REGION H
Water Planning Group



2021 REGIONAL WATER PLAN
INITIALLY PREPARED PLAN
VOLUME 1

Prepared by:
Region H Water Planning Group

Prepared for:
Texas Water Development Board

With assistance from:
Freese and Nichols, Inc.
WSP USA, Inc.
Ekistics Corporation

March 2020

2021 Regional Water Plan
Initially Prepared Plan

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TBPE Reg. No. F-2144

WSP USA, Inc.

TBPE Reg. No. F-2263

Ekistics Corporation

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List of Abbreviations

AMI	Automated Metering Infrastructure
AWWA	American Water Works Association
BAWA	Baytown Area Water Authority
BBASC	Basin and Bay Area Stakeholder Committee
BBEST	Basin and Bay Expert Science Team
BEG	Bureau of Economic Geology
BMP	Best Management Practice
BRA	Brazos River Authority
BWA	Brazosport Water Authority
CCI	Construction Cost Index
cfs	cubic feet per second
CHCRWA	Central Harris County Regional Water Authority
CLCND	Chambers-Liberty Counties Navigation District
CLCWA	Clear Lake City Water Authority
COA	Certificate of Adjudication
COH	City of Houston
CRP	Clean Rivers Program
CRU	Collective Reporting Unit
CWA	Coastal Water Authority
CWSRF	Clean Water State Revolving Fund
DCP	Drought Contingency Plan
DFC	Desired Future Condition
DOR	Drought of Record
DWSRF	Drinking Water State Revolving Fund
EPA	Environmental Protection Agency
FBSD	Fort Bend Subsidence District
FSA	Farm Service Agency
FWSD	Fresh Water Supply District
GAM	Groundwater Availability Model
GCD	Groundwater Conservation District
GCWA	Gulf Coast Water Authority
GMA	Groundwater Management Area
gpcd	gallons per-capita daily
GRP	Groundwater Reduction Plan
HGSD	Harris-Galveston Subsidence District
IFR	Infrastructure Finance Report
IPP	Initially Prepared Plan
IWA	International Water Association
IWRP	Integrated Water Resource Plan
iWUD	Integrated Water Utility Database
LAWA	La Porte Area Water Authority
LNVA	Lower Neches Valley Authority
LSGCD	Lone Star Groundwater Conservation District
LVGUs	Large Volume Groundwater Users
MAG	Modeled Available Groundwater
MCL	maximum contaminant level

mgd	million gallons per day
mg/l	milligrams per liter
msl	mean sea level
MUDs	Municipal Utility Districts
MWP	Major Water Provider
NCWA	North Channel Water Authority
NFBWA	North Fort Bend Water Authority
NHCRWA	North Harris County Regional Water Authority
PDSI	Palmer Drought Severity Index
PWS	Public Water Supply
Region G	Brazos G Regional Water Planning Group
Region I	East Texas Water Planning Group
RHWPG	Region H Water Planning Group
RWP	Regional Water Plan
RWPA	Regional Water Planning Area
RWPG	Regional Water Planning Group
SAM-Houston	Small Area Model Houston
SDC	State Data Center
SJRA	San Jacinto River Authority
SWIFT	State Water Implementation Fund for Texas
SWP	State Water Plan
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
TPWD	Texas Parks and Wildlife Department
TRA	Trinity River Authority
TTWP	Trans-Texas Water Program
TWC	Texas Water Code
TWDB	Texas Water Development Board
UCM	Unified Costing Model
UHCPP	University of Houston Center for Public Policy
UNESCO	United Nations Educational, Scientific and Cultural Organization
WAM	Water Availability Model
WCP	Water Conservation Plan
WHCRWA	West Harris County Regional Water Authority
WIF	Water Infrastructure Fund
WMS	Water Management Strategy
WRAP	Water Resources Analysis Package
WUD	Water Utility Database
WUG	Water User Group
WWP	Wholesale Water Provider

Water Measurements

Acre-foot (ac-ft) = 43,560 cubic feet = 325,851 gallons

Acre-foot per year (ac-ft/yr) = 325,851 gallons per year = 893 gallons per day

Gallon per minute (gpm) = 1,440 gallons per day = 1.6 ac-ft/yr

Million gallons per day (mgd) = 1,000,000 gallons per day = 1,120 ac-ft/yr

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EXECUTIVE SUMMARY

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ES – Executive Summary

ES.1 INTRODUCTION

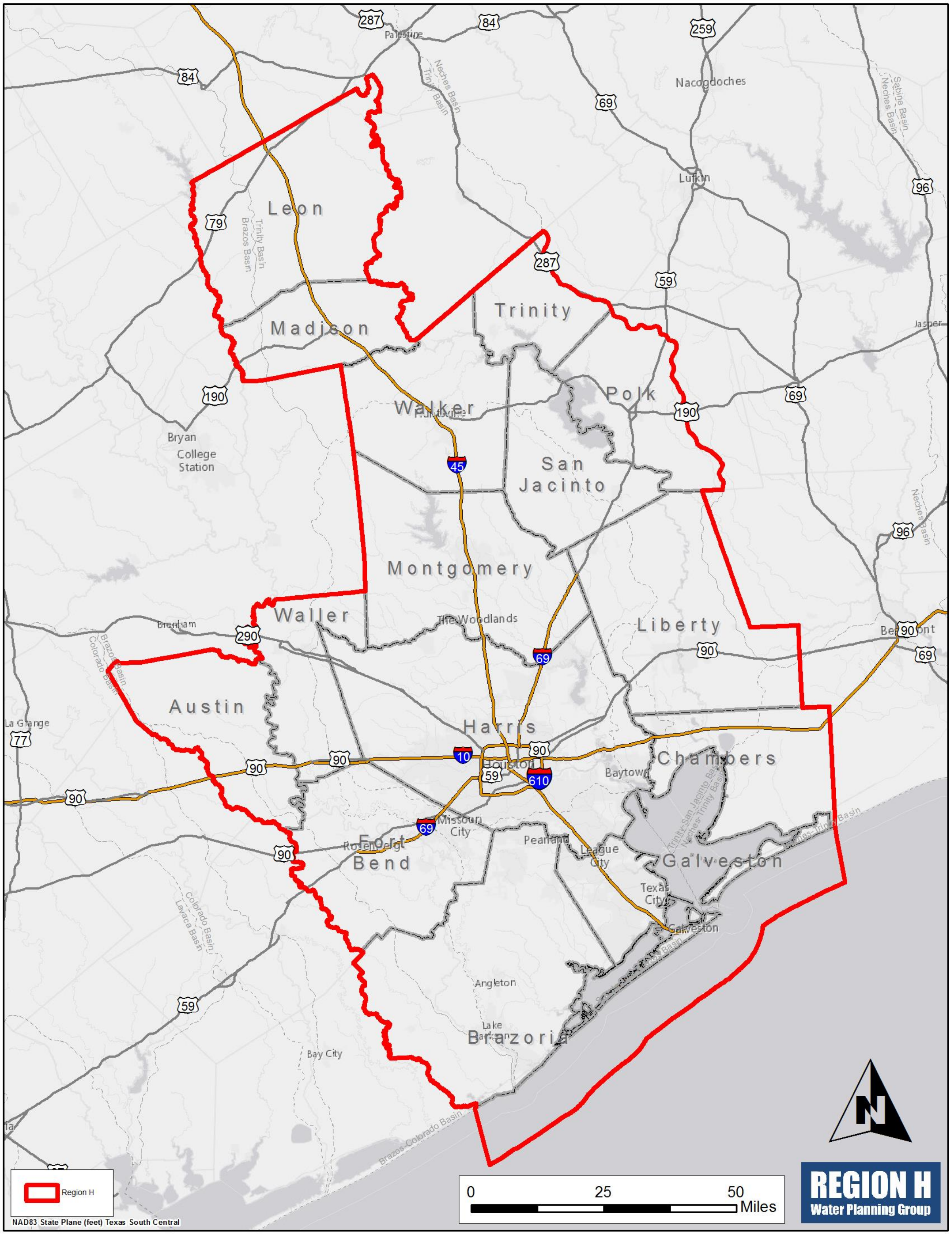
In 1997 the State Legislature, through Senate Bill 1, determined that a Texas State Water Plan for the 2000 to 2050 timeframe would be developed through a regional water planning approach. To accomplish this task, the Texas Water Development Board (TWDB) divided the state into 16 regional water planning areas and appointed representational Regional Water Planning Groups (RWPGs) that have guided the development of each region's plan. In 2001, a new set of rules and guidelines from TWDB were enacted through Senate Bill 2. The 2002 State Water Plan received enormous public involvement compared to previous plans. The planning process is cyclic, with updated Regional Water Plans (RWPs) and State Water Plans (SWPs) being produced every five years. The 2016 Region H Water Plan and the 2017 State Water Plan were created during the fourth planning cycle and are now being updated as part of the fifth round of regional planning.

Region H encompasses all or part of fifteen counties in southeast Texas and includes the majority of the San Jacinto River Basin and the lower reaches of the Brazos and Trinity River Basins. A location map showing the regional boundaries is included in *Figure ES-1*. The Region H Water Planning Group (RHWPG) consists of 26 voting and 10 non-voting members that represent a diverse range of backgrounds and interests. Additional information about Region H and the RHWPG can be found in ***Chapter 1*** of the 2021 RWP and on the Region H Water website, *http://www.regionhwater.org*. Regional water planning is conducted under the oversight of TWDB. Information on regional water planning and the State Water Plan can be found at the TWDB website, *http://www.twdb.texas.gov*.

Region H is an economic powerhouse crucial to the Texas and national economies. Adequate water supplies are essential to continued economic health and to the region's future growth. Two thirds of all U.S. petrochemical production and almost a third of the nation's petroleum industries are located in Region H. The area provides some of the state's most popular vacation spots that generate hundreds of millions of dollars in annual tourism revenues. The Port of Houston is the second busiest port in the nation. Region H is generally characterized by urbanizing land uses and broad-based economic development. In areas outside of the urban core, agriculture is a major contributor to economic activities.

Any large-scale water supply or conveyance projects will require the close cooperation of political entities in the affected areas. While municipal and county governments are most visible in Region H, there are numerous other governmental and regulatory agencies with jurisdiction over aspects of water supply development in the region. These include fifteen river and water authorities, seven groundwater-regulating entities, three councils of governments, eleven soil and water conservation districts, and hundreds of utility districts and water supply corporations that outnumber any other region in the state.

Figure ES-1 – Region H Location Map



ES.2 PROJECTED POPULATION AND WATER DEMANDS

Population in Region H is projected to grow from approximately 6.8 million in 2015 to approximately 11.7 million in 2070. The almost doubling of population over the fifty-year planning period represents an annual growth rate of slightly less than one percent.

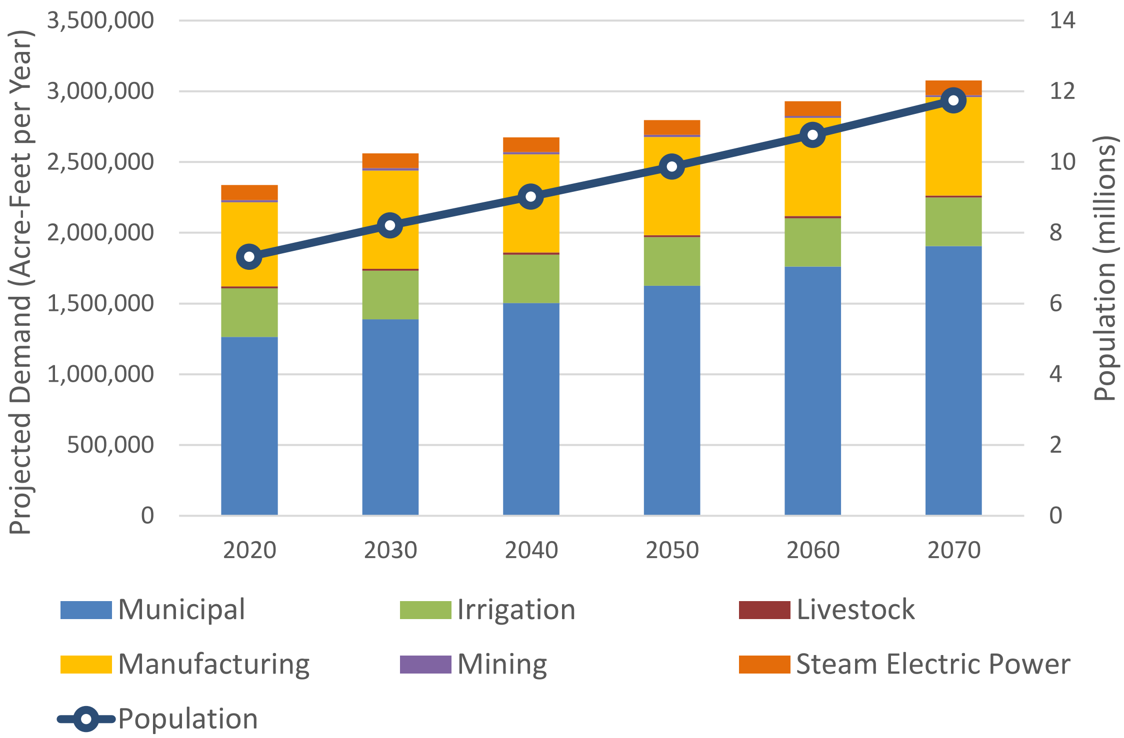
Population data are projected for each of the fifteen counties in the region and at a more refined scale for accounting units known as Water User Groups (WUGs). Defined municipal WUGs are entities serving more than 100 acre-feet per year (ac-ft/yr) for municipal use. All smaller service providers and rural/unincorporated areas of municipal and domestic water use, aggregated at the county level, are considered part of an additional WUG and are referred to as "County-Other" for each county. Within Region H, there are numerous municipal WUGs as well as fifteen County-Other WUGs, each of which are further divided by basin and county.

Population projections for Brazoria, Fort Bend, Galveston, Harris, and Montgomery Counties were developed for the 2016 RWP through an outside study to examine population growth based on the 2010 United States Census and projected on the basis of an economically driven growth model. This five-county area accounts for almost 95 percent of the region's population. These projections were subsequently adapted by TWDB for the 2021 RWP. Population projections for other areas were developed based on a standard cohort-component methodology applied by TWDB. Population-based demands were developed from these population projections based on recorded water use information compiled by TWDB and adjusted for future adoption of passive water conservation measures. It was observed that prior to adjustment for passive conservation, the mean and median per-capita water use by municipal WUGs in the 2021 RWP are 153 and 129 gallons per-capita daily (gpcd). These values are similar to those in the 2016 RWP, for which mean and median per-capita use were 154 and 127 gpcd. This change in gpcd is more heavily influenced by the way WUGs are defined in this 2021 round of planning rather than trends in per-capita use, since both plans rely heavily upon dry-year usage trends observed in 2011.

Water use in other sectors also represents significant demands within Region H. This is most notably true for the Irrigation and Manufacturing sectors. Projections from the 2016 RWP for these demands, along with Livestock, Mining, and Steam Electric Power segments, were reviewed and amended by TWDB to generate the 2021 RWP projections based on observed historical trends in water use. Manufacturing and Steam Electric Power demand projects in the 2021 RWP are significantly lower than previous projections due to revisions to TWDB's methodology for developing projections. During a review of the updated projections, the RHWPG noted that the required assumptions of constant manufacturing water demand after 2030 and constant water demand for steam electric power after 2020 do not reflect the ongoing growth in these sectors in Region H. The RHWPG recommends that these trends should be revisited in the next round of planning.

Population and water demand projections by WUG category are shown in *Figure ES-2*. Additional information regarding the projection of population and demand can be found in ***Chapter 2*** of the 2021 RWP.

Figure ES-2 – Population and Water Demand Projections by WUG Category



ES.3 ANALYSIS OF CURRENT WATER SUPPLIES

The total water supply currently available to Region H from existing water sources within the region is approximately 3.35 million ac-ft/yr in 2020. Of that amount, about two-thirds is surface water. By the year 2070, the available supply will be approximately 3.13 million ac-ft/yr. The reduction in supply between 2020 and 2070 reflects restrictions on the use of the Gulf Coast Aquifer, instituted to combat subsidence in a large part of the region. Reduced reservoir yields due to sedimentation also contribute to the reduction in supply over time. The predominant sources of surface water supply are three reservoirs: Lakes Conroe and Houston within the San Jacinto River Basin and Lake Livingston within the lower Trinity River Basin.

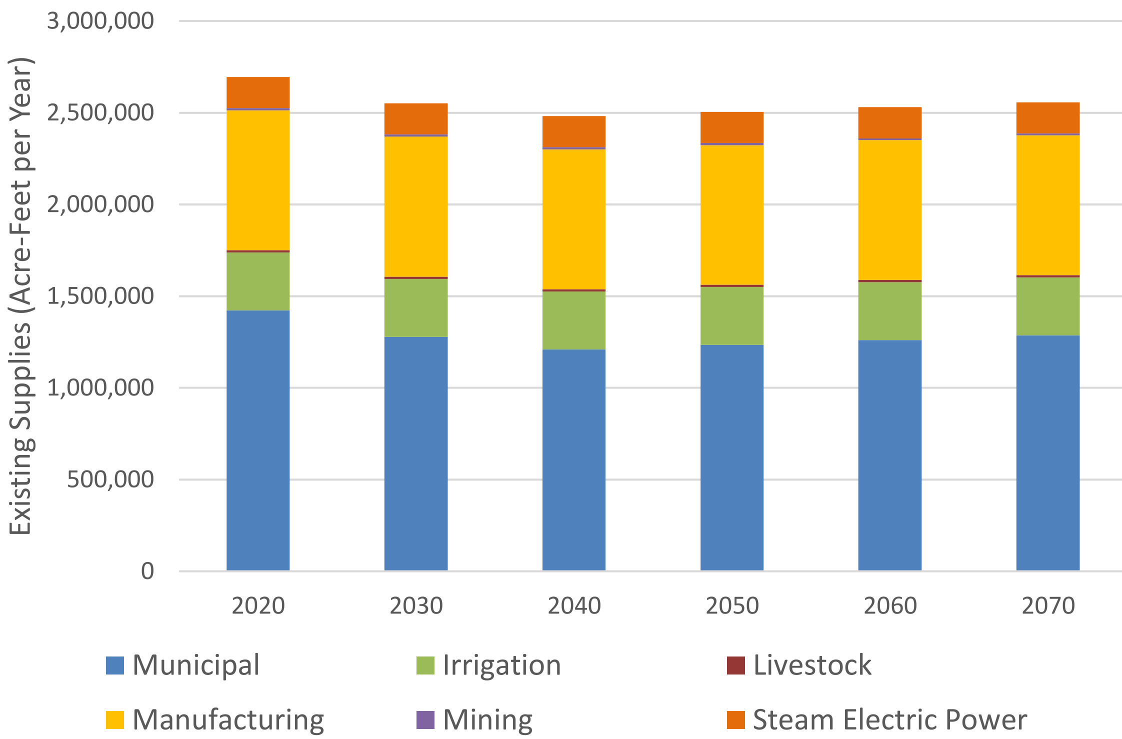
Surface water supply for each river basin and coastal basin was determined using the Texas Commission on Environmental Quality (TCEQ) Water Availability Models (WAMs), which analyze permitted diversions against the historic rainfall record, including the drought of record period in the 1950s. In the Trinity and Brazos River Basins, limited wastewater return flows were included in the models based on expectations that full reuse would not occur during the planning period. For all other basins, the yields are based upon the no-return-flow scenario used for water rights permitting.

Groundwater supply projections were largely derived from estimates of Modeled Available Groundwater (MAG) that are developed as a result of the Groundwater Management Area (GMA) joint planning process. Regional planning groups are required to use these availabilities when planning for all applicable aquifer formations, but additional guidance implemented by TWDB during the 2021 planning cycle allows RWPGs to apply a peaking factor to these volumes to reconcile the differences in the GMA and regional water planning processes and better reflect management by groundwater districts. During the development of the 2021 RWP, the RHWPG coordinated with groundwater-regulating entities in Region H and developed MAG peak factors for some of the formations in Region H.

Direct and indirect reuse of wastewater return flows accounts for a small portion of the existing supplies in Region H. These supplies were estimated based on existing levels of reuse as reported by TWDB and by individual WUGs.

A detailed analysis of the entire water supply is found in ***Chapter 3*** of the 2021 RWP. A summary of available water supply allocated by WUG category is provided in *Figure ES-3*.

Figure ES-3 – Existing Water Supplies by WUG Category and Decade

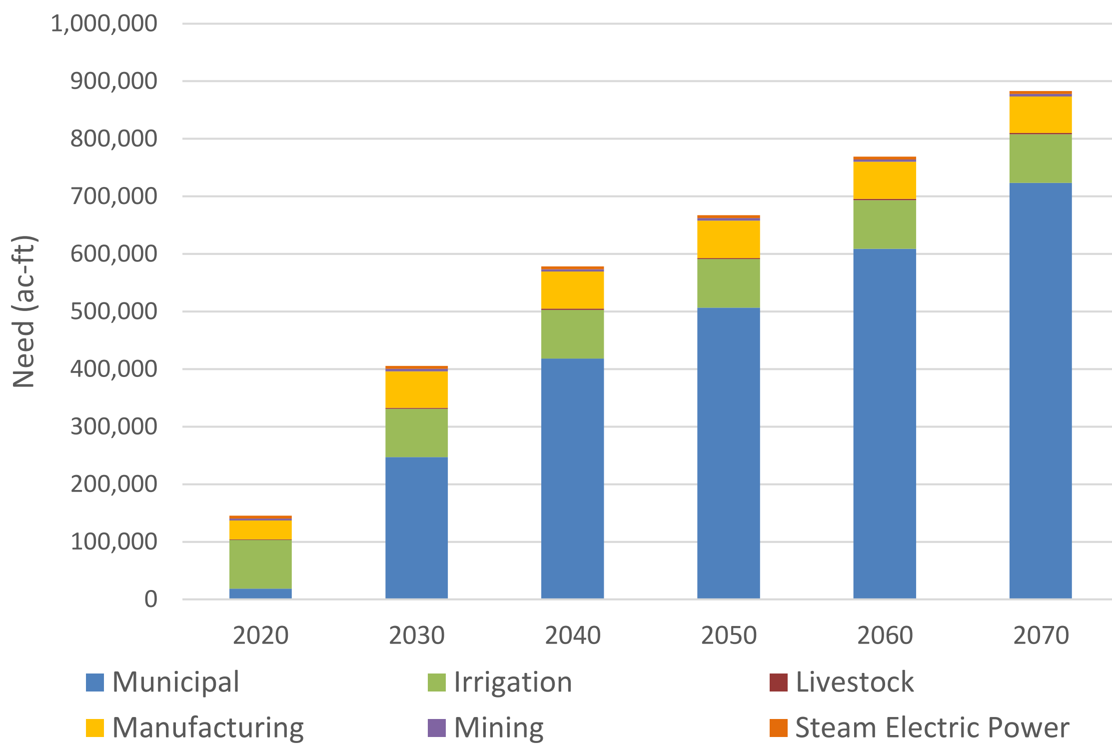


ES.4 ANALYSIS OF NEEDS

Water supplies were compared to projected water demands to determine if any areas in the region are expected to experience water shortages during the planning period. Despite substantial overall water supplies on a regional level through the year 2070, the RHWPG has identified communities and non-municipal water users that will experience water shortages during the planning period under conditions similar to the drought of record unless they take action to increase their supplies. Some of these WUGs will be able to meet their demands simply by extending or increasing existing water supply contracts.

The projected shortages identified in the year 2020 for WUGs wholly or partly within Region H totaled 145,122 acre-feet per year, increasing to as much as 883,136 acre-feet per year in the year 2070. Needs across Region H are shown by water use category in *Figure ES-4*. The projections estimate lower needs compared to the 2016 RWP, largely due to the reduction in projected Manufacturing and Steam Electric Power demands. Needs identified in the 2021 RWP are discussed in further detail in ***Chapter 4***.

Figure ES-4 – Identified Water Needs by WUG Category by Decade



ES.5 WATER MANAGEMENT STRATEGIES

State legislation and TWDB rules specify that RWPGs shall identify potentially feasible Water Management Strategies (WMS) for all WUGs and Wholesale Water Providers (WWPs) with future water supply needs. As a growing region with expanding populations and increasing economic development, Region H projects substantial needs over the 2020–2070 planning horizon. In order to address these needs, consideration was given to a wide range of data when developing recommendations for WMS and associated projects (specific infrastructure or measures used to increase or manage water supplies). Potentially feasible WMS were identified in three ways. First, strategies recommended in the 2016 Region H Water Plan for either implementation or additional study were considered. Next, new strategies were solicited during the scope development period for the 2021 RWP. Finally, entities that conducted independent strategy studies for WMS or projects that they intend to sponsor were able to bring their reports to the planning group and request that they be considered in the plan. The list of potentially feasible WMS and projects considered by the RHWPG are listed in *Table ES-1*.

Table ES-1 – Region H Potentially Feasible WMS and Projects

Conservation
Advanced Municipal Conservation and Water Loss Reduction
Irrigation Conservation
Conveyance
BWA Transmission Expansions
CHCRWA Transmission and Distribution Expansion
City of Houston GRP Transmission
COH, NHCRWA, and CHCRWA Shared Transmission
CWA Transmission Expansion
East Texas Transfer
GCWA Industrial Raw Water Line
Lake Livingston to SJRA Transfer
LNVA Neches-Trinity Basin Interconnect
NFBWA Phase 2 Distribution Segments
NHCRWA Distribution Expansion
NHCRWA Transmission Lines
Southeast Transmission Line Improvements
Surfside Beach Supply Infrastructure
WHCRWA Distribution Expansion
WHCRWA/NFBWA Transmission Line
Groundwater Development
Aquifer Storage and Recovery
Brackish Groundwater Development and Groundwater Blending
BWA Brackish Groundwater Development
City of Houston Area 2 Groundwater Infrastructure
Expanded Use of Groundwater
Forestar Houston County Project
Forestar Liberty County Project
GCWA Backup Well Development
Groveton Groundwater Expansion
SJRA Catahoula Aquifer Supplies
Groundwater Reduction Plans
CHCRWA GRP
City of Houston GRP
City of Missouri City GRP
City of Richmond GRP
City of Rosenberg GRP
City of Sugar Land IWRP
Fort Bend County MUD 25 GRP
Fort Bend County WC&ID No. 2 GRP
Montgomery County MUDs 8 and 9 GRP

NFBWA GRP
NHCRWA GRP
Porter SUD Joint GRP
River Plantation and East Plantation Joint GRP
SJRA GRP
WHCRWA GRP
Reuse
City of Houston Reuse
City of Pearland Reuse
Galveston County Industrial Reuse
NFBWA Member District Reuse
NHCRWA Member District Reuse
San Jacinto Basin Regional Return Flows
Wastewater Reclamation for Industry
Wastewater Reclamation for Municipal Irrigation
Westwood Shores MUD Reuse
Surface Water Development
Allens Creek Reservoir
BRA System Operation Permit
Dow Reservoir and Pump Station Expansion
Freeport Seawater Desalination
Lake Somerville Augmentation
Lone Star Lake
Manvel Supply Expansion
Mustang Reservoir Improvements
NRG Cedar Bayou Desalination
Treatment
BWA Conventional Treatment Expansion
City of Houston Treatment Expansion
City of Houston West Water Purification Plant
GCWA Galveston County Treatment Expansion
Northeast Water Purification Plant Expansion
Pearland Surface Water Treatment Plant
SEWPP Additional Module
Other
Brazos Saltwater Barrier
Chocolate Bayou Pump Station Expansion
Chocolate Bayou Saltwater Barrier Improvements
Municipal Drought Management
New and Expanded Contracts

Depending on the information available, Region H may adapt data directly from detailed studies developed by project sponsors or develop a high-level analysis of a concept for inclusion in the RWP.

In other cases, Region H has performed more in-depth planning studies to evaluate the potential of projects that may yield great regional benefits to water supply. The evaluation of each potentially feasible WMS included assessments of supply quantity and reliability, cost, and impacts to cultural and environmental resources. WMS evaluation and selection for recommendation also incorporated a dual-phased selection process, with one phase focused on the applicability of a WMS or project to the needs of individual WUGs and the other phase focused on evaluating a set of criteria applied to the overall WMS or associated projects.

Due to the extensive geographic area within Region H and the diverse nature of demands, a variety of WMS were recommended to meet needs including but not limited to the following approaches:

- water conservation,
- development of conveyance infrastructure and contracts to more fully utilize existing supplies,
- development of groundwater resources within areas with sufficient groundwater availability,
- reuse,
- development of new surface water supplies,
- development of treatment infrastructure.

Needs remaining after the application of conservation and direct reuse WMS are known as second tier needs. These needs are shown in *Figure ES-5*. A summary of source allocations and remaining unallocated volumes is shown in *Table ES-2*. *Table ES-3* summarizes the key projects selected as part of recommended WMS along with their total potential yield, capital cost, and decade of implementation. The evaluation and recommendation of WMS and projects in the 2021 RWP are discussed in further detail in ***Chapter 5***.

Figure ES-5 – Second Tier Needs After Application of Conservation and Direct Reuse WMS

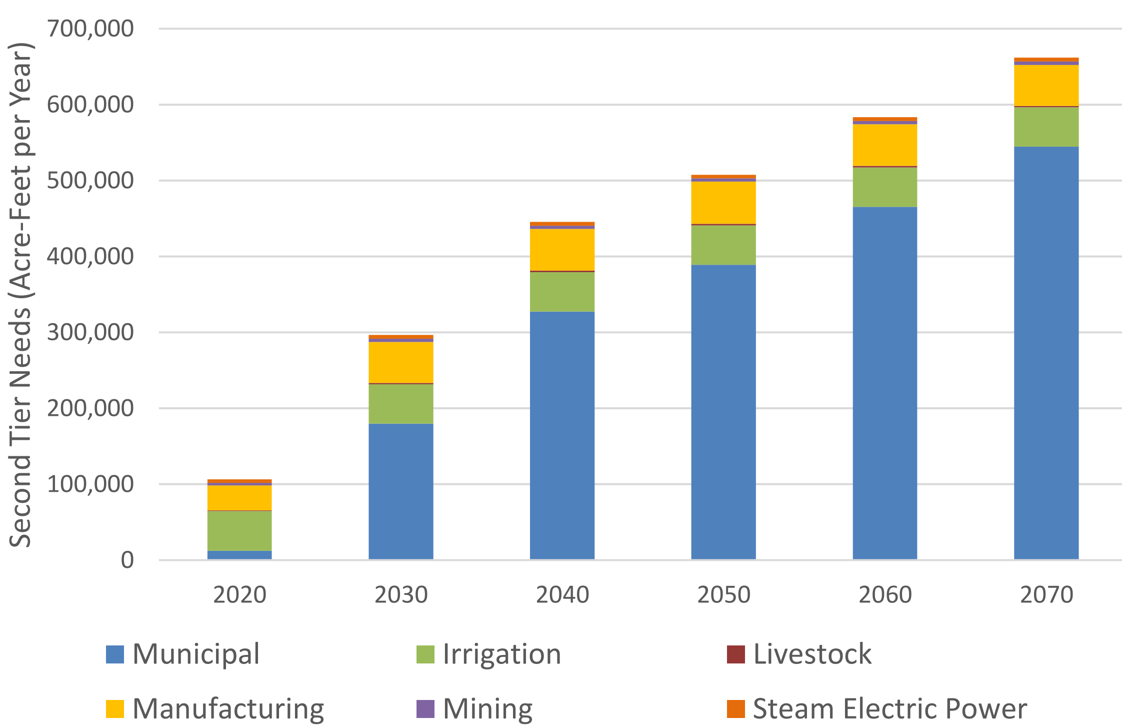


Table ES-2 – Source Water Balance Summary

Source Type	2070 Existing and Future Allocations (ac-ft)	2070 Unallocated Source Balance (ac-ft)
Reservoirs		
Allens Creek Reservoir	99,650	0
Lake Conroe	75,600	0
Lake Houston	156,400	0
Lake Livingston-Wallisville Saltwater Barrier System	1,275,900	0
Other Surface Water		
Gulf of Mexico Saline	11,200	0
Brazos Run-Of-River	541,130	0
Brazos-Colorado Run-Of-River	11,729	0
Neches Run-Of-River	0	176
Neches-Trinity Run-Of-River	37,474	7
San Jacinto Run-Of-River	12,618	9
San Jacinto-Brazos Run-Of-River	39,729	0
Trinity Run-Of-River	137,250	1
Trinity-San Jacinto Run-Of-River	5,537	0
Trinity-San Jacinto Run-Of-River (Saline)	22,400	0
Groundwater		
Gulf Coast Aquifer ASR	9,426	0
Brazos River Alluvium Aquifer	0	19,971
Carrizo-Wilcox Aquifer	9,261	10,505
Gulf Coast Aquifer System	732,732	102,248
Queen City Aquifer	677	526
San Bernard River Alluvium Aquifer	0	520
San Jacinto River Alluvium Aquifer	0	1,450
Sparta Aquifer	3,491	2,810
Trinity River Alluvium Aquifer	0	3,913
Yegua-Jackson Aquifer	2,925	4,250
Reuse		
Direct Reuse	75,622	0
San Jacinto Regional Return Flows	119,673	0
San Jacinto COH Reuse	242,554	0
Indirect Reuse, Houston	5,147	0
Indirect Reuse, Huntsville	2,240	0
Indirect Reuse, Montgomery County MUDs 8 And 9	697	0
Indirect Reuse, SJRA	11,939	0
Indirect Reuse, SJRA And Conroe	8,834	0
Indirect Reuse, The Woodlands	438	0

Source Type	2070 Existing and Future Allocations (ac-ft)	2070 Unallocated Source Balance (ac-ft)
Conservation		
Irrigation Conservation	93,562	0
Municipal Conservation	124,573	0
Water Loss Reduction	62,601	0

Table ES-3 – Key Project Overview

Project	Potential Volume[1] (ac-ft)	Capital Cost ($)	Unit Cost ($/ac-ft)		Start Decade
			Start Decade	2070	
Conservation					
Irrigation Conservation	93,562	$1,489,156	$133	$131	2020
Municipal Conservation (Advanced Conservation)	123,251	$2,211,236,519	$754	$591	2020
Municipal Conservation (Water Loss Reduction)	62,601	$891,822,048	$625	$578	2020
Conveyance					
BWA Transmission Expansions	26,211	$77,755,692	$248	$39	2030
CHCRWA Transmission and Distribution Expansion	5,466	$17,202,167	$238	$16	2030
City of Houston GRP Transmission	27,216	$31,986,905	$91	$8	2040
COH, NHCRWA, and CHCRWA Shared Transmission	154,575	$462,453,409	$246	$27	2030
CWA Transmission Expansion	349,785	$119,336,981	$43	$19	2040
East Texas Transfer	250,000	$423,969,947	$134	$15	2050
GCWA Industrial Raw Water Line	33,600	$20,909,636	$63	$19	2020
Lake Livingston to SJRA Transfer	50,000	$245,492,975	$437	$92	2050
LNVA Neches-Trinity Basin Interconnect	67,000	$103,316,000	$135	$27	2040
NFBWA Phase 2 Distribution Segments	62,496	$83,859,522	$104	$9	2030
NHCRWA Distribution Expansion	143,360	$919,703,916	$489	$44	2030
NHCRWA Transmission Lines	143,360	$327,910,960	$185	$24	2030
Southeast Transmission Line Improvements	39,928	$119,413,067	$229	$19	2030
Surfside Beach Supply Infrastructure	323	$1,900,440	$450	$36	2020
WHCRWA Distribution Expansion	92,288	$276,977,822	$237	$26	2030
WHCRWA/NFBWA Transmission Line	169,030	$1,310,701,901	$613	$67	2030
Groundwater Development					
Aquifer Storage and Recovery	9,426	$222,907,186	$2,551	$2,551	2070
Brackish Groundwater Development[2]	Varies	Varies by project	Varies by WUG	Varies by WUG	2020
BWA Brackish Groundwater Development	3,136	$33,246,167	$579	$370	2030
City of Houston Area 2 Groundwater Infrastructure	50,400	$122,751,076	$403	$222	2030
Expanded Use of Groundwater[2]	31,000+	Varies by WUG	Varies by WUG	Varies by WUG	2020
GCWA Backup Well Development	1,120	$1,346,492	$169	$84	2040

Project	Potential Volume[1] (ac-ft)	Capital Cost ($)	Unit Cost ($/ac-ft)		Start Decade
			Start Decade	2070	
Groveton Groundwater Expansion	242	$2,211,952	$699	$56	2020
SJRA Catahoula Aquifer Supplies	10,500	$18,200,411	$479	$358	2040
Groundwater Reduction Plans					
CHCRWA GRP[3]	5,466	$0	$0	$0	2030
City of Houston GRP[3]	124,914	$0	$0	$0	2020
City of Missouri City GRP	25,760	$87,837,323	$405	$165	2030
City of Richmond GRP	7,178	$70,936,844	$1,108	$363	2020
City of Rosenberg GRP	3,920	$12,963,110	$261	$29	2030
City of Sugar Land IWRP	15,492	$133,134,039	$1,210	$390	2030
Fort Bend County MUD 25 GRP	1,120	$26,718,250	$2,541	$862	2030
Fort Bend County WC&ID No. 2 GRP	6,720	$63,535,966	$1,106	$440	2030
Montgomery County MUDs #8 and #9 GRP	2,240	$30,510,375	$1,875	$917	2020
NFBWA GRP[3]	62,496	$0	$0	$0	2030
NHCRWA GRP[3]	143,360	$0	$0	$0	2030
Porter SUD Joint GRP	2,240	$26,862,533	$1,542	$699	2020
River Plantation and East Plantation Joint GRP[4]	51	$0	$0	$0	2030
SJRA GRP	100,000	$998,910,850	$697	$340	2030
WHCRWA GRP[3]	92,288	$0	$0	$0	2030
Reuse					
City of Houston Reuse	242,554	$555,093,732	$373	$139	2040
City of Pearland Reuse	1,154	$12,648,000	$913	$142	2030
Galveston County Industrial Reuse	22,400	$90,746,960	$564	$279	2030
NFBWA Member District Reuse	3,816	$46,640,088	$1,695	$835	2020
NHCRWA Member District Reuse	300	$4,295,775	$1,913	$905	2020
San Jacinto Basin Regional Return Flows[3]	119,673	$0	$0	$0	2020
Wastewater Reclamation for Municipal Irrigation	19,776	$181,028,438	$1,308	$896	2030
Westwood Shores MUD Reuse	150	$2,031,251	$1,921	$968	2020
Surface Water Development					
Allens Creek Reservoir	99,650	$365,446,301	$211	$39	2040
BRA System Operation Permit[3]	78,276	$0	$0	$0	2020
Dow Reservoir and Pump Station Expansion	80,000	350,000,000	$373	$66	2020
Freeport Seawater Desalination	11,200	155,877,822	$2,273	$1,293	2040
Manvel Supply Expansion	15,680	$269,052,608	$1,488	$309	2030
Mustang Reservoir Improvements	3,734	$14,551,195	$298	$23	2020
NRG Cedar Bayou Desalination	22,400	$342,840,391	$2,637	$1,560	2030
Treatment					
BWA Conventional Treatment Expansion	8,400	$19,085,165	$351	$191	2030
City of Houston Treatment Expansion[3]	89,396	$0	$0	$0	2040
City of Houston West Water Purification Plant	103,385	$959,257,534	$1,418	$407	2040
GCWA Galveston County Treatment Expansion	22,400	$167,919,105	$894	$367	2030

Project	Potential Volume[1] (ac-ft)	Capital Cost ($)	Unit Cost ($/ac-ft)		Start Decade
			Start Decade	2070	
Northeast Water Purification Plant Expansion	448,000	$2,179,413,588	$615	$272	2030
Pearland Surface Water Treatment Plant	22,400	$232,787,093	$973	$242	2030
SEWPP Additional Module	22,400	$97,597,266	$497	$191	2030
Other Infrastructure					
Brazos Saltwater Barrier	10,000	$67,552,043	$517	$42	2040
Chocolate Bayou Pump Station Expansion	33,600	$8,577,765	$29	$11	2020
Chocolate Bayou Saltwater Barrier Improvements	1,120	$1,034,798	$72	$7	2020

1. *Volumes listed in this table represent the maximum anticipated volume associated with the projects rather than new increments of yield. Volumes shown in this table may overlap and are not necessarily additive.*
2. *Includes brackish groundwater projects implemented under Expanded Use of Groundwater. Costs vary by WUG.*
3. *Costs, including construction costs, engineering, legal, and permitting fees, land acquisition, and other capital costs, are included under associated infrastructure projects.*
4. *Supply generated through expanded use of existing infrastructure. Cost estimated to be minimal.*

Following the application of WMS and key projects, some identified needs were found to remain. Under drought of record conditions, it was determined that needs would persist in the Irrigation and Livestock demand sectors within some areas of Region H without the availability of an interruptible water supply to provide a low-cost option for meeting demands. These sectors are particularly sensitive to the cost of water and are also unable to easily develop long-term contracts for water on the firm yield basis that is required for development of water supply projects in the RWP. Each of these sectors will continue to rely on low-cost, interruptible supplies of water as well as local supplies and a balance of groundwater and surface water resources when they are available. However, according to the guidelines for RWP development, these supplies are not permissible for planning purposes and may not be shown in the RWP. For this reason, the needs identified in *Table ES-4* are shown as unmet although, in reality, cost-effective solutions exist that may provide water to these demands. The development of firm yield projects within the RWP may also provide additional interruptible supplies to meet these demands in most, if not all, years.

Table ES-4 – Remaining Unmet Needs

WUG Name	County	Basin	Unmet Needs (ac-ft)					
			2020	2030	2040	2050	2060	2070
Irrigation	Brazoria	SJ-B	38,229	38,229	38,229	38,229	38,229	38,229
	Chambers	T	4,695	4,695	4,695	4,695	4,695	4,695
		T-SJ	1,616	1,616	1,616	1,616	1,616	1,616
	Galveston	SJ-B	2,765	2,765	2,765	2,765	2,765	2,765
Livestock	Brazoria	B-C	0	0	0	0	0	8
	Galveston	N-T	53	53	53	53	53	53
		SJ-B	184	184	184	184	184	184
	Harris	SJ	383	766	1,022	1,022	1,022	1,022
		T-SJ	101	101	101	101	101	101

N-T = Neches-Trinity, T = Trinity, T-SJ = Trinity-San Jacinto, SJ = San Jacinto, SJ-B = San Jacinto-Brazos, B-C = Brazos-Colorado

ES.5.1 Conservation Recommendations

Water conservation plays an important role in meeting future water needs across the State of Texas. Because of this, TWDB guidance requires that RWPs dedicate a subchapter of ***Chapter 5*** to conservation recommendations for each region. This section contains information related, not only to the importance of water conservation implementation, but also to its challenges within Region H and the state as a whole.

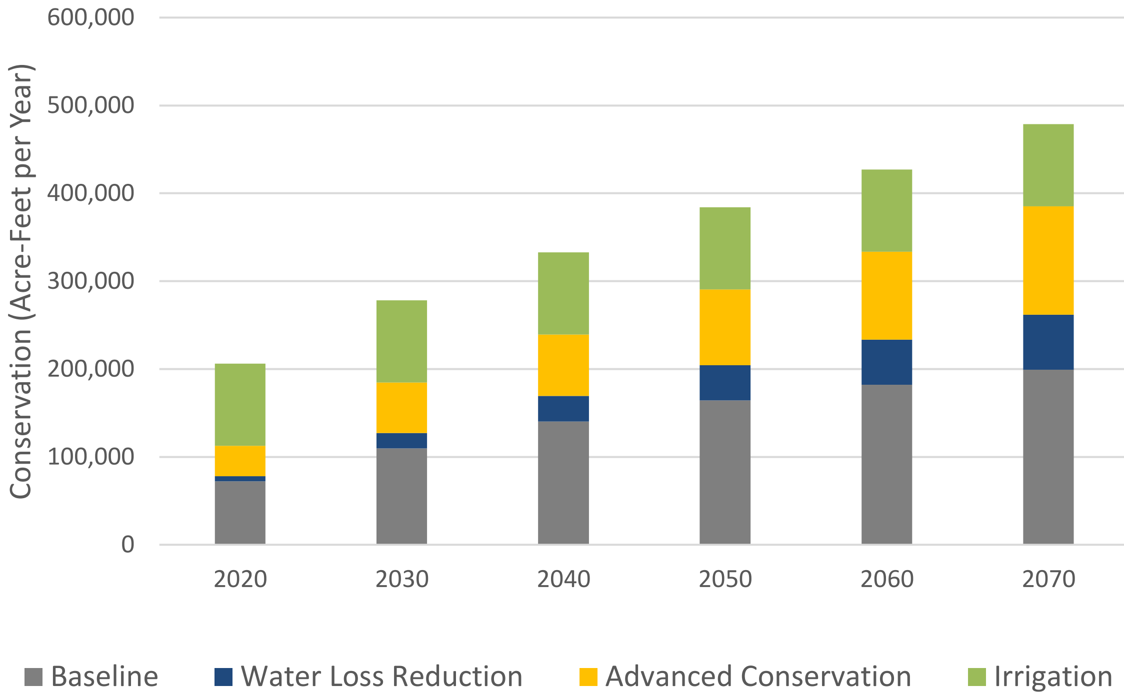
Current conservation efforts were evaluated for the region based on the conservation plans developed by individual water utilities. This analysis demonstrated that Region H focuses much of its conservation resources toward outreach, conservation-oriented rate structures, water system audits, and leak detection and repair.

Water conservation recommendations in the 2021 RWP are based on conservation measures and associated estimated water savings included in the TWDB Municipal Water Conservation Planning Tool (MWCPT). The RHWPG has recommended varying levels of outdoor residential conservation and other measures for nearly all municipal WUGs based on the demand profiles of individual WUGs. Long-term projections for savings attributed to municipal conservation programs were combined with estimates of potential savings related to water loss reduction to provide a comprehensive water conservation program for WUGs in Region H.

Conservation was also applied to Irrigation demands. Region H recommends both on-farm and off-farm measures based on an evaluation of the extent of existing conservation measures in order to prevent overestimation of potential savings. Irrigation conservation practices provide significant potential water savings due to the magnitude of these demands in Region H.

The comprehensive water conservation applied in the 2021 RWP is summarized in *Figure ES-6*. Additional information related to conservation can be found in ***Chapter 5*** and ***Chapter 5B***.

Figure ES-6 – Total Region H 2021 RWP Conservation



ES.6 IMPACTS OF THE REGIONAL WATER PLAN

Both surface water and groundwater in Region H are generally of good quality and can be used with conventional treatment only. Advanced treatment measures are recommended to develop direct wastewater reuse projects and the utilization of non-traditional water supplies such as brackish groundwater. The management strategies recommended in the plan are not anticipated to directly affect water quality in most basins, although the reduction of instream flows due to full use of water rights may indirectly increase the concentration of some contaminants (by reducing the overall volume of water). However, plan development was guided by the principle that the designated water quality and related water uses as shown in the state water quality management plan shall be improved or maintained. The Brazos Saltwater Barrier is specifically recommended to improve water quality in the lower Brazos Basin by preventing seawater from migrating upstream during periods of low flows. The transfer of water to the San Jacinto River Authority (SJRA) from Trinity River supplies will introduce Trinity River water into the San Jacinto River Basin. It should be noted that Trinity River water is currently transferred into Harris County via other conveyances. Similarly, the East Texas Transfer will also introduce water from basins as far east as the Sabine River into western basins on a path toward the Houston area. The reuse of wastewater and other treatment projects will produce a brine concentrate, which must be judiciously discharged to prevent adverse environmental impacts.

Agricultural areas in Region H are generally served by a combination of groundwater and surface water supplies depending primarily on the location of use and the application. Groundwater use is not projected to change during the planning period. Surface water used for irrigation is typically contracted on a year-to-year basis and often originates from supplies that are not firm during the drought of record. The RHWPG recognizes the sensitivity of agriculture to the availability of less expensive water supplies that are not available on a regular basis during drought-of-record conditions. Although these supplies cannot be used in the RWP per planning guidance, these interruptible supplies will continue to be an important resource in meeting the needs of irrigation users in Region H.

The management strategies recommended in this plan will fully utilize, to the extent applicable to projected needs, the currently available water rights in all basins. Many projects in the plan will require some environmental mitigation due to habitat impacts. However, the plan strives to identify the most feasible projects from standpoints of economics and sustainability. The recommended reuse of wastewater will further reduce instream flows, particularly during drought conditions. Some of this reduction will be mitigated by an overall increase in wastewater discharges beyond the current level and the reduction in need for developing new raw water supplies.

Groundwater use in the region is projected to increase within the sustainable yield of the aquifers or the regulated withdrawal cap, as applicable. The export of groundwater from its county of origin is not recommended in this plan.

Additional information related to impacts of the plan can be found in ***Chapter 6*** of the RWP.

ES.7 DROUGHT RESPONSE

Drought is the primary driver behind water planning in Texas, and the historical drought of record serves as the fundamental basis for evaluating the supplies and needs in the development of each RWP. As specified in TWDB guidance for RWP development, the 2021 RWP includes material related to preparation for and response to drought conditions.

The drought of record in Region H has consistently been the drought of the 1950s. Although recent dry years have eclipsed the severity of the 1950s drought for short periods of time, the long-term severity of the 1950s drought has, so far, not been exceeded. Current drought contingency plans for surface water supplies in Region H have used the 1950s drought as a basis for assigning triggers and responses to drought conditions. The RHWPG recommends adoption of the triggers and responses prescribed by project owners and sponsors for management of surface water supplies such as reservoirs. For groundwater supplies, identification of drought conditions generally requires evaluation of other factors in order to recognize and respond to drought. For these supplies, Region H recommends that water providers regularly review the Palmer Drought Severity Index (PDSI) as a basis for recognizing drought conditions and taking appropriate measures to respond.

Some drought conditions are of such a severity that they pose risks to life, safety, and the economy. This is particularly true for small water systems that have limited sources of water currently connected, as well as for rural communities that are distant from alternative supplies that may serve to meet needs during emergency conditions. As part of the evaluation of drought responses, Region H proposed a number of emergency measures for these utilities to consider, should drought conditions deem emergency response necessary. These measures include, where viable, the use of additional surface water supplies, development of additional local groundwater or brackish groundwater, or utilization of existing or potential interconnections with neighboring systems. It should be noted that these approaches may become necessary during either hydrologic drought periods or emergency conditions brought about by failure of water source or infrastructure.

Additional information related to drought response can be found in ***Chapter 7*** of the RWP.

ES.8 UNIQUE STREAM SEGMENTS, RESERVOIR SITES, AND OTHER RECOMMENDATIONS

The Texas Water Code guides the RWPGs to adopt recommendations on Unique Stream Segments, Unique Reservoir Sites, and legislative policy. ***Chapter 8*** of the 2021 RWP describes these recommendations in depth, and a summary is provided below.

ES.8.1 Unique Stream Segments

The Texas Water Code offers the opportunity for RWPGs to identify river and stream segments of unique ecological value. Stream segments designated by the legislature as having unique ecological value cannot be developed as reservoir sites by the State or any political subdivision of the State. Based on the information provided in past RWPs, the RHWPG elected to retain the unique designations for the eight segments designated by the Texas Legislature based on prior consideration and review. These segments are listed in *Table ES-5.* No additional segments were nominated for designation in the 2021 RWP. Additional information is contained in ***Chapter 8***.

Table ES-5 – Recommended Unique Stream Segments

Stream Segment	County
Armand Bayou	Harris
Austin Bayou	Brazoria
Bastrop Bayou	Brazoria
Big Creek	Fort Bend
Big Creek	San Jacinto
Cedar Creek Lake	Brazoria
Menard Creek	Liberty and Polk
Oyster Bayou	Chambers

ES.8.2 Unique Reservoir Sites

The Texas Water Code also offers an opportunity for RWPGs to designate sites of unique value for use as surface water supply reservoirs. Designation by the Legislature as a unique reservoir site prevents the State from constructing major infrastructure (such as major highways) within the project limits. Through use of a decision-based water management strategy analysis and selection process, the RHWPG selected two reservoir projects for meeting needs in the 2021 RWP: Allens Creek Reservoir and the Dow Expansion to Harris Reservoir. Region H chose to select Allens Creek Reservoir as a recommendation for any future reaffirmation of Unique Reservoir Sites. This site is described below in *Table ES-6*. Additional information is contained in ***Chapter 8***.

Table ES-6 – Recommended Unique Reservoir Sites

Name	County	General Location
Allens Creek	Austin	1 mile north of the City of Wallis

ES.8.3 Regulatory, Administrative, and Legislative Recommendations

Guidance for regional water planning specifies that RWPGs may develop and include in the RWP regulatory, administrative, and legislative recommendations. These recommendations are addressed to each governmental agency that has the appropriate jurisdiction over each subject. It is generally assumed that regulatory recommendations are directed toward TCEQ, that administrative recommendations are directed toward TWDB, and that legislative recommendations are directed toward the State of Texas Legislature.

The RHWPG has adopted the following regulatory, administrative, and legislative recommendations:

Regulatory and Administrative Recommendations

- The Region H Water Planning Group recommends that the TWDB determines, in conjunction with the TCEQ and TPWD, which specific environmental studies and analysis are required for each category of management strategy (i.e., new water right, new reservoir, etc.). Furthermore, the guidance should be added to the Planning Guidelines, so that Regional Water Planning Groups can reflect the cost of those requirements in their budgets and scopes of work. Adding environmental guidelines will also make water plans consistent across the state.
- The Region H Water Planning Group recommends that the TPWD, in cooperation with TWDB and the Regional Water Planning Groups, develop an updated analysis of ecologically significant river and stream segments, including identification of river and stream segments of unique ecological value.
- The Region H Water Planning Group recommends that TCEQ continue routine updates to Water Availability Models across the state based on a prioritized methodology based on observed climate conditions and the overall limitation on water resources in each basin. This may be prescribed in future rulemaking. Furthermore, these rules should require that the most recent model for each basin be made available through the TCEQ website for use by both the RWPGs and the public.
- Provide for additional opportunities for Groundwater Management Areas and Regional Water Planning Groups to align their planning through rules that recognize the inherent differences of these processes and account for the timing of the methodologies so that changes in groundwater management can be reflected in the Regional Water Plans.
- Work with water utilities and planners to identify the limitations of current planning approaches regarding OneWater management and how these programs may best be reflected in regional plans. This will have the added benefit of promoting these options for comprehensive water management.

Legislative Recommendations

- The Region H Water Planning Group recommends that the legislature remove the unnecessary and counterproductive barriers to interbasin transfers that exist in current law.
- The Region H Water Planning Group recommends establishment of additional and dedicated funding to pursue necessary future efforts of the state’s bay and estuary programs.
- The Region H Water Planning Group supports continued usage of the Rule of Capture as the basis of groundwater law throughout the State of Texas except as modified through creation of certified groundwater conservation districts.

- The Region H Water Planning Group supports creation of groundwater conservation districts, as necessary, by local subarea water interests. These districts provide a unique opportunity for balancing local management with regional planning through the joint planning exercises of Groundwater Management Areas.
- The Region H Water Planning Group wishes to recognize the Legislature's efforts in implementing the SWIFT program and also supports ongoing and expanded support for financing methods by the State of Texas for development of water supply projects recommended within adopted Regional Water Plans.
- The Region H Water Planning Group supports continued funding for the Groundwater Availability Modeling effort and recommends comprehensive analysis of all groundwater resources within the state.
- The Region H Water Planning Group supports funding of research and development studies associated with the efficient usage of irrigation technologies and practices.
- The Region H Water Planning Group supports water conservation and recommends that the legislature continue to address and improve water conservation activities in the state. In addition, the RHWPG recommends the State consider improvements to statewide efforts and messaging regarding the importance of water conservation.
- The Region H Water Planning Group recommends that the State fund research into advanced conservation technologies.
- The Region H Water Planning Group recommends that the State consider legislation clarifying the liability exposure of reservoir operators for passing storm flows through water supply reservoirs.
- The Region H Water Planning Group recommends that the State direct the State Demographer's office to explore the potential changes in population distribution made possible by rapid advancements in information technology.
- The Region H Water Planning Group recommends that the TWDB request additional and adequate funding and the adoption of the appropriate administrative procedures from the legislature to facilitate ongoing activities of the RWPGs. Funding should be made available throughout the entirety of the planning cycle without funding gaps that make it difficult for planning groups to accomplish their ongoing efforts.

Infrastructure Financing Recommendations

- The Region H Water Planning Group recommends increasing the funding of the State Revolving Funds Program in future decades and expand the program to include coverage for system capacity increases to meet projected growth for communities.
- Provide a mechanism to leverage federal grant programs for agriculture by providing the local matching share. Increase funding of associated loan programs and consider adding a one-time grant or subsidy component to stimulate early adoption of conservation practices by individual irrigators. Provide opportunities for joint cooperation between growers and landowners to facilitate the use of funding programs for property under long-term lease agreements.
- The Region H Water Planning Group recommends continued state and federal support of the Texas Community Development Program and increase the allocation of funds for the Small Town Environment Program.

- The Region H Water Planning Group recommends continued support and increased funding of Water and Waste Disposal Loans and Grants from USDA Rural Utilities Service at the federal level.
- Provide technical assistance grants for the advancement of desalination water supplies and implementation of new desalination technologies available to wholesale and retail water suppliers. Provide resources for identification and feasibility assessment of opportunities for aquifer storage and recovery projects. Continue to fund appropriate demonstration facilities to develop a customer base and pursue federal funding for desalination programs.
- Region H supports the forming of regional partnerships and encourages the State to allow them the greatest possible latitude for financing in their governing regulations. Additionally, funding opportunities should be made available to these public/private partnerships and to private nonprofit water supply corporations.

Additional information is contained in ***Chapter 8***.

ES.9 REPORTING OF FINANCING MECHANISMS FOR WATER MANAGEMENT STRATEGIES

Approximately $20.8 billion in capital costs were identified for meeting needs throughout the planning period. These capital costs primarily represent infrastructure (wells, pump stations, treatment facilities, transmission mains, etc.) required to implement water management strategies at the WWP and WUG levels. This total capital cost does not include the annual costs such as debt service associated with the new projects. Additionally, these costs do not represent improvements that will be required within individual WUGs' water supply systems for providing adequate water supply.

With the assistance of the RHWPG, TWDB will conduct a survey of water utilities related to the anticipated cost of infrastructure and approaches to fund these projects. Anticipated costs developed as part of the RWP will be submitted to WUGs in order to determine their interest in pursuing one or more of the financial assistance programs offered by TWDB. Please see ***Chapter 9*** for an overview of this methodology. Results of the survey will be contained in the final, adopted 2021 RWP.

ES.10 ADOPTION OF PLAN AND PUBLIC PARTICIPATION

During the course of developing the 2021 RWP, the RHWPG conducted numerous public meetings corresponding with various phases of plan development. Details of these meetings and comments from the public and interested agencies are provided in ***Chapter 10*** of the RWP.

After the submittal of the Initially Prepared Plan (IPP) to TWDB by March 3, 2020, the RHWPG will also conduct public hearings to receive comment from the public. Details of these hearings and public comments received after the submittal of the IPP will be included in the final, adopted 2021 RWP.

ES.11 IMPLEMENTATION AND COMPARISON TO THE PREVIOUS REGIONAL WATER PLAN

Guidance for the development of regional water plans requires that each RWP, beginning with the 2016 plan, include a comparison to the previous plan. As part of this comparison, RWPs should discuss the implementation of WMS and projects recommended in the previous plan, as well as the development of water demands, supplies, and strategies associated with each RWP. A detailed comparison of the 2016 and 2021 RWPs is provided in ***Chapter 11***.

A number of projects in the 2016 RWP were identified as implemented, partially implemented, or in progress at the time of development of the 2021 RWP. Many of the projects currently in development are related to groundwater reduction plans (GRPs) and provide additional alternative water supplies to meet 2025 conversion requirements by subsidence districts. Numerous projects, including GRP projects and others, have received funding from TWDB to facilitate their completion.

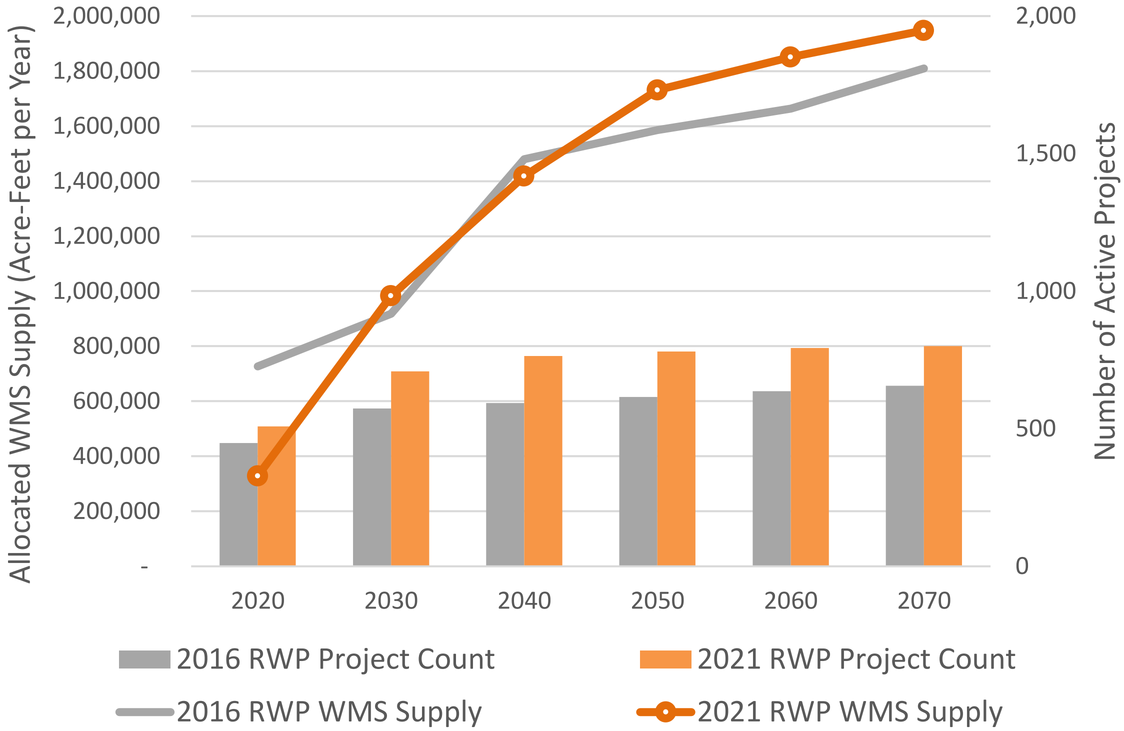
Overall, the two plans differ slightly in relation to water demands. Municipal demands in Region H have remained relatively similar between the two RWPs with only minor differences, which are primarily attributable to the new method of delineating WUGs in the 2021 RWP. While some categories of non-population demands remained very similar to projections in the 2016 RWP, projected demands in the Manufacturing and Steam Electric Power sectors were reduced dramatically due to the new projection methodology applied by TWDB.

The estimated availability of surface water in Region H, including both reservoir and run-of-the-river supplies, has remained similar between the 2016 and 2021 RWPs. Small differences may be attributed to updated modeling assumptions in the WAMs, as well as the approval of the Brazos River Authority System Operations Permit by TCEQ, some of the yield of which is utilized within Region H. Estimates of the MAG for each aquifer and county are required for use in development of 2021 RWPs. During the previous planning cycle, Region H identified issues related to the use of these numbers related to the differences in planning approaches between regional water plans and the GMA joint planning process. This issue was addressed in the current planning cycle through the application of MAG peak factors, as well as the acknowledgment by TWDB that aquifers in Fort Bend, Harris, and Galveston Counties are not governed by the GMA process and are instead subject to subsidence district regulations. As a result of these changes, groundwater supplies in the 2021 RWP more closely align with regional planning assumptions and groundwater regulations than those in the 2016 RWP.

The identified WUG needs in the 2021 RWP are lower than those identified in the 2016 RWP, primarily due to the revised methodologies that have projected lower demands in the Manufacturing and Steam Electric Power sectors. However, needs for all non-population demand categories have been reduced, with the exception of a small increase in Steam Electric Power needs in 2020 and 2030 and retention of Mining demand projections from the 2016 RWP. Municipal needs have decreased in 2020, primarily due to the implementation of strategies recommended in the 2016 RWP. However, municipal needs have increased in all decades after 2020, which is mostly due to the changes in WUG delineation which more accurately assigns demands and available supplies to water users. The total water need in Region H in 2070 in the 2021 RWP was found to be less than the identified 2070 needs in the 2016 RWP.

In total, the RHWPG has recommended 61 WMSs and 822 projects in the 2021 RWP. This compares to 58 WMSs and 718 projects identified in the 2016 RWP. Allocations of WMS supplies in the 2021 RWP differ from those in the 2016 RWP for a number of reasons, including differences in projected WUG demands, establishment of new existing contracts between water providers and WUG customers, implementation of 2016 WMS as existing supplies, changes in recommended WMS, and changes to associated project schedules. A comparison of allocated WMS volume and active project count for the two plans is presented in *Figure ES-7* below.

Figure ES-7 – WMS Supply and Active Projects by Decade



CHAPTER 1
DESCRIPTION OF REGION

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Chapter 1 – Description of Region

1.1 REGIONAL WATER PLANNING IN TEXAS

In 1997 the State Legislature, through Senate Bill 1, determined that a Texas State Water Plan for the 2000 to 2050 timeframe would be developed through a regional water planning approach. To accomplish this task, the Texas Water Development Board (TWDB) divided the state into 16 Regional Water Planning Areas (RWPAs) and appointed representational Regional Water Planning Groups (RWPG) that have guided the development of each region's plan. In 2001, a new set of rules and guidelines were enacted through Senate Bill 2. The 2002 State Water Plan received enormous public involvement compared to previous plans. The planning process is cyclic, with updated Regional and State Water Plans produced every five years. The 2016 Region H Water Plan and the 2017 State Water Plan were created during the last planning cycle.

1.2 DESCRIPTION OF REGION H

Region H, located along the upper Texas coast, consists of all or part of 15 counties: Austin, Brazoria, Chambers, Fort Bend, Galveston, Harris, Leon, Liberty, Madison, Montgomery, Polk, San Jacinto, Trinity, Walker, and Waller. The eastern portions of Trinity and Polk counties are included in the Region I planning area. The region spans three river and four coastal basins in southeast Texas. Region H encompasses the San Jacinto River Basin and the lower portions of the Trinity and Brazos River Basins, as well as part or all of the Brazos-Colorado, the San Jacinto-Brazos, the Trinity-San Jacinto, and the Neches-Trinity Coastal Basins. This area includes the Galveston and Trinity Bay estuaries; the urbanized, rapidly growing Houston-Galveston Metropolitan Area encompassing Brazoria, Harris, Galveston, Fort Bend, and Montgomery counties; the coastal port communities of Galveston and Freeport; and agricultural areas in Austin, Chambers, Leon, Liberty, Madison, Polk, San Jacinto, Trinity, Walker, and Waller counties. *Figure 1-1* is a map of the Region H Water Planning Area. The Region H Water Planning Group (RHWPG) is a 26-member committee representing the diverse interests of the region. *Table 1-1* lists the RHWPG membership.

Figure 1-1 – Region H Water Planning Area

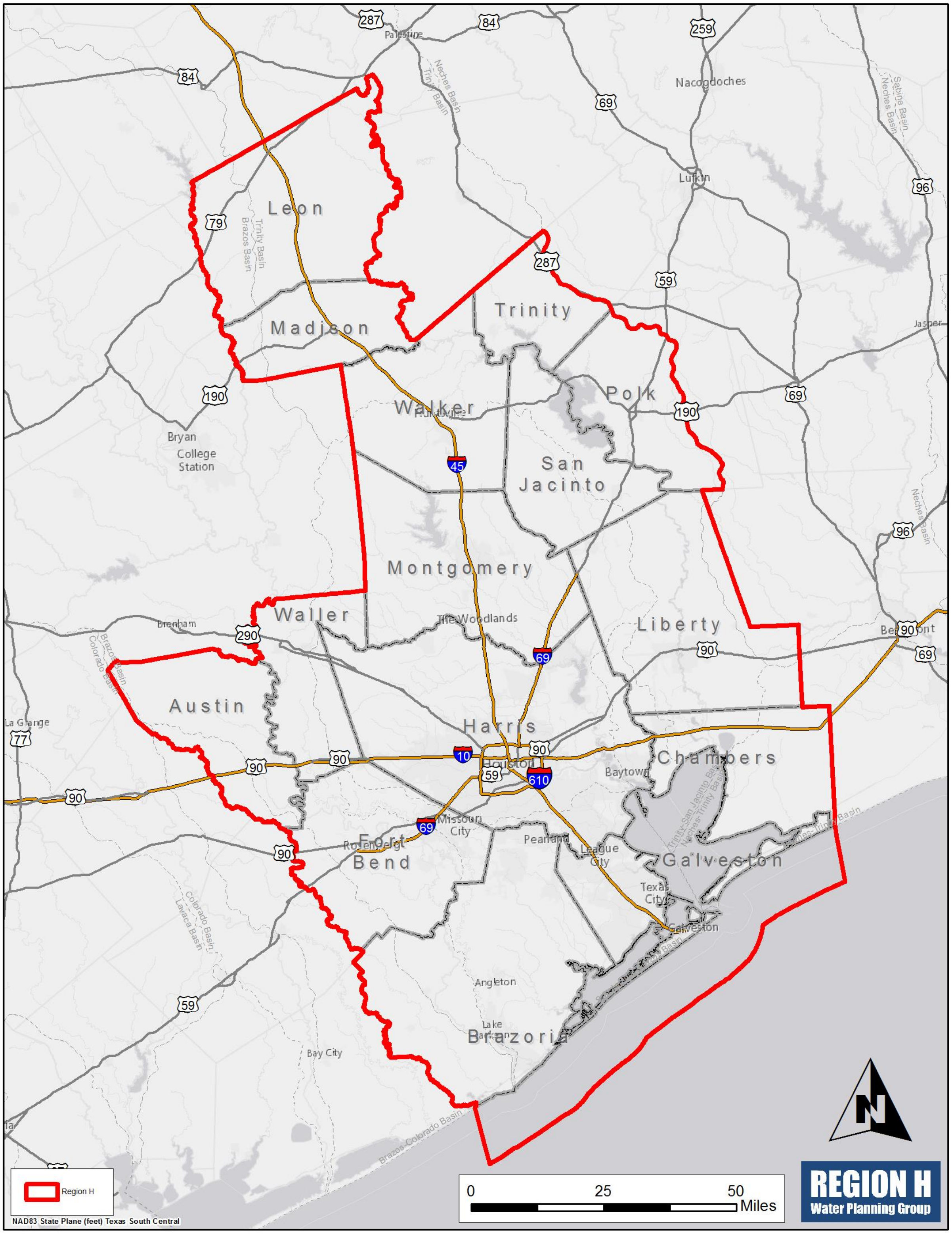


Table 1-1 – Member Information for the Region H Water Planning Group

Executive Committee	
Office	**Incumbent**
Chair	Mark Evans
Vice-Chair	Marvin Marcell
Secretary	Jace Houston
At-Large	John R. Bartos
At-Large	Pudge Wilcox
Administration	
Office	**Organization**
Administrative	San Jacinto River Authority P.O. Box 329 Conroe, Texas 77305-0329 Phone: (936) 588-1111 Fax: (936) 588-1114
Political Subdivision	San Jacinto River Authority P.O. Box 329 Conroe, Texas 77305-0329 Phone: (936) 588-1111 Fax: (936) 588-1114

Notes:
Administrative Office manages records.
Political Subdivision is the entity eligible to apply for State grant funds.

Voting Membership			
Category	**Member**	**Organization**	**County (Location of Interest)**
Agriculture	Robert Bruner 03/1998-Present	Rancher	Walker
	Pudge Willcox 02/2007-Present	CLCND	Chambers
Counties	John Blount, P.E. 09/2004-Present	Harris County Public Infrastructure Department	Harris
	Mark Evans 03/1998-Present	North Harris County Regional Water Authority	Trinity
	Art Henson 11/2009-Present	Madison County	Madison
Electric Generation Utilities	Carl Burch 11/2019-Present	NRG Energy	Harris
Environmental	John R. Bartos 03/1998-Present	Galveston Bay Foundation	Harris
GMA 12	David Bailey 12/2011-Present	Mid-East Texas GCD	GMA 12 Counties
GMA 14	Gary Ashmore 03/2019-Present	Lower Trinity GCD	GMA 14 Counties
Industries	James Comin 08/2014-Present	Exxon-Mobil Corp.	Harris
	Glenn Lord 11/2014-Present	Dow Chemical Company	Brazoria

Voting Membership			
Municipalities	Robert Istre 07/2003-Present		Galveston
	Yvonne Forrest 10/2017-Present	City of Houston	Harris
Public	Carl Masterson 12/2011-Present	General Public	Region H
River Authorities	Brad Brunett 04/2018-Present	Brazos River Authority	McLennan (service in west and southwest portion of region)
	Jace Houston 02/2012-Present	San Jacinto River Authority	Harris, Montgomery (service in central portion of region)
	J. Kevin Ward 06/2012-Present	Trinity River Authority	Tarrant (service in east and southeast portion of region)
Small Business	W.R. Baker 02/2019-Present	Rancher	Polk
	Bob Hebert 05/2007-Present	Robert Hebert and Associates	Fort Bend
Water Districts	Marvin Marcell 07/1998-Present	Fort Bend Subsidence District	Fort Bend
	Michael Turco 02/2016-Present	Harris-Galveston Subsidence District	Harris, Galveston
	Jimmie Schindewolf 11/2005-Present	North Harris County Regional Water Authority	Harris
Water Utilities	Ivan Langford 02/2016-Present	Gulf Coast Water Authority	Brazoria
	James Morrison 03/1998-Present	Walker County Special Utility District	Walker
	William Teer, P.E. 03/1998-Present	Southeast WSC	Leon

Non-Voting Membership	
Member	**Organization**
David Alders	East Texas Water Planning Group
Wayne Ahrens, P.E.	West Harris County Regional Water Authority
Jennifer Bailey	Texas Dept of Agriculture
Lann Bookout	Texas Water Development Board
Rick Gangluff	South Texas Project Electric Generating Station
Scott Hall	Lower Neches Valley Authority
Larry Jacobs	Montgomery County Soil and Water Conservation District
Charles Shumate	North Fort Bend Water Authority
Glen Sutton	Texas Parks & Wildlife Department
Wayne Wilson	Wilson Cattle Company

1.2.1 Governmental Authorities in Region H

While municipal and county governments are the primary governmental entities, there are three regional councils of government represented in the region. The Houston-Galveston Area Council of Governments represents thirteen counties in the central and eastern part of the planning area and surrounding areas: Austin, Brazoria, Chambers, Colorado, Fort Bend, Galveston, Harris, Liberty, Matagorda, Montgomery, Wharton, Walker, and Waller Counties. The Brazos Valley Council of

Governments includes Leon and Madison counties, the two northwestern counties of the region. The Deep East Texas Council of Governments represents Trinity, Polk, and San Jacinto counties located in the northeastern part of Region H.

In addition to these regional councils there are several other entities with regulatory or management authority of importance to long range water planning for the region. The State exercises certain responsibilities over water planning, supply, and quality through the TWDB, the Texas Commission on Environmental Quality (TCEQ), and Texas Parks and Wildlife Department (TPWD). Points of contact for these state agencies are listed in *Table 1-2*. Three river authorities manage surface water supply in the region's three river basins: the Brazos River Authority, the San Jacinto River Authority, and the Trinity River Authority. There are eleven soil and water conservation districts within Region H. Five groundwater conservation districts (GCD) and two subsidence districts in Region H have the authority to regulate groundwater withdrawals. Three groundwater conservation districts were formed in 2001: Lone Star GCD in Montgomery County, Bluebonnet GCD, which includes Austin, Grimes, and Walker Counties, and the Mid-East Texas GCD, which includes Leon, Madison, and Freestone Counties. In November 2005, the Brazoria County Groundwater Conservation District was confirmed by voters in Brazoria County. The Lower Trinity Groundwater Conservation District in Polk and San Jacinto Counties was confirmed by vote in November 2006. The Harris-Galveston Subsidence District and the Fort Bend Subsidence District were created in 1975 and 1989, respectively, with the authority to regulate groundwater pumpage for the purpose of reducing subsidence. Region H also includes five Regional Water Authorities that provide for regional water infrastructure pursuant to conversion to surface water sources: Central Harris County Regional Water Authority, North Harris County Regional Water Authority, West Harris County Regional Water Authority, North Channel Water Authority, and North Fort Bend Water Authority.

Table 1-2 – State Agencies with Oversight of Water Planning

Texas Water Development Board
Jeff Walker Executive Administrator PO Box 13231, 1700 N. Congress Ave., Austin, TX 78711-3231 (512) 463-7847
Amanda Lavin Assistant Executive Administrator, Office of Planning PO Box 13231, 1700 N. Congress Ave., Austin, TX 78711-3231 (512) 463-7847
Texas Commission on Environmental Quality (plan review)
Toby Baker Executive Director 12500 Park 35 Circle, Austin, TX 78753 (512) 239-3900
Texas Parks and Wildlife Department (plan review)
Carter Smith Executive Director 4200 Smith School Road, Austin, TX 78744-3291 (512) 389-4802

1.2.2 General Economic Conditions

Two thirds of all U.S. petrochemical production and almost a third of the nation's petroleum industries are located in Region H. The Port of Houston handles over 200 million tons of cargo annually, contributing billions of dollars to the state economy. In 2019, the Houston area employed 3.1 million people as estimated by the US Department of Labor. Region H is generally characterized with urbanized land uses and broad-based economic development. In areas outside of the urban core, agriculture is a major contributor to economic activities. The region supports six primary economic sectors: services, manufacturing, transportation, government, agriculture, and fishing.

The service sector employs the greatest number of people in Region H. The most common service industries include: accounting, law, banking, computer software, engineering, healthcare, and telecommunications. Medical specialties are concentrated at the Texas Medical Center in Houston and the University of Texas Medical Branch in Galveston. Tourism is also a major industry for both Galveston and Houston. Galveston alone has drawn as many as 6.4 million tourists a year in recent years.

