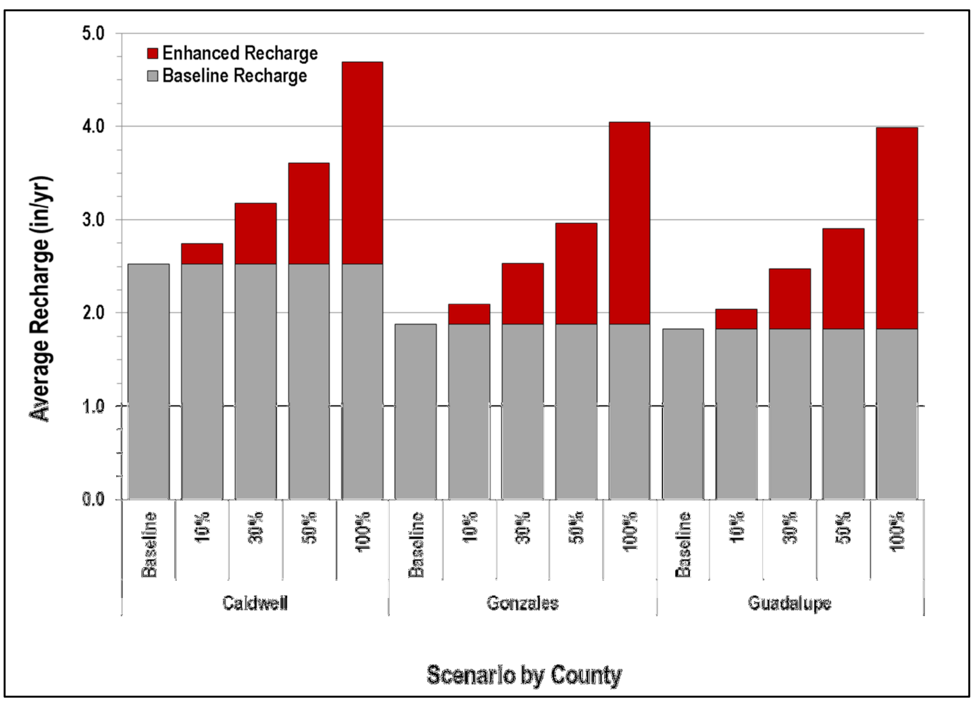


Figure 5.2.44-4 Middle Wilcox Baseline and Enhanced Recharge by County/ Scenario

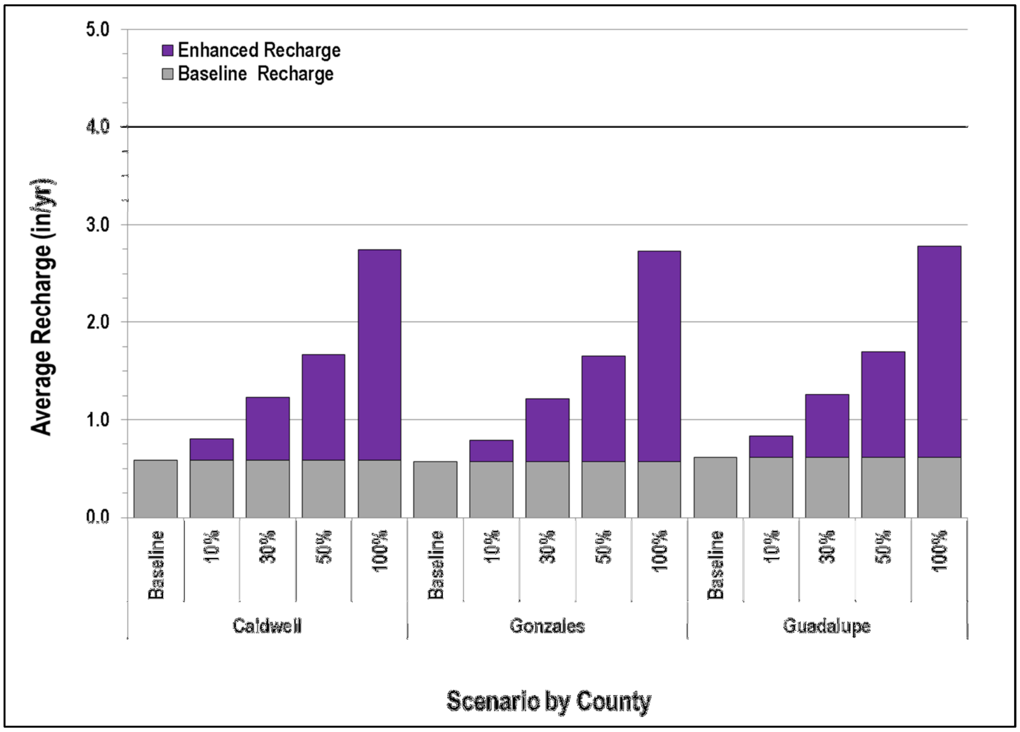
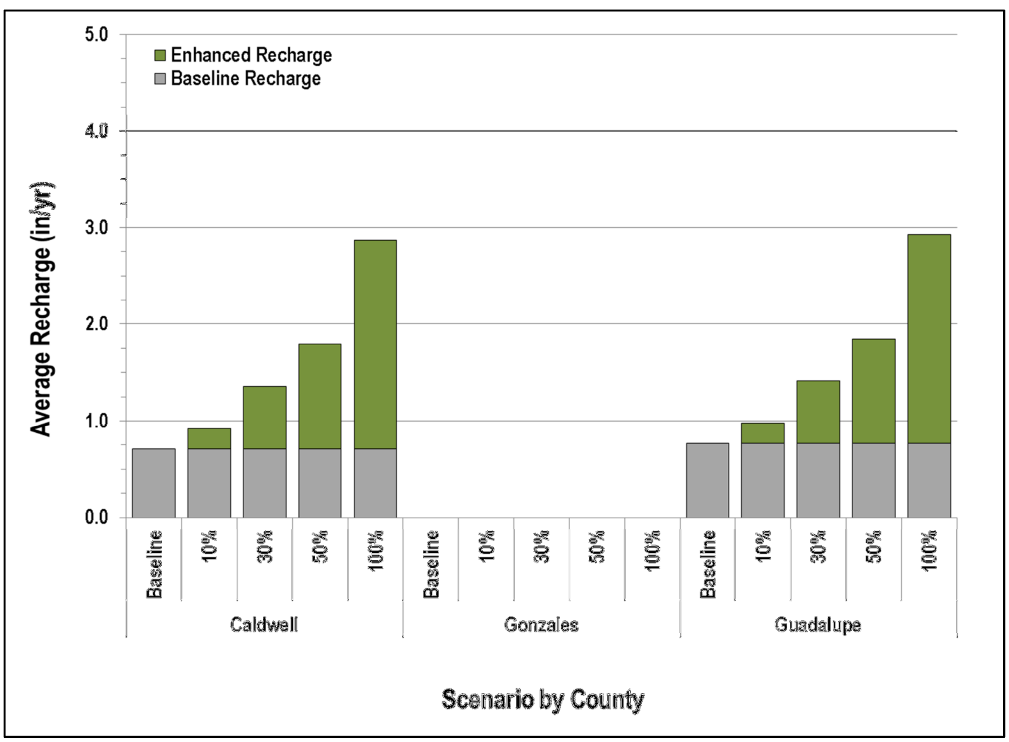


Figure 5.2.44-5 Lower Wilcox Baseline and Enhanced Recharge by County/ Scenario



The specific modeling steps included the following:

Calculate and Add Enhanced Recharge to the Model's Baseline Recharge in Guadalupe, Caldwell, & Gonzales

The average baseline recharge in the Carrizo aquifer is about 2.5 in/yr in Caldwell County and 1.8 in/yr in Gonzales and Guadalupe Counties. The baseline recharge in the middle and lower Wilcox is significantly less and ranges from 0.58 to 0.76 in/yr in the study area. Using the enhanced recharge equation, the enhanced recharge was calculated and added to the baseline recharge for each scenario. As shown on the graphs, the enhanced recharge in some scenarios is up to 3 times greater than the existing baseline recharge.

Figure 5.2.44-6 through Figure 5.2.44-10 show the baseline recharge and the modeled brush management recharge for each scenario. Recharge was only modified in Guadalupe, Caldwell, and Gonzales counties in the Carrizo, middle Wilcox, and lower Wilcox aquifers representing model layers 5, 7, and 8, respectively. There is no recharge in the upper Wilcox aquifer (layer 6) in the study area. The recharge in all other aquifers and counties was unchanged.

Run the groundwater model for baseline and enhanced recharge scenarios

A series of monitoring wells were placed in the Carrizo and Wilcox aquifers throughout the study area, shown on Figure 5.2.44-11, to record the model results. Hydrographs of the model results at these monitoring wells were plotted to for a visual presentation of water levels over time. **Figure 5.2.44-12** shows three representative hydrographs plotting the modeled scenarios for wells located in the outcrop and downdip sections of the model. The model results comparing the baseline model water levels with no enhanced recharge (blue line) to the enhanced recharge scenario (red line) show that the water levels in the outcrop areas for the scenario runs are considerably higher.