The region's manufacturing industry is based on the historically important energy industries. Petroleum refining and chemical production are the two largest industries in the region. Technology and biotechnology firms have contributed to the diversification of the region's economic base. Petro-chemical, chemical, and pulp and paper industries are major employers outside of the urban core of the region.

The transportation industry includes the Port of Houston and the Houston Ship Channel, the second largest port in the nation based on total tonnage. A well-developed highway system and rail connections support this activity. The Gulf Intracoastal Waterway connects the ports of Freeport, Galveston, Houston, and Texas City.

Government sector jobs are distributed throughout the region. The Johnson Space Center has program management responsibility for the International Space Station, ensuring continued economic importance into the next decade. There are numerous colleges in the region, and local school districts continue to grow and expand as population increases.

The agricultural industry, while providing limited numbers of jobs, contributes significantly to the region's economy. Major agricultural crops in the region include rice, soybeans, vegetables, and hay. Cattle are the principal livestock, followed by horses and hogs.

Fishing, both commercial and sport, within Galveston Bay and other major bodies of surface water including Lake Conroe, Lake Houston, and Lake Livingston are major contributors to the local economic base in addition to their primary role as surface water supply reservoirs. One third of the state's commercial fishing income and one half of the state's expenditures for recreational fishing come from Galveston Bay. Oysters, shrimp, and finfish are important commercial species in the bay.

1.3 POPULATION AND WATER DEMAND IN REGION H

Based on data from the 2000 Census, the first Regional Water Plan (RWP) reflected a regional population of approximately 4,898,948. Based on the 2010 census, the population for Region H had grown to approximately 6,093,968 in the year 2010, of which approximately 59 percent (3,592,506) resided in 125 cities and towns with populations of over 500 persons. Additionally, Regional Water Authorities and water utilities of over 500 persons accounted for approximately 1,792,152 people, or 29 percent of the Region H population. By 2015, data from the U.S. Census Bureau indicated that the population within Region H had grown to 6,836,200.

Population in the RWP is accounted for on a Water User Group (WUG) basis, with municipal WUGs representing the retail service area of cities, towns, utility districts, and the aggregated service areas within regional water authorities. *Table 1-3* lists the WUGs with estimated year 2015 retail service area populations of over 25,000 persons and the associated reported municipal water use.

Table 1-3 – WUGs with Populations Over 25,000

WUG	2015 Population	2015 Estimated Municipal Use (acre-feet)
Baytown	69,248	10,562
Central Harris County Regional Water Authority	50,781	5,075
Clear Lake City Water Authority	67,008	8,213
Conroe	67,508	9,178
Deer Park	32,000	4,575
Fort Bend County WCID 2	39,768	6,285
Friendswood	42,232	5,490
Galveston	47,743	15,762
Houston	2,230,830	349,753
Huntsville	41,061	14,416
La Porte	34,733	4,042
Lake Jackson	27,631	3,766
League City	95,105	11,751
North Channel Water Authority	82,528	9,194
North Fort Bend Water Authority	209,658	30,717
North Harris County Regional Water Authority	725,812	87,145
Pasadena	144,478	17,322
Pearland	106,525	14,884
Rosenberg	36,047	3,768
Sugar Land	90,379	16,782
Sunbelt FWSD	26,845	2,397
Texas City	45,219	5,547
The Woodlands	101,581	15,680
West Harris County Regional Water Authority	488,956	53,444

Source: Texas Water Development Board

The year 2015 total county populations and reported municipal water use are listed in *Table 1-4*. Detailed information on local, county, and regional population estimates and projections for the 50-year planning period are included in the ***Chapter 2*** of this plan. In 2015, municipal uses accounted for 55 percent of the region's total reported water use, a substantial increase from 41 percent during the first RWP in year 2000.

Table 1-4 – County Population and Municipal Water Demand

County	2015 Population (TWDB Population)	2015 Estimated Municipal Use (acre-feet)
Austin	30,446	3,785
Brazoria	345,717	41,194
Chambers	39,041	5,667
Fort Bend	716,491	111,258
Galveston	320,926	49,559
Harris	4,530,268	638,490
Leon	17,272	2,523
Liberty	79,746	9,514
Madison	14,185	3,392
Montgomery	539,335	72,065
Polk[1]	47,767	6,832
San Jacinto	27,503	2,984
Trinity[1]	14,387	2,011
Walker	71,485	17,649
Waller	48,349	4,836
Total[1]	**6,842,918**	**971,759**

Source: Texas Water Development Board
[1]Includes the portion of Trinity and Polk Counties in adjacent Region I.

Manufacturing uses accounted for approximately 28 percent of the region's total use in 2015, compared to 30 percent in year 2000. Irrigation uses represented approximately 12 percent of the region's total 2015 reported use, a decline from the 22 percent reported in year 2000. *Figure 1-2* illustrates the distribution of 2015 water demand by use type. Total non-municipal water demands for each county in 2015 are listed in *Table 1-5*.

Figure 1-2 – Percentage of 2015 Total Water Demand by Use

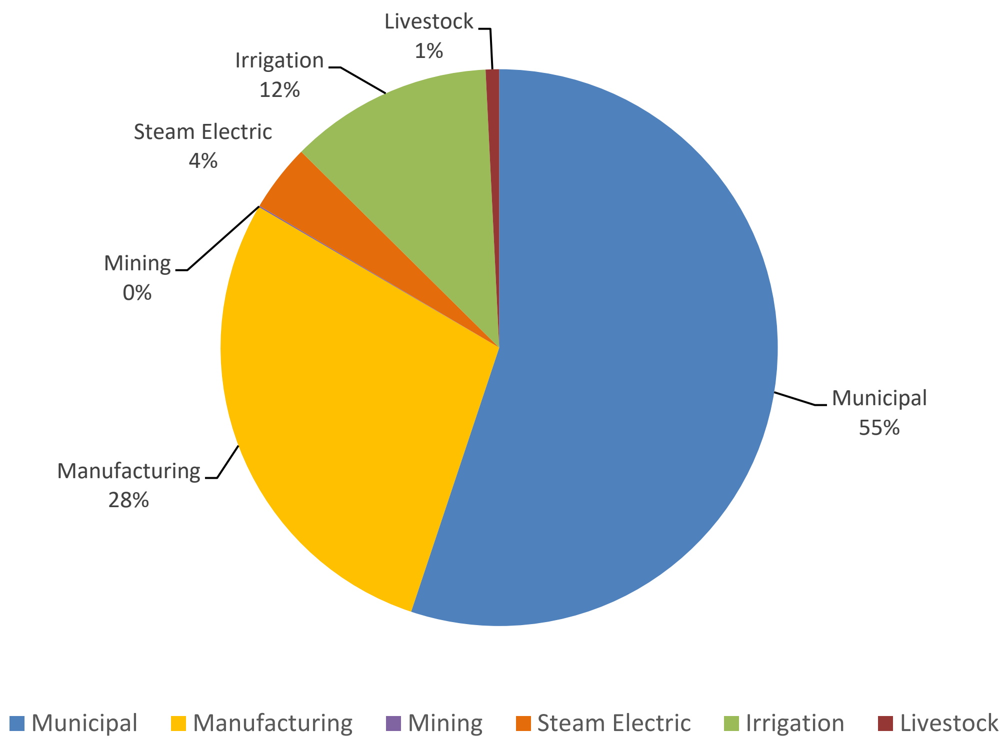


Table 1-5 – Reported 2015 Non-Municipal Water Use (acre-feet)

County	MFR	MIN	POW	IRR	STK	Total
Austin	14	45	0	4,951	1,195	6,205
Brazoria	145,906	0	0	52,764	1,606	200,276
Chambers	25,664	1	905	85,767	506	112,843
Fort Bend	2,341	6	51,631	24,753	673	79,404
Galveston	39,948	134	2,725	3,156	212	46,175
Harris	282,492	0	8,757	9,440	1,124	301,813
Leon	581	846	0	127	2,963	4,517
Liberty	166	0	0	14,161	964	15,291
Madison	0	288	0	101	1,383	1,772
Montgomery	741	0	4,842	2,779	493	8,855
Polk[1]	339	0	0	210	303	852
San Jacinto	8	0	0	68	339	415
Trinity[1]	0	0	0	458	313	771
Walker	230	14	0	231	767	1,242
Waller	29	0	0	9,023	1,188	10,240
Total[1]	**498,459**	**1,334**	**68,860**	**207,989**	**14,029**	**790,671**

Source: Texas Water Development Board
Categories: Manufacturing (MFR), Mining (MIN), Steam Electric Power (POW), Irrigation (IRR), and Livestock (STK)
[1] Includes the portion of Trinity and Polk Counties in adjacent Region I.

1.3.1 Major Demand Centers

Major demand centers are locations of water uses that require a significant portion of the region's water supply. In Region H, major demand centers are defined for municipal, manufacturing, and irrigation uses as having a reported use, by use type, exceeding 25,000 acre-feet per year for counties and 10,000 acre-feet per year for cities.

Houston has the greatest overall water demand in the region, as shown in *Table 1-6*, followed closely by remaining demands in Harris County. The next highest demands are Fort Bend, Montgomery, Galveston, and Brazoria Counties. Harris County and the City of Houston dominate municipal water use in Region H. In addition to the City of Houston, municipalities identified as major demand centers (reported municipal retail service area annual demands in excess of 10,000 acre-feet) for year 2015 include the cities of Pasadena, Sugar Land, Galveston, The Woodlands, Pearland, Huntsville, League City, and Baytown.

Table 1-6 – Major Municipal Demand Centers

County/City*	2015 Estimated Municipal Use (acre-feet)
City of Houston	349,753
Harris County (excluding Houston)	295,935
Fort Bend County	111,258
Montgomery County	72,065
Galveston County	49,559
Brazoria County	41,194
Pasadena	17,322
Sugar Land	16,782
Galveston	15,762
The Woodlands	15,680
Pearland	14,884
Huntsville	14,416
League City	11,751
Baytown	10,562

** Values listed for counties include associated city demands except where noted above.*

Source: Texas Water Development Board

The largest manufacturing demand center is Harris County, which used 282,492 acre-feet of water in 2015 (57 percent of the regional total). Brazoria, Chambers, and Galveston Counties also utilized extensive supplies for manufacturing. The principal industries for water use in the region are petroleum refining, chemical production, and pulp and paper mills. The four largest manufacturing demand centers are shown in *Table 1-7*.

Table 1-7 – Major Manufacturing Demand Centers

County	2000 Manufacturing Use (acre-feet)	2015 Manufacturing Use (acre-feet)
Brazoria	134,778	145,906
Chambers	16,262	25,664
Galveston	26,891	39,948
Harris	333,885	282,492

Source: Texas Water Development Board

The four largest irrigation demand centers are Brazoria, Chambers, Liberty, and Fort Bend counties. It should be noted that water use for irrigation from an individual year may not be representative of typical use due to year-to-year variability based on available precipitation. *Table 1-8* highlights each county's reported 2000 and 2015 irrigation use, as well as average annual use from 2000 to 2015. The major irrigated crops in the region are rice, soybeans, vegetables, and cotton.

Table 1-8 – Major Irrigation Demand Centers

County	2000 Irrigation Use (acre-feet)	2015 Irrigation Use (acre-feet)	Average Irrigation Use 2000 to 2015 (ac-ft/year)
Brazoria	98,754	52,764	78,102
Chambers	36,857	85,767	76,614
Fort Bend	48,887	24,753	31,032
Liberty	28,162	14,161	39,297

Source: Texas Water Development Board

Livestock and mining water use represent smaller demands in the Region H area. Mining water demands in Region H are associated primarily with oil and gas production.

1.3.2 Water User Group WUG Updates

For the 2021 RWPs, TWDB implemented rule changes to streamline the criteria for municipal WUG categorization and to better align the WUG definition, and hence the population and water demand projections, with active retail service areas. Defined WUGs are entities serving more than 100 acre-feet per year for municipal use. All smaller service providers and rural/unincorporated areas of municipal and domestic water use, aggregated at the county level, are considered part of an additional WUG and are referred to as "County-Other" for each county.

Under this revised WUG definition, some smaller WUGs were aggregated into overarching retail providers, while many new WUGs were identified which had, in prior RWPs, been components of other named WUGS or part of County-Other. New named municipal WUGs in Region H are listed in *Table 1-9* by primary county.

Table 1-9 – New WUGs in 2021 Region H Water Plan

WUG Name	Primary County
Austin County WSC	Austin
Baker Road MUD	Harris
Baybrook MUD 1	Harris

WUG Name	Primary County
Bayview MUD	Galveston
Blue Ridge West MUD	Fort Bend
Brazoria County MUD 25	Brazoria
Brazoria County MUD 29	Brazoria
Brazoria County MUD 31	Brazoria
Cape Royale UD	San Jacinto
Chambers County MUD 1	Chambers
Chateau Woods MUD	Montgomery
Clear Lake City Water Authority [1]	Harris
Corinthian Point MUD 2	Harris
Country Terrace Water	Harris
Devers	Liberty
Dodge Oakhurst WSC	Walker
Domestic Water	Montgomery
Douglas Utility	Harris
Far Hills UD	Montgomery
First Colony MUD 9	Fort Bend
Forest Hills MUD	Harris
Fort Bend County FWSD 1	Fort Bend
Fort Bend County FWSD 2	Fort Bend
Fort Bend County MUD 5	Fort Bend
Fort Bend County MUD 24	Fort Bend
Fort Bend County MUD 26	Fort Bend
Fort Bend County MUD 42	Fort Bend
Fort Bend County MUD 46	Fort Bend
Fort Bend County MUD 47	Fort Bend
Fort Bend County MUD 48	Fort Bend
Fort Bend County MUD 49	Fort Bend
Fort Bend County MUD 81	Fort Bend
Fort Bend County MUD 115	Fort Bend
Fort Bend County MUD 128	Fort Bend
Fort Bend County MUD 140	Fort Bend
Fort Bend County MUD 149	Fort Bend
Fort Bend County MUD 152	Fort Bend
Fort Bend County MUD 155	Fort Bend
Fort Bend County MUD 158	Fort Bend
Fort Bend County MUD 162	Fort Bend
Fort Bend County MUD 187	Fort Bend
Fort Bend County WCID 2 [1]	Fort Bend
Fort Bend County WCID 3	Fort Bend

WUG Name	Primary County
Galveston County FWSD 6	Galveston
Galveston County MUD 12	Galveston
Galveston County WCID 1 [1]	Galveston
Galveston County WCID 8	Galveston
Galveston County WCID 12	Galveston
Glendale WSC	Trinity
Gulf Utility	Montgomery
Harris County FWSD 1-A	Harris
Harris County FWSD 27	Harris
Harris County FWSD 58	Harris
Harris County MUD 6	Harris
Harris County MUD 23	Harris
Harris County MUD 36	Harris
Harris County MUD 58	Harris
Harris County MUD 122	Harris
Harris County MUD 216	Harris
Harris County MUD 321	Harris
Harris County MUD 342	Harris
Harris County MUD 344	Harris
Harris County MUD 361	Harris
Harris County MUD 372	Harris
Harris County MUD 386	Harris
Harris County MUD 412	Harris
Harris County MUD 420	Harris
Harris County WCID 50	Harris
Harris County WCID 70	Harris
Harris County WCID 89	Harris
Harris County WCID 156	Harris
Harris County WCID-Fondren Road	Harris
Hilltop Lakes WSC	Leon
HMW SUD	Montgomery
Johnston Water Utility	Harris
Kendleton	Fort Bend
Lake Bonanza WSC	Montgomery
Lake Conroe Hills MUD	Montgomery
Lake MUD	Harris
Lazy River Improvement District	Montgomery
Leggett WSC	Polk
Liberty County FWSD 1 Hull	Liberty
Luce Bayou PUD	Harris

WUG Name	Primary County
Madison County WSC	Madison
Meadowcreek MUD	Fort Bend
Memorial Point UD	Polk
Memorial Villages Water Authority	Harris
Mercy WSC	San Jacinto
Montgomery County MUD 56	Montgomery
Montgomery County MUD 84	Montgomery
Montgomery County MUD 88	Montgomery
Montgomery County MUD 95	Montgomery
Montgomery County MUD 98	Montgomery
Montgomery County MUD 99	Montgomery
Montgomery County MUD 112	Montgomery
Montgomery County MUD 115	Montgomery
Montgomery County MUD 119	Montgomery
Morgans Point	Harris
Moscow WSC	Polk
MSEC Enterprises	Montgomery
North Forest MUD	Harris
North Zulch MUD	Madison
Northwest Harris County MUD 16	Harris
Oak Hollow Utility	Waller
One Five O WSC	San Jacinto
P B & S C WSC	San Jacinto
Palmer Plantation MUD 1	Fort Bend
Palmer Plantation MUD 2	Fort Bend
Pattison WSC	Waller
Pennington WSC	Trinity
Phelps SUD	Walker
Pine Village PUD	Harris
Pinehurst Decker Prairie WSC	Montgomery
Pinewood Community	Harris
Prairie View A&M University	Waller
Providence WSC	Polk
Quadvest	Montgomery
Quail Valley UD	Fort Bend
Ranch Utilities	Montgomery
Rolling Fork PUD	Harris
Royal Valley Utilities	Fort Bend
Sedona Lakes MUD 1	Brazoria
Sequoia Improvement District	Harris

WUG Name	Primary County
Soda WSC	Polk
South Cleveland WSC	Liberty
Southeast WSC	Leon
Southern Water	Harris
Southwest Harris County MUD 1	Harris
Spring Meadows MUD	Chambers
Suburban Utility	Harris
Surfside Beach	Brazoria
T & W Water Service	Montgomery
TDCJ Jester Units	Fort Bend
TDCJ Ramsey Area	Brazoria
Tempe WSC 1	Polk
Thunderbird UD	Fort Bend
Valley Ranch MUD 1	Montgomery
Waterwood MUD 1	San Jacinto
West End WSC	Austin
Westwood Shores MUD	Trinity
White Oak Utilities	Montgomery
White Oak WSC	Montgomery
Woodcreek Water of Liberty	Liberty

[1] Clear Lake City Water Authority, Fort Bend County WCID 2, and Galveston County WCID 1 were included in the 2016 Region H RWP as wholesale water providers only. These are now also associated with the population and water demands in their retail service areas as WUGs.

1.4 REGION H WATER SUPPLY SOURCES AND PROVIDERS

Groundwater, surface water captured in reservoirs, and run-of-river sources comprise the majority of the water supply within Region H. Reclaimed water and brackish groundwater are additional supply sources utilized in Region H.

Traditionally, water supplies in Region H have originated from groundwater sources. As development has occurred in the area, communities developed with their own groundwater wells and wastewater services, making them self-contained in meeting their needs from a water resources perspective. This characteristic makes Region H unique among many other urbanized regions who have relied upon regional infrastructure to develop, transmit, and deliver water supplies from regional sources.

This perspective has changed over time as the greater Houston area has coped with groundwater reduction due to the risks of subsidence. In many areas, water providers in Region H have developed regional infrastructure for the use of surface and other water supplies in lieu of groundwater to offset this threat. Therefore, the water supply systems within the region face challenges due to, not only the organic growth of demands over time, but also the conversion from groundwater to alternative supplies.

In addition, these regional infrastructure projects are typically layered in their development. Water users rarely rely upon one project to develop and deliver their water supplies. Instead, users typically rely upon one project that provides for development of raw water, one or more raw water transmission projects, a treatment project, and one or more treated water transmission projects to finally deliver water to the demand center. In addition, there are also costs associated with distribution of this water to retail customers which is outside of the scope of the RWP. This is an important factor to consider when reviewing the way in which projects are presented in the RWP. Regional projects are most often interrelated and require numerous other components in order to provide a comprehensive water supply solution.

1.4.1 Groundwater Sources

Two major aquifers supply groundwater within the Region H area. The aquifer that furnishes the most groundwater within the area is the Gulf Coast Aquifer. This aquifer is composed of the Evangeline, Chicot, Jasper, and Catahoula formations and extends from near the Gulf Coast shoreline to approximately 100 to 120 miles inland, to Walker and Trinity Counties. The other major aquifer in the study area is the Carrizo-Wilcox, which begins 115 to 125 miles inland and extends beyond the northern boundary of the region. There are also four minor aquifers in this part of the state. The Sparta and Queen City Aquifers occur in Leon County, the southern part of Madison County, and northern parts of Walker and Trinity Counties. In Leon and Madison Counties, these aquifers lie above the Carrizo-Wilcox Aquifer. The Yegua Formation and the Jackson Group comprise the Yegua-Jackson Aquifer, located in parts of Madison, Walker, Trinity, and Polk Counties. The Brazos River alluvium occurs along the main stem of the Brazos River as it passes through the region, except in Brazoria County. *Figure 1-3* and *Figure 1-4* illustrate these groundwater sources. Groundwater withdrawals accounted for approximately 34 percent of the total regional water supply in 2000 and approximately 28 percent in 2015.

Groundwater use is regulated in Harris, Galveston, Fort Bend, and Montgomery Counties due to the potential for over-drafting of the Gulf Coast Aquifer and related subsidence and water level impacts. For these areas, the availability of groundwater is determined by the regulatory plans developed for each county or area in accordance with the goals of each regulating entity: the Harris-Galveston Subsidence District, the Fort Bend Subsidence District, and the Lone Star GCD. In addition, Groundwater Management Plans have been published for Austin, Brazoria, Leon, Madison, Polk, San Jacinto, Walker, and Waller Counties by the Bluebonnet, Brazoria County, Mid-East Texas, and Lower Trinity GCDs. The active GCDs and Subsidence Districts within Region H are shown in *Figure 1-5*.

Region H includes portions of Groundwater Management Areas (GMAs) 11, 12, and 14. Trinity County lies within GMA 11. GMA 12 encompasses Leon and Madison Counties with all other Region H counties falling within GMA 14. All three GMAs have established Desired Future Conditions (DFCs) for their relevant aquifers, which have been used to determine the Modeled Available Groundwater (MAG) for incorporation into planning documents for the GCDs within each GMA. Information on this process and associated reports can be found in ***Chapter 3*** of the RWP.

1.4.2 Surface Water Sources

Surface water sources in Region H are reservoir storage and run-of-river supply for the three rivers in the area: the Trinity, the San Jacinto, and the Brazos. There are no major springs located within Region H, although small springs and seeps supply base flows for some streams. Historically there were numerous small seeps identified throughout the region. Many of these have ceased flowing due to land use changes and groundwater pumping. *Figure 1-6* illustrates the region's surface water sources. A selected bibliography of related references is included in ***Appendix 1-A*.**

Figure 1-3 – Region H Major Groundwater Sources

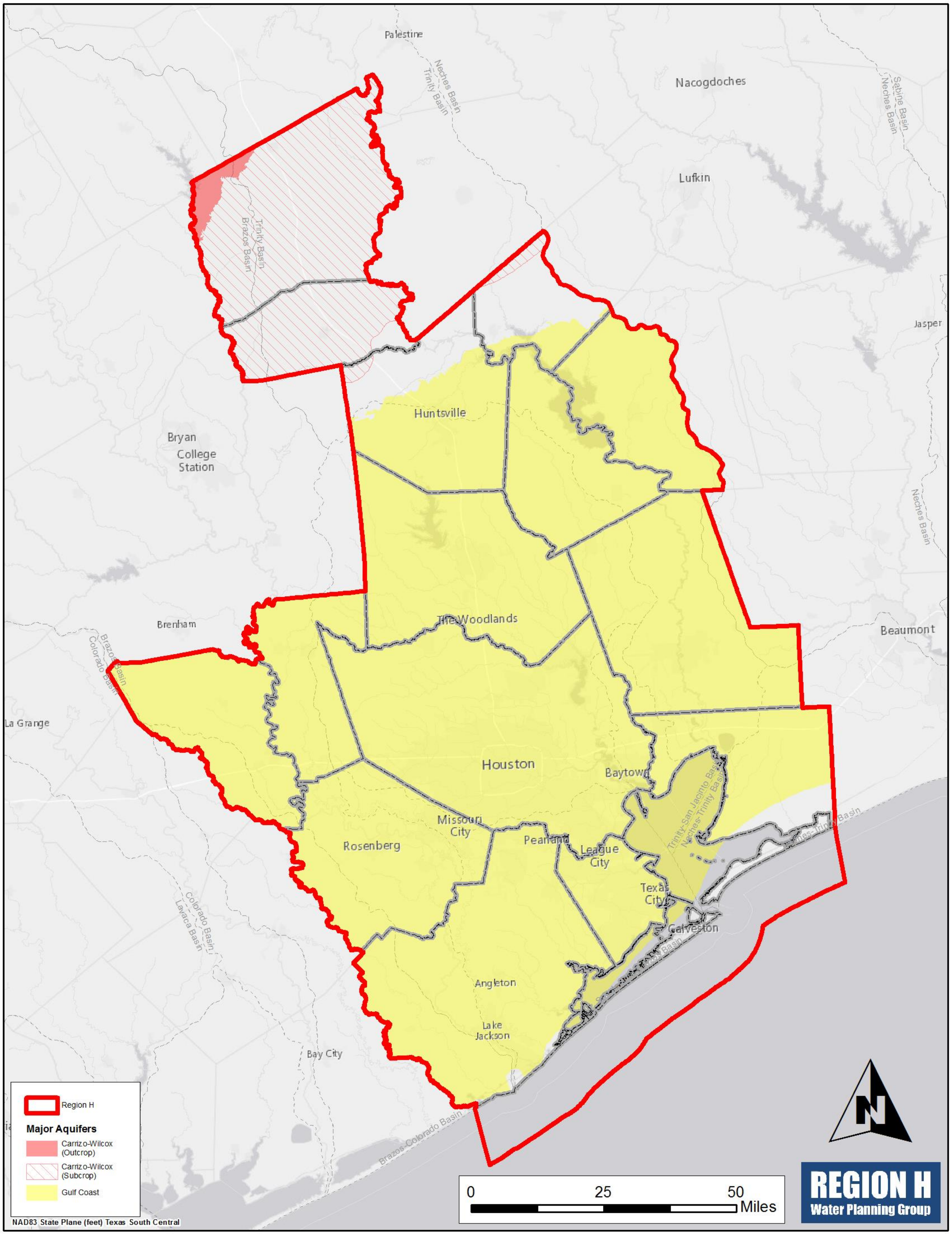


Figure 1-4 – Region H Minor Groundwater Sources

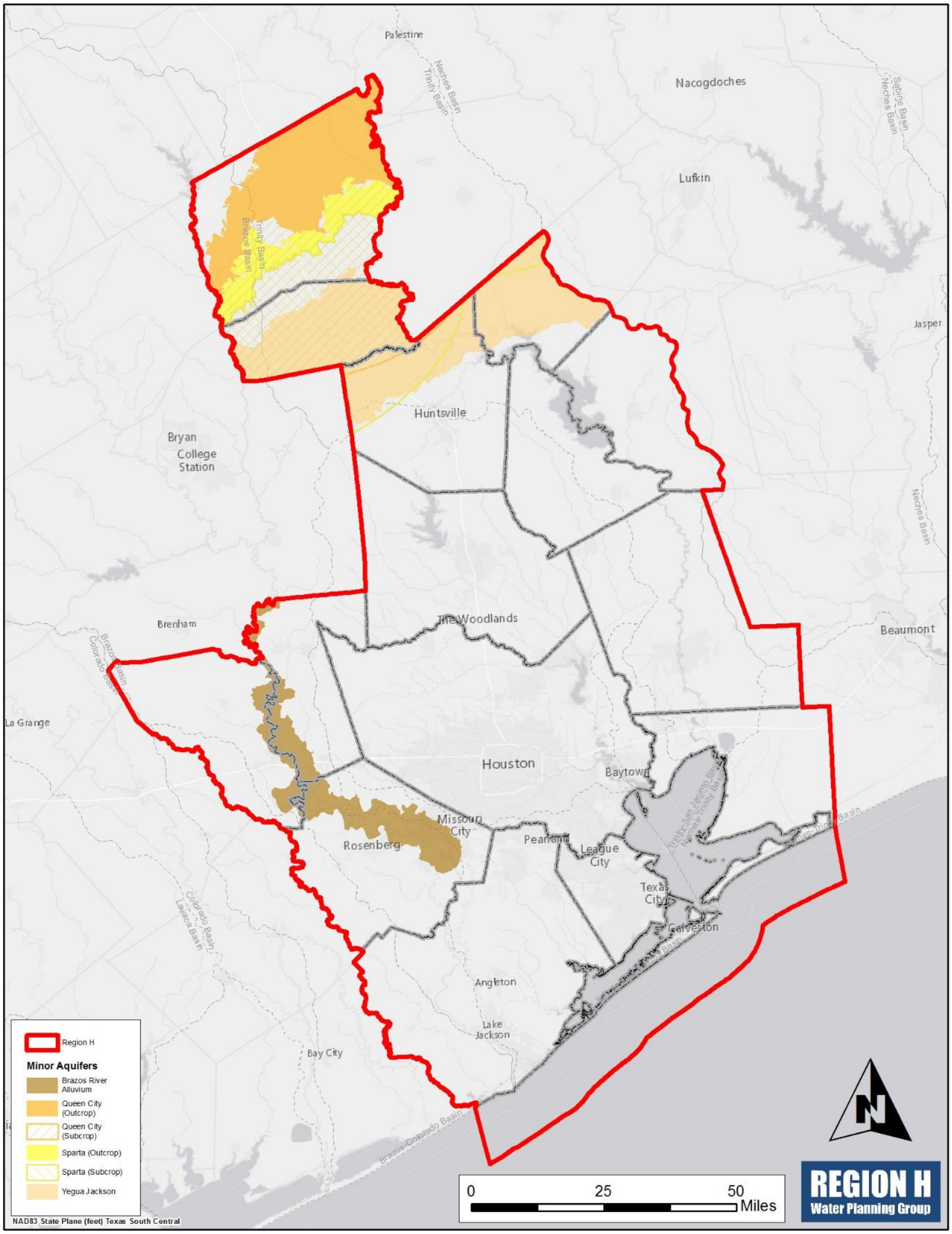


Figure 1-5 – Region H Groundwater Conservation and Subsidence Districts

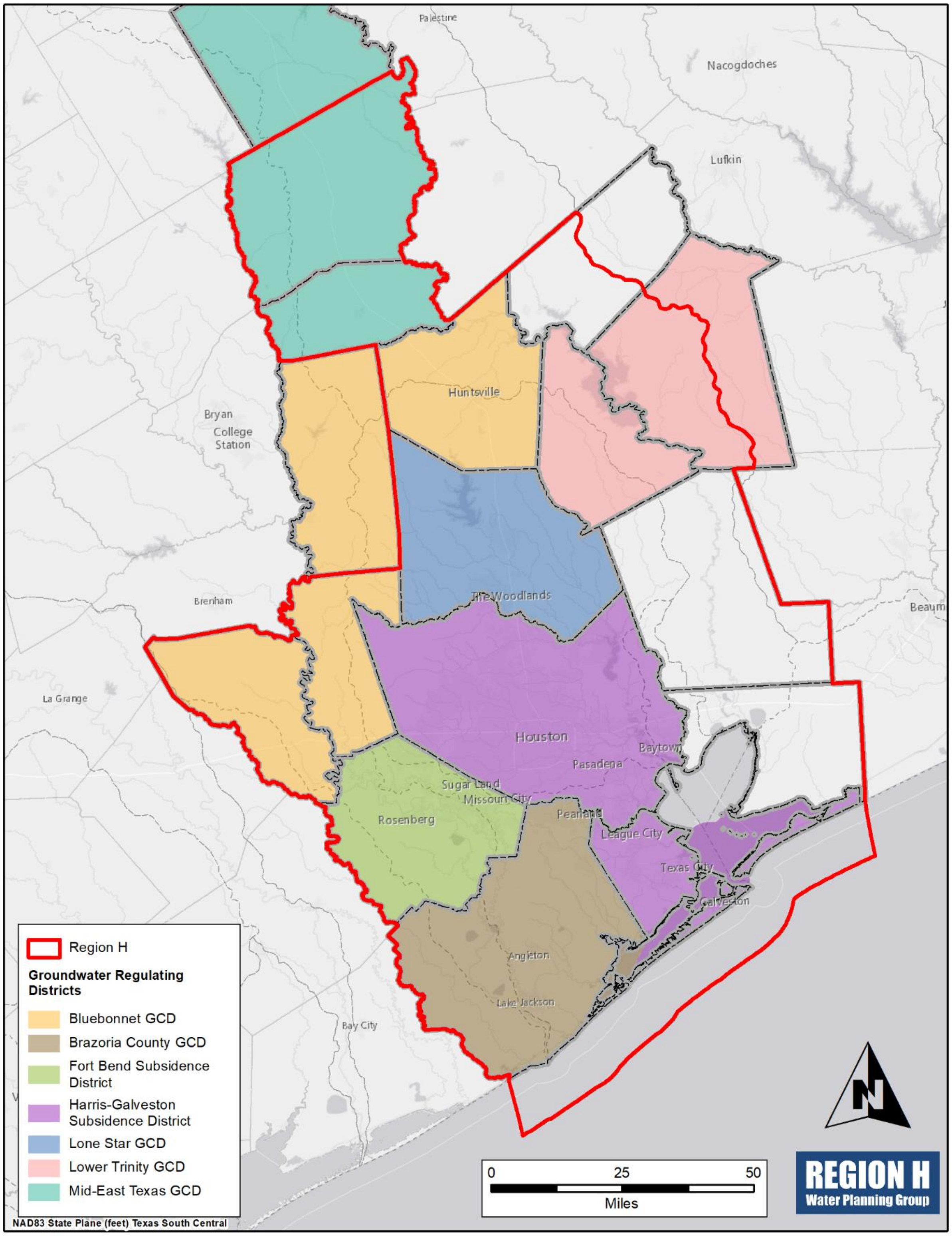
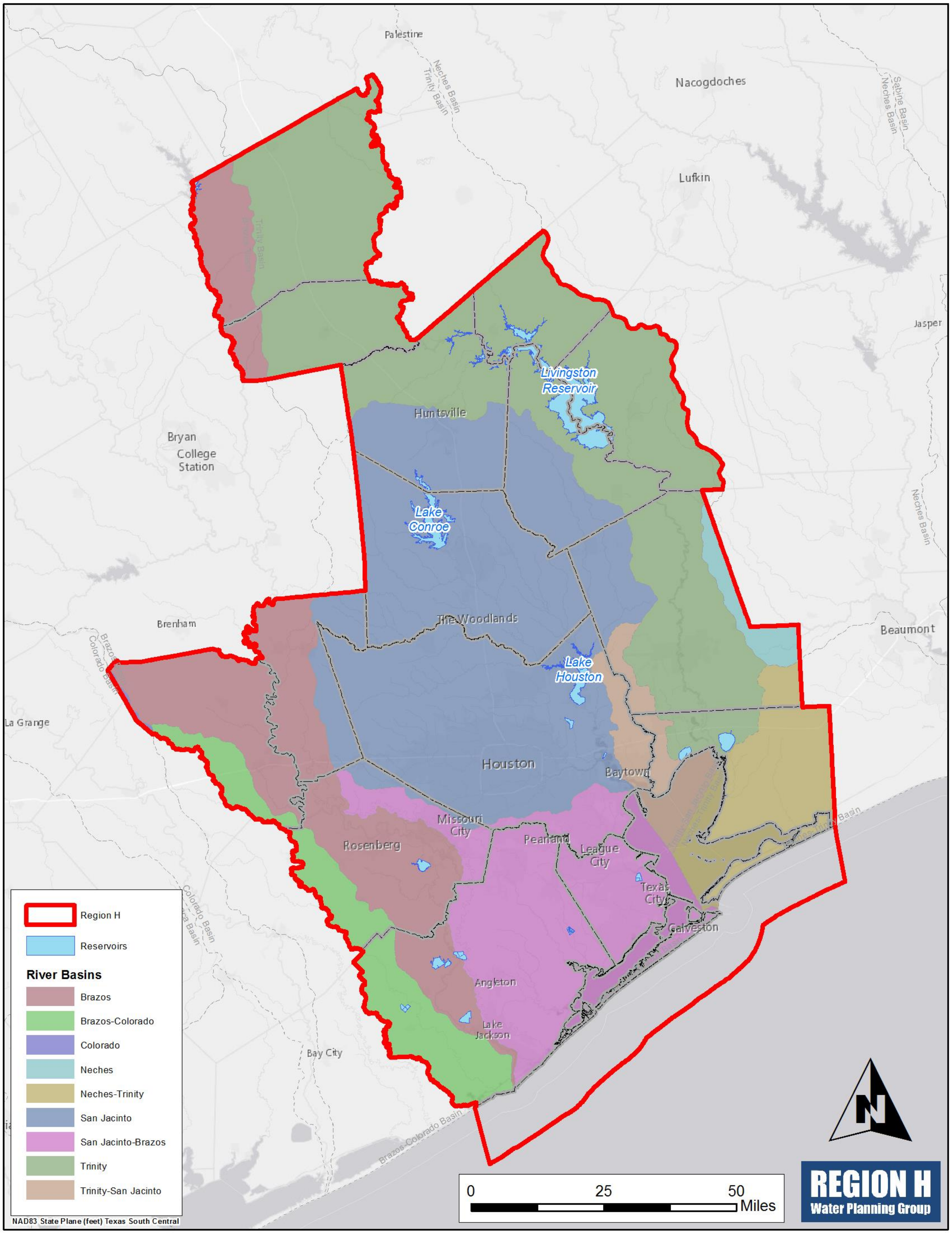


Figure 1-6 – Region H Surface Water Sources



1.4.3 Trinity River Basin

The Trinity River Basin contains two water projects in Region H: Lake Livingston and the Wallisville Saltwater Barrier. The City of Houston (COH) and the Trinity River Authority (TRA) sponsored Lake Livingston's construction. It is operated by the TRA to meet the service demands of the COH and other local users in the Trinity River Basin and in the Neches-Trinity Coastal Basin. These two projects are operated as a system, using Livingston primarily to store water and Wallisville to control the migration of saltwater from Trinity Bay. The combined permitted diversion from the Livingston-Wallisville system is 1,344,000 acre-feet per year. Additional permitted run-of-river water supplies downstream of Lake Livingston total 220,230 acre-feet per year. These supplies are associated with the water rights agreements established at the time of Lake Livingston permitting.

1.4.4 San Jacinto River Basin

The San Jacinto River Basin has two major public water supply reservoirs: Lake Houston and Lake Conroe. Lake Houston, with a permitted diversion of 168,000 acre-feet/year, is owned by COH for use in its service area and operated by the Coastal Water Authority (CWA). COH and the San Jacinto River Authority (SJRA) jointly own Lake Conroe, with COH holding two-thirds of the permitted rights (66,667 acre-feet/year) and SJRA holding one-third (33,333 acre-feet/year). SJRA manages Lake Conroe, providing supply to Montgomery and Harris Counties. SJRA has an additional run-of-river water right of 55,000 acre-feet per year and an indirect reuse water right of 14,944 acre-ft per year that are physically diverted out of Lake Houston. Collectively, COH and SJRA also hold permits for additional yield from Lake Houston as well as an excess flows permit that may be diverted at Lake Houston.

1.4.5 Brazos River Basin

The Brazos River Authority (BRA) manages the water supply resources from 11 reservoirs within this basin. These reservoirs are operated by BRA as a system where commitments made to downstream demands may be met from one or more upstream reservoir using storage available in the system. The U.S. Army Corps of Engineers (USACE) owns eight of these reservoirs and BRA owns three reservoirs within the basin. In addition to the BRA water supply reservoirs, there are several other reservoirs in the basin. While none of these reservoirs are located within the Region H area, supply from the system is committed in Region H. Approximately 163,450 acre-feet per year of firm supply from the BRA system is contracted for use in the Region H area. BRA also has contracted additional firm supplies to customers in Region H from the increased availability authorized by a recently granted permit associated with system operation. Other large surface water suppliers also divert water from the Brazos River Basin to serve needs in the basin or adjoining coastal basins. Dow Chemical diverts surface water from the Brazos River and enhances the reliability of their supplies through the use of off-channel surface reservoirs as well as contracts with BRA for upstream supplies. Gulf Coast Water Authority (GCWA), Brazosport Water Authority (BWA), and NRG also utilize Brazos River Basin supplies.

1.4.6 San Jacinto-Brazos Coastal Basin

There are several significant water users within the San Jacinto-Brazos Coastal Basin, further supported by run-of-river water supplies from the Brazos Basin. Suppliers include the GCWA, which has historically owned water rights on the Brazos River as well as within the coastal basin. GCWA also enhances the reliability of their surface water supplies through the use of off-channel surface reservoirs as well as contracts with BRA for upstream supplies.

1.4.7 Use by Source

TWDB reports that Region H used 1,826,366 acre-feet of water in 2000. Of that, 618,438 acre-feet (34 percent) came from groundwater wells, with the remaining 66 percent from rivers and other surface sources. The TWDB reported that, in 2015, Region H used a total of 1,759,604 acre-feet of water. Groundwater use accounted for 484,653 acre-feet (28 percent) of that total. The majority of year 2015 water supply came from surface water sources, at an amount of approximately 1,255,879 acre-feet. The remainder of the water used is attributed to reuse. Average regional water use for years 2000 through 2015 was approximately 1,933,000 acre-feet/year. *Table 1-10* summarizes the groundwater and surface water usage for each county. *Table 1-11* lists the estimated year 2070 reliable yields available from existing sources to Region H. Further information regarding the yield of major surface water rights in Region H is available in ***Chapter 3***.

Table 1-10 – County Water Use by Source

County	2015 Groundwater (acre-feet)	2015 Surface Water (acre-feet)	2015 Reuse (acre-feet)	2015 Total Use (acre-feet)
Austin	9,109	881	0	9,990
Brazoria	31,798	203,538	6,134	241,470
Chambers	6,544	111,966	0	118,510
Fort Bend	90,485	98,521	1,656	190,662
Galveston	1,361	93,310	1,063	95,734
Harris	227,576	702,926	9,801	940,303
Leon	3,429	3,535	76	7,040
Liberty	10,402	14,403	0	24,805
Madison	3,840	1,267	57	5,164
Montgomery	73,912	6,833	175	80,920
Polk [1]	5,261	2,420	3	7,684
San Jacinto	3,128	271	0	3,399
Trinity [1]	1,303	1,372	107	2,782
Walker	4,550	14,338	3	18,891
Waller	14,230	846	0	15,076
Total	**486,928**	**1,256,427**	**19,075**	**1,762,430**

Source: TWDB Annual Survey of Ground and Surface Water Use
[1]Includes portion of the county in adjacent Region I

Table 1-11 – Projected 2070 Supplies Available for Use in Region H

Groundwater	Projected Yield (acre-feet/year)
Gulf Coast Aquifer[1,2]	883,261
Carrizo-Wilcox Aquifer	19,766
Queen City Aquifer	1,203
Sparta Aquifer[2]	6,301
Yegua-Jackson Aquifer	7,175
Brazos River Alluvium	19,971
San Bernard River Alluvium	520
San Jacinto River Alluvium	1,450
Trinity River Alluvium	3,913
Subtotal	**943,560**
Reuse	
Direct Reuse	21,168
Indirect Reuse	29,295
Subtotal	**50,463**
Basin/Reservoir/Run-of-River	
Neches Basin	
Sam Rayburn Contract[3]	68,910
Run-of-River	176
Neches-Trinity Coastal Basin	
Run-of-River	37,481
Trinity Basin	
Lake Livingston/Wallisville	1,275,900
Run-of-River, Lower Basin	137,251
Trinity-San Jacinto Coastal Basin	
Run-of-River	5,537
San Jacinto Basin	
Lake Houston	156,400
Lake Conroe	75,600
Run-of-River	12,627
San Jacinto-Brazos Coastal Basin	
Run-of-River	38,827
Brazos River Basin	
Brazos River Authority System[4]	163,450
Run-of-River, Lower Basin	451,130
Brazos-Colorado Coastal Basin	
Run-of-River	11,729
Subtotal	**2,435,018**
Total	**3,429,041**

[1]*Value includes use from the Catahoula Aquifer.*
[2]*Value includes short-term peak use anticipated to be offset by lower use under typical conditions.*
[3]*Values based on input from LNVA and Region I.*
[4]*Values based on long-term contracts from BRA to Region H customers. Excludes contracts associated with the BRA System Operation Permit which are addressed in the RWP as future strategies.*

1.4.8 Major Water Providers

TWDB rules require the determination of demands associated with each of the Major Water Providers (MWPs) designated by the RHWPG. MWPs are entities which function as critical links in the regional water supply chain. Region H chose to utilize supply volume as the key metric in its this designation, with entities with current or anticipated supply volumes of 25,000 acre-feet per year or greater categorized as MWPs. Of the 24 entities categorized (*Table 1-12*) as MWPs through this methodology, 21 serve users from within the region, while the other three (BRA, LNVA, and TRA) provide supplies to Region H from their primary region. Over half of the MWPs in Region H are also WUGs, including cities and regional water authorities which serve their own needs as well as those of their contract customers. It should be noted that while certain entities have been formally categorized as MWPs, all water suppliers are recognized as playing a vital role in meeting the Region's complex and growing water demands.

Table 1-12 – Major Water Providers in Region H

MWP Name	Primary RWPG
Brazosport Water Authority	H
Brazos River Authority	G
Chambers-Liberty Counties Navigation District	H
Clear Lake City Water Authority	H
Conroe	H
Dow Chemical USA	H
Galveston	H
Gulf Coast Water Authority	H
Houston	H
Huntsville	H
League City	H
Lower Neches Valley Authority	I
Missouri City	H
North Fort Bend Water Authority	H
North Harris County Regional Water Authority	H
NRG	H
Pasadena	H
Pearland	H
San Jacinto River Authority	H
Sugar Land	H
Texas City	H
The Woodlands	H
Trinity River Authority	C
West Harris County Regional Water Authority	H

1.5 WATER QUALITY AND NATURAL RESOURCES

1.5.1 Water Quality

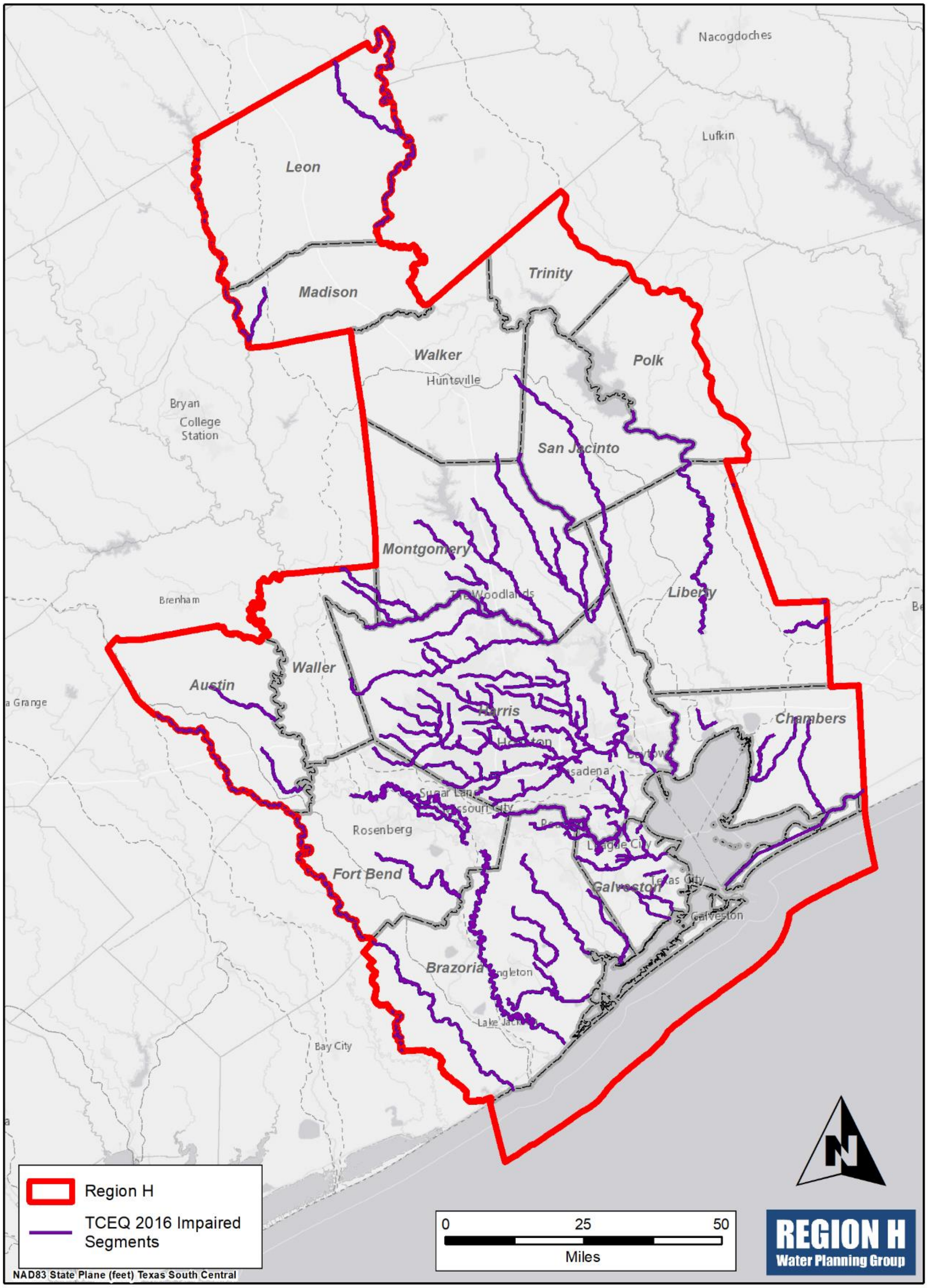
The TCEQ 2016 *Integrated Report of Surface Water Quality* was prepared in compliance with Sections 305(b) and 303(d) of the Federal Clean Water Act. *Figure 1-7* illustrates the impaired stream segments within Region H identified by TCEQ in 2016. The figure was prepared using the 2016 list of impaired segments and GIS data available on the TCEQ website. In addition to water quality data collected by TCEQ, agencies participating in the Texas Clean Rivers Program (CRP) annually compile and publish Regional Water Quality Assessments. In Region H, the Brazos, San Jacinto, and Trinity River Authorities participate in the Texas Clean Rivers Program and have each published reports on the water quality conditions within their respective basins. These reports established the condition of each river and stream segment and identified those segments with water quality concerns for a number of parameters.

Surface water throughout Region H is of sufficient water quality to be treated for municipal use using conventional measures. Contact recreation use is limited in the lower Trinity River due to fecal coliform bacteria levels. Growth in the San Jacinto River Basin has increased nutrient loading and fecal coliform levels in many streams, particularly Buffalo Bayou. Sand mining, in particular, has led to increased nutrient loads in the San Jacinto River which can result in an increase in cyanobacteria levels. One concern in the lower Brazos River are periods of low flows during dry years or seasons, which allow the tidal salt-wedge to reach municipal and industrial freshwater intakes.

Groundwater within the region is generally of good quality, with total dissolved solids below 1,000 mg/l. Iron is a concern in some portions of the Carrizo-Wilcox Aquifer, and calcium, magnesium, and sulfate cause high total hardness in portions of the Brazos River alluvium. Some groundwater supplies contain arsenic and radon. The current maximum contaminant level (MCL) for arsenic in water used for public supply is 0.01 mg/l set by the Environmental Protection Agency (EPA) in January of 2006. Currently, most groundwater produced within Region H has an arsenic content below the existing MCL. There is a limited area within the northwestern part of Harris County where the concentration of arsenic in some sands of the Gulf Coast Aquifer exceeds 0.01 mg/l. Wells are now constructed to not screen these sands. In some instances, consideration is being given to treating the water from older wells to lower the arsenic content below 0.01 mg/l. Some shallow aquifer contamination has been reported in heavily industrialized areas within the region.

Radon is not a regulated constituent, as a MCL has not been established for it. There are some areas in the western part of Harris County where isolated sands can contain water with higher concentrations of radon. Through geophysical logging to identify these depth intervals and by the use of well construction techniques that isolate the sands, production wells produce water with low levels of radon.

Figure 1-7 – Region H Surface Water Quality



1.5.2 Topography

Region H is located in the Gulf Coastal Plains of Texas. It is primarily made up of two vegetational areas: the Gulf Prairies and the Piney Woods.

The Gulf Prairies make up the majority of the region. They hold marsh and saltwater grasses in tidal areas and bluestems and tall grasses inland. Oaks, elms, and other hardwoods grow in limited amounts. The natural grasses make the region ideal for cattle grazing, and the fertile soils support rice, cotton, wheat, and hay farming. Wildlife in the area includes alligator, river otter, eastern brown pelican, Eskimo curlew, piping plover, and whooping crane. Counties in the Gulf Prairies include Austin, Brazoria, Chambers, Fort Bend, Galveston, Harris, and Waller.

The Piney Woods encompass the northeastern portion of Region H, consisting of pine forests interspersed with native and improved grasslands. Longleaf, shortleaf, and loblolly pine are the dominant native species harvested, but slash pine and various hardwood species are cultivated as well. Timber production and cattle are the principal agricultural products in that portion of the region. Wildlife in the area includes bobcat, ringtail, river otter, red-cockaded woodpecker, and bald eagle. Counties in the Piney Woods include Leon, Liberty, Madison, Montgomery, Polk, San Jacinto, Trinity, and Walker.

1.5.3 Public Lands

Region H contains several hundred thousand acres of state and national forests, supporting hiking, camping, picnicking, and horseback riding. It also contains extensive areas of coastal wildlife refuges for migratory waterfowl, as well as native waterfowl and plant species. It contains a portion of the Big Thicket National Preserve, designated by the United Nations Educational, Scientific and Cultural Organization (UNESCO) as part of the International Biosphere Reserve. Finally, the region holds approximately 12,170 acres of Texas Wildlife Management Areas, preserved for bird watching in coastal areas and seasonal hunting inland. The area names and locations are presented in *Table 1-13*.

Table 1-13 – Public Lands

Resource Area	Acreage	County
State and National Forests		
W. Goodrich Jones State Forest	1,725	Montgomery
Davy Crockett National Forest	161,842[1]	Total
	67,361	Trinity
Sam Houston National Forest	161,508	Total
	47,609	Montgomery
	59,706	San Jacinto
	54,153	Walker
State and National Preserve		
Big Thicket National Preserve	113,122[1]	Total
National Wildlife Refuges		
Anahuac NWR	34,000	Chambers
Brazoria NWR	44,413	Brazoria
San Bernard NWR	54,000[1]	Brazoria
Trinity River NWR	30,000	Liberty
Texas Wildlife Management Areas		
Candy Cain Abshier	207	Chambers
Atkinson Island	150	Harris
Keechi Creek	1,500	Leon
Justin Hurst	10,311	Brazoria

Source: Texas Almanac, Texas Parks & Wildlife Department
[1]Total includes portion of public lands located in counties outside of Region H

1.5.4 Navigation

Navigation within Region H rivers is generally limited to the lower reaches of the main stems of the Brazos, San Jacinto, and Trinity Rivers including the Houston Ship Channel and Turning Basin. In addition, the Gulf Intracoastal Waterway, an inland canal system that connects ports in the Gulf of Mexico, traverses the Region H coastline through the ports of Galveston and Freeport. There is significant use of rivers, streams, and reservoirs throughout the region by recreational boaters and fishermen. There are no navigation water permits in the Region H area.

1.5.5 Agricultural and Natural Resources

Agricultural interests in Region H are impacted by threats to water supply during drought of record conditions. As in other parts of the state, agricultural interests in water resources are often the first ones limited in times of shortage. Traditionally, Region H has been immune to these pressures due to its relatively plentiful supply of water. However, in recent years of drought and with the increased utilization of water for other purposes, water supply has become a critical driver in agricultural operations. Most surface water is provided through annual contracts that do not provide certainty in planning long-term water supplies. Additionally, water rights that are held by agricultural interests are often not reliable without storage to provide backup during drought. Because of these issues, many farmers have turned to use of groundwater, where allowable through local regulation, to augment the unpredictable surface water supplies. However, the prospect of developing wells is often only a viable alternative for growers who farm the land that they own. Growers who lease land are typically not able to make long-term commitments to developing groundwater resources or other fixed assets on the property they farm. Region H is also able to meet a portion of agricultural need through irrigation conservation practices, which are most effective for water-intensive crops such as rice. Impacts upon agricultural resources are discussed in detail in ***Chapter 6***. The need for financial assistance to realize the agricultural water conservation goal is addressed in **Chapter 8**.

The Galveston Bay estuary is the single most significant natural resource in Region H. The estuary is dependent upon freshwater inflows to maintain seasonal salinity ranges for wildlife habitat and fisheries productivity. In addition, the development of wastewater return flows over the years from the growing urban development has provided an important baseflow for preserving the system. The estuary is capable of withstanding natural flood and drought cycles, but the amplified effects of water diversions during a drought may pose a threat to this resource.

Senate Bill 3, passed in 2007 by the 80th Texas Legislature, developed a framework for evaluation and determination of future environmental flows throughout the state including Region H. Region H is home to two separate SB3 processes: the Trinity-San Jacinto Basin working groups in the eastern basins of the region and the Brazos Basin working groups in the western basins. The Trinity-San Jacinto Basin and Bay Expert Science Team (BBEST) submitted their report in November 2009 and the Trinity-San Jacinto Basin and Bay Area Stakeholder Committee (BBASC) concluded its findings in two series of recommendations transmitted in May 2010. TCEQ adopted standards in April 2011 based on these recommendations. In the Brazos River Basin, evaluations were completed by the BBEST and BBASC in March and September 2012, respectively. In turn, final rules for the Trinity-San Jacinto and Brazos systems were formerly adopted on May 15, 2011 and March 6, 2014, respectively.

The number of federally and state-listed threatened and endangered species is presented in *Table 1-14.* Threatened and endangered species are further discussed in ***Chapter 6***.

Table 1-14 – Threatened and Endangered Species

County	County Total
Austin	20
Brazoria	29
Chambers	21
Fort Bend	20
Galveston	24
Harris	26
Leon	22
Liberty	26
Madison	20
Montgomery	20
Polk	24
San Jacinto	21
Trinity	25
Walker	21
Waller	20

Source: Texas Parks & Wildlife
Number of species listed as of August 2018

The strategies recommended in this water plan will have some impacts upon wetlands habitats which may require mitigation. In the 2021 Region H Water Plan, one new reservoir project, the Allens Creek

Reservoir, is recommended. However, the potential impacts at this proposed site are less than on the main stem of a river. It should be pointed out that the Allens Creek project was modified by the project sponsor to avoid impacting a wetland segment adjacent to the project site. Remaining reservoir projects recommended in the 2021 Region H Water Plan consist of enhancements to existing impoundments and sites.

Transfers of supply to the San Jacinto Basin from Lake Livingston and beyond and transfer of water from Toledo Bend in the East Texas Transfer are recommended in this plan. While the recommended amounts are less than the full yield of the source reservoirs, it will still impact lake levels during dry periods as well as wetlands along the periphery of the source reservoirs, but no permanent impacts to these habitats are foreseen. Substantial portions of associated conveyance are anticipated to occur through existing infrastructure or may be made possible through expansion within or adjoining to an existing right-of-way, thereby reducing potential future impacts on wetlands.

A significant portion of the Planning Area has experienced subsurface compaction and land surface subsidence due to prolonged dependence on groundwater to support growing water demands. Increased utilization of surface water supplies, including many of the strategies recommended in this plan, allows achievement of mandated limits on groundwater production and substantially reduces the rate of subsurface capacity reduction and the negative impacts to the surface environment caused by subsidence.

In developing the RWP, the RHWPG balanced meeting water needs with good stewardship of the water, agricultural, and natural resources within the region. Water conservation is recommended as the first strategy applied to meet projected shortages where appropriate, and yield and environmental impact of projects were given greater consideration than the unit cost of water in the strategy selection process. Consideration of impacts to agricultural and natural resources are further discussed in ***Chapter 6***, as well as in strategy technical memoranda in ***Appendix 5-B***.

1.6 EXISTING WATER PLANNING

1.6.1 Existing Regional and Local Water Management Plans

The first Region H Water Plan was published in 2001 and was incorporated into the State Water Plan in 2002. Since that time, RWPs have been developed at 5-year intervals in 2006, 2011, 2016, and 2021 for incorporation into subsequent State Water Plans. The 2016 Region H Water Plan recommended several water management strategies to meet water demands. First, water conservation was recommended for municipal WUGs that were deemed to exhibit a significant potential to achieve savings through conservation programs, along with irrigation and manufacturing WUGs in certain counties. Next, expanded development of groundwater was recommended where regulatory constraints allowed for additional pumping. The 2016 RWP also included many water supply contracts and ongoing infrastructure projects based on stakeholder input during the regional planning process; both contractual transfers and infrastructure development accounted for a substantial portion of recommended water management strategies.

The Region H area was formerly part of The Trans-Texas Water Program (TTWP): Southeast Area, a comprehensive water resource planning program created to evaluate a full range of water management strategies for a 32-county area of East Texas. This area encompassed all of Region H, plus the lower Sabine River Basin and portions of the middle Brazos River Basin. The Phase I Report

(1994) identified a regional long-term shortage by the year 2035. To meet that need, several management techniques were studied further: water conservation, wastewater reclamation, use of existing reservoir surplus supply, coordinated reservoir system operation, interbasin transfers, and contractual transfers.

Technical studies of these management techniques were completed in Phase II of the TTWP. The Phase II Report (1998) determined that the Southeast Area could develop adequate supplies to meet expected regional demands and could export water to Central Texas (RWPAs L and N). Various management strategies would need to be implemented to accommodate growth in the different geographic areas across the fifty-year planning period. Water conservation, wastewater reclamation, and coordinated systems operations strategies would extend the period of adequate supply, allowing additional time to plan and develop new water sources. The Allens Creek Reservoir in the Brazos River Basin, with an estimated yield at the time of approximately 70,000 acre-feet per year, was reported as a potentially feasible project. Contractual transfers were identified that would align surface water rights with the owner's service areas, shortening conveyance systems. Finally, sustained interbasin transfers from the Toledo Bend Reservoir in the Sabine River Basin to the Trinity and San Jacinto River Basins were also reported as feasible strategies to meet the growing needs of the region and areas of central Texas.

Other major regional water supply plans include the SJRA Raw Water Supply Master Plan and the Trinity River Basin Master Plan.

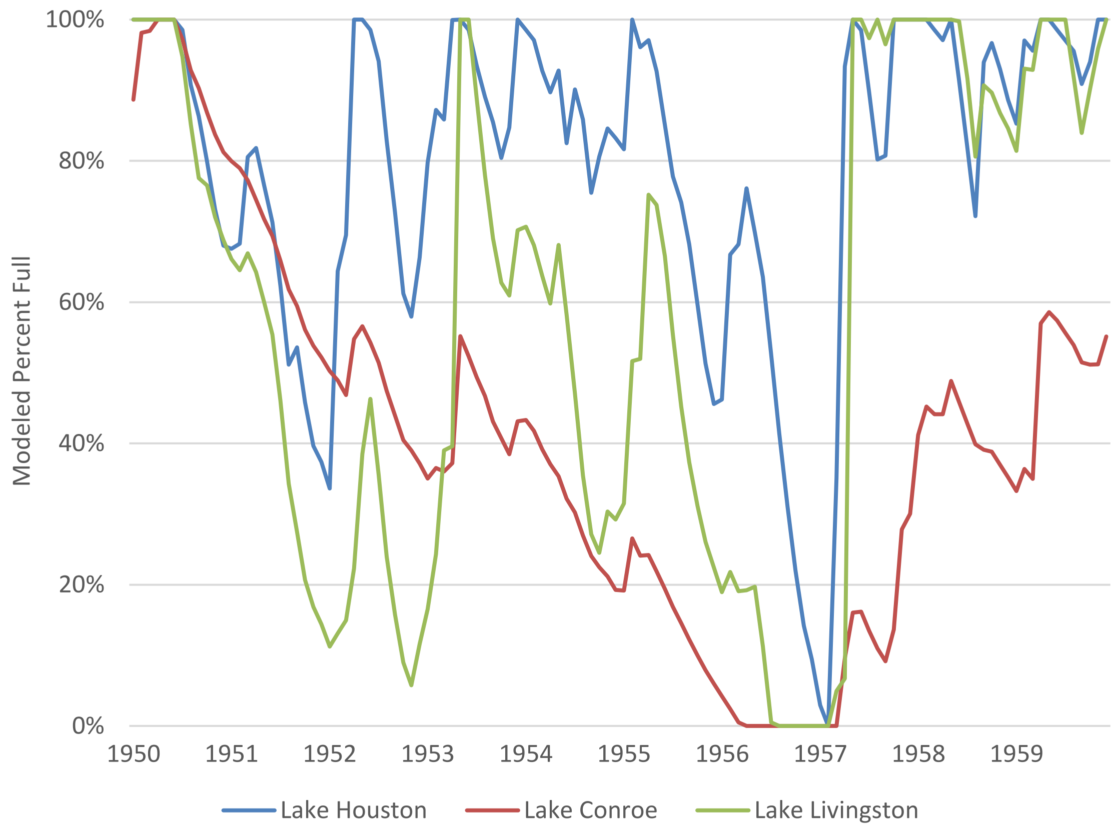
The Harris-Galveston Subsidence District and Fort Bend Subsidence District developed Regulatory Plans to address subsidence through reduced groundwater extraction within their respective regulatory areas. These districts each adopted their most recent regulatory plans in 2013, setting limits on groundwater use as a percentage of total water demand. The most recent amended regulatory plan for Lone Star GCD was adopted in 2015. In addition, the Bluebonnet, Brazoria County, Lower Trinity, and Mid-East Texas GCDs have published management plans although these districts have not proposed limitations on groundwater withdrawals to maintain groundwater resources.

Additional plans are noted in the Region H Bibliography, included as ***Appendix 1-A***.

1.6.2 Drought of Record

Water supplies included in the 2021 Region H RWP are based on drought of record conditions. Specifically, the drought of record condition used in Region H is the drought of the 1950s as recreated in simulation by the Water Resources Analysis Package (WRAP) using the Trinity, San Jacinto, and Brazos River Basin Water Availability Models (WAMs). *Figure 1-8* below represents the percentage full for the three major reservoirs in Region H during the drought of record. Note that this analysis represents the Run 3 WAM for each basin, which does not include any revisions to allowable annual diversions in order to maintain firm yield and assumes no return flows.

Figure 1-8 – Modeled Drought of Record Effects on Region H Reservoirs



1.6.3 Current Preparations for Drought

The amended Title 30, Texas Administrative Code, Chapter 288 became effective on December 6, 2012, and made changes to the drought contingency planning process, including aligning deadlines for drought contingency planning submittals to a five-year cycle. Any new or revised drought plans must be submitted to the TCEQ within 90 days of adoption by the governing body of the entity. For entities serving fewer than 3,300 connections, the plans must be developed and made available upon request by TCEQ.

In the completed drought plans, the predominant response activities are first a public information effort to alert the public to drought conditions and encourage water conservation. If drought conditions persist, many plans impose mandatory water conservation measures, including restrictions on landscape watering and car washing. Water conservation and drought response are discussed in ***Chapter 5*** and ***Chapter 7*** of this report.

1.6.4 Water Loss Audits

An important part of a municipal conservation plan is minimizing the amount of water loss in the distribution system. Retail entities that have an active financial obligation with TWDB or have more than 3,300 connections are required to submit water loss audits annually. All retail public water suppliers are required to submit a water loss audit every five years.

The water loss reporting follows a methodology recommended by the International Water Association (IWA) and the American Water Works Association (AWWA) Water Loss Control Committee. The methodology relies on defined water use categories as shown below:

Apparent Losses represent water that was used but not paid for, resulting in lost revenue. Apparent Losses include (but are not limited to):

- Unauthorized consumption,
- Customer meter under-registering, and
- Billing adjustment and waivers.

Real Losses represent water that is physically lost from the water system prior to use, resulting in lost revenue. Real Losses include:

- Main breaks and leaks,
- Storage overflows, and
- Customer service line breaks and leaks.

Table 1-15 details these various components of water use in Region H, as reported in the 2015 Water Loss Audit Report, which included data submitted by 623 entities in Region H. As demonstrated, real losses represent approximately 13.3 percent of the total reported water input to the region, which is slightly higher than the statewide average of 12.4 percent. This data represents a real potential for the reduction of water demand through leak detection and other practices aimed at increasing accountability.

Table 1-15 – Region H 2015 Water Balance (acre-feet per year)

Totals for Region H 623 Audit(s) Submitted	System Input Value 226,717,480,304 100%	Authorization Consumption 191,447,807,741 84.4%	Bill Consumption 184,787,631,509 81.5%	Billed Metered 182,879,507,099 80.7%	Revenue Water 184,787,631,509 81.5%
				Billed Unmetered 1,908,124,410 0.8%	
			Unbilled Consumption 6,660,176,232 2.9%	Unbilled Metered 3,228,736,597 1.4%	Non-Revenue Water 43,837,973,205 18.4%
				Unbilled Unmetered 3,431,439,635 1.5%	
		Water Loss 35,269,672,563 15.5%	Apparent Loss 5,209,306,107 2.2%	Unauthorized Consumption 528,688,120 0.2%	
				Customer Meter Accuracy Loss 4,401,389,053 1.9%	
				System Data Handling Discrepancy 279,228,934 0.1%	
			Real Loss 30,060,366,456 13.3%	Reported Breaks And Leaks 15,172,086,264 6.7%	
				Unreported Loss 14,888,280,192 6.6%	

CHAPTER 2
PROJECTED POPULATION AND WATER DEMANDS

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Chapter 2 – Projected Population and Water Demands

2.1 INTRODUCTION

Statewide estimates indicate that the population of Texas will increase by over 70 percent from 2020 to 2070, growing from almost 29.7 million people to over 51 million. Region H is anticipated to make up approximately 23 percent of this 2070 population, or roughly 11.7 million people. In addition to municipal water supply for this growing population, the manufacturing sector accounts for a significant portion of water demand in Region H. Irrigated agriculture, which has declined considerably over the past several decades, also continues to be a center for substantial demands within the region, particularly in Brazoria, Chambers, Fort Bend, Liberty, and Waller Counties.

This chapter summarizes the long-term projections for Region H as well as the methodology employed to generate these estimates for development of the 2021 Regional Water Plan (RWP). In this effort, the Region H Water Planning Group (RHWPG) was assisted by the members of the Region H Population and Non-Population Water Demand Committees. Members of these committees are listed below in *Table 2-1*. The results of the analyses described in the following sections can be found in detail within the Texas Water Development Board's (TWDB's) DB22 and attached to the RWP document in ***Appendix DB***.

Table 2-1 – Region H Committee Members

Non-Population Demands Committee	
Member	**Organization**
Pudge Willcox (Chair)	Chambers-Liberty Counties Navigation District
W.R. Baker	Polk County
James Comin	ExxonMobil
Robert Istre	Municipalities
Glenn Lord	Dow Chemical Company
Mark Evans*	North Harris County Regional Water Authority
Population Demands Committee	
Member	**Organization**
Marvin Marcell (Chair)	Fort Bend Subsidence District
John Blount	Harris County
Art Henson	Madison County
Robert Istre	Municipalities
Carl Masterson	General Public
Michael Turco	Harris Galveston Subsidence District
Mark Evans*	North Harris County Regional Water Authority

**Non-voting*

2.2 NON-POPULATION WATER DEMANDS

Non-population water demands include water use for Water User Groups (WUGs) that are not associated with domestic purposes. These include Irrigation, Livestock, Manufacturing, Mining, and Steam Electric Power use and are distributed throughout the Regional Water Planning Areas (RWPAs) by county and river basin.

2.2.1 Methodology

Information regarding non-population water use was compiled from a number of sources based on the type of demand considered. Due to the increasing utilization of reuse water supplies by a number of demand sectors, TWDB's methodologies for developing draft water demand projections for the 2021 RWP include demands met through reuse. In each category, projections were initially presented by TWDB and were reviewed and amended by the RHWPG as required. The demands, as prepared by TWDB and revised by the RHWPG were formally adopted by TWDB on April 16, 2018.

2.2.1.1 Irrigation

TWDB's draft Irrigation demand projections were developed by averaging the annual irrigation water use from 2010 to 2014, with this amount projected to be held constant between years 2020 and 2070. TWDB developed draft Irrigation demand projections by applying an evapotranspiration-based estimated crop water need to Farm Service Agency (FSA) acreage to generate water need estimates by county, crop, and year; these values were further adjusted based on available surface water release data and availability of groundwater for the portion of irrigation demand estimated to originate from that source.

The RHWPG conducted an assessment of available information and concluded that the second-highest volume of irrigation use from 2010 to 2015 should be used to develop the long-term projections in order to achieve a worst-case demand scenario while omitting a single outlier year in historical usage. Demands were held constant out to 2070 in absence of any additional data representing long-term trends in agricultural production.

2.2.1.2 Livestock

Draft Livestock water demands were developed by TWDB by applying a water use coefficient for each livestock category to county level estimates of livestock inventories from the Texas Agricultural Statistics Service (TASS). The average result for years 2010 through 2014 was then applied as the projected year 2020 water demand, with the rate of change from the 2016 RWP applied to calculated projected demand through 2070. Upon review, the RHWPG recognized that the projections were within reasonable levels based on available information and the projections were retained for use in the RWP.

2.2.1.3 Manufacturing

TWDB developed draft Manufacturing water demand projections for 2020 using the maximum historical manufacturing water use from 2010 to 2014 by county. Growth in demand between 2020 and 2030 was estimated based on projections of employment growth from the Texas Workforce Commission. Draft manufacturing demands were held constant from 2030 to 2070.

Following review, the RHWPG concluded that the demand projection in 2020 should be based on the maximum use from the 2010 to 2015 TWDB Water Use Surveys, with the inclusion of estimated unaccounted manufacturing water use provided by TWDB. The RHWPG also identified opportunities to better characterize recent manufacturing water demand for Brazoria and Galveston Counties, with supporting information obtained from TWDB, Dow Chemical, and Gulf Coast Water Authority. The RHWPG further noted that the required assumption of constant manufacturing water demand after 2030 does not reflect the ongoing growth in the manufacturing sector in Region H, and it is unlikely that reductions in water use per production unit will offset all growth in manufacturing. This has been observed in recent years with the frequency of requests for additional water supply to support new and expanding manufacturing clients around the industrial centers of the region.

2.2.1.4 Mining

TWDB draft Mining water demand projections from the 2016 RWP were maintained for the present round of regional planning. These projections were derived through a 2012 TWDB-contracted study performed by the Bureau of Economic Geology (BEG), *Oil & Gas Water Use in Texas: Update to the 2011 Mining Water Use Report*. The BEG examined a number of factors and mining industry sectors in development of water demand projections. This study was embarked upon due to the heightened level of oil and gas activity in the state due to shale gas exploration. Although this phenomenon is less relevant to mining demands in Region H than other regions, some Region H counties are anticipated to be impacted by this activity. Upon review, the RHWPG recognized that the projections were within reasonable levels based on available information and the projections were retained for use in the RWP.

2.2.1.5 Steam Electric Power

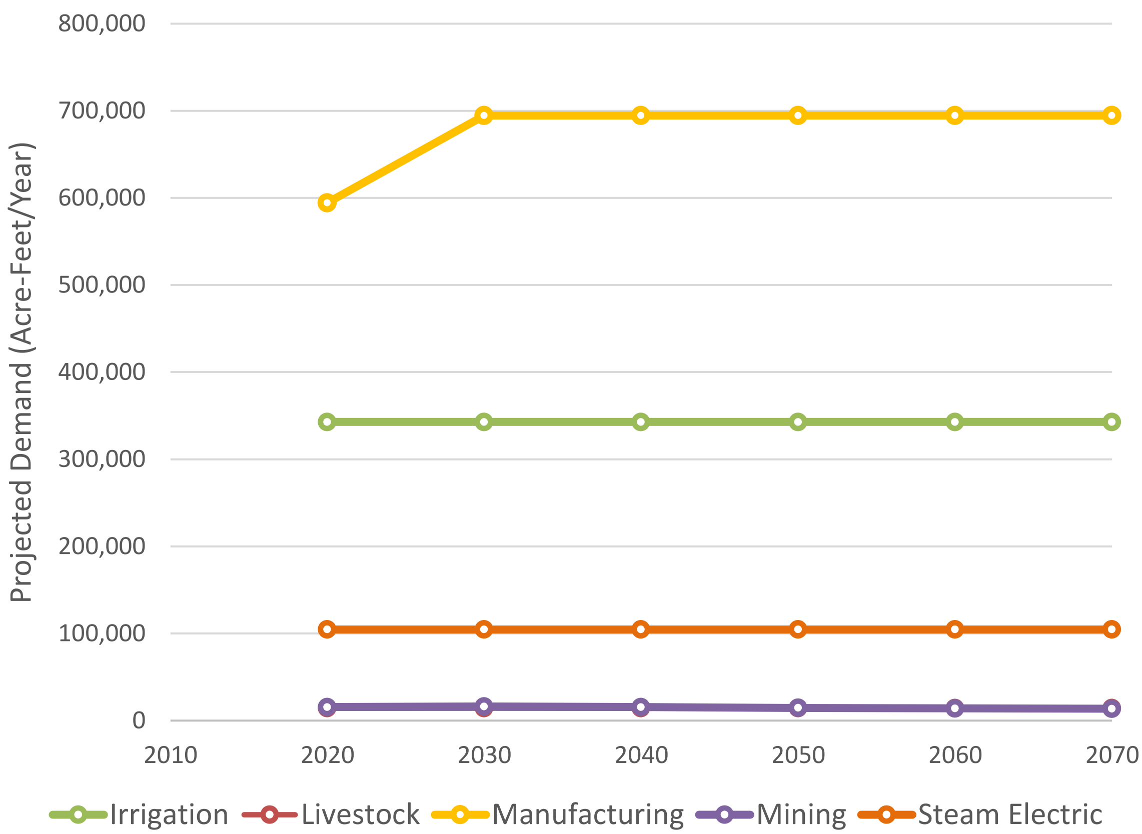
TWDB developed draft Steam Electric Power water demand projections by using the highest single-year water use from 2010 to 2014 on a county basis, held constant between 2020 and 2070. The steam electric water use estimates were intended to be reflective of the consumptive portion of water use, with the portion of water that is returned to the source excluded from the estimate. TWDB draft projections also included anticipated water use of future facilities listed in state and federal reports as well as deductions in use for facilities scheduled for retirement as reflected in state and federal reports.

Upon review, the RHWPG determined that steam electric water demand projections should be based on the maximum historical use from year 2010 through 2015 for each facility and summing the maximum values by county. The RHWPG was also able to identify a portion of demand from cogeneration facilities which represent a manufacturing rather than steam-electric category and were this removed by the RHWPG from its revised projections. The RHWPG further noted that the required assumption of constant steam electric water demand after 2020 does not reflect the ongoing growth in the electrical demands in the region.

2.2.2 Demand Projections

The resulting projections demonstrate growth of non-population demands from approximately 1.07 million acre-feet per year in 2020 to 1.17 million acre-feet per year of demand in 2070. Increases in non-population demand are attributed to the Manufacturing sector; a minor decrease in demand occurs in the Mining category. These patterns are demonstrated in *Figure 2-1*. Detailed non-population demand information can be found in ***Appendix DB***.

Figure 2-1 – Projected Non-Population Demand Growth



2.3 POPULATION WATER DEMANDS

Population water demands are associated with municipal and domestic use. Previous RWPs have determined population water demands based on political boundaries. In accordance with TWDB rule changes intended to align projections with active retail service areas, population water demand projections have been estimated to align with utility-based water user groups (WUG) for the fifth round of regional planning. Defined WUGs are entities serving more than 100 acre-feet per year for municipal use and include:

- Privately-owned utilities,
- Water systems serving state or federal government-owned institutions or facilities,
- Any other publicly owned retail utilities, and
- Collective Reporting Units (CRUs) consisting of grouped retail public utilities having a common association.

All smaller service providers and rural/unincorporated areas of municipal and domestic water use, aggregated at the county level, are considered part of an additional WUG and are referred to as "County-Other" for each county.

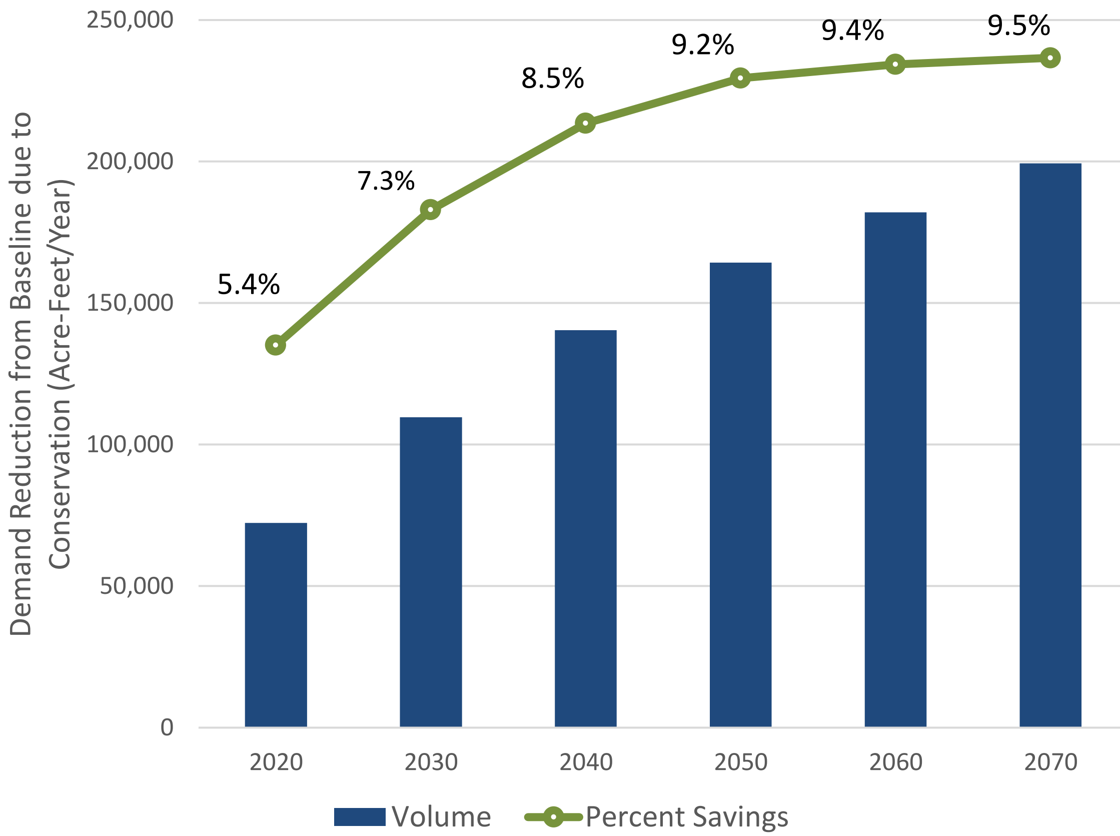
2.3.1 Methodology

For the 2016 RWP, the RHWPG developed long-term population projections in coordination with the Harris-Galveston Subsidence District (HGSD), Fort Bend Subsidence District (FBSD), and Lone Star Groundwater Conservation District (LSGCD). The result was a detailed depiction of population growth in Brazoria, Fort Bend, Galveston, Harris, and Montgomery Counties for use in both the groundwater study and Region H planning. Projections for other counties were developed by the Texas State Data Center (SDC) and TWDB using 2010 U.S. Census data. Populations were then allocated to WUGs geographically to develop the final Region H population projections. As no new Census data has become available since the fourth cycle of regional planning, these projections have primarily been retained at the county level in the fifth cycle. However, for the 2021 RWP, the population projections from the previous plan have been redistributed to align with the new WUG boundaries using geographic census block data, information from TWDB's annual Water Use Survey utility population and connection data, and TCEQ population and connection data.

Water demands were calculated by multiplying projected populations against a dry-year per-capita water demand. Where possible, the per-capita demand for a WUG was retained from the value applied for that WUG in the 2017 SWP. Due to the move to a utility-based WUG definition, a number of current utility-based WUGs include all or part of multiple WUGs from the prior planning cycle; in this case, the WUG was assigned the per-capita demand of its largest 2017 SWP WUG component. New named WUGs from systems formerly associated with County-Other were assigned a baseline per-capita water demand based on year 2011 or 2014 water use from the TWDB Water Use Survey. TWDB applied a lower bound of 60 gallons per-capita daily (gpcd) to the demand estimation methodology.

The effective per-capita demand for each decade was adjusted from this baseline according to anticipated conservation savings due to plumbing code enforcement and the proliferation of water-efficient appliances. This reduction on overall demands resulted in a reduction of year 2070 water demands of 199,385 acre-feet annually, or approximately 9.5 percent from projected 2020 demands. The decadal increase in conservation savings factored into the demand projections is shown in *Figure 2-2*.

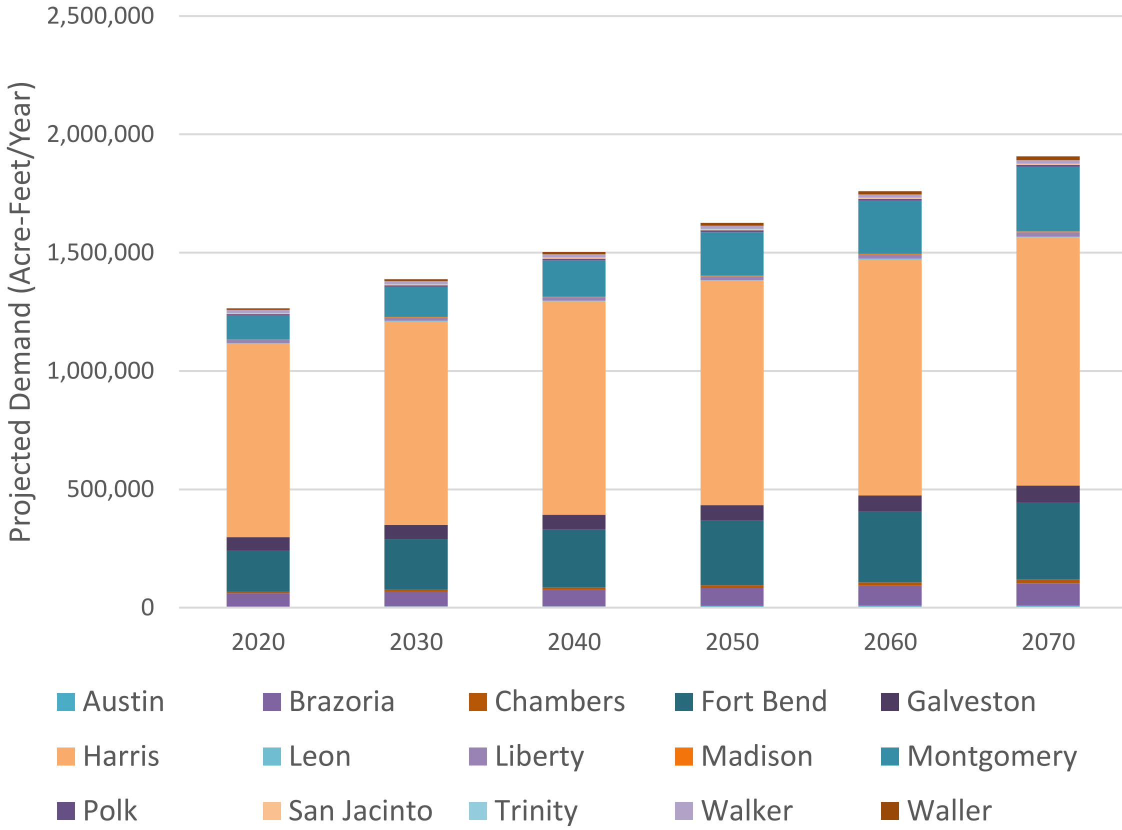
Figure 2-2 – Demand Reduction through Baseline Conservation



2.3.2 Demand Projections

The resulting projections demonstrate growth of population demands from approximately 1.27 million acre-feet per year in 2020 to 1.91 million acre-feet per year of demand in 2070. Overall increases in demand volume are greatest in Harris, Montgomery, and Fort Bend Counties (230,866 acre-feet, 170,994 acre-feet, and 151,262 acre-feet, respectively); Montgomery County demonstrates the greatest relative growth with a 169 percent increase in demand during the planning period. These patterns are demonstrated below in *Figure 2-3*. Detailed population demand information can be found in ***Appendix DB***.

Figure 2-3 – Projected Population Demand Growth



2.4 MAJOR WATER PROVIDER DEMANDS AND CONTRACTUAL OBLIGATIONS

TWDB rules require the determination of demands associated with each of the Major Water Providers (MWPs) designated by the RHWPG. MWPs are entities which function as critical links in the regional water supply chain. Region H elected to utilize supply volume as the key metric in its this designation, with entities with current or anticipated supply volumes of 25,000 acre-feet per year or greater categorized as MWPs. Of the 24 entities categorized as MWPs through this methodology (*Table 2-2*), 21 serve users from within the region, while the other three (BRA, LNVA, and TRA) provide supplies to Region H from their primary region. Over half of the MWPs in Region H are also WUGs, including cities and regional water authorities which serve their own needs as well as those of their contract customers. It should be noted that while certain entities have been formally categorized as MWPs, all water suppliers are recognized as playing a vital role in meeting the region's complex and growing water demands. Water demands associated with MWPs are summarized by category of water use in ***Appendix 2-A***.

Table 2-2 – Major Water Providers in Region H

MWP Name	Primary RWPG
Brazosport Water Authority	H
Brazos River Authority	G
Chambers-Liberty Counties Navigation District	H
Clear Lake City Water Authority	H
Conroe	H
Dow Chemical USA	H
Galveston	H
Gulf Coast Water Authority	H
Houston	H
Huntsville	H
League City	H
Lower Neches Valley Authority	I
Missouri City	H
North Fort Bend Water Authority	H
North Harris County Regional Water Authority	H
NRG	H
Pasadena	H
Pearland	H
San Jacinto River Authority	H
Sugar Land	H
Texas City	H
The Woodlands	H
Trinity River Authority	C
West Harris County Regional Water Authority	H

CHAPTER 3
ANALYSIS OF CURRENT WATER SUPPLIES

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Chapter 3 – Analysis of Current Water Supplies

3.1 INTRODUCTION

Region H occupies a location on the Texas Gulf Coast which provides a wealth of water resources, with many aquifer formations capable of rapid recharge and with a number of surface water catchments with generally large flows. However, the region is also home to approximately a quarter of the State's population and is projected to experience significant growth over the next 50 years. This large population, and the region's status as a major industrial area, generates extremely large water demands.

A key component in addressing these growing demands is understanding the reliability and ownership of existing water supplies. This chapter summarizes the results of Task 3, and describes the resources available to the region and their allocation to Water User Groups (WUGs) throughout Region H. In this effort, the Region H Water Planning Group (RHWPG) was assisted by the members of the Region H Groundwater Supply Committee and Surface Water Supply Committee. Members of these committees are listed below in *Table 3-1*.

Table 3-1 – Region H Committee Members

Groundwater Supply Committee	
Member	**Organization**
Mike Turco (Chair)	Harris-Galveston Subsidence District
Gary Ashmore	Lower Trinity GCD
David Bailey	Mid-East Texas GCD
Yvonne Forrest	City of Houston
James Morrison	Walker County SUD
Bill Teer	Southeast WSC
Pudge Willcox	Chambers-Liberty Counties Navigation District
Mark Evans*	North Harris County Regional Water Authority
Surface Water Supply Committee	
Member	**Organization**
Jace Houston (Chair)	San Jacinto River Authority
Brad Brunett	Brazos River Authority
Yvonne Forrest	City of Houston
Ivan Langford	Gulf Coast Water Authority
Kevin Ward	Trinity River Authority
Pudge Willcox	Chambers-Liberty Counties Navigation District
Mark Evans*	North Harris County Regional Water Authority

**Non-voting*

Also, to provide consistency and facilitate the compilation of the different regional plans, the Texas Water Development Board (TWDB) required the incorporation of this data into a standardized online database referred to as DB22. The results of the analyses described below can be found in detail within DB22 and attached to the RWP in ***Appendix DB***. The following sections describe water resources available to the region, procedures for estimating reliable availability, description of major water providers, and procedures for assigning available water supplies to users in the Plan.

3.2 GROUNDWATER SOURCES

3.2.1 Groundwater Aquifer Overview

Groundwater resources in Region H consist of two major aquifers and four minor aquifers. The two major aquifers are the Gulf Coast Aquifer and the Carrizo-Wilcox Aquifer (*Figure 3-1*). The four minor aquifers present are the Sparta, Queen City, Yegua-Jackson, and Brazos River Alluvium (*Figure 3-2*). The Carrizo-Wilcox is used primarily in Leon and Madison Counties, the Sparta Aquifer system in Madison, Walker, and Trinity Counties, and the Gulf Coast Aquifer system in the central and southern sections of the region. Smaller amounts of water are provided by the Queen City, Yegua-Jackson, and Brazos River Alluvium Aquifers. Individual aquifers are described in greater detail in the following subsections.

3.2.2 Major Aquifers

3.2.2.1 Carrizo-Wilcox Aquifer

The Carrizo-Wilcox is the main aquifer in the northern part of Region H in Leon County and the northern portion of Madison County. The Carrizo-Wilcox Aquifer was deposited in a manner that resulted in a sequence of geologic formations of interbedded sand, silt, clay, and shale having a thickness of about 2,000 feet in the northern part of the region. The Carrizo Sand is one of two principal water-producing units of the Carrizo-Wilcox Aquifer and it is about 100 to 200 feet thick. It is a generally uniform, well sorted sand that contains a few very thin beds of clay; the aquifer dips downward to the southeast at about 70 to 100 feet per mile. The Wilcox Group is composed of alternating beds of sand, sandy clay, and clay with locally interbedded gravel, silt, clay, and lignite. The Simsboro Sand is the major water-producing unit in the Wilcox and is about 200 to 400 feet thick. The Carrizo and Wilcox formations are weakly connected hydraulically and are generally described as one major aquifer. Water from the aquifer contains less than 1,000 milligrams per liter (mg/l) of total dissolved solids, but water from the Carrizo Sand can contain elevated levels of iron that require sequestering or treatment for removal for water used for most municipal and industrial purposes.

Figure 3-1 – Region H Major Groundwater Sources

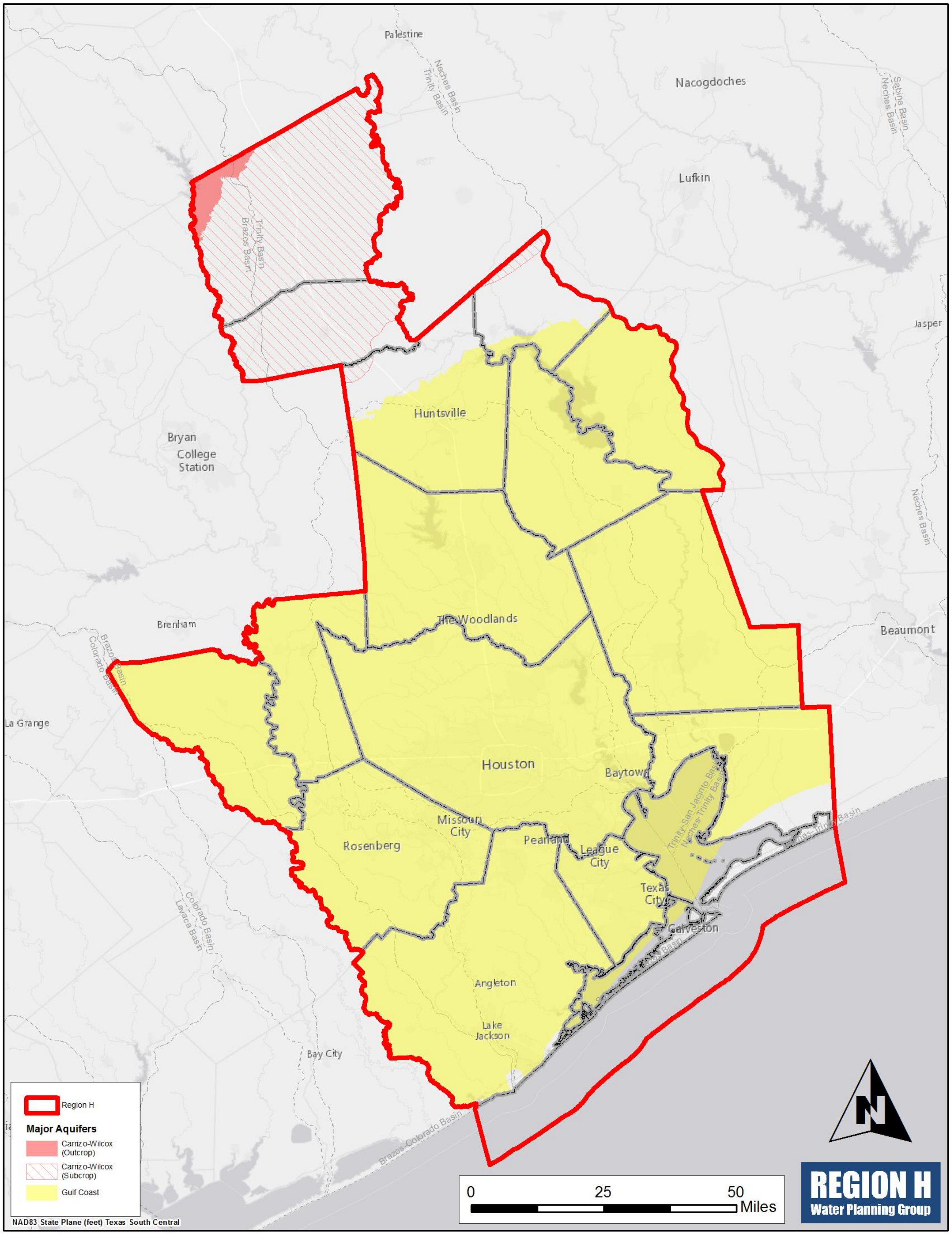
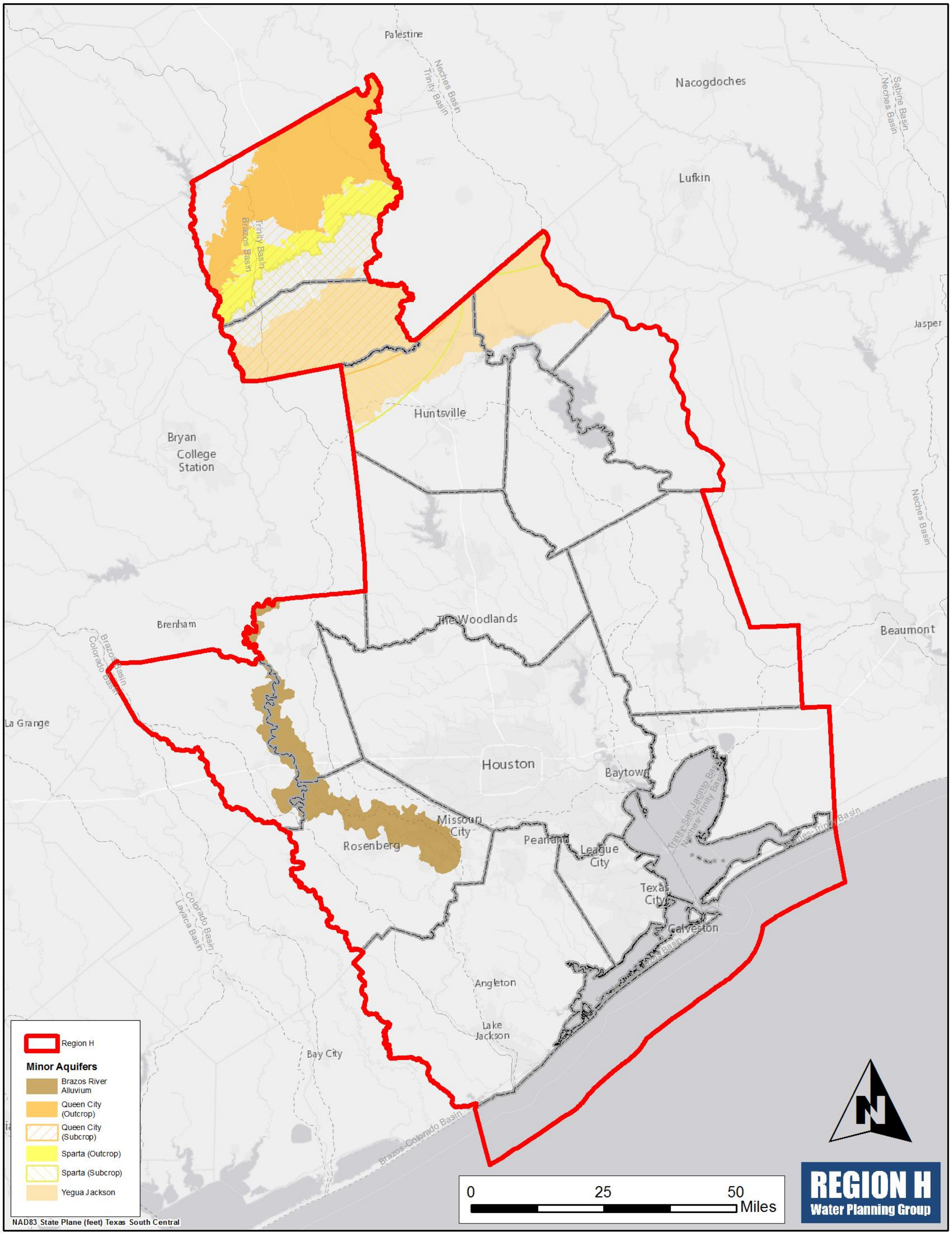


Figure 3-2 – Region H Minor Groundwater Sources



3.2.2.2 Gulf Coast Aquifer

The Gulf Coast Aquifer extends from the Gulf Coast to approximately 100 to 120 miles inland into Walker and Trinity Counties. The Gulf Coast Aquifer consists of four general water-producing units. The geologically youngest unit is the Chicot Aquifer, followed by the Evangeline Aquifer, the Jasper Aquifer, and the Catahoula Formation. The Chicot and Evangeline Aquifers are the more prolific water-producing units in the Gulf Coast Aquifer followed by the Jasper Aquifer and the Catahoula Formation. The units are composed of alternating beds of sand, silt, and clay; shale can occur at deeper depths at and below the base of the Evangeline Aquifer. The Gulf Coast Aquifer has sand thicknesses ranging from about 200 to 500 feet in the central and southern parts of the region with the sands containing freshwater decreasing in thickness as the aquifers approach within about 30 to 40 miles of the Gulf Coast. Formation beds vary in thickness and composition and the areal extent of individual beds normally cannot be traced over extended distances. Total aquifer sand thickness varies and can be as great as several hundred feet. The lower unit of the aquifer, the Catahoula Sandstone, is screened by wells for the City of Huntsville and other wells in Walker and Montgomery Counties. To the south, in Galveston County, the Chicot unit is screened in wells used by the City of Galveston. The aquifer is capable of yielding larger quantities of water in the central and southern parts of Region H and has been utilized over the past 100 years to provide part of the water supply, although heavy usage has also resulted in land surface subsidence and its use is now restricted in Fort Bend, Galveston, and Harris Counties for this reason.

3.2.3 Minor Aquifers

3.2.3.1 Queen City Formation

The Queen City Formation is a minor aquifer that occurs in central and southeastern Leon County and in the northern part of Madison County. The Queen City Formation is composed of sand and loosely cemented sandstone with interbedded shale layers occurring throughout. The Queen City Formation ranges in thickness from 250 to 400 feet with approximately 60 to 70 percent of the total thickness being sand according to *Texas Water Commission Bulletin 6513* (1965), *Availability and Quality of Ground Water in Leon County, Texas*. Groundwater in small to moderate quantities is provided by the Queen City Formation for domestic, municipal, industrial, and agricultural uses in Leon and Madison Counties.

3.2.3.2 Sparta Formation

The Sparta Formation or Sparta Sand occurs in southeastern Leon County, all of Madison County, northwestern Walker County, and northeastern Trinity County. The Sparta Formation consists of sand and interbedded clay, with the lower portion of the aquifer containing massive unconsolidated sands with a few layers of shale. The Sparta Formation ranges in thickness from 150 to 300 feet in Leon County and Madison County (*Texas Water Commission Bulletin 6513*). Groundwater from the aquifer is provided for domestic, municipal, and agricultural uses in Leon County and for domestic, municipal, manufacturing, and agricultural uses in Madison County. The Sparta Formation is the groundwater source for the Town of Madisonville and for some water supply corporations in the area.

3.2.3.3 Yegua-Jackson Aquifer

The Yegua Formation and Jackson Group make up a minor aquifer, designated as the Yegua-Jackson Aquifer, which occurs within the region in parts of Madison, Walker, Trinity, and Polk Counties. The Yegua Formation consists of sand, interbedded clay, and scattered lignite. The Jackson Group includes all strata between the Yegua Formation and the Catahoula Sandstone and consists of sand, clay, sandstone, and siltstone. The Yegua Formation ranges in thickness from 1,000 to 1,500 feet; the Jackson Group is approximately 1,100 feet thick, according to *Texas Board of Water Engineers Bulletin 5003* (1950), *Geology and Ground-Water Resources of Walker County, Texas*. Small to moderate quantities of groundwater are provided by the Yegua-Jackson Aquifer for domestic, municipal, industrial, and agricultural uses.

3.2.3.4 Brazos River Alluvium

The Brazos River Alluvium occurs in the floodplain and terrace deposits of the Brazos River in Austin, Fort Bend, and Waller Counties. The Quaternary alluvial sediments consist of clay, silt, sand, and gravel according to *TWDB Report 345* (1995), *Aquifers of Texas*, with the more permeable sand and gravel present in the lower part of the aquifer. The saturated thickness of the sediments is as much as 85 feet and the width of the alluvium ranges from less than 1 mile to approximately 7 miles, with the Brazos River located within the width of the alluvial deposits. The Brazos River Alluvium supplies groundwater for domestic and agricultural purposes in Fort Bend and Waller Counties. In Austin County, it supplies groundwater for domestic, manufacturing, and agricultural uses. The aquifer may contain water with total dissolved solids that approach 1,000 mg/l and have a high total hardness due to the amounts of calcium, magnesium, and sulfate in the aquifer water.

3.2.4 Groundwater Availability

Region H relies on a significant portion of supply from groundwater-based sources. Historically, the coastal counties within the region have been significant users of groundwater, such that initiatives to assess the reliable yield from groundwater supplies and offset excess groundwater demand to alternative sources began long before these initiatives began in other parts of the State because of recognized issues with subsidence. For this reason, the issue of groundwater reliability is a mature topic within the study area and of vital importance to overall water supply planning.

3.2.4.1 Groundwater Regulation in Region H

Region H contains the entirety or portions of seven entities that have authority over groundwater resources. Of these seven, two are subsidence districts with the remaining five being groundwater conservation districts (GCDs) governed under Chapter 36 of the Texas Water Code (TWC). Of the seven entities of various types, three of these have engaged in regulatory plans that involve the restriction of groundwater pumpage for the sake of preserving groundwater resources or preventing undue harm to other natural resources as a result of excess groundwater withdrawal. In effect, these plans and regulations represent the availability of groundwater in these counties for practical purposes.

The Harris-Galveston Subsidence District (HGSD) was created in 1975 to “end subsidence” in those counties at the threat of impacts resulting from excess use of groundwater. Prior to that time, it was observed that subsidence had increased the risk from coastal flooding in those counties and threatened to further increase the potential for inundation along the coast and in inland areas. Through a series of regulatory plans, HGSD has curtailed impacts from subsidence since its inception. In 2013, HGSD adopted a District Regulatory Plan that maintained existing limits on groundwater production in its three Regulatory Areas and set future reductions for Regulatory Area 3 located in north and west Harris County. These reductions are applied to water users on a basis of a percentage of their total water demand. These percentages are developed based on detailed study of long-range population and water demand projections and groundwater modeling for the region. In addition, entities are allowed to enter into Groundwater Reduction Plans (GRPs) that allow for aggregated compliance with groundwater regulation to maximize efficiency in goal attainment. Limits to the maximum annual percentage of groundwater use must be achieved on an annual basis to prevent dewatering of clay layers which causes subsidence and the incurring of disincentive fees on the part of groundwater users.

The Fort Bend Subsidence District (FBSD) was created in 1989 to address similar issues of subsidence that posed a risk to flood-prone areas within the county. In 2013, FBSD approved a District Regulatory Plan that maintained groundwater reductions for areas in the more urbanized northern and eastern portions of the county. Like the limitations placed on pumping by HGSD, these restrictions are applied as a percentage of total water demand and allow for compliance through GRPs.

The Lone Star Groundwater Conservation District (LSGCD) was created in 2001 to help Montgomery County continue its growth in a responsible manner without overpumping of the Gulf Coast Aquifer which has historically been its primary source of water for all purposes, including municipal use. Through a series of regulatory plan developments, LSGCD set a sustainable supply for the Gulf Coast Aquifer in Montgomery County at 64,000 acre-feet per year and called on large-volume groundwater users (LVGUs) in the county to identify and develop alternative water supplies in order to reduce pumping to sustainable levels. These limitations, which were required to be met in 2016 and adhered to on a long-term average in subsequent years, were based on a firm cap specified for each large-volume groundwater user based on historical use rather than a methodology of percentage reduction as used in the HGSD and FBSD regulatory plans. A District Court judgment subsequently found LSGCD's rule requiring a reduction in pumpage by LVGUs to be invalid. At the time of evaluation of existing water supplies for the 2021 Regional Water Plan (RWP), a revised District Regulatory Plan had not been adopted by LSGCD.

3.2.4.2 MAG and MAG Peak Factors

Groundwater Management Areas (GMAs) were created by the 74th Texas Legislature to facilitate a number of groundwater management goals including conservation and protection of groundwater. The GMAs, which were delineated by TWDB and represented by the GCDs within their boundaries, engage in a cyclical process joint planning process for groundwater resources. In 2016, the GMAs across Texas submitted their second round of Desired Future Conditions (DFCs) to the TWDB for the purpose of developing estimates of Modeled Available Groundwater (MAG) as described under Section 36.108 of the TWC. The GCDs adopting DFCs are required to develop management plans that include goals that are consistent with achieving the DFCs, per Section 36.1085 of the TWC.

In recent cycles of regional water planning, TWDB has endeavored to bring the efforts of the Regional Water Planning Groups (RWPGs) and GMAs together through the language in the planning rules. Whereas early RWPs allowed for considerable discretion of the RWPGs in assigning groundwater availability, starting in the 2016 round of RWP development the TWDB took a different approach. Per Section 16.053(e)(2-a) of the TWC, regional plans must be "consistent with the desired future conditions…" as developed by the GMAs. Going a step further, Title 31 of the Texas Administrative Code (TAC) Section 357.32 (d) dictates that, for regional planning, RWPGs "shall use Modeled Available Groundwater volumes for groundwater availability" unless there is no MAG volume.

During the development of the 2016 RWPs, it became apparent that strict adherence to the MAG as a limit on groundwater availability in the RWPs presents a number of issues to the RHWPG as well as other RWPGs in other regions of the State. The perspectives of the GMA and RWP processes are inherently different, with the Regional Plans built around "dry-year" demand and minimum supply to represent worst-case conditions, while the GMA process is focused on the study of groundwater resources which must be evaluated over long-term averages and broad scales of time. Further, the TWC, while listing the MAG as one of a number of considerations for GCDs, does not necessarily limit GCDs to strict adherence to the MAG. Some Groundwater Conservation Districts (GCDs) have rules and regulatory structures which allow for short-term peak pumping while still complying with the DFC on a long-term basis. In these cases, application of the MAG to the RWP process excludes this regulatory flexibility and may place unnecessary limitations upon supplies used for planning purposes, thus underrepresenting the water supply available to meet short-term peak demands.

In order to address these challenges while maintaining the valuable technical dialog between different planning processes, TWDB integrated the concept of a MAG Peak Factor into the 2021 RWP to bridge the gap between groundwater joint planning and regional planning perspectives. MAG Peak Factors are multipliers greater than 100% applied to MAG values to estimate dry-year availability; they are not intended to adjust the long-term supply as derived from the DFCs developed through joint planning process for groundwater but are, instead, intended to make the regional planning process consistent with regulations by local groundwater districts and patterns of permitted and exempt water use. RWPGs are not required to use Peak Factors but are given the option to apply them where deemed appropriate on a county-aquifer basis, with proposed factors subject to a multi-stage approval process involving the RWPG, applicable GCDs and GMAs, and TWDB. Approved Peak Factors for Region H are shown in *Table 3-2*, with more detailed information of the Peak Factor process available in ***Appendix 3-A***.

Table 3-2 – MAG Peak Factors

County	Aquifer	GCD	GMA	MAG Peak Factor
Austin	Gulf Coast	Bluebonnet GCD	14	123.92%
Brazoria	Gulf Coast	Brazoria County GCD	14	140.87%
Madison	Sparta	Mid-East Texas GCD	12	117.41%
Montgomery	Gulf Coast	Lone Star GCD	12	133.15%
Walker	Gulf Coast	Bluebonnet GCD	14	114.76%
Waller	Gulf Coast	Bluebonnet GCD	14	144.70%

3.2.4.3 Groundwater Availability Development

As described previously, annual volumes of groundwater available for supply in the 2021 Region H RWP are based on the MAG and any approved MAG Peak Factor for all geographic aquifer units for which a DFC has been adopted. Groundwater formations that have been deemed by a GMA to be non-relevant for the purpose of joint planning may be assigned an annual yield based on the judgment of an individual RWPG. The RHWPG has estimated the available groundwater in Fort Bend, Galveston, and Harris Counties based on projected demands in the 2021 RWP and allowable percentages of demand as specified in the FBSD and HGSD District Regulatory Plans.

For all other counties, Region H has historically recognized existing studies of groundwater availability as the source of information for planning purposes. At a public meeting on April 4, 2018, the RHWPG elected to retain the yield values included in the 2017 State Water Plan as the available yield of all other non-MAG formations in the 2021 RWP. Subsequently, at a public meeting on August 1, 2018, the RHWPG took action to update the availability of the Catahoula Formation in Montgomery County to a level matching permitted pumping and also to reflect a small amount of supply availability in the portion of the Gulf Coast Aquifer in Trinity County that is within the Trinity River Basin. Although no DFC has been adopted for the Gulf Coast Aquifer in Trinity County, which is part of GMA 11, this formation was included in the Groundwater Availability Model (GAM) used to determine MAG values for the Gulf Coast Aquifer System within GMA 14. TWDB provided the RHWPG with the groundwater availability data from GAM Run 16-024, which used MODFLOW-2000 to run Version 3.01 of the GAM for the northern portion of the Gulf Coast Aquifer System. The groundwater availability modeled for the Gulf Coast Aquifer in Trinity County in GAM Run 16-024 was adopted by the RHWPG for planning purposes in the 2021 RWP. As a result, the available groundwater for the Gulf Coast Aquifer in Trinity County is consistent with DFCs adopted by GMA 14 in adjacent counties. Availability of existing water supplies is summarized in ***Appendix DB***.

3.3 SURFACE WATER SOURCES

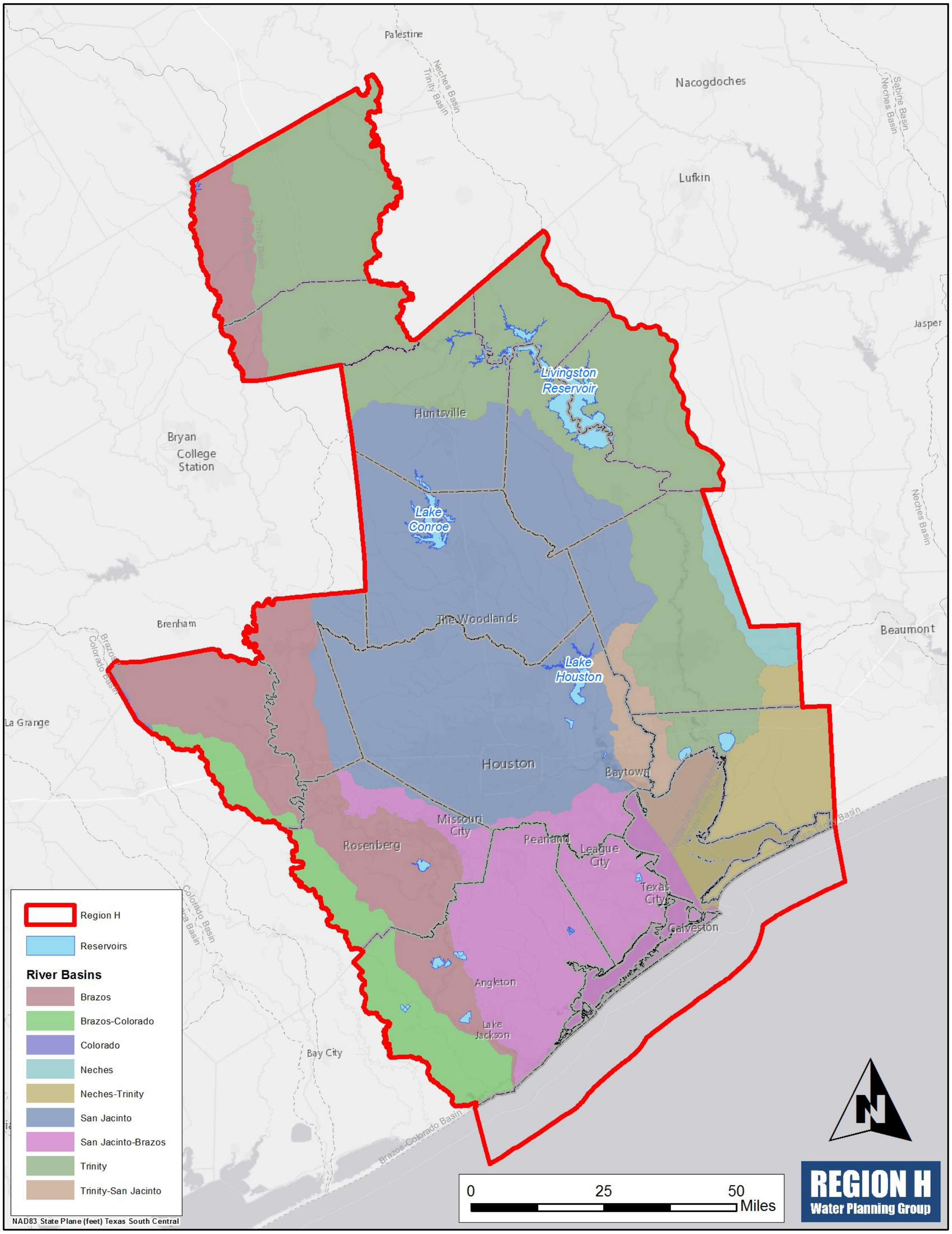
3.3.1 Surface Water Overview

Surface water in Texas is based on a prior appropriation water right system, wherein individuals or entities are granted rights to use surface water, with more senior rights having priority over junior rights. Senior rights are allowed the opportunity to fully satisfy their allowable diversion volume before more junior rights can divert. In practice these priorities are of limited concern in many basins for most years, due to an abundance of available surface water adequate to meet surface water demands. However, in drier portions of the State or during times of drought, priorities play an important role in determining ownership of limited surface water supplies. Water rights in the State are administered through a system of water right permits, or Certificates of Adjudication, issued by the Texas Commission on Environmental Quality (TCEQ). These permits specify water right ownership, the allowable amounts of water which can be diverted, the locations of diversion, the allowable uses and basins of use, any special conditions or limitations on the permit, and a priority date establishing the right's seniority. Certain basins within the State, including the Brazos River Basin within Region H, are also under the jurisdiction of a watermaster program which facilitates the prior appropriation system by monitoring streamflow, water use, and other parameters and coordinating surface water diversions.

Surface water supply planning in Texas, and with limited exceptions the State's surface water rights permitting system, is based on the concept of "firm yield." The firm yield of a particular surface water source is defined as the amount of water that can be provided each year including during drought-of-record hydrologic conditions, assuming full utilization and consumption of existing water rights and assuming that any applicable environmental flow requirements are fully satisfied (e.g., instream flows, bay and estuary inflow). The concept of firm yield, as applied in water supply planning and water rights permitting, represents a very conservative approach to surface water availability and allocation that is intended to provide a high degree of water supply reliability.

Region H encompasses parts of three major river basins, four adjoining coastal basins, and three major water supply reservoirs as shown in *Figure 3-3*. The following sections discuss the surface water available to Region H from these sources, other surface water sources used in the region, and determination of supply reliability.

Figure 3-3 – Region H Surface Water



3.3.2 Major Region H Reservoir Supplies

3.3.2.1 Lake Livingston / Wallisville Saltwater Barrier

Lake Livingston, which was completed in 1971 by the Trinity River Authority (TRA) and the City of Houston (COH), is located on the Trinity River in Polk, San Jacinto, and Trinity Counties; the dam is located approximately seven miles southwest of the City of Livingston. The reservoir is impounded by an earthen dam and concrete spillway and has a drainage area of over 16,000 square miles. At the conservation pool elevation of 131 feet, the reservoir has a volume of 1,791,709 acre-feet and a water surface area of 82,583 acres (approximately 129 square miles). The reservoir and dam are owned and operated by the TRA. The Wallisville Saltwater Barrier is located on the Trinity River downstream of Lake Livingston near the town of Wallisville.

Storage and diversions from Lake Livingston/Wallisville system are authorized under Certificate of Adjudication (COA) 08-4248 and COA 08-4261. Total permitted yield from the system is 1,344,000 ac-ft/yr. TRA is authorized to divert 403,200 ac-ft/yr for multiple uses. It should be noted that physical diversions are not made from Lake Wallisville, but the combined yield of Lake Livingston is increased when operated in conjunction with the Wallisville Saltwater Barrier. The remaining yield is owned by the COH. A portion of this supply is currently conveyed westward to the COH service area.

3.3.2.2 Lake Conroe

Lake Conroe is located on the West Fork of the San Jacinto River in Montgomery County, approximately seven miles west of the City of Conroe. The reservoir, which was completed in 1973 by COH and the San Jacinto River Authority (SJRA), is impounded by an earthen dam and concrete spillway and has a drainage area of 445 square miles. At the conservation pool elevation of 201 feet above mean sea level (msl), the reservoir has a volume of 411,022 acre-feet and a water surface area of 19,640 acres (approximately 30.7 square miles). Lake Conroe is operated by SJRA. COA 10-4963 authorizes 100,000 ac-ft/yr in permitted water rights from the Lake, with one third (33,333 ac-ft/yr) owned by SJRA and the remaining two thirds owned by the COH. SJRA holds an option contract to purchase water from the COH’s portion of the yield of Lake Conroe. The reservoir is permitted for municipal, industrial, irrigation, mining, and recreation uses.

3.3.2.3 Lake Houston

Lake Houston, which was completed in 1954 by COH, is located on the San Jacinto River in northeastern Harris County, approximately 15 miles from downtown Houston. The lake, which is impounded by an earthen dam and concrete spillway, has a drainage area of 2,828 square miles and is operated by COH and the Coastal Water Authority (CWA). At the conservation pool elevation of 41.73 feet above msl, the reservoir has a volume of 124,661 acre-feet and a water surface area of 10,160 acres (approximately 15.9 square miles).

COA 10-4965, held by the COH, authorizes storage in the lake as well as 168,000 ac-ft/year of permitted diversions. Priority dates for the right are May 7, 1940 for the first 112,000 ac-ft/yr and February 26, 1944 for the remaining 56,000 ac-ft/yr. Authorized uses include municipal, industrial, irrigation, and recreation purposes. COA 10-4965 also authorizes storage of water diverted from the Trinity River Basin in Lake Houston for subsequent diversion and use. COA 10-5807 authorizes diversion of an additional 28,000 ac-ft/yr from Lake Houston for municipal and industrial purposes. The permitted amount is divided evenly between the COH and SJRA. Water diverted under COA 10-

5807 may be used in Harris, Fort Bend, Galveston, and Montgomery Counties within the San Jacinto River Basin, and in portions of Brazoria and Chambers Counties within the Trinity-San Jacinto Coastal Basin, Trinity River Basin, and San Jacinto-Brazos Coastal Basin.

3.3.3 Run-of-River and Contractual Surface Water Supplies

3.3.3.1 Brazos-Colorado Coastal Basin

Region H includes the Brazos-Colorado Coastal Basin in Brazoria and Fort Bend Counties, including Jones Creek and the lower reach of the San Bernard River. Fourteen water rights are associated with the Region H portion of the basin, with total permitted run-of-river and off-channel reservoir diversions of 65,655 ac-ft/yr. Permitted uses include irrigation, industry, mining, and habitat maintenance.

3.3.3.2 Brazos River Basin

The Brazos River Authority (BRA) stores water in 11 water supply and flood control reservoirs in the middle and upper portions of the Brazos River Basin. BRA owns Possum Kingdom, Granbury, and Limestone Reservoirs, with the remainder owned by the U.S. Army Corps of Engineers. While BRA does not currently own or operate any major reservoirs within Region H, these upstream reservoirs provide water to entities in Region H through multiple water supply contracts. BRA currently has long term supply agreements with eight entities in Region H for supplies from these reservoirs, totaling 163,450 ac-ft/yr. BRA also holds COA 12-5166 and COA 12-5167, which authorize the diversion of 850,000 ac-ft/yr of interruptible excess flows in Fort Bend County. Because these are non-priority water rights and are therefore not firm, their associated supplies are not included as reliable existing supplies in DB22. In late 2016, BRA was also granted COA 12-5851 authorizing diversion of additional supply made available through coordinated reservoir system operation and contracted, in part, to Region H entities.

Several entities located in Region H hold large water rights in the basin. Dow Chemical Company holds COA 12-5328, which authorizes 305,656 ac-ft/yr of diversions from the Brazos River, Oyster Creek, and Buffalo Camp Bayou for municipal, industrial, irrigation, and recreation purposes. The permit also authorizes storage in Dow's Harris Reservoir and Brazoria Reservoir. Dow Chemical is also responsible for diverting water used by Brazosport Water Authority (BWA).

Gulf Coast Water Authority (GCWA) holds multiple water rights in the basin. COA 12-5168 authorizes 99,932 ac-ft/yr in diversions from the Brazos River for municipal, industrial, and irrigation use, as well as 7,373 ac-ft of storage in two small reservoirs. COA 12-5171 authorizes the diversion of 125,000 ac-ft/yr from the Brazos River for municipal, industrial, irrigation, and mining purposes. GCWA also holds COA 12-5322, which authorizes 864 ac-ft of storage and the diversion of 155,000 ac-ft/yr from the Brazos River for municipal, industrial, and irrigation use.

COA 12-5325, held by NRG, authorizes storage in Smithers Lake and industrial use of 28,711 ac-ft/yr of flows from the Dry Creek tributary of Big Creek. NRG is also granted 40,000 ac-ft/yr of water rights from the Brazos River by COA 12-5320 for industrial and irrigation use.

BWA holds COA 12-5366, which authorizes the diversion of 45,000 ac-ft/yr from the Brazos River in Brazoria County for municipal use. As described above, these supplies are diverted from the Brazos River by Dow Chemical.

3.3.3.3 San Jacinto-Brazos Coastal Basin

The San Jacinto-Brazos Coastal Basin includes a combination of dense urban development, irrigated agriculture, and industry in Brazoria, Fort Bend, Harris, and Galveston Counties. Total run-of-river water rights in the basin total approximately 288,407 ac-ft/yr, excluding an authorization for Dow Chemical Company to divert 4,209,000 ac-ft/yr of saline water from the Freeport Harbor Channel. There are several major run-of-river water rights within the basin. The City of Sugar Land holds COA 11-5170, which authorizes diversion of 18,159 ac-ft/yr from Jones and Oyster Creeks for municipal, industrial, irrigation, and recreation uses. GCWA holds COA 11-5169, which authorizes 12,000 ac-ft/yr of diversion and approximately 8,925 ac-ft of storage. COA 11-5357, also held by GCWA, authorizes 57,500 ac-ft of diversion from Chocolate, Mustang, and Halls Bayous in Brazoria County. Both of these rights include provision for municipal, industrial, irrigation, and recreational uses.

3.3.3.4 San Jacinto River Basin

The San Jacinto River Basin includes a number of run-of-river water rights in addition to the rights associated with the storage and yield of Lakes Conroe and Houston. While the majority of these rights authorize diversions of 1,000 ac-ft/yr or less, there are 17 rights for authorizations exceeding this amount. The largest of these is COA 10-3994 held by OxyVinyls LP, which authorizes diversion of 140,000 ac-ft/yr for industrial use. The COH holds Permit 10-5826, (the Houston Bayous Permit), which authorizes the diversion of 130,000 ac-ft/yr of run-of-river supplies from Sims, Brays, Buffalo, and White Oak Bayous for municipal and industrial purposes. The Excess Flows Permit (Permit 10-5808) authorizes diversion of 80,000 ac-ft/yr of run-of-river flows at Lake Houston for municipal and industrial purposes; the permitted diversion amount is divided evenly between the COH and SJRA. COA 10-4964, also held by SJRA, authorizes diversion of 55,000 ac-ft/yr of run-of-river supply at Lake Houston for municipal, industrial, and irrigation use. This water right serves as the primary supply for the SJRA Highlands Canal System, which serves industrial users in eastern Harris County.

3.3.3.5 Trinity-San Jacinto Coastal Basin

The Trinity-San Jacinto Coastal Basin includes run-of-river water rights totaling approximately 44,474 ac-ft/yr for industrial and irrigation uses. The largest of these authorizations, COA 09-3926, is for 30,000 ac-ft/yr and is associated primarily with saline water at NRG's Cedar Bayou power generation facility.

3.3.3.6 Trinity River Basin

In addition to the yield of Lake Livingston, several entities within the Region H portion of the basin hold large water rights. COA 10-4261 grants the COH 45,000 ac-ft/yr of run-of-river rights from the Trinity River and the Old River tributary for municipal, industrial, and power generation use. COH also holds COA 10-4277, authorizing 38,000 ac-ft/yr of diversions for municipal, industrial, irrigation, and mining use. The Chambers-Liberty Counties Navigation District (CLCND) is authorized under COA 08-4279 to divert up to 112,947 ac-ft/yr from Turtle Bayou (Lake Anahuac) for municipal, industrial, irrigation, and mining uses. The right additionally authorizes 30,000 ac-ft/yr of diversion by SJRA. SJRA also holds 56,000 ac-ft/yr in water rights through partial ownership of COA 08-5271. The remaining 2,500 ac-ft/yr from COA 08-5271 is permitted to the Lower Neches Valley Authority (LNVA).

3.3.3.7 Neches-Trinity Coastal Basin

The portion of the Neches-Trinity Coastal Basin located within Region H includes run-of-river water right permits totaling 70,175 ac-ft/yr in permitted diversions. The largest individual right included (COA 07-4296) is the U.S. Fish and Wildlife Service water right for the Anahuac National Wildlife Refuge, which has a right for 21,000 ac-ft/yr. The remaining permits are authorized for irrigation, recreation, and wetland habitat uses.

3.3.3.8 Neches River Basin

Lake Sam Rayburn is located on the Neches River approximately 11 miles northwest of the City of Jasper in Region I. The lake is owned by the U.S. Army Corps of Engineers and operated by LNVA. Several entities in Region H receive supplies from the lake through contracts with LNVA, including the Trinity Bay Conservation District, Bolivar Peninsula SUD, and irrigators in Chambers and Liberty Counties. Region H receives run-of-river surface water from two small rights permitted for irrigation use in the Neches River Basin.

3.3.4 Local Supplies

Local supplies (stock ponds, small catchments, etc.) are currently used in Region H to meet a portion of livestock and mining demands. The TCEQ allows a landowner to impound up to 200 acre-feet of water without obtaining a water right, and therefore these supplies cannot be tied to specific water rights. Because these individual sources are generally undocumented and are typically unreliable under drought-of-record conditions, the Region H water plan does not include these local supplies in its analysis of existing surface water supplies.

3.3.5 Surface Water Availability

3.3.5.1 Surface Water Availability Modeling

Surface water availability was estimated using the TCEQ Water Availability Models (WAMs) for the river basins within Region H. The WAMs use the Water Rights Analysis Package (WRAP), developed at Texas A&M University, to simulate water right diversions using historical rainfall and evaporation data. The WAMs are not intended to serve as predictive tools but rather simulate the behavior of included water rights under a repeat of a certain period of historical hydrology. The model simulates a set of monthly diversion targets attempted annually against a historical inflow dataset, which is typically 50 years long and varies each year. The drought of record (DOR) for most of Texas occurred in the 1950s and is reflected in the historic dataset for each basin. Water diversions are modeled according to the parameters of each particular water right and are taken in priority order, such that the most senior water rights are satisfied before junior rights are allowed to divert water. It is important to note that the TCEQ WAMs are based on historic hydrologic data to account for rainfall and evaporation losses. While the model provides an approximation of water right availability during the DOR, the model does not predict water right availability in future droughts which may have different hydrologic conditions. The models generally do not include return flows that often increase the reliability of downstream water rights. The reliability of water rights that rely on reservoir storage is also based on assumed sedimentation rates that are projected through the planning period. While this assumption is reasonable for planning purposes, it may not reflect current near-term sedimentation rates. The models also contain assumptions in the internal modeling routines that affect the accuracy of results. Currently, the models are also not able to simulate the interaction between groundwater and surface water supplies.

There were originally eight WAM scenarios (referred to as model runs) simulated under the TCEQ program. TWDB's First Amended General Guidelines for Regional Water Plan Development requires the use of WAM Run 3, reflecting full authorized diversion of current water rights with no return flows, when determining the supply available to the region. Run 3 represents a conservative approach, since not all rightholders attempt to divert their full permit amount every year and diversions for municipal and manufacturing users typically return a portion of diverted water to streams as treated wastewater effluent. However, the majority of water rights do not address return flows to source streams, implying a right to full consumptive use. For this reason, and because the planning period extends 50 years into the future, use of a model reflecting full consumptive diversion by all rights is appropriate for long-term planning.

Output files are compared by reviewing the statistical frequency of meeting diversion amounts or target instream flow levels. For purposes of regional water planning, supply availability for a water right is limited to its firm yield, the amount of water that can be diverted every year of the WAM simulation period without shortage. Regional planning groups may elect to constrain availability of a water right to a value lower than the firm yield based on stakeholder / rightholder input, to maintain an added margin of safety for reservoir supplies, or for other considerations relevant to the supply.

While availability of surface water rights is determined on a right-by-right basis, the method of representing surface water supplies in DB22 is dependent on the nature of the right. Multiple reservoirs operated as a system are treated as a single source in the database, with supplemental information showing the contribution of firm yield associated with each component reservoir. Non-system reservoirs are listed individually. Run-of-river rights are typically aggregated into a single source for each county and river or coastal basin. The availabilities of these rights are based on the sum of the monthly diversions in the year of least availability. This approach reflects the way in which run-of-river rights in Region H are typically combined as part of an overall water portfolio that allows the use of these supplies with other more firm rights to provide a greater overall firm yield. Many water rights are modeled in the TCEQ WAMs as run-of-river rights without storage although storage is in place for these supplies to guard against the risks of low-flow conditions on critical water supplies. Often, these rights are also backed up with firm contracts from upstream reservoirs.

Specific information on modeling procedures and availability results for each basin in Region H are described in greater detail in the following subsections. Availability of existing water supplies is summarized in ***Appendix DB***. Additional reference information regarding the models executed for surface water availability estimation, including documentation of hydrologic modeling variances, is available in ***Appendix 3-B***. A comprehensive list of water rights used as a basis for determining the availability of surface water in Region H is contained in ***Appendix 3-C***.

3.3.5.2 Brazos-Colorado Coastal Basin

Surface water supplies for the Brazos-Colorado Coastal Basin were analyzed using a modified version of the TCEQ Run 3 WAM for the Colorado and Brazos-Colorado basins (02/01/2008 TCEQ release). Region H identified several opportunities to adjust model code to facilitate determination of firm yield and reflect annual streamflow diversion limits as specified in water right permits. These changes included modeling of complex multi-cell off-channel reservoir facilities as composite storage, application of streamside diversion limits where applicable to off-channel storage, and application of iterative firm yield analysis to a large off-channel impoundment. A variance to apply these modifications to the Region H RWP analysis was requested by the RHWPG and approved by TWDB.

Of the 65,455 ac-ft permitted within the Region H portion of the basin, 11,729 ac-ft were determined to be firm for regional planning purposes. An additional 136 ac-ft of firm yield held by the US Fish and Wildlife Service was not included, as the wetlands maintenance use specified for the permit is likely outside of the demand projected for Region H.

3.3.5.3 Brazos River Basin

Surface water supplies for the Brazos River Basin were analyzed using a modified version of the TCEQ Run 3 WAM for the Brazos and San Jacinto-Brazos basins developed by the Brazos G Regional Water Planning Group (Region G). Brazos G developed models for year 2020 and year 2070 conditions, which include modifications to extend the modeled period of record, reflect existing subordination agreements, and incorporate some return flows, as well as other changes. Revision of the TCEQ WAM by Brazos G was approved by TWDB. Due to the importance of maintaining consistency in availability analyses for the basin, the RHWPG requested and received from TWDB a variance to use the modified Brazos G model as a basis for evaluation of surface water in Region H. Supplies were assessed for years 2020 and 2070 conditions, with results used to linearly interpolate availabilities for years 2030 through 2060. The firm portion of run-of-river diversions was found to be 453,420 ac-ft/yr for year 2020 conditions and 451,132 ac-ft/yr for year 2070 conditions. Additionally, eight entities in Region H receive supplies through non-interruptible water supply contracts with BRA, with a reliable year 2070 yield of 163,450 ac-ft/yr.

3.3.5.4 San Jacinto-Brazos Coastal Basin

Surface water supplies for the San Jacinto-Brazos Coastal Basin were analyzed using a modified version of the TCEQ Run 3 WAM for the Brazos and San Jacinto Brazos basins developed by Region G as discussed in *Section 3.3.5.3*. Supplies were assessed for years 2020 and 2070 conditions, with results used to linearly interpolate availabilities for years 2030 through 2060. 38,827 ac-ft/yr of run-of-river supply was found to be firm for year 2020 through year 2070 conditions. Of this yield, 21,568 ac-ft/yr is associated with multi-use permits held by GCWA and the City of Sugar Land, with the rest of the firm yield coming from a number of irrigation water rights.

3.3.5.5 San Jacinto River Basin

Surface water supplies for the San Jacinto River Basin were analyzed using the most recent version of the TCEQ Run 3 WAM for the basin (09/24/2014 TCEQ release). A total of 12,627 ac-ft/yr of run-of-river supply was found to be firm. The San Jacinto River Basin also includes major reservoir supplies associated with Lake Conroe and Lake Houston. Reservoirs reduce the velocity of the streams they impound, causing suspended soil particles to settle; over time, storage volume is lost due to this accumulation. Therefore, sedimentation rates were determined and applied to Lake Houston and Lake Conroe to calculate estimated year 2020 through year 2070 storage volumes at ten-year intervals. For each sedimentation condition, the target diversion for each reservoir was iteratively reduced until a firm yield was determined, with the diversion target for other reservoir modeled at its permitted amount. The modeled available yield of Lake Houston was 176,800 ac-ft/yr for year 2020 conditions, decreasing to 156,400 ac-ft/yr for year 2070 conditions due to sedimentation. The modeled firm yield of Lake Conroe was 79,500 ac-ft/yr for year 2020 sedimentation, decreasing slightly to 75,600 ac-ft/yr for year 2070 conditions.

3.3.5.6 Trinity-San Jacinto Coastal Basin

Surface water supplies for the Trinity-San Jacinto Coastal Basin were analyzed using the TCEQ Run 3 WAM for the basin (01/02/2013 version). Of the 14,474 ac-ft/yr in permitted run-of-river rights included in the WAM, 5,537 ac-ft/yr were found to be firm under DOR conditions. An additional 30,000 ac-ft/yr permitted by COA 09-3926 is excluded from the WAM and from availability for regional planning purposes as the diversion point is subject to salinity impacts due to tidal influence.

3.3.5.7 Trinity River Basin

Surface water supplies for the Trinity River Basin were analyzed using a modified version of the TCEQ Run 3 WAM for the basin (11/27/2017 TCEQ release) developed by the Region C Regional Water Planning Group (Region C) and subsequently adapted to Region H. The models developed by Region C include modifications to incorporate major water right amendments granted by TCEQ but not yet integrated into the WAM, code adjustments to reflect operation of groups of reservoirs as systems, adjustment of pool elevations where appropriate, adjustment of complex reservoir code to facilitate firm yield determination where applicable, as well as other changes. Revision of the TCEQ WAM by Region C was approved by TWDB. Due to the importance of maintaining consistency in availability analyses for the basin, the RHWPG requested and received from TWDB a variance to use the modified Region C model as a basis for evaluation of surface water in Region H.

The RHWPG has adopted the use of a modified Run 3 model for determining firm yield in the lower Trinity River Basin in the 2001, 2006, 2011, and 2016 RWPs. These models included a limited quantity of return flows in the upper basin expected to be available for future conditions as determined through correspondence with the Region C Planning Group. The RHWPG therefore requested and received from TWDB variance to include a limited quantity of return flows in the Trinity River Basin for evaluation of firm reservoir diversions. Return flows were not incorporated into the analysis of reliable run-of-river availability in the basin.

A total of 137,252 ac-ft/yr in run-of-river water was determined to be firm under DOR conditions. A small portion of this yield (1,077 ac-ft/yr) is held by irrigators and state agencies in Leon, Liberty, Madison, and Walker Counties. The remainder is associated with large water rights owned by the COH, SJRA, and CLCND. The modeled firm yield of Lake Livingston, which included estimated future sedimentation, was 1,326,000 ac-ft/yr for year 2020 sedimentation, decreasing slightly to 1,275,900 ac-ft/yr for year 2070 conditions.

3.3.5.8 Neches-Trinity Coastal Basin

Surface supplies in the Neches-Trinity Coastal River Basin were modeled using the TCEQ WAM Run 3 model for the basin (01/02/2013 TCEQ release). Of the water right permits totaling 70,175 ac-ft/yr from the Neches-Trinity coastal basin in Region H, 37,481 ac-ft/yr were reliable during the DOR. Approximately one-third of this firm total is the U.S. Fish and Wildlife Service water right for the Anahuac National Wildlife Refuge.

3.3.5.9 Neches River Basin

Surface supplies in the Neches River Basin were modeled using the TCEQ WAM Run 3 model for the basin (10/01/2012 TCEQ release). Of the water right permits totaling 1,604 ac-ft/yr from the Neches River Basin in Region H, 176 ac-ft/yr were reliable during the DOR. Entities in Region H also utilize contractual supplies originating in the Neches River Basin outside of the Region H boundary, including water from the Lake Sam Rayburn / B.A. Steinhagen Reservoir System. Surface water availability for the remaining Neches River Basin and the Lake Sam Rayburn / B.A. Steinhagen Reservoir System was determined by the East Texas Water Planning Group (Region I). Applicable supplies utilized by entities in Region H are reflected in DB22 as the contract amounts between LNVA and individual WUGs.

3.4 REUSE SOURCES

3.4.1 Reuse Overview

The reuse of existing water sources allows entities to increase their available supply portfolio and, in some cases, replace or defer more expensive projects to develop new supplies. Reuse, or reclaimed supply, is typically classified as either direct or indirect. Direct reuse infrastructure diverts return flows from a wastewater treatment facility at some point in the treatment train and conveys the water to points of use. The required infrastructure and level of treatment are dependent upon the intended use. Indirect reuse typically involves discharge of treated wastewater from one facility into a receiving body, with the receiving stream used to convey the treated water for subsequent diversion at a downstream point.

The permitting process and regulatory requirements for reuse in the State are dependent on whether the water is for municipal or industrial purposes, the intended use, and if the supply is direct or indirect. Permitting of reclaimed supplies is administered by TCEQ. All types of reuse are subject to the requirements of 30 TAC §210. If an indirect reuse supply is to be discharged into a State watercourse, it will also require a water right authorization similar to other surface water sources and will be subject to water rights restrictions and subject to the prior appropriation system.

3.4.2 Reuse Availability

Determination of the reliable availability of reclaimed supplies presents several challenges. Permitted reuse amounts cannot be assumed to be fully reliable as existing supplies, as permitted volumes may exceed current return flow levels and permitted indirect reuse is subject to curtailment during times of drought. Even in communities or industries with longstanding direct reuse programs, the amount of reclaimed water utilized can vary considerably from year to year based on hydrologic conditions, patterns of indoor versus outdoor water use, or industrial facility production. Reuse potential also changes over time with population. Existing reuse water supplies were estimated for Region H based on data provided by TWDB, stakeholder input, and known infrastructure limitations. In order to estimate appropriate reliable reuse supplies, the following procedure was applied as the primary method for identifying reuse availability:

- Year 2007 through 2017 data was extracted from the TWDB Water Use Survey for entities in Region H with reclaimed supplies, and each entity was associated with the appropriate WUG.
- For each WUG, volumes of self-supplied reuse were calculated by year for direct and indirect reuse sources.

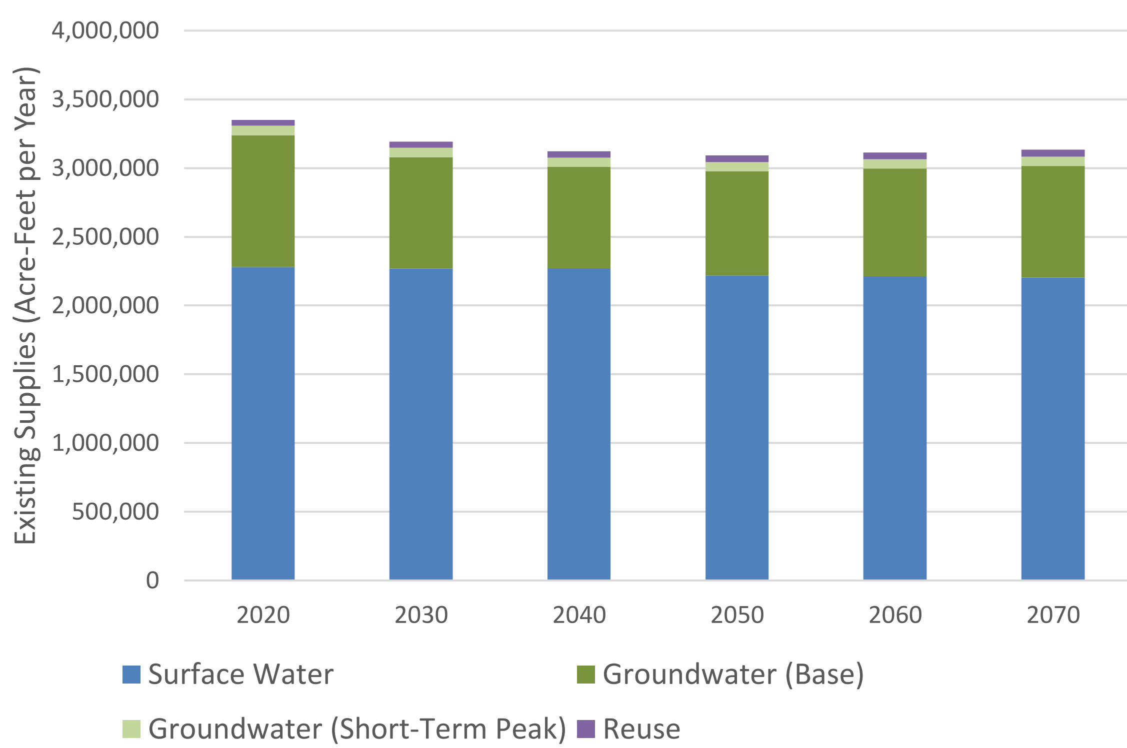
- For WUGs with intermittent reuse or no reported reuse in the last several years of the dataset, reuse supplies were assumed to not be firm.
- For Manufacturing WUGs with reported reuse supplies in recent years, reuse availability was estimated as the maximum value from years 2007 through 2017. Due to the dependence of recorded volumes on the number of entities reporting in a given year and the overall growth in manufacturing in the region, this is intended to provide a conservative estimate of manufacturing reuse availability.
- For WUGS with recently developed reuse supplies or with longer-term utilization without frequent supply declines, reuse availability was estimated as the maximum value from years 2007 through 2017.

Consideration was also given to other data sources, as available, including records of reclaimed water sales and analyses from the 2016 Region H RWP. Several municipal WUG reuse supplies were also identified from stakeholder responses to a Region H survey of municipal WUGs.

3.5 TOTAL REGIONAL WATER AVAILABILITY

Combined, the availability of water supplies within Region H is adequate to provide for a large number of existing demands. However, it is noteworthy that the availability of supply at the source level does not necessarily translate to availability at the WUG level. The applicability of these supplies to meeting specific demands based on contracts and existing infrastructure are considered in *Section 3.6*. The total supply availability from sources originating in Region H is shown in *Figure 3-4*. Availability of existing water supplies is summarized in ***Appendix DB***.

Figure 3-4 – Total Regional Water Availability by Source Type



3.6 MAJOR WATER PROVIDERS AND MAJOR SUPPLY CONTRACTS

Region H depends on a large number of supply contracts among entities ranging from small utility districts to large river authorities and other wholesale water providers (WWPs) to meet the demands of both municipal and non-municipal users. As part of the evaluation process for the RWP and in accordance with TWDB requirements, the RHWPG developed a methodology to identify Major Water Providers (MWPs), entities which function as critical links in the regional supply chain. Region H elected to utilize supply volume as the key metric in this designation, with consideration given to existing self-supply and contractual transfers as well as potential future supplies from recommended Water Management Strategies (WMS). Entities with current or anticipated supply volumes of 25,000 ac-ft/yr or greater were categorized as MWPs. Of the 24 entities categorized as MWPs through this methodology, 21 serve users within the region, while the other three (BRA, LNVA, and TRA) provide supplies to Region H from their primary region. Over half of the MWPs in Region H are also WUGs, including cities and regional water authorities which serve their own needs as well as those of their contract customers. It should be noted that, while certain entities have been formally categorized as MWPs, all water suppliers are recognized as playing a vital role in meeting the region's complex and growing water demands. The MWPs supplying Region H are discussed in greater detail in the following subsections.

3.6.1 Brazosport Water Authority

BWA's service area includes treated water customers in the southern portion of Brazoria County including seven municipalities, Dow Chemical, and two prison units. BWA is supplied by its own water right through the Harris and Brazoria Reservoirs. BWA provides raw surface water to the following WUG and WWP entities:

- City of Angleton
- City of Brazoria
- City of Clute
- City of Freeport
- City of Lake Jackson
- City of Oyster Creek
- City of Richwood
- City of Rosenberg (treats raw water for transmission to Rosenberg)
- Dow Chemical USA
- Texas Department of Criminal Justice Ramsey Area

3.6.2 Brazos River Authority

BRA operates multiple reservoirs and holds a substantial portion of the water rights in the Brazos River Basin. BRA provides raw surface water to the following WUG and WWP entities:

- City of Manvel
- City of Richmond
- City of Rosenberg
- City of Sugar Land
- Dow Chemical USA
- GCWA
- Irrigation in Waller County (Brazos River Basin)

- Manufacturing in Brazoria County (Brazos and San Jacinto-Brazos Basins)
- Manufacturing in Galveston County (San Jacinto-Brazos Basin)
- NRG
- Pecan Grove MUD

3.6.3 Chambers-Liberty Counties Navigation District

The CLCND provides raw water through its canal system to the City of Anahuac, the Trinity Bay Conservation District, and irrigators in Chambers County. CLCND is supplied through its own water rights from the Trinity River and Lake Anahuac.

3.6.4 City of Conroe

The City of Conroe is among the largest municipalities in Montgomery County and provides water to its own municipal service are as well as surrounding communities in the County-Other WUG in Montgomery. The City also has a contractual agreement to provide indirect reuse supplies to Porter SUD. Conroe utilizes self-supplied groundwater and treated surface water purchased from SJRA.

3.6.5 City of Galveston

The City of Galveston purchases wholesale treated water from GCWA, which is conveyed from GCWA's Thomas Mackey Water Treatment Plant to Galveston Island via pipeline. This water is used to meet needs for the city. Galveston also supplies the following WUGS:

- City of Jamaica Beach
- County-Other in Brazoria County (San Jacinto-Brazos Basin)
- County-Other in Galveston County (San Jacinto-Brazos Basin)
- Manufacturing in Galveston County (San Jacinto-Brazos Basin)

3.6.6 City of Houston

The COH is the most populous WUG in Region H. Major surface water supplies held by COH include majority ownership of the firm yield of Lakes Conroe, Houston, and Livingston. COH also owns run-of-river water rights. In the Trinity River Basin, COH holds two major water rights permitted for industrial, irrigation, and other uses. COH also holds water rights authorizing withdrawals from several bayous in the San Jacinto Basin and diversion of excess run-of-river flows at Lake Houston (shared permit with SJRA). Additional permitted sources include both direct and indirect reuse. COH also produces groundwater which is primarily used to meet its own demands but also makes up a small portion of the supply to other customers through either direct supply of groundwater or blending with other supply sources. COH's WUG and WWP customers include:

- Baybrook MUD #1
- Baytown Area Water Authority
- City of Bellaire
- City of Bunker Hill Village
- City of Deer Park
- City of Friendswood
- City of Galena Park

- City of Hilshire Village
- City of Humble
- City of Jacinto City
- City of Jersey Village
- City of League City
- City of Pasadena
- City of Pearland
- City of South Houston
- City of Southside Place
- City of Spring Valley
- City of Webster
- City of West University Place
- Central Harris County Regional Water Authority
- Chimney Hill MUD
- Clear Brook City MUD
- Clear Lake City Water Authority
- County-Other in Harris County (multiple utility districts)
- Greenwood Utility District
- Harris County MUDs #5, 6, 8, 23, 49, 55, 96, 148, 158, 278, 321, 344, 372, 412, and 420
- Irrigation in Chambers and Liberty Counties
- La Porte Area Water Authority
- Manufacturing in Chambers County (Trinity-San Jacinto Basin)
- Manufacturing in Harris County
- Memorial Villages Water Authority
- Montgomery County MUD #98
- North Channel Water Authority
- North Fort Bend Water Authority
- North Harris County Regional Water Authority
- NRG
- Parkway MUD
- Pine Village PUD
- Rolling Fork PUD
- Sagemeadow Utility District
- SJRA
- Southwest Harris County MUD #1
- Steam-Electric Power in Harris County
- Sunbelt FWSD
- West Harris County Regional Water Authority

3.6.7 City of Huntsville

The City of Huntsville provides water to its own municipal service are as well as surrounding communities in the County-Other WUG in Walker County. The city's water demands are met partially with self-supplied groundwater. Huntsville also receives surface water from a contract with TRA through the Huntsville Regional Water Supply System, of which a portion is conveyed to manufacturing demands outside of Region H. The city also provides indirect reuse supplies to Montgomery County MUDs 8 and 9.

3.6.8 City of League City

The City of League City supplies water to a large population of customers within its own boundaries. League City utilizes self-supplied groundwater as well as water purchased from the COH and GCWA.

3.6.9 City of Missouri City

The City of Missouri City supplies water to customers within its own boundaries as well as to numerous other municipal water providers in Fort Bend County. Missouri City utilizes self-supplied groundwater as well as water purchased from GCWA.

3.6.10 City of Pasadena

The City of Pasadena supplies water to customers within its own boundaries as well as to the City of Seabrook (which in turn provides water to the City of El Lago) and manufacturing located in Harris County. Pasadena utilizes self-supplied groundwater as well as water purchased from the COH.

3.6.11 City of Pearland

The City of Pearland occupies portions of Harris, Fort Bend, and Brazoria counties and supplies water to a large population of customers within its own boundaries. Pearland utilizes self-supplied groundwater as well as water purchased from the COH and also has supply agreements with GCWA.

3.6.12 City of Sugar Land

The City of Sugar Land supplies water to customers within its own boundaries as well as to users in its extra-territorial jurisdiction including Fort Bend MUD #128 and portions of County-Other in Fort Bend County. In addition to self-supplied groundwater and surface water, the city has contracts with both GCWA and BRA for surface water supply.

3.6.13 City of Texas City

The City of Texas City supplies water to customers within its own boundaries as well as to industrial customers in Galveston County. Texas City utilizes some self-supplied groundwater as well as surface water purchased from GCWA.

3.6.14 Clear Lake City Water Authority

CLCWA obtains its water supplies through a contract with the COH. CLCWA provides water supply to WUGs in southeast Harris County, including:

- City of Nassau Bay
- City of Webster
- Clear Lake City Water Authority WUG
- Harris County WCID #156
- Manufacturing in Harris County (San Jacinto-Brazos Basin)

3.6.15 Dow Chemical USA

Dow Chemical is supplied primarily by its own water rights on the lower Brazos River, with the ability to receive a smaller amount of water through a contract with BRA. Dow supplies manufacturing demands in Brazoria County, including its own facilities.