Layout conceptual well fields across Guadalupe, Caldwell, & Gonzales Counties

As noted in Step 2, when enhanced recharge is applied to the baseline scenarios, the water levels throughout the model rise. To calculate the potential MAG increase from enhanced recharge, the scenario water levels must nearly match the baseline water levels. In order to lower scenario model water levels from Step 2 to match the baseline model runs, conceptual well fields were added to the model in the Carrizo and Wilcox aquifers (

Figure 5.2.44-13).

Adjust Well Pumping to Match Water Levels

Pumping was added to the conceptual well field and adjusted in an iterative process until the scenario water levels (Figure 5.2.44-12, green line) nearly match the baseline water levels (**Figure 5.2.44-12**, blue line). The amount of pumping needed to drawdown the water levels is the potential MAG increase due to enhanced recharge, i.e. brush management.

Calculate Increase in MAG by Landowner Participation Levels

After the conceptual well field model pumping was adjusted so that the scenario water levels nearly match the baseline water levels, the additional pumping rate was summed and this result is the potential MAG increase if brush management practices were implemented.

Figure 5.2.44-6 Baseline Recharge (in/yr)

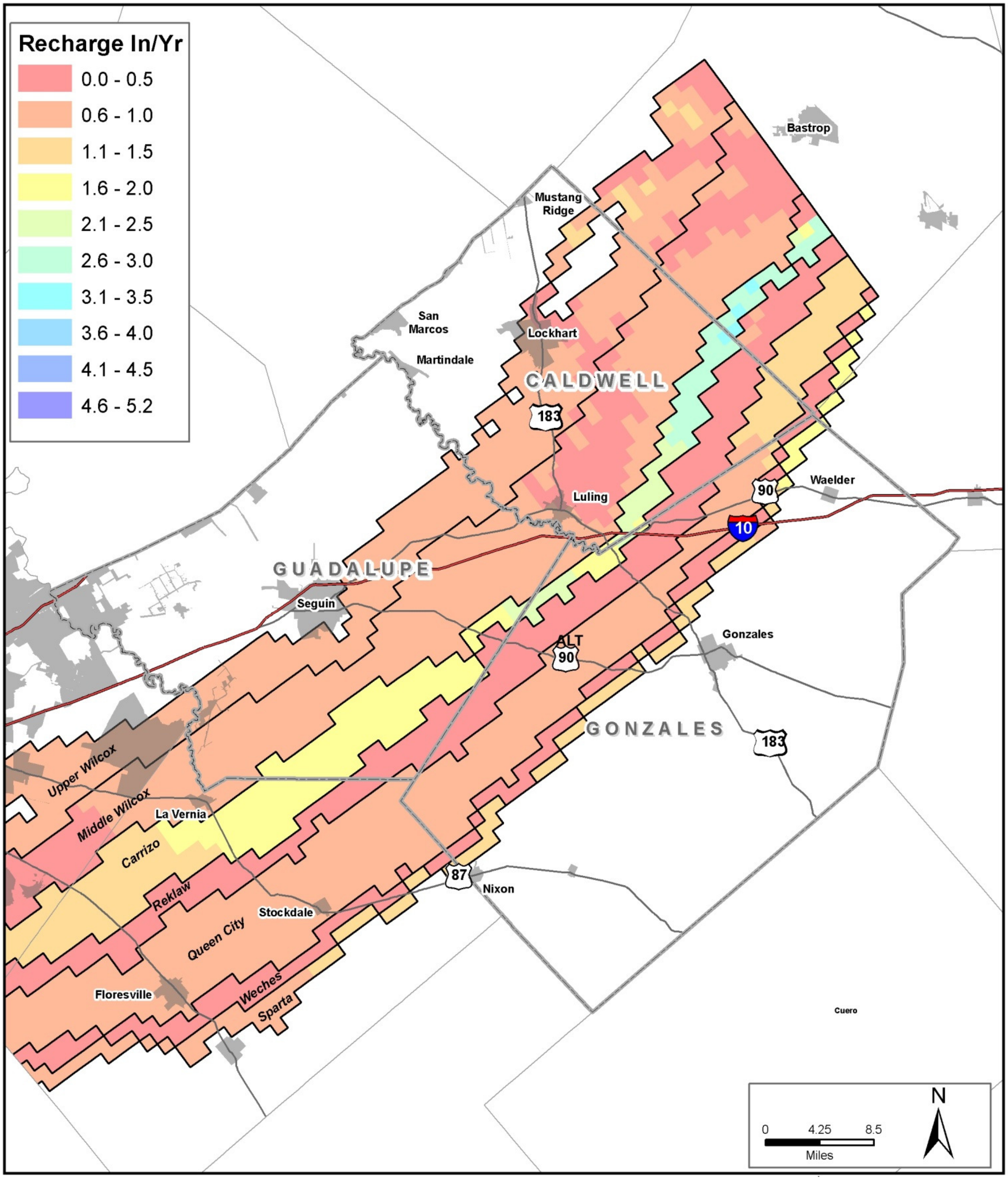


Figure 5.2.44-7 Recharge for Baseline plus 10 Percent Landowner Participation Scenario

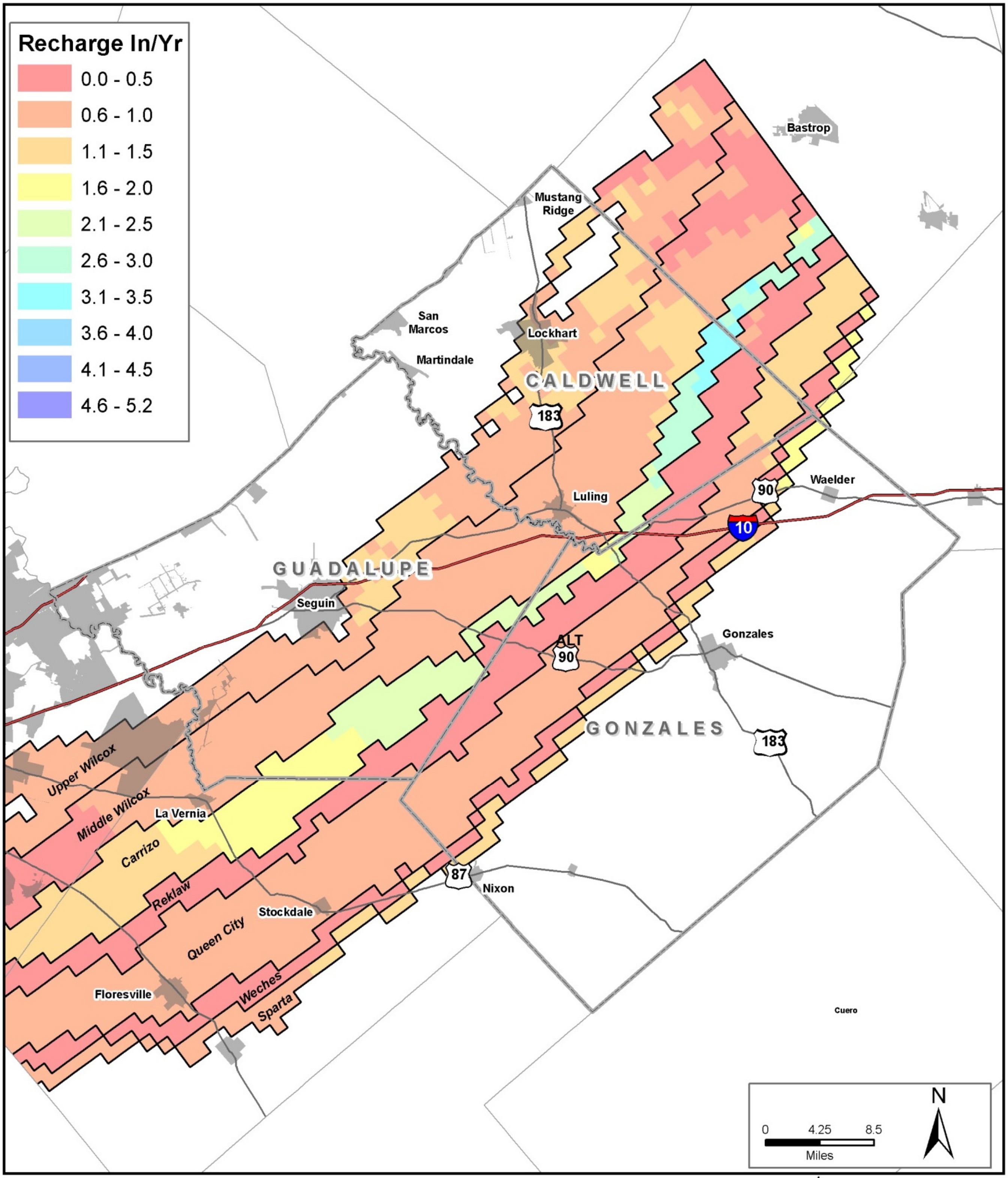


Figure 5.2.44-8 Recharge for Baseline plus 30 Percent Landowner Participation Scenario