3.6.16 Gulf Coast Water Authority

GCWA is a major water provider to municipal, manufacturing, and irrigation users in the San Jacinto-Brazos and lower Brazos Basins. GCWA provides raw water to users in Fort Bend, Brazoria, and Galveston Counties through an extensive canal network. Treated water is also supplied through a pipeline system to a number of users in Galveston County. GCWA is primarily supplied by its own rights on the Brazos River, with additional supplies purchased through a contract with BRA. WUGs with supply contracts from GCWA include:

- Bacliff MUD
- Bayview MUD
- City of Galveston
- City of Hitchcock
- City of La Marque
- City of League City
- City of Missouri City (raw)
- City of Pearland (raw)
- City of Sugar Land (raw)
- City of Texas City
- Fort Bend County WCID #2 (raw)
- Galveston County FWSD #6
- Galveston County MUD #12
- Galveston County WCID #1
- Galveston County WCID #8
- Galveston County WCD #12
- Irrigation in Fort Bend, Brazoria, and Galveston Counties (raw)
- Manufacturing in Brazoria and Galveston Counties (raw)
- Pecan Grove MUD #1 (raw)
- San Leon MUD

3.6.17 Lower Neches Valley Authority

LNVA holds rights to both reservoir yield and run-of-river supplies in the Neches River Basin and serves customers through an extensive canal system in Jefferson, Chambers, and Liberty County. LNVA also owns a portion of the water rights from the former Devers Canal Company. LNVA customers in Region H include:

- Bolivar Peninsula SUD
- Irrigation in Chambers County (Neches-Trinity Basin)
- Irrigation in Liberty County (Neches-Trinity Basin)
- Trinity Bay Conservation District

3.6.18 North Fort Bend Water Authority

North Fort Bend Water Authority (NFBWA) provides water supply to communities in northern Fort Bend County and a small portion of western Harris County. Member districts of NFBWA are partially supplied through their own groundwater production. NFBWA also purchases water from the COH to meet demands within its service area.

3.6.19 North Harris County Regional Water Authority

North Harris County Regional Water Authority (NHCRWA) provides water supply to communities in northern and northwestern Harris County north of the COH. Member districts of NHCRWA are partially supplied through their own groundwater production. NHCRWA also purchases water from the COH to meet demands within its service area.

3.6.20 NRG

NRG operates several steam-electric power generation facilities within Region H, as well as providing water supply to other power generation and irrigation water users. In the eastern portion of the region, NRG is supplied largely by its own water right in the Trinity-San Jacinto Basin and by groundwater, as well as through contract with COH. In Fort Bend County, NRG is supplied through a combination of its own Brazos River Basin rights, groundwater, and a contract with BRA. WUGs served by NRG include:

- Irrigation in Fort Bend County (Brazos Basin)
- Steam-Electric Power in Chambers County (Trinity-San Jacinto Basin)
- Steam-Electric Power in Fort Bend County (Brazos Basin)
- Steam-Electric Power in Harris County (San Jacinto Basin)

3.6.21 San Jacinto River Authority

SJRA acts as a major water provider in Harris and Montgomery Counties. SJRA holds partial ownership of the Lake Conroe water right, which it uses to serve irrigation and power generation customers as well as participants in the SJRA Joint GRP in Montgomery County. SJRA serves as the water provider to The Woodlands, supplying the community's demands through a combination of groundwater and surface water. SJRA also holds run-of-river rights in the San Jacinto and Trinity Basins and a portion of Lake Houston reservoir supply, which are used to meet municipal, manufacturing, and irrigation demands in Harris County through SJRA's Highlands Canal system. SJRA's customers include:

- City of Conroe
- City of Oak Ridge North
- Crosby MUD
- Harris County MUD #50
- Irrigation in Harris County (San Jacinto Basin)
- Irrigation in Montgomery County (San Jacinto Basin)
- Manufacturing in Harris County (Trinity-San Jacinto Basin)
- Montgomery County MUD #99
- MSEC Enterprises
- Newport MUD

- Rayford Road MUD
- Southern Montgomery County MUD
- Steam-Electric Power in Montgomery County
- The Woodlands

3.6.22 The Woodlands

The Woodlands supplies water to customers within its own boundaries as well as to Harris-Montgomery Counties MUD 386. The Woodlands water system is operated by SJRA, which provides groundwater and surface water supply.

3.6.23 Trinity River Authority

TRA holds a number of water rights in the Trinity River Basin and provides supply to several planning areas, including Region H. Contracts from TRA to entities in Region H are associated exclusively with TRA's share of the Lake Livingston permit. Supplied entities in Region H include:

- City of Groveton
- City of Houston
- City of Huntsville
- City of Livingston
- City of Trinity
- County-Other in Polk County (Trinity Basin)
- County-Other in Trinity County (Trinity Basin)
- Glendale WSC
- Irrigation in Chambers County (Neches-Trinity Basin)
- Irrigation in Liberty County (Trinity and Neches-Trinity Basins)
- Irrigation in San Jacinto County (Trinity Basin)
- Lake Livingston Water Supply & Sewer Service Company
- Memorial Point Utility District
- Mining in Polk County (Trinity Basin)
- Riverside WSC
- San Jacinto SUD
- Trinity Rural WSC
- Waterwood MUD #1
- Westwood Shores MUD

3.6.24 West Harris County Regional Water Authority

West Harris County Regional Water Authority (WHCRWA) provides water supply to communities in western and northwestern Harris County. Member districts of WHCRWA are partially supplied through their own groundwater production. WHCRWA also purchases water from the COH to meet demands within its service area.

3.7 ASSIGNMENT OF SOURCES

The assignment of existing available water supplies to WWPs and WUGs within Region H requires consideration of many potential sources of information and the application of multiple supply allocation processes to account for differences in physical, contractual, and regulatory constraints across the region. The processes associated with allocation of reuse supplies and assignment of water right yield to owning entities can be applied in a simple and consistent manner across the region. Contractual supply arrangements vary in complexity from simple, single-source agreements with a defined volume to more complex arrangements with open-ended commitments, potential for source blending, indirect rearrangement of supplies, or contracts limited by source availability. Assignment of groundwater resources is particularly complex as groundwater available to an individual WUG is not driven by a set of water rights but rather can be influenced by local groundwater regulation, WUG pumping capacity, and overall availability of groundwater in an area relative to the demand for the resource. The procedures applied in assigning existing water supplies, along with the information considered in each process, are discussed in greater detail in the following subsections. Existing water supplies assigned to each WUG are summarized in ***Appendix DB***. Water supplies provided by MWPs to each category of water use are summarized in ***Appendix 3-D***.

3.7.1 Groundwater

Due to the complexity of groundwater supplies in Region H, including the use of several groundwater formations and the presence of multiple entities with regulatory authority, assignment of groundwater resources in the Regional Plan cannot follow a single rigid methodology for all counties. While some counties have the ability to meet much or all of their projected demand with groundwater, others are limited by hydrogeological conditions or regulatory factors. As such, the process of assignment of existing groundwater supplies to individual WUGs was performed on a county-by-county basis and included consideration of a broad variety of factors, including TWDB-supplied MAG values, historical water use, groundwater production capacity, projected water demand, regulatory requirements of GCDs or subsidence districts, and ongoing implementation of GRPs. Groundwater allocation strategies are discussed in greater detail in the following subsections.

3.7.1.1 Counties within Subsidence Districts

As noted in the section on groundwater availability, allowable groundwater pumpage in Fort Bend, Harris, and Galveston Counties is determined by the regulatory requirements established by the FBSD and the HGSD. These Districts have established several regulatory sub-areas, with allowable groundwater pumpage within these sub-areas limited to a certain percentage of an entity's overall water use. For certain sub-areas, these percentages also reduce over time. Entities are allowed to enter into GRPs that allow for regional compliance with groundwater regulation to maximize efficiency in goal attainment. Multiple entities may participate together in a joint GRP, with some converting wholly or partially to alternative water sources and allowing others to continue growth on groundwater so long as the composite use by participating entities meets regulatory restrictions. These regulations served as the primary driver of the following groundwater allocation procedure:

1. A geospatial analysis was performed to determine the sub-area(s) associated with each WUG. Each WUG county-basin split was assigned the sub-area in which it had the greatest coverage. The majority of WUGs were in a single regulatory sub-area.

2. Certain large WUG county-basin splits were determined to be of such size that assignment of a single sub-area was inadequate to capture regulatory availability correctly. In these cases, a further spatial analysis of the projected Census block level population within each regulatory sub-area was performed, with population used to develop ratios of demand for subsets of the WUG county-basin split. This methodology was applied for the COH in Harris County, County-Other in Harris County, and County-Other within the Brazos Basin for Fort Bend County.
3. Projected water demands for each WUG county-basin split were multiplied by the percentage of allowable groundwater for the appropriate regulatory sub-area to calculate a preliminary value of allowable groundwater pumpage.
4. For WUGs which do not produce their own groundwater but rather purchase groundwater supplies from another entity, allowable groundwater pumpage volumes were reassigned from the purchasing WUG to the supplying WUG.
5. Allowable groundwater pumpage amounts were reassigned among joint GRP participants. If specific volumes of conversion or allowed groundwater expansion for currently implemented GRP stages were known, these values were used. Otherwise, for participants continuing growth on groundwater sources, the difference between projected demand and allowable pumpage was calculated and then deducted from allowable pumpage for entities converting to alternative water supplies.
6. Allowable groundwater pumpage amounts were further constrained by existing groundwater production capacities. Because of the historical reliance of the coastal counties in Region H on groundwater and a longer history of urbanization, this impacted a limited number of WUGs, primarily in Fort Bend and Galveston counties. These WUGS tended to be either non-municipal uses with limited historical use of groundwater and younger or smaller municipal developments anticipated to experience substantial growth in demand in the future.

3.7.1.2 Montgomery County

Groundwater production in Montgomery County is determined by the regulatory requirements established by the LSGCD. The LSGCD District Regulatory Plan (as amended December 8, 2015) requires large volume groundwater users (LVGUs), defined as entities producing 10,000,000 gallons or more of groundwater, to reduce their groundwater production to not more than 70 percent of their Total Qualifying Demand (TQD, equivalent to permitted Year 2009 groundwater pumpage). A judgement by the 284th District Court in Montgomery County subsequently found LSGCD's rule requiring a reduction in pumpage by LVGUs to be invalid. However, at the time of evaluation of existing supplies for the 2021 Regional Water Plan, a revised District Regulatory Plan had not been adopted by LSGCD.

A large portion of the initial infrastructure associated with the GRPs in the county has been developed, and many of the systems with GRPs or participating in Joint GRPs have continued to do so. Further, no responses indicating cancellation or abandonment of GRP programs was received as part of the Region H WUG Survey. In order to properly reflect current and anticipated GRP infrastructure and measures in the RWP, the Region H RWP assumes that systems formerly categorized as LVGUs will continue to adhere to the requirements established by the December 8, 2015 District Regulatory Plan for LSGCD.

Because this approach is based on a reference value rather than a demand percentage, estimates of existing allowable pumpage in Montgomery County remain level over time. LSGCD provided flexibility in methods for achieving the mandated groundwater reduction, including granting early conversion credits to entities converting before specific dates and allowing entities to meet their reduction goals in composite form through joint GRPs. Additionally, water systems were allowed to produce groundwater in excess of 70 percent of their TQD in some years, provided that their average production from year 2016 through year 2045 meets the conversion requirement. These assumptions were applied through the following groundwater allocation procedure:

1. The WUG associated with each LVGU was identified through a geospatial analysis. Certain WUGS, particularly County-Other and non-municipal WUGs, were typically associated with multiple LVGUs.
2. A preliminary estimate of allowable groundwater pumpage was calculated for each LVGU by multiplying its TQD by 70 percent.
3. After preliminary calculations, portions of allowable groundwater pumpage for some LVGUs were reassigned in accordance with relevant GRPs.
4. No changes were made for GRPs relying solely on conservation or allowing shortages.
5. For small joint GRPs with a strategy of basic underconversion and overconversion of constituent LVGUs, excess pumpage from underconverting participants was deducted from allowable pumpage by overconverting participants.
6. For entities relying upon self-generated or purchased early conversion credits, allowable groundwater pumpage was increased under the assumption that such credits would be depleted at a constant rate between 2016 and 2045. After 2045, availabilities for these entities reverted to the preliminary estimate.
7. The SJRA Joint GRP involved several steps based on participant type and base allowable pumpage. Allowable pumpage for participants converting partially to surface water were assigned based on their Year 2016 target conversion percentage. For participants remaining on groundwater with base allowable pumpage sufficient to meet Year 2020 projected demands, no changes were made. For participants remaining on groundwater with base allowable pumpage below Year 2020 projected demands, allowable pumpage was increased to 2020 demands and confirmation was made that composite allowable groundwater use across joint GRP participants did not exceed 70 percent of the composite TQD.
8. Allowable pumpage, as determined in steps 1 through 3, was rolled up to the WUG level. Because some WUGs include both LVGU and non-LVGU entities, total allowable pumpage for these entities was set equal to the sum of LVGU allowable pumpage and Year 2020 projected WUG demand less the TQD of LVGUs within the WUG to prevent double counting. This impacted non-municipal WUGs and County-Other.
9. Availability of named WUGs which are not currently LVGUs was set to 31 ac-ft/yr for each WUG, or approximately 10,000,000 gallons per year.

Because groundwater availability in the Regional Plan for Montgomery County is limited to the peaked MAG, each WUG's share of the peaked MAG was calculated by dividing its allowable pumpage as calculated in steps 1 through 5 above by the total allowable pumpage for all WUGs in the county and multiplying the resultant percentage by the peaked MAG.

3.7.1.3 Other Counties

In accordance with TWDB requirements, groundwater availability for other areas within the region were set equal to the MAG, or in the case of counties and formations for which a MAG Peak Factor was approved, to the peaked MAG. Availabilities for aquifers deemed non-relevant for the GMA process were set by the RWPG as described in *Section 3.2.4*. The following procedure was applied in the allocation process:

1. WUGs with groundwater infrastructure were identified from TWDB's Historical Groundwater Use records, the TCEQ Water Utility Database (WUD), responses to the Region H WUG Survey, or other information as available.
2. Identification of the source groundwater formation or formations for each WUG within the county was determined using data from TWDB's Historical Groundwater Use records. In cases where source formation was listed as unknown or information on the WUG was unavailable, source formation was estimated from WUG location.
3. Maximum existing groundwater production capacity for each WUG was estimated. Available sources of information on production capacity varied by WUG, with the least restrictive (highest estimated groundwater production capability) applied as the WUG limit. Primary references included Region H WUG Survey responses, listed production capacities from TCEQ's WUD, or maximum historical pumpage for years 2000-2015 calculated from TWDB's Historical Groundwater Use records.
4. In the event that adequate data was not available from the preferred data sources, groundwater production capacity was assumed to be equal to estimated year 2020 demands under drought conditions. This situation was most commonly associated with Irrigation, Livestock, and Mining WUGs for which records of reported pumpage are often unable to capture all users and hence the full extent of existing infrastructure capacity. In a few cases with minimal projected demand growth after year 2020, existing groundwater production was assumed to fully meet WUG demand.
5. For WUGs with both surface and groundwater supplies, available surface water was deducted from the portion of projected demand assigned to groundwater.
6. Groundwater from the appropriate source formation was allocated to each WUG in an amount not to exceed the lesser of the projected demand for each decade and the estimated groundwater production capacity. In the limited number of cases of a WUG selling groundwater to another, consideration was given to the demands of the customer WUG as well.

3.7.2 Surface Water

Surface water sources included as existing supplies in the Regional Plan are associated with permanent water rights granted by the TCEQ. As such, reliable (firm) supplies from both reservoir and run-of-river sources were allocated to specific right holders in accordance to the terms of each water right. Large water rights in the region are typically held by WWPs or named WUGs; smaller rights are generally held by non-municipal entities (irrigation, manufacturing, etc.) and were allocated to the appropriate non-municipal WUG based on use type and location of demand. For purposes of the Regional Planning process, run-of-river water rights are also grouped in the Plan by basin and county of origin. Total run-of-river diversions assigned as existing supplies in the 2021 RWP are listed by county, basin, and use type in ***Appendix 3-E***.

3.7.3 Reuse

The existing reliable yield of reuse sources in Region H were determined in accordance with the procedures previously described in the section regarding reuse availability. The majority of existing reuse supplies in the region are direct reuse systems and were therefore allocated to their originating WUG. Indirect reuse sources currently in place were also assumed to be used to meet demands within the originating WUGs or its customers.

3.7.4 Contracts

Contractual supplies were assigned in accordance with the most recent available information regarding contractual relationships, contract volume or maximum, limitations on existing conveyance infrastructure, and source. Sources of information included the Region H WUG survey, stakeholder correspondence, available information on service area boundaries, and the 2016 Region H RWP. The majority of contracts reflected in the Plan consist of the transfers as discussed in *Section 3.6* among major and wholesale providers and from these entities to WUGs. While contractual supply agreements among utility districts and similar entities are common in Region H, only a relatively small number are reflected in the Plan as the majority of these transfers occur internal to either a regional water authority WUG or County-Other WUG and therefore do not need to be reflected separately in the plan.

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CHAPTER 4
ANALYSIS OF NEEDS

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Chapter 4 – Analysis of Needs

4.1 INTRODUCTION

Identification of entities with projected water needs (shortages) and quantification of those needs is a key component of the Regional Planning process, facilitating evaluation and recommendation of water management strategies of the appropriate location and magnitude. Due to its geographic extent, large population, diverse economic base, and complex water supply portfolio, projected needs in Region H occur for a broad range of locations and water use categories. Although some of these needs are associated with the development of new water supplies that produce new sources of raw water, many of the shortages identified require only the development of infrastructure to finish water to the required level of quality (water treatment) or transmission infrastructure to deliver it to the point of demand (conveyance).

4.2 IDENTIFICATION OF NEEDS

4.2.1 Methodology

Projected water demands for all Water User Groups (WUGs) within Region H were assessed as part of Task 2 of the 2021 Regional Water Planning (RWP) process, as described in ***Chapter 2***. Identification and allocation of existing water supplies was performed under Task 3, with volumes reflecting source availability, legal and regulatory limits, and contractual arrangements. Needs or surpluses were then determined by comparing existing supplies to projected demands on a WUG-by-WUG basis, with values for each WUG further characterized by county and river basin. This process was executed by Texas Water Development Board (TWDB) based on data entered into the DB22 planning database. Information from DB22 was also used to compile projected needs by Major Water Provider (MWP).

Projected shortages for a WUG or other provider may occur for a number of reasons. Reliability of existing supplies is a significant factor in determining needs, as the RWP only considers the fully reliable (firm) availability of sources to enable appropriate planning for meeting demands under drought conditions. Additionally, access to the reliable portion of an existing source may be limited by water rights, regulatory constraints, contracts, or the existing infrastructure in place to extract, convey, or treat supplies. For many WUGs, needs are also impacted by projected growth in demand which exceeds current supply availability. In some cases, needs may also be influenced by declining availability of a supply over time due to regulation (for example, regulations limiting groundwater pumpage to a certain percentage of demand) or physical factors (declining quality, reservoir sedimentation, etc.).

4.2.2 Summary of Needs

Projected needs and surpluses for MWPs are summarized in ***Appendix 4-A,*** and projected needs and surpluses for all WUGs in Region H are included in ***Appendix DB***. Projected needs by water use type are summarized in *Table 4-1* and *Figure 4-1*, with needs by river basin summarized in *Table 4-2* and *Figure 4-2*. Note that the values shown in these tables represent total needs, with any surpluses reflected as zero. Also, please note that the values for Polk and Trinity Counties only reflect the portions of those counties within Region H. The geographic location and magnitude of needs throughout the region are shown in *Figure 4-3* through *Figure 4-8*.

Figure 4-1 – Projected Needs by Water Use Type

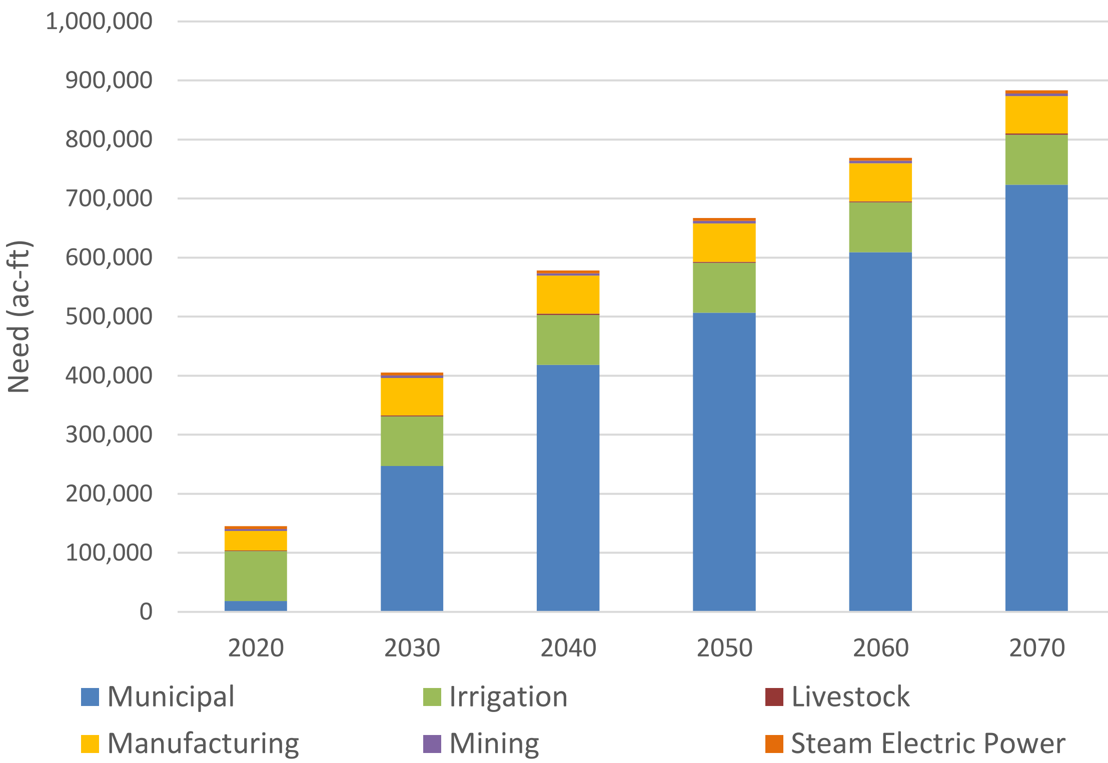


Figure 4-2 – Projected Needs by Basin

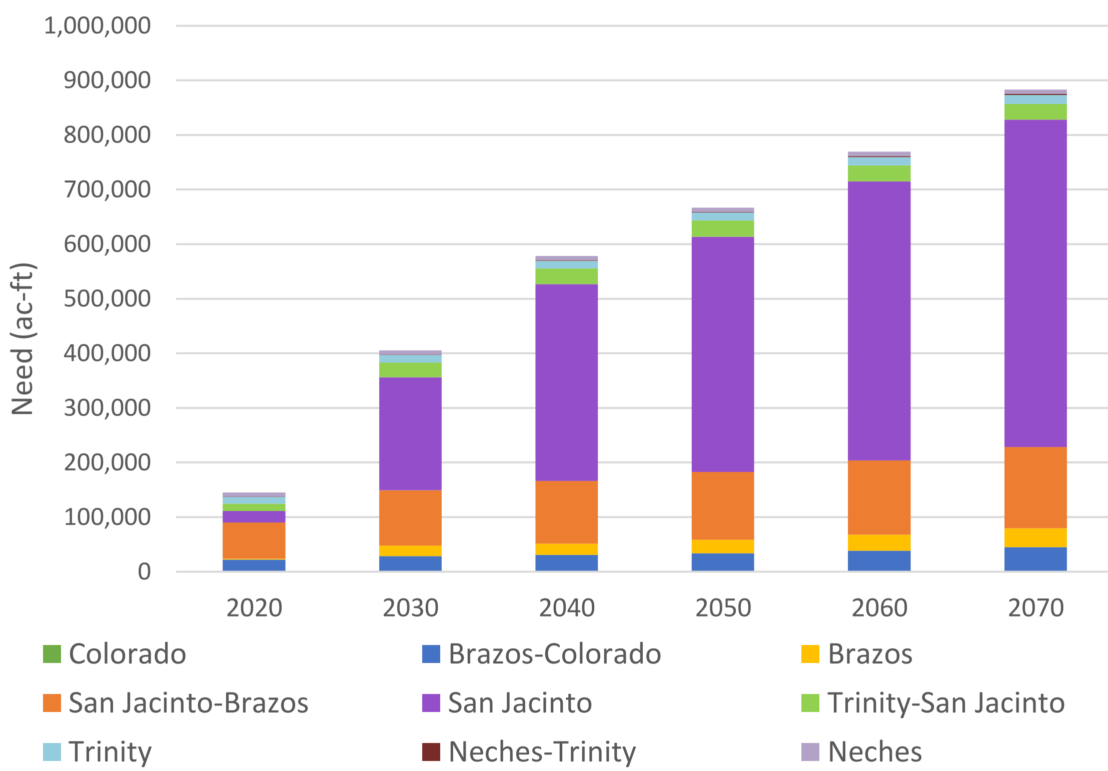


Table 4-1 – Projected Needs by County and Water Use Type (acre-feet per year)

	2020	2030	2040	2050	2060	2070
Austin						
Irrigation	0	0	0	0	0	0
Livestock	0	0	0	0	0	0
Manufacturing	0	0	0	0	0	0
Mining	0	193	130	67	5	0
Municipal	0	212	584	1,047	1,578	2,177
Total	0	405	714	1,114	1,583	2,177
Brazoria						
Irrigation	57,717	57,717	57,717	57,717	57,717	57,800
Livestock	0	0	0	0	0	8
Manufacturing	21,772	27,812	27,812	27,812	27,812	27,855
Mining	0	221	421	641	874	1,163
Municipal	0	2,223	6,667	11,794	17,702	24,383
Total	79,489	87,973	92,617	97,964	104,105	111,209
Chambers						
Irrigation	12,572	12,572	12,572	12,572	12,572	12,572
Livestock	0	0	0	0	0	0
Manufacturing	2,753	3,452	3,452	3,452	3,452	3,452
Mining	0	0	0	0	0	0
Municipal	410	753	1,676	2,909	4,249	5,662
Steam Electric Power	1,387	1,387	1,387	1,387	1,387	1,387
Total	17,122	18,164	19,087	20,320	21,660	23,073
Fort Bend						
Irrigation	0	0	0	0	0	0
Livestock	0	0	0	0	0	0
Manufacturing	256	1,086	1,086	1,086	1,086	1,086
Mining	4	10	7	5	4	2
Municipal	1,584	64,133	80,093	93,291	107,927	122,510
Steam Electric Power	0	0	0	0	0	0
Total	1,844	65,229	81,186	94,382	109,017	123,598

	2020	2030	2040	2050	2060	2070
Galveston						
Irrigation	4,804	4,804	4,804	4,804	4,804	4,804
Livestock	237	237	237	237	237	237
Manufacturing	138	9,394	9,420	9,445	9,472	9,497
Mining	343	368	405	437	468	500
Municipal	2,416	2,868	3,114	3,403	3,739	4,926
Total	7,938	17,671	17,980	18,326	18,720	19,964
Harris						
Irrigation	0	0	0	0	0	0
Livestock	484	867	1,123	1,123	1,123	1,123
Manufacturing	7,404	20,900	21,962	22,731	21,907	20,903
Mining	2,946	2,927	2,875	2,843	2,818	2,798
Municipal	6,767	148,438	272,886	308,752	348,418	389,992
Steam Electric Power	3,581	3,581	3,581	3,581	3,581	3,581
Total	21,182	176,713	302,427	339,030	377,847	418,397
Leon						
Irrigation	0	0	0	0	0	0
Livestock	0	0	0	0	0	0
Manufacturing	0	143	143	143	143	143
Mining	0	79	0	0	0	0
Municipal	0	0	0	0	0	0
Total	0	222	143	143	143	143
Liberty						
Irrigation	9,344	9,344	9,344	9,344	9,344	9,344
Livestock	538	538	538	538	538	538
Manufacturing	0	0	0	0	0	0
Mining	0	20	9	31	59	102
Municipal	0	18	40	64	89	116
Total	9,882	9,920	9,931	9,977	10,030	10,100
Madison						
Irrigation	0	0	0	0	0	0
Livestock	0	0	0	0	0	0
Mining	0	375	157	0	0	0
Municipal	0	0	0	0	0	0
Total	0	375	157	0	0	0

	2020	2030	2040	2050	2060	2070
Montgomery						
Irrigation	0	0	0	0	0	0
Livestock	0	0	0	0	0	0
Manufacturing	292	570	570	570	570	570
Mining	0	0	0	0	0	0
Municipal	6,720	27,075	51,824	82,948	122,189	169,417
Steam Electric Power	0	0	0	0	0	0
Total	7,012	27,645	52,394	83,518	122,759	169,987
Polk						
Irrigation	0	0	0	0	0	0
Livestock	0	0	0	0	0	0
Manufacturing	0	0	0	0	0	0
Mining	0	0	0	0	0	0
Municipal	0	0	0	0	0	0
Total	0	0	0	0	0	0
San Jacinto						
Irrigation	0	0	0	0	0	0
Livestock	0	0	0	0	0	0
Manufacturing	0	0	0	0	0	0
Mining	0	0	0	0	0	0
Municipal	0	0	0	0	0	0
Total	0	0	0	0	0	0
Trinity						
Irrigation	0	0	0	0	0	0
Livestock	0	0	0	0	0	0
Mining	0	0	0	0	0	0
Municipal	0	0	0	0	0	0
Total	0	0	0	0	0	0
Walker						
Irrigation	0	0	0	0	0	0
Livestock	0	0	0	0	0	0
Manufacturing	0	0	0	0	0	0
Mining	0	0	0	0	0	0
Municipal	0	0	0	0	0	0
Total	0	0	0	0	0	0

	2020	2030	2040	2050	2060	2070
Waller						
Irrigation	18	18	18	18	18	18
Livestock	0	0	0	0	0	0
Manufacturing	0	0	0	0	0	0
Mining	0	0	0	0	0	0
Municipal	635	1,108	1,660	2,325	3,243	4,470
Total	653	1,126	1,678	2,343	3,261	4,488
Region H Total						
Irrigation	84,455	84,455	84,455	84,455	84,455	84,538
Livestock	1,259	1,642	1,898	1,898	1,898	1,906
Manufacturing	32,615	63,357	64,445	65,239	64,442	63,506
Mining	3,293	4,193	4,004	4,024	4,228	4,565
Municipal	18,532	246,828	418,544	506,533	609,134	723,653
Steam Electric Power	4,968	4,968	4,968	4,968	4,968	4,968
Total	145,122	405,443	578,314	667,117	769,125	883,136

Table 4-2 – Projected Needs by County and River Basin (acre-feet per year)

	2020	2030	2040	2050	2060	2070
Austin						
Brazos	0	357	604	923	1,297	1,766
Brazos-Colorado	0	45	108	190	286	408
Colorado	0	3	2	1	0	3
Total	0	405	714	1,114	1,583	2,177
Brazoria						
San Jacinto-Brazos	57,528	59,223	63,157	67,789	73,047	78,985
Brazos	51	82	110	140	310	586
Brazos-Colorado	21,910	28,668	29,350	30,035	30,748	31,638
Total	79,489	87,973	92,617	97,964	104,105	111,209
Chambers						
Neches-Trinity	326	598	888	1,215	1,578	1,963
Trinity	12,229	12,999	13,503	14,219	14,992	15,806
Trinity-San Jacinto	4,567	4,567	4,696	4,886	5,090	5,304
Total	17,122	18,164	19,087	20,320	21,660	23,073
Fort Bend						
San Jacinto	165	25,738	32,512	36,169	38,264	39,508
San Jacinto-Brazos	174	21,385	28,084	32,138	37,065	40,942
Brazos	1,505	18,106	19,316	22,317	26,280	30,392
Brazos-Colorado	0	0	1,274	3,758	7,408	12,756
Total	1,844	65,229	81,186	94,382	109,017	123,598
Galveston						
Neches-Trinity	127	134	143	151	160	170
San Jacinto-Brazos	7,811	17,537	17,837	18,175	18,560	19,794
Total	7,938	17,671	17,980	18,326	18,720	19,964
Harris						
Trinity-San Jacinto	8,329	22,161	23,662	24,741	24,207	23,495
San Jacinto	12,284	151,194	273,371	308,148	346,198	386,075
San Jacinto-Brazos	569	3,358	5,394	6,141	7,442	8,827
Total	21,182	176,713	302,427	339,030	377,847	418,397
Leon						
Trinity	0	198	143	143	143	143
Brazos	0	24	0	0	0	0
Total	0	222	143	143	143	143

	2020	2030	2040	2050	2060	2070
Liberty						
Neches	7,699	7,701	7,700	7,703	7,706	7,711
Neches-Trinity	30	31	30	32	33	35
Trinity	323	353	368	404	446	500
Trinity-San Jacinto	36	37	37	38	40	42
San Jacinto	1,794	1,798	1,796	1,800	1,805	1,812
Total	9,882	9,920	9,931	9,977	10,030	10,100
Madison						
Trinity	0	300	126	0	0	0
Brazos	0	75	31	0	0	0
Total	0	375	157	0	0	0
Montgomery						
San Jacinto	7,012	27,645	52,394	83,518	122,759	169,987
Total	7,012	27,645	52,394	83,518	122,759	169,987
Polk						
Trinity	0	0	0	0	0	0
Total	0	0	0	0	0	0
San Jacinto						
Trinity	0	0	0	0	0	0
San Jacinto	0	0	0	0	0	0
Total	0	0	0	0	0	0
Trinity						
Trinity	0	0	0	0	0	0
Total	0	0	0	0	0	0
Walker						
Trinity	0	0	0	0	0	0
San Jacinto	0	0	0	0	0	0
Total	0	0	0	0	0	0
Waller						
San Jacinto	369	597	863	1,195	1,693	2,237
Brazos	284	529	815	1,148	1,568	2,251
Total	653	1,126	1,678	2,343	3,261	4,488

	2020	2030	2040	2050	2060	2070
Region H Total						
Neches	7,699	7,701	7,700	7,703	7,706	7,711
Neches-Trinity	483	763	1,061	1,398	1,771	2,168
Trinity	12,552	13,850	14,140	14,766	15,581	16,449
Trinity-San Jacinto	12,932	26,765	28,395	29,665	29,337	28,841
San Jacinto	21,624	206,972	360,936	430,830	510,719	599,619
San Jacinto-Brazos	66,082	101,503	114,472	124,243	136,114	148,548
Brazos	1,840	19,173	20,876	24,528	29,455	34,995
Brazos-Colorado	21,910	28,713	30,732	33,983	38,442	44,802
Colorado	0	3	2	1	0	3
Total	145,122	405,443	578,314	667,117	769,125	883,136

Figure 4-3 – Location of Identified 2020 WUG Needs

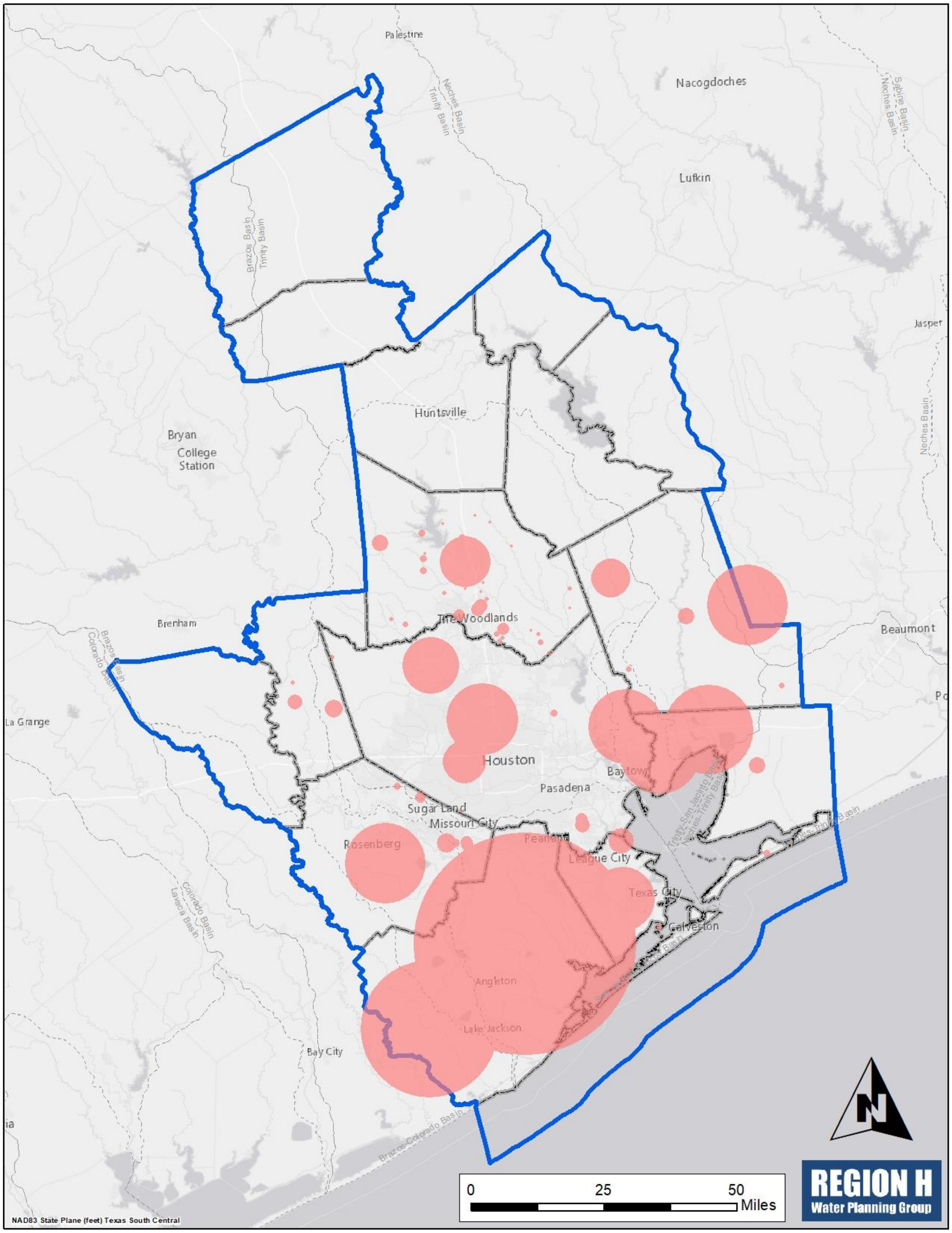


Figure 4-4 – Location of Identified 2030 WUG Needs

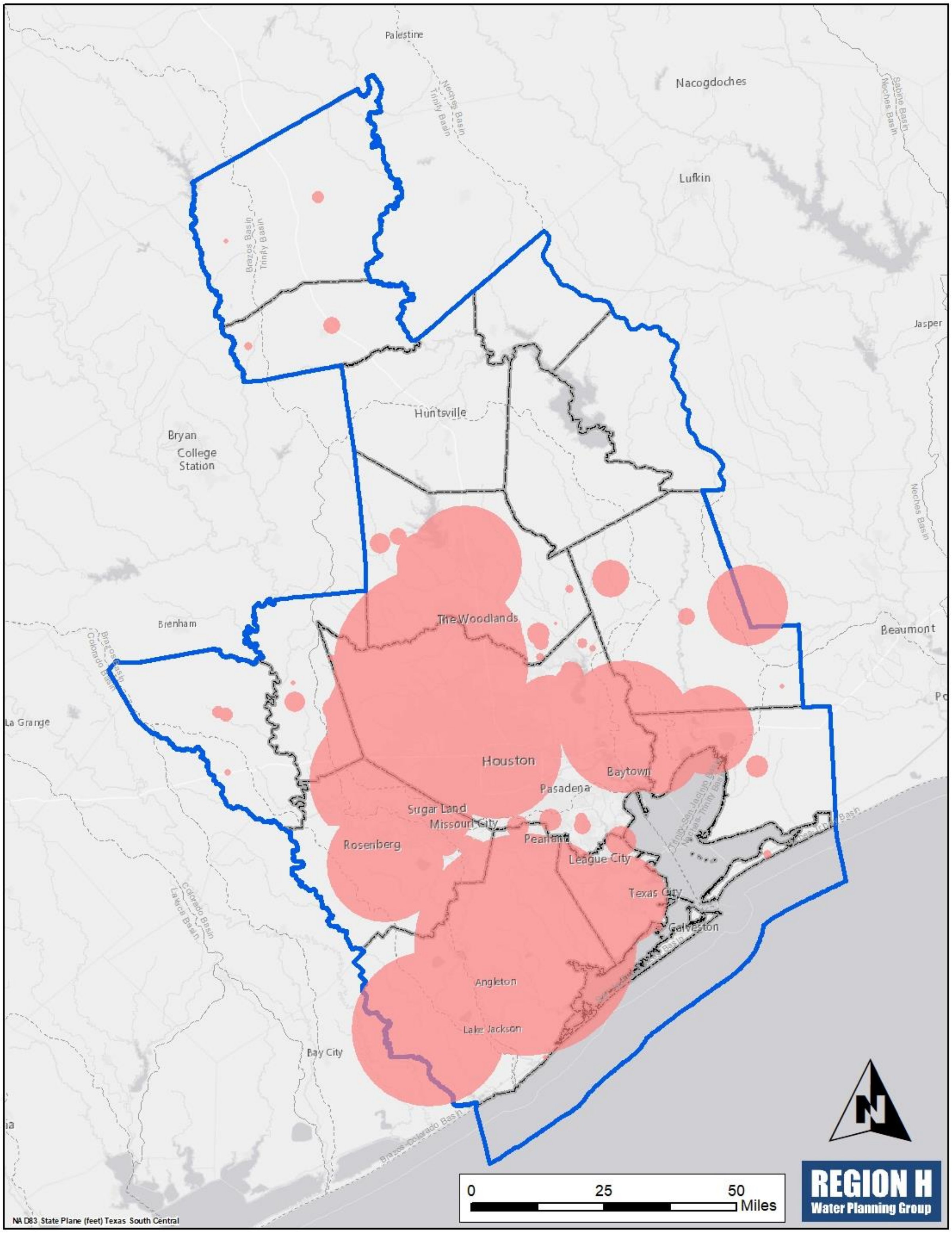


Figure 4-5 – Location of Identified 2040 WUG Needs

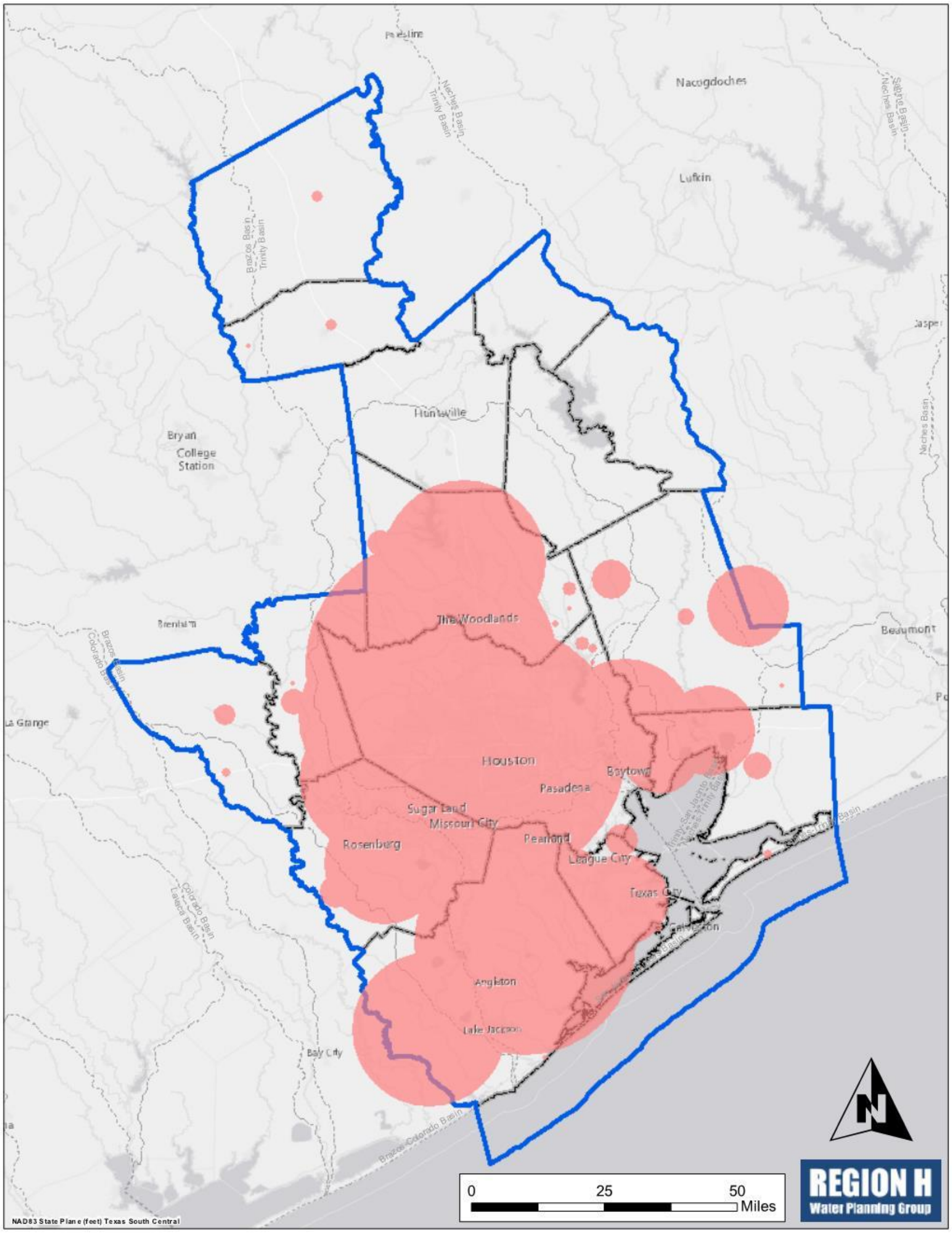


Figure 4-6 – Location of Identified 2050 WUG Needs

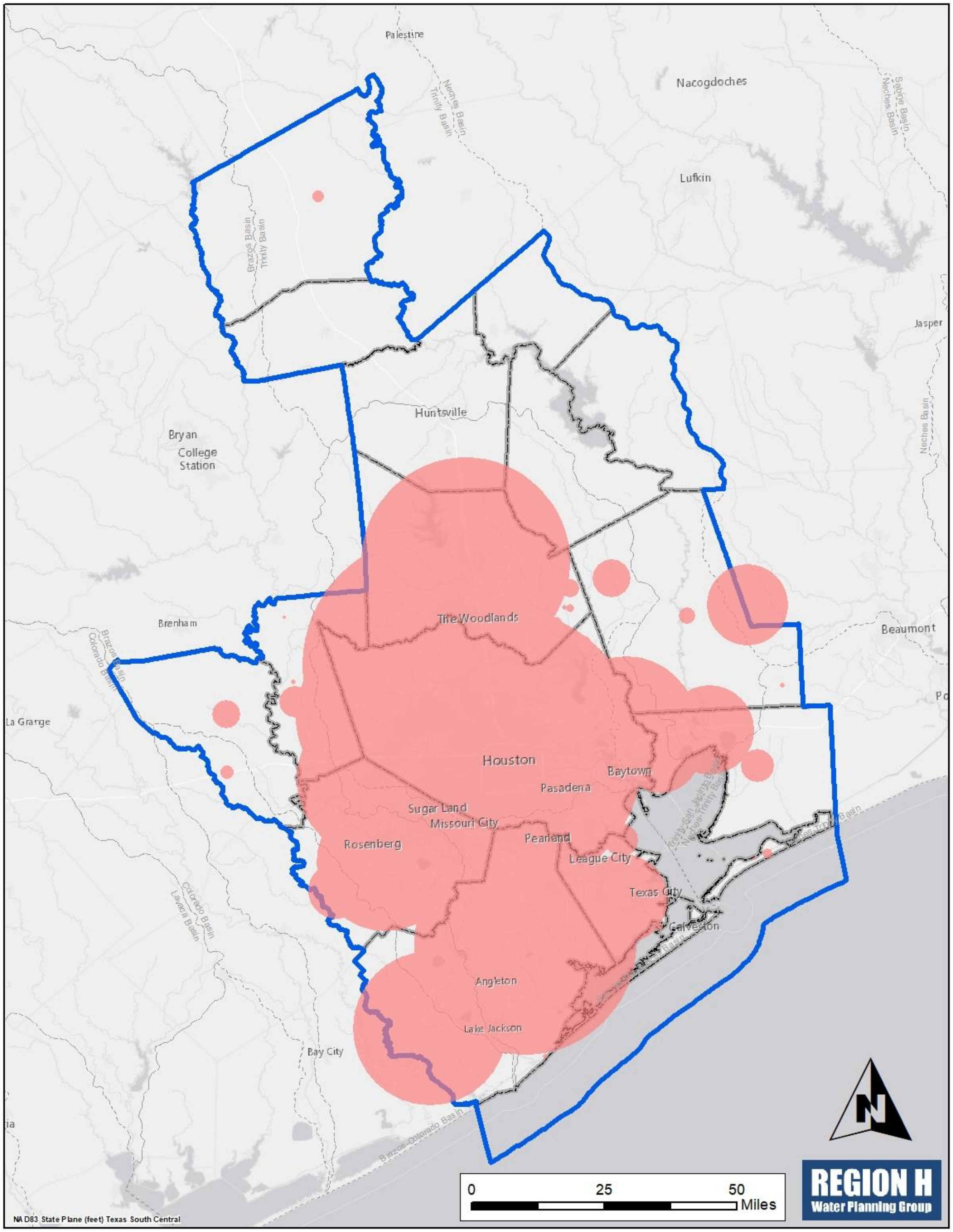


Figure 4-7 – Location of Identified 2060 WUG Needs

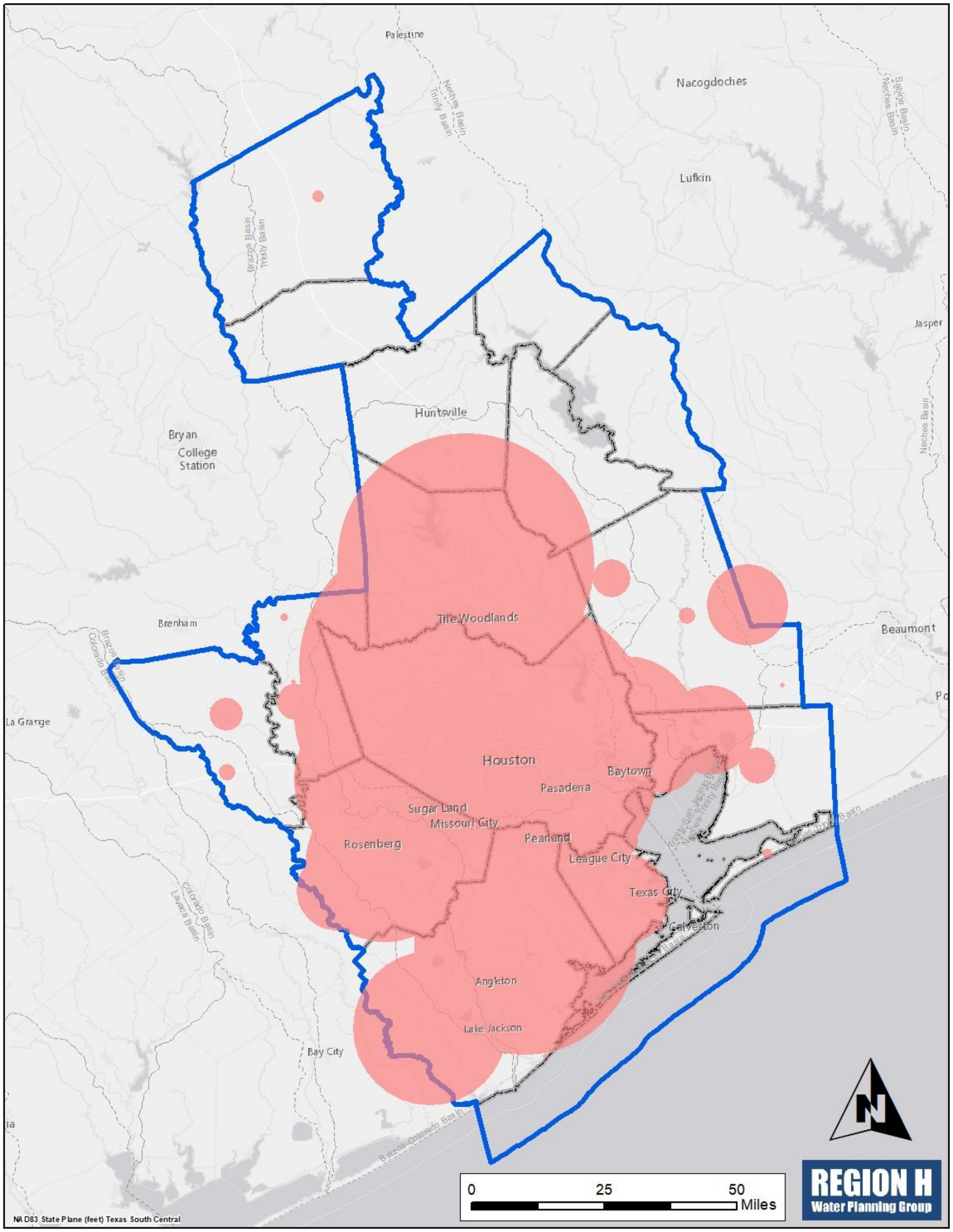
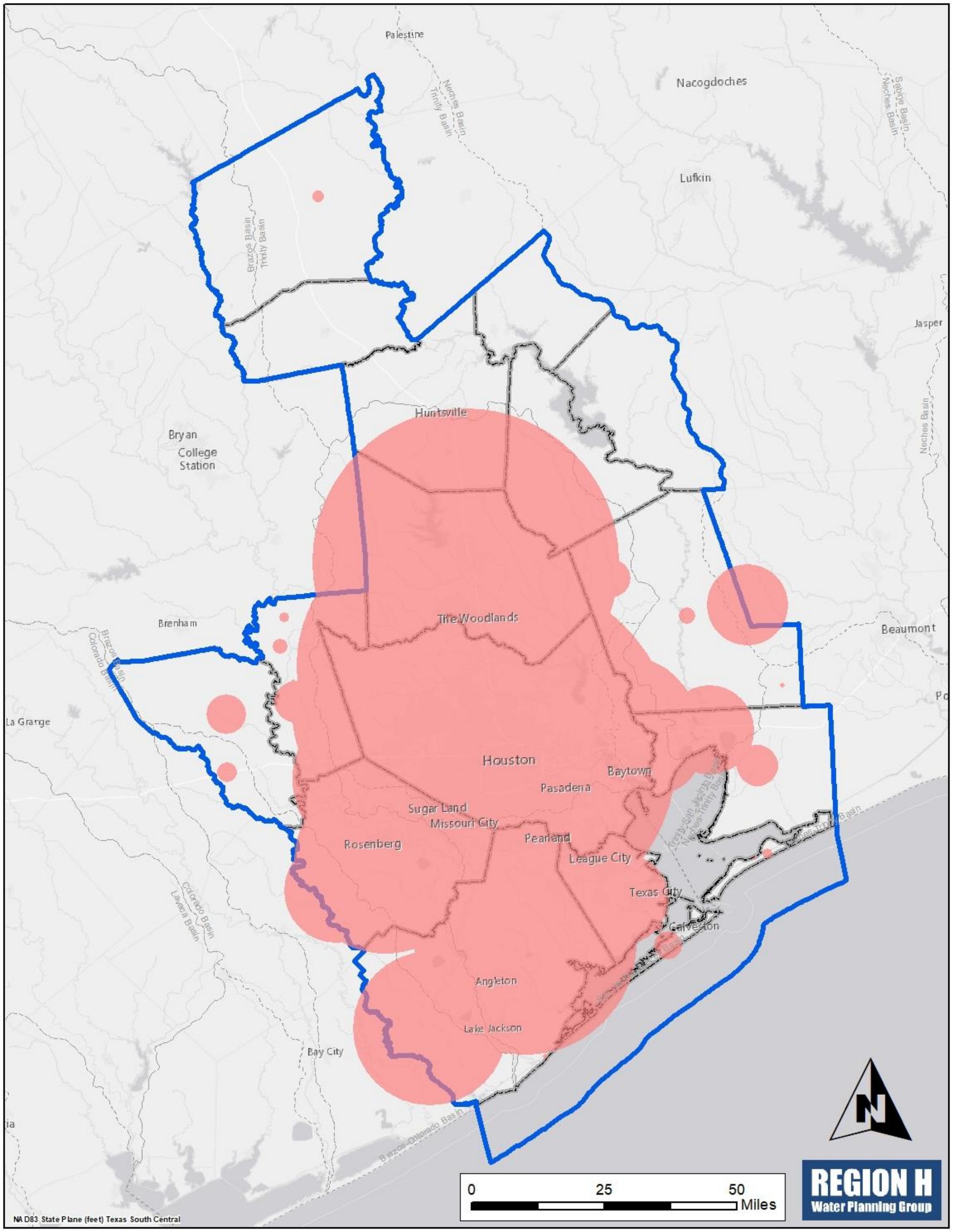


Figure 4-8 – Location of Identified 2070 WUG Needs



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CHAPTER 5
WATER MANAGEMENT STRATEGIES

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Chapter 5 – Water Management Strategies

5.1 INTRODUCTION

As a growing region with expanding populations and increased economic development, Region H projects substantial needs over the planning horizon through the 2070 decade. However, through the application of Water Management Strategies (WMS), critical needs can be met through the development of infrastructure and operational approaches to ensure a safe, reliable water supply for decades to come.

This chapter examines approaches to meeting the needs identified in ***Chapter 4*** of this Regional Water Plan (RWP). The WMS evaluated in this chapter are applied on a Water User Group (WUG)-level basis in order to collectively meet the needs of the region. This evaluation is primarily intended to compile the individual planning efforts for near-term projects that are being implemented by Wholesale Water Providers (WWPs) and WUGs and to verify their consistency with regional goals. Subsequent to the assessment of projects currently planned by sponsors, this analysis aims to evaluate options for meeting long-term needs that that are outside of the near-term focus of regional providers.

The Region H Water Planning Group (RHWPG) was assisted in this effort by the members of the Region H Water Management Strategy Committee. Members of this committee are listed below in *Table 5-1*.

Table 5-1 – Region H Water Management Strategy Committee Members

Water Management Strategy Committee	
Member	**Organization**
Robert Hebert (Chair)	Robert Hebert and Associates
John Bartos (Vice-Chair)	Galveston Bay Foundation
Robert Bruner	Walker County
Brad Brunett	Brazos River Authority
Mark Evans (non-voting)	North Harris County Regional Water Authority
Yvonne Forest	City of Houston
Jace Houston	San Jacinto River Authority
Ivan Langford	Gulf Coast Water Authority
Glenn Lord	Dow Chemical
Jimmie Schindewolf	North Harris County Regional Water Authority
Michael Turco	Harris-Galveston Subsidence District
J. Kevin Ward	Trinity River Authority

Also, to provide consistency and facilitate the compilation of the different regional plans, the Texas Water Development Board (TWDB) required the incorporation of this data into a standardized online database referred to as DB22. The results of the analyses described below can be found in detail within DB22 and are attached to the RWP in ***Appendix DB*** and ***Appendix 5-A***. The following sections describe procedures for evaluation of WMS, potentially feasible WMS, and recommended and alternative WMS applied to WUG needs in Region H.

5.2 REQUIREMENTS

Regional Water Planning Groups (RWPGs) shall identify and evaluate potentially feasible WMS for each WUG and WWP where future water supply needs exist (as required by statute and administrative rules Title 31 Texas Administrative Code (TAC) §357.34; 357.35). A need for water is identified when existing water supplies are less than projected water demands for a given WUG within any planning decade. If no potentially feasible WMS are identified or recommended the RWP shall document the reason.

As required by Texas Water Code (TWC) 16.053(e)(5), the regional water plans shall consider, but not be limited to, the following potentially feasible water management strategies for all identified water needs:

- improved conservation;
- reuse;
- management of existing water supplies;
- conjunctive use;
- acquisition of available existing water supplies;
- development of new water supplies;
- developing regional water supply facilities or providing regional management of water supply facilities;
- voluntary transfer of water within the region using, but not limited to, regional water banks, sales, leases, options, subordination agreements, and financing agreements;
- emergency transfer of water under Section 11.139; and
- developing large-scale desalination facilities for marine seawater and/or brackish groundwater.

The RWP shall include:

- the documented process used by the RWPG to identify potentially feasible WMS; and,
- the list of all identified WMS that were considered potentially feasible for meeting a need in the region per 31 TAC 357.12(b). Potentially feasible WMS shall include those listed above and may also include, but is not limited to, those listed in 31 TAC 357.34(c).

All potentially feasible WMS must be evaluated in accordance with 31 TAC 357.34.

This information shall be included in Chapter 5 of the RWP along with additional narrative description and other relevant materials and documentation associated with the RWPG's identification of potentially feasible WMS considered for the region.

As necessary, RWPGs shall update or redevelop any previous WMS evaluations (e.g., developed for other RWPs) to: meet current rule and guidance requirements, reflect changed physical or socioeconomic conditions that have since occurred, reflect changes in water project configurations or conditions, consider newly identified WUGs or WWPs, or to accommodate changes in identified water needs.

Beginning with the 4th cycle of RWP development, the concept of a “project” has been used to describe specific infrastructure used to increase or manage water supplies. Projects may be associated with one or more WMS and, similarly, a WMS may leverage one or more projects. The methodologies discussed below for the evaluation of WMS is equally applicable to projects and has been used as such.

5.3 STRATEGY EVALUATION METHODOLOGY

Evaluation of WMS and associated projects for inclusion in the Region H RWP requires consideration of a wide range of data from a number of sources. Depending on the information available, Region H may adapt information directly from detailed studies developed by project sponsors or develop a high-level analysis of a concept for inclusion in the RWP. In other cases, Region H has performed more in-depth planning studies to evaluate the potential of projects that may yield great regional benefits to water supply. Each of these approaches requires adherence to applicable standards set forth in guidance for regional planning.

5.3.1 Supply Quantity and Reliability

Water supply volumes should take into account the supply conditions set forth in the guidance for RWP development. For groundwater sources, this includes the use of estimates of Modeled Available Groundwater (MAGs) for appropriate formations that have been assigned a Desired Future Condition (DFC) through the Groundwater Management Area (GMA) process. Groundwater availability for formations with a DFC may be augmented by MAG Peak Factors applied to MAG values based on analysis by the RHWPG and contingent on approval by the associated Groundwater Conservation District (GCD) and GMA, as well as TWDB. These peak factors reflect increased pumping in a drought year that is still consistent with meeting the DFCs, as compared to the long-term average represented by the MAG.

Surface water resources are evaluated using the Texas Commission on Environmental Quality (TCEQ) Water Availability Model (WAM) Run 3 for each basin. These versions of the WAMs assume maximum permitted diversions and no return flows. Where applicable, the models are to include environmental flow provisions in the determination of firm yield supplies.

Supplies are required to be firm under drought of record (DOR) conditions. Therefore, interruptible supplies and local supplies that are not firm during drought are not available for use in meeting needs.

It is required that supply volumes associated with strategies be exclusive and that multiple projects do not rely on the same volume of water. Water losses should be factored into supplies. In many cases, these losses are considered in the per-capita demands for some WUGs with water supplies that originate directly from raw water sources although they must be considered separately in other cases.

5.3.2 Cost Development Methodology

Project costs include the capital costs, debt service, and annual costs associated with implementing and operating a project. Guidance for the 2021 round of regional planning specifies that all costs be adjusted to September 2018 values using approved indices such as the Engineering News Record Construction Cost Index (CCI) and the U.S. Bureau of Labor Statistics Producer Price Index (PPI).

Project costs are often provided by project sponsors as a result of their own specific studies. In these cases, the costs may be adapted for the RWP by adjusting with cost indices to reach representative September 2018 values.

For development of project costs based on general criteria, TWDB sponsored the development of a Unified Costing Model (UCM) that provides capital, finance, and annual costs for a wide range of project types. Region H adapted this tool for use in development of the 2021 RWP and the documentation for this tool serves as the basis for Region H cost estimates. The resulting Region H tool uses the same unit costs and methodologies as the UCM but presents the information in a manner consistent with the values presented in previous RWPs. These tables can be found for the evaluated projects in ***Appendix 5-B*** of this chapter.

In many cases the information provided by a project sponsor may be incomplete but may account for some aspects of project cost. In these cases, appropriate regional planning assumptions and methods are applied to fill in any remaining information.

For each project, costs have been adapted or developed for the following categories:

- Capital Costs
  - Construction costs
  - Interest during construction
  - Engineering and feasibility studies, legal assistance, financing, bond counsel, and contingencies
  - Permitting and mitigation
  - Land purchase and easement costs
  - Purchase of water supplies
- Debt Service
  - Based on a rate of 3.5 percent for 20 years or 40 years for reservoir projects
- Annual Operating and Maintenance Costs
  - Annual costs
  - Energy costs
- Unit Costs of Water
  - Developed based on project yield and total annual project costs

Certain cost categories, which are associated with maintenance or improvement of existing infrastructure but which do not increase supply, are excluded from Regional Water Plans except for limited cases associated with conservation strategies or distribution line replacement to address water loss. Excluded categories include:

- Facilities associated with retail distribution networks
  - Retail internal distribution facilities
  - Water storage facilities associated with retail distribution
  - Wastewater collection system components associated with direct reuse
- Water system improvements to address quality or pressure compliance issues
- Replacement and maintenance of existing facilities without supply increase
  - New wells which simply replace existing aging wells
  - Maintenance or upgrades to existing facilities that do not increase supply volumes
  - Preventive measures to protect against future water loss or degradation

5.3.3 Strategy Impacts

In evaluating strategies and their associated projects, planning groups are directed to provide a quantitative report of how cultural and environmental resources may be affected. This includes environmental water needs, wildlife habitats, cultural resources, and the effects of upstream development on the bays, estuaries, and arms of the Gulf of Mexico. Information from project sponsors is used, where possible, to identify these concerns. For other projects that lack this level of study at this point, assumptions are used based on the type, scope, and location of a project or strategy.

5.3.4 Region H Strategy Selection Process

Pursuant to 31 TAC 357.12(b), the RHWPG is required to prepare a summary of its process for identifying and selecting WMS for development of the 2021 RWP. This process shall be presented to the public for comment at a public meeting. The methodology described below was presented in a regular, public meeting of the RHWPG on December 6, 2017 and adopted by the group in that same meeting. This evaluation methodology has also been applied by the RHWPG to evaluate “projects” which, for the purposes of regional planning, refer to specific infrastructure used to increase or manage water supplies. It is recognized that WMS may include one or more projects that can each be scored individually in the selection process.

Potential WMS are defined based on a determination of needs developed from a comparison of projected demands and existing supplies. These strategies are analyzed at the WWP or WUG levels. A detailed technical memorandum has been prepared for each of the management strategies and projects that were selected and considered to be overarching key strategies or projects.

The regional water planning process begins with identifying current and projected future water demands. After water demands are identified for all WUGs, water supplies available to Region H are identified and allocated to WUGs and WWPs based on current usage and contracts. By matching the supplies and the demands, projected surpluses and shortages are determined. Major Water Provider (MWP) supplies and contracts are also reviewed to determine their respective surplus or need during the planning period.

The selection of WMS begins with the identification of certain “general WMS” that are readily available. Such alternatives can provide simple, cost-effective solutions to shortage without the development of new, major water projects. These strategies include the use of groundwater where available, the expansion or extension of existing contracts for water supplies between WUGs and WWPs, and the reduction of demand through water conservation.

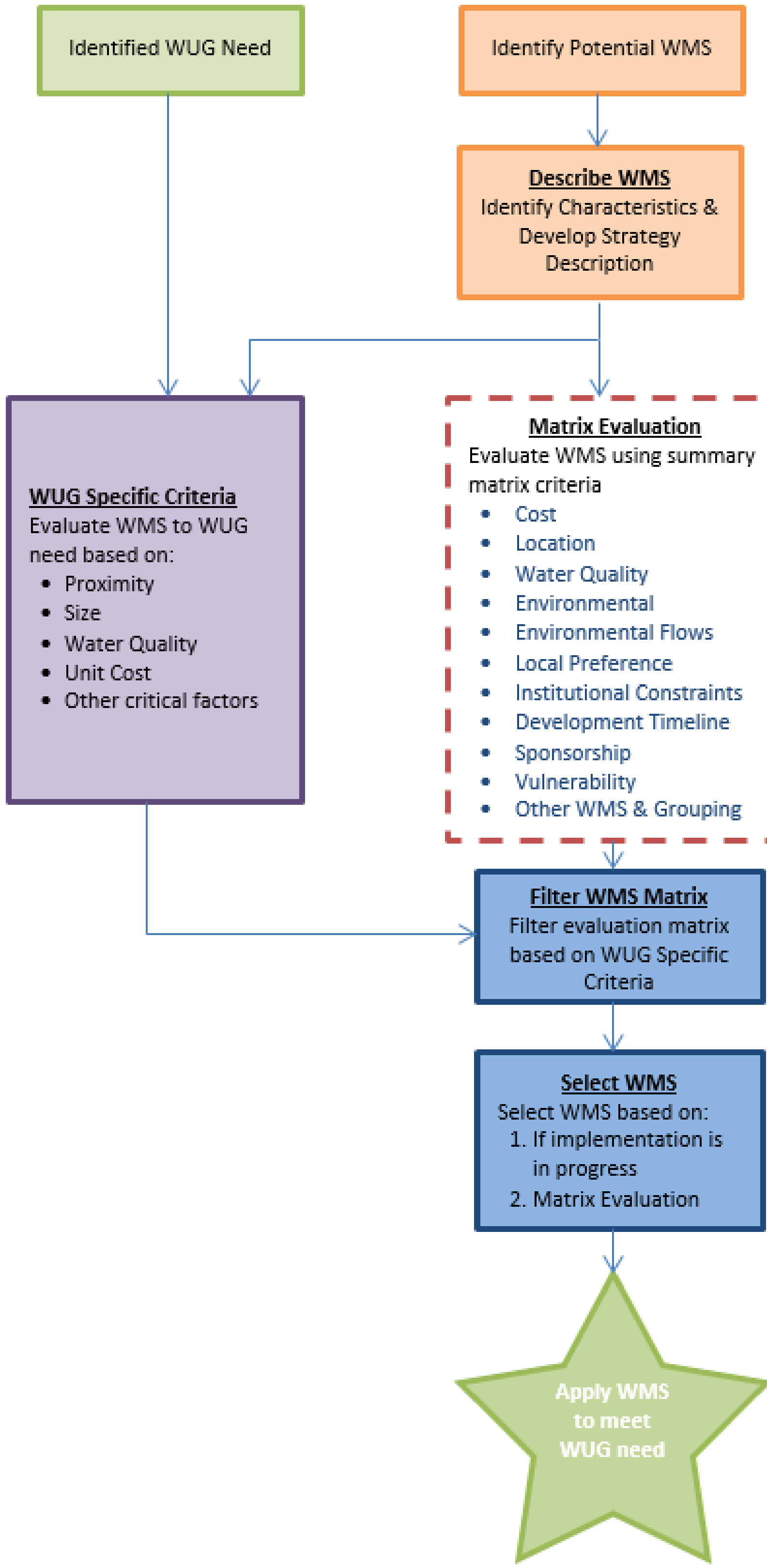
In evaluating the general WMS, the RHWPG makes three assumptions. First, the RHWPG assumes that every municipal WUG with a projected shortage would, where feasible, utilize conservation before developing additional groundwater supplies, seeking out or increasing a WWP contract, or pursuing any other strategies to increase supply. This is pursuant to the language of 31 TAC 357.34(g).

Secondly, WUGs would continue to develop groundwater until it is fully utilized. This is based upon the observed pattern of development in the region, where the Gulf Coast Aquifer is available in all of the southern counties. The supply of groundwater will not be allocated in excess of regulations set forth by subsidence or groundwater conservation districts or other entities that have regulatory power over the consumption of groundwater.

Finally, those WUGs currently receiving water from WWPs would be able to increase their contract amounts until the WWP supplies were fully allocated. This assumes the use of existing supplies conveyed through existing infrastructure wherever possible.

For the development of the 2021 RWP, a dual-phased WMS selection process was proposed. Inputs into the dual-phase process include the identified WUG needs (after the application of general WMS) and the potential WMS. The output is the application of one or more WMS(s) to meet a WUG need. *Figure 5-1* presents a flow chart of the proposed WMS selection process.

Figure 5-1 – Region H WMS Selection Methodology Process



Prior to the dual phases, the proposed strategies will be described in detail. Within the dual phases, the first phase (the WUG Specific Criteria phase) focuses on the WUG, as it aims to evaluate the WMS for a specific WUG need. During this phase, questions such as the following must be addressed for a given WMS to be considered acceptable to apply to meet a WUG need:

- Is the strategy within reasonable proximity to location of water need?
- Is the strategy right-sized or easily paired with another WMS?
- Is the expected water quality produced by the strategy significantly different from existing water quality at the WUG?
- Is the unit cost (and capital if no WWP is present) supportable by the target WUG?
- Has any other flaw relating to the WMS and WUG been identified?

The second phase (the Matrix Evaluation phase) focuses on the evaluation of the WMS. In this phase, each WMS will be evaluated based on the matrix criteria presented in *Table 5-2*. Each WMS will be given a score from one to five for each analysis criterion, and the phase will ultimately develop a matrix of rated WMS. The analysis criteria include the following:

- Cost – Evaluates the unit cost of the water produced by the strategy.
- Location – Evaluates the degree of interbasin transfer or conveyance required to move the water to significant demand centers within Region H.
- Water Quality – Evaluates the strategy's impact on water quality.
- Environmental Land & Habitat – Evaluates the degree of environmental land impacts and the degree of public opposition expected by the strategy.
- Environmental Flows – Evaluates the degree of impact to environmental flows to bays and estuaries. This evaluation is independent of the application of adopted environmental flow standards that are required to be enforced upon new water right appropriations. Projects that are found to reduce flows are not necessarily in violation of these standards just as compliance with the adopted standards does not mean a project will not reduce instream flows.
- Local Preference – Evaluates the local preference and likelihood for public support or opposition created by the strategy.
- Institutional Constraints/Risk of Implementability – Evaluates the potential for factors such as permitting and land acquisition to affect the strategy.
- Development Timeline – Evaluates the amount of time necessary to implement the strategy.
- Sponsorship – Evaluates whether a sponsor has been identified and is committed to implementing the strategy.
- Vulnerability – Evaluates the risk from natural or man-made disasters such as hurricanes, climate change, or terrorism to impact the strategy's ability to deliver water.
- Impacts on Other WMS – Evaluates the likelihood of the strategy to impact other WMS and the potential for the strategy to be applied in coordination with other WMS.

After the dual-phase description, the emphasis of the methodology shifts to the identification and selection of Water Management Strategies to meet the needs of a particular WUG of interest. To accomplish this process, the evaluation matrix is filtered for each WUG need, such that all WMS that meet the WUG Specific Criteria are available for selection.

Selection of the WMS will first occur by selecting any strategies that are already in progress. This is intended to make the planning process parallel with ongoing developments within Region H while still allowing for thorough quantitative evaluation of each strategy under consideration. Subsequent selections of WMS will be made, as needed, based on the filtered Matrix Evaluation. After WMS selection, the selected WMS are applied to meet WUG needs.

Table 5-2 – Region H WMS Rating Criteria

Category	Rating Criteria				
	1	2	3	4	5
Cost	>$1,000/ac-ft	$750 to $1,000/ac-ft	$500 to $750/ac-ft	$250 to $500/ac-ft	<$250/ac-ft
Location	IBT required, long distance or outside Region H.	IBT & Conveyance required for use to meet significant needs.	IBT required for some need centers. Conveyance required.	Some conveyance required to need centers.	No IBT required. Relatively near centers of high demand.
Water Quality	Quality of supply is reduced significantly.	Quality of supply is reduced.	No known water quality issues.	Quality of supply is improved.	Existing water quality problems are reduced.
Environmental Land & Habitat	Significant environmental issues and opposition.	Some environmental issues and opposition.	Environmental impacts can be mitigated. Limited concerns.	Minimal mitigation of impacts needed. Minimal concerns.	Limited or no known impacts.
Impacts on Environmental Flows	Significantly reduces instream or B&E flows.	Reduces instream or B&E flows.	No impact.	Increases instream or B&E flows.	Significantly increases instream or B&E flows.
Local Preference	No local support. Significant opposition.	Minimal local support. Some opposition.	Some local support. Limited opposition.	Local support. Minimal opposition.	Widespread local support. Multi-use benefits likely.
Institutional Constraints / Risk of Implementability	Permits opposed. Significant property required.	Some permit opposition. Some property acquisition necessary.	Permits expected with minimal problems. Property available.	Permit application in progress. Property acquired or under acquisition.	Permits issued. Facilities or land owned. Water available.
Development Timeline	>35 years	25-35 years	15-25 years	5-15 years	0-5 years
Sponsorship	No sponsor readily identifiable.	Sponsor identifiable, but uncommitted.	Sponsor(s) identified; commitment level uncertain.	Sponsor(s) are identified and committed to strategy.	Sponsors identified and strategy is in development.
Vulnerability	Significant risk from natural and man-made disasters.	Substantial risk from natural and man-made disasters.	Moderate risk from natural and man-made disasters.	Slight risk from natural and man-made disasters.	Minimal risk from natural and man-made disasters.
Impacts on Other Management Strategies	Significant negative impacts.	Some negative impacts and/or little chance of grouping.	No impact.	Some positive impacts, potential synergistic effects.	Significant positive impacts, synergy achieved.

5.4 POTENTIAL WATER MANAGEMENT STRATEGIES AND PROJECTS

Potentially feasible WMS were identified in three ways. First, strategies recommended in the 2016 Region H RWP for either implementation or additional study were considered. Next, new strategies were solicited during the scope development period for the 2021 RWP. Finally, entities that conducted independent strategy studies for WMS or projects that they intend to sponsor could bring their reports to the planning group and request they be considered in the plan. As examples, the 2021

RWP includes new projects being developed by the City of Manvel and the City of Surfside Beach which were identified by the sponsors since the completion of the 2016 RWP.

A summary of identified WUG needs and considered and potential WMS types is included in ***Table 5-A1*** of ***Appendix 5-A***.

It should also be noted that an alternative to WMS implementation that is always an available option is the choice to not meet identified needs. Socio-economic impacts of this option are discussed in ***Section 5.4.5***. Although not a WMS or a project in the traditional sense, this does serve as an alternative for addressing needs in Region H. The RHWPG has not pursued this option except for some agricultural needs that lack an economically viable alternative. However, a detailed study on the potential of using drought management strategies to reduce demands rather than meeting needs with additional supply is discussed in ***Section 5.4.3***, ***Chapter 7***, and a technical memorandum in ***Appendix 5-B***.

5.4.1 Studies by the RHWPG and Others

Potential WMS were defined based on the determination of needs described above. Strategies were updated and configured to address the specific types and nature of identified shortages. Several key projects were identified and either studied or summarized as part of this process. A list of the potentially feasible WMS and projects considered by the RHWPG are shown in *Table 5-3*.

Table 5-3 – Region H Potentially Feasible WMS and Projects

Conservation
Advanced Municipal Conservation and Water Loss Reduction
Irrigation Conservation
Conveyance
BWA Transmission Expansions
CHCRWA Transmission and Distribution Expansion
City of Houston GRP Transmission
COH, NHCRWA, and CHCRWA Shared Transmission
CWA Transmission Expansion
East Texas Transfer
GCWA Industrial Raw Water Line
Lake Livingston to SJRA Transfer
LNVA Neches-Trinity Basin Interconnect
NFBWA Phase 2 Distribution Segments
NHCRWA Distribution Expansion
NHCRWA Transmission Lines
Southeast Transmission Line Improvements
Surfside Beach Supply Infrastructure
WHCRWA Distribution Expansion
WHCRWA/NFBWA Transmission Line
Groundwater Development
Aquifer Storage and Recovery
Brackish Groundwater Development and Groundwater Blending

BWA Brackish Groundwater Development
City of Houston Area 2 Groundwater Infrastructure
Expanded Use of Groundwater
Forestar Houston County Project
Forestar Liberty County Project
GCWA Backup Well Development
Groveton Groundwater Expansion
SJRA Catahoula Aquifer Supplies

Groundwater Reduction Plans

CHCRWA GRP
City of Houston GRP
City of Missouri City GRP
City of Richmond GRP
City of Rosenberg GRP
City of Sugar Land IWRP
Fort Bend County MUD 25 GRP
Fort Bend County WC&ID No. 2 GRP
Montgomery County MUDs 8 and 9 GRP
NFBWA GRP
NHCRWA GRP
Porter SUD Joint GRP
River Plantation and East Plantation Joint GRP
SJRA GRP
WHCRWA GRP

Reuse

City of Houston Reuse
City of Pearland Reuse
Galveston County Industrial Reuse
NFBWA Member District Reuse
NHCRWA Member District Reuse
San Jacinto Basin Regional Return Flows
Wastewater Reclamation for Industry
Wastewater Reclamation for Municipal Irrigation
Westwood Shores MUD Reuse

Surface Water Development

Allens Creek Reservoir
BRA System Operation Permit
Dow Reservoir and Pump Station Expansion
Freeport Seawater Desalination
Lake Somerville Augmentation
Lone Star Lake
Manvel Supply Expansion
Mustang Reservoir Improvements
NRG Cedar Bayou Desalination

Treatment
BWA Conventional Treatment Expansion
City of Houston Treatment Expansion
City of Houston West Water Purification Plant
GCWA Galveston County Treatment Expansion
Northeast Water Purification Plant Expansion
Pearland Surface Water Treatment Plant
SEWPP Additional Module
Other
Brazos Saltwater Barrier
Chocolate Bayou Pump Station Expansion
Chocolate Bayou Saltwater Barrier Improvements
Municipal Drought Management
New and Expanded Contracts

For each of these projects, a detailed technical memorandum is provided in ***Appendix 5-B***. Not all of the strategies evaluated are based on developing additional water. For instance, several projects consist of water transfer facilities only (e.g., Regional Water Authority transmission strategies). Expanded use of groundwater addresses the requirements to fully develop existing groundwater supplies, with consideration given to the regulatory guidelines set by groundwater conservation districts. Other strategies involve the contractual exchange of water supplies between various water suppliers. These strategies recognize the need to transfer supplies from areas of excess to the specific areas of need, mainly within the western and lower portions of the region. In many cases, there are aspects of a particular project that cross categories. The major categories these projects are listed under are meant to represent the general nature of each project or strategy only.

5.4.2 Conservation

Water conservation has always been a key component of the Region H RWP. For the development of the 2021 RWP, the RHWPG expanded municipal conservation to consider both water loss reduction and the application of other advanced methods in addition to the baseline conservation applied by TWDB. Advanced conservation methods were applied to WUGs based on the methodology used in the TWDB Municipal Water Conservation Planning Tool, which was developed in 2018 to guide water utilities in planning conservation programs and determining the potential costs and benefits of such programs. The RHWPG assessed conservation for all municipal WUGs. Water loss reduction was applied to municipal WUGs with water loss levels of greater than 10 percent.

Conservation practices for agricultural irrigation are also a significant source of savings throughout the region. The RHWPG did not apply conservation to Livestock, Mining, Manufacturing, or Steam-Electric Power WUGs, as adequate information was not available to reasonably apply conservation for these demand categories. Additionally, the required assumption of constant manufacturing water demand after 2030 for the current cycle of RWP development does not reflect the ongoing growth in the manufacturing sector in Region H. For this reason, the RHWPG has not included Industrial Conservation as a recommended WMS for the 2021 RWP in order to avoid further underrepresenting the need for water supply and infrastructure development.

Detailed information regarding the analysis and application of conservation strategies may be found in ***Appendix 5-B***. Additional information may be found in ***Subchapter 5B*** of this plan.

5.4.3 Drought Management

Pursuant to 31 TAC 357.34(g), guidelines for regional water planning require that drought management strategies be considered for each identified need. If drought management is not selected as a strategy, current TWDB policy for regional water supply planning requires that reasons for its exclusion must be documented. Drought management strategies may include water demand management.

The supply and demand values used for this plan are based on estimated DOR conditions. Under non-drought conditions, many entities in the region will have an overall surplus of supply. However, this surplus does not coexist with the growing demand areas. A significant portion of available supply is in Lake Livingston, which is in the Trinity Basin. The majority of the demand growth is occurring in Brazoria, Fort Bend, Harris, and Montgomery Counties which are in the Brazos and San Jacinto Basins. To meet the demands where they occur, supply from the Trinity must be transferred into the San Jacinto River Basin. Once that infrastructure is constructed, it is not “drought-susceptible” in the context of the RWP, because the supply volume applied in the RWP does not exceed the modeled firm DOR record yield of the underlying water rights.

Municipalities and water providers throughout the region have published drought contingency plans (DCPs). In general, these plans are designed to address short-term periods of limited water availability through public notice and outdoor water use restrictions. In 2009, the RHWPG conducted a study to assess the impact of DCP implementation on reservoir supplies. The study indicated that the duration of impacts on lake levels could be reduced by implementing drought response measures, but that the benefits of such measures to a reservoir are relatively limited in terms of an annual increase in supply. During the development of the 2021 RWP, the RHWPG considered drought management as a potential water management strategy (WMS) and performed a broader region-wide analysis to assess the potential benefits of implementing mandatory drought response measures outlined in DCPs in Region H. This study is discussed in more detail in ***Chapter 7*** and within a dedicated memorandum in ***Appendix 5-B***.

Due to the short-term nature of drought response measures and the variability of benefits based on levels of customer compliance, implementing DCPs cannot be considered to provide a firm volume of demand reduction analogous to a physical source. Furthermore, the RHWPG recognizes that implementation of DCPs is a mandated curtailment of demands rather than a strategy to provide supply or reduce demands on a long-term basis, and thus the costs associated with short-term drought management represent economic impacts of not meeting demands. Also, utilization of DCPs as tools to prepare for known droughts prevents them from providing additional protection in the face of a drought worse than the DOR. Although drought contingency planning is a critical component of water supply management and may provide short-term benefits during severe drought conditions, the RHWPG does not recommend drought management as a replacement for long-term water management strategies.

This does not preclude some WUGs from electing to use drought management in lieu of a recommended strategy. The best example of this is for irrigation. Region H recommends irrigation conservation as a management strategy in those counties with substantial water demands related to rice production, as rice irrigation typically has the most potential for demand reduction. However, portions of the irrigation demands in those and other counties are often met today through the use of water rights which are not fully reliable, backed up by one-year contracts for reliable supply as needed. Irrigators holding interruptible water rights may choose not to implement conservation (at an annual cost), but instead choose to reduce their irrigated acreage during a drought year (for a discrete cost), or enter into long-term contracts for reliable surface water from a wholesale supplier (which will be available in the eastern counties). That is an individual economic decision and the Region H plan recognizes the flexibility of these irrigators to exercise that option.

5.4.4 Interruptible Supplies

TWDB guidelines require the water supply sources that are recommended in the regional water plans to meet future needs to be firm supplies. Firm water supplies are those supplies predicted to be 100% reliable during DOR conditions, and this guidance applies to supplies for any category of water use. While this planning criterion represents a sound and conservative approach for water users that require supplies with a high degree of reliability, such as municipal and manufacturing demands, some types of water uses such as irrigated agriculture may be able to utilize surface water supplies that are less than fully dependable during a DOR by suspending irrigation in favor of dry-land crops during these periods. These supplies, which are less than 100 percent reliable, are called “interruptible” supplies. Although these supplies are vital to providing cost-effective water to agriculture, they do not qualify as a potential supply under the current guidance for RWP development and, therefore, have not been included as potential strategies in the 2021 RWP. It is expected that the unmet needs identified in this RWP for irritation are routinely met during wet and typical years with these supplies.

5.4.5 Socio-Economic Impacts of Not Meeting Identified Needs

One alternative for addressing needs identified in the RWP is the choice to not meet the shortages. However, this alternative is associated with costs due to losses in economic revenue, population growth, and tax base. An analysis of these factors was conducted by TWDB following the entry of existing supplies into DB22 and is included as ***Appendix 5-C***.

Impacts were considered for the occurrence of a drought producing the identified water needs outlined in ***Chapter 4*** of this plan for one year. The TWDB methodology utilized the software package Impact for Planning Analysis (IMPLAN) to determine a range of impacts within various categories. These include the following:

- Regional Economic Impacts, shown in *Figure 5-2*
  - Income Losses
  - Job Losses
- Financial Transfer Impacts, shown in *Figure 5-3*
  - Tax Losses on Production and Imports
  - Water Trucking Costs
  - Utility Revenue Losses
  - Utility Tax Revenue Losses
- Social Impacts, shown in *Figure 5-4*
  - Consumer Surplus Losses
  - Population Losses
  - School Enrollment Losses

Figure 5-2 – Projected Region H Annual Regional Economic Impacts of Not Meeting Needs

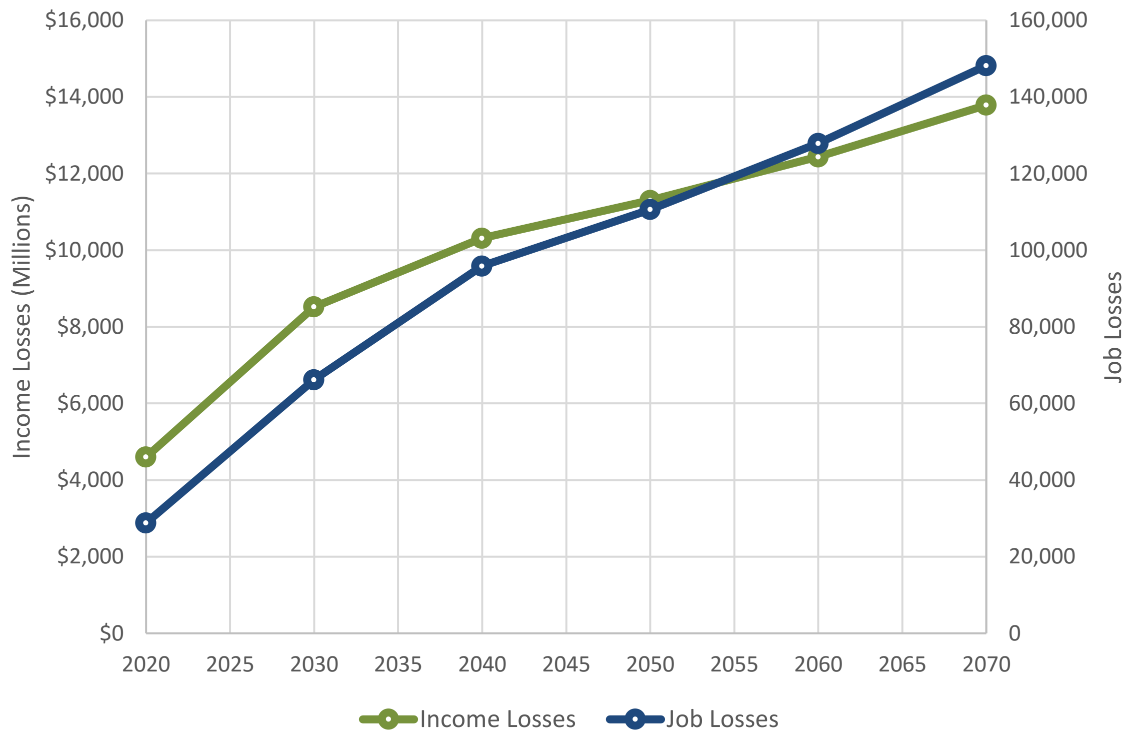


Figure 5-3 – Projected Region H Annual Financial Transfer Impacts of Not Meeting Needs

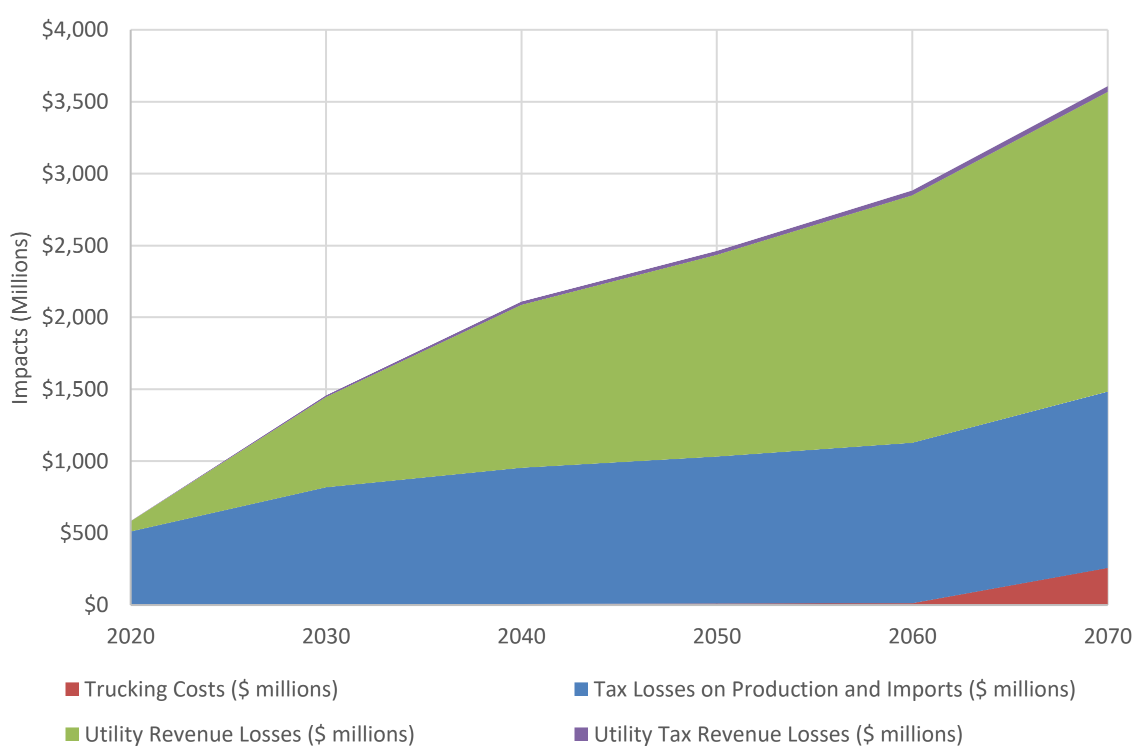
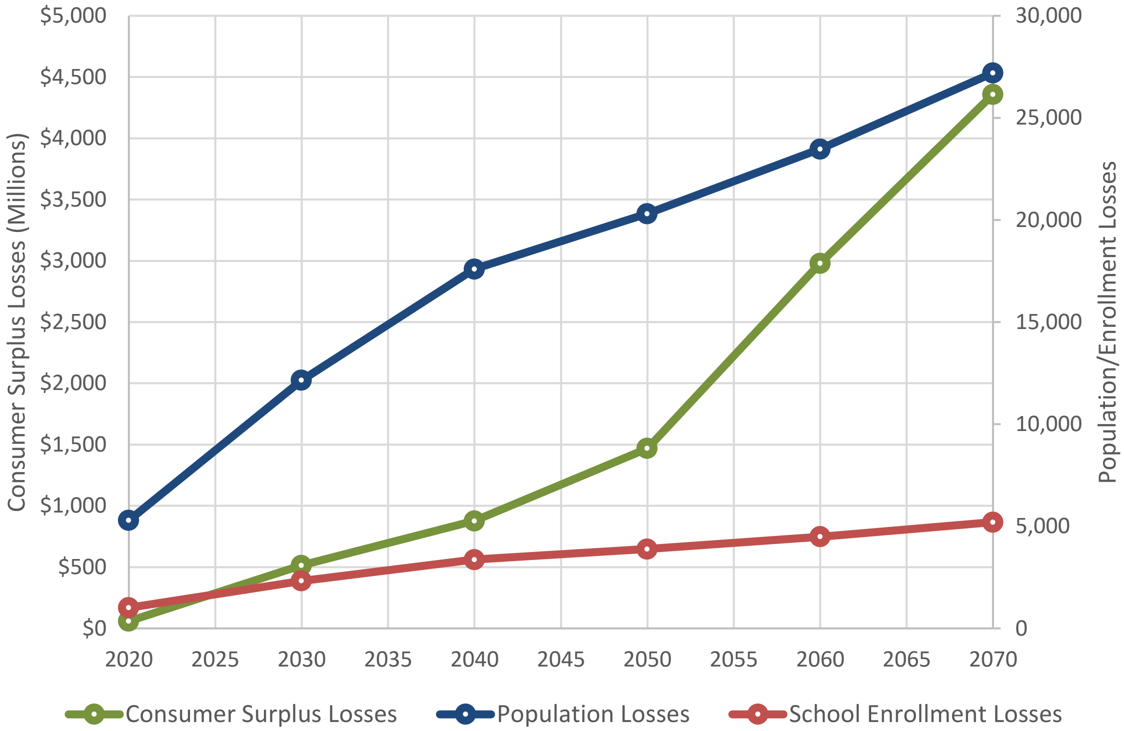


Figure 5-4 – Projected Region H Annual Social Impacts of Not Meeting Needs



Several considerations should be made when reviewing the socioeconomic impact data depicted in the report which determine the way the data may be used and the impacts suggested.

- **Impacts represent a one-year loss.** Drought conditions typically occur over a multi-year period and it is assumed that the one-year impacts identified here would amplify over time.
- **Impacts may be caused by various forces.** In addition to climatic drought, many of the needs represented within Region H are due to reduction of supply due to regulatory forces and growth of demands. Therefore, these needs may occur in any given year even without the occurrence of dry climate conditions and, therefore, may cause much greater impacts if adequate strategies are not employed.
- **Costs cannot be readily compared to the cost of implementing the plan.** Making a direct comparison to costs of strategies in the plan would require the discounting of future benefits and costs to present value dollars using some assumed discount rate. The methodology for determining socioeconomic impacts did not use any discounting procedures to weigh future costs differently through time. Furthermore, the costs presented in the plan do not consider the comprehensive cost of all infrastructure to support future development.
- **Several factors are not accounted for in this analysis.** These include cross-region impacts of multiple regions experiencing needs, the cost of recovery for such economic components such as the rebuilding of cattle herds following a drought, impacts to recreation, and the negative publicity impacts of water shortages which may have long-term consequences on the overall region.

5.5 RECOMMENDED WATER MANAGEMENT STRATEGIES

5.5.1 New and Increased Supply Availability

The development of WMS and associated projects have the potential to either optimize the use of existing water sources, increase the availability from existing sources, or provide water from new sources. In total, the WMS recommended in the 2021 RWP provide as much as 945,474 acre-feet per year of additional supply and conservation savings by 2070 through increased source availability, newly developed water, and long-term demand management. These increases in overall supply for the region are detailed in ***Table 5-A2*** in ***Appendix 5-A***.

Additional supply has not been included to provide for water loss. It is assumed that the demands, as developed in ***Chapter 2*** of this plan, include appropriate levels of water loss that are consistent with current system performance. Therefore, supplies and projects identified for meeting these demands are already accounting for current levels of water loss without additional consideration. In reality, the RHWPG hopes that future projects will be developed and maintained in a responsible manner such that these water losses will actually be reduced below the level recognized today. This reduction itself is contained within the water loss reduction component of the municipal conservation strategy.

5.5.2 Project Scoring

The RHWPG conducted a scoring process for the key projects identified during the planning process. This followed the methodology described in ***Section 5.3.4***. The results of this scoring evaluation are included in each technical memorandum in ***Appendix 5-B*** along with an explanation of how the score for each criterion was selected. Finally, ***Table 5-A3*** in ***Appendix 5-A*** summarizes the scores for all key projects for easy comparison.

5.5.3 Selected WMS and Projects

A number of WMS and projects were selected for meeting the needs identified within Region H. As noted previously, WMS represent general approaches to water supply that are accomplished through a number of projects. *Table 5-4* below represents the relationship between recommended WMS and the key projects required to implement them. A complete list of projects associated with each WMS is included as ***Table 5-A4*** in ***Appendix 5-A***.

Table 5-4 – WMS and Key Project Relationships

Water Management Strategy*	WMS Project Name
Additional Supply from GCWA	WUG Infrastructure Expansion (WUG-level projects)
Brackish Groundwater Supplies	WUG Infrastructure Expansion (WUG-level projects)
Brazos Saltwater Barrier	Brazos Saltwater Barrier
CHCRWA GRP	CHCRWA Transmission and Distribution Expansion
	COH, NHCRWA, and CHCRWA Shared Transmission
	Northeast Water Purification Plant Expansion
City of Houston Area 2 Groundwater Development	City of Houston Area 2 Groundwater Infrastructure

Water Management Strategy*	WMS Project Name
City of Houston GRP	Allens Creek Reservoir
	City of Houston GRP Transmission
	City of Houston West Water Purification Plant
	COH, NHCRWA, and CHCRWA Shared Transmission
	CWA Transmission Expansion
	Northeast Water Purification Plant Expansion
City of Houston Reuse	City of Houston Reuse
City of Pearland Reuse	City of Pearland Reuse
Dow Reservoir and Pump Station Expansion	BWA Transmission Expansions
	BWA Conventional Treatment Expansion
	Dow Reservoir and Pump Station Expansion
East Texas Transfer	East Texas Transfer
Expanded Use of Groundwater	Expanded Use of Groundwater (WUG-level projects)
Fort Bend MUD 25 GRP	Fort Bend County MUD 25 GRP
Fort Bend WC&ID 2 GRP	Fort Bend County WC&ID No. 2 GRP
Freeport Seawater Desalination	Freeport Seawater Desalination
Galveston County Industrial Reuse	Galveston County Industrial Reuse
GCWA Backup Wells	GCWA Backup Well Development
GCWA Brazoria County Raw Water Expansion	Chocolate Bayou Pump Station Expansion
	Chocolate Bayou Saltwater Barrier Improvements
	Mustang Reservoir Improvements
GCWA Galveston County Raw Water Expansion	GCWA Industrial Raw Water Line
GCWA Galveston County Treated Water Expansion	GCWA Galveston County Treatment Expansion
Groveton Groundwater Expansion	Groveton Groundwater Expansion
Industrial Supply Reallocation	WUG Infrastructure Expansion (WUG-level projects)
Irrigation Conservation	Irrigation Conservation
LNVA Neches-Trinity Basin Interconnect	LNVA Neches-Trinity Basin Interconnect
Manvel Supply Expansion	Manvel Supply Expansion
Missouri City GRP	City of Missouri City GRP
Montgomery County MUDs #8 and #9 GRP	Montgomery County MUDs #8 and #9 GRP
Municipal Conservation	Adv. Municipal Conservation (WUG-level projects)
New / Expanded Contract with BRA	Allens Creek Reservoir
New / Expanded Contract with BWA	BWA Brackish Groundwater Development
	BWA Transmission Expansions
	BWA Conventional Treatment Expansion
New / Expanded Contract with City of Houston	Northeast Water Purification Plant Expansion
New / Expanded Contract with GCWA	Allens Creek Reservoir
	GCWA Galveston County Treatment Expansion
	GCWA Industrial Raw Water Line
New / Expanded Contract with LNVA	WUG Infrastructure Expansion (WUG-level projects)
New / Expanded Contract with SJRA	Lake Livingston to SJRA Transfer
	SJRA GRP

Water Management Strategy*	WMS Project Name
NFBWA GRP	City of Houston Reuse
	NFBWA Phase 2 Distribution Segments
	Northeast Water Purification Plant Expansion
	WHCRWA/NFBWA Transmission Line
NFBWA Member District Reuse	NFBWA Member District Reuse Infrastructure
NHCRWA GRP	City of Houston Reuse
	COH, NHCRWA, and CHCRWA Shared Transmission
	NHCRWA Distribution Expansion
	NHCRWA Transmission Lines
	Northeast Water Purification Plant Expansion
NHCRWA Member District Reuse	NHCRWA Member District Reuse Infrastructure
NRG Cedar Bayou Desalination	NRG Cedar Bayou Desalination
Other BRA System Operation Supplies	WUG Infrastructure Expansion (WUG-level projects)
Pearland SWTP	Pearland Surface Water Treatment Plant
Porter SUD Joint GRP	Porter SUD Joint GRP
Richmond GRP	Allens Creek Reservoir
	City of Richmond GRP
River Plantation and East Plantation Joint GRP	River Plantation and East Plantation Joint GRP
Rosenberg GRP	BWA Conventional Treatment Expansion
	City of Rosenberg GRP
SJRA Aquifer Storage and Recovery	SJRA Aquifer Storage and Recovery
SJRA Catahoula Aquifer Supplies	SJRA Catahoula Aquifer Supplies
SJRA GRP	Lake Livingston to SJRA Transfer
	SJRA GRP
SJRA Reuse Supplies for Manufacturing	WUG Infrastructure Expansion (WUG-level projects)
Southeast Transmission Line Expansion	SEWPP Additional Module
	Southeast Transmission Line Improvements
Sugar Land Advanced Demand Management	City of Sugar Land IWRP
Sugar Land IWRP	City of Sugar Land IWRP
Surfside Beach Supply Enhancement	Surfside Beach Supply Infrastructure
Wastewater Reclamation for Municipal Irrigation	Wastewater Reclamation for Municipal Irrigation
Water Loss Reduction	Water Loss Reduction (WUG-level projects)
Westwood Shores MUD Reuse	Westwood Shores MUD Reuse
WHCRWA GRP	City of Houston Reuse
	Northeast Water Purification Plant Expansion
	WHCRWA Distribution Expansion
	WHCRWA/NFBWA Transmission Line

**WMS and project names included in the TWDB Regional Planning database (DB22) may vary slightly from those shown in this summary table where necessary due to the DB22 data structure and to properly reflect project phasing and project type.*

For many WUGs within the region, conservation and direct reuse projects are considered first-tier options for addressing projected needs; an assessment of need remaining (second-tier) after applying these project types but before applying other projects or WMS is included in ***Tables 5-A5*** through ***5-A7*** in ***Appendix 5-A.*** The compilation of all recommended projects results in as much as 1,947,784 acre-feet per year for Region H. These allocations are detailed in ***Table 5-A8*** in ***Appendix 5-A***. A summary of water source supply balance after allocation of WMS supplies is shown in ***Table 5-A9*** in ***Appendix 5-A.*** *Table 5-5* below summarizes the key projects selected as part of recommended WMS along with their total potential yield, capital cost, and decade of implementation. These key projects represent substantial supply volumes, large expenditures, or important nodes in WMS supply relationships.

Table 5-5 – Key Project Overview

Project	Potential Volume[1] (ac-ft)	Capital Cost ($)	Unit Cost ($/ac-ft)		Start Decade
			Start Decade	2070	
Conservation					
Irrigation Conservation	93,562	$1,489,156	$133	$131	2020
Municipal Conservation (Advanced Conservation)	123,251	$2,211,236,519	$754	$591	2020
Municipal Conservation (Water Loss Reduction)	62,601	$891,822,048	$625	$578	2020
Conveyance					
BWA Transmission Expansions	26,211	$77,755,692	$248	$39	2030
CHCRWA Transmission and Distribution Expansion	5,466	$17,202,167	$238	$16	2030
City of Houston GRP Transmission	27,216	$31,986,905	$91	$8	2040
COH, NHCRWA, and CHCRWA Shared Transmission	154,575	$462,453,409	$246	$27	2030
CWA Transmission Expansion	349,785	$119,336,981	$43	$19	2040
East Texas Transfer	250,000	$423,969,947	$134	$15	2050
GCWA Industrial Raw Water Line	33,600	$20,909,636	$63	$19	2020
Lake Livingston to SJRA Transfer	50,000	$245,492,975	$437	$92	2050
LNVA Neches-Trinity Basin Interconnect	67,000	$103,316,000	$135	$27	2040
NFBWA Phase 2 Distribution Segments	62,496	$83,859,522	$104	$9	2030
NHCRWA Distribution Expansion	143,360	$919,703,916	$489	$44	2030
NHCRWA Transmission Lines	143,360	$327,910,960	$185	$24	2030
Southeast Transmission Line Improvements	39,928	$119,413,067	$229	$19	2030
Surfside Beach Supply Infrastructure	323	$1,900,440	$450	$36	2020
WHCRWA Distribution Expansion	92,288	$276,977,822	$237	$26	2030
WHCRWA/NFBWA Transmission Line	169,030	$1,310,701,901	$613	$67	2030
Groundwater Development					
Aquifer Storage and Recovery	9,426	$222,907,186	$2,551	$2,551	2070
Brackish Groundwater Development[2]	Varies	Varies by project	Varies by WUG	Varies by WUG	2020
BWA Brackish Groundwater Development	3,136	$33,246,167	$579	$370	2030
City of Houston Area 2 Groundwater Infrastructure	50,400	$122,751,076	$403	$222	2030
Expanded Use of Groundwater[2]	31,000+	Varies by WUG	Varies by WUG	Varies by WUG	2020
GCWA Backup Well Development	1,120	$1,346,492	$169	$84	2040
Groveton Groundwater Expansion	242	$2,211,952	$699	$56	2020
SJRA Catahoula Aquifer Supplies	10,500	$18,200,411	$479	$358	2040
Groundwater Reduction Plans					
CHCRWA GRP[3]	5,466	$0	$0	$0	2030
City of Houston GRP[3]	124,914	$0	$0	$0	2020
City of Missouri City GRP	25,760	$87,837,323	$405	$165	2030
City of Richmond GRP	7,178	$70,936,844	$1,108	$363	2020
City of Rosenberg GRP	3,920	$12,963,110	$261	$29	2030

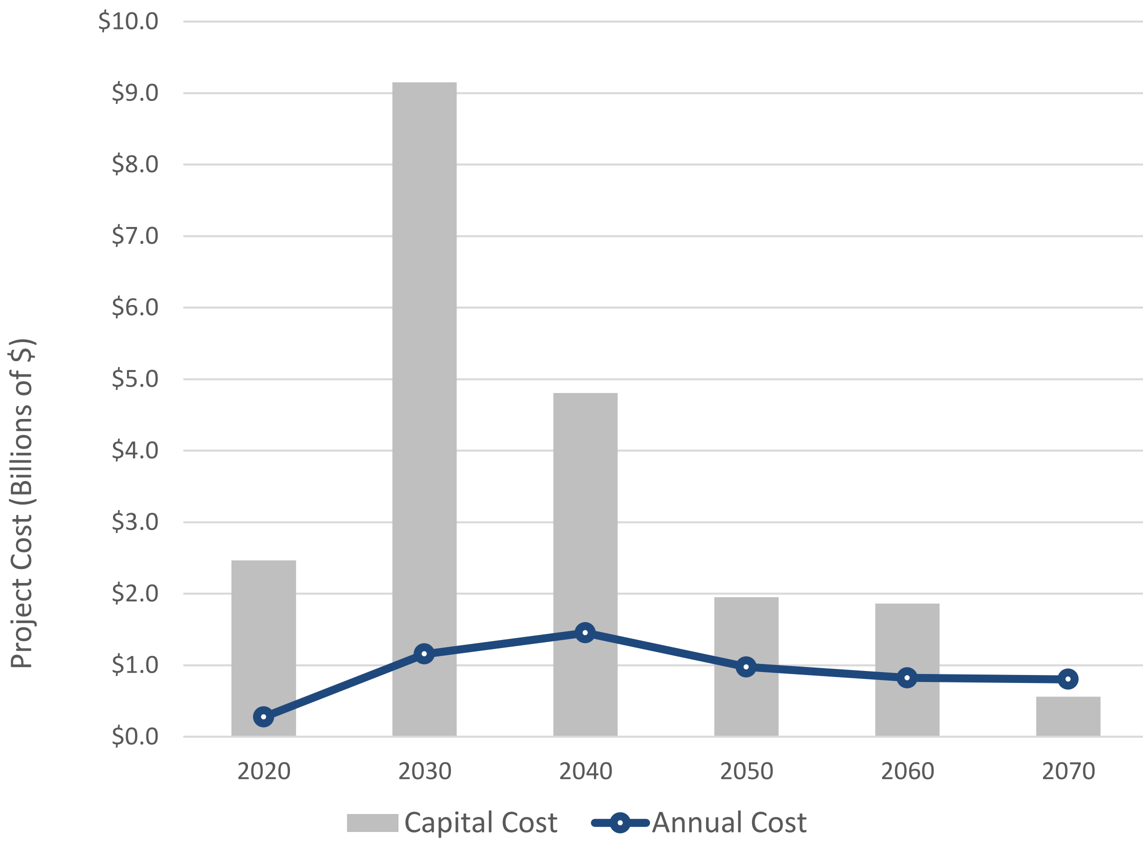
Project	Potential Volume[1] (ac-ft)	Capital Cost ($)	Unit Cost ($/ac-ft)		Start Decade
			Start Decade	2070	
City of Sugar Land IWRP	15,492	$133,134,039	$1,210	$390	2030
Fort Bend County MUD 25 GRP	1,120	$26,718,250	$2,541	$862	2030
Fort Bend County WC&ID No. 2 GRP	6,720	$63,535,966	$1,106	$440	2030
Montgomery County MUDs #8 and #9 GRP	2,240	$30,510,375	$1,875	$917	2020
NFBWA GRP[3]	62,496	$0	$0	$0	2030
NHCRWA GRP[3]	143,360	$0	$0	$0	2030
Porter SUD Joint GRP	2,240	$26,862,533	$1,542	$699	2020
River Plantation and East Plantation Joint GRP[4]	51	$0	$0	$0	2030
SJRA GRP	100,000	$998,910,850	$697	$340	2030
WHCRWA GRP[3]	92,288	$0	$0	$0	2030
Reuse					
City of Houston Reuse	242,554	$555,093,732	$373	$139	2040
City of Pearland Reuse	1,154	$12,648,000	$913	$142	2030
Galveston County Industrial Reuse	22,400	$90,746,960	$564	$279	2030
NFBWA Member District Reuse	3,816	$46,640,088	$1,695	$835	2020
NHCRWA Member District Reuse	300	$4,295,775	$1,913	$905	2020
San Jacinto Basin Regional Return Flows[3]	119,673	$0	$0	$0	2020
Wastewater Reclamation for Municipal Irrigation	19,776	$181,028,438	$1,308	$896	2030
Westwood Shores MUD Reuse	150	$2,031,251	$1,921	$968	2020
Surface Water Development					
Allens Creek Reservoir	99,650	$365,446,301	$211	$39	2040
BRA System Operation Permit[3]	78,276	$0	$0	$0	2020
Dow Reservoir and Pump Station Expansion	80,000	350,000,000	$373	$66	2020
Freeport Seawater Desalination	11,200	155,877,822	$2,273	$1,293	2040
Manvel Supply Expansion	15,680	$269,052,608	$1,488	$309	2030
Mustang Reservoir Improvements	3,734	$14,551,195	$298	$23	2020
NRG Cedar Bayou Desalination	22,400	$342,840,391	$2,637	$1,560	2030
Treatment					
BWA Conventional Treatment Expansion	8,400	$19,085,165	$351	$191	2030
City of Houston Treatment Expansion[3]	89,396	$0	$0	$0	2040
City of Houston West Water Purification Plant	103,385	$959,257,534	$1,418	$407	2040
GCWA Galveston County Treatment Expansion	22,400	$167,919,105	$894	$367	2030
Northeast Water Purification Plant Expansion	448,000	$2,179,413,588	$615	$272	2030
Pearland Surface Water Treatment Plant	22,400	$232,787,093	$973	$242	2030
SEWPP Additional Module	22,400	$97,597,266	$497	$191	2030
Other Infrastructure					
Brazos Saltwater Barrier	10,000	$67,552,043	$517	$42	2040
Chocolate Bayou Pump Station Expansion	33,600	$8,577,765	$29	$11	2020
Chocolate Bayou Saltwater Barrier Improvements	1,120	$1,034,798	$72	$7	2020

1. *Volumes listed in this table represent the maximum anticipated volume associated with the projects rather than new increments of yield. Volumes shown in this table may overlap and are not necessarily additive.*
2. *Includes brackish groundwater projects implemented under Expanded Use of Groundwater. Costs vary by WUG.*
3. *Costs, including construction costs, engineering, legal, and permitting fees, land acquisition, and other capital costs, are included under associated infrastructure projects.*
4. *Supply generated through expanded use of existing infrastructure. Cost estimated to be minimal.*

5.5.4 Selected WMS and Project Costs

The total capital costs identified for the 2021 Region H RWP total $20,798,308,136. These costs are distributed over the planning period as shown in *Figure 5-5*. *Figure 5-5* also includes the annual costs anticipated over each decade of the plan. Detailed costs by project are shown in ***Table 5-A10*** and ***Table 5-A11*** in ***Appendix 5-A***.

Figure 5-5 – Region H Capital and Annual Costs



5.5.5 Contractual Relationships

Contracts for raw or treated water represent a major strategy for providing water supply in Region H and other regions that rely on a large number of WWPs in order to facilitate the transfer of developed water to demands. In addition to meeting demands, WWPs are obligated to provide water under the terms of their contracts to customers. These contractual demands are often far in excess of actual demands as water providers aim to plan for long-term demands when they acquire new water supplies. Contractual commitments and expansions are detailed in ***Table 5-A12*** of ***Appendix 5-A***.

5.5.6 Management Supply Factor

Guidance for development of the 2021 RWPs includes a requirement for consideration of a Management Supply Factor. This factor represents the quantity to which a WUG is over- or under-supplied based on a multiple of 1. A WUG with all of its demands met with no additional surplus would be represented by a factor of 1.0. WUGs with supplies exceeding or below their demand level would receive a factor above or below 1.0, respectively. The Management Supply Factors for Region H WUGs as a result of applying identified WMS are shown in ***Tables 5-A13*** and ***5-A14*** of ***Appendix 5-A***.

5.6 ALTERNATIVE WATER MANAGEMENT STRATEGIES AND PROJECTS

The RHWPG has not elected to recommend any WMS or projects as Alternative Water Management Strategies.

5.7 REMAINING UNMET NEEDS

Following the development of WMS for the 2021 RWP, certain needs identified in ***Chapter 4*** of the RWP remain unmet. That is, either no WMS was found suitable to apply to these needs, or the application of actual supplies is not allowable under the guidance for RWP development. After the application of WMS recommended by the RHWPG, the needs identified for Irrigation and Livestock in a small number of counties in Region H are the only needs which remain unmet. It was recognized in the planning process that the nature of some projects, particularly related to cost, make them unlikely solutions to the needs of some WUGs. Agriculture operates on a very narrow margin in terms of cost. Rather than invest in firm water supplies, the characteristics of agricultural production require investment in lower-cost, short-term sources of water. As a result, many of these supplies may be interrupted during times of drought. Therefore, it is not reasonable to assign a WMS for agricultural use that will deviate from this existing cost model.

The RHWPG recognized irrigation conservation as one affordable strategy that could limit the needs experienced by agriculture. However, during times of exceptional drought, conservation measures alone are not enough to alleviate potential needs as no reduction in water demand is capable of providing the baseline supply of water in absence of a reliable water source from either groundwater or surface water.

In addition to conservation, the RHWPG recognizes the following potential solutions for agriculture during drought that are not compatible with the guidance for inclusion in a RWP:

- Use of interruptible supplies: The predominant source of surface water for use in Irrigation in Region H comes from regional providers who provide water for a number of uses in addition to agriculture. During drought when supplies are limited, firm water supplies are first set aside for municipal and industrial uses. This practice is common and provides a cost-effective interruptible supply for agriculture in most years. Similarly, water supplies for livestock are often supplied by on-site ponds that receive water from runoff and are supplemented with shallow groundwater production. During drought these supplies may be cut off, but they remain vital supplies during most climate conditions. The guidance pertaining to RWP development prevents the application of any of these supplies to meet identified needs due to their lack of firm yield availability.
- Refraining from production during DOR: Often, when interruptible supplies are depended upon for agricultural production, it is essential to limit demands in order to eliminate water needs that cannot be met through the production cycle. The RHWPG encourages the efforts of local WWPs to work with irrigators to responsibly project the availability of water supplies during the growing season in order to provide reliable outlooks regarding the long-term availability of water for agriculture and to prevent the unnecessary investment in crops that

may ultimately fail due to limited resources. This option is more difficult to implement for livestock, which requires water for maintenance of herds. In these situations, herd reduction may be the only viable option when water supplies are not available and may occur as part of seasonal agricultural operation management in response to water or hay availability.

- Conjunctive use: Finally, the RHWPG recommends that agricultural water users seek options for conjunctive use of resources to meet needs. Increasingly, users have access to both surface and groundwater supplies and this presents an opportunity for conjunctive use. Although surface water supplies are less expensive to use, the security of groundwater availability has promoted the development of wells in many areas. Furthermore, many groundwater-regulating entities do not limit the production of water for agricultural purposes. There is potential to produce groundwater and surface water in order to capitalize on the drought-resistant nature of groundwater while extending the sustainability of this resource through surface water use. Although the guidance for RWP development does not provide for the inclusion of this sort of conjunctive use in the RWPs, it remains a viable, real-world solution to the issue of agricultural water availability. It should be noted that the RHWPG respects the opportunity for water users to use groundwater and surface water resources in a responsible manner; it does not support the use of groundwater in a way that would exceed regulatory plans or the long-term sustainability of the aquifer.

Remaining unmet needs in the 2021 RWP following application of identified WMS and projects are shown below in *Table 5-6*.

Table 5-6 – Remaining Unmet Needs

WUG Name	County	Basin	Unmet Needs (ac-ft)					
			2020	2030	2040	2050	2060	2070
IRRIGATION	BRAZORIA	SJ-B	38,229	38,229	38,229	38,229	38,229	38,229
	CHAMBERS	T	4,695	4,695	4,695	4,695	4,695	4,695
		T-SJ	1,616	1,616	1,616	1,616	1,616	1,616
	GALVESTON	SJ-B	2,765	2,765	2,765	2,765	2,765	2,765
LIVESTOCK	BRAZORIA	B-C	0	0	0	0	0	8
	GALVESTON	N-T	53	53	53	53	53	53
		SJ-B	184	184	184	184	184	184
	HARRIS	SJ	383	766	1,022	1,022	1,022	1,022
		T-SJ	101	101	101	101	101	101

N-T = Neches-Trinity, T = Trinity, T-SJ = Trinity-San Jacinto, SJ = San Jacinto, SJ-B = San Jacinto-Brazos, B-C = Brazos-Colorado

CHAPTER 5B
CONSERVATION RECOMMENDATIONS

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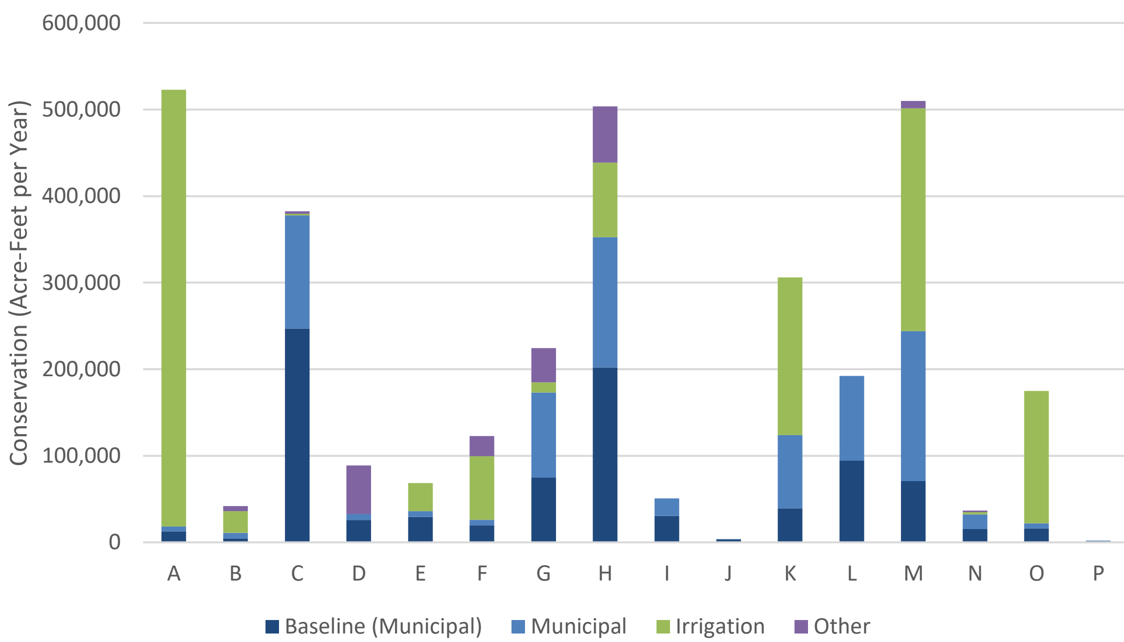
Chapter 5B – Conservation Recommendations

5B.1 INTRODUCTION

Water conservation plays an important role in meeting future water needs across the State of Texas. The 2017 State Water Plan (SWP) identified approximately 810,000 acre-feet of water that could be conserved annually through municipal practices and another 1.3 million acre-feet associated with irrigation use. These savings along with over 200,000 acre-feet of savings in other sectors was applied above approximately 890,000 acre-feet of annual savings applied by the Texas Water Development Board (TWDB) in the initial development of demand projections. These savings, for all regions, are shown below in *Figure 5B-1*.

Figure 5B-1 – 2017 State Water Plan Year 2070 Conservation by Region



Conservation has been a prime project choice for regions throughout Texas due to the low cost and scalability of the approach. As Water Management Strategies (WMS) grow more expensive over time, the avoided cost of developing new infrastructure projects becomes more attractive. This is made all the more attractive by the minimal environmental impacts brought about by conservation projects compared to other strategies. Conservation can also be implemented at nearly any level because virtually all communities and demand centers have some potential for enhanced water use efficiency.

Senate Bill 1094, enacted by the Texas Legislature in 2003, created the Water Conservation Implementation Task Force to review, evaluate, and recommend optimum levels of water use efficiency and conservation for the state. Members of the Task Force, which were appointed by the Texas Water Development Board (TWDB), were a volunteer group of persons with experience in and commitment to using water more efficiently. The Task Force developed *TWDB Report 362 – Water*

Conservation Best Management Practices Guide, which outlines specific water conservation best management practices (BMPs) for various water uses. The Task Force was a temporary group, but it has been succeeded by the state Water Conservation Advisory Council, created by the Legislature in 2007. Among its other responsibilities, the Council updates the BMP Guide as needed.

5B.1.1 Challenges

Various challenges exist for the implementation of water conservation practices. Perhaps the most significant is the lack of information regarding the effectiveness of various practices. Traditionally, per-capita demand levels have not been tracked closely, and even when demand levels have been recorded, these values can be difficult to make use of due to the number of variables that may affect per-capita demand. For example, shifts in climate may dramatically influence outdoor water use. The only way to mitigate this data gap is the routine, annual collection of data to provide metrics on long-term benefits from conservation practices. This need for data carries over to the regional planning process as well. It is difficult for a Regional Water Planning Group (RWPG) to identify and recommend conservation practices for various Water User Groups (WUGs) within its region without knowledge of incorporated practices and the observed, realized benefits from conservation.

As interest in conservation has increased over time, driven in part by the challenge of procuring new water supplies and the experience of extreme drought, more information on conservation efficacy has become available. Multiple state agencies, including TWDB and the Texas Commission on Environmental Quality (TCEQ), have engaged in extensive efforts to promote water conservation and have greatly expanded the knowledge base available to water systems through studies, development of BMPs, and distribution of educational materials. Recognizing the difficulties involved in quantifying conservation, TWDB and the Water Conservation Advisory Council have prepared a guidance document, titled *Guidance and Methodology for Reporting on Water Conservation and Water Use*, to aid water suppliers in calculating and reporting water use over time. TWDB has engaged in a number of other activities promoting conservation, including:

- The Statewide Water Conservation Quantification Project to evaluate savings of conservation practices in relation to recommended conservation goals in the 2017 SWP.
- Administration of a detailed annual water use survey of municipal and industrial entities within the state, with the data obtained further utilized to develop per-capita usage estimates for WUGs.
- Development of a Municipal Water Conservation Planning Tool (MWCPT) to assist water systems in developing conservation plans.

Other organizations have also enhanced the knowledge base regarding conservation within Texas. The Texas Living Waters Project has examined the outdoor water use characteristics of single-family residential development for the 16 Regional Water Planning Areas in its report *Water Conservation by the Yard: A Statewide Analysis of Outdoor Water Savings Potential*. The Goldwater Project coordinated closely with numerous water systems to quantify water conservation efforts in Region H and contributed substantial information to the assessment of recommended municipal conservation WMS in the 2016 Region H Regional Water Plan (RWP).

There are also challenges associated with the implementation of water conservation at the regional level due to the fragmentation of the water supply system. Regional planning groups are responsible for planning and have no power to enforce or incentivize the recommendations resulting from the planning process. Therefore, producing meaningful results from water conservation requires buy-in at the WUG-level from hundreds of entities. When compared to traditional projects that can be sponsored by one or a handful of major stakeholders to produce significant results, conservation is often difficult to form partnerships around.

A lack of buy-in at the lowest levels is often associated with the lack of incentives to conserve. Although the total cost of water delivery such as treatment and pressure maintenance is driven by the total volume of water delivered, in many cases, the actual cost of water is independent of the volume consumed. In Region H, take-or-pay contracts are typical, and although they are easy to implement, they tend to offer little benefit to customers who conserve water. It is not until additional water must be purchased beyond the existing take-or-pay contract that a WUG would be financially compelled to conserve water to limit the need for contracting additional supply. While municipal conservation should save the utility capital expenses on new or expanded water and/or wastewater projects, there might need to be short-term rate increases depending on how much those rate structures are reliant on base fees.

5B.1.2 Importance of Conservation

Despite the many obstacles to implementing conservation projects for mitigating regional demands, the potential benefits make such programs incredibly valuable. Routinely, water conservation programs show up in the regional planning process as some of the lowest-cost strategies available. This avoidance of major infrastructure projects through reducing demands has the potential to delay or even eliminate much more costly programs in the regional plans.

Conservation is a scalable approach that can be applied to WUGs of any size. Typically, larger WUGs with larger water needs can also benefit the most from conservation programs. However, conservation programs have the opportunity to mitigate the need for additional water for virtually all WUGs.

The TWDB has placed a major emphasis on conservation through the implementation of its funding programs. Under the State Water Implementation Fund for Texas (SWIFT), TWDB has set aside at least 20 percent of the program's available funding for projects related to conservation and reuse. Furthermore, the rules adopted regarding the program provide consideration for "entities that have demonstrated water conservation or projects which will achieve water conservation, including preventing the loss of water" and provides opportunities for municipalities to demonstrate this through historical reduction in per-capita demand or water loss. Agricultural projects may also demonstrate successful conservation through proposed projects.

5B.1.3 Continuous Process

Where most water development projects are discrete efforts that result in making a new water supply available, conservation is a continuous process. Conservation benefits are recognized gradually over time and, while this does not allow for rapid implementation of these projects, the long-term impact yields great value for water supply management.

This characteristic of conservation programs is ideally suited to the regional water planning process. As regional planning occurs on a cyclical basis, conservation programs can be continually examined and projections adjusted to account for trends in past performance. By design, each round of regional water planning examines trends in per-capita demands and therefore benefits from the conservation already implemented at the WUG level. Successful implementation of conservation programs would mean that future rounds of planning could see needs diminishing without the implementation of projects simply due to the reduced demands.

However, in order to achieve these goals, the process requires routine and robust data collection and analysis. This information is required at the regional level to accurately ascertain the extent of conservation benefits and to responsibly guide future projections. At the utility level, it is required to provide metrics of program performance and cost and to give an understanding of what works and what changes need to be made.

5B.2 CONSERVATION IN REGION H

Recognizing the obvious benefits of responsible water management, Region H assigns high priority to the application of water conservation projects. Utilities within Region H are already taking advantage of a wide range of conservation practices, although the level of effort and the associated benefits vary throughout the region. In the scope of regional planning process, conservation projects are applied before other strategies in the RWP and, where appropriate, for WUGs regardless of identified need.

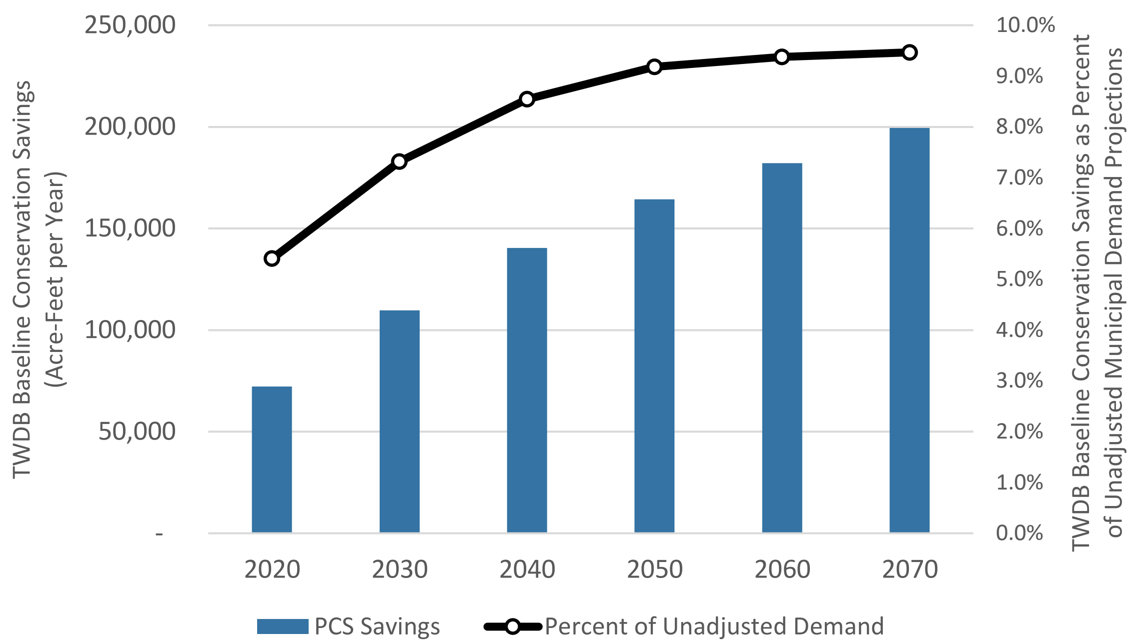
5B.2.1 Recommended Municipal Conservation

In the 2021 RWP, municipal conservation is divided into Baseline Conservation, Water Loss Reduction, and Advanced Conservation.

5B.2.1.1 Baseline Conservation

Baseline Conservation is developed and applied to total water demands by TWDB staff in the early stages of RWP development. This conservation is described as conservation that is anticipated due to factors outside of the projects identified in regional planning. For instance, there are water savings that are projected to occur due to implementation of plumbing code requirements that favor water-efficient fittings and fixtures. As older communities age, the legacy fixtures are replaced with more water-efficient ones. Additionally, the availability of higher-efficiency appliances is another factor that may reduce net water demand in the future. TWDB's baseline conservation includes these efficiency enhancements over time by default. Region H has adopted the TWDB recommendations, with limited approved changes, in every cycle of regional water planning. Baseline Conservation savings for Region H are shown in *Figure 5B-2*. It should be noted that Baseline Conservation is not included in WMS recommendations but rather is incorporated into the demand projections for the regional planning process.

Figure 5B-2 – Region H 2021 RWP Baseline Conservation



5B.2.1.2 Water Loss Reduction

Estimates of potential savings as a result of water loss reduction were developed using data from the 2015, 2016, and 2017 Water Loss Audit Reports prepared by TWDB. These reports identified by utility the estimated losses of various types calculated from production and sales records, including apparent losses due to unbilled or unmetered usage, metering accuracy limitations, and other causes as well as real losses from line breaks and leakage. *Figure 5B-3* details these various components of water use in Region H as reported in the 2017 Water Loss Audit Report. As demonstrated, real losses represent over 15 percent of the total water input to the region. The 2015 Water Loss Audit Report included data from 623 submitted audits in Region H, with a smaller number of additional reports submitted in other years; the water loss audit is performed on a five-year cycle which was initiated in 2005. The data represented in the 2015 report closely resembled that of the 2017 report, with real losses accounting for more than 13 percent of water input to Region H.

Figure 5B-3 – Region H Summary from 2017 Water Loss Audit Report

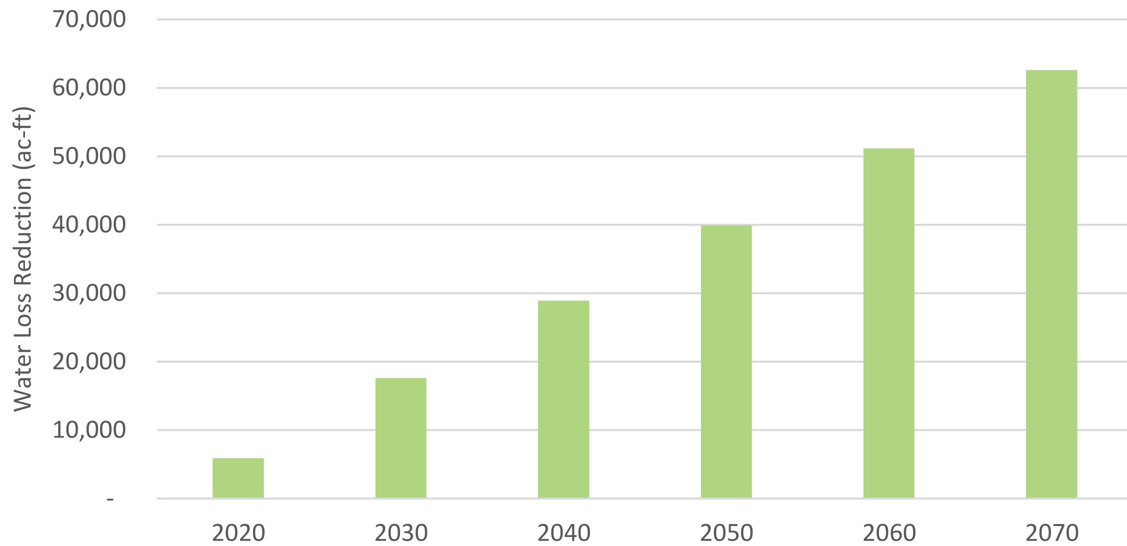
Totals for Region H 108 Audit(s) Submitted	System Input Value 174,159,904,788 100%	Authorization Consumption 145,238,706,368 83.3%	Bill Consumption 139,410,674,591 80.0%	Billed Metered 139,398,337,419 80.0%	Revenue Water 139,410,674,591 80.0%
				Billed Unmetered 12,337,172 0.0%	
			Unbilled Consumption 5,828,031,777 3.3%	Unbilled Metered 3,305,221,182 1.9%	Non-Revenue Water 34,761,567,369 19.9%
				Unbilled Unmetered 2,522,810,595 1.4%	
		Water Loss 28,921,198,419 16.6%	Apparent Loss 1,904,340,500 1.1%	Unauthorized Consumption 435,399,762 0.3%	
				Customer Meter Accuracy Loss 1,423,182,542 0.8%	
				System Data Handling Discrepancy 45,758,196 0.0%	
			Real Loss 27,016,857,919 15.5%	Reported Breaks And Leaks 15,660,052,421 9.0%	
				Unreported Loss 11,356,805,498 6.5%	

For the 2021 RWP, Region H identified utilities with real losses greater than 10 percent as potential targets for water loss reduction. Utilities meeting this criterion were assumed to reduce the fraction of their demands attributable to real loss by one percent annually throughout the planning period or until they reached the threshold level of ten percent real loss. No additional water loss reduction was applied to utilities with water loss identified at or below 10 percent. For the utilities which were identified as potential targets, reductions in water loss from this methodology would reduce per-capita demands, expressed in gallons per-capita daily (gpcd), for individual WUGs as shown in *Table 5B-1*. The total volume of potential savings from this methodology are shown below in *Figure 5B-4*, and a detailed summary of savings by individual WUGs can be found in **Appendix 5B-A**.

Table 5B-1 – Impact of Water Loss Reduction on Per-Capita Demands for Individual WUGs

Reduction in Per-Capita Demand (gpcd)	2020	2030	2040	2050	2060	2070
Minimum WUG Savings	0.3	0.3	0.3	0.3	0.2	0.2
Median WUG Savings	1.1	3.0	4.6	5.7	6.7	7.0
Average WUG Savings	1.4	3.7	5.6	7.1	8.3	9.3
Maximum WUG Savings	6.2	17.6	27.3	36.8	45.2	52.5

Figure 5B-4 – Region H 2021 RWP Water Loss Reduction



5B.2.1.3 Advanced Conservation

In the 2021 RWP, Region H identifies Advanced Conservation as methods for municipal demand reduction beyond Baseline Conservation with the exception of Water Loss Reduction. The estimated water savings from Advanced Conservation methods were developed using the Region H Municipal Regional Conservation Tool (MRCT), which is based largely on the methods, savings, and cost assumptions in the MWCPT, developed in 2018 by TWDB to assist utilities in water conservation planning and reporting. The MRCT was adapted to account for local water use characteristics and additional information specific to Region H. Because Baseline Conservation savings attributed to residential plumbing codes are already embedded in RWP water demand projections, the analysis for Advanced Conservation focused primarily on measures to reduce outdoor water use, which is a major driver of overall local municipal demand. Most of these measures are expected to reduce demand by single-family customers of water suppliers through measures such as rebate programs and distribution of home water reports, among others. Consideration was also given to some advanced indoor measures for commercial facilities. Additionally, mandatory outdoor watering restrictions were applied to municipal WUGs with the exception of the Woodlands, which already utilizes permanent outdoor watering restrictions. A 2018 report by the Texas Living Waters Project estimates that restrictions on outdoor municipal watering could save 2 percent to 11 percent of total municipal water use, depending on the amount of education and enforcement implemented by a water utility. Projected savings for the 2021 Region H RWP were based on the assumption that all connections would implement a twice-per-week watering restriction, resulting in overall savings of 2 percent of demand. In order to account for the potential for different levels of implementation and water system customer compliance, particularly in the early stages of a watering restriction program, estimates for Region H apply the lower end of the savings spectrum identified by the Texas Living Waters Project; utilities that implement conservation programs early on with a significant amount of education and enforcement could see even greater savings of water.

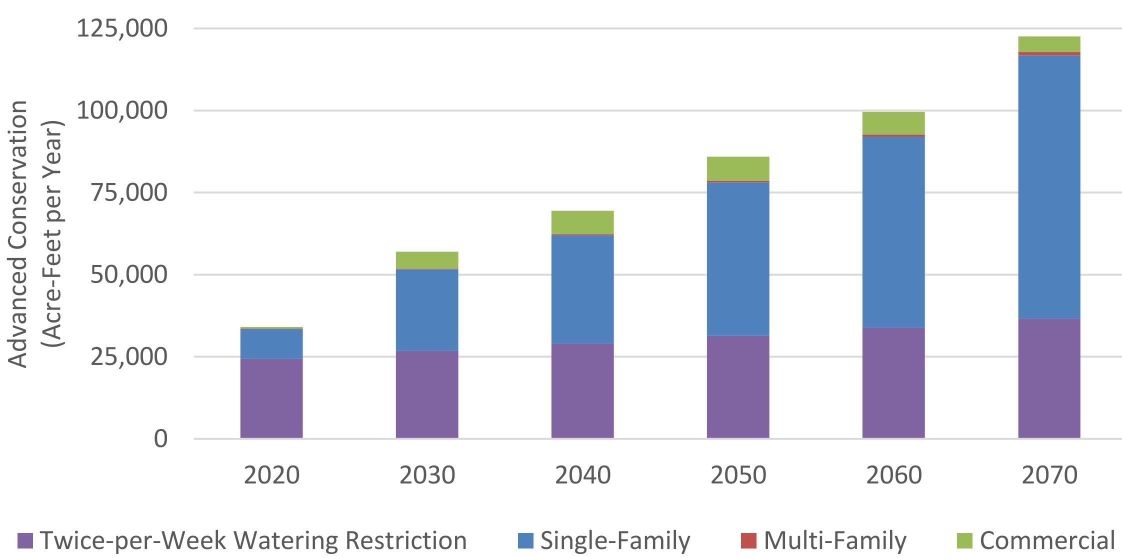
While mandatory outdoor watering restrictions were applied to all municipal WUGs in Region H, other measures were implemented at varying levels for different WUGs. Because the financial resources and savings potential varies widely among WUGs, municipal WUGs were grouped into three categories (small, medium, and large) based upon population, with these further divided into categories of low, mid, and high savings potential based upon per-capita demand after the inclusion of baseline savings assumed by TWDB each decade. This categorization acknowledges that larger WUGs would likely have greater resources available to implement a broader range of measures at a more aggressive rate, while smaller WUGs may be limited to more gradual programs. Additionally, WUGs with higher per-capita demands offer the greatest potential for conservation savings, while those with low per-capita demands may have limited savings potential or, through existing proactive conservation programs, have already substantially reduced water use. Population thresholds of 15,000 and 300,000 persons served were used to categorize WUGs by size, and per-capita demand thresholds of 120 gpcd and 220 gpcd were used to indicate the WUG's potential for conservation savings. This methodology is discussed in more detail in the technical memorandum for Municipal Conservation found in **Appendix 5-B**.

Table 5B-2 describes the impact on per-capita demands of individual WUGs by the advanced conservation measures recommended by Region H. The resulting savings are shown below in *Figure 5B-5*, and a detailed summary of savings by individual WUGs can be found in **Appendix 5B-B**.

Table 5B-2 – Impact of Advanced Conservation on Per-Capita Demands for Individual WUGs

Reduction (gpcd)	2020	2030	2040	2050	2060	2070
Minimum	0.0	0.0	0.0	0.0	0.0	0.0
Median	3.8	5.6	6.1	6.8	7.3	8.3
Average	4.1	5.9	6.3	7.0	7.5	8.4
Maximum	16.3	17.3	17.3	18.5	18.3	18.7

Figure 5B-5 – Region H 2021 RWP Advanced Conservation

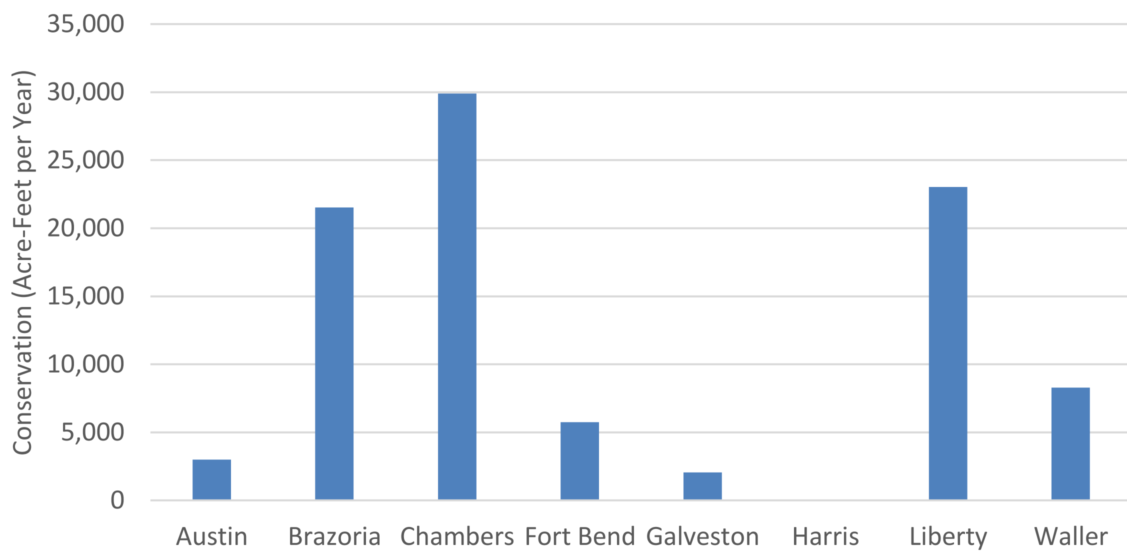


5B.2.2 Recommended Non-Municipal Conservation

In addition to being a major population center, Region H is also filled with competing, non-municipal water demands that may also benefit from water-efficient practices. Irrigation users have limited opportunity to fund substantial infrastructure projects to develop new water supplies. For these WUGs, conservation presents an affordable opportunity to maximize limited water supplies during drought of record conditions. Irrigation conservation methods recommended in the 2021 RWP include off-farm techniques (lining canals) as well as the incorporation of on-farm best management practices (laser leveling, reduced levee intervals, etc.) in eight counties. The potential savings from irrigation conservation are shown below in *Figure 5B-6*, for a total of 93,562 ac-ft/yr in all planning decades.

Region H is a major industrial nexus, not only within Texas but on a global scale, and as a result exhibits a large water demand for multiple manufacturing sectors. As noted in ***Chapter 2***, the required assumption of constant manufacturing water demand after 2030 for the current cycle of RWP development does not reflect the ongoing growth in the manufacturing sector in Region H. For this reason, the Region H Water Planning Group (RHWPG) has not included Industrial Conservation as a recommended WMS for the 2021 RWP in order to avoid further underrepresenting the need for water supply and infrastructure development. In reality, many manufacturing facilities already practice extensive internal water recycling and conservation, and Region H recognizes the value in continued and expanded industrial conservation.

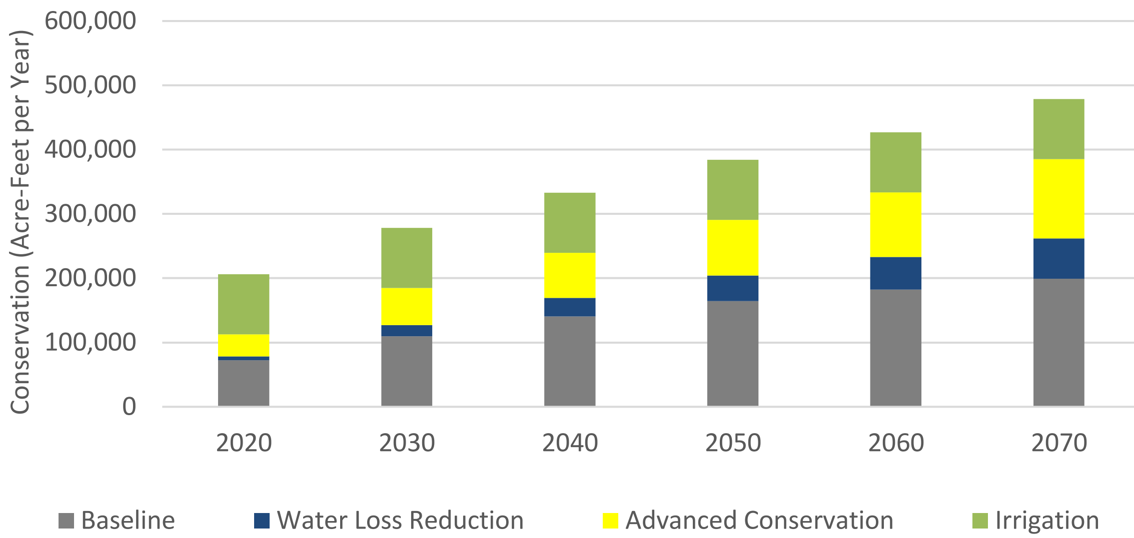
Figure 5B-6 – Region H 2021 RWP Irrigation Conservation



5B.2.3 Total Impact of Recommended Conservation in Region H

Collectively, conservation represents a major water management strategy for Region H. The total amount of recommended municipal and irrigation conservation exceeds the level applied in the 2016 RWP. In particular, greater implementation of advanced municipal conservation in early decades has been recommended in the 2021 RWP, as compared to the more gradual implementation approach in the previous plan. Recommended conservation for the 2021 Region H RWP is illustrated *Figure 5B-7*.

Figure 5B-7 - Total Region H 2021 RWP Conservation



As Baseline Conservation is applied to total water demand rather than the net water demands generally discussed in plan development, it is necessary to describe the impact of these demand reductions in terms of total demand. Meanwhile, Water Loss Reduction and Advanced Conservation are applied to the net demand after Baseline Conservation is applied, meaning their impacts can be compared against the net demand. The actual impacts of all conservation methods are described below in *Table 5B-3*.

Table 5B-3 – Summary of Municipal Conservation Impacts by Decade

Conservation Metric	Basis	2020	2030	2040	2050	2060	2070
Baseline Conservation	% of Total Demand	5.4%	7.3%	8.5%	9.2%	9.4%	9.5%
Water Loss Reduction	% of RWP Net Demand	0.5%	1.3%	1.9%	2.5%	2.9%	3.3%
Advanced Conservation		2.7%	4.1%	4.7%	5.3%	5.7%	6.5%
Total Additional Conservation (Water Loss + Advanced)		*3.2%*	*5.4%*	*6.6%*	*7.8%*	*8.6%*	*9.7%*
Total Conservation Methods (Baseline + Water Loss + Advanced)	**% of Total Demand**	**8.4%**	**12.3%**	**14.6%**	**16.2%**	**17.2%**	**18.3%**

Based on the projected Baseline Conservation, net per-capita demands in the RWP decrease slightly with each decade for most municipal WUGs. The RWPG anticipates that most WUGs will experience some reduction in average per-capita water use over the 50-year planning horizon, and per-capita demand goals reflect the expectation that WUGs will, at a minimum, achieve the reduction in water use projected by TWDB as part of Baseline Conservation. Additionally, the RWPG strongly encourages water providers to actively pursue methods to reduce per-capita water demand, such as Water Loss Reduction and the measures recommended in the Advanced Conservation strategies. The projected per-capita demand after implementation of such strategies may be considered as the target gallons per-capita daily goal for municipal WUGs in Region H. However, the ability of individual utilities to implement recommended strategies may vary, and the RHWPG recognizes that actual conservation may result in future per-capita demands that are smaller or larger than these goals. Additionally, the per-capita demand targets recommended in Region H are specifically related to the drought-of-record conditions assessed throughout the RWP. Demands in an average year may be greater or less than dry-year demands, depending on the specific nature of water use within each utility's service area. As a result, these recommendations are not intended to be compared to the demand goals set by many entities in their water conservation plans, as discussed in the following sections. Actual per-capita demands will also vary among individual utilities represented by County-Other municipal WUGs. The per-capita demand goals for each municipal WUG in Region H can be found in **Appendix 5B-C**.

5B.2.4 Current Conservation Efforts in Region H

Conservation efforts vary across Region H. It is noted that different utilities take various levels of interest in effectively developing, deploying, and measuring their conservation programs. The variation between utilities is demonstrated in the numerous approaches to water conservation plans (WCPs) prepared by Region H water suppliers. In current conservation efforts, Region H water suppliers commonly adopted variations of Best Management Practices (BMPs) recommended by TWDB within their WCPs. BMPs are measures that water users can choose to implement in order to achieve water conservation goals and benchmarks. BMPs are voluntary measures intended to save a quantifiable amount of water, either directly or indirectly, and can be implemented within a specific time frame. The TWDB has extensive resources describing water conservation BMPs applicable to various water use sectors (agricultural, commercial/institutional, industrial, municipal, and wholesale) that entities can choose to apply in their water conservation efforts.