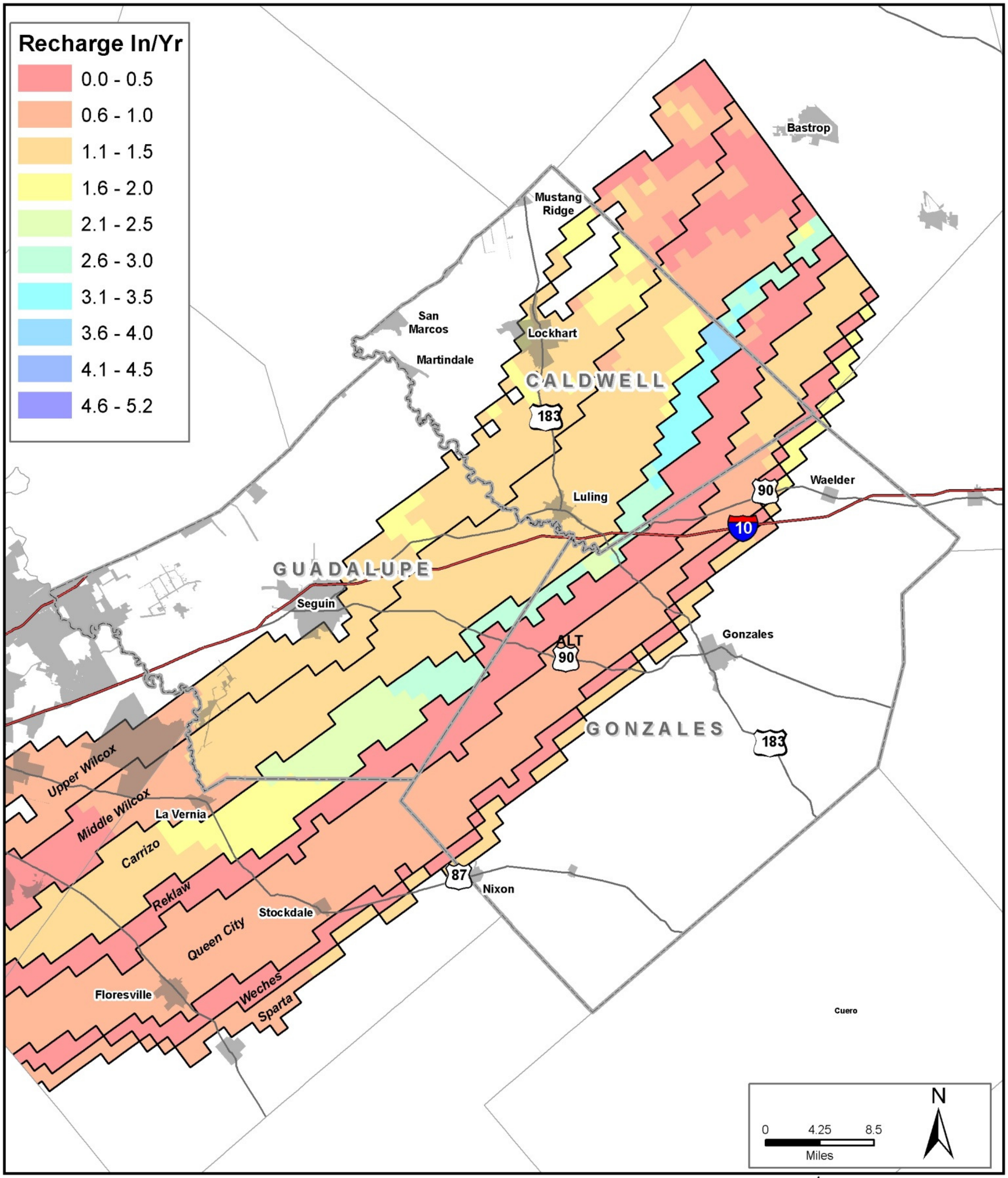


Figure 5.2.44-9 Recharge for Baseline plus 50 Percent Landowner Participation Scenario

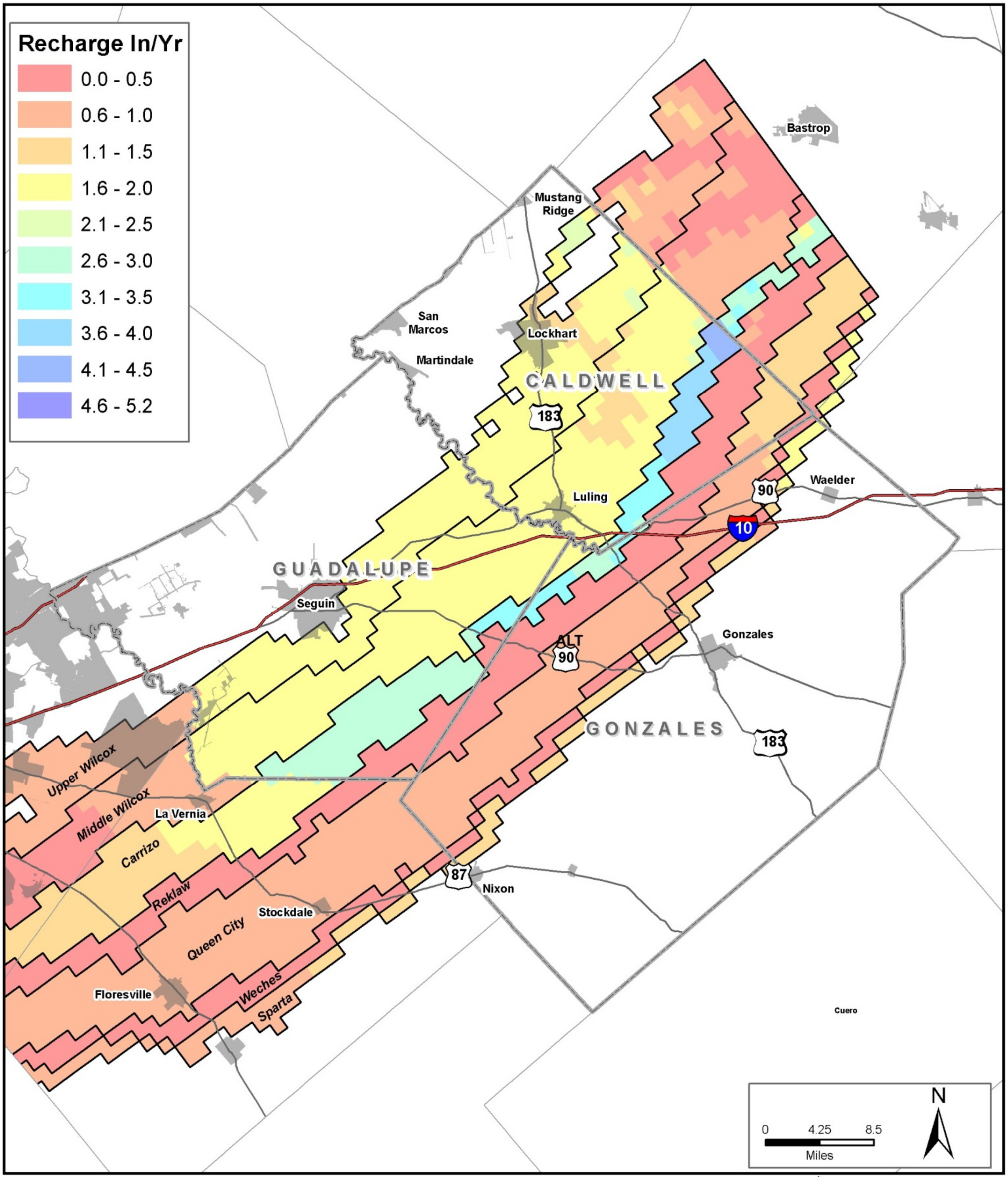


Figure 5.2.44-10 Recharge for Baseline plus 100 Percent Landowner Participation Scenario