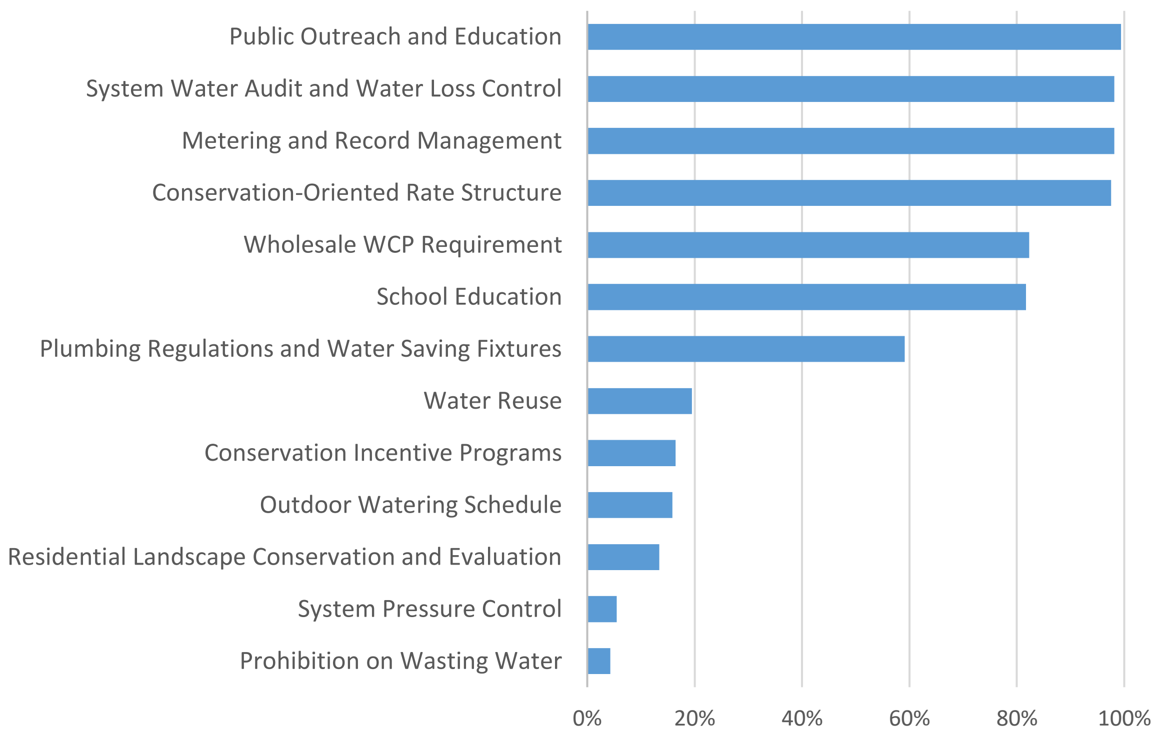
In order to quantify current conservation efforts within Region H, WCPs adopted by 164 water systems in Region H during the period 2015 to 2019 (inclusive) and provided to the RWPG were reviewed to assess water conservation practices and water savings goals. Based on this review, 13 common water conservation practices were identified which were recommended by at least five percent of water systems. These practices primarily correspond to the TWDB water conservation BMPs; however, they have been adapted to fit the specific needs of entities within Region H. *Table 5B-4* includes a list and description of these practices.

Table 5B-4 – Common Conservation Practices in Water Conservation Plans Within Region H

Conservation Practice	Description
Metering and Record Management	Master metering to measure and account for water produced or received, universal metering of customers and public use, and maintenance of a detailed record management system.
System Water Audit and Water Loss Control	Programs to determine nonrevenue water, including periodic visual inspections along distribution lines, system audits to determine illegal connections, investigation of abandoned services, and continuous programs of leak detection, repair, and water loss.
Conservation-Oriented Rate Structure	Adoption of conservation-oriented rate structures that encourage conservation and discourage excessive use and waste of water, such as an increasing block rate.
Conservation Incentive Programs	Incentivized programs that promote water conservation, including funding opportunities for upgrading infrastructure or irrigation systems, as well as rebates for irrigation system upgrades and evaluations.
Residential Landscape Conservation and Evaluation	Use of water conserving landscape techniques (e.g., "Water Wise" landscape design), irrigation system updates, or residential landscape evaluations offered by licensed irrigators.
School Education	Informational programs conducted at local schools to educate students about water conservation.
Public Outreach and Education	Educational programs to promote water conservation to the general public, including publication of conservation literature, distribution of educational materials on-line or through mail, and education programs for users at a public place.
Plumbing Regulations and Water Saving Fixtures	Adoption of plumbing codes and ordinances; implementation of plumbing retrofit programs, water-conserving plumbing fixtures installed in new construction and in the replacement of plumbing in existing structures.
Prohibition on Wasting Water	Enforcement of ordinances prohibiting water theft and wasteful water use activities.
Water Reuse	Direct or indirect water reuse efforts are implemented in the current system or reuse adoption is encouraged and/or supported by the utility.
Outdoor Watering Schedule	Voluntary or mandatory outdoor watering restrictions in effect on designated days and times during a week.
System Pressure Control	Programs for pressure control and/or reduction in the distribution system, adequate operational pressure determined for the system.
Wholesale WCP Requirement	Wholesale water provider requires that any customers develop and submit a water conservation plan .

Based on the analysis of WCP documents submitted to the RHWPG, the adoption rates of various practices in WCPs within Region H are summarized in *Figure 5B-8*. Popular approaches to conservation (those with an adoption rate of greater than 80 percent) include metering and record management, system auditing and water loss control, conservation-oriented rate structures, and public outreach and education. Other common conservation approaches (adoption rate greater than 50 percent) include school education and implementation of plumbing regulations and water saving fixtures. Water reuse, outdoor watering schedules, conservation incentive programs, and residential landscape conservation and evaluations have also been adopted, although at a less consistent rate (10 to 50 percent of WCPs). Water system control and prohibitions on wasting water are rarely prescribed (less than 10 percent of WCPs). Furthermore, in the majority of WCPs, wholesale water providers (WWPs) require their customers to develop and submit a WCP in accordance with the rules of TCEQ or TWDB. The RWPG encourages WWPs and retail providers to coordinate with their customers on developing and implementing their WCP and water conservation measures.

Figure 5B-8 – Percentage of Common Practices in Region H Water Conservation Plans



Over 90% of the 164 water systems that submitted WCPs established five and ten-year goals for water savings. *Table 5B-5* shows a statistical summary of the five- and ten-year water savings goals from the submitted WCPs. Common water savings goals include targets for total gallons-per-capita daily (GPCD), total GPCD reduction, residential GPCD, and water loss (GPCD and/or percentage). Many entities developed these goals based on the historic water use and non-revenue water (water losses) within their individual system. As a result, the water savings goals set by the different water systems vary significantly.

Table 5B-5 – Summary of Water Conservation Goals in Region H Water Conservation Plans

Water Savings Goal Type	Number of WCPs that Set Goal Type	5-Year			10-Year		
		Average	Max	Min	Average	Max	Min
Total GPCD	103	138	1,100	7	133	1,000	5
Total GPCD Reduction	44	3	6	1	9	13	1
Water Loss (%)	147	7%	20%	0%	7%	17%	0%

5B.2.5 Water Conservation Planning

The RHWPG recognizes the benefits of conservation as part of a diverse water management portfolio. For this reason, the RHWPG recommends water providers take special care in preparation of conservation programs which include the development of useful, comprehensive water conservation plans.

The RHWPG recommends the conservation plan development process begin with the templates developed by the TCEQ. These templates have been developed for specific types of water providers and users and form a strong basis for development of conservation plans. The templates and other resources related to conservation planning may be found at the following location:

https://www.tceq.texas.gov/permitting/water_rights/conserve.html.

The RHWPG also recognizes and would like to stress that conservation efforts do not end at the development of conservation plans. It is imperative that conservation planning go beyond the statutory requirements to develop plans and perform required reporting. It is essential that utilities seek to identify and apply effective, meaningful conservation practices that are suited to their specific needs and customer base. In addition, regular review of conservation progress and performance is required in order to accurately adjust plans and practices in order to achieve meaningful goals. Conservation plans should be regularly reviewed even between required submittal deadlines and adjusted, as necessary, to optimize programs on a cost-benefit basis.

One factor that should be considered when examining a water conservation strategy is the cost of water. Developing an effective, meaningful water rate structure can not only encourage responsible water use but can also aid in the funding of future projects. There are many resources available to assist in this process. One resource has been developed by the Sierra Club in conjunction with the University of North Carolina and can be found online:

http://texaslivingwaters.org/wp-content/uploads/2014/03/Texas-Rate-Report-2014-Final-1.pdf.

The Alliance for Water Efficiency has also developed a handbook on designing water rate structures, which can be accessed online as well:

https://www.financingsustainablewater.org/tools/building-better-water-rates-uncertain-world.

Finally, it is absolutely essential to distinguish the purposes of water conservation plans and drought contingency plans. Each of these documents serves an important purpose in managing water resources but they are often confused and improperly associated in planning efforts. Utilities should remember to consider water conservation practices that encourage long-term reductions in water use that can be continued on a sustainable basis. Effective conservation plans should promote gradual and consistent reduction in water use over the life of the plan. Short-term measures that curtail water use to meet emergency drought conditions are discussed in greater detail in ***Chapter 7***.

CHAPTER 6
IMPACTS OF THE REGIONAL WATER PLAN

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Chapter 6 – Impacts of the Regional Water Plan

6.1 IMPACTS OF WATER MANAGEMENT STRATEGIES AND PROJECTS ON KEY WATER QUALITY PARAMETERS IN THE STATE AND IMPACTS OF MOVING WATER FROM AGRICULTURAL AND RURAL AREAS

The development of the Region H Regional Water Plan (RWP) is part of a consensus-based planning effort to include local concerns in the statewide water supply planning process. This chapter addresses:

- Impacts of Water Management Strategies (WMS) and Projects on Key Parameters of Water Quality, and
- Impacts of Moving Water from Rural and Agricultural Areas.

As defined by the rules and guidance for regional water plan development, the concept of a "project" refers to specific infrastructure that is used to increase or manage water supplies. Projects may be associated with one or more WMS and, similarly, a WMS may consist of one or more projects. References in the discussion below to WMS should be considered inclusive of the associated concept of projects.

6.1.1 Impacts of Water Management Strategies and Projects on Key Parameters of Water Quality

The potential impacts that WMS and associated projects may have on water quality are discussed in this section, including the identified water quality parameters which are deemed important to the use of the water resources within the region. Under the Clean Water Act, Texas must define designated uses for all major water bodies and, consequently, the water quality standards that are appropriate for that designated water body use. The water quality parameters which are listed for Region H below were selected based on the *TCEQ Water Quality Inventory for Designated Water Body Uses* as well as the water quality parameters identified in the Texas Commission on Environmental Quality (TCEQ) 303d list of impaired water bodies. For reference purposes, ***Appendix 6-A*** contains the TCEQ 303d list of impaired waters within the region. Throughout this process, plan development was guided by the principle that the designated water quality parameters and related water uses as shown in the state water quality management plan shall be improved or maintained.

Key surface water parameters identified within Region H fall into two broad categories:

<u>Nutrients and non-conservative substances:</u>

- Bacteria
- pH
- Dissolved Oxygen
- Total Suspended Solids (TSS)
- Temperature

- Nutrients (Nitrogen, Phosphorus)

<u>Minerals and conservative substances:</u>

- Total Dissolved Solids (TDS)
- Chlorides
- Mercury
- Salinity
- Sediment Contaminants

Non-conservative substances are those parameters that undergo rapid degradation or change as the substance flows downstream, such as nutrients which are consumed by plant life. Nutrient and non-conservative loading to surface water originates from a variety of natural and man-made sources. One significant source of these loads is wastewater treatment facilities. As population increases, the number and size of these wastewater discharges will likely increase as well. Stormwater runoff from certain land use types constitutes another significant source of nutrient loading to the region's watercourses, including agricultural areas, golf courses, residential development, or other landscaped areas where fertilizers are applied. Nutrient loads in Region H are typically within the limits deemed acceptable for conventional water treatment facilities and are therefore not considered a major concern as related to source of supply.

Conservative substances are those that do not undergo rapid degradation or do not change in water as the substance flows downstream, such as metals. Mineral and other conservative substance loading to surface water generally originates from three sources: (1) non-point source runoff or groundwater seepage from mineralized areas, either natural or man-made, (2) wastewater discharges, and (3) sea water migration above estuaries. Region H is fortunate in that the first category is not typical of this area except for the Brazos River, which has several natural salt-contributing areas; fortunately, flows in the lower basin generally are sufficient to dilute these sources to easily manageable concentrations. Wastewater discharges, and industrial discharges in particular, have improved over historical levels due to enforcement and the implementation of projects compliant with appropriate standards. If local concentrations of conservative contaminants beyond an acceptable standard are identified, they are remediated by the appropriate agency. Salinity migration above estuaries is controlled in the Trinity River by the Wallisville Saltwater Barrier and in the San Jacinto River by the Lake Houston Dam. The 2021 Regional Water Plan recommends a saltwater barrier be added above the Brazos estuary to protect water quality in that reach of the Brazos River as well. Additionally, sediment contaminants can provide particulate matter that can encourage the growth of blue-green algae (cyanobacteria). Sand mining in particular has led to increased nutrient loads in the San Jacinto River which can result in an increase in cyanobacteria levels.

Groundwater in Region H is generally of good quality with no usage limitations. Quality parameters of interest include Total Dissolved Solids (TDS), metals, and hardness. Portions of the Carrizo-Wilcox Aquifer can contain levels of iron that require sequestering or removal through treatment facilities. The Brazos River Alluvium is directly recharged from the base flow in the Brazos River and has the potential to reflect any contaminant loading of the Brazos River. Portions of the aquifer currently experience elevated TDS and hardness.

Water quality of the Gulf Coast Aquifer is generally good throughout the region. The Chicot and Evangeline formations are capable of yielding moderate to large amounts of fresh water in most of the region. Fresh water is overlain and underlain by saline water in coastal areas, and the coastal deposits are not capable of yielding fresh water. Deeper formations throughout the region are able to supply limited freshwater and slightly saline water in updip areas.

Some localized sites within the region have the potential to cause contamination of the aquifer under adverse conditions. These sites formerly generated surface water pollution which, if not properly handled, could cause contamination of local soils or shallow groundwater supplies. Except for the northern areas of the region, the thickness of the near-surface clay soils located over much of the region provide an effective barrier to deeper aquifer contamination due to normal infiltration. As a consequence, the primary risk for groundwater contamination in the Gulf Coast Aquifer occurs if there are improperly designed or inadequately sealed wells which are exposed to this surface contamination. Localized shallow alluvial aquifers primarily located along the major streams such as the Brazos River are at greater risk for contamination from these sites as a result of the more direct travel paths for potential contaminated water to reach these areas, especially if they are being pumped by small household or livestock wells. At this time, there are no recorded incidents of contaminated groundwater in the region as a result of these sites.

The WMS and projects selected by the Region H Water Planning Group (RHWPG) were evaluated to determine their impacts on water quality. This evaluation used the data available to compare current conditions to future conditions with Region H management strategies in place. The key recommended management strategies, as described in ***Chapter 5*** of this report and used in this evaluation, are listed below in *Table 6-1*.

Table 6-1 – Key Recommended Water Management Strategies and Projects

Conservation
Advanced Municipal Conservation
Irrigation Conservation
Water Loss Reduction
Conveyance
BWA Transmission Expansions
CHCRWA Transmission and Distribution Expansion
City of Houston GRP Transmission
COH, NHCRWA, and CHCRWA Shared Transmission
CWA Transmission Expansion
East Texas Transfer
GCWA Industrial Raw Water Line
Lake Livingston to SJRA Transfer
LNVA Neches-Trinity Basin Interconnect
NFBWA Phase 2 Distribution Segments
NHCRWA Distribution Expansion
NHCRWA Transmission Lines
Southeast Transmission Line Improvements
Surfside Beach Supply Infrastructure
WHCRWA Distribution Expansion
WHCRWA/NFBWA Transmission Line

Groundwater Development
Aquifer Storage and Recovery
Brackish Groundwater Development
BWA Brackish Groundwater Development
City of Houston Area 2 Groundwater Infrastructure
Expanded Use of Groundwater
GCWA Backup Well Development
Groveton Groundwater Expansion
SJRA Catahoula Aquifer Supplies
Groundwater Reduction Plans
CHCRWA GRP
City of Houston GRP
City of Missouri City GRP
City of Richmond GRP
City of Rosenberg GRP
City of Sugar Land IWRP
Fort Bend County MUD 25 GRP
Fort Bend County WC&ID No. 2 GRP
Montgomery County MUDs 8 and 9 GRP
NFBWA GRP
NHCRWA GRP
Porter SUD Joint GRP
River Plantation and East Plantation Joint GRP
SJRA GRP
WHCRWA GRP
Reuse
City of Houston Reuse
City of Pearland Reuse
Galveston County Industrial Reuse
NFBWA Member District Reuse
NHCRWA Member District Reuse
San Jacinto Basin Regional Return Flows
Wastewater Reclamation for Municipal Irrigation
Westwood Shores MUD Reuse
Surface Water Development
Allens Creek Reservoir
BRA System Operation Permit
Dow Reservoir and Pump Station Expansion
Freeport Seawater Desalination
Manvel Supply Expansion
Mustang Reservoir Improvements
NRG Cedar Bayou Desalination

Treatment
BWA Conventional Treatment Expansion
City of Houston Treatment Expansion
City of Houston West Water Purification Plant
GCWA Galveston County Treatment Expansion
Northeast Water Purification Plant Expansion
Pearland Surface Water Treatment Plant
SEWPP Additional Module
Other
Brazos Saltwater Barrier
Chocolate Bayou Pump Station Expansion
Chocolate Bayou Saltwater Barrier Improvements

The following paragraphs discuss the impacts of each key project on the chosen water quality parameters.

Water Conservation, including municipal and agricultural conservation, can have both positive and negative impacts on water quality. Water that is being processed through a wastewater treatment plant typically has acquired additional dissolved solids prior to discharge to the waters of the state. Conventional wastewater treatment reduces suspended solids but does not reduce dissolved solids in the effluent. Water conservation measures will reduce the volume of water passing through the wastewater plants without reducing the mass loading rates (a 1.6-gallon flush carries the same waste mass to the plant that a 6-gallon flush once carried). This may result in slightly increased conservative contaminant loads in the stream. However, it should be noted that, during low flow conditions, the wastewater effluent in a stream may represent water that helps to augment and maintain the minimum stream flows. Tail water is the term used to describe that water returned to the stream after application to irrigated cropland. Tail water carries nutrients, sediments, salts, and other pollutants from the farmland. This return flow can have a negative impact on water quality, and by implementing conservation measures which reduce tail water losses, the nutrient and sediment loading can be reduced. Once again, however, this return flow tends to be introduced into the receiving stream during normally dry periods so it may have a net beneficial effect in terms of maintaining minimum stream flow conditions. Furthermore, the loss of the return flows could be offset by a reduction in irrigation diversions resulting in no net effect on the stream flow.

The Lake Livingston to SJRA Transfer is not expected to create any new water quality issues. Fully utilizing existing water supplies may amplify some existing concerns, particularly contaminant concentrations due to reduced opportunities for instream dilution. The continued return of flows via wastewater treatment facility discharges will provide additional return flow in the receiving basin. Typical municipal return flows are 60 percent of the total quantity diverted for use.

The East Texas Transfer has the potential to introduce Neches and Sabine River water into the Trinity, San Jacinto, San Jacinto-Brazos, and Brazos Basins. This strategy therefore has the potential to result in changes in water chemistry, temperature, nutrients, organic particulates, and sediment in the Neches and Trinity Basins and possibly in receiving basins, depending on how the water is received and utilized. Instream flows in the lower Sabine River will also be reduced by the additional diversion of water from the Sabine River Basin. Instream flows in portions of the Neches, Trinity, and San Jacinto Rivers will increase slightly. Water transferred from the Sabine to the San Jacinto Basin will be used to meet demands primarily in the San Jacinto, Brazos, and San Jacinto-Brazos Basins. This may be accomplished by using the imported water in lieu of Trinity water from Lake Livingston to meet demands in Harris County. Additional infrastructure would be required to convey water from the San Jacinto Basin to meet demands in the Brazos and San Jacinto-Brazos Basins.

The LNVA Neches-Trinity Basin Interconnect would allow the movement of Neches River water westward toward the upper reaches of the Devers Canal system and potentially back into the Trinity River, with some potential for changes in water chemistry and other parameters. Non-consumptive use of a portion of the water by agriculture could also result in an increase in return flows in the receiving basin.

Conveyance and Treatment projects, including those related to Groundwater Reduction Plans (GRPs), Southeast Transmission Line Improvements, and the Chocolate Bayou Pump Station Expansion are not expected to have any direct impact on the on key water quality parameters. However, they do facilitate the implementation of other projects that may have impacts. The development of Surfside Beach Supply Infrastructure will convey additional high-quality supplies, addressing current water quality limitations through blending.

Projects such as BWA Brackish Groundwater and the general Brackish Groundwater Development sometimes utilize dilution and discharge to deal with brine concentrated during treatment processes. This can result in an elevated level of TDS in streams used as receiving waters as well as other quality impacts depending upon the quality of the groundwater source. The SJRA Catahoula Aquifer Supplies project aims to potentially use the bed and banks of Lake Conroe to convey raw groundwater and this may, similarly, impact water quality.

Groundwater projects, including GCWA Backup Well Development, Groveton Groundwater Expansion, and general Expanded Use of Groundwater projects are not expected to have significant environmental effects. Groundwater within the region is generally of good quality and available at the point of use. Increases in well pumping will also contribute to return flows in all river basins in Region H. The return flows will increase in proportion to increased groundwater use and significantly contribute to flows into Galveston Bay. Increased groundwater pumping in the region will continue to be monitored by groundwater regulatory agencies since excessive pumping can lead to land subsidence and exacerbate flooding and drainage problems. Aquifer Storage and Recovery would result in only limited impacts to water quality, with reduction in instream flows during periods of filling additional subsurface capacity.

Wastewater Reuse projects will potentially reduce instream flows, thus concentrating any instream contaminants. However, the reuse process should remove a portion of the waste load discharged from these facilities, either through the secondary treatment process or simply by the rerouting of effluent. Much of this reuse is not projected to occur until a time when the overall water use of the region has increased. Wastewater return flows will increase proportionally, so that the reuse of this portion will not constitute a significant reduction below current return flows.

Allens Creek Reservoir and the Dow Reservoir and Pump Station Expansion will modify downstream flow regimes but potentially have positive impacts on water quality. These off-channel reservoirs will be operated as “scalping reservoirs.” During times of high flow, water quality in the Brazos River is often poor in terms of suspended solids due to increased sediment loads. At the same time, that water is of better quality in terms of dissolved solids concentrations since the salt being introduced into the Brazos in its upper reaches is diluted. The water that is diverted and stored in reservoirs would allow sediments to settle and accordingly water released from the reservoir would potentially have less sediment concentration. However, reduced sediment loads may have negative impacts on habitats relying on sediments downstream of the proposed reservoirs. Nutrients such as nitrogen and phosphorous are often attached to fine sediment particles that settle in reservoirs reducing nutrient loads to downstream aquatic species. Water that is released from the reservoirs during low flow conditions would have a beneficial effect by diluting the low flow salt concentration in the river. Other surface water development projects, including Mustang Reservoir Improvements, and Manvel Supply Expansion would result in only limited impacts to water quality, with reduction in instream flows during periods of filling additional capacity.

Projects utilizing supplies from the BRA System Operation Permit potentially impact the water quality in the lower basin depending on the actual diversion quantities and diversion locations. Decreased instream flows directly influence saltwater intrusion, which may be mitigated by a saltwater barrier. Although the maximum diversions anticipated under the system operations conditions may cause some slight impact on estuary conditions, the frequency of occurrence for these maximum diversions is very low. Additionally, since the Brazos River empties directly into the Gulf of Mexico, operational changes will not affect a large bay system but may impact flows into the Brazos River Estuary and the Columbia Bottomlands. Changes to flow patterns will likely be localized and fall within historical parameters.

Freeport Seawater Desalination does not affect other WMSs and affects only the salinity levels in the area of discharge. The discharge water will blend with and be diluted by other water before flowing into the Brazos River above the Intracoastal Waterway. The diversion of Brazos River water to supplement seawater supplies to the desalination plant would maximize the operational efficiency but could increase the salinity of the Brazos River Estuary, depending upon the size and season of the diversion. NRG Cedar Bayou Desalination would similarly not impact other WMS and would utilize an existing saline diversion authorization as a source, with discharge to existing canal infrastructure being diluted by large quantities of existing water circulated for cooling.

Saltwater Barrier projects would help maintain water quality in the lower Brazos Basin and San Jacinto-Brazos Coastal Basin during low flow periods. Currently, during low flow periods the Dow Chemical and Brazosport Water Authority lower intakes are compromised due to saltwater intrusion. Increased use of Brazos River supplies will extend this seasonal condition upstream unless a barrier or other control measure is implemented. Similar limitations during low flow periods impact the Gulf Coast Water Authority Chocolate Bayou intake.

6.1.2 Impacts of Moving Water from Rural and Agricultural Areas

Currently, the water used in rural and agricultural areas represents approximately 13 percent of the total water used in Region H. From the year 2000 to 2017, agricultural water use declined approximately 20.2 percent, and this trend continues as overall production is reduced. Although irrigation and livestock sector demands are held constant throughout the planning period, these trends are retained as a conservative estimate of demand and have not been proven accurate when compared against actual trends. Water management strategies, along with current sources of reliable water supply and interruptible supplies, are available to agricultural users throughout the planning period. However, these projects often come at a price that cannot be supported by agriculture.

The potential impacts of moving water from rural and agricultural areas are mainly associated with socio-economic impacts to third parties. The potential impetus for moving water is expected to occur from two sources: 1) the cost of raw water may become too great for the local irrigator to afford, and the irrigator may elect to voluntarily leave the industry for economic reasons; or 2) the value of the raw water for municipal or industrial purposes may create a market for the wholesale owner to redirect the sale of the water making it unavailable to the irrigator. In some cases, it may be feasible for a third-party, such as a water wholesaler, to pay for conservation measures and then utilize the saved water for their own needs (through recontracting or other agreements) and allow the irrigator to remain in business; however, there are few contractual and institutional measures in effect to allow this trade-off to occur at this time. The intent of this plan is to provide water or the conservation means to meet all projected water demands throughout the planning period.

In many cases, drought-of-record climate conditions bring about economic conditions where agriculture is left without a reasonable water supply. Throughout the region, irrigation usage is already met almost entirely through interruptible water supplies that do not have the benefit of storage and drought protection as a result of the overall cost of water. Livestock supplies are often sourced from local supplies and stock ponds that do not have reliable supplies under drought conditions. In both of these cases, agricultural users often turn to additional groundwater pumpage to close the gap in need. Often these supplies are outside of the Modeled Available Groundwater (MAG) used for planning and, therefore, are outside of this planning process.

6.2 DESCRIPTIONS OF HOW REGIONAL WATER PLANS ARE CONSISTENT WITH THE LONG-TERM PROTECTION OF THE STATE'S WATER, AGRICULTURAL, AND NATURAL RESOURCES

The Region H Water Planning Group balanced meeting water needs with good stewardship of the water, agricultural, and natural resources within the region to promote a balance of economic, social, aesthetic, and ecological viability. The RHWPG recommended water conservation as the first strategy applied to meet projected shortages where appropriate. In the strategy selection process, the yield and environmental impact of projects were given greater consideration than the unit cost of water.

The RHWPG believes that local groundwater conservation districts are best suited to manage groundwater resources in the areas which the individual districts have the responsibility to regulate. This plan recommends using groundwater up to the local sustainable yield or to the restrictive limit established under subsidence district regulations to meet local demands but does not recommend the exportation of groundwater from its county of origin. The effects of the recommended WMS on specific resources are discussed in further detail within this chapter.

6.2.1 Water Resources within Region H

Water resources available by basin within Region H are discussed in further detail below.

6.2.1.1 Neches-Trinity Coastal Basin

The Neches-Trinity Coastal Basin has numerous creeks and bayous which flow into East Bay. Many of these creeks and bayous provide water for irrigation and it is expected that this irrigation use will continue. Additional supplies are transferred into the Neches-Trinity Basin by the Lower Neches Valley Authority (water from the Sam Rayburn Reservoir and B.A. Steinhagen Lake System) and by the

Chambers-Liberty Counties Navigation District (CLCND) (water from the Trinity River). This plan recommends increased use from existing sources. Additional supplies from the Trinity are not recommended, which would affect the discharge location of return flows within Galveston Bay. No other impacts by these strategies are foreseen.

Groundwater supplies within the Neches-Trinity Basin come from the Gulf Coast Aquifer. The plan reflects using but not exceeding the sustainable yield of the aquifer in this basin.

6.2.1.2 Trinity River Basin

The Trinity River serves both Regions C and H. Within Region H, the Lake Livingston and Wallisville Saltwater Barrier System represents approximately one half of the available, regional surface water supply. This plan recommends allocating additional firm yield from this system in addition to the use of water rights below the lake. Achieving the full yield of Lake Livingston is dependent upon return flows from the upper basin. Region C is recommending wastewater reuse as a WMS in the upper basin, which will limit these flows, but is also recommending the import of new supplies into the upper basin. In combination, the upper basin additional supply and reuse strategies should have a long-term neutral effect on the Lake Livingston supply.

This plan recommends transferring much of the Trinity River supply west into the adjacent coastal basin and the San Jacinto Basin. This will result in decreased flows in the lower Trinity Basin during drought periods. Senior water rights below Lake Livingston are protected by the lake's operating rules. Return flows from these transfers will still reach Galveston Bay, but will return via the San Jacinto Basin.

Groundwater in the lower Trinity Basin predominantly comes from the Gulf Coast Aquifer as well as from the Carrizo-Wilcox, the Sparta, the Queen City, and the Yegua-Jackson Aquifers. The plan reflects using but not exceeding the sustainable yield of the Gulf Coast Aquifer in this area. In addition, the other aquifers are only used to meet local demands. The export of groundwater from its source county is not recommended in this plan.

6.2.1.3 Trinity-San Jacinto Coastal Basin

The Trinity-San Jacinto Coastal Basin is relatively small with Cedar Creek being the most significant stream. There are several surface water rights for irrigation within the basin along with a substantial saline water right for cooling water from Galveston Bay. Both of these uses are expected to continue throughout the planning period. This plan recommends expanded use of existing supply sources, including increasing the transfer of water from the Trinity River to meet the projected demands, which will affect the return flow's discharge location within Galveston Bay. No other impacts from the transfers are foreseen.

The groundwater supply source within this basin is the Gulf Coast Aquifer. The plan reflects using but not exceeding the sustainable yield of the aquifer in this basin. In Harris County, the Harris-Galveston Subsidence District regulations further restrict the use of groundwater to address land subsidence. These groundwater pumpage restrictions are reflected in the plan.

6.2.1.4 San Jacinto River Basin

The San Jacinto River Basin contains Lakes Houston and Conroe. These reservoirs make up approximately one tenth of the total surface water available in the region. This plan recommends utilizing the yield of these reservoirs and other surface water rights within the San Jacinto Basin. In addition, the plan calls for the movement of supply from the Trinity River and from the future Allens Creek Reservoir in the Brazos Basin to meet projected demands. Full use of the existing water rights will reduce stream flows during drought conditions. However, this will be mitigated by increased return flows, including those from imported supply.

Wastewater reuse is a recommended WMS in the basin. This includes major indirect reuse projects such as San Jacinto Basin Regional Return Flows and City of Houston Reuse. Other, smaller direct reuse projects are also included. Overall, these projects have the impact of reducing instream flows. However, provisions have been put into place in existing permits to protect flows necessary for stream and bay health.

The groundwater supply source in the San Jacinto Basin is the Gulf Coast Aquifer. The current regional water plan reflects using but not exceeding the sustainable yield of the aquifer in this basin. In Harris and Fort Bend Counties, the Harris-Galveston and Fort Bend Subsidence District regulations further restrict the use of groundwater to address land subsidence. These groundwater pumpage restrictions as well as the MAG estimates derived from joint groundwater planning performed by Groundwater Management Areas (GMAs) are reflected in the plan. Aquifer storage and recovery is recommended as a WMS in Montgomery county to utilize currently unappropriated San Jacinto Basin surface water flows with storage in the Gulf Coast Aquifer.

6.2.1.5 San Jacinto-Brazos Coastal Basin

The San Jacinto-Brazos Coastal Basin encompasses most of Galveston County, most of Brazoria County, and portions of Harris and Fort Bend Counties. The coastal basin contains numerous streams and bayous which flow into Galveston Bay and West Bay. Major bayous contributing to Galveston Bay include Clear Creek, Dickinson Bayou, and Chocolate Bayou. Bastrop Bayou, located at the western edge of the basin, flows into Christmas Bay. There are numerous surface water rights for irrigation, mining, and manufacturing within the basin, and these uses are expected to continue throughout the planning period. Water from the Brazos River is transferred into the coastal basin to meet current demands. The Gulf Coast Water Authority (GCWA) maintains and operates canals and off-channel reservoirs within the coastal basin. The plan includes near-term improvements to the existing saltwater barrier on Chocolate Bayou to counter saltwater intrusion and allow for increased beneficial use of existing water supplies.

This plan recommends increasing the transfer of water from the Brazos River to meet the projected growth in demands of Brazoria and Galveston Counties, which will increase the return flows to Galveston Bay. This transfer would be further facilitated by a number of infrastructure enhancement projects which would allow increased utilization of existing sources as well as future supplies.

Finally, seawater desalination is included as a recommended strategy to meet manufacturing demands in Brazoria County. This strategy will meet a portion of the demands and will potentially increase stream flows, since the return flows from desalination are not associated with a diversion from the source streams. No other surface water impacts are foreseen.

The groundwater supply source in the San Jacinto-Brazos Basin is the Gulf Coast Aquifer. The plan reflects utilizing, but not exceeding the sustainable yield of the aquifer in this basin. In Fort Bend, Galveston, and Harris Counties, regulations enacted by the Fort Bend Subsidence District and the Harris-Galveston Subsidence District further restrict the use of groundwater to address land subsidence. These groundwater pumpage regulations are reflected in the plan.

6.2.1.6 Brazos River Basin

The Brazos River Basin is the second largest basin in the state (after the Rio Grande), primarily serving Regions O, G, and H. The Brazos River Authority (BRA) operates a system of reservoirs within the middle and upper portions of the basin which provide a portion of the lower basin supply. There are also numerous water rights on the Brazos River and its tributaries which provide water for various uses. This plan increased use of the existing water rights in the lower basin as well as developing new sources of supply.

BRA has identified and received a permit for additional yield that can be realized by operating its reservoirs as a system. This allows the Brazos River Authority to divert flows to meet customer needs when these flows are available in lieu of releasing water from reservoir storage. During drought periods, more stored water would then be available, thus increasing the total yield of the BRA system. These supplies have been committed to various entities, including a number of water providers in Region H. Use of this additional reliable availability is associated in the Regional Plan with a number of recommended strategies and projects. Utilization of this supply would reduce the peak flows in the lower Brazos River due to the increase in diversions. However, when base flows are below the median value, the BRA would release flows to meet customer demands. This would result in increased flows in the river segments above the customer diversion points and should have no effect below those diversions.

Allens Creek Reservoir is located in Austin County and will generate firm yield through the diversion and storage of interruptible peak flows. In addition, an expansion to the Dow Harris Reservoir will store water diverted using Dow Chemical’s existing water rights and will be used to meet manufacturing and municipal demands in Brazoria County. This will reduce the net flow within the basin, but the impacts during drought or seasonal low flow periods would be limited.

To protect water quality in the lower Brazos River Basin, particularly at the diversion points serving the southwestern portion of Brazoria County, the construction of a permanent saltwater barrier is recommended. Protection from the seasonal tidal influence of saltwater is currently provided by a temporary saltwater barrier structure. Basin salinity modeling performed by the TWDB has shown that the saltwater influence will move farther upstream under full use of water rights. This project will mitigate that effect and still allow flows to pass into the small Brazos River estuary.

Groundwater within this basin predominantly comes from the Gulf Coast Aquifer as well as the Carrizo-Wilcox, the Brazos Alluvium, the Sparta, and the Queen City Aquifers. The plan reflects using but not exceeding the sustainable yield of the Gulf Coast Aquifer in this area. The Carrizo-Wilcox, Sparta, and Queen City Aquifers are only used to meet local demands. The export of groundwater from its source county is not recommended in this plan. In Fort Bend County, regulations enacted by the Fort Bend Subsidence District further restrict the use of groundwater from the Gulf Coast Aquifer to address land subsidence. These regulations are reflected in the plan.

6.2.1.7 Brazos-Colorado Coastal Basin

The Brazos-Colorado Coastal Basin contains the San Bernard River and its tributary streams. There are several surface water rights along the San Bernard River for manufacturing and irrigation uses. Both of these uses are expected to continue. Needs for other sources of water appear early in the planning horizon. It is recommended that the large manufacturing demands in this basin utilize imported supplies from the neighboring Brazos River Basin to meet needs during extreme droughts.

Groundwater supply in the Brazos-Colorado Basin primarily comes from the Gulf Coast Aquifer, with limited supplies also available from the San Bernard Alluvium. The plan reflects using but not exceeding the sustainable yield of the Gulf Coast Aquifer in this basin.

6.2.2 Agricultural Resources within Region H

Region H has approximately 3,500,000 acres of land in farms, with about one quarter of that land in production during any given year. Total farm acreage has declined in recent years and, over time, the crops and water usage within those farms that remain have changed. Sugar Land is no longer surrounded by its namesake cane fields and the Imperial Sugar Mill in that city closed its doors in 2004.

Data from the USDA Census of Agriculture is provided in ***Appendix 6-B***. The data shows that, since 1997, irrigated acreage within Region H has declined by 24%. This decline is driven by economic factors, but the cost of water is among them. Rural land data obtained from the Texas Agri-Life Extension at Texas A&M University is also provided in ***Appendix 6-B***. It indicates that rural land use is decreasing across the region, including large reductions in cropland acreage due to urbanization in the southern and central parts of the region. While total rural land and cropland have decreased, the coverage of grazing land has increased in Brazoria, Chambers, Galveston, Leon, and Montgomery Counties due to repurposing of former row crop acreage and conversion of native rangeland to improved, non-irrigated pasture. Use of rural land for wildlife management has also increased across the region.

This plan holds the projected irrigation demand constant over the planning period at 342,862 acre-feet per year. Region H is able to meet a portion of those demands from a combination of existing supplies and conservation. The need for financial assistance to realize the conservation goal is addressed in **Chapter 8** under legislative recommendations. Access to an affordable water supply is necessary to mitigate economic threats to agriculture. Providing interruptible water is expected to preserve local agricultural resources by providing irrigators with water at a more affordable rate when surface water supplies are available. Many irrigators in Region H contract water on a year-to-year basis. The water provided under these contracts is generally less expensive than contracts for firm water supplies. However, guidance for the development of regional water plans precludes the incorporation of such projects. Therefore, many agricultural needs go unmet in the plan as there are years of drought when agriculture does not have access to reliable water supplies and must limit production.

6.2.3 Natural Resources within Region H

Region H contains many natural resources and the WMS recommended in this plan are intended to protect those resources while still meeting the projected water needs of the region. The impacts of recommended strategies on specific resources are discussed below.

6.2.3.1 Threatened and Endangered Species

Region H has abundant habitat areas within the Sam Houston National Forest, the Big Thicket Nature Preserve, several National Wildlife Refuges, and significant undeveloped areas. Numerous native and migratory species live within these habitats, including over ten threatened and endangered aquatic species (listed in ***Appendix 6-C***).

The WMS recommended in this water plan will have some impacts upon wetlands habitats. In the 2021 Region H Water Plan, one new reservoir project is recommended. Allens Creek Reservoir has the potential to impact wetlands habitat. However, the potential impacts at this proposed site are less than on the main stem of a river. At the Allens Creek site in Austin County, habitats for the White-faced Ibis, Wood Stork, and Houston Toad may be inundated and require mitigation. It should be pointed out that the Allens Creek project was modified by the project sponsor to avoid impacting Alligator Hole, a wetland segment adjacent to the project site. The current plan includes the Allens Creek Reservoir as a recommended WMS. Remaining reservoir projects recommended in the 2021 Region H Water Plan consist of enhancements to existing impoundments.

The transfer of supply to the San Jacinto Basin from Lake Livingston and beyond is recommended in this plan. While the recommended amount is less than the full yield of the source reservoirs, it will still impact lake levels during dry periods as well as wetlands along the periphery of the source reservoirs. Habitats for the Wood Stork and Alligator Snapping Turtle may be affected during drought periods, but no permanent impacts to these habitats are foreseen. Conveyance from the Trinity to the San Jacinto Basin is anticipated to occur primarily through existing canal infrastructure including the CWA Canal and the Luce Bayou Interbasin Transfer, thereby reducing potential future impacts on wetlands.

The conveyance of water from Toledo Bend in the East Texas Transfer is expected to have similar impacts in some locations. However, significant portions of this route are already developed to the point that capacity either already exists or may be made possible through expansion within or adjoining to an existing right-of-way.

6.2.3.2 Parks and Public Lands

As described in ***Chapter 1***, Region H contains over 350,000 acres of state and national forests, over 100,000 acres of coastal wildlife refuges, and over 12,000 acres of Texas wildlife management areas. The transfer of supply from Lake Livingston into the San Jacinto Basin has the potential to reduce flows through the Trinity River National Wildlife Refuge during drought periods. The transfer may also include an interbasin pipeline route potentially impacting lands in the Sam Houston National Forest, increasing possible environmental impacts from construction and maintenance activities.

6.2.3.3 Impacts of Water Management Strategies on Unique Stream Segments

Region H recommended retaining eight previously designated unique stream segments in the 2021 RWP. These streams are:

- Armand Bayou in Harris County,
- Austin Bayou in Brazoria County,
- Bastrop Bayou in Brazoria County,
- Big Creek in Fort Bend County,
- Big Creek in San Jacinto County,
- Cedar Lake Creek in Brazoria County,
- Menard Creek in Polk and Liberty Counties, and
- Oyster Bayou in Chambers County.

All of these segments occur within riparian conservation areas, and there are no WMSs that divert additional water from or above these streams. Additionally, terrestrial strategies such as brush control or salt cedar removal are not recommended within Region H, so the riparian habitats should not be affected. Finally, there is some concern that overuse of groundwater would impact spring flows within the Sam Houston National Forest. Region H does not recommend the export of groundwater from any county, and the RHWPG encourages the formation of groundwater conservation districts to actively manage these resources. The western portion of the National Forest lies in Walker and Montgomery Counties, which both have active groundwater conservation districts. The southern portion of the National Forest is in San Jacinto and Liberty Counties, the latter of which does not currently have a groundwater-managing district in place.

The current unique stream segments and an analysis of all proposed stream segments is provided in ***Chapter 8***.

6.2.3.4 Protection of Galveston Bay

The Galveston Bay estuary is arguably the most significant natural resource within Region H, providing habitat for a rich diversity of permanent and migratory species, recreational and tourism use, employment for fishermen and the tourism industry, and serving as the gateway to the second busiest port in the U.S.

Galveston Bay is affected by the water plans for both Region C (in the Upper Trinity River Basin) and for Region H (in the Lower Trinity and San Jacinto River Basins). The Galveston Bay Freshwater Inflows Group has defined target frequencies for inflows to the estuary, based upon salinity and harvest models developed by the TCEQ and TPWD. These investigations provided a platform for the efforts of the Trinity and San Jacinto Rivers and Galveston Bay Basin and Bay Area Stakeholder Committee (BBASC) and Basin and Bay Expert Science Team (BBEST). The results of the BBASC review of the initial study of the BBEST was transmitted to TCEQ in two recommendations in May 2010. TCEQ used these reports when developing the final, adopted standards for instream flows and bay and estuary inflows for the Trinity and San Jacinto Rivers and Galveston Bay. These standards are illustrated in *Table 6-2* below.

Table 6-2 – Bay and Estuary Freshwater Inflow Standards for Galveston Bay

		Trinity		San Jacinto	
Annual Inflow (Ac-Ft) [Target Frequency]	Winter Inflow (Ac-Ft) [Target Frequency]	2,816,532 [50%]	500,000 [40%]	1,460,424 [50%]	450,000 [40%]
			250,000 [50%]		278,000 [50%]
			160,000 [60%]		123,000 [60%]
	Spring Inflow (Ac-Ft) [Target Frequency]		1,300,000 [40%]		500,000 [40%]
		2,245,644 [60%]	750,000 [50%]	1,164,408 [60%]	290,000 [50%]
			500,000 [60%]		155,000 [60%]
	Summer Inflow (Ac-Ft) [Target Frequency]		245,000 [40%]		220,000 [40%]
			180,000 [50%]		100,000 [50%]
		1,357,133 [75%]	75,000 [60%]	703,699 [75%]	75,000 [60%]
	Fall Inflow (Ac-Ft) [Target Frequency]		N/A		200,000 [40%]
			N/A		150,000 [50%]
			N/A		90,000 [60%]

The standards for bay and estuary inflow demonstrated in *Table 6-2* implies the importance of not only the overall magnitude of inflows but also the basin of origin. Over time, the transfer of water from the Trinity River Basin into the San Jacinto River Basin will relocate return flows from Trinity Bay to Upper Galveston Bay. This may have some impact on the oyster beds located within Trinity Bay. The increase of flows into Upper Galveston Bay should be less of a concern, because that flow will occur in the Houston Ship Channel (a dredged channel that is significantly deeper than the rest of the estuary).

6.2.3.5 Energy Reserves

Oil, gas, and other energy reserves are considered natural resources of the state. While Region H is home to a large portion of the nation's petrochemical industry, the amount of actual oil and gas mining within Region H is small compared to other portions of the state. In this plan, Region H was able to identify reliable supplies to meet all projected mining and manufacturing demands throughout the planning period. No adverse effect on this resource is foreseen.

6.2.4 Navigation within Region H

Navigation within Region H is generally limited to the lower reaches of the main stems of the Brazos, San Jacinto, and Trinity Rivers including the Houston Ship Channel and Turning Basin, as well as the Gulf Intracoastal Waterway. No navigation water permits exist within Region H. It is not anticipated that the strategies recommended in the 2021 Region H RWP will impact navigation, nor the use of waters by recreational boaters and fishermen.

CHAPTER 7
DROUGHT RESPONSE

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Chapter 7 – Drought Response

7.1 INTRODUCTION

Drought is a natural and recurring meteorological phenomenon where precipitation is significantly below "normal" for a period of time. Relatively mild, short-duration droughts are common throughout Texas and typically result in limited impacts. However, extended severe drought conditions can have serious impacts on water supplies, water suppliers, and water users including:

- Reduction in available water supply leading to shortage conditions;
- Increases in water demand, particularly for seasonal demands such as landscape irrigation;
- Stress on water utility infrastructure due to elevated seasonal peak water demands relative to capacity limitations of water supply infrastructure;
- Deterioration of source water quality;
- Lifestyle and financial impacts to water users associated with restrictions on non-essential water uses (e.g., loss of landscaping); and
- Financial impacts on water suppliers due to reduced revenues from water sales during periods of water demand curtailment.

Early detection of drought can also be a challenge for robust water planning. Typically, climate models are inadequate for predicting the seasonal drought patterns that occur in Texas due to significantly reduced summer rainfall. A study in 2015 by the Texas Water Development Board (TWDB) and the University of Texas at Austin, *Early Warning of Summer Drought over Texas and the South Central United States: Spring Conditions as a Harbinger of Summer Drought,* explored this phenomenon and alternative methodologies to forecast potential problem conditions. This study utilized a process of evaluating large-scale middle tropospheric circulation, convective inhibition energy, and land surface moisture during the spring months as a means of improving forecasts. The study found that land surface moisture and large-scale circulation for April could be used to predict summer droughts with a skill level acceptable for decision makers involved in drought emergency management.

Due to the potentially devastating effects of drought on both individuals and the state's economy, it is important that water suppliers and users consider the potential impacts of drought and develop robust plans to address supply or demand management under drought conditions. This chapter presents information concerning historical droughts in the region, current drought preparations and responses, recommendations for region-specific drought responses, and region-specific model drought contingency plans.

7.2 DROUGHT OF RECORD IN THE REGIONAL WATER PLANNING AREA

7.2.1 Regional Drought of Record

The Drought of Record (DOR) is typically defined as the worst drought to occur for a particular area during the available period of hydrologic record. Due to the variety of ways in which drought may be characterized (deviation from normal precipitation, temperature trends, economic losses, duration, impacts to reservoirs, etc.), defining which drought is the DOR for an area can be a complex issue. For much of the state, the DOR is generally considered to have occurred from 1950 through 1957. This drought combined severe reductions in rainfall with a multi-year duration, resulting in reduction or cessation of flows for many springs and streams, losses to livestock production and irrigated agriculture, and widespread impacts to vegetation. By the end of the drought in late 1956 or early 1957, nearly all of the counties in the state had been declared disaster areas. The 1950-1957 drought is considered to be the DOR for the 15 counties making up Region H. While subsequent major droughts have occurred in the region, none have displayed the combination of intensity and duration of the 1950s drought.

7.2.2 Surface Water Drought Indication

The significance of the 1950s drought for the region can be illustrated in several ways. For reservoir supplies, which make up a large portion of surface water supply for Region H, the DOR corresponds to the period of minimum storage in the reservoir. While many of the major water supply reservoirs serving Region H were not yet constructed during the DOR, their performance under a repeat of historical hydrology including the DOR can be assessed using the Texas Commission on Environmental Quality (TCEQ) Water Availability Model (WAM); this assessment is directly associated with the use of the various WAMs to determine firm availability of surface water for the Regional Water Plan (RWP). Modeled reservoir data was extracted from the WAM for Lakes Houston and Conroe in the San Jacinto River Basin, and Lake Livingston in the Trinity Basin, which are the major reservoirs located within Region H. Storage information was also extracted for the reservoirs owned or operated by the Brazos River Authority (BRA) in the Brazos River Basin which supply water to downstream users in Region H through a number of supply contracts. The results of this analysis are shown in *Figure 7-1*. As shown in the figure, the reservoirs and reservoir systems supplying Region H would experience their lowest storage during a repeat of the DOR, with severe and prolonged decline in stored volume. The extended hydrology available for the Brazos River Basin model shows that the lowest total volume in the reservoirs owned or operated by BRA occurs in 2014. The BRA evaluated the impact of the most recent drought (2011-2015) on the Brazos River Basin through a drought study that was completed in 2017. The results of that study indicated that the most recent drought is a new drought of record for the upper portion of the Brazos River Basin including Possum Kingdom Lake, Lake Granbury, Lake Whitney, and Lake Proctor. The study also concluded that the 1950s drought remains the drought of record for the remaining seven reservoirs that are a part of the BRA system (Lake Aquilla, Lake Belton, Lake Stillhouse Hollow, Lake Georgetown, Lake Granger, Lake Somerville, and Lake Limestone) as well as the proposed Allens Creek Reservoir.

7.2.3 Palmer Drought Severity Index

Another indicator commonly used by federal and state agencies to characterize drought severity is the Palmer Drought Severity Index (PDSI). The PDSI is an estimate of soil moisture conditions calculated based on precipitation and temperature. The PDSI classifies soil moisture on a scale ranging from approximately -6.0 to 6.0, with values of approximately -0.49 to 0.49 reflecting normal conditions and -4.0 or lower representing extreme drought. The monthly PDSI for the upper Texas Gulf Coast area, which includes the majority of the population in Region H, is shown in *Figure 7-2*. As illustrated in the figure, the 1950s drought is among the most severe in terms of PDSI and is also prolonged.

Figure 7-1 – Modeled Reservoir Storage

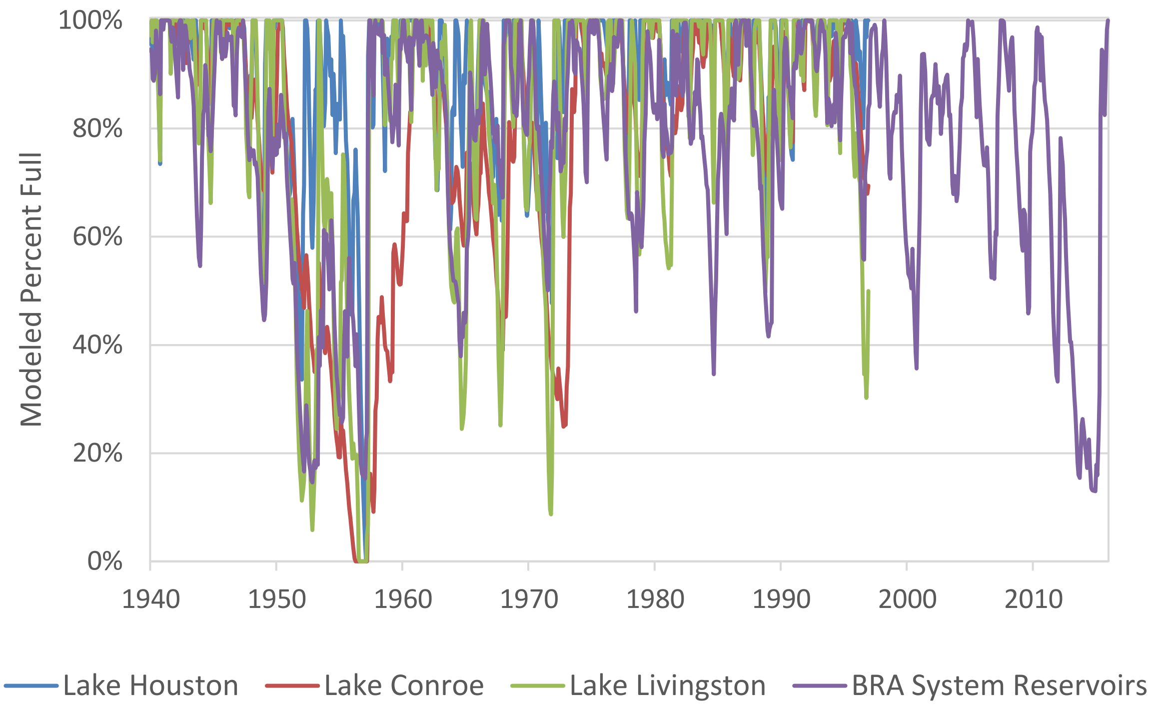
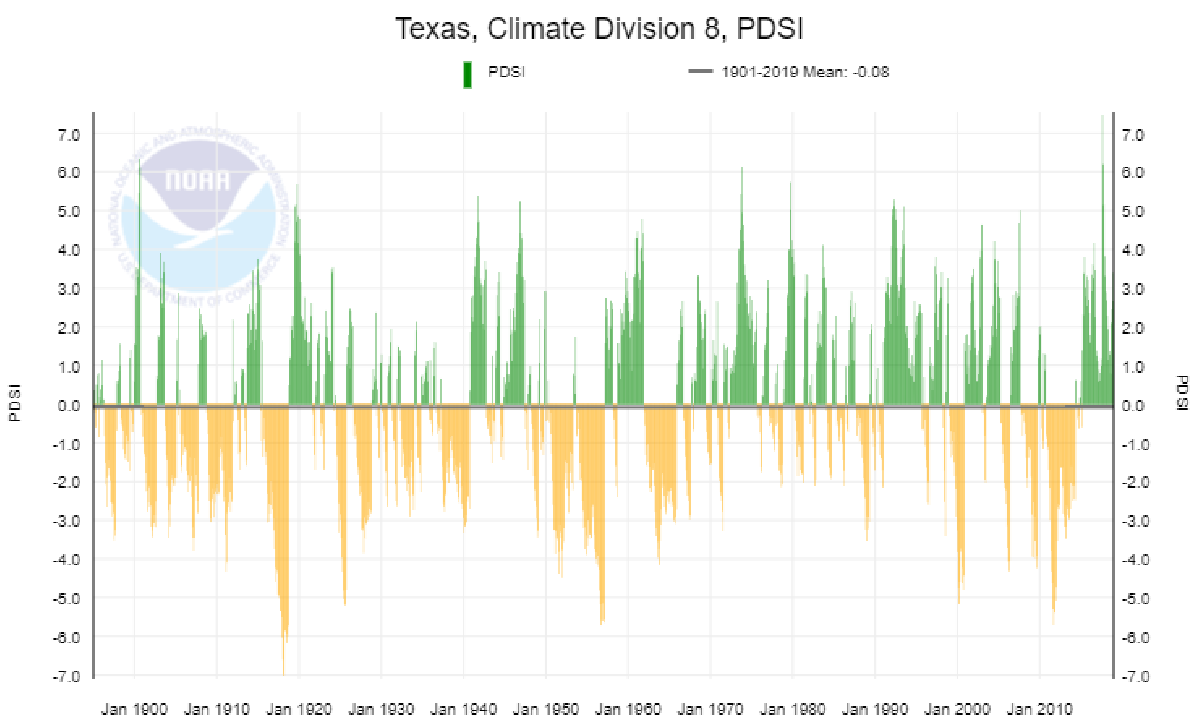


Figure 7-2 – Palmer Drought Severity Index



7.2.4 Other Regional Droughts

The Region H area, like much of Texas, has experienced a number of droughts in addition to the DOR, including several more recent dry periods. The recent drought period which began in approximately year 2010 or 2011 resulted in extremely high temperatures and low rainfall and soil moisture, and in some locations in the state, this period became the new drought of record. In Region H this drought, while intense, was of limited duration and did not impact water supplies to the extent that would occur in a repeat of the DOR.

7.3 CURRENT PREPARATIONS FOR DROUGHT IN REGION H

7.3.1 Drought Contingency Planning Overview

The TCEQ, in accordance with the Texas Administrative Code (TAC), requires all wholesale public water suppliers, retail public water suppliers, and irrigation districts to prepare and submit drought contingency plans (DCPs) meeting the requirements of 30 TAC §288(b) and to update these plans at least every five years. TCEQ administrative rules in 20 TAC §288.1 define a drought contingency plan as "a strategy or combination of strategies for temporary supply management and demand management responses to temporary and potentially recurring water supply shortages and other water supply emergencies." TCEQ rules and associated guidance documents for drought contingency planning embody several key principles including:

- Drought and its potential impacts on both water supply and demand, as well as water supply infrastructure, can be anticipated;
- Drought response measures and implementation procedures can be defined in advance of drought;
- Through timely implementation of drought response measures, it is possible to avoid, minimize, or mitigate the risks and impacts of water shortages and other drought-related water supply emergencies;
- All water demands are not of equal value or importance. Some can be considered essential to public health and safety or to the economy while others can be considered non-essential or discretionary; and
- Drought contingency plans should be tailored to the unique circumstances of each water supplier (e.g., vulnerability of water supply and/or infrastructure to drought, end-users and demand characteristics, objectives, etc.).

Notwithstanding the aforementioned principle that drought contingency plans should be tailored to each water supplier's unique circumstances, there are a few elements that are found in most drought contingency plans. These include:

- Criteria and procedures for determining when to initiate and when to terminate drought response measures. These are typically referred to as drought triggers. Common examples of drought triggers include indicators of supply availability (e.g., quantity of water supply remaining in a source) and demand indicators (e.g., daily demand relative to infrastructure capacity).
- Successive stages of drought response that require the implementation of increasingly stringent measures in response to increasingly severe drought conditions. A typical drought

contingency plan will have an initial stage of voluntary measures followed by two or three successive stages of increasing stringent mandatory measures.
- Demand reduction goals or targets for each stage.
- Predetermined drought response measures for each stage that may include supply management, such as the temporary use of an alternative water source, and/or demand management, such as restrictions on non-essential water uses.
- Procedures for plan implementation and enforcement.
- Public information, notification, and education.

Most drought contingency plans place a heavy emphasis on demand management measures that are designed to reduce water demands by means of curtailment of certain uses. It is important to note that demand management in this context is distinctly different from water conservation, although the terms are often used interchangeably. The objective of water conservation is to achieve lasting, long-term reductions in water use through improved water use efficiency, reduced waste, and through reuse and recycling. By contrast, demand curtailment is focused on temporary reductions in water use in response to temporary water supply shortages or other water supply emergencies, such as equipment failures caused by excessively high peak water demands. Common approaches to water demand curtailment, applied individually or in combination, include:

- Proscriptive restrictions or bans on non-essential water uses and waste. In a municipal setting, such restrictions commonly target landscape irrigation, car washing, ornamental fountains, and other similar uses.
- Use of water pricing strategies, such as excess use surcharges, to encourage compliance with water use restrictions or to penalize excessive water use.
- Water rationing, where water is allocated to users on some proportionate or pro rata basis.

7.3.2 Current Drought Preparation

All wholesale public water providers and most municipalities in Region H have made preparation for responding to drought conditions, including the development of individual DCPs to be implemented when necessary. These plans typically identify multiple stages of drought response, each with specific triggers for initiation and termination, responses to be implemented, and quantified targets for water use reduction or other impacts for each stage. The plans also include notification procedures, means for enforcement, and in many cases a mechanism for granting variances.

7.3.3 Summary of Existing Triggers and Responses

As part of the effort associated with Task 7 of the RWP, the RHWPG performed an assessment of existing drought triggers and planned responses in the region based on DCPs submitted by water utilities to the RHWPG. TCEQ rules and 30 TAC §288(b) require that DCPs include documentation of coordination with the RWPGs to ensure consistency with the regional plans. The Region H Water Planning Group (RHWPG) was able to obtain DCPs for 254 entities in the region, including Wholesale Water Providers (WWPs), named Water User Groups (WUGs), and retail suppliers within the County-Other WUGs and Regional Water Authorities.

A Region H drought contingency plan database was developed during the previous planning cycle to store available information on the available DCPs, including sponsor information, number of stages, and the trigger and response types associated with each stage. Each drought stage was also characterized by the reduction type (percent demand, seasonal percent demand, unit reduction, etc.), and associated reduction quantity value (percentage, MGD, or other). This database was updated with new DCPs submitted to the RHWPG subsequent to the 2016 RWP, and the characteristics of the most recently available DCP for each entity have been summarized in *Table 7-1*, with more detailed data by entity included in ***Appendix 7-A***.

Table 7-1 – Summary of Existing DCPs in Region H

Stage	Total Entities	Trigger Type													Response Type																Reduction Type					
		Contamination	Customer Awareness	Demand/Capacity Based	Emergency Condition	Failures and Damages	Production Rate	Reservoir Level	Stream Flow Rate	Supply Based	System Pressure	Well Run Time	Wholesale Provider	Other	Assessment and Identification	Continue Previous Stage Response(s)	Emergency Rate	Invoke All/Any Response Measures	Outdoor Watering Schedule	Leak Detection and Repair	Mandatory Reduction	Stakeholder Notification	Prohibited Use	Public Information	System Control	Terminate Contracts	Terminate Outdoor Watering	Voluntary Reduction	Water Allocation	Other	Percent Demand	Percent Demand Remaining	Percent Limit	Unit Reduction	Other	N/A
1	254	0	6	172	0	18	3	10	3	17	0	35	24	58	3	0	1	0	141	28	30	251	6	1	19	0	0	237	8	2	227	1	1	7	7	16
2	254	0	0	199	0	19	3	10	3	34	2	35	24	40	10	160	7	1	98	38	185	252	49	0	20	2	1	36	9	8	240	2	1	7	1	9
3	254	3	0	198	0	21	2	10	0	33	5	35	25	44	4	185	130	1	44	12	66	251	191	0	23	14	160	3	121	3	239	2	1	6	2	9
4	117	8	0	82	2	28	1	5	0	18	2	10	18	34	5	60	31	2	18	12	25	113	67	0	6	23	27	2	59	3	101	2	1	0	12	1
5	30	17	0	2	13	18	0	1	0	1	0	0	0	7	1	21	0	1	0	0	4	29	24	0	2	0	24	0	3	1	23	0	1	0	6	0
6	10	0	0	4	0	1	0	0	0	0	0	0	0	6	0	0	3	0	0	0	0	10	0	0	0	0	0	0	7	0	0	0	0	0	10	0
Emergency	201	44	0	0	157	51	0	0	0	1	0	0	13	40	8	5	0	180	0	0	5	15	6	0	2	1	5	1	8	10	0	0	0	0	201	0
1	100%	0%	2%	68%	0%	7%	1%	4%	1%	7%	0%	14%	9%	23%	1%	0%	0%	0%	56%	11%	12%	99%	2%	0%	7%	0%	0%	93%	3%	1%	89%	0%	0%	3%	3%	6%
2	100%	0%	0%	78%	0%	7%	1%	4%	1%	13%	1%	14%	9%	16%	4%	63%	3%	0%	39%	15%	73%	99%	19%	0%	8%	1%	0%	14%	4%	3%	94%	1%	0%	3%	0%	4%
3	100%	1%	0%	78%	0%	8%	1%	4%	0%	13%	2%	14%	10%	17%	2%	73%	51%	0%	17%	5%	26%	99%	75%	0%	9%	6%	63%	1%	48%	1%	94%	1%	0%	2%	1%	4%
4	46%	7%	0%	70%	2%	24%	1%	4%	0%	15%	2%	9%	15%	29%	4%	51%	26%	2%	15%	10%	21%	97%	57%	0%	5%	20%	23%	2%	50%	3%	86%	2%	1%	0%	10%	1%
5	12%	57%	0%	7%	43%	60%	0%	3%	0%	3%	0%	0%	0%	23%	3%	70%	0%	3%	0%	0%	13%	97%	80%	0%	7%	0%	80%	0%	10%	3%	77%	0%	3%	0%	20%	0%
6	4%	0%	0%	40%	0%	10%	0%	0%	0%	0%	0%	0%	0%	60%	0%	0%	30%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	70%	0%	0%	0%	0%	0%	100%	0%
Emergency	79%	22%	0%	0%	78%	25%	0%	0%	0%	0%	0%	0%	6%	20%	4%	2%	0%	90%	0%	0%	2%	7%	3%	0%	1%	0%	2%	0%	4%	5%	0%	0%	0%	0%	100%	0%

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As shown in the table, all of the DCPs analyzed include at least three drought stages, while less than 50 percent have four stages, less than 15 percent have five stages, and less than 5 percent have six stages. Approximately 80 percent of DCPs include a distinct emergency response or contingency stage, while a number of DCPs include some level of emergency response planning within the triggers and responses of numbered stages rather than in a separate emergency stage. For instance, DCPs with six stages typically define Stage 6 as a "Water Allocation" stage, during which a designated official has the authority to allocate water at their discretion.

A broad range of drought stage trigger types were identified across the region. *Figure 7-3* illustrates the most common trigger types and the frequency with which each type is included in Region H DCPs. Over 65 percent of the DCPs analyzed include triggering based on demand or system capacity within the first three stages, which is by far the most common trigger type in Region H. Some DCPs, particularly those with more than three stages, include a broad variety of other conditions for drought stage initiation, often entity-specific, which do not fit standard trigger categories (classified as "Other" in *Figure 7-3*). The majority of emergency response or contingency stages are triggered by emergency conditions that prevent a utility from providing potable water to customers, such as a natural disaster or infrastructure component failure. A list and descriptions of the trigger types identified in DCPs within Region H can be found in *Table 7-2*.

Figure 7-3 – Frequency of Trigger Types

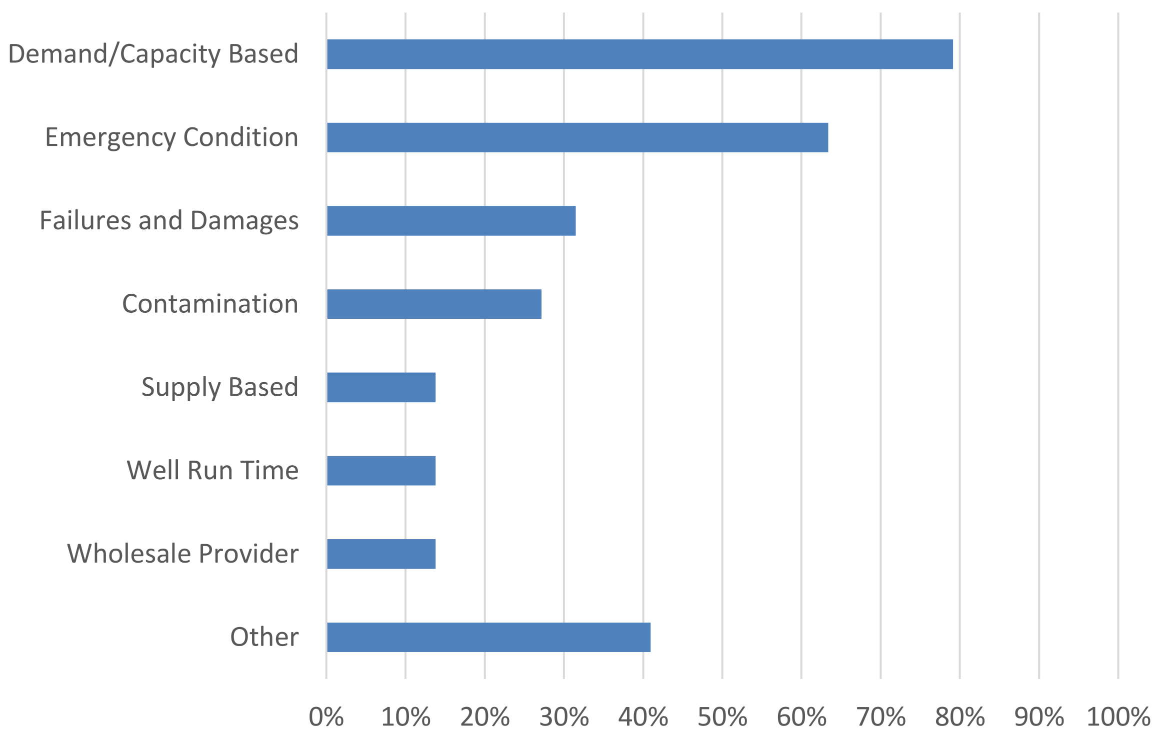
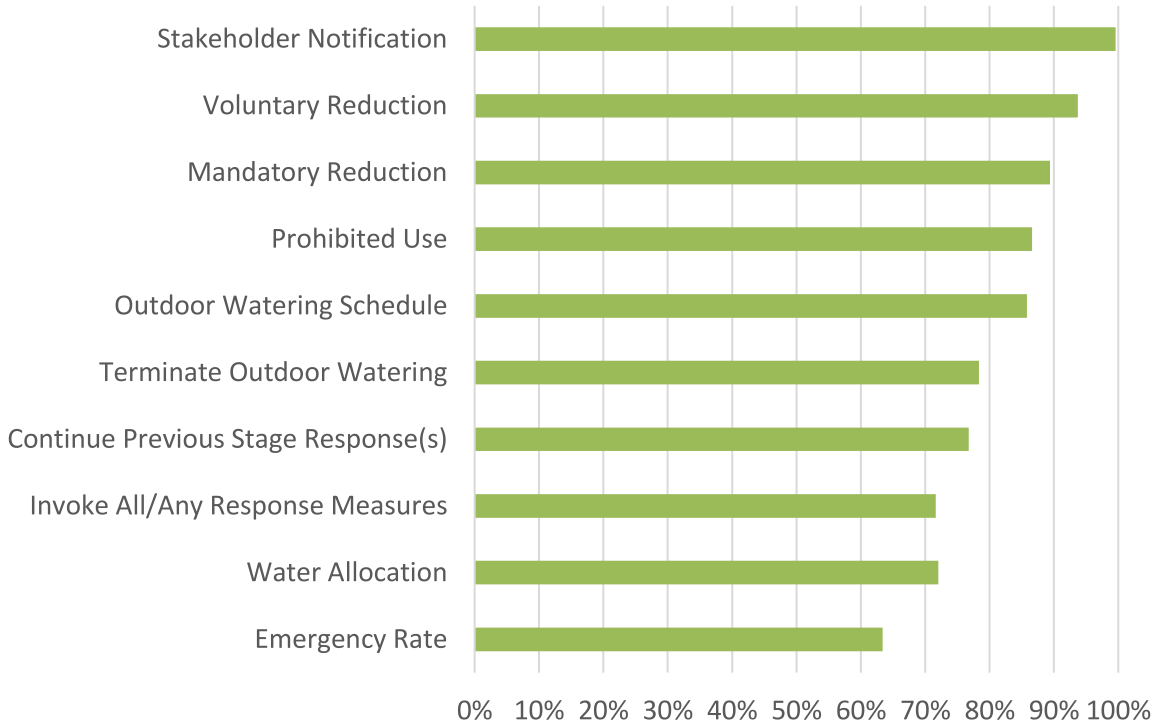


Table 7-2 – Drought Stage Trigger Types

Trigger Type	Description
Contamination	Natural or man-made contamination of water supply source(s).
Customer Awareness	Water customers are notified of drought proclamations by the utility or WWP.
Demand/Capacity Based	Demand on the water supply system reaches or exceeds a certain capacity for a defined time period.
Emergency Condition	Unforeseen emergency conditions in the event of a fire, flood, hurricane, civil disturbance, or other disaster.
Failures and Damages	Failure or damage to the water delivery system and its components, e.g., a well motor, major water line, pump system, etc.
Groundwater Level	Static water level of water wells falls below normal operating level or continues to decline.
Production Rate	Pumping production exceeds a certain rate for a defined time period.
Reservoir Level	Reservoir volume or elevation falls below a certain level.
Stream Flow Rate	River flow falls below a certain rate.
Supply Based	Supplies become limited or are reduced to a certain volume by the WWP for a defined time period.
System Pressure	The average water system pressure falls below a certain threshold.
Well Run Time	The average well run time exceeds a certain extent of time for a defined time period.
Wholesale Provider	The Wholesale Water Provider (WWP) declares drought conditions and/or water shortages that are implemented by the utility, pursuant to their contract requirements.
Other	Other miscellaneous drought triggers mentioned in Drought Contingency Plans.

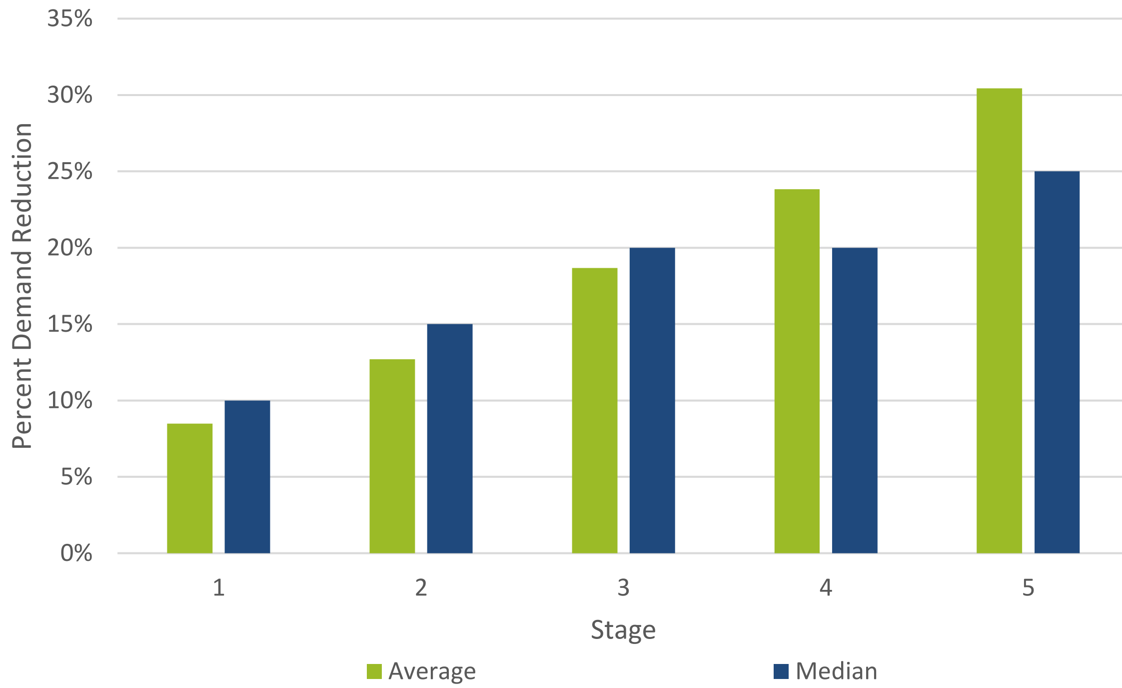
Individual DCPs often include multiple responses for each drought stage. Consequently, a variety of response types were identified. *Figure 7-4* illustrates the most common response types and how frequently they are used in DCPs. Detailed information on the prevalence of response types by individual stage is included in *Table 7-1*. Notification of relevant stakeholders such as customers, WWPs, and the general public is the most common response across all stages. Voluntary water use reductions are commonly specified for the first drought stage but are uncommon at other stages. After the first stage, other frequently specified measures include mandatory water use reductions, application of outdoor watering schedules, termination of outdoor watering, prohibitions on certain water uses, and entity-specific water allocation measures. Many stage responses include continuing the implementation of response measures from the previous stage in addition to an increase in number and/or restrictiveness of measures as more severe drought stages are triggered. Some systems may continue implementation of earlier stage responses even when not explicitly indicated in the response for subsequent stages. Emergency response or contingency stage response measures typically involve invoking any or all necessary drought response measures set forth in their respective DCPs in order to mitigate emergency conditions.

Figure 7-4 – Frequency of Response Types



Reductions are predominantly defined in the DCPs in terms of percent demand, with a limited number of entities setting quantified goals on entity-specific unit reductions or other factors. *Figure 7-5* illustrates the average and median reduction targets for Stages 1 through 5 for entities which defined reduction goals in terms of percent of demand. Generally, target demand reductions increase as drought conditions become more severe. Entities typically did not set numerical reduction targets for emergency drought stages, nor for Stage 6 (water allocation stage) conditions. Instead, emergency drought and water allocation stages involve taking actions that mitigate and reduce emergency drought conditions as soon as possible.

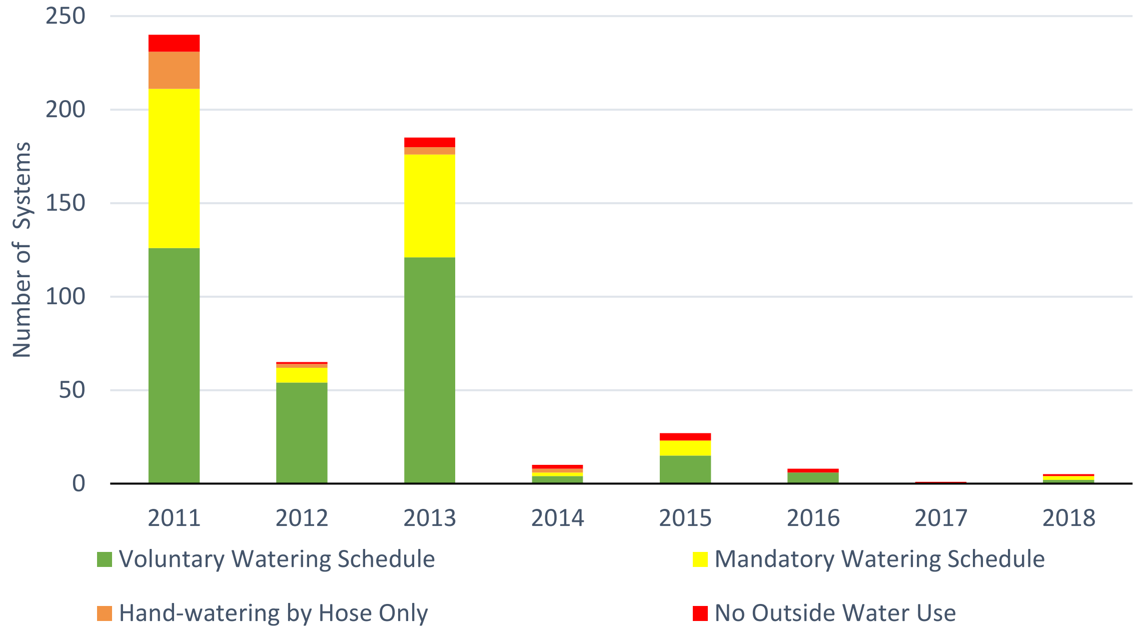
Figure 7-5 – Average and Median Target Demand Reduction



7.3.4 Recent Implementation of Drought Contingency Measures in Region H

In addition to the assessment of DCPs submitted by entities across Region H, the RHWPG also reviewed recent occurrences of entities implementing measures from their DCPs. Since 2011, TCEQ has required any wholesale or retail water supplier to report any restrictions on outdoor water use implemented due to drought or emergency conditions. The RHWPG performed an analysis of the TCEQ records of entities implementing mandatory landscape watering restrictions between May 2011 and December 2018, including WWPs, named WUGs, and retail suppliers within the County-Other WUGs and Regional Water Authorities. The drought of 2011 and dry conditions in 2013 are apparent in the results of this analysis, shown in *Figure 7-6*. Since the publication of the 2016 Region H RWP, over 400 public water systems in the region have reported implementation of outdoor watering restrictions in response to drought. Additionally, 10 entities at various points in time reported that the remaining supply available to the system was insufficient to meet 180 days of demand.