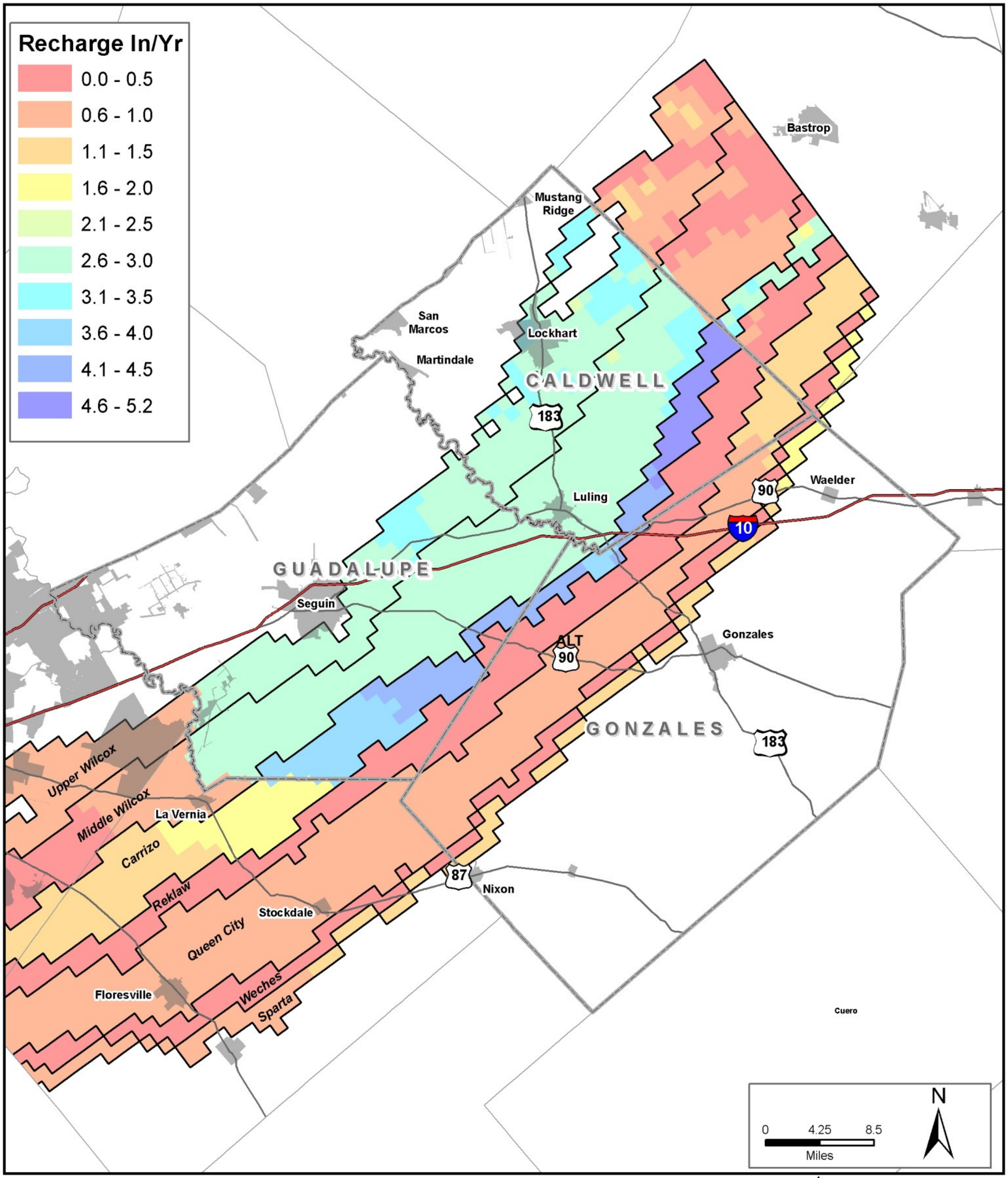


Figure 5.2.44-11 Monitoring Wells

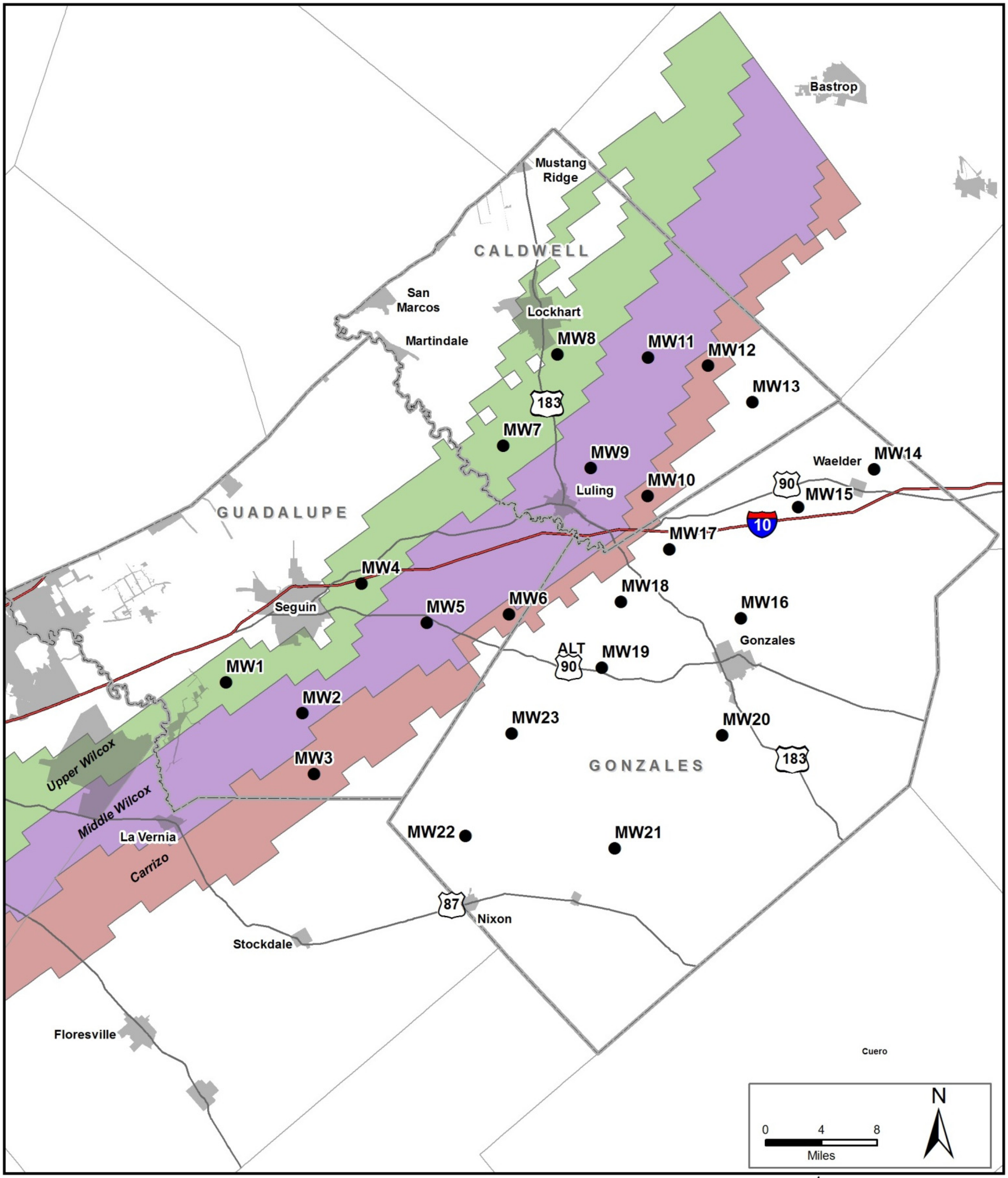


Figure 5.2.44-12 Three Representative Hydrographs illustrating model results in the Outcrop, Downdip, and Conceptual Well Field