Figure 7-6 – Number of Water Systems Restricting Outdoor Watering Due to Drought



In addition to the review of implementation data from TCEQ, information regarding drought contingency measures, identified demand reduction, history of drought response implementation, and program cost was requested from named WUGs as part of the Region H survey for the 2021 Regional Water Plan (RWP).

Of the 341 WUGs that received the survey, 77 WUGs (23%) provided information on recently implemented drought contingency measures, as well as measures which these entities would consider implementing in the future. *Figure 7-7* indicates the percentage of survey respondents that had implemented the drought response measures included in the survey in the 10 years prior to August 2017, as well as the percentage of respondents that would consider such measures for potential future implementation. Most of the respondents (74 WUGs) currently have a DCP, and a few of those without DCPs indicated a willingness to implement drought response measures in the future. No data was provided on quantities of demand reduction or program costs. Those WUGs which reported that at least one measure of their DCP had been implemented in the previous 10 years as of August 2017 are listed in *Table 7-3*.

Figure 7-7 – WUG Survey Drought Response Information

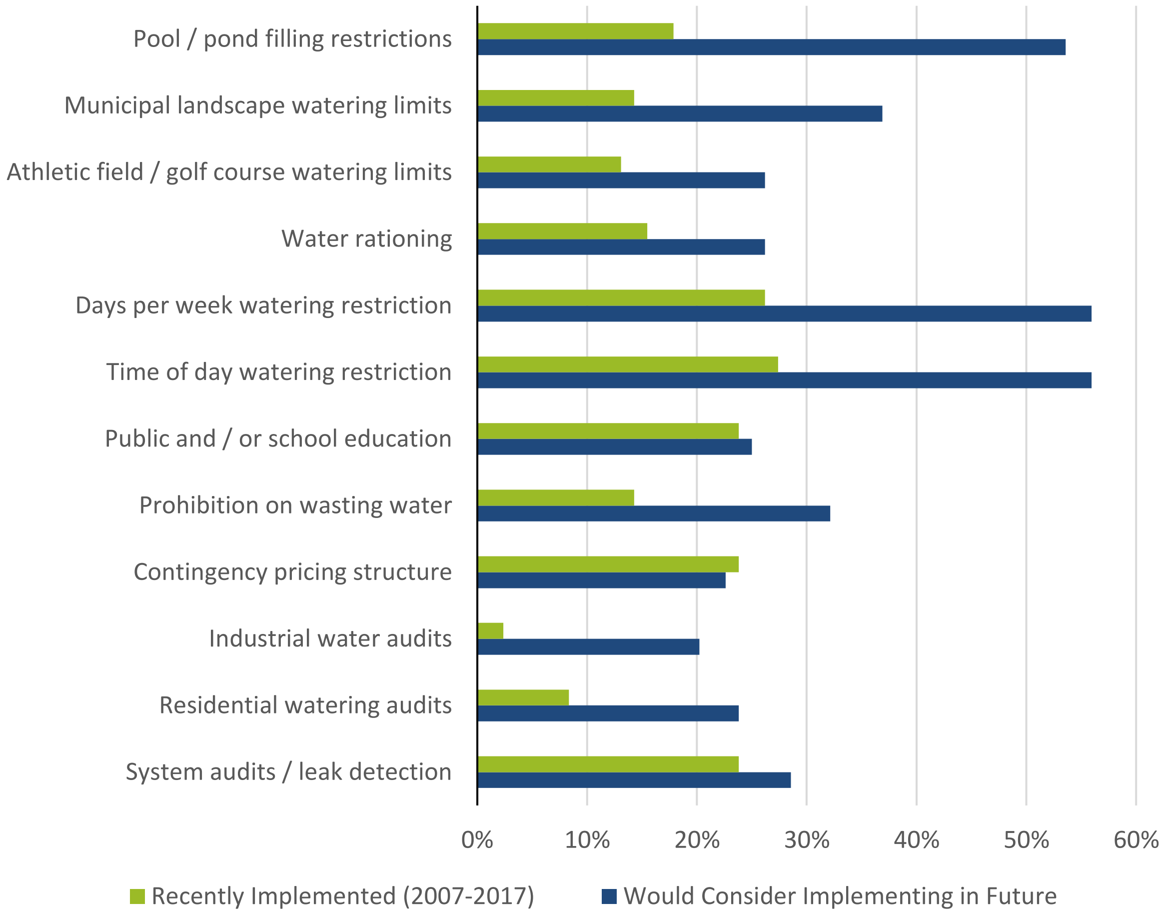


Table 7-3 – WUGs Reporting Recent Drought Response

Water User Group	County
Baker Road MUD	Harris
Brazoria	Brazoria
Central Harris County Regional Water Authority	Harris
Cleveland	Liberty, Montgomery
Concord-Robbins WSC	Leon
First Colony MUD 9	Fort Bend
Fort Bend County MUD 121	Fort Bend
Fort Bend County MUD 140	Fort Bend
Fort Bend County MUD 187	Fort Bend
Fort Bend County MUD 47	Fort Bend
Fort Bend County MUD 48	Fort Bend
Fort Bend County WCID 2	Fort Bend, Harris
Friendswood	Galveston, Harris
Galveston County MUD 12	Galveston
Galveston County WCID 1	Galveston
Greenwood UD	Harris
Groveton	Trinity
Harris County MUD 321	Harris
Harris County WCID 1	Harris
Hilltop Lakes WSC	Leon
Jersey Village	Harris
Kings Manor MUD	Harris, Montgomery
La Porte	Harris
Lake MUD	Harris
Longhorn Town UD	Harris
Memorial Villages Water Authority	Harris
Missouri City	Fort Bend
MSEC Enterprises	Montgomery
Nassau Bay	Harris
Onalaska WSC	Polk
Pasadena	Harris
San Jacinto SUD	San Jacinto
T & W Water Service	Liberty, Montgomery
Texas City	Galveston
The Woodlands	Harris, Montgomery
West University Place	Harris

7.3.5 Variations in Drought Response Measures

As part of the effort associated with Task 7 of the RWP, the RHWPG performed an assessment to identify potential unnecessary or counterproductive variations in drought response measures which could impede effective drought response or cause confusion to the public regarding required drought contingency activities. Evaluation of potential conflicts in drought response, both in the context of specific measures and overall demand reduction, presents a number of challenges. Various entities, including those that have a water supply relationship, may have different usage patterns, demand types, source blends, and infrastructure configurations that necessitate differing but compatible approaches to structuring stages and responses. Likewise, a specific measure type such as an outdoor watering restriction may be implemented in different manners or at different stages by various water systems; this is not indicative of a counterproductive approach, as each system has unique characteristics which should be considered in development of its DCP to achieve demand reduction. Further, it should be noted that in addition to the specific system characteristics, the efficacy of drought response measures also depends on the intensity and duration of a particular drought and, for retail municipal providers, with the public's willingness to quickly and thoroughly comply with drought restrictions.

While these differences preclude a detailed numerical evaluation of incompatible demand reductions or measure efficacy among systems, Region H did perform a general assessment of demand reduction goals for retail systems relative to their primary wholesale water provider. This analysis was limited to WUGs with at least one external supplier and with Year 2019 DCPs with drought response goals expressed as a percentage of demand. Comparisons were made for each stage between 1 and 5. As noted above, the drivers for stages and responses may differ among entities and thus this was intended solely as a simplifying assumption to allow general assessment. In spite of this difference, approximately 64 percent of these WUGs demonstrated target reduction percentages for all five stages equal or exceeding those of their wholesale provider; 85 percent had equal or larger percentage targets for stages 1 through 3. The remaining 15 percent, along with many of the other entities examined, are contract wholesale customers and not directly subject to the response measures that their providers apply to their own retail service area. The overall demands for the WUGs examined were also small relative to their provider's own internal retail demands. Based on these observations and the necessarily system-specific nature of drought planning, clear indication of counterproductive drought planning was not observed.

Additional factors further reduce the likelihood of counterproductive or confusing drought planning within Region H. Water systems often communicate closely with each other, and in particular with their wholesale providers, during planning efforts including drought contingency planning. During periods of limited source availability, these channels of communication are also important in implementing response. Region H encourages all water systems to coordinate closely with their providers during DCP development and implementation.

The effective implementation of drought response measures requires not just an established plan but also awareness and compliance on the part of end users. DCPs typically include description of the method or methods of communication which will be used to notify water users of drought conditions and required responses in order to promote effective DCP implementation. Most often, end-users of municipal water receive notification regarding drought stages and responses directly from their retail provider, preventing confusion from multiple messaging. Region H strongly encourages water systems to include a robust plan for customer notification in their DCPs.

7.3.6 Effectiveness of Drought Response Measures and Challenges in Quantification

The information available to the RWPG through survey responses and submitted DCP documents does not quantify the historical or potential reductions in water use associated with implementation of the DCPs. However, in the 2011 RWP, the RHWPG performed a study of drought response measures which considered the efficacy of drought measure implementation and the challenges associated with quantifying the benefits of implementation. A key observation made in the 2011 RWP was that the demand-centric nature of drought planning makes quantification of benefits difficult, due in large part to the variability of municipal water use within and among communities; this variability is commonly attributed to differences in climatic, demographic, and socioeconomic characteristics. In particular, since most demand curtailment measures target seasonal water uses, such as lawn watering, the effectiveness of such measures is dependent on and will vary greatly according to the seasonal water use characteristics of different communities. Therefore, a drought response measure applied in one community likely will not produce the same effect when implemented in another community with different seasonal water use characteristics. Isolating the effectiveness of specific drought response measures is also problematic in that most municipal drought contingency plans employ multiple measures, such as water use restrictions, public education, and perhaps pricing policies, that in combination may have synergistic rather than additive effects. This is further complicated by behavioral factors (particularly rate of compliance by water users and stringency of enforcement) that may influence the effectiveness of drought response measures, either individually or in combination.

The 2011 RWP drought study found some limited potential benefits to DCP implementation, although most water suppliers in Region H that had implemented DCPs at that time had not thoroughly evaluated the effects. Post-event analyses were found to typically only report gross changes in water demand, most commonly expressed as a percentage reduction. It was also found at that time that most DCPs in Texas were focused on seasonal peaking problems rather than actual water shortage and were generally addressed as peak shaving. The study also included a modeling analysis of the impacts of drought contingency planning on reservoir performance. It was found that that DCPs had little near-term efficacy at that time, as water demands at the time of the study were low relative to available supply. It was also noted that efficacy of drought contingency planning would increase as demands on each source approach full permitted authorizations and/or the firm yield of the source. In general, implementation of DCPs could reduce reservoir drawdown and shorten the duration of impacts on lake levels during a repeat of DOR conditions. Thus, while drought planning may not be a replacement for development of water management strategies (WMS) to meet growth in demand, it is an important part of the management of water supplies.

7.4 EXISTING AND POTENTIAL EMERGENCY INTERCONNECTS

In accordance with the requirements of TWDB and the TAC, the RHWPG performed an analysis of existing water infrastructure that may be used for emergency interconnects. The details of this analysis are to be submitted to the TWDB Executive Administrator as confidential information separately from the RWP.

As part of the Region H survey for the 2021 RWP, information was requested from WUGs and WWPs regarding interconnect relationships, facilities, general locations, and supply volumes and sources. While some basic information on interconnect relationships was collected, the quantity of data was limited by the low response rate to the survey. Data on interconnects was also compiled from the Texas Drinking Water Watch online database, which is maintained by TCEQ. A query was executed on this data to identify which entities have interconnects for emergency use and with what partnering supplier or recipient these interconnects exist. Information on existing and potential interconnect supply capacity was not available. Altogether, the RHWPG identified 277 permanent supply interconnects and 669 emergency supply interconnects between public water systems within the region which are listed as active and could be utilized for emergency supply. An additional 49 inactive interconnects were identified. While the physical condition of this inactive infrastructure is unknown, some of these connections may be capable of being reestablished relatively quickly and could be viable options for emergency supply. Additionally, during the review of DCPs submitted to the RHWPG, 21 entities were identified that include establishment or activation of interconnects as a potential drought response in their DCPs. TWDB guidance for regional planning requires the RWP to include non-confidential information on currently existing interconnections such as who is connected to whom. A list of public water systems with interconnects and which systems they are connected to is provided in ***Appendix 7-B***. In accordance with TWDB guidance, information regarding the location and description of interconnect facilities is not included in the RWP.

7.5 EMERGENCY RESPONSES TO LOCAL DROUGHT CONDITIONS OR LOSS OF MUNICIPAL SUPPLY

In addition to regional or statewide droughts, entities may be subject to localized drought conditions or loss of existing water supplies due to infrastructure failure, temporary water quality impairment, or other unforeseen conditions. Loss of existing supplies, while relatively uncommon, is particularly challenging to address as the causes are often difficult to anticipate. Numerous entities within Region H have DCPs which include an emergency response stage and corresponding measures for droughts exceeding the DOR or for other emergency water supply conditions. Some entities, including a number of WWPs, also have emergency action plans which establish procedures for responding rapidly and effectively to emergency conditions.

Because it is not possible for water providers to predict all emergency conditions and because responses or repairs may require an extended period of time, it is important to consider the range of options for emergency water supply sources available under emergency conditions. In accordance with TWDB guidance, it is assumed that emergency conditions include, but are not limited to, entities having approximately 180 days or less of remaining supply. A high-level analysis of options was performed to assess potential emergency water supply options for WUGs in Region H with estimated Year 2010 population of 7,500 or less, as well as for all County-Other WUGs (see *Figure 7-8*) and WUGs reliant on a sole source for water supply. Consideration of emergency supply options for these entities is particularly important as many smaller WUGs may not have existing access to backup supplies through interconnect facilities with adjacent systems. Applicable WUGs were characterized by projected Year 2020 population, Year 2020 demand, existing supply source type (surface water, groundwater, or blend), and other WUG-specific information. These characteristics were then used to identify potentially feasible emergency supply options and associated infrastructure requirements. Results of this analysis are summarized in *Table 7-4*, and more detailed data for each entity is included in ***Appendix 7-C***.

Figure 7-8 – Water Systems Analyzed for Emergency Response Measures

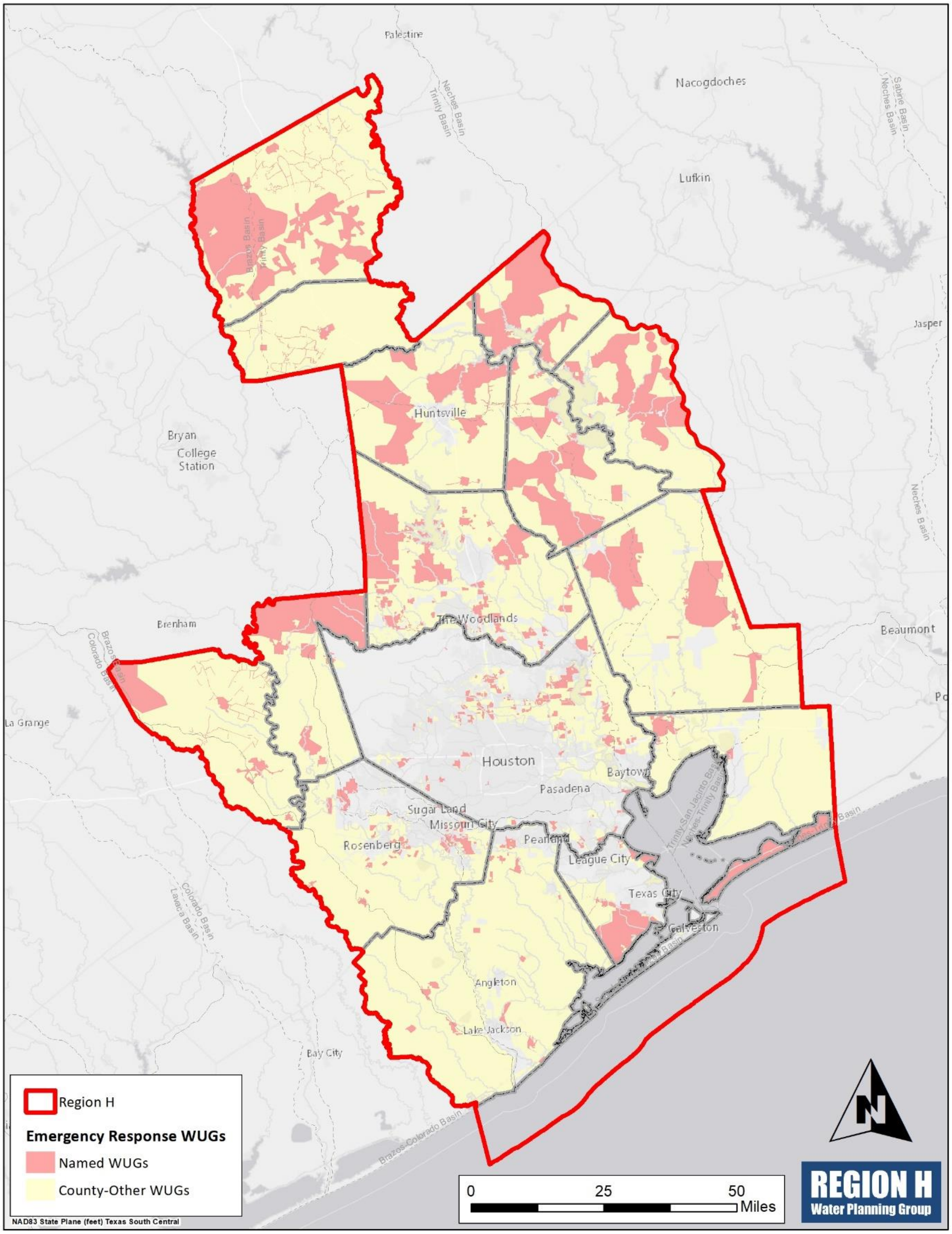


Table 7-4 – Potential Emergency Supply Options

Primary Source of Supply	Count	Potential Emergency Water Supply Source(s)								
		Release from Upstream Reservoir	Curtailment of Junior Water Rights	Local GW Well	Brackish GW	Existing Inter-connect	New Inter-connect	Other Local Supply	Trucked-In Water	Other
Surface Water	9	9	9	0	0	8	1	0	9	0
Groundwater	174	0	0	174	12	83	61	0	174	0
Multiple[1]	102	102	102	102	11	71	31	9	102	9

[1] Includes individual utilities using a blend of multiple source types as well as County-Other WUGs which include individual utilities using multiple source types.

7.6 REGION-SPECIFIC DROUGHT RESPONSE RECOMMENDATIONS

7.6.1 Drought Response Recommendation for Surface Water

The RHWPG acknowledges that the DCPs for surface water suppliers are the best drought management tool for surface supplies and recommends that the DCPs developed by the operators of these supplies serve as the RHWPG triggers for surface water. The RHWPG also recognizes that these triggers are subject to change as providers periodically reassess their needs and encourages both wholesale providers and other entities using surface water to reexamine their DCPs regularly. In particular, reservoirs are a major source of surface water in Region H, and drought triggers for direct providers and users of surface water in Region H are typically tied to reservoir levels or storage volume. The three major reservoir supplies located within Region H are Lakes Conroe, Houston, and Livingston. Major triggers and responses for these reservoirs as of June 2019 are summarized in the following text.

The San Jacinto River Authority (SJRA) adopted revised DCPs on February 28, 2019 for each of its four water supply divisions including the Lake Conroe Division. Drought triggers were developed through a detailed study of hydrologic conditions in the San Jacinto River Basin as well as projected demands of SJRA customers on Lake Conroe. The DCP includes four primary stages as well as an emergency stage that may be utilized in the case of infrastructure failure, water supply contamination, or the occurrence of a drought more severe than the drought of record. The response actions specified for the emergency stage include responses from Stage 1 through 4 and any actions deemed necessary to resolve the emergency condition. SJRA's triggers and responses for Lake Conroe are summarized in *Table 7-5*. The City of Houston (COH) also owns water rights in Lake Conroe. However, the COH DCP is based on the comprehensive storage in all COH reservoirs and cannot be applied specifically to any one reservoir.

Table 7-5 – Summary of Lake Conroe Drought Triggers and Responses

Drought Stage	Trigger	Action
1 (Voluntary)	Lake Conroe below 198'	Voluntary 5% reduction.
2 (Moderate)	Lake Conroe below 196'	Mandatory 5/10% (Winter/Summer) reduction in non-industrial use.
3 (Advanced)	Lake Conroe below 193'	Mandatory 10/20% (Winter/Summer) reduction in non-industrial use. Mandatory 1% reduction in industrial use.
4 (Severe)	Lake Conroe below 190'	Mandatory 15/30% (Winter/Summer) reduction in non-industrial use. Mandatory 5% reduction in industrial use.

As stated above, the SJRA adopted a revised DCP on February 28, 2019 related to its four operating divisions, including the Highlands Division which diverts water from Lake Houston. As Lake Houston receives some diversions from the Trinity River, drought triggers were developed through detailed study of hydrologic conditions in the San Jacinto River Basin and the Trinity River Basin as well as projected demands of SJRA customers on supplies taken at Lake Houston. The Highlands Division DCP includes four primary stages as well as an emergency stage that may be utilized in the case of infrastructure failure, water supply contamination, or the occurrence of a drought more severe than the drought of record. SJRA's triggers and responses for Lake Houston are summarized in *Table 7-6*. The COH also owns water rights in Lake Houston. However, the COH DCP is based on the comprehensive storage in all COH reservoirs and cannot be applied specifically to any one reservoir.

Table 7-6 – Summary of Lake Houston Drought Triggers and Responses

Drought Stage	Trigger	Action
1 (Voluntary)	Lake Houston below 40.2' and Trinity River flows at Romayor, TX are below 4,000 cfs	Voluntary 5% reduction.
2 (Moderate)	Lake Houston below 39.2' and Trinity River flows at Romayor, TX are below 4,000 cfs	Mandatory 5/10% (Winter/Summer) reduction in non-industrial use.
3 (Advanced)	Lake Houston below 37.2'	Mandatory 10/20% (Winter/Summer) reduction in non-industrial use. Mandatory 1% reduction in industrial use.
4 (Severe)	Lake Houston below 35.2'	Mandatory 15/30% (Winter/Summer) reduction in non-industrial use. Mandatory 5% reduction in industrial use.

The Trinity River Authority (TRA) DCP for Lake Livingston, adopted on April 24, 2019, includes three primary stages as well as an emergency stage that may be utilized in the case of infrastructure failure. Triggers and responses for these stages are summarized in *Table 7-7*. The COH also owns water rights in Lake Livingston. However, the COH DCP is based on the comprehensive storage in all COH reservoirs and cannot be applied specifically to any one reservoir.

Table 7-7 – Summary of Lake Livingston Drought Triggers and Responses

Drought Stage	Trigger	Action
1 (Mild)	Lake Livingston below 126.50'	Voluntary 5% reduction.
2 (Moderate)	Lake Livingston below 124.00'	Mandatory 15% reduction.
3 (Severe)	Lake Livingston below 121.40'	Mandatory 25% reduction.

7.6.2 Drought Response Recommendation for Groundwater and Other Sources

Much of Region H has historically been heavily dependent on groundwater and, although increased demands from a growing population and the risk of subsidence in some areas has necessitated increased regulation of groundwater use, the Gulf Coast Aquifer and several other formations remain important sources of water for many users in the region. Groundwater production is generally local to points of use and aquifer properties vary spatially. Likewise, the characteristics of other sources such as reuse are specific to the associated supplier. As such, many providers using these sources have developed their DCPs in the context of their individual supply portfolios. The RHWPG acknowledges that the DCPs for groundwater suppliers are the best drought management tool for groundwater supplies and recommends that the DCPs developed by the operators of these supplies serve as the RHWPG triggers for groundwater. The RHWPG also recognizes that the number and specific components of these triggers are subject to change as providers periodically reassess their needs and encourages both wholesale providers and other entities to examine their DCPs regularly.

The RHWPG recommends that water providers regularly review the U.S. Drought Monitor as a tool for tracking drought conditions and in drought planning efforts leading up to drought measure implementation. The drought monitor is easily accessible, regularly updated, and does not require entities to directly monitor specific sources to benefit from its information. Its simplicity also facilitates its use in communicating drought conditions to customers and other water users. *Table 7-8* shows the categories of the U.S. Drought Monitor with corresponding PDSI values.

Table 7-8 – Palmer Drought Severity Index (PDSI)

Category	Description	Possible Impacts	PDSI
D0	Abnormally Dry	Going into drought: short-term dryness slowing planting, growth of crops or pastures. Coming out of drought: some lingering water deficits; pastures or crops not fully recovered	-1.0 to -1.9
D1	Moderate Drought	Some damage to crops, pastures; streams, reservoirs, or wells low, some water shortages developing or imminent; voluntary water-use restrictions requested	-2.0 to -2.9
D2	Severe Drought	Crop or pasture losses likely; water shortages common; water restrictions imposed	-3.0 to -3.9
D3	Extreme Drought	Major crop/pasture losses; widespread water shortages or restrictions	-4.0 to -4.9
D4	Exceptional Drought (Emergency)	Exceptional and widespread crop/pasture losses; shortages of water in reservoirs, streams, and wells creating water emergencies	-5.0 or less

The RHWPG recommends the following actions based on each of the drought classifications listed:

- Abnormally Dry – Entities should begin to review their DCP, status of current supplies, and current demands to determine if implementation of a DCP stage is necessary.
- Moderate Drought – Entities should review their DCP, status of current supplies, and current demands to determine if implementation of a DCP stage is necessary.
- Severe Drought – Entities should review their DCP, status of current supplies, and current demands to determine if implementation of a DCP stage or changing to a more stringent stage is necessary. At this point, if the review indicates current supplies may not be sufficient to meet reduced demands, the entity should begin considering alternative supplies.
- Extreme Drought – Entities should review their DCP, status of current supplies, and current demands to determine if implementation of a DCP stage or changing to a more stringent stage is necessary. At this point, if the review indicates current supplies may not be sufficient to meet reduced demands, the entity should consider alternative supplies.
- Exceptional Drought – Entities should review their DCP, status of current supplies, and current demands to determine if implementation of a DCP stage or changing to a more stringent stage is necessary. At this point, if the review indicates current supplies are not sufficient to meet reduced demands, the entity should implement alternative supplies.

7.6.3 Recommendations for Entities Not Required to Submit a DCP

While wholesale and retail public water suppliers and irrigation districts are required to have a DCP, there are a number of users such as industrial operations and individual irrigators which are not. While some of these users receive water from providers with established drought management procedures, all water users are subject to the impacts of drought. For entities not required to have a DCP, the RHWPG recommends regular monitoring of drought conditions in order to facilitate decision making processes. Several resources are available to water users for monitoring drought. For users which receive water from an outside supplier, communication with their supplier and notifications of anticipated or implemented drought stages is a key resource. The following references are also recommended for consideration when planning for or experiencing drought:

- Palmer Drought Severity Index: *http://www.drought.gov/drought/content/products-current-drought-and-monitoring-drought-indicators/palmer-drought-severity-index*
- U.S. Drought Monitor (Texas detail): *https://www.drought.gov/drought/states/texas*
- TCEQ drought information: *https://www.tceq.texas.gov/response/drought*
- TWDB drought information: *http://waterdatafortexas.org/drought/*
- Texas State Climatologist: *https://climatexas.tamu.edu/drought/index.html*
- National Integrated Drought Information System: *https://www.drought.gov/*

The RHWPG further recommends that water providers, including those not required to submit a DCP, regularly monitor the activities and findings of the Texas Drought Preparedness Council. Additional information on the Texas Drought Preparedness Council Situation Reports and other useful references are discussed in greater detail in *Section 7.8.1*.

7.6.4 Recommendations and Model Plans for the Development of DCPs

Model drought contingency plans addressing the requirements of 30 TAC §288(b) were developed for Region H and are available in ***Appendix 7-D***. Model plans were developed for wholesale water providers, irrigation districts, retail public water suppliers, and industrial users. It should be noted that 30 TAC §288(b) does not require the development of drought contingency plans for industrial water users; however, a template has been provided for consideration based on the recommendation of the Texas Drought Preparedness Council. These model plans were largely based on templates provided by the TCEQ, with several modifications made to elaborate on notification procedures, DCP revision, and other components.

7.7 DROUGHT MANAGEMENT WMS

As part of the fifth cycle of regional planning, the RHWPG considered drought management as a potential WMS and performed a study to assess the potential impacts of implementing mandatory drought response measures outlined in DCPs in Region H. Rather than estimating the efficacy of individual measures prescribed in the DCPs, as was considered in the 2011 RWP, this study applied the demand reduction targets that entities set in their DCPs to post-conservation demands. The application of demand reduction percentages was subject to the following assumptions:

- Reductions in demand can only reliably be expected during implementation of mandatory use restrictions.
- Entities would likely not be implementing mandatory restrictions for an entire year. Rather, reductions were applied based on the amount of time during 2011 that entities had implemented drought response measures.
- Water savings attributable to twice-per-week watering restrictions in the Advanced Municipal Conservation WMS were excluded from the potential savings provided by drought management measures.
- Potential demand reduction volumes were capped at each entity's needs remaining after application of conservation and loss reduction strategies, as drought management measures by nature cannot provide surplus supply.

The methodology and results of this study, including a simplified analysis of economic impacts, are described in more detail in ***Appendix 5-B***.

After consideration, the RHWPG does not support the recommendation of drought management measures as a WMS in the Region H 2021 RWP. Such measures are not designed to address long-term growth in demands but, rather, are inherently temporary strategies intended to conserve water supplies or reduce adverse impacts during times of drought or emergency and are not active under more hydrologically favorable conditions. Because drought management is only active and beneficial under certain periods of time, its reliable yield is essentially zero when considered in an analogous manner to surface water, groundwater, reuse, or conservation. Also, as discussed previously, the efficacy of individual drought response measures is difficult to quantify and can vary considerably from one entity to another and one drought to another due to hydrologic and human factors. This creates additional uncertainty in the use of drought response as a reliable measure for addressing water needs.

A further challenge in reflecting drought management as a WMS, associated with both of these factors, is the potential for such a WMS to reflect demand reductions already inherent within the per-capita water demand projections utilized by the Plan. Demand projections for the regional plans are typically based on observed WUG per-capita usage for the driest year or years within a timeframe established by TWDB recently preceding projection development. Therefore, demand projections are based on the conditions during which DCP measures would be most likely to be actively implemented. For this reason, incorporation of drought management as a WMS could effectively double-count potential savings. Finally, the RHWPG recognizes that implementation of DCPs is a curtailment of demands rather than a strategy to meet demands, and therefore, the costs associated with short-term drought management represent economic impacts of not meeting demands.

While drought management measures are not included as WMS in the Region H RWP, drought management remains a critical component of water supply management. The RHWPG strongly supports the development of robust DCPs and implementation of DCPs under appropriate conditions by water providers in order to prolong supply availability and reduce impacts to water users and local economies. This is essential in light of potential shifts in climate and the opportunity for drought conditions that are more severe than the drought of record.

7.8 OTHER RECOMMENDATIONS

7.8.1 Texas Drought Preparedness Council

The Texas Drought Preparedness Council is composed of representatives from multiple state agencies and plays an important role in monitoring drought conditions, advising the governor and other groups on significant drought conditions, and facilitating coordination among local, state, and federal agencies in drought-response planning. The Council meets regularly to discuss drought indicators and conditions across the state and releases Situation Reports summarizing their findings. Additionally, the Council has developed the Drought Annex to the State of Texas Emergency Management Plan (formerly the State Drought Preparedness Plan), which sets forth a framework for state agencies to "conduct an effective, coordinated, and timely response to drought" in order to minimize impacts to people and resources.

The RHWPG supports the ongoing efforts of the Texas Drought Preparedness Council. As part of the 5th cycle of regional water planning in Texas, the Council recommended that RWPGs develop region-specific model drought contingency plans for all water use categories in a region that account for more than 10 percent of regional water demands in any decade over the 50-year planning horizon. The model DCPs found in ***Appendix 7-D*** include plans for municipal, irrigation, and industrial users, corresponding to the Council's recommendation. Additionally, the RHWPG recommends that water providers and other interested parties regularly review the Situation Reports as part of their drought monitoring procedures. More information can be found at the following references:

- Texas Drought Preparedness Council: *http://www.txdps.state.tx.us/dem/CouncilsCommittees/droughtCouncil/stateDroughtPrepCouncil.htm*
- Drought Annex to the State of Texas Emergency Management Plan: *https://waterdatafortexas.org/drought/twdb-reports/state_of_texas_drought_annex_2016.pdf*
- Emergency Drinking Water Supplement to the State of Texas Drought Preparedness Plan: *https://www.tceq.texas.gov/assets/public/agency/annex-a.pdf*

7.8.2 Development, Content, and Implementation of DCPs

The RHWPG recognizes that the DCPs developed by water providers in the region are the best available tool for drought management, and makes the following recommendations to providers regarding development, content, and implementation of DCPs:

- In addition to any monitoring procedures included in the DCP, regular monitoring of resources and information from TCEQ, TWDB, the Texas Drought Preparedness Council, and the U.S. Drought Monitor.
- Coordination with wholesale providers regarding drought conditions and potential implementation of drought stages, particularly during times of limited precipitation.
- Review of the DCP by appropriate water provider representatives, particularly during times of limited precipitation.
- Regular consideration of updates to the DCP document to accommodate changes in supply source, infrastructure, water demands, or service area.
- Communication with customers during times of decreased supply or precipitation in order to facilitate potential implementation of drought response measures and reinforce the importance of compliance with any voluntary measures.
- Designation of appropriate resources to allow for consistent application of enforcement procedures as established in the DCP.

Additionally, retail and wholesale public water suppliers are required under 30 TAC §288.20 to notify TCEQ within five business days when implementing any mandatory provisions of a DCP or when the water system has access to less than 180 days of supply. Notice can be provided to TCEQ through an online form at *http://www.DroughtReport.org.*

CHAPTER 8
UNIQUE STREAM SEGMENTS, RESERVOIR SITES, AND OTHER RECOMMENDATIONS

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Chapter 8 – Unique Stream Segments, Reservoir Sites, and Other Recommendations

8.1 INTRODUCTION

Title 31, §357.43 of the Texas Administrative Code (TAC) specifies that the Regional Water Plan (RWP) shall include recommendations on regulatory, administrative, or legislative issues. The Regional Water Planning Group (RWPG) establishes these recommendations in order to facilitate the orderly development, management, and conservation of water resources. In addition, the group forms recommendations to prepare for and respond to drought conditions in order that sufficient water will be available at a reasonable cost to ensure public health and welfare, provide further economic development, and protect the agricultural and natural resources of the state and the regional water planning area. Furthermore, 31 TAC §357.43 specifies that each RWPG throughout Texas shall make recommendations to identify which stream segments, if any, can be classified as ecologically unique within the region along with determining unique sites for reservoir construction. This chapter presents the recommendations made by the Region H Water Planning Group (RHWPG), referencing these chapters from the TAC and the Texas Water Code (TWC).

The RHWPG believes that stewardship of the environment can be coupled with water supply development. Successful planning and implementation of these recommendations will serve to enhance the quality of life and sustain the local economy throughout the water planning area.

8.2 UNIQUE STREAM SEGMENTS

The TAC offers the opportunity for RWPGs to identify river and stream segments of unique ecological value within a planning area. Per the language of §357.43:

> *(b) Ecologically Unique River and Stream Segments. RWPGs may include in adopted RWPs recommendations for all or parts of river and stream segments of unique ecological value located within the RWPA by preparing a recommendation package consisting of a physical description giving the location of the stream segment, maps, and photographs of the stream segment and a site characterization of the stream segment documented by supporting literature and data. The recommendation package shall address each of the criteria for designation of river and stream segments of ecological value found in this subsection. The RWPG shall forward the recommendation package to the Texas Parks and Wildlife Department and allow the Texas Parks and Wildlife Department 30 days for its written evaluation of the recommendation. The adopted RWP shall include, if available, Texas Parks and Wildlife Department's written evaluation of each river and stream segment recommended as a river or stream segment of unique ecological value.*

Furthermore, 31 TAC §357.43(b) provides the opportunity for the RWPG to recommend such segments to be designated as unique and subsequently requires that the RWPG assess impacts of the RWP on such segments:

(1) A RWPG may recommend a river or stream segment as being of unique ecological value based upon the criteria set forth in §358.2 of this title (relating to Definitions).

(2) *For every river and stream segment that has been designated as a unique river or stream segment by the legislature, during a session that ends not less than one year before the required date of submittal of an adopted RWP to the Board, or recommended as a unique river or stream segment in the RWP, the RWPG shall assess the impact of the RWP on these segments. The assessment shall be a quantitative analysis of the impact of the plan on the flows important to the river or stream segment, as determined by the RWPG, comparing current conditions to conditions with implementation of all recommended WMSs. The assessment shall also describe the impact of the plan on the unique features cited in the region's recommendation of that segment.*

Furthermore, 31 TAC §358.2 defines the criteria by which a stream segment may be identified as unique:

(A) ***Biological function:*** *stream segments which display significant overall habitat value including both quantity and quality considering the degree of biodiversity, age, and uniqueness observed and including terrestrial, wetland, aquatic, or estuarine habitats;*

(B) ***Hydrologic function:*** *stream segments which are fringed by habitats that perform valuable hydrologic functions relating to water quality, flood attenuation, flow stabilization, or groundwater recharge and discharge;*

(C) ***Riparian conservation areas:*** *stream segments which are fringed by significant areas in public ownership including state and federal refuges, wildlife management areas, preserves, parks, mitigation areas, or other areas held by governmental organizations for conservation purposes, or stream segments which are fringed by other areas managed for conservation purposes under a governmentally approved conservation plan;*

(D) ***High water quality/exceptional aquatic life/high aesthetic value:*** *stream segments and spring resources that are significant due to unique or critical habitats and exceptional aquatic life uses dependent on or associated with high water quality; or*

(E) ***Threatened or endangered species/unique communities:*** *sites along stream where water development projects would have significant detrimental effects on state or federally listed threatened and endangered species; and sites along streams significant due to the presence of unique, exemplary, or unusually extensive natural communities.*

The significance of streams of unique ecological value is defined in TWC 16.051:

> *The legislature may designate a river or stream segment of unique ecological value. This designation solely means that a state agency or political subdivision of the state may not finance the actual construction of a reservoir in a specific river or stream segment designated by the legislature under this subsection.*

Texas Parks and Wildlife Department (TPWD) provided the RHWPG with the document *Ecologically Significant River and Stream Segments of Region H Regional Water Planning Area* (Norris and Linam, October 1999) that detailed information on the impact to water resources in the region due to rapid population growth. As the region's population continues to grow, water resources will become limited; therefore, identifying ecologically unique streams is imperative. Several sources were used to identify the 259 river and stream segments that exist within Region H boundaries. The methodology stated above was used to determine which of these water bodies should be classified as ecologically unique. TPWD selected 29 for inclusion as "ecologically significant" streams. This analysis served as the basis for further consideration of which streams might be of "unique ecological value." In 2003, TPWD updated their recommendations list, adding two streams. Members of the RHWPG nominated two tributaries of Galveston Bay as unique due to high aesthetic value. In 2005, the Houston Sierra Club submitted nominations for 18 stream segments within the region, nine of which coincided with previously mentioned nominations. Finally, in 2009, the Houston Sierra Club nominated four segments which had previously been nominated.

The RHWPG considered all 40 nominated stream segments, using the following described methodology to make a final selection.

(1) Screened 40 nominated streams based on data provided by TPWD and other sources (see *Table 8-1*) using a decision rule of selecting those streams with five or more criteria factors cited by the TPWD.
(2) Compared screened streams with previously studied reservoir sites and published or potential water conveyance plans and eliminated streams that might conflict with potential water development projects.
(3) Compared screened streams with the Texas Commission on Environmental Quality (TCEQ) water rights and wastewater discharge information and identified streams that might raise water quality permitting issues.
(4) Compared screened streams with Bayou Preservation Association and Houston Canoe Club ranking of streams in the region and other recreational use information.
(5) Compared screened streams with riparian conservation areas and public lands, adding segments entirely within conservation areas and narrowing the recommendations to only those segments bordered by public lands.

Table 8-1 – Streams Considered for Recommendation as Unique Stream Segments

River or Stream Segment	County	Biological Function	Hydrologic Function	Riparian Conservation Area	High Water Quality/ Aesthetic Value	Endangered/ Threatened Species	Conveyance Project/ Proposed Reservoir Site	Water Rights	Wastewater Outfall
Considered in 2001 Regional Plan:									
Armand Bayou	Harris	●	●●	●●	●			●	●●
Austin Bayou	Brazoria	●	●	●●		●●●		●●	
Bastrop Bayou	Brazoria	●	●	●●		●●●		●	
Big Creek	Fort Bend	●	●	●●	●●			●	●
Big Creek	San Jacinto	●		●●●	●	●		R	●
Brazos River	Austin/Waller/Braz./Ft. Bend	●	●●●	●●●		●●	●	●●	●●
Caney Creek[1]	Walker/Harris	●	●●	●●					●
Carpenters Bayou	Harris	●	●●	●				●	●●
Cedar Lake Creek	Brazoria	●	●●	●●		●●●●		●	
Clear Creek	Waller	●	●●		●			R	
East Fork San Jacinto River	Walker/Harr./San J./Lib./Mont.	●	●●	●●	●●●				●
East Sandy Creek	Walker	●	●	●					
Halls Bayou	Brazoria	●	●			●			
Harmon Creek	Walker	●	●●	●	●			●●	●
Jones Creek	Brazoria	●	●	●●				●●	
Lake Creek	Montgomery	●	●●		●●●	●		R	●
Luce Bayou	Harris/Liberty	●	●●				●	●	
Menard Creek	Polk	●	●●	●		●		R	
Mill Creek	Austin	●	●●		●●	●			●●
Nelson Creek	Walker	●	●		●●				●
Old River	Liberty	●	●●	●	●				
Oyster Bayou	Chambers	●	●	●●				●●	
Redfish Bayou	Brazoria		●	●●				●	●
San Bernard River	Brazoria/Fort Bend/Austin	●	●●			●●		●●	●
Upper Trinity River	Walker/Leon/Houston		●			●		●●	
Lower Trinity River	Chambers/Liberty	●	●●●	●●●		●●	E	●●	●
Upper Keechi Creek	Leon	●	●	●				●	
Wheelock Creek	Leon		●		●				
Winters Bayou[1]	San Jacinto/Walker	●	●●	●	●				
Recommended by Houston Sierra Club (2005):									
Boswell Creek	Walker/San Jacinto	●	●	●	●	●●			
Briar Creek	Walker		●	●					
East Bay Bayou	Chambers		●	●				●●	
Henry Lake Branch	San Jacinto		●	●					●
Little Lake Creek[1]	Montgomery/Walker		●	●					
Lost River	Chambers/Liberty	●	●	●					
Onion Bayou West Fork San Jacinto	Chambers	●	●	●				●●	
West Fork San Jacinto[1]	Walker		●	●			●		
West Sandy Creek	Walker		●	●					
Recommended by RHWPG Members (2005):									
Lone Oak Bayou	Chambers	●	●		●				
Whites Bayou, below IH-10	Chambers/Liberty		●	●	●				

Note: More than one "●" in a criteria column indicates that the river or stream segment satisfies that particular criterion in more than one way. For example, Armand Bayou is a State Coastal Preserve and is also a part of the Great Texas Coastal Birding Trail.

More than one "●" on the Water Rights or Wastewater Outfall column indicates more than one right or outfall located on that stream.

1 - Also proposed by Houston Sierra Club in 2009.

R - Recreational permit without diversion

E - Existing reservoir or impoundment

Based on the information provided in past RWPs, the RHWPG recommended retention of the unique designations for the eight segments designated by the Texas Legislature based on prior consideration and review. These segments are listed in *Table 8-2* and shown in *Figure 8-1*. The following text describes each of the unique stream segments designated by the Texas Legislature and reaffirmed in the 2021 Region H RWP.

Table 8-2 – Recommended Unique Stream Segments

Stream Segment	County
Armand Bayou	Harris
Austin Bayou	Brazoria
Bastrop Bayou	Brazoria
Big Creek	Fort Bend
Big Creek	San Jacinto
Cedar Creek Lake	Brazoria
Menard Creek	Liberty and Polk
Oyster Bayou	Chambers

8.2.1 Armand Bayou

Armand Bayou is a coastal tributary of Clear Lake, a secondary bay in the Galveston Bay System, in southern Harris County. The bayou is often shallow and has a mean width of 40 feet that supports varying flow over a muddy substrate. This scenic natural bayou and associated riparian forest offer habitat for wildlife such as alligators, waterfowl, raccoons, bobcats, and river otters. Noteworthy bird species known to inhabit the area include pileated woodpeckers, red-shouldered hawks, barred owls, ospreys, and migratory songbirds. Several hundred acres of restored coastal prairie offer habitat for grassland species such as the sedge wren and Le Conte's sparrow. The associated marshes that border the riparian forest provide valuable habitat to commercially and recreationally important species such as white shrimp, blue crabs, and red drum. In addition, the bayou also provides valuable recreational opportunities to local residents within an urban context. The ecologically significant segment is from the confluence with Clear Lake in Harris County upstream to Genoa-Red Bluff Road in Harris County.

(1) **Biological Function:** significant riparian zone and associated marshes display significant overall habitat value.
(2) **Hydrologic Function:** performs valuable hydrologic function relating to flood attenuation for the Pasadena and Clear Lake areas.
(3) **Riparian Conservation Area:** fringed by the Armand Bayou Coastal Preserve and is a part of the Great Texas Coastal Birding Trail.
(4) **High Water Quality/Exceptional Aquatic Life/High Aesthetic Value:** high aesthetic value for outdoor recreation within an urban context.

8.2.2 Austin Bayou

Austin Bayou is a scenic coastal plain bayou fringed by native prairie, agricultural land, and woodlands. It begins near Rosharon in north central Brazoria County and flows southeasterly 26 miles into Bastrop Bay. The bayou is narrow (about 25 feet wide) with a limited flow of water. It provides valuable habitat for wildlife and is a recreational resource to local residents. The bayou and associated coastal marsh offer significant habitat for wading birds such as the wood stork, reddish egret, and white-faced ibis. Other known inhabitants include white-tailed kites, white-tailed hawks, waterfowl (geese and sandhill cranes), and grassland species (sedge wren, Le Conte's sparrow, and grasshopper sparrow). The ecologically unique segment is that portion of the stream within the Brazoria National Wildlife Refuge (from the confluence with Bastrop Bayou to FM 2004).

(1) **Biological Function:** coastal stream fringed with native prairie and woodlands that display significant overall habitat value.
(2) **Riparian Conservation Area:** fringed by the Brazoria National Wildlife Refuge and part of the Great Texas Coastal Birding Trail.
(3) **Threatened or Endangered Species/Unique Communities:** designated as an internationally significant shorebird site by the Western Hemisphere Shorebird Reserve Network, providing habitat for the wood stork, reddish egret, and white-faced ibis.

8.2.3 Bastrop Bayou

Bastrop Bayou is a scenic coastal waterway fringed by extensive freshwater wetland habitat. The bayou rises in the central part of Brazoria County and flows deeply in a southeasterly direction for 13 miles where it empties into Austin Bayou and ultimately Bastrop Bay. Like Austin Bayou, Bastrop Bayou provides valuable habitat for endangered or threatened shorebirds as well as waterfowl, grassland species, and birds of prey. These include geese, sandhill cranes, sedge wrens, grasshopper sparrows, white-tailed kites, and white-tailed hawks. In addition to numerous birdwatching opportunities, the bayou also provides outdoor opportunities in the form of water related activities to local residents. The ecologically significant segment is that portion within the Brazoria National Wildlife Refuge. This segment is within TCEQ stream segment 1105.

(1) **Biological Function:** extensive freshwater wetland habitat that displays significant overall habitat value.
(2) **Hydrologic Function:** extensive freshwater wetlands that perform valuable hydrologic function relating to water quality.
(3) **Riparian Conservation Area:** fringed by the Brazoria National Wildlife Refuge and part of the Great Texas Coastal Birding Trail.
(4) **Threatened or Endangered Species/Unique Communities:** designated as an internationally significant shorebird site by the Western Hemisphere Shorebird Reserve Network, providing habitat for the wood stork, reddish egret, and white-faced ibis.

8.2.4 Big Creek (Fort Bend County)

Big Creek begins south of Rosenberg and flows southeasterly 25 miles into the Brazos River in Fort Bend County. The creek is an old Brazos River channel with associated sloughs, bayous, oxbow lakes, and coastal prairies that are bordered by bottomland hardwood forest. This habitat provides an excellent opportunity for birdwatching, as over 270 species of birds have been sighted in this area. Birds commonly seen here include purple gallinules, least bitterns, prothonotary warblers, barred owls, white-ibis, herons, and egrets among others. Other wildlife that inhabits the area includes alligators, bobcats, raccoons, feral hogs, and gray foxes. The ecologically significant segment is that portion of the stream within the Brazos Bend State Park.

(1) **Hydrologic Function:** bottomland hardwood forest and associated wetlands that perform valuable hydrologic function relating to water quality.
(2) **Riparian Conservation Area:** fringed by Brazos Bend State Park and part of the Great Texas Coastal Birding Trail.

(3) **High Water Quality/Exceptional Aquatic Life/High Aesthetic Value:** designated as an Ecoregion Reference Stream by the TPWD River Studies Program for high dissolved oxygen and diversity of benthic macroinvertebrates.

8.2.5 Big Creek (San Jacinto County)

Big Creek rises near Coldspring in central San Jacinto County and flows southeasterly into northern Liberty County where it joins the Trinity River. The creek is narrow with a sandy bottom, follows a run, riffle, pool sequence, and contains abundant woody debris. This provides habitat for a diverse community of fish and macroinvertebrates including the southern brook lamprey, blacktail shiner, blacktail redhorse, blackstripe topminnow, numerous perch species, and several species of sunfish. The creek meanders through pristine forestland in the Sam Houston National Forest and provides significant opportunities for birdwatching and outdoor recreation. Bird species often found include Louisiana waterthrushes and worm-eating warblers, as well as the endangered red-cockaded woodpecker around which the National Forest Service developed an interpretive site. An interpretive trail through the Big Creek Scenic Area and the Lone Star Hiking Trail provide access to the creek and provide an opportunity to see mammals such as bobcats, squirrels, and beavers. The ecologically significant segment is that portion of the stream that exists within the Sam Houston National Forest within San Jacinto County.

(1) **Biological Function:** displays significant overall habitat value considering the high degree of biodiversity.
(2) **Riparian Conservation Area:** fringed by the Sam Houston National Forest and the Big Creek Scenic Area and is part of the Great Texas Coastal Birding Trail.
(3) **High Water Quality/Exceptional Aquatic Life/High Aesthetic Value:** exceptional aesthetic value.
(4) **Threatened or Endangered Species/Unique Communities:** red-cockaded woodpecker group nearby.

8.2.6 Cedar Lake Creek

Cedar Lake Creek begins in northwest Brazoria County and flows southeasterly 28 miles into Cedar Lake and ultimately to the Gulf of Mexico. The creek is bordered by bottomland hardwood forest in the northern portion and by interspersed native prairies, farmland, and coastal marshes in the south. It is one of the few remaining unchannelized bayous in the region. The creek itself and the adjacent San Bernard National Wildlife Refuge provide habitat to numerous bird species including the scissortailed flycatcher and numerous shorebirds. The ecologically significant segments are those portions of the stream adjacent to the San Bernard Wildlife Refuge within Brazoria County.

(1) **Biological Function:** undredged bayou with extensive forest and wetlands that display significant overall habitat value.
(2) **Hydrologic Function:** bottomland forest and wetlands that perform valuable hydrologic functions relating to flood attenuation and water quality.
(3) **Riparian Conservation Area:** fringed by San Bernard National Wildlife Refuge and part of the Great Texas Coastal Birding Trail.
(4) **Threatened or Endangered Species/Unique Communities:** significant due to presence of reddish egret, wood stork, and white-faced ibis.

8.2.7 Menard Creek

Menard Creek begins east of Livingston in central Polk County and flows southeasterly to the Polk County line where it turns northwesterly and flows through Liberty County into the Trinity River. The creek channel is narrow and shallow with a sandy bottom and follows a sinuous path through banks lined with pine and hardwood forest. The ecologically significant segment is from the confluence with the Trinity River near the Polk and Liberty County line upstream to its headwaters located east of Livingston in the central part of Polk County. The portion that runs through Hardin County is not included in the segment as it is outside Region H.

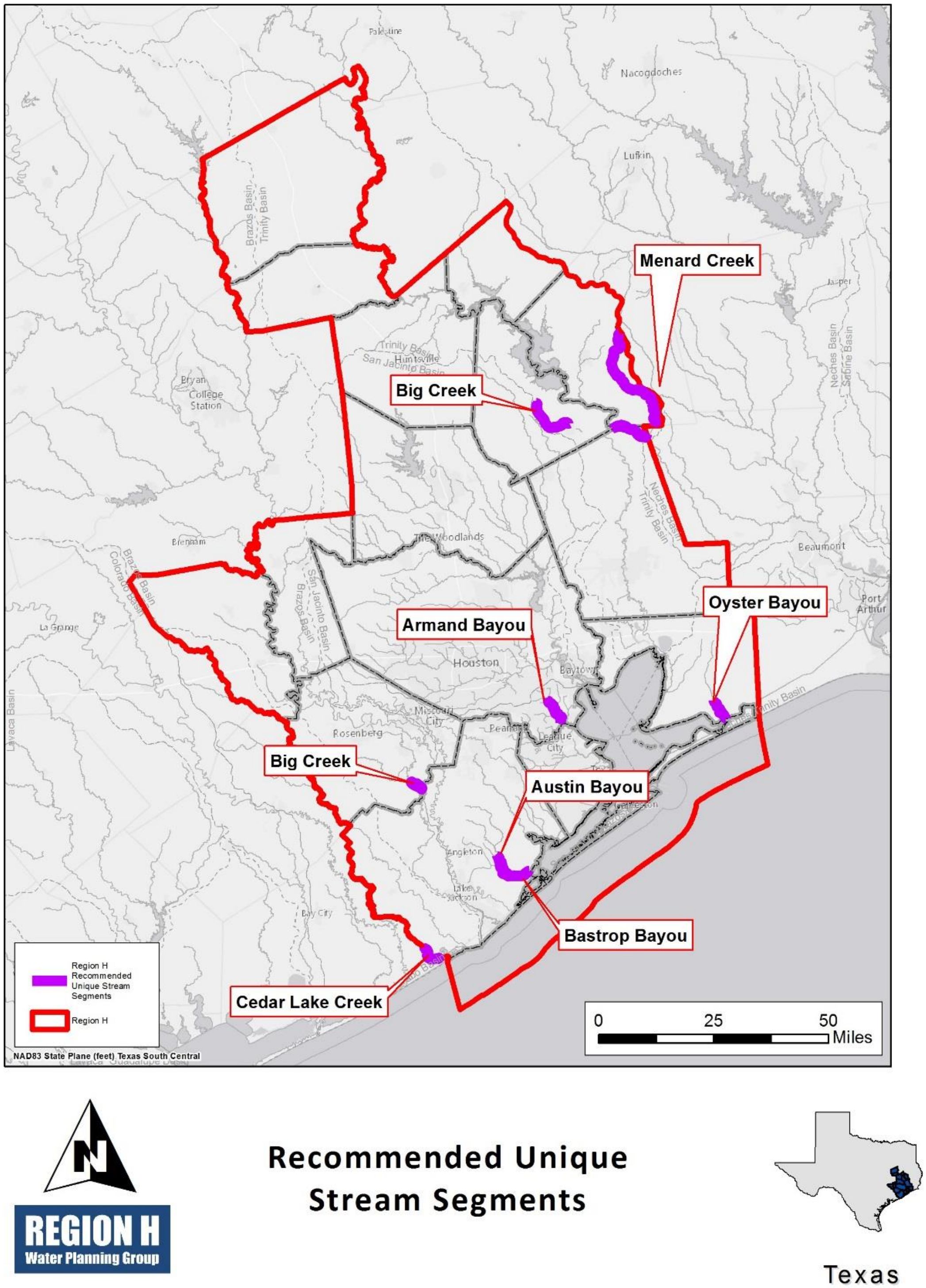
(1) **Biological Function:** bottomland hardwood forest that displays significant overall habitat value.
(2) **Hydrologic Function:** performs valuable hydrologic functions relating to water quality and groundwater recharge of the Chicot Aquifer.
(3) **Riparian Conservation Area:** fringed by the Big Thicket National Preserve.
(4) **Threatened or Endangered Species/Unique Communities:** high diversity of freshwater mussels, many of which are rare.

8.2.8 Oyster Bayou

Oyster Bayou, Chambers County: The segment within the Anahuac National Wildlife Refuge provides freshwater inflow to the coastal marsh. Wetland habitats provide important wintering and migration stopover habitat for migratory birds including Central Flyway waterfowl, shorebirds, wading birds, and marsh and waterbirds. Upland habitats including prairie and woodlands are important to many neotropical or nearctic and temperate landbirds, including several sensitive or declining species. The mottled duck is an important resident waterfowl species for which the refuge provides habitat year-round for nesting, brood-rearing, molting, and wintering. Coastal marshes serve as nursery areas for many important commercial and recreational fish and shellfish species including white and brown shrimp, blue crab, red drum, flounder, and speckled sea trout. The ecologically significant segment is that portion of the stream within the Anahuac National Wildlife Refuge.

(1) **Biological Function:** provides nursery for commercial and recreational fisheries.
(2) **Hydrologic Function:** provides sediment removal above East Bay.
(3) **Riparian Conservation Area:** part of the Anahuac National Wildlife Refuge.
(4) **Threatened or Endangered Species/Unique Communities:** piping plover habitat within the Anahuac NWR.

Figure 8-1 – Recommended Unique Stream Segments



8.3 UNIQUE RESERVOIR SITES

According to the 2017 State Water Plan (SWP), Texas has 188 major water supply reservoirs which provide a large portion of the state's water supply. The SWP also recommended the construction of 26 reservoirs for future supplies, meaning that reservoirs will continue to be a vital asset in future water management and should be protected.

The TAC offers an opportunity to designate sites of unique value for use as surface water supply reservoirs within a planning region. The following criteria are outlined in order to provide for this protection. Per the language of §357.43:

> *(c) Unique Sites for Reservoir Construction. An RWPG may recommend sites of unique value for construction of reservoirs by including descriptions of the sites, reasons for the unique designation and expected beneficiaries of the water supply to be developed at the site. The criteria at §358.2 of this title shall be used to determine if a site is unique for reservoir construction.*

Per the language of §358.2(7), these criteria include:

- *(A) Site-specific reservoir development is recommended as a specific water management strategy or as a unique reservoir site in an adopted regional water plan; or*
- *(B) The location, hydrologic, geologic, topographic, water availability, water quality, environmental, cultural, and current development characteristics, or other pertinent factors make the site uniquely suited for reservoir development to provide water supply for:*
  - *(i) The current planning period; or*
  - (ii) *Where it might reasonably be needed to meet needs beyond the 50-year planning period.*

The significance of sites of unique value for reservoir construction is defined in TWC 16.051:

> *The legislature may designate a site of unique value for the construction of a reservoir. A state agency or political subdivision of the state may not obtain a fee title or an easement that would significantly prevent the construction of a reservoir on a site designated by the legislature under this subsection.*

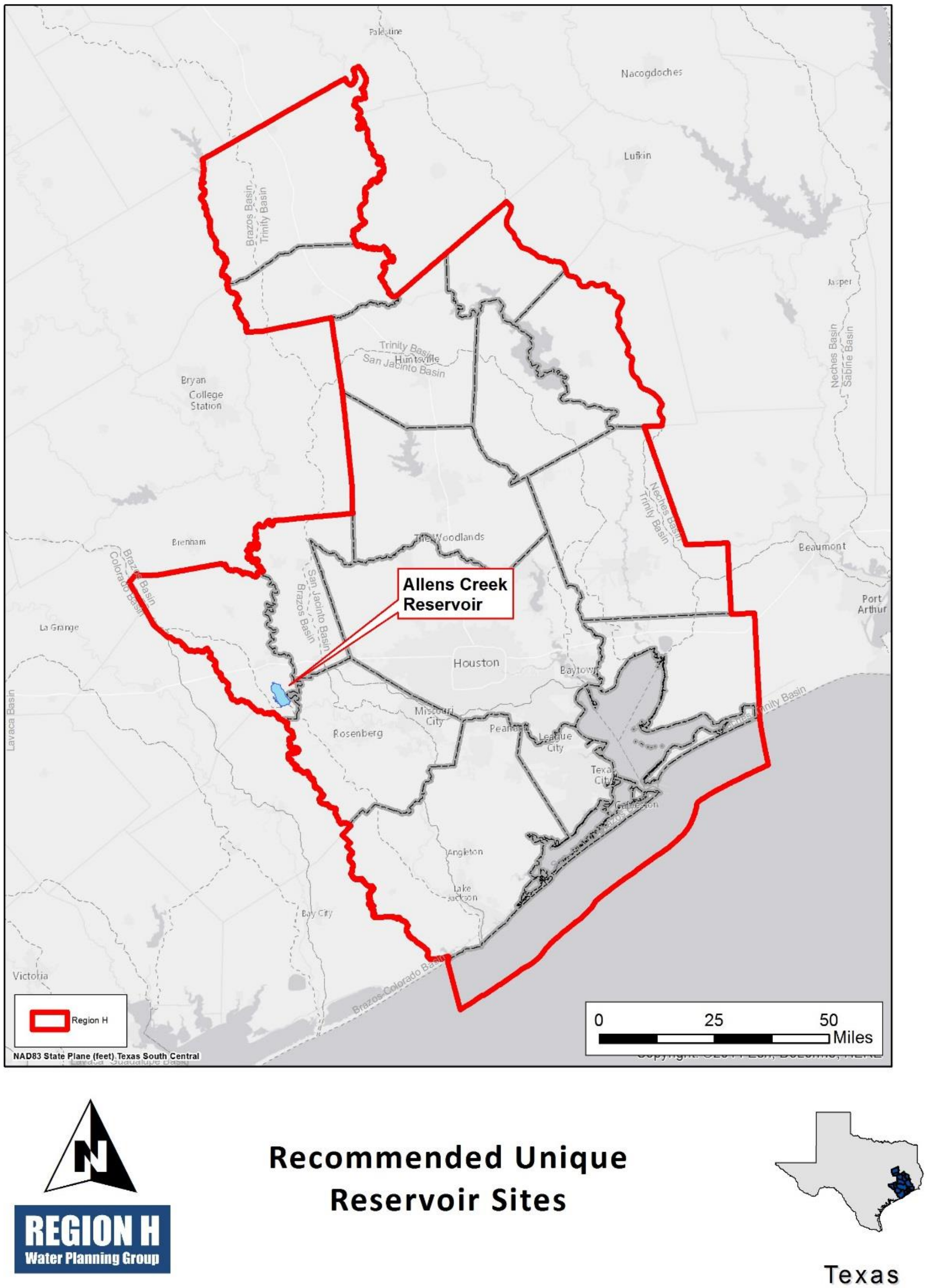
The TWC continues to declare that the reservoir sites designated as having a unique value in the 2007 SWP were designated under this section until September 1, 2015. In July 2008, the Texas Water Development Board (TWDB) provided the *Reservoir Site Protection Study* that recommended proposed reservoir project sites to be designated as unique reservoir sites by the legislature. The board identified 220 major reservoir sites in Texas that were included in previous studies to be screened. The TWDB used the screening process stated above in the TWC for all the reservoirs. After technical evaluations, the 16 top ranked reservoirs (14 major and 2 minor reservoirs) were selected to be recommended as unique reservoir sites.

Of the four unique reservoir sites identified in the TWDB study, Region H has continued to include one of them as active strategies in the 2011, 2016, and 2021 RWPs. In each plan, Allens Creek Reservoir has been selected as a water management strategy. Details on this project are described below and the site is illustrated in *Figure 8-2*.

8.3.1 Allens Creek Reservoir

This site is located in Austin County, one mile north of the City of Wallis, on Allens Creek, a tributary to the Brazos River. This site exists within the Brazos River Basin and is in Region H. Approximately 7,000 acres would be inundated. This project is configured as a scalping reservoir that would divert stormwater flows from the Brazos River and impound these flows in the reservoir to create storage yield. During periods of median to low flows, diversions are limited by instream flow thresholds established to protect the environment and downstream water rights. The maximum dam height is 53 feet. The conservation storage quantity is approximately 145,500 acre-feet at an elevation of 121 feet msl. The projected firm yield of this project is 99,650 acre-feet per year. The total project capital cost is estimated at $365,446,301. Supplies from the reservoir could be used to meet needs in the lower Brazos and San Jacinto River Basins as well as adjoining coastal basins.

Figure 8-2 – Recommended Unique Reservoir Sites



8.4 OTHER REGULATORY, ADMINISTRATIVE, AND LEGISLATIVE RECOMMENDATIONS

RWPGs may develop and include in the RWP regulatory, administrative, or legislative recommendations that will facilitate the orderly development, management, and conservation of water resources in Texas and will facilitate more voluntary water transfers and help the state prepare for and respond to droughts. In addition, they may develop information regarding the potential impacts of recommendations enacted into law once proposed changes are in effect.

These recommendations are addressed to each governmental agency that has the appropriate jurisdiction over each subject. It is generally assumed that regulatory recommendations are directed toward the TCEQ, that administrative recommendations are directed toward the TWDB, and that legislative recommendations are directed toward the State of Texas Legislature.

The RHWPG has adopted the following regulatory, administrative, and legislative recommendations, which are discussed in detail in ***Appendix 8-A***.

8.4.1 Regulatory and Administrative Recommendations

The RHWPG recommends that the TWDB determines, in conjunction with the TCEQ and TPWD, which specific environmental studies and analysis are required for each category of management strategy (i.e., new water right, new reservoir, etc.). Furthermore, the guidance should be added to the Planning Guidelines, so that Regional Water Planning Groups can reflect the cost of those requirements in their budgets and scopes of work. Adding environmental guidelines will also make water plans consistent across the state.

The RHWPG recommends that the TPWD, in cooperation with TWDB and the Regional Water Planning Groups, develop an updated analysis of ecologically significant river and stream segments, including identification of river and stream segments of unique ecological value.

The RHWPG recommends that TCEQ continue routine updates to Water Availability Models across the state based on a prioritized methodology based on observed climate conditions and the overall limitation on water resources in each basin. This may be prescribed in future rulemaking. Furthermore, these rules should require that the most recent model for each basin be made available through the TCEQ website for use by both the RWPGs and the public.

Provide for additional opportunities for Groundwater Management Areas and Regional Water Planning Groups to align their planning through rules that recognize the inherent differences of these processes and account for the timing of the methodologies so that changes in groundwater management can be reflected in the Regional Water Plans.

Work with water utilities and planners to identify the limitations of current planning approaches regarding OneWater management and how these programs may best be reflected in regional plans. This will have the added benefit of promoting these options for comprehensive water management.

8.4.2 Legislative Recommendations

The RHWPG recommends that the Legislature remove the unnecessary and counterproductive barriers to interbasin transfers that exist in current law.

The RHWPG recommends establishment of additional and dedicated funding to pursue necessary future efforts of the State's bay and estuary programs.

The RHWPG supports continued usage of the Rule of Capture as the basis of groundwater law throughout the State of Texas except as modified through creation of certified groundwater conservation districts.

The RHWPG supports creation of groundwater conservation districts, as necessary, by local subarea water interests. These districts provide a unique opportunity for balancing local management with regional planning through the joint planning exercises of Groundwater Management Areas.

The RHWPG wishes to recognize the Legislature's efforts in implementing the SWIFT program and also supports ongoing and expanded support for financing methods by the State of Texas for development of water supply projects recommended within adopted Regional Water Plans.

The RHWPG supports continued funding for the Groundwater Availability Modeling effort and recommends comprehensive analysis of all groundwater resources within the state.

The RHWPG supports funding of research and development studies associated with the efficient usage of irrigation technologies and practices.

The RHWPG supports water conservation and recommends that the Legislature continue to address and improve water conservation activities in the state. In addition, the RHWPG recommends the State consider improvements to statewide efforts and messaging regarding the importance of water conservation.

The RHWPG recommends that the State fund research into advanced conservation technologies.

The RHWPG recommends that the State consider legislation clarifying the liability exposure of reservoir operators for passing storm flows through water supply reservoirs.

The RHWPG recommends that the State direct the State Demographer's office to explore the potential changes in population distribution made possible by rapid advancements in information technology.

The RHWPG recommends that the TWDB request additional and adequate funding and the adoption of the appropriate administrative procedures from the Legislature to facilitate ongoing activities of the RWPGs. Funding should be made available throughout the entirety of the planning cycle without funding gaps that make it difficult for planning groups to accomplish their ongoing efforts.

8.4.3 Infrastructure Finance Recommendations

The RHWPG recommends increasing the funding of the State Revolving Funds Program in future decades and expand the program to include coverage for system capacity increases to meet projected growth for communities.

Provide a mechanism to leverage federal grant programs for agriculture by providing the local matching share. Increase funding of associated loan programs and consider adding a one-time grant or subsidy component to stimulate early adoption of conservation practices by individual irrigators.

Provide opportunities for joint cooperation between growers and landowners to facilitate the use of funding programs for property under long-term lease agreements.

The RHWPG recommends continued state and federal support of the Texas Community Development Program and increase the allocation of funds for the Small Town Environment Program.

The RHWPG recommends continued support and increased funding of Water and Waste Disposal Loans and Grants from USDA Rural Utilities Service at the federal level.

Provide technical assistance grants for the advancement of desalination water supplies and implementation of new desalination technologies available to wholesale and retail water suppliers. Provide resources for identification and feasibility assessment of opportunities for aquifer storage and recovery projects. Continue to fund appropriate demonstration facilities to develop a customer base and pursue federal funding for desalination programs.

Region H supports the forming of regional partnerships and encourages the State to allow them the greatest possible latitude for financing in their governing regulations. Additionally, funding opportunities should be made available to these public/private partnerships and to private nonprofit water supply corporations.

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CHAPTER 9
REPORTING OF FINANCING MECHANISMS FOR WATER MANAGEMENT STRATEGIES

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Chapter 9 – Reporting of Financing Mechanisms for Water Management Strategies

9.1 INTRODUCTION

In Senate Bill 2 of the 77th Texas Legislature, the preparation of an Infrastructure Financing Report (IFR) was added to the regional planning process. The purpose of the IFR is to identify the funding needed to implement the water management strategies recommended in the Regional Water Plan (RWP). The primary objectives of this chapter and report are:

- Determine the number of political subdivisions with identified needs that will be unable to finance their water infrastructure needs;
- Determine the amount of infrastructure costs in the 2021 RWP that cannot be financed by the local political subdivisions;
- Determine funding options, such as State funding, that are proposed by the political subdivisions to finance water infrastructure costs that cannot be financed locally; and
- Determine additional roles the Regional Water Planning Group (RWPG) proposes for the State in financing the recommended water supply projects.

A survey of Water User Groups (WUGs) with identified infrastructure needs will be conducted, and the results of those surveys will be summarized in *Section 9.3* of this chapter. Completion of the survey and tabulation of the results will follow the completion of the Initially Prepared Plan (IPP). Additional text will be included in *Chapter 9* to discuss proposed projects, their locations in the RWP, and the sources and WUGs associated with each project.

The Region H Water Planning Group (RHWPG) reviewed the current role of the State in financing water supply projects and made recommendations for program increases and new initiatives in ***Chapter 8*** of this plan. Updates to this section will be completed after the 2021 water infrastructure financing survey is completed.

9.2 CAPITAL COSTS FOR THE 2021 REGION H WATER PLAN

The estimated cost of the 2021 Region H RWP is approximately $20.8 billion over the 50-year planning period. This cost includes the development of new water sources, estimates for distribution and treatment facilities, municipal conservation programs, and the capital improvements required to achieve agricultural conservation and municipal water loss reduction targets. In addition, these costs also include WUG-level projects that are required to make the supplies originating from major projects accessible to meet WUG demands. Costs for key projects in the 2021 RWP are shown below in *Table 9-1.* Detailed costs for projects can be found in ***Appendix 5-A*** and in the detailed discussion of key water projects in ***Appendix 5-B***.