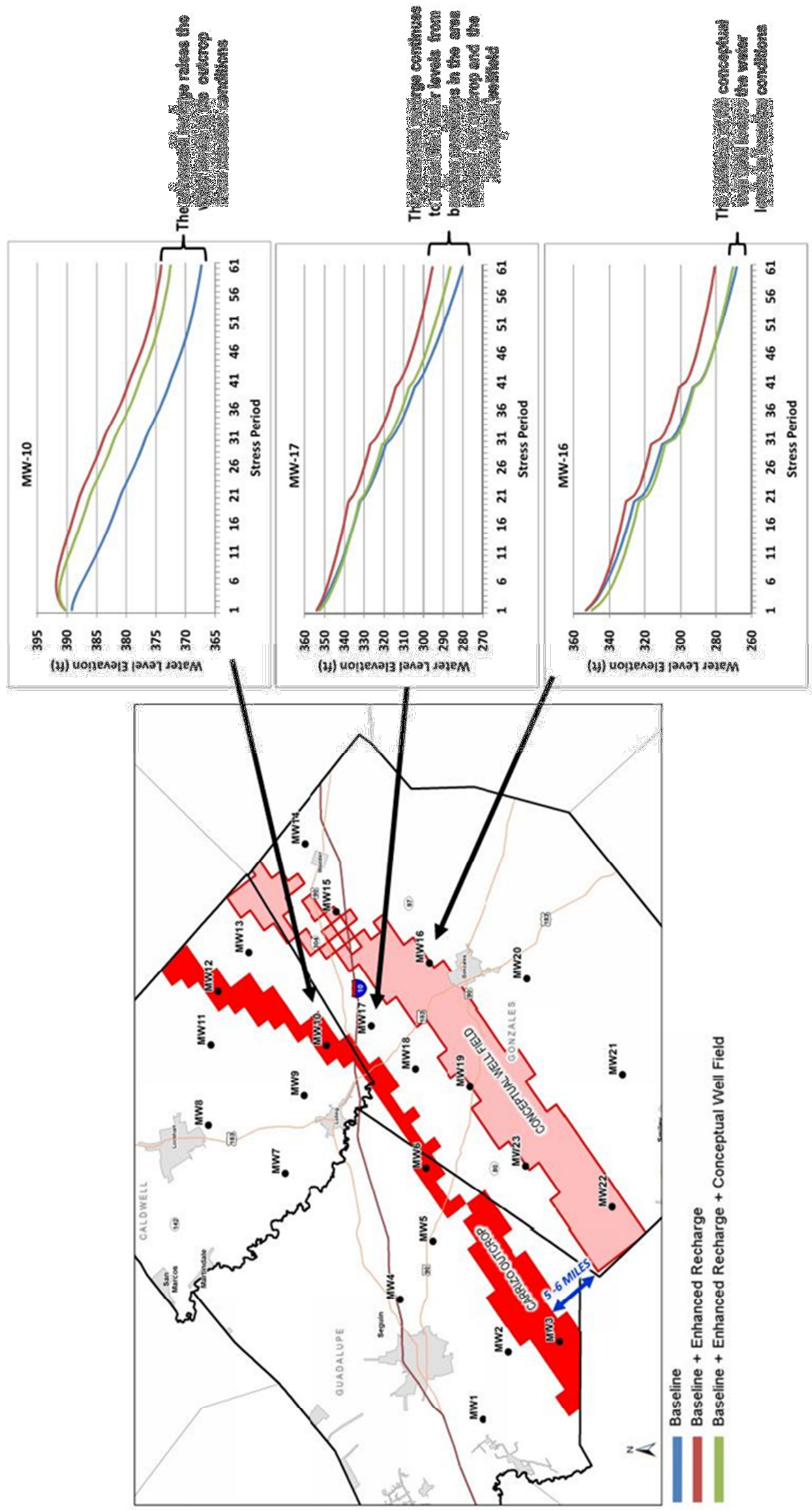
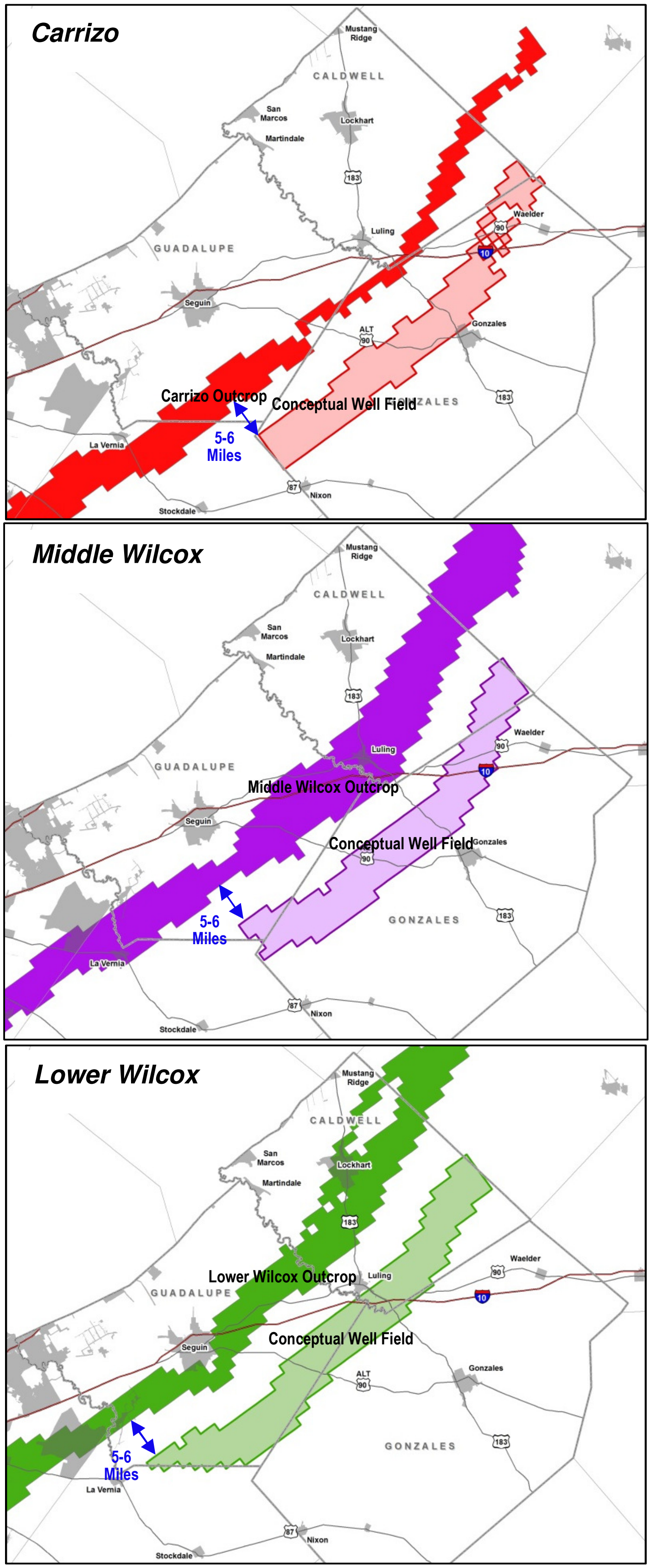


Figure 5.2.44-13 Conceptual Well Fields by Aquifer



Modeling Results

Applying the steps above, the modeling results for each of the five scenarios are discussed in the following sections. Model results focus on stress period 61, which is the last year of the simulation.

Baseline (no landowner participation)

The baseline scenario is the adopted GMA 13 Desired Future Condition Scenario 4. This model run was *not* modified to include a conceptual well field or enhanced recharge. The results of this model were solely used to subtract and compare water levels with all other model scenarios water levels to determine the affects of enhanced recharge and pumping. Baseline water levels are shown on the hydrographs and discussed in the following sections. In general, water levels decline throughout the 61 stress period model run in both the Carrizo and Wilcox aquifers.

Baseline + 10% landowner participation

In this scenario, an additional 0.22 in/yr of recharge was added to the existing recharge in the Carrizo and Wilcox aquifers, as shown in Figure 5.2.44-7. The water levels rise slightly from baseline conditions in the outcrop and less so in the downdip areas. The added recharge increases the water levels in the Carrizo and middle Wilcox outcrops by about 5 ft and by about 1 foot in the downdip areas. The lower Wilcox aquifer outcrop water levels rise by 10 ft in Guadalupe County, up to 20 ft in Caldwell County, and by 1 ft in the downdip areas.

The amount of potential MAG increase with 10 percent landowner participation is 758 acft/yr from the Carrizo aquifer, 35 acft/yr from the Middle Wilcox, and 576 from the Lower Wilcox to total 1,370 acft/yr, as shown in Table 5.2.44-3. For comparison purposes, the enhanced recharge was 1,489 acft/yr, 3,704 acft/yr, and 2,723 acft/yr for the Carrizo, middle Wilcox, and lower Wilcox, respectively. The difference between the increase in MAG and enhanced recharge is largely attributed to an increase in groundwater storage (rise in groundwater levels).

Table 5.2.44-3 MAG increase with 10 percent landowner participation (acft/yr)

Aquifer	Well Field	Individual Well Pumping	Enhanced Recharge
Carrizo	758	4.0	1,489
Middle Wilcox	35	0.16	3,704
Lower Wilcox	576	2.35	2,723
Total	**1,370**		**7,916**

Baseline + 30% landowner participation

In this scenario, an additional 0.65 in/yr of recharge was added to the existing recharge in the Carrizo and Wilcox aquifers, as shown in Figure 5.2.44-8. The water levels rise moderately from baseline conditions in the outcrop and less so in the downdip areas. The added recharge increases the water levels in the Carrizo aquifer by about 15 ft and by about 5 foot in the downdip areas. The middle Wilcox aquifer water levels increase by 20 to 25 ft in the outcrop and by about 3 ft in the downdip areas. The lower Wilcox aquifer outcrop water levels increase by 25 to 30 ft in Guadalupe County and about 20 ft in Caldwell County with localized areas of increased recharge and by 5 ft in the downdip areas.

The amount of potential MAG increase with 30 percent landowner participation is 2,274 acft/yr from the Carrizo aquifer, 105 acft/yr from the Middle Wilcox, and 2,251 from the lower Wilcox to total 4,631 acft/yr, as shown in Table 5.2.44-4. For comparison purposes, the enhanced recharge was 4,466 acft/yr , 11,113 acft/yr , and 8,170 acft/yr for the Carrizo, Middle Wilcox, and Lower Wilcox, respectively.

Table 5.2.44-4 MAG increase with 30 percent landowner participation (acft/yr)

Aquifer	Well Field	Individual Well Pumping	Enhanced Recharge
Carrizo	2,274	12	4,466
Middle Wilcox	105	0.49	11,113
Lower Wilcox	2,251	9	8,170
Total	**4,631**		**23,749**

Baseline + 50% landowner participation

In this scenario, an additional 1.08 in/yr of recharge was added to the existing recharge in the Carrizo and Wilcox aquifers, as shown in Figure 5.2.44-9. The water levels rise moderately from baseline conditions in the outcrop and less so in the downdip areas. The added recharge increases the water levels in the Carrizo aquifer by about 30 ft in Guadalupe County and 10 ft in Caldwell County and by about 5 ft in the downdip areas. The middle Wilcox aquifer water levels increase by about 40 ft in the outcrop and by about 5 ft in the downdip areas. The lower Wilcox aquifer outcrop water levels increase by 40 to 60 ft in Guadalupe County and about 40 ft in Caldwell County with localized areas of increased recharge and by 10 ft in the downdip areas.

The amount of potential MAG increase with 50 percent landowner participation is 3,790 acft/yr from the Carrizo aquifer, 280 acft/yr from the Middle Wilcox, and 2,855 from the lower Wilcox to total 6,925 acft/yr, as shown in Table 5.2.44-5. For comparison purposes, the enhanced recharge was 7,443 acft/yr, 18,521 acft/yr, and 13,617 acft/yr for the Carrizo, Middle Wilcox, and Lower Wilcox, respectively.

Table 5.2.44-5 MAG increase with 50 percent landowner participation (acft/yr)

Aquifer	Well Field	Individual Well Pumping	Enhanced Recharge
Carrizo	3,790	20	7,443
Middle Wilcox	280	1.3	18,521
Lower Wilcox	2,855	11.7	13,617
Total	**6,925**		**39,582**

Baseline + 100% landowner participation

In this scenario, an additional 2.16 in/yr of recharge was added to the existing recharge in the Carrizo and Wilcox aquifers, as shown in Figure 5.2.44-10. The water levels rise significantly from baseline conditions in the outcrop and less so in the downdip areas. The added recharge increases the water levels in the Carrizo aquifer by about 60 ft in Guadalupe County and 25 ft in Caldwell County and by about 10 ft in the downdip areas. The middle Wilcox aquifer water levels increase by about 70 to 80 ft in the outcrop and by about 10 ft in the downdip areas. The lower Wilcox aquifer outcrop water levels increase by 70 ft in Guadalupe County and about 70 ft in Caldwell County with localized areas of increased recharge and by 20 ft' in the downdip areas.

The amount of potential MAG increase with 100 percent landowner participation is 6,065 acft/yr from the Carrizo aquifer, 641 acft/yr from the Middle Wilcox, and 7,204 from the lower Wilcox to total 13,910 acft/yr, as shown in Table 5.2.44-6. For comparison purposes, the enhanced recharge was 7,443 acft/yr, 18,521 acft/yr, and 13,617 acft/yr for the Carrizo, Middle Wilcox, and Lower Wilcox, respectively.

Table 5.2.44-6 MAG increase with 100 percent landowner participation (acft/yr)

Aquifer	Well Field	Individual Well Pumping	Enhanced Recharge
Carrizo	6,065	32	14,886
Middle Wilcox	641	3.0	37,043
Lower Wilcox	7,204	29.4	27,234
Total	**13,910**		**79,163**

The model scenarios show that implementing a brush management program in Gonzales, Caldwell, and Guadalupe Counties could potentially increase the ground water levels and the subsequent MAG in these counties by 1,370 acft/yr to 13,910 acft/yr depending on the landowner participation levels. The enhanced recharge added to the model by scenario that resulted in increased MAG is shown on Figure 5.2.44-14. The enhanced recharge increases the MAG by about 17 to 19 percent for the tested scenarios. The total increase in year 2060 MAG by land owner participation and county is shown in Table 5.2.44-7 and on Figure 5.2.44-15 and distribution by aquifer is shown in Table 5.2.44-8. The greatest increase in additional MAG is in Guadalupe County. With 100 percent landowner participation, the MAG could increase by 25%. One hundred percent participation is probably impracticable; however, 10 percent or 30 percent landowner participation may be attainable and would increase the MAG by 1,370 acft/yr or 4,631 acft/yr, respectively.

Figure 5.2.44-14 Comparison of Enhanced Recharge Added to the Model and Resulting Enhanced MAG (acft/yr)

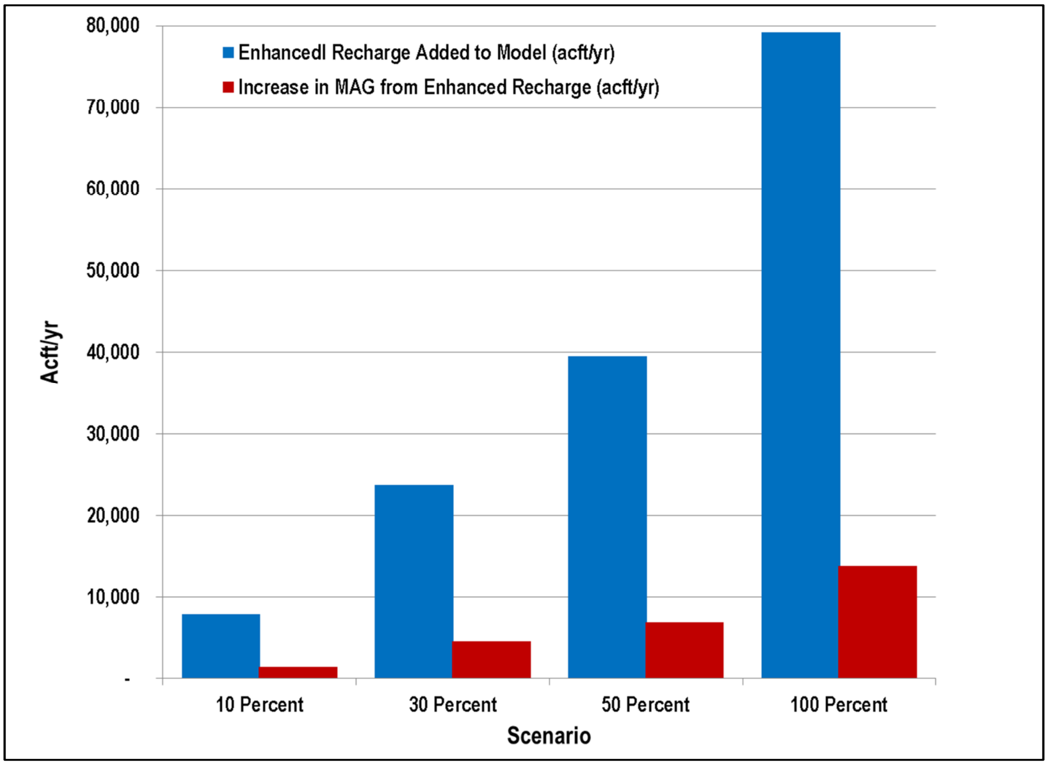


Figure 5.2.44-15 2060 MAG and Increase in MAG by Land Owner Participation Level and County

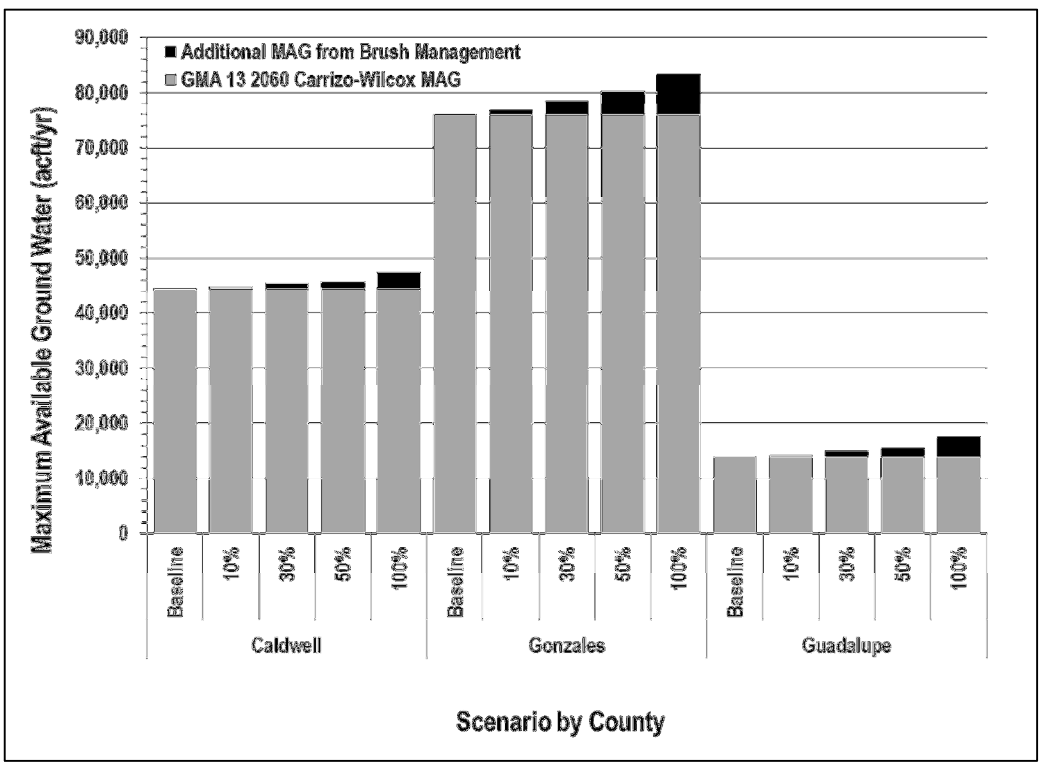


Table 5.2.44-7 MAG Increase by Percent Landowner Participation and by County (acft/yr)

County	County	10 Percent Participation	30 Percent Participation	50 Percent Participation	100 Percent Participation
Caldwell	2060 MAG:	44,544	44,544	44,544	44,544
	Increase in MAG:	242	921	1,215	2,948
	Total 2060 MAG:	**44,786**	**45,465**	**45,759**	**47,492**
	Percent Increase:	**0.5%**	**2%**	**3%**	**7%**
Gonzales	2060 MAG:	75,970	75,970	75,970	75,970
	Increase in MAG:	843	2,601	4,296	7,397
	Total 2060 MAG:	**76,813**	**78,571**	**80,266**	**83,367**
	Percent Increase:	**1%**	**3%**	**6%**	**10%**
Guadalupe	2060 MAG:	14,041	14,041	14,041	14,041
	Increase in MAG:	284	1,109	1,414	3,564
	Total 2060 MAG:	**14,325**	**15,150**	**15,455**	**17,605**
	Percent Increase:	**2%**	**8%**	**10%**	**25%**

Table 5.2.44-8 MAG Increase by Percent Landowner Participation and by Aquifer (acft/yr)

Carrizo	758	2,274	3,790	6,065
Middle Wilcox	35	105	280	641
Lower Wilcox	576	2,251	2,855	7,204
Total	**1,370**	**4,631**	**6,925**	**13,910**

5.2.44.3 Environmental Issues

In general, brush management encompasses the control of junipers, mesquites and other woody species that compete with native grasses for water, light and nutrients, but whose growth may be encouraged by conventional land use practices. In the context of water supplies for Region L, brush management means reduction of juniper cover on Edwards Plateau watersheds upstream of the Edwards Aquifer recharge zone to increase runoff that might percolate to the Edwards Aquifer. Environmental concerns with brush control projects focus primarily on the reduction or removal of the wildlife habitat provided by the brush cover, and secondarily on the potential for soil erosion from exposed, disturbed soils where mechanical clearing methods are used, or the effects of herbicides on non-target species when chemical methods are employed.

Chaining, cabling, disking and other mechanical methods that strip brush displace resident wildlife populations, remove the habitat on which they depend and expose soil surfaces to erosion by wind and water. Brush management guidelines applicable to Edwards Plateau habitats are available from the Texas Parks and Wildlife Department and the Texas State Soil and Water Conservation Board that can be used to avoid or minimize potential impacts, but individual management plans should be developed for specific locations that take into account the topography of the site, the character of the brushy cover and the vegetation intended to replace it, local and regional wildlife needs, and the potential for impacts to endangered species. Management practices may include limitation of clearings to slopes of less than 10 percent, avoiding disturbance to riparian areas, limiting the size of cleared areas and limiting the proportion of open to wooded habitat to about 2:1. Low impact hand techniques that clear brush in a patchwork fashion, leaving brush berms to control erosion and provide protection for wildlife, may be necessary where soils on slopes are thin and droughty.

Chemical methods of brush control carry some risk of chemical runoff into streams and subsequent percolation into the underlying aquifers. The chemicals to be used should be applied strictly according to the label directions to avoid toxicity to aquatic organisms. Where large areas are to receive herbicide treatments, stream monitoring (particularly storm flows) above the recharge zone for those substances may be necessary to evaluate potential exposures to water users and endangered species resident in the aquifer and its large spring openings.

5.2.44.4 Engineering and Costing

The Texas A&M University (TAMU) study provided a cost estimate for brush control as well as a cost for the associated monitoring program that was used in the SCTRWP. The costs were updated for inflation assuming 1.5 percent for 5 years. Initial clearing costs were assumed to be $215.5/acre and total cost would depend on landowner participation. Based on the findings of the study, maintenance clearing is assumed to cost $26.96/acre every 5 years or $5.39/ac/yr.

The monitoring program consists of three parts; 1) a wide-scale remote sensing program, 2) a mid-scale streamflow monitoring program, and 3) a small-scale example catchment program. Assuming that TCEQ would require a continuous monitoring program the three-part monitoring program has an estimated cost of $313,500/yr. Long-term monitoring program costs could be less as the initial field data would be used to calibrate models and wide-scale remote sensing technology improves. Table 5.2.44-9 contains annual unit cost estimates for brush management at increasing levels of landowner participation.

Table 5.2.44-9 Brush Management Cost Estimates by Participation

Landowner Participation	Total MAG Increase (acft/yr)	Unit Cost ($/acft/yr)
10%	1,370	1,209
30%	4,631	937
50%	6,925	1,015
100%	13,910	988

5.2.44.5 Implementation Issues

Several implementation issues pertain to this potential water management strategy. In situ brush control studies have been effective for catchment-level examples of areas of 1,000 acres or less. To make a significant impact upon increasing the recharge of an aquifer, brush control would have to be practiced over a considerable area. The area of interest above the Carrizo outcrop (Figure 5.2.44-1), covering aver 800,000 acres, is significantly larger than typical brush control study areas and will require significant participation from stakeholders and state and federal agencies to achieve program goals for additional water supply. It is not proven that a large-scale brush control program would be practical because it would require the cooperation of many different landowners having different interests in their property. In a specific target watershed, there may be property owners who are not dependent on grazing income and therefore have limited interest in brush control. To ensure cooperation of these ranch owners, additional subsidies or other considerations may be required which could alter the cost profiles for brush control.

Another issue is that most of the assumptions and results presented above are based on computer modeling rather than in situ examples that have the benefit of several years of performance to demonstrate results. It would be recommended that much more research be performed in situ at specific sites before public funds are invested in major projects.

One critical implementation issue is how the increase in recharge resulting from brush control would be related to water supply yield in a permit application with the Texas Commission on Environmental Quality. Key questions that need answers are:

- How is the increased recharge verified?
- How much of the increased recharge results in increased yields of affected aquifers? and
- How is the increased MAG verified?

Finally, it is important to note that the outcome of GMA 9, specifically the Desired Future Conditions (DFC) and associated pumpage could affect the potential supply associated with a Brush Management project in the area.

5.2.45 Victoria ASR

5.2.45.1 Description of Water Management Strategy

Through most of its history, the City of Victoria (Victoria) relied on locally available groundwater supplies withdrawn from the Gulf Coast Aquifer. To support continued growth, limit drawdowns in aquifer levels, and maintain water quality, Victoria obtained a new surface water appropriation (P#5466) in the 1990s authorizing diversions of up to 20,000 acft/yr from the Guadalupe River. Subject to the senior water rights of others and special conditions requiring inflow passage for environmental protection, however, supplies available under P#5466 are severely limited during drought. Since the 1990s, Victoria has obtained six additional surface water rights senior in priority to P#5466 and totaling 7,007 acft/yr from willing sellers.

Aquifer storage and recovery (ASR) is a recognized means for storing treated surface water during periods when it is available in a suitable aquifer formation for subsequent recovery during periods when run-of-river diversions are limited. In this way, evaporative losses associated with storage in a surface reservoir are avoided. Hence, ASR is a potentially feasible means to firm up periodically limited supplies available under Victoria's surface water rights. The Victoria ASR water management strategy involves amendment of Victoria surface water rights to authorize aquifer storage, acquisition of necessary well injection, drilling, and production permits, and installation of appurtenant facilities, thereby enhancing the firm surface water supply available to Victoria.

The primary source of information for this 2016 SCTRWP technical evaluation is the recently completed Victoria Area ASR Feasibility Study.[1] This study focuses on the following key objectives:

- Seasonal storage to meet peak demands;
- Long-term storage to increase reliability during drought;
- Deferring additional water treatment capacity;
- Emergency storage for use during flood events; and
- Disinfection byproduct reduction.

The reader is encouraged to review the Victoria Area ASR Feasibility Study for additional background and technical information.

5.2.45.2 Available Yield

Surface water rights held by Victoria are summarized in Table 5.2.45-1 and total 27,007 acft/yr. As shown in evaluations of existing supply (Chapter 3 & Appendix C) using the Guadalupe – San Antonio River Basin Water Availability Model (GSA WAM), firm supply available under Victoria's surface water rights is quite limited. Consideration of the volume reliabilities of these rights (Appendix C), however, demonstrates that high percentages of their authorized diversion amounts are available in most years.

[1] Naismith Engineers, Inc., ARCADIS, ASR Systems, and Intera Geosciences & Engineering, "Victoria Area Feasibility Study," Texas Water Development Board, City of Victoria, Victoria County Groundwater Conservation District, Port of Victoria, Guadalupe-Blanco River Authority, and Lavaca-Navidad River Authority, 2014.

Diversion, treatment, and aquifer storage of this surface water available most of the time can ensure that sufficient storage is available for recovery during drought to increase firm supplies available to Victoria. Among the seven ASR options evaluated in the Victoria Area ASR Feasibility Study, the one providing an incremental firm yield enhancement of 7,900 acft/yr is reported herein and identified as a recommended water management strategy in the 2016 SCTRWP.

Table 5.2.45-1 Victoria Surface Water Rights

CA#/P#	Priority Date	Annual Diversion (acft/yr)	Maximum Diversion (cfs)
3844	8/16/1918	608	9.8
3858	6/27/1951	1,000	4.44
3860	8/15/1951	260	8.91
3862	12/12/1951	262.7	12.62
3606	7/10/1978	4,676	13.4
4117	4/2/1984	200	1.67
5466	5/28/1993	20,000	150
	Sums	**27,006.7**	**200.84**

5.2.45.3 Environmental Issues

Potential environmental issues associated with this water management strategy are rather limited as many of the physical facilities and surface water are already in place. Retrofitting of existing wells and installation of additional wells is likely to occur within or near developed areas of Victoria so significant disturbance of natural terrestrial habitats is expected to be minimal. Relative to the drawdowns associated with historical reliance on the Gulf Coast Aquifer for municipal water supplies, ASR would be expected to sustain somewhat higher aquifer levels with greater frequency, thereby enhancing flux from the aquifer and incrementally enhancing base flows of the Guadalupe River and its tributaries.

5.2.45.4 Engineering and Costing

As reported in the Victoria Area ASR Feasibility Study, a phased project relying on Victoria's existing surface water diversion and treatment facilities, adding 10 new ASR wells, retrofitting six existing wells, and integrating connection pipelines and control systems could enhance firm supplies by about 7,900 acft/yr. It is envisioned that storage of treated surface water would occur in the Upper Goliad formation of the Evangeline Aquifer beneath the City of Victoria and that monitoring wells would be installed in both the storage zone and the overlying Chicot Aquifer. Capital costs for new facilities and overall project costs are estimated at $14,500,000 and $21,100,000, respectively. Accounting for debt service, operations and maintenance, and pumping energy, annual cost is estimated at $1,500,000 and the annual unit cost of additional firm supply is about $192/acft ($0.59/kgal).

5.2.45.5 Implementation Issues

It will be necessary to obtain the following permits and authorizations:

- Amendments to Victoria surface water rights to include aquifer storage authorizations;
- Texas Commission on Environmental Quality (TCEQ) Class V injection permits for ASR wells; and
- VCGCD drilling and production permits.

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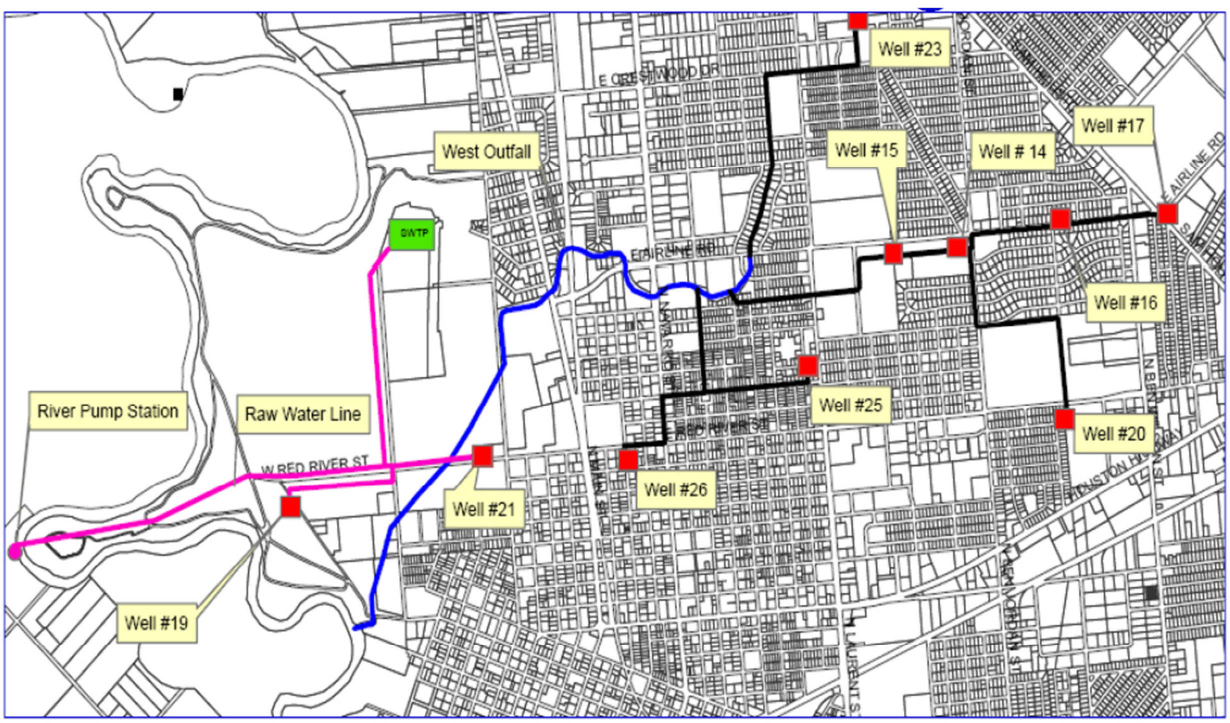
5.2.46 Victoria Groundwater-Surface Water Exchange

5.2.46.1 Description of Water Management Strategy

Through most of its history, the City of Victoria (Victoria) relied on locally available groundwater supplies withdrawn from the Gulf Coast Aquifer. To support continued growth, limit drawdowns in aquifer levels, and maintain water quality, Victoria obtained a new surface water appropriation (P#5466) in the 1990s authorizing diversions of up to 20,000 acft/yr from the Guadalupe River. Subject to the senior water rights of others and special conditions requiring inflow passage for environmental protection, however, supplies available under P#5466 are severely limited during drought. Since the 1990s, Victoria has obtained six additional surface water rights senior in priority to P#5466 and totaling 7,007 acft/yr from willing sellers. Each of these rights has been amended to allow diversions for municipal uses at the same location as P#5466 and two of them totaling 4,939 acft/yr include provisions for offset of surface water diversions with discharged groundwater during drought. This groundwater offset effectively firms up these previously interruptible surface water rights. The Victoria Groundwater – Surface Water Exchange water management strategy involves potential amendment of additional Victoria surface water rights to authorize groundwater offset, thereby enhancing the firm surface water supply available to Victoria. Figure 5.2.46-1 shows the locations of the diversion pump station on the Guadalupe River, surface water treatment plant (SWTP), wells potentially used to firm up surface water rights through groundwater offset and/or conjunctive use, the Guadalupe River tributary into which groundwater is discharged.

Figure 5.2.46-1 Facility Locations for Victoria Groundwater – Surface Water Exchange



5.2.46.2 Available Yield

As shown in evaluations of existing supply (Chapter 3 & Appendix C) using the Guadalupe – San Antonio River Basin Water Availability Model (GSA WAM), firm supply available under Victoria's surface water rights is quite limited. Surface water rights totaling 27,007 acft/yr held by Victoria are summarized in Table 5.2.46-1. Among these rights, Certificate of Adjudication (CA) #18-3862 (as amended) and Permit (P) #3606 (as amended) totaling 4,939 acft/yr include provisions for offset of surface water diversions with discharged groundwater during drought. Hence, Victoria has up to 22,068 acft/yr in additional surface water rights that could potentially be amended to authorize groundwater offset during drought.

The tested capacities of and authorized annual production rates from Victoria wells potentially involved in the Groundwater – Surface Water Exchange strategy are summarized in Table 5.2.46-2. As is apparent in this table, physical groundwater production capacity (27,081 acft/yr) slightly exceeds authorized surface water diversions on an annual basis. Production capacity authorized by the Victoria County Groundwater Conservation District (VCGCD) for the listed wells, however, is limited to 8,544 acft/yr.

Recognizing that some water is available under Victoria's surface water rights during even the most severe drought year on record, it is understood that allocation of the full authorized groundwater production of 8,544 acft/yr to offset Victoria surface water diversions would enhance the firm supply available under those surface water rights by at least 8,544 acft/yr. This minimum amount is, therefore, the firm yield assigned to the Victoria Groundwater – Surface Water Exchange strategy in the 2016 SCTRWP.

Table 5.2.46-1 Victoria Surface Water Rights

CA#/P#	Priority Date	Annual Diversion (acft/yr)	Maximum Diversion (cfs)
3844	8/16/1918	608	9.8
3858	6/27/1951	1,000	4.44
3860	8/15/1951	260	8.91
3862	12/12/1951	262.7	12.62
3606	7/10/1978	4,676	13.4
4117	4/2/1984	200	1.67
5466	5/28/1993	20,000	150
	Sums	**27,006.7**	**200.84**

Table 5.2.46-2 Victoria Well Capacity and Authorized Production

Well #	Capacity (gpm)	Capacity (cfs)	Capacity (acft/yr)	Victoria County GCD Authorized Production (acft/yr)
14	1,560	3.48	2,516	825
15	2,100	4.68	3,387	1,158
16	1,557	3.47	2,511	1,344
17	1,529	3.41	2,466	285
19	500	1.11	807	664
20	1,538	3.43	2,481	623
21	2,090	4.66	3,371	639
23	1,830	4.08	2,952	333
25	1,705	3.80	2,750	1,264
26	2,380	5.30	3,839	1,408
Sums	**16,789**	**37.41**	**27,081**	**8,544**

5.2.46.3 Environmental Issues

Potential environmental issues associated with this water management strategy are rather limited as the physical facilities and surface water and groundwater permits are already in place. Primary environmental concerns would likely be related to potential changes in surface water quality resulting from the offset discharge of groundwater. These concerns could be addressed by integration of special conditions in future surface water rights amendments to authorize groundwater offset similar to those included in amended CA#18-3862 and P#3606. Such special conditions include compliance with applicable water quality standards, weekly water quality monitoring of both groundwater discharged and the Guadalupe River upstream and downstream of the groundwater discharge, water sample analyses for multiple constituents, biotic and aquatic habitat sampling, and limitation of groundwater discharge to 33 percent of the flow in the river.

5.2.46.4 Engineering and Costing

A cost estimate is not provided for this water management strategy as the physical facilities and surface water and groundwater permits are already in place. Although some costs would be incurred in amending additional surface water rights for groundwater offset and complying with special conditions potentially included therein, water supply operations costs are avoided by elimination of process changes at the water treatment plant and flushing of the distribution system associated with periodic switching between surface water and groundwater sources.

5.2.46.5 Implementation Issues

Implementation issues are limited as the physical facilities and surface water and groundwater permits are already in place.

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