Table 9-1 – Key Project Overview

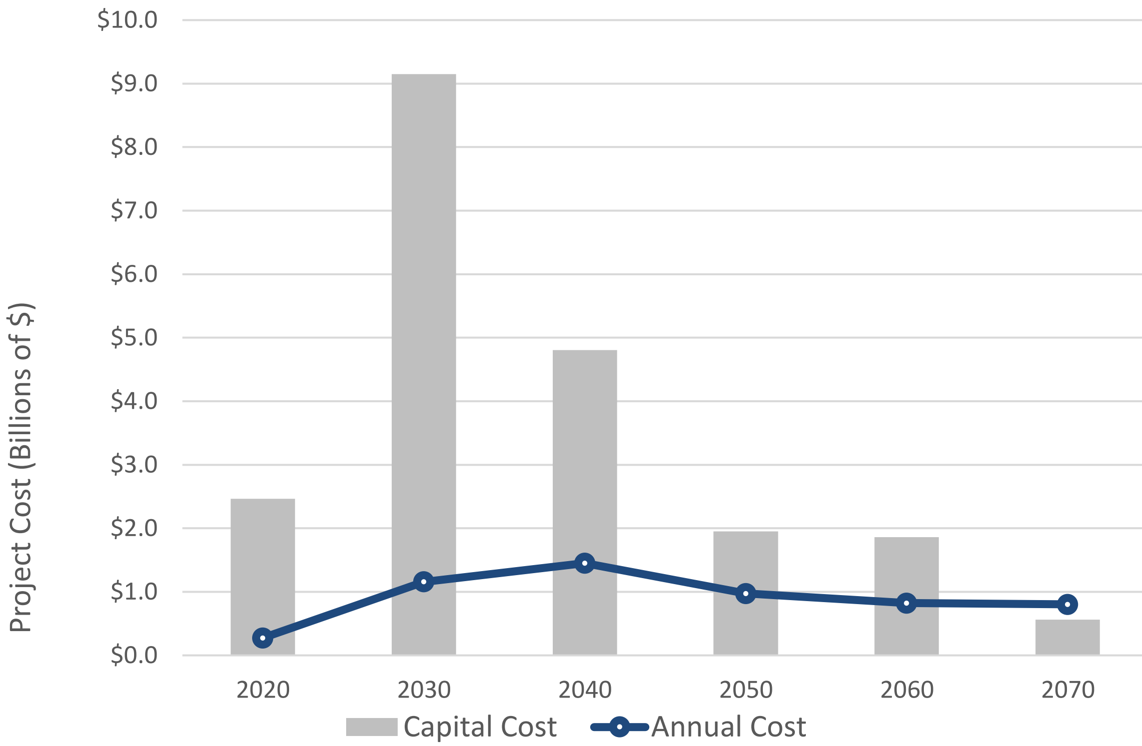
Project	Potential Volume[1] (ac-ft)	Capital Cost ($)	Unit Cost ($/ac-ft)		Start Decade
			Start Decade	2070	
Conservation					
Irrigation Conservation	93,562	$1,489,156	$133	$131	2020
Municipal Conservation (Advanced Conservation)	123,251	$2,211,236,519	$754	$591	2020
Municipal Conservation (Water Loss Reduction)	62,601	$891,822,048	$625	$578	2020
Conveyance					
BWA Transmission Expansions	26,211	$77,755,692	$248	$39	2030
CHCRWA Transmission and Distribution Expansion	5,466	$17,202,167	$238	$16	2030
City of Houston GRP Transmission	27,216	$31,986,905	$91	$8	2040
COH, NHCRWA, and CHCRWA Shared Transmission	154,575	$462,453,409	$246	$27	2030
CWA Transmission Expansion	349,785	$119,336,981	$43	$19	2040
East Texas Transfer	250,000	$423,969,947	$134	$15	2050
GCWA Industrial Raw Water Line	33,600	$20,909,636	$63	$19	2020
Lake Livingston to SJRA Transfer	50,000	$245,492,975	$437	$92	2050
LNVA Neches-Trinity Basin Interconnect	67,000	$103,316,000	$135	$27	2040
NFBWA Phase 2 Distribution Segments	62,496	$83,859,522	$104	$9	2030
NHCRWA Distribution Expansion	143,360	$919,703,916	$489	$44	2030
NHCRWA Transmission Lines	143,360	$327,910,960	$185	$24	2030
Southeast Transmission Line Improvements	39,928	$119,413,067	$229	$19	2030
Surfside Beach Supply Infrastructure	323	$1,900,440	$450	$36	2020
WHCRWA Distribution Expansion	92,288	$276,977,822	$237	$26	2030
WHCRWA/NFBWA Transmission Line	169,030	$1,310,701,901	$613	$67	2030
Groundwater Development					
Aquifer Storage and Recovery	9,426	$222,907,186	$2,551	$2,551	2070
Brackish Groundwater Development[2]	Varies	Varies by project	Varies by WUG	Varies by WUG	2020
BWA Brackish Groundwater Development	3,136	$33,246,167	$579	$370	2030
City of Houston Area 2 Groundwater Infrastructure	50,400	$122,751,076	$403	$222	2030
Expanded Use of Groundwater[2]	31,000+	Varies by WUG	Varies by WUG	Varies by WUG	2020
GCWA Backup Well Development	1,120	$1,346,492	$169	$84	2040
Groveton Groundwater Expansion	242	$2,211,952	$699	$56	2020
SJRA Catahoula Aquifer Supplies	10,500	$18,200,411	$479	$358	2040
Groundwater Reduction Plans					
CHCRWA GRP[3]	5,466	$0	$0	$0	2030
City of Houston GRP[3]	124,914	$0	$0	$0	2020
City of Missouri City GRP	25,760	$87,837,323	$405	$165	2030
City of Richmond GRP	7,178	$70,936,844	$1,108	$363	2020
City of Rosenberg GRP	3,920	$12,963,110	$261	$29	2030
City of Sugar Land IWRP	15,492	$133,134,039	$1,210	$390	2030
Fort Bend County MUD 25 GRP	1,120	$26,718,250	$2,541	$862	2030
Fort Bend County WC&ID No. 2 GRP	6,720	$63,535,966	$1,106	$440	2030

Project	Potential Volume[1] (ac-ft)	Capital Cost ($)	Unit Cost ($/ac-ft)		Start Decade
			Start Decade	2070	
Montgomery County MUDs #8 and #9 GRP	2,240	$30,510,375	$1,875	$917	2020
NFBWA GRP[3]	62,496	$0	$0	$0	2030
NHCRWA GRP[3]	143,360	$0	$0	$0	2030
Porter SUD Joint GRP	2,240	$26,862,533	$1,542	$699	2020
River Plantation and East Plantation Joint GRP[4]	51	$0	$0	$0	2030
SJRA GRP	100,000	$998,910,850	$697	$340	2030
WHCRWA GRP[3]	92,288	$0	$0	$0	2030
Reuse					
City of Houston Reuse	242,554	$555,093,732	$373	$139	2040
City of Pearland Reuse	1,154	$12,648,000	$913	$142	2030
Galveston County Industrial Reuse	22,400	$90,746,960	$564	$279	2030
NFBWA Member District Reuse	3,816	$46,640,088	$1,695	$835	2020
NHCRWA Member District Reuse	300	$4,295,775	$1,913	$905	2020
San Jacinto Basin Regional Return Flows[3]	119,673	$0	$0	$0	2020
Wastewater Reclamation for Municipal Irrigation	19,776	$181,028,438	$1,308	$896	2030
Westwood Shores MUD Reuse	150	$2,031,251	$1,921	$968	2020
Surface Water Development					
Allens Creek Reservoir	99,650	$365,446,301	$211	$39	2040
BRA System Operation Permit[3]	78,276	$0	$0	$0	2020
Dow Reservoir and Pump Station Expansion	80,000	350,000,000	$373	$66	2020
Freeport Seawater Desalination	11,200	155,877,822	$2,273	$1,293	2040
Manvel Supply Expansion	15,680	$269,052,608	$1,488	$309	2030
Mustang Reservoir Improvements	3,734	$14,551,195	$298	$23	2020
NRG Cedar Bayou Desalination	22,400	$342,840,391	$2,637	$1,560	2030
Treatment					
BWA Conventional Treatment Expansion	8,400	$19,085,165	$351	$191	2030
City of Houston Treatment Expansion[3]	89,396	$0	$0	$0	2040
City of Houston West Water Purification Plant	103,385	$959,257,534	$1,418	$407	2040
GCWA Galveston County Treatment Expansion	22,400	$167,919,105	$894	$367	2030
Northeast Water Purification Plant Expansion	448,000	$2,179,413,588	$615	$272	2030
Pearland Surface Water Treatment Plant	22,400	$232,787,093	$973	$242	2030
SEWPP Additional Module	22,400	$97,597,266	$497	$191	2030
Other Infrastructure					
Brazos Saltwater Barrier	10,000	$67,552,043	$517	$42	2040
Chocolate Bayou Pump Station Expansion	33,600	$8,577,765	$29	$11	2020
Chocolate Bayou Saltwater Barrier Improvements	1,120	$1,034,798	$72	$7	2020

1. *Volumes listed in this table represent the maximum anticipated volume associated with the projects rather than new increments of yield. Volumes shown in this table may overlap and are not necessarily additive.*
2. *Includes brackish groundwater projects implemented under Expanded Use of Groundwater. Costs vary by WUG.*
3. *Costs, including construction costs, engineering, legal, and permitting fees, land acquisition, and other capital costs, are included under associated infrastructure projects.*
4. *Supply generated through expanded use of existing infrastructure. Cost estimated to be minimal.*

The distribution of capital and annual costs over the planning period is shown in *Figure 9-1*. While many projects are developed in a single phase, if necessitated by increasing strategy volumes, WUG capital costs are also shown in subsequent decades, reflecting phased infrastructure expansion to handle additional project capacity. A significant portion of the overall infrastructure will be built by 2025 due to groundwater reduction goals and thus reflected in the 2030 decade. The City of Houston (COH), San Jacinto River Authority (SJRA), and Regional Water Authorities cost projections reflect meeting surface water conversion milestones in Harris, Fort Bend, and Montgomery Counties as a result of local groundwater district regulations.

Figure 9-1 – Region H Capital and Annual Costs



9.3 INFRASTRUCTURE FINANCING SURVEY

Information in this section will be populated upon completion of the infrastructure financing survey by Texas Water Development Board (TWDB).

CHAPTER 10
ADOPTION OF PLAN AND PUBLIC PARTICIPATION

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Chapter 10 – Adoption of Plan and Public Participation

10.1 INTRODUCTION

The Region H Water Planning Group (RHWPG) has sought to encourage public involvement and the participation of interested parties during the process of plan development so that any concerns could be addressed before the draft plan was completed. From its initial deliberations in preparing the 2001 Regional Water Plan (RWP), the RHWPG has made a commitment to an open planning process and has actively solicited public input and involvement in developing the elements of the 2021 RWP. Securing a high level of public participation continues to be a challenge for long-term planning, even for a topic as vital to public well-being as the water supply, particularly if there is no drought. Nevertheless, the RHWPG has reached out to communicate with the general public by pursuing several avenues to gain public involvement.

10.1.1 Regional Water Planning Group as Stakeholder Representatives

The first line of public involvement occurs through the membership of the RHWPG. Each of the members of the RHWPG represent an interest category, such as river authorities, agriculture, small businesses, the general public, etc. They also represent the different geographic areas within this expansive region. Most of these members have connections to the community through various organizations. These linkages, such as professional organizations or citizen groups, are the first avenue for taking information to the public and for receiving input to the RHWPG.

During development of the 2021 RWP, the RHWPG has met at least four times per year, typically on the first Wednesday of the month, so that interested parties can plan to attend and follow the proceedings. Notices of these meetings are posted on the Texas Secretary of State website and the Region H website and are e-mailed to a list of "interested persons" who have requested to be informed. The RHWPG maintains minutes of its meetings and places them on the Region H Water website for review, along with other meeting resources.

10.1.2 Public Outreach

In addition to regular meetings related to the routine business of plan development, the RHWPG and its representatives participated in numerous opportunities to address organizations associated with water supply and natural resources as well as the general public. A partial list of these organizations includes the following:

- Baytown Area Community Advisory Panel
- Bluebonnet Groundwater Conservation District
- Brazoria County Groundwater Conservation District
- Fort Bend Subsidence District
- Greater Houston Partnership
- Groundwater Management Area 14
- Gulf Coast Water Conservation Symposium

- Gulf Coast Water Efficiency Network
- H2O4Texas Coalition
- Harris-Galveston Subsidence District
- Houston-Galveston Area Council
- Lone Star Groundwater Conservation District
- Lower Brazos River Coalition
- Mid-East Texas Groundwater Conservation District
- The Woodlands G.R.E.E.N.

10.1.3 Public Notes and Press Releases

RHWPG meetings and meetings of RHWPG technical committees were held as public meetings, with notice posted in accordance with 31 Texas Administrative Code (TAC) §357.21. The RHWPG met all requirements under 31 TAC §357.21 as well as the Public Information Act and Open Meetings Act.

10.1.4 Region H Water Website

A website was developed at the onset of the first biennium of the 2011 RWP in order to maintain contact with the public and to provide members of the RHWPG with resources for plan development. The site, Region H Water (*http://www.regionhwater.org*), provides visitors with an overview of the regional planning process in Texas and specific information on the Region H Water Planning Area and Water Planning Group. The site also provides information and announcements for meetings of the RHWPG and downloads of past RWPs.

10.1.5 Texas Water Development Board Website

The Texas Water Development Board (TWDB) provides extensive information on the regional water planning process, including background information, current planning documents, and relevant rules and statutes, on its regional planning webpage (*www.twdb.texas.gov/waterplanning/rwp*). Upcoming meetings, minutes of previous meetings, contact information, and downloadable copies of previously adopted RWPs are available as well.

10.2 PLANNING GROUP ACTIVITIES

10.2.1 Regional Planning Group Meetings

The public meetings held as part of the planning process for Region H during the 2021 regional water planning cycle are summarized below. Additional information and supporting materials, including detailed meeting minutes, are available on the Region H website (*http://www.regionhwater.org*).

10.2.1.1 Public Meeting, February 3, 2016

A public meeting to receive comments, address RHWPG membership, and discuss updates from the Consultant Team regarding the 2021 Region H RWP was held on February 3, 2016 at 10:00 a.m. as part of the regular meeting of the RHWPG. The meeting was held at the SJRA offices in Conroe. No public comments were provided.

The RHWPG received the resignation of Ron Neighbors as a voting member of the RHWPG representing water districts. Mr. Schindewolf, Chair of the Nominating Committee, presented recommendations by the Nominating Committee to fill three vacancies, based on discussions during a Committee conference call on January 21, 2016. The Nominating Committee recommended Mr. Michael Turco, General Manager of the Harris-Galveston Subsidence District, to replace Mr. Ron Neighbors for Water Districts; secondly they recommended Mr. Ivan Langford, General Manager of the Gulf Coast Water Authority, to fill the vacancy of Mr. Harold Wallace for Water Utilities; and lastly, the committee recommended Ms. Ruth Stultz to fill the vacancy of Mr. Steve Tyler for Small Business. Mr. Collinsworth made a motion to elect the nominees as recommended; this motion was amended to accept the resignation of Mr. Neighbors. The motion was seconded by Mr. Bruner and was carried unanimously.

Following a brief explanation by Mr. Houston regarding the current terms of voting members, Mr. Marcell made a motion to extend the term of existing Region H voting members for an additional five-year term. The motion was seconded by Mr. Fisseler and was carried unanimously.

The Nominating Committee had also made recommendations for the Executive Committee, being Mr. Evans to continue as Chair, Mr. Chang to be elected to the position of Vice Chair, Mr. Houston to continue as Secretary, Mr. Bartos to continue as a member, and Mr. Willcox be elected as a member. Mr. Hebert made a motion to accept the elections of Executive Committee members as recommended. The motion was seconded by Mr. Blount and was carried unanimously.

Mr. Afinowicz stated that the 2016 Regional Water Plan had been submitted to TWDB and was subsequently approved. He then explained the process for developing the State Water Plan (SWP). He also summarized a recent call with regional chairs and stakeholders. Mr. Afinowicz then informed the RHWPG that the TWDB contract with SJRA and the consultant contract with SJRA had been approved in December of 2015. He also provided a brief overview of the 2021 RWP Scope of Work for Tasks 2 and 10.

After an explanation by Mr. Afinowicz of the budget amendment for the previous plan, Mr. Houston made a motion to amend the budget for the development of the 2016 Regional Water Plan. The motion was seconded by Mr. Masterson and carried unanimously.

Mr. Evans welcomed Mr. Scott Galaway from TWDB. Ms. Sarah Backhouse of TWDB announced the appointment of Mr. Peter Lake, new TWDB Board Member, and gave a brief overview of his background. She went on to announce the deadline for SWIFT Abridged Applications and explained that these would be based on projects in the 2016 Regional Plan and the 2017 SWP. She also explained that TWDB would be revising their planning rules. Ms. Carmen Cernosek stated that she welcomed suggestions regarding public outreach related to the agricultural and rural programs.

10.2.1.2 Public Meeting, May 4, 2016

A public meeting to receive comments and discuss updates from the Consultant Team regarding the 2021 Region H RWP was held on May 4, 2016 at 10:00 a.m. as part of the regular meeting of the RHWPG. The meeting was held at the SJRA offices in Conroe.

One member of the public provided comment. Ms. Jill Savory spoke in reference to agenda item 5, Draft 2017 SWP, expressing concern about the utilization of the drought of record as it relates to future planning. She discussed modes of communication related to public input.

Mr. Kevin Kluge, of TWDB, gave a presentation regarding population and water demand projections for the 2021 RWP. He explained several methodologies to improve projections would be studied and possibly recommended in the upcoming cycle relative to water demand projections for irrigation, livestock, manufacturing, mining, steam-electric power, population, and municipal. Mr. Kluge concluded with a tentative timeline for the completion of this project.

Lann Bookout, Project Manager for Water Use, Projections, and Planning with TWDB, provided an overview of the purpose of the SWP. Mr. Bookout then explained the projected population growth in Texas and its relationship to projected water demand versus existing water supplies. He concluded with an overview of the upcoming timeline related to the Draft 2017 SWP.

Mr. Afinowicz provided information related to the development of the 2021 Region H RWP, stating that the consultant team just recently had been authorized to review water demand projections. He stated that the consultant team would review the projections and provide information to committees in the near future.

Mr. Afinowicz summarized recommendations by Freese and Nichols, Inc., to TWDB regarding proposed revisions to 31 Texas Administrative Code (TAC) Chapters 357 and 358.

Mr. Evans explained the process by which members are appointed to committees. Mr. Afinowicz provided an update on recently attended meetings of the Gulf Coast Water Conservation Symposium as well as the upcoming meeting at the Greater Houston Partnership. Mr. Lann Bookout spoke about upcoming financial workshops and reported that SWIFT applications would be due in May.

10.2.1.3 Public Meeting, August 3, 2016

A public meeting to receive comments and discuss updates from the Consultant Team regarding the 2021 Region H RWP was held on August 3, 2016 at 10:00 a.m. as part of the regular meeting of the RHWPG. The meeting was held at the SJRA offices in Conroe.

One member of the public provided comment. Ms. Jill Savory gave comments with regard to regulations related to water production data.

Mr. Evans welcomed Director Peter Lake, Chief of Staff Tara Rejino, and Ms. Sarah Backhouse of TWDB. Director Lake provided a brief summary of his experience and then explained the various types of financing programs relevant to state water planning as well as the cost savings of each plan. He also announced that a Financial Assistance Workshop would be held at SJRA in September to provide more details on various financing options.

Mr. Philip Taucer provided an overview of the 2021 Regional Water Plan schedule, particularly providing information related to the rules and guidance revisions, the continued work regarding the identification of WUGs and the projection process, and the determination of water supplies.

Mr. Taucer explained the process of the rule change and the reasoning behind the change to take a more utility-based approach by defining WUGs based upon retail water service to an area. He then explained that the proposed definition of a municipal WUG, if approved, would be defined as a utility serving 100 acre-feet per year or more of water on a retail basis. Both Mr. Marcell and Mr. Taucer acknowledged that this change would be a beneficial one. Mr. Taucer stated that the Population Demands Committee met on July 26, 2016, and the Committee recommended the potential list of municipal WUGs, as identified by TWDB, for inclusion in Region H. Following further discussion, Mr. Chang made a motion to recommend the addition of municipal WUGs and authorize transmittal of recommendations to TWDB. The motion was seconded by Mr. Henson and carried unanimously.

Mr. Taucer stated that a presentation was made on May 25, 2016, to the Greater Houston Partnership Environmental Advisory Committee, and he mentioned the upcoming meeting on August 25, 2016, to the Gulf Coast Water Efficiency Network.

Ms. Sarah Backhouse with TWDB announced that the draft rules would be posted to the Texas Register and a link would be available on their website. She reviewed the timeline for the various stages of the proposed rule changes. Ms. Backhouse mentioned that TWDB was revising the methodology for projecting irrigation, manufacturing, and steam electric demands and would be providing the proposed methodologies by the end of the summer, with draft projections to be potentially provided by next June. She also mentioned that the current regional water planning contract between SJRA and TWDB via Freese and Nichols would need to be amended in the fall to incorporate a full scope of work. Lastly, she provided information related to upcoming financial workshop as well as the Water for Texas conference. Mr. Kramer provided information regarding the Sierra Club's public education booklet related to Texas water.

10.2.1.4 Public Meeting, November 2, 2016

A public meeting to receive comments and discuss updates from the Consultant Team regarding the 2021 Region H RWP was held on November 2, 2016 at 10:00 a.m. as part of the regular meeting of the RHWPG. The meeting was held at the SJRA offices in Conroe. No public comments were provided.

Mr. Evans stated that Mr. Houston and Mr. Bartos agreed to volunteer to review and amend the bylaws to reflect Region H changes. Mr. Bartos provided an overview of the proposed changes to the bylaws, stating that all of the changes were minor amendments. Mr. Evans stated that the proposed amendments would be presented for consideration and approval at the next RHWPG meeting.

Mr. Cory Stull, of Freese and Nichols, presented information related to the results of a supply and retention feasibility study. He stated that in 2014, the Harris County Flood Control District identified two reservoir sites (Plan 3 and Plan 5) to try to manage the Cypress Creek overflows as part of the Cypress Creek Overflow Management Plan. Mr. Stull provided details related to the analysis for the potential for a firm water supply, concluding that Plan 3 "Mound Creek Reservoir" and Plan 5 "Katy-Hockley Reservoir" had a high evaporation rate and did not provide benefit for a firm yield to be generated. Next, he provided information related to two conceptual retention sites within the Addicks and Little Cypress Watersheds. He stated that studies were also conducted related to interruptible supplies, return flows, water demands/population growth, the feasibility of distributed retention facilities, and TCEQ financing. Overall, Mr. Stull concluded that the modeled reservoirs were not a viable source of water supply. Further, the dual use (flood control and water supply) were counteracting to each other, reducing the volume available to each use. Finally, he stated that distributed retention may provide the potential to supplement irrigation and other non-potable demands, however permitting, treatment, and transmission requirements may hinder implementation.

Mr. Afinowicz stated that TWDB is on schedule to finalize the rules later this month. He provided information regarding the deliverables which are related to population and non-population water demands. Mr. Afinowicz then provided a high-level overview of the schedule for 2017 through 2020.

Mr. Afinowicz also provided an update related to the identification of Municipal WUGs. He briefly reviewed the list of privately-owned utilities and state or federal owned facilities that responded to be included in the plan. With no discussion, Mr. Fisseler made a motion to ratify the recommendations made previously for the new WUGs. The motion was seconded by Mr. Blount and carried unanimously.

Mr. Afinowicz provided an overview of the proposed funding allocations and contracting process for the completion of the 2021 RWP. Mr. Henson made a motion to submit a grant application for the Request for Application ("RFA"), to post notice related to the RFA submittal, and to negotiate and execute the contract with TWDB. The motion was seconded by Mr. Hebert and carried unanimously.

Mr. Afinowicz reported on the August 25, 2016, meeting of the Gulf Coast Water Efficiency Network related to the Region H Plan. Ms. Backhouse provided an update related to the Texas Administrative Code Chapter 357 Administrative Rules. Mr. Jun Chang announced his retirement from the City of Houston and his new position with the North Harris County Regional Water Authority. He stated that as he is no longer with the City of Houston, he could no longer represent municipalities and resigned his position, effective immediately.

10.2.1.5 Public Meeting, February 28, 2017

A public meeting to receive comments and discuss updates from the Consultant Team regarding the 2021 Region H RWP was held on February 28, 2017 at 10:00 a.m. as part of the regular meeting of the RHWPG. The meeting was held at the SJRA offices in Conroe.

One member of the public provided comment. Ms. Jill Savory spoke in regard to Agenda Item 6, concerning the TWDB's introduction to the 5th cycle of regional water planning; she expressed the opinion that voters should have an opportunity to vote for upcoming projects if the voters will have to pay for such projects.

Mr. Evans reported that the members of the Nominating Committee participated in a conference call to discuss nominations related to officers and members to the Executive Committee. Mr. Evans stated that the Acting Chair, Mr. Hebert sent correspondence, in his absence, recommending the following nominations: Mark Evans, Chair; Marvin Marcell, Vice Chair; Jace Houston, Secretary; John Bartos, At-Large Member; and Pudge Willcox, At-Large Member. With no further discussion, Mr. Turco made a motion to accept the nominations as recommended by the Nominating Committee. The motion was seconded by Mr. Masterson and carried unanimously.

Mr. Houston provided a brief overview of the proposed amendments to the Region H Bylaws, as previously presented at the November 2, 2016, Region H meeting. He briefly reviewed each amendment and discussed the determination to exceed the requirements of the Texas Open Meetings Act by holding all committee meetings open to the public and providing notice above and beyond current practices, of same. With no further discussion, Mr. Fisseler made a motion to adopt the proposed amendments to the Region H Bylaws. The motion was seconded by Mr. Lord and carried unanimously.

Ms. Backhouse presented information related to regional water planning in Texas and introduced the fifth cycle. She provided background information related to regional and state water planning in Texas, an overview of regional water planning groups, fundamentals of water planning, and the foundation of the SWP. Mr. Willcox commended the Texas Water Development Board for its ability to compile sixteen water plans into one concise plan.

Mr. Taucer reviewed the timeline related to the development of the 2021 Region H RWP, providing a list of scheduled events and tasks.

Mr. Taucer provided details on the revised methodologies related to manufacturing, steam-electric power, and irrigation demand projections, stating that further review was anticipated by the Non-Population Demands Committee. Further, he stated that draft projections for these use categories were anticipated from TWDB in June 2017 and that TWDB had recently released the draft 2022 SWP Mining Water Demand Projections for Region H.

Mr. Taucer stated that the draft projections for municipal population and water demands had been received from TWDB, and he provided an overview of the information related to same. Mr. Taucer reviewed various timelines stating that the deadline for regions to submit requested changes to population and non-population demands is November 15, 2017.

Mr. Taucer briefly reported on a presentation to the Gulf Coast Water Authority regarding regional planning that took place on January 12, 2017. Ms. Backhouse stated that contract amendments to complete the fifth cycle of regional water planning would be considered at the April 6, 2017, TWDB Board meeting. She stated that Ms. Temple McKinnon is now the Director of Water Use, Projections, and Planning, and that Mr. Kevin Kluge is now the Director of Conservation and Innovative Water Technologies.

10.2.1.6 Public Meeting, June 7, 2017

A public meeting to receive comments and discuss updates from the Consultant Team regarding the 2021 Region H RWP was held on June 7, 2017 at 10:00 a.m. as part of the regular meeting of the RHWPG. The meeting was held at the SJRA offices in Conroe. No public comments were provided.

Mr. Houston clarified a correction to the minutes of the February 28, 2017 RHWPG meeting and made a motion to approve the minutes, as amended. The motion was seconded by Mr. Bailey with all present voting aye.

Mr. Bookout of TWDB provided information related to the revised 31 Texas Administrative Rules, Chapter 357. He stated that the purpose of the 2016 rules revisions were to implement legislative changes, address stakeholder concerns, improve the planning process, increase flexibility in planning requirements, reduce certain unessential reporting requirements, clarify rules, and refine definitions.

Mr. Afinowicz reviewed various due dates in the 2021 RWP schedule. He also explained the process by which funding is obtained from TWDB for the Fifth Round of Regional Water Planning for Region H, stating that amended contracts with subconsultants needed to be executed in order to proceed. Mr. Bartos made a motion to authorize SJRA to execute amended contracts with subconsultants. The motion was seconded by Mr. Masterson and carried unanimously.

Mr. Philip Taucer stated that the non-municipal demand projections were recently released. He provided an overview of the data related to irrigation, livestock, manufacturing, mining, and steam-electric power. The RHWPG discussed the significant changes in manufacturing demand projections.

Mr. Taucer explained that the demand projections could be changed due to various reasons and stated that the deadline to submit the requested changes to TWDB is January 12, 2018.

Mr. Taucer explained that the consultant team had coordinated with TWDB to obtain more information on the process of developing population and municipal demand projections, and he explained the TWDB methodology in detail. He stated that at the county and region levels, the Census and population projections were very close and are well within the percentage that is recommended by TWDB. He explained that the largest change from the previous RWP is related to the definition of WUGs, stating that redistribution among WUGs was a major undertaking for TWDB. Finally, he stated that the WUG stakeholder survey would be distributed in the near future.

Regarding the Sub-WUG Planning Option, Mr. Taucer explained that several RWPGs had requested such an option in order to account for rural areas. However, he stated that additional effort would be required to develop data for this option, which would be due to TWDB by September 1, 2017. Mr. Marcell recommended that the Population Demands Committee meet to discuss the sub-WUG planning option. Mr. Fisseler made a motion to authorize the Population Demands Committee to evaluate the inclusion of potential sub-WUGs for possible submittal of same to TWDB. The motion was seconded by Mr. Masterson and carried unanimously.

Mr. Taucer presented the Major Water Provider (MWP) concept as a new concept in the fifth planning cycle, which largely replaces the designated Wholesale Water Provider (WWP) role, explaining that determination of MWPs would be made by individual water planning groups. Mr. Taucer reviewed the previously designated WWPs in Region H and discussed the possibility of adding large supplies and/or large groundwater reduction plan sponsors. The RHWPG discussed a potential threshold for defining MWPs as well as a logical methodology for rolling up supplies. Mr. Evans recommended that the Population Demands Committee resume this discussion and provide a recommendation at the next scheduled RHWPG meeting.

Mr. Evans reported that he attended the Lower Brazos River Coalition meeting on May 31, 2017. Mr. Bartos announced that the Trinity and San Jacinto River Basins and Galveston Bay BBASC would meet at 1:00 p.m., June 7, 2017, at the San Jacinto River Authority.

10.2.1.7 Public Meeting, November 1, 2017

A public meeting to receive comments and discuss updates from the Consultant Team regarding the 2021 Region H RWP was held on November 1, 2017 at 10:00 a.m. as part of the regular meeting of the RHWPG. The meeting was held at the SJRA offices in Conroe.

One member of the public provided comment. Mr. John Jones commented on youth water conservation efforts and programs.

Mr. Bartos made a motion to appoint Yvonne Forrest to represent municipalities for the Region H Water Planning Group. The motion was seconded by Mr. Hebert and carried unanimously. Ms. Forrest was welcomed by the group and provided a brief overview of her duties and responsibilities at the City of Houston.

Mr. Evans reported that Mr. Gene Fisseler submitted his resignation as a member of the Region H Water Planning Group effective August 23, 2017. Mr. Chang made a motion to accept Mr. Fisseler’s resignation. The motion was seconded by Mr. Turco and carried unanimously. Mr. Evans stated that

Mr. Fisseler recommended Mr. Craig Eckberg, NRG's regional environmental director, be appointed to the RHWPG as the voting member representing electric generating utilities. Mr. Evans stated appointments due to this vacancy would be considered at a future meeting.

Mr. Bookout of TWDB presented an overview of the 85th Legislative Session. He discussed details of legislation relevant to regional water planning – specifically, Senate Bill 347, House Bill 2215, and Senate Bill 1511. Mr. Evans explained that Senate Bill 347 stipulates that each regional water planning group (RWPG), committee, and subcommittee of the RWPG are subject to the Open Meetings Act and the Public Information Act. Mr. Houston explained that RWPG members must complete the Open Meetings Act training required by Texas Government Code, Section 551.005 and the Public Information Act training required by Government Code, Section 552.012. Further, he explained, the Open Meetings Act and Public Information Act both state that completing the training in one capacity satisfies the requirement in all capacities, so RWPG members who have completed these trainings as part of their outside employment would not need to complete them again as RWPG members. Discussion ensued and a consensus was had that alternate voting members would also complete the training. Mr. Houston suggested that all completed certificates be provided to the RHWPG Secretary's designee for official filing to comply with the bill prior to December 1, 2017. Discussion ensued related to the requirement for members to take the Public Information Act training. Mr. Houston along with Mr. Bookout explained that the interpretation of the Act is that the RWPG could designate a person to complete the Public Information Act training which would satisfy the requirement of the Act. Mr. Langford made a motion to designate Jace Houston, Secretary, as the designated official Public Information Act training certificate holder of the RHWPG. The motion was seconded by Mr. Chang and carried unanimously.

Mr. Afinowicz provided an update on upcoming meetings, events, and tasks.

Mr. Afinowicz then stated that the Non-Population Demands Committee met on September 22, 2017, to review and make recommendations related to irrigation, livestock, manufacturing, mining, and steam electric power. He stated that the committee recommended gathering a historical use data from 2010 to 2015 in order to view a longer range of data than was used in the TWDB methodology. Mr. Afinowicz stated that the final recommendation would be considered at the December RHWPG meeting in order to meet January 12, 2018, deadline for requesting changes from TWDB.

Mr. Taucer provided an update related to the draft municipal population and water demands projections. He stated that Population Demands Committee convened in June and reviewed projections to confirm the overall approach. It was stated that the consensus of the committee is that projected growth was in line with that shown in the previous plan.

Mr. Taucer provided an update related to MWPs, stating that the MWPs largely replace specifically designated WWPs. He stated that the Population and Non-Population Committees reviewed a methodology to identify MWPs based on volumetric breakpoints. It was suggested by the Population Committee that any entity supplying less than 25,000 acre-feet per year would not be considered a MWP. Mr. Langford made a motion to accept the recommendation of designating entities which supply 25,000 acre-feet per year and above as MWPs. The motion was seconded by Mr. Bruner and carried unanimously.

Mr. Evans discussed the possibility of designating specific sites for future committee meetings to be held; this item was postponed to a later meeting for further discussion. Mr. Bookout of TWDB discussed the upcoming public comment period related to changes in the rules.

10.2.1.8 Public Meeting, December 6, 2017

A public meeting to receive comments and discuss updates from the Consultant Team regarding the 2021 Region H RWP was held on December 6, 2017 at 10:00 a.m. as part of the regular meeting of the RHWPG. The meeting was held at the SJRA offices in Conroe.

One member of the public provided comment. Ms. Jill Savory spoke in regard to the USGS program MODFLOW 6.

The RHWPG consultant team and Mr. Jordan Furnans of LRE Water, LLC, gave a presentation on the City of Manvel's proposed application to amend the 2016 Region H RWP. Mr. Furnans explained that the city is looking for potential surface water supplies and is requesting water rights on Mustang Bayou of 5,237 acre-feet per year. Mr. Afinowicz explained the first step of the amendment process would be to submit the amendment application package to TWDB for the determination of amendment status as major or minor. Mr. Bookout of TWDB explained the processes for the determination of an amendment as major or minor. Discussion ensued related to environmental impacts, environmental flows, and in general, the process by which the city is requesting this amendment. Mr. Lord made a motion to approve the submittal of the application package from the City of Manvel to the TWDB for the determination of amendment status. The motion was seconded by Mr. Houston. After further discussion, the motion carried with eighteen ayes, two nays (Mr. Langford and Mr. O'Connell), and two abstentions (Mr. Masterson and Mr. Collinsworth).

Mr. Taucer updated the RHWPG on the ongoing development of the 2021 RWP, explaining that the study was on schedule and that the consultant team was in the process of coordinating with wholesale and major water providers.

Mr. Taucer stated that pursuant to TAC 357.12(b), the RHWPG is required to document its process for identifying and selecting Water Management Strategies (WMS) for development of the 2021 RWP. He stated that this process is required to be presented to the public for comment at a public meeting. Further, he explained the primary goal of the WMS selection methodology is to pair WMS with a need of a particular water user group (WUG). Mr. Taucer explained that potential WMS would be defined based on a determination of needs developed from a comparison of projected demand and existing supplies. He stated that the strategies would be analyzed by the MWP or WUGs. Mr. Taucer then provided details related to the shortage analysis, application of general WMS, identification of potential WMS to add new water supplies, and the WMS selection process. Mr. Chang made a motion to approve the presented process to identify and evaluate potentially feasible WMS to use in the 2021 Region H RWP. The motion was seconded by Mr. Collinsworth and carried unanimously.

Mr. Taucer summarized the Non-Population Demands Committee's analysis and recommendations for each non-municipal water use category. He stated that the committee considered the draft projections developed by TWDB, as well as local data provided by several industries and wholesale water providers. Based on the committee review, proposed demand revisions to the draft projections had been developed, and Mr. Taucer detailed how the proposed demand revisions were derived. Mr. Chang made a motion to approve the recommended revisions to the draft TWDB projections and to approve submittal of same to the TWDB. The motion was seconded by Ms. Forrest and carried unanimously.

Mr. Taucer then summarized the Populations Demands Committee's analysis and recommendations regarding population and municipal demand projections. He explained that draft projections of population and municipal water demand were developed by TWDB at the WUG level based on the projected population and demand in the 2017 SWP and were adjusted to align with utility boundaries based on TWDB Water Use Survey data. He stated that based on the *Second Amended General Guidelines for Fifth Cycle of RWP Development*, RWPGs may request revisions to these draft projections. He then explained that in July 2017, the RHWPG issued a survey to the 342 WUGs in the region in which WUGs were asked to review the draft population and demand projections for their entity. He explained and detailed how the committee developed proposed revisions to population and municipal demand projections for 16 named municipal WUGs which had been identified based on survey results. Mr. Masterson made a motion to approve the Populations Demands Committee's revisions to the TWDB draft projections for the 2021 Region H RWP and approve submittal of same to TWDB. The motion was seconded by Mr. Houston and carried unanimously.

Mr. Afinowicz updated the RHWPG on the ongoing evaluation of existing water supplies as related to surface water, groundwater, reuse, contractual transfer, and data management. He provided the status and activities for each category.

Mr. Evans discussed the possibility of designating specific locations for future RHWPG and committee meetings. Mr. Houston stated that he researched the subject and did not find any statutory requirements related to the designation of meeting locations. Mr. Bookout of TWDB reported on the proposed rulemaking process that would be presented to TWDB on December 7, 2017. Mr. Evans reminded the RHWPG that there is a vacancy representing electric generating utilities and a vacancy representing small business, which would be addressed at the next RHWPG meeting.

10.2.1.9 Public Meeting, April 4, 2018

A public meeting to receive comments and discuss updates from the Consultant Team regarding the 2021 Region H RWP was held on April 4, 2018 at 10:00 a.m. as part of the regular meeting of the RHWPG. The meeting was held at the SJRA offices in Conroe. No public comments were provided.

Mr. Hebert, Chair of the Nominating Committee provided a recommendation of the Nominating Committee for the election of officers and members to the Executive Committee. Mr. Henson made a motion to elect Mark Evans as Chairman, Marvin Marcell as Vice Chairman, Jace Houston as Secretary, and John Bartos and Pudge Willcox as Directors. The motion was seconded by Ms. Max and carried unanimously. Mr. Hebert then made a motion to declare the river authorities' position, previously occupied by David Collinsworth, vacant and to appoint Brad Brunett to this position as a voting member representing river authorities. The motion was seconded by Mr. Langford and carried unanimously.

Mr. Taucer stated that the development of the 2021 RWP had reached the halfway mark in the schedule of the planning cycle. He stated that the technical memo would be due in September, the Initially Prepared Plan (IPP) due in March 2020, and the Final RWP due in October 2020. Mr. Evans stated that committee assignments are on the Region H website and he went on to discuss the logistics related to committee quorums, alternate member participation, and teleconference participation relative to the Open Meetings Act.

Mr. Taucer updated the RHWPG on the development of surface water supply availability, explaining that TWDB requires that supplies be based on TCEQ's Water Availability Model ("WAM") Run 3, which is a water rights model that simulates all existing permanent water rights and environmental flow requirements, in priority order using historical hydrology. He reviewed methodology and supply estimates for run-of-river, reservoir, and local surface water supplies. He also explained that TWDB requires a formal request submittal to make changes beyond reservoir sedimentation in the WAM to appropriately reflect surface water availability. Mr. Henson made a motion to authorize the consultant team to develop and submit to TWDB a request for potential exceptions to surface water modeling requirements. The motion was seconded by Mr. Willcox and carried unanimously.

Mr. Taucer also provided an update related to the draft estimates for availability of reuse. He stated that both direct and indirect reuse supplies have increased over the years in Region H but that determining a firm supply availability is challenging, as reuse is not included surface water or groundwater models. He explained that TWDB provides guidance on limiting the existing supply numbers for reuse to ensure it is not overstated and reviewed a list of new reuse sources to be added that were not included in the previous RWP.

Mr. Taucer then discussed groundwater supply availability in the three groundwater management areas (GMAs) in Region H, including modeled available groundwater (MAG) and non-MAG availability in various aquifers. Mr. Taucer stated that for non-MAG sources, the Groundwater Supply Committee recommended the approval of the groundwater supply estimates from the 2016 RWP for use in the 2021 RWP. Mr. Hebert made a motion to approve the groundwater supply estimates for use in the 2021 RWP which includes the use of values in 2016 RWP. Mr. Turco seconded the motion and carried with all present voting aye. Mr. Taucer also explained that TWDB has incorporated percentage factors, or "peak factors" into the planning process to assist in bridging the gap between the regional planning process and the groundwater processes by applying a factor greater than 100% to MAG volumes to reflect that in some circumstances, temporary increases in pumpage could be greater than the MAG volume. To be included in the RWP, this factor would require approval prior to the IPP by the relevant groundwater district, GMA, and Executive Administrator of TWDB. Mr. Masterson made a motion to authorize the consultant team to coordinate with groundwater regulatory entities to develop peak factors for Region H and submit an associated request to TWDB. Mr. Lord seconded the motion, which carried with all present voting aye.

Mr. Taucer explained that the WMS analyses funds were allocated by TWDB under Phase 2 of the planning cycle totaling $948,695 for Region H. He stated that TWDB requires submittal of a scope and fee approved by the RHWPG for each strategy analysis in order to obtain a Notice to Proceed. Mr. Taucer reviewed the proposed scope and budget for each analysis, which totaled $482,200. Mr. Bartos made a motion to approve the notice to proceed request and to authorize the consultant team and SJRA to submit the request in the amount of $482,200; coordinate with TWDB as needed on follow-up information; and to execute the subsequent contract amendment issued. The motion was seconded by Mr. Masterson and carried unanimously. Following a brief explanation by Mr. Taucer regarding the allocation of planning funds, Mr. Hebert made a motion to authorize SJRA to execute a contract amendment with TWDB for additional funding. The motion was seconded by Mr. Masterson and carried unanimously.

Mr. Taucer stated that TWDB allows RWPGs to declare a goal for management safety factor, also explaining how this factor is calculated. He reported that the WMS Committee recommended declining the option to set a declared goal and to instead allocate management strategies as the

RHWPG had done in prior planning cycles. Mr. Turco made a motion to designate a WMS allocation safety factor for use in development of the 2021 RWP. The motion was seconded by Mr. Nelson and carried unanimously. Upon further clarification and discussion, Mr. Turco made a motion to reconsider previous action taken under the agenda item regarding management supply factors. The motion was seconded by Mr. Nelson and carried unanimously. Mr. Turco then made a motion to report safety factors as they are calculated on a project-by-project basis but to decline the option to establish a goal for the safety factor. The motion was seconded by Mr. Nelson and carried unanimously.

Mr. Taucer gave a brief report on a recent presentation to the Baytown Area Community Advisory Panel.

10.2.1.10 Public Meeting, June 6, 2018

A public meeting to receive comments and discuss updates from the Consultant Team regarding the 2021 Region H RWP was held on June 6, 2018 at 10:00 a.m. as part of the regular meeting of the RHWPG. The meeting was held at the SJRA offices in Conroe. No public comments were provided. Mr. Evans welcomed Director Kathleen Jackson of TWDB. She thanked everyone for the work that is being done relative to the regional water planning process.

Mr. Taucer provided an update on the schedule and progress of the 2021 RWP and stated that the next major deadline would be the submittal of the Technical Memorandum prior to September 10, 2018, which would be presented to and considered by the RHWPG at the August RHWPG meeting. Mr. Taucer stated that the consultant team was working on the analysis of existing supply and was wrapping up the examination of supply availability contracts.

Mr. Taucer provided a review of the previous meeting's update related to the rules, methodology, and initial results for the surface water assessment in Region H, including potential modeling exceptions for some basins. He stated that the request for modeling exceptions in the Trinity and Brazos Basins and the Brazos-Colorado Coastal Basin had been submitted to TWDB. He also discussed recent interregional coordination efforts between Regions H, C, G, and K to finalize the models. Mr. Taucer stated that based on incoming data, the use of reuse water has grown each planning cycle and that analysis of reuse supplies was ongoing. Mr. Taucer explained that the increase in reuse is mainly due to municipal use.

Mr. Taucer also provided additional explanation on the new planning concept of MAG Peak Factors, noting that application of peak factors does not change the predetermined MAG but allows an increased supply to be available for regional planning purposes only while still meeting desired future conditions for an aquifer on a long-term basis. He explained that these factors require approval by Groundwater Conservation Districts (GCDs), GMAs, and the TWDB Executive Administrator and staff. Based on preliminary analysis for Region H by the consultant team, the potential peak factors would likely be between 1.2 and 1.3. Further, he explained that this would be a non-issue for areas where the projected demand is well below the base MAG. He stated that coordination with the GCDs was ongoing.

Mr. Taucer provided a detailed overview of the process to accurately allocate existing supplies in the 2021 RWP and explained that once compiled, these supply allocations would be entered in TWDB's database. He then discussed the Technical Memorandum to be submitted to TWDB in September, explaining that this interim deliverable contains TWDB DB22 (database) reports, assumptions and unmodified values, model files and documentation, methodology for RWPG-estimated groundwater availability, process for potentially feasible WMS, the latest list of potentially feasible WMS, and declaration of intent for simplified planning. Mr. Taucer explained the process for public input, approval by the RHWPG, public comment period, TWDB Executive Administrator review process, and the due date for TWDB to receive same.

Mr. Taucer reported on two community outreach presentations given on May 24, 2018, to the Gulf Coast Water Efficiency Network and The Woodlands G.R.E.E.N. Mr. Bookout of TWDB reported on updates to resources from TWDB related to regional planning.

10.2.1.11 Public Meeting, August 1, 2018

A public meeting to receive comments and discuss updates from the Consultant Team regarding the 2021 Region H RWP was held on August 1, 2018 at 10:00 a.m. as part of the regular meeting of the RHWPG. The meeting was held at the SJRA offices in Conroe. No public comments were provided.

Mr. Taucer reviewed the regional planning schedule and then went on to discuss how MAG peak factors had been introduced as a mechanism to reconcile the regional planning and groundwater planning processes by representing potential temporary increases in groundwater pumping during drought conditions while remaining consistent with desired future conditions. He reviewed the required approval process for peak factors and provided an overview of the counties and GCDs that had approved, were considering, or had declined the MAG peak factors. He reiterated that this mechanism is solely for regional planning purposes and does not affect any permitting, regulatory plans, DFCs, etc.

Mr. Taucer explained that the 2016 RWP was the first time that the Catahoula Aquifer had been recognized as a specific supply in the regional plan, at which time the existing supply for that formation was based upon the anticipated use from groundwater reduction plans. He stated that the RHWPG agreed at a previous meeting to retain 2016 plan values for all non-MAG groundwater formations. He then explained that according to the Lone Star Groundwater Conservation District, the permitted amount from the Catahoula has increased over the years and presented the total permit allocations of 8,761 ac-ft/yr as a potential availability for this formation. Mr. Henson made a motion to update the source availability for the Catahoula Formation to 8,761 ac-ft/yr. Mr. Bartos seconded the motion and carried unanimously. Mr. Taucer then presented the portion of the Gulf Coast Aquifer in Trinity County as a potential new source for the Region H RWP, explaining that TWDB groundwater modeling had shown this portion of that aquifer to have some availability even though there was no DFC and therefore no MAG. Mr. Houston made a motion to authorize the consultant team to request a new source to reflect non-MAG availability of the Gulf Coast Aquifer in Trinity County. The motion was seconded by Mr. Chang and carried unanimously.

Mr. Evans explained that Senate Bill 1511 of the 85th Legislative Session had established a simplified planning process. He reiterated that the RHWPG had previously concluded that this option would not be advantageous for Region H. Mr. Lord made a motion to forgo pursuit of simplified planning for the 2021 Region H RWP and approve documentation of this action in the Technical Memorandum. The motion was seconded by Mr. Turco and carried unanimously.

Mr. Taucer discussed the Technical Memorandum, explaining that it is a major deliverable that documents and summarizes the first few major steps of the regional planning process. He reiterated that this deliverable is intended to be a draft and included components could still be altered if needed.

He provided an overview of the included information and explained the associated public comment period. Mr. Masterson made a motion to authorize the consultant team to prepare and submit the Technical Memorandum to TWDB and to authorize the consultant team to make minor non-substantive changes discussed hereto (updates to Catahoula and Trinity supplies, TWDB's minor changes to supplies, and the RHWPG's decision to forgo simplified planning). The motion was seconded by Mr. Henson and carried unanimously.

Mr. Taucer explained that planning groups have some flexibility to adjust task budgets initially set by TWDB and that any adjustments over thirty-five percent must be approved by an action of the planning group. Mr. Taucer explained that the original distribution of funds for population and non-population demand projections and existing supplies were not enough to completely fund the additional level of effort needed to complete the tasks. He presented a reallocation of funds which would not increase the overall budget. Mr. Chang made a motion to approve a budget amendment to increase the Non-Population Demands line item by $9,000; Population Demands line item by $20,000; Supply line item by $35,000, and to decrease the Impacts of RWP line item by $26,000; the Drought Response line item by $21,000; the Recommendations line item by $4,000; and the Water Infrastructure Funding Report line item by $13,000. The motion was seconded by Ms. Forrest and carried unanimously.

In consideration of the upcoming legislative session, the RHWPG discussed forming a Legislative Committee to review pending legislation and decided to consider this at the next RHWPG meeting.

10.2.1.12 Public Meeting, October 31, 2018

A public meeting to receive comments and discuss updates from the Consultant Team regarding the 2021 Region H RWP was held on October 31, 2018 at 10:00 a.m. as part of the regular meeting of the RHWPG. The meeting was held at the SJRA offices in Conroe. No public comment was provided.

Mr. Bruner introduced Mr. W.R. Baker of Polk County and requested that he fill the Small Business position on the RHWPG. Mr. Evans stated that the recommendation would be considered at the next Nominating Committee meeting, whereby their recommendation would be placed on the agenda at the next RHWPG meeting for consideration.

Mr. Afinowicz provided information related to the proposed application by the Gulf Coast Water Authority (GCWA) to amend the 2016 Region H RWP. He described the different aspects of the amendment, stating that it will better align their water supply strategies with the RWP, reflect anticipated sources, and provide for consistency. Mr. Afinowicz provided an overview of the primary strategies identified by GCWA. He then briefly explained the necessary revisions to the RWP, including impacted projects and strategies, and the necessary procedures for amending an RWP. Mr. Lord made a motion to approve the submittal of the application package to TWDB for determination of a minor amendment status. The motion was seconded by Mr. Hebert and carried unanimously.

Mr. Taucer briefly reviewed the planning schedule and explained that plan development was transitioning into the development of WMS. He then updated the RHWPG on groundwater supply availability in Fort Bend, Harris, and Galveston Counties, explaining that TWDB had reclassified these supplies as non-MAG, allowing availability to be determined by the RHWPG. He explained the methodology of using regulatory pumpage as the availability for the Gulf Coast Aquifer in these counties. Mr. Turco explained that the Harris-Galveston Subsidence District planning process, as related to the regulatory plan, is based on expectations related to population projections, migration, and per capita use as opposed to a worst-case drought. Further, he stated that, to date, the regulatory plan is the best methodology to determine the availability of groundwater in Harris, Fort Bend, and Galveston Counties. After discussion by the RHWPG, Mr. Turco made a motion to authorize the consultant team to update source availability for the Gulf Coast Aquifer in Subsidence District counties. The motion was seconded by Mr. Lord and carried with all present voting aye.

Mr. Taucer explained the methodologies and data used to develop MAG peak factors for Region H and stated that if MAG peak factors were approved, the numbers in the RWP would still remain compatible with the GCDs and the GMAs. Mr. Lord made a motion to submit the peak factor request to TWDB. The motion was seconded by Mr. Bartos and carried unanimously.

Mr. Taucer provided an update of water supply investigations, including an update on the development of the Region H WMS planning database and analyses of Groundwater Reductions Plans.

The RHWPG then considered a new notice-to-proceed request for additional WMS analyses. Mr. Taucer stated that TWDB allocated $948,695 to Region H for WMS. He explained the process for TWDB to release funds and reviewed previous requests. He then provided an overview of potential WMS projects which include brackish groundwater and groundwater blending, regional return flows, WUG-level reuse, BRA system operation permit, interbasin transfers, the Northeast Water Purification Plant expansion, and other facility and storage projects. He stated that the aforementioned tasks total $348,100, leaving approximately $118,395 of unassigned, unallocated funds. Mr. Chang made a motion to approve the notice-to-proceed request and authorize the consultant team and SJRA to submit the request to TWDB, coordinate with TWDB as needed on follow-up information, and execute the subsequent contract amendment issued. The motion was seconded by Mr. Comin and carried unanimously.

Mr. Evans proposed that the RHWPG authorize a legislative committee for the upcoming 86th Legislative Session. He explained that the purpose of the committee would be to take a proactive approach and to provide information to the legislature to clarify information related to Region H's planning efforts. Mr. Chang made a motion to approve the RHWPG Legislative Committee. The motion was seconded by Mr. Masterson and carried unanimously.

Ms. Thompson provided an overview of the 2018 Galveston Bay Foundation report card.

10.2.1.13 Public Meeting, February 6, 2019

A public meeting to receive comments and discuss updates from the Consultant Team regarding the 2021 Region H RWP was held on February 6, 2019 at 10:00 a.m. as part of the regular meeting of the RHWPG. The meeting was held at the SJRA offices in Conroe. No public comment was provided.

Mr. Hebert made a motion to approve the appointment of Mr. W.R. Baker to the RHWPG to represent small business. The motion was seconded by Mr. Bruner and carried unanimously.

After a brief review of the RWP development schedule, Mr. Taucer provided a recap of the run-of-river and reservoir surface water availability. Mr. Taucer then provided an overview of groundwater and reuse availabilities for the region.

Mr. Taucer discussed the substantial changes in projected water needs since the 2016 RWP, explaining that the changes were due to better data, utility-based WUGs, changes to non-municipal demand projections, MAG peak factors, and implementation of project. He provided an overview of projected water needs in various basins, explaining that the projected need is primarily in agricultural demand with little growth in manufacturing demand over time, and much more growth in municipal needs. Based on this needs analysis, Mr. Lord made a motion to authorize the consultant team to submit a request to TWDB for analysis of socioeconomic impacts of unmet water needs in the Region H Water Planning Area. The motion was seconded by Mr. Ward and carried unanimously.

Ms. Jennifer Walker of Texas Living Waters and Ms. Meagan Bach presented information related to *Water Conservation by the Yard*. They provided outdoor water use metrics and data exhibiting estimated potential municipal savings from outdoor watering restrictions for the Region H area. Ms. Walker stated that enacting this program can significantly reduce municipal water demand, which will in turn help close the gap between future municipal demand and future water supplies.

Mr. Taucer provided information related to water supply alternatives. Regarding conservation, he discussed TWDB's municipal conservation planning tool, which he stated provides an accounting framework for projecting future conservation program costs and water savings as well as estimating the water savings from previous implementation of conservation measures. Mr. Taucer also discussed the ongoing analysis of other water supply alternatives such as water loss reduction, expanded use of groundwater, groundwater reduction plans, reuse, and other infrastructure projects. He briefly discussed data management and comprehensive cost updates.

Mr. Bookout provided an update on the upcoming Finance Workshop by TWDB in Dallas on February 12, 2019.

10.2.1.14 Public Meeting, June 5, 2019

A public meeting to receive comments and discuss updates from the Consultant Team regarding the 2021 Region H RWP was held on June 5, 2019 at 1:00 p.m. as part of the regular meeting of the RHWPG. The meeting was held at the SJRA offices in Conroe.

Two members of the public provided comment. Ms. Laura Norton and Mr. Neil Gainer spoke in reference to the recent changes in the Lone Star Groundwater Conservation District.

Mr. Evans announced that Ruth Stultz resigned her position representing Small Business and reiterated the current vacancy for Electric Generating Utilities. He stated that discussion and possible action to fill these two vacancies would be held at the next RHWPG meeting.

Mr. Bookout of TWDB explained the process for the biennial disbursement of TWDB funds and stated that the funds would be disbursed following the execution of an amendment to the contract. Mr. Bookout projected the funds to be approximately $332,000. Mr. Hebert made a motion to authorize SJRA to execute a contract amendment with TWDB to increase committed funds. The motion was seconded by Mr. Lord and carried unanimously.

Mr. Taucer reviewed upcoming due dates in the regional planning cycle and stated that the consultant team was currently in the WMS stage of the process. He then provided an overview of the water supply alternatives being evaluated.

Regarding project prioritization, Mr. Taucer explained that each RWPG prioritizes all recommended WMS Projects in their RWP using uniform regional standards set by each RWPG. He explained that the minimum criteria to be considered for prioritization are the decade of need and the feasibility, viability, sustainability, and cost-effectiveness of each project. He explained that the list of recommended projects for each RWPG is submitted to the TWDB along with the final adopted RWP, and the regional prioritization of each project is incorporated into the state prioritization.

Mr. Evans provided a brief overview of Senate Bills 7 and 8, related to flood planning, mitigation, and infrastructure projects and state and regional flood planning, respectively. Mr. Bookout commented on HB 807 relating to the state and regional water planning process. Mr. Evans stated that a more in-depth update by the Legislative Committee will take place at the next meeting.

Mr. Taucer reported on meetings with the Houston-Galveston Area Council (H-GAC) Natural Resources Advisory Committee and the Brazoria County Groundwater Conservation District, at which the consultant team presented on the Region H RWP and the regional planning process. Mr. Bookout of TWDB provided information related to the Unified Costing Model. He also stated that the Drought Preparedness Council had provided recommendations to the RWPGs.

10.2.1.15 Public Meeting, September 4, 2019

A public meeting to receive comments and discuss updates from the Consultant Team regarding the 2021 Region H RWP was held on September 4, 2019 at 10:00 a.m. as part of the regular meeting of the RHWPG. The meeting was held at the SJRA offices in Conroe. No public comments were provided.

Ms. Pam Steiger of SJRA presented a financial report for the RHWPG.

Mr. Taucer provided an update on the progress and schedule of the 2021 RWP development, stating that the current tasks in progress were WMS analysis, drought contingency plan reviews, and legislative recommendations. He then provided statistics from the updated WMS analyses for advanced municipal conservation, irrigation conservation, water loss reduction, expanded use of groundwater, and municipal reuse. He stated that these strategy analyses had produced favorable results. Mr. Taucer then provided more details on water conservation in the RWP, including the requirement of a conservation-focused subchapter. He stated that industrial conservation was not being considered for this RWP due to the change in demand projection methodology. Furthermore, he indicated that municipal conservation recommendations would include a greater focus on outdoor conservation than indoor conservation. Mr. Taucer also reviewed current water conservation planning in Region H, including survey responses from WUGs as well as updated water conservation plans and the recommendations therein. Finally, he discussed the inclusion of per-capita demand goals required by new legislation for WUGs and presented a possible recommendation that would be consistent with implementation of the recommended advanced conservation WMS.

Mr. Taucer provided an overview of drought contingency planning. He stated that over 253 new drought contingency plans were received by the RHWPG in 2019, along with 77 survey responses. He explained the different challenges and risks related to the inclusion of drought contingency planning as a WMS in the RWP. After a lengthy discussion by members of the planning group, it was determined that the consultant team would provide several different drought management options based upon the RHWPG comments for consideration at a subsequent meeting.

Mr. Taucer informed the RHWPG of the completion by the consultant team of a report on emergency interconnection facilities between water providers in the region, which is required to be submitted confidentially to TWDB separately from the RWP. Mr. Henson made a motion to authorize the consultant team to submit a confidential emergency interconnect report to the TWDB. The motion was seconded by Mr. Hebert and carried unanimously.

Mr. Taucer then provided a brief overview of new legislation related to regional water planning, including the requirement that RHWPGs nominate one or more members to the new Interregional Planning Council. Mr. Hebert made a motion to nominate Mr. Evans as the Region H member for the Interregional Planning Council. The motion was seconded by Mr. Kramer and carried unanimously. Mr. Bookout of TWDB provided additional details on the new legislation.

Mr. Taucer notified the RHWPG that a shift in the budget allocation for the subconsultant WSP was needed. Mr. Lord made a motion to approve the amendment of the budget for the development of the 2021 RWP. The motion was seconded by Mr. Bartos and carried unanimously.

10.2.1.16 Public Meeting, November 6, 2019

A public meeting to receive comments and discuss updates from the Consultant Team regarding the 2021 Region H RWP was held on November 6, 2019 at 10:00 a.m. as part of the regular meeting of the RHWPG. The meeting was held at the SJRA offices in Conroe. No public comments were provided.

Mr. Evans announced the vacancies for Electric Generating Utilities and Small Business. Mr. Langford spoke in favor of Mr. Carl Burch of NRG becoming the designated member of the Region H Planning Group representing Electric Generating Utilities. Mr. Henson made a motion to approve Mr. Carl Burch as a member of the Planning Group to represent Electric Generating Utilities. The motion was seconded by Mr. Masterson and carried unanimously.

Mr. Taucer provided information related to the milestones for the development of the 2021 Region H Regional Water Plan by reviewing upcoming deadlines related to Water Management Strategies, Infrastructure Finance Report, and Project Prioritization. He then provided updates on the evaluation of WMS analyses, noting that that the projected capital costs for these projects exceeded $10.1 billion and would rise as additional strategies were analyzed. He then explained the various needs met by water management strategies versus the remaining need that has no strategy because it cannot be sustained at an economically supportable level. He stated that agriculture is the only category identified with an unmet need. Mr. Taucer then reviewed the different sources of management strategies for the western and eastern regions, supply redundancy, and applied water management strategies and provided a status update of ongoing strategy evaluations.

Mr. Taucer provided information related to drought management as a potential water management strategy. He stated that the Water Management Strategy Committee recommended the need to formalize it as a considered but not recommended strategy, document the analysis and results in the WMS technical memorandum, and re-emphasize advocacy of drought planning in Chapter 7. Discussion ensued. Mr. Houston made a motion, seconded by Mr. Lord, to approve and accept the recommendations of the Water Management Strategy Committee. The motion carried with 20 in favor and with one abstention (Mr. Masterson).

Mr. Taucer provided an overview related to the remaining task 5 funds and stated that the Water Management Strategy Committee discussed and recommended submittal of a notice-to-proceed to utilize the remaining funds for post IPP adjustments. Mr. Langford made a motion to approve the notice-to-proceed request and authorize the Consultant Team and the San Jacinto River Authority to submit the request to TWDB, coordinate with TWDB as needed on follow-up information, and execute the subsequent contract amendment issued. The motion was seconded by Mr. Bailey and carried unanimously.

Mr. Taucer also provided information related to new legislative requirements, relative to House Bill 807, and discussed the processes to address same, as well as an overview of legislative and policy recommendations and infrastructure finance. Information related to unique stream segments was discussed, including the recommendation to retain the 2016 Region H recommendations. He also provided information related to unique reservoir sites, stating that Allen's Creek was designated in 2016 RWP and the recommendation was to re-designate Allen's Creek for this cycle.

Mr. Bookout provided an update related to the emergency interconnect letter authorized to be submitted to the Texas Water Development Board's Executive Administrator.

10.2.1.17 Public Meeting, January 8, 2020

A public meeting to receive comments and discuss updates from the Consultant Team regarding the 2021 Region H RWP was held on January 8, 2020 at 10:00 a.m. as part of the regular meeting of the RHWPG. The meeting was held at the SJRA offices in Conroe.

One member of the public provided comment. Mr. Rob VanTil of Houston Stronger explained the coalition's goal of working with officials to implement a comprehensive regional flood control plan.

Mr. Taucer explained that the comment period for input on the draft rules for the flood financial assistance rules and Flood Intended Use Plan. It was determined that the specified timeframe and need to incorporate comments from all interest groups of the RHWPG precluded submission of formal comments at the time. Mr. Taucer also provided information related to the schedule and milestones for the development of the 2021 Region H Regional Water Plan, including the deadline for the Initial Prepared Regional Water Plan and the series of public hearings related to same. He also discussed the regional planning requirement for analysis of social and economic impacts of not meeting identified water needs and summarized the evaluation performed by TWDB on behalf of Region H. It was noted that the projected impacts to income, jobs, and other parameters of not meeting water needs were substantial.

Mr. Taucer provided a brief summary of each of the chapters of the draft Initially Prepared Plan (IPP). He stated that the conservation approach, MAG Peak Factors, drought management analysis, and HB 807 Requirements were some key differences between previous RWP submissions and this one. He stated that any comments submitted would be reviewed and discussed at the next meeting.

Mr. Bookout provided an update related to various TWDB program due dates. Mr. Rusty Ray provided information on behalf of the Texas State Soil and Water Conservation Board.

10.2.1.18 Public Meeting, February 5, 2020

A public meeting to receive comments and discuss updates from the Consultant Team regarding the 2021 Region H RWP was held on February 5, 2020 at 10:00 a.m. as part of the regular meeting of the RHWPG. The meeting was held at the SJRA offices in Conroe.

Two members of the public provided comment. Ms. Suzanne Allen and Mr. Erich Birch expressed concerns over temporary lowering of Lake Conroe.

Mr. Evans and Mr. Taucer briefed the RWPG on the election of officers and the Executive Committee of the RHWPG. Following discussion, the RHWPG took action with all in favor of reelecting the prior officers and Executive Committee members.

Mr. Taucer provided information related to the milestones for the development of the 2021 Region H Regional Water Plan, including upcoming submittals and meetings. He also provided an update on the anticipated schedule and areas of public hearings to follow submittal of the IPP to TWDB. The RHWPG voted unanimously to authorize San Jacinto River Authority and the Consultant Team to prepare and mail notices related to the public hearings.

Mr. Taucer presented an overview of comments received on the Draft IPP and proposed revisions for incorporation into the IPP for submittal to TWDB, including editorial items, revisions to project technical details, and additional projects for addition to the IPP. Mr. Langford briefed the RWPG on a potential alternative WMS under consideration by Region G to utilize supplies from the Brazos River Alluvium. The RWWPG discussed concerns with potential downstream impacts to surface water availability. It was determined that the issue did not at this time necessitate revision of the IPP but was an issue of concern that would be monitored by the RWPG. Mr. Taucer discussed general locations of changes to the IPP document, as well as supporting materials required as part of the submittal to TWDB. The RWPG unanimously voted to adopt the IPP and approve the Consultant Team to prepare final copies of the revised Initially Prepared Plan and supporting documentation and submit to Texas Water Development Board no later than March 3, 2020.

Mr. Bookout provided an update related to 2020 SWIFT program applications received by TWDB.

10.2.2 Technical Committee Meetings

In addition to regular public meetings of the full RHWPG, the RHWPG also conducted several working meetings with technical committees. In order to promote transparency and seek input from stakeholders, technical committee meetings were held as public meetings with notice posted in accordance with statutory guidance.

10.2.2.1 Population Demands Committee Meeting, July 26, 2016

A meeting of the Population Demands Committee was held on July 26, 2016 at 3:00 P.M. at the Freese and Nichols Houston Office. Topics of discussion included proposed TWDB rule changes, identified municipal WUGs, and TWDB’s request for recommendations on WUGs. The Committee considered recommendations to the RHWPG regarding private utilities, facilities, and collective reporting units for inclusion in the RWP.

10.2.2.2 Population Demands Committee Meeting, July 31, 2017

A meeting of the Population Demands Committee was held on July 31, 2017 at 2:00 P.M. at the Freese and Nichols Houston Office to discuss various topics relevant to population and water demand projections in the RWP, including the Region H WUG survey, TWDB data, projections, and the process for requesting revised projections. The Committee also discussed and considered recommendations to the RHWPG on sub-WUG data accounting, revised projections, and identification of MWPs.

10.2.2.3 Non-Population Demands Committee Meeting, September 22, 2017

A meeting of the Non-Population Demands Committee was held on September 22, 2017 at 1:00 P.M. at the Freese and Nichols Houston Office. The Committee received presentations on several items, including TWDB data, projections, the process for requesting revised projections, and identification of MWPs. The Committee also considered recommendations to the RHWPG on revised projections and identification of MWPs.

10.2.2.4 Water Management Strategy Committee Meeting, November 1, 2017

A meeting of the Water Management Strategy Committee was held on November 1, 2017 at 9:00 A.M. at the SJRA offices in Conroe. The Committee discussed options for processes to identify and evaluate potentially feasible Water Management Strategies and considered recommendations to the RHWPG on these processes.

10.2.2.5 Water Management Strategy Committee Meeting, March 21, 2018

A meeting of the Water Management Strategy Committee was held on March 21, 2018 at 9:30 A.M. at the Freese and Nichols Houston Office. The Committee discussed a range of topics, including Water Management Strategy recommendations and process from the Region H 2016 Regional Water Plan, preliminary scope and budget for requesting Task 5 funds, additional potential water management strategy focus areas, and options for a supply allocation safety factor. The committee further considered recommendations to the RHWPG on initial notice to proceed request items for strategy investigations.

10.2.2.6 Groundwater Supply Committee Meeting, March 26, 2018

A meeting of the Groundwater Supply Committee was held on March 26, 2018 at 9:30 A.M. at the Lone Star Groundwater Conservation District Office. The Committee received updates on a number of topics, including the process and activities for the Groundwater Management Area Joint Planning process as well as Modeled Available Groundwater in the Region H Water Planning Area. The Committee also received information on and discussed recommendations regarding evaluation of existing groundwater supplies in portions of aquifers deemed non-relevant by the Joint Planning process. The committee also discussed the addition of the MAG Peak Factor concept to the RWP process.

10.2.2.7 Water Management Strategy Committee Meeting, September 4, 2019

A meeting of the Water Management Strategy Committee was held on September 4, 2019 at 12:00 P.M. at the San Jacinto River Authority General and Administration Building. The Committee discussed water management strategy recommendations and process from the Region H 2021 Regional Water Plan. The Committee also discussed and considered recommendations to the RHWPG regarding options for utilization of remaining unallocated Task 5 funds.

10.2.2.8 Water Management Strategy Committee Meeting, October 30, 2019

A meeting of the Water Management Strategy Committee was held on October 30, 2019 at 2:00 P.M. at the Freese and Nichols Houston Office. The Committee discussed recommendations for water management strategies as well as options for utilization of remaining unallocated Task 5 funds. The

Committee also received an update regarding drought management as a potential water management strategy and considered recommendations to the RHWPG on potential inclusion of Drought Management as a water management strategy for the Region H 2021 Regional Water Plan.

10.3 PUBLIC REVIEW AND COMMENT ON INITIALLY PREPARED PLAN

Additional information concerning public hearings associated with the public comment on the IPP will be added once these meetings are held following IPP submittal.

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CHAPTER 11
IMPLEMENTATION AND COMPARISON TO PREVIOUS REGIONAL WATER PLAN

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Chapter 11 – Implementation and Comparison to Previous Regional Water Plan

11.1 INTRODUCTION

The development of Regional Water Plans (RWPs) is a cyclical process that provides continual input to the State Water Plan (SWP). By design, the plans are updated regularly on a five-year cycle which allows for refinement of water demands, supplies, and recommended strategies. Texas Water Development Board (TWDB) guidance for 2021 RWP development provides for the inclusion of a chapter dedicated to the discussion of implementation of the previous RWP as well as identified differences between the two cycles of planning which point to revised perspectives on demands, supplies, and application of water management strategies (WMS). This chapter identifies the level of project implementation for projects identified in the 2016 RWP and speaks to the differences between the previous plan and the updated 2021 RWP. Additionally, this chapter addresses the progress of the Region H Water Planning Group (RHWPG) in encouraging cooperation between water user groups for the purpose of achieving economies of scale and otherwise incentivizing strategies that benefit the entire region.

11.2 IMPLEMENTATION OF PREVIOUSLY RECOMMENDED WATER MANAGEMENT STRATEGIES

The following sections discuss those projects and WMS that were recommended in the 2016 RWP and have been partially or completely implemented since that plan was published. These WMS or portions thereof which have been implemented are not included in the current RWP.

In order to evaluate the status of various projects in Region H, a variety of information was collected from a number of sources. These include:

- Survey responses collected during the Region H Water User Group (WUG) survey conducted in 2017,
- Information from TWDB on funded projects from January 2000 to December 2018, and
- Local knowledge of members of and consultants to the RHWPG.

An implementation reporting workbook was developed by TWDB to compile consistent and detailed information on the implementation of 2016 RWP projects. This implementation report was completed by the RHWPG based on data from the sources listed above. Results can be found in ***Appendix 11-A***.

11.2.1 Conservation Strategies

- **Industrial Conservation:** It is assumed that industrial conservation practices have been implemented in Region H since the development of the 2016 RWP. Due to changes in the methodology for projecting industrial water demands, these projects are no longer recommended in the 2021 RWP.

- **Irrigation Conservation:** It is assumed that irrigation conservation practices have been implemented in Region H since the development of the 2016 RWP. These projects have been carried out by individual irrigators as the economics make conservation projects viable. These projects continue to be recommended in the 2021 RWP.
- **Municipal Conservation:** It is assumed that municipal conservation practices have been implemented in Region H since the development of the 2016 RWP. Noteworthy conservation programs within Region H include implementation of automated metering infrastructure (AMI) by the City of West University and a detailed plan including AMI and water loss reduction by the City of Sugar Land. Additionally, retail water supplies with more than 3,300 connections have developed updated Water Conservation Plans, as described in ***Subchapter 5B***. These projects continue to be recommended in the 2021 RWP.

11.2.2 Contractual Strategies

- **New and Expanded Contracts:** It is assumed that contractual arrangements have been made, where necessary, to increase supplies to current water users. Contractual transfers continue to be recommended in the 2021 RWP.
- **TRA to COH Transfer:** The City of Houston (COH) and Trinity River Authority (TRA) have entered into an agreement for COH to purchase 200,000 acre-feet of water annually from TRA's rights for Lake Livingston. This contractual transfer is facilitated by the Luce Bayou conveyance project, which was completed in 2019.

11.2.3 Groundwater Strategies

- **Brackish Groundwater Supplies:** Municipal WUGs in Montgomery County have been developing groundwater wells in the fresh to brackish Catahoula Aquifer. Some WUGs utilize this supply through blending with other sources before treatment. Additional brackish supply is recommended in the 2021 RWP.
- **BWA Brackish Groundwater Development:** BWA has completed the first two brackish groundwater wells of this strategy, and the development of two additional wells is in progress. The first phases of the membrane treatment facility are anticipated to be operational by the end of 2023. This project continues to be recommended in the 2021 RWP. This project received funding in 2015 under the State Water Implementation Fund for Texas (SWIFT) program.
- **Conroe Brackish Groundwater Desalination:** The City of Conroe began utilizing groundwater from the Catahoula Aquifer in 2014 as an additional source of water supply. The water quality was sufficient to not require a reverse osmosis treatment facility as had been recommended in the 2016 RWP. No further development of this source by the City of Conroe has been recommended in the 2021 RWP.
- **Expanded Use of Groundwater:** It is assumed that groundwater supply development has occurred where necessary and, in accordance with local regulation, to increase supplies to current water users. These projects continue to be recommended in the 2021 RWP.
- **Groveton Groundwater Expansion:** Development of a new groundwater well and associated transmission infrastructure by the City of Groveton is in progress and the City has applied for funding through the DWSRF. This project is recommended in the 2021 RWP.

11.2.4 Groundwater Reduction Plans

- **CHCRWA GRP:** The Central Harris County Regional Water Authority (CHCRWA) continues to implement projects to convert from groundwater to alternative sources on the schedule set forth by the Harris-Galveston Subsidence District (HGSD). This strategy utilizes other infrastructure projects to allow for this conversion. Future phases of this WMS and associated infrastructure projects continue to be recommended in the 2021 RWP.
- **City of Houston GRP:** The COH continues to utilize its surface water capacity for its own groundwater reduction requirement as well as that of its contract Groundwater Reduction Plan (GRP) participants. This strategy utilizes other infrastructure projects to allow for this conversion. Future phases of this WMS and associated infrastructure projects continue to be recommended in the 2021 RWP.
- **Fort Bend MUD 25 GRP:** Fort Bend County MUD 25 successfully implemented the first phase of its GRP prior to the 2016 RWP, including the development of a reuse system for adjoining water users. Future phases of this project are recommended in the 2021 RWP.
- **Fort Bend WCID 2 GRP:** Fort Bend WCID 2 successfully implemented the first phase of its GRP prior to the 2016 RWP, including the construction of a surface water treatment plant. Future phases of this project are recommended in the 2021 RWP.
- **Missouri City GRP:** The City of Missouri City successfully implemented the first phase of its GRP prior to the 2016 RWP, including the construction of a surface water treatment plant. The City has also applied for funding through the Clean Water State Revolving Fund (CWSRF) to develop direct reuse supplies. Future phases of this project are recommended in the 2021 RWP.
- **NFBWA GRP:** The North Fort Bend Water Authority (NFBWA) continues to implement projects to convert from groundwater to alternative sources on the schedule set forth by the Fort Bend Subsidence District (FBSD). This strategy utilizes other infrastructure projects to allow for this conversion. Future phases of this WMS and associated infrastructure projects continue to be recommended in the 2021 RWP.
- **NHCRWA GRP:** The North Harris County Regional Water Authority (NHCRWA) continues to implement projects to convert from groundwater to alternative sources on the schedule set forth by HGSD. This strategy utilizes other infrastructure projects to allow for this conversion. Future phases of this WMS and associated infrastructure projects continue to be recommended in the 2021 RWP.
- **Porter SUD Joint GRP:** Porter SUD has a contract with the City of Conroe for groundwater-based effluent from the City's wastewater discharge, which had not yet been permitted for use as of the 2016 RWP. TCEQ has since approved the permit for the City of Conroe to use the bed and banks of the West Fork of the San Jacinto River to convey a portion of the City's return flows for downstream use. Development of the infrastructure associated with this GRP is recommended in the 2021 RWP.
- **Richmond GRP:** The initial surface water treatment facility and associated transmission infrastructure identified in the GRP have been constructed and are operational. Future phases of this WMS and associated infrastructure projects continue to be recommended in the 2021 RWP.
- **Rosenberg GRP:** Rosenberg has entered into a contractual agreement to receive treated water from the Brazosport Water Authority (BWA). The pipeline conveying this contract water has been constructed, and this supply is reflected as existing in the 2021 RWP. Future

phases of this WMS and associated infrastructure projects continue to be recommended in the 2021 RWP.

- **SJRA GRP:** The San Jacinto River Authority (SJRA) completed the first phase of surface water conversion for its GRP participants prior to the 2016 RWP. Future phases of infrastructure expansion projects for delivery of alternative water supplies to GRP participants are recommended in the 2021 RWP.
- **Sugar Land GRP:** Sugar Land constructed a surface water treatment plant to provide for its first phase of conversion prior to the 2016 RWP. In 2019, Sugar Land completed an Integrated Water Resource Plan (IWRP) to better define future projects for meeting conversion requirements and growing demands. Sugar Land has also secured a contract with the Brazos River Authority (BRA) for use of water made available through its system operations permit. Future phases of this WMS and associated infrastructure projects continue to be recommended in the 2021 RWP through the Sugar Land IWRP WMS.
- **WHCRWA GRP:** The West Harris County Regional Water Authority (WHCRWA) continues to implement projects to convert from groundwater to alternative sources on the schedule set forth by HGSD. This strategy utilizes other infrastructure projects to allow for this conversion. Future phases of this WMS and associated infrastructure projects continue to be recommended in the 2021 RWP.

11.2.5 Infrastructure Strategies

- **BWA Conventional Treatment Expansion:** BWA is engaged in the implementation of improvements to its conventional water treatment facilities which will modernize and ultimately increase the capacity of the facility. Some of these efforts are being funded through the Drinking Water State Revolving Fund (DWSRF). This project continues to be recommended in the 2021 RWP.
- **CHCRWA Transmission and Internal Distribution:** CHCRWA has participated with NHCRWA in developing transmission infrastructure to receive water from the NEWPP and has implemented the first phase of these efforts. CHCRWA is also developing internal distribution infrastructure to serve individual member districts. This project utilized funding from TWDB to facilitate project implementation. This project also received funding in 2016 under the SWIFT program. Future phases of this project are recommended in the 2021 RWP.
- **COH, NHCRWA, and CHCRWA Shared Transmission:** The shared northeast transmission line is under construction with completion anticipated in 2023. Project sponsors received funding for the treatment plant expansion in 2015, 2016, and 2018 through the SWIFT program. This project is recommended in the 2021 RWP.
- **COH Northeast Water Purification Plant Expansion:** The NEWPP expansion project is under construction and is expected to be online by 2025. Project sponsors received funding for the treatment plant expansion in 2015, 2017, and 2018 through the SWIFT program. This project is recommended in the 2021 RWP.
- **Lake Livingston to SJRA Transfer:** In 2018, SJRA developed a Raw Water Master Supply Plan that included strategy screening and preliminary feasibility studies to explore several alternative projects for developing future sources of supply, including the Lake Livingston to SJRA Transfer. This project continues to be recommended in the 2021 RWP.
- **LNVA Irrigation System Expansion:** This transmission project is in the planning phase. This project is included as a recommended project in the 2021 RWP as the LNVA Neches-Trinity Basin Interconnect.

- **Luce Bayou Transfer:** The Coastal Water Authority (CWA) has completed development of the 26.5-mile conveyance from the Trinity River at Capers Ridge to Lake Houston. These efforts were assisted through the TWDB Water Infrastructure Fund (WIF) program. This project also received funding in 2015 under the SWIFT program.
- **NFBWA Phase 2 Distribution Segments:** Phase 2 Distribution Segments for NFBWA are in the design phase and NFBWA has received pre-construction funding for this project through the SWIFT program. This infrastructure development continues to be a recommended project in the 2021 RWP.
- **NHCRWA Distribution Expansion:** NHCRWA has worked to implement internal distribution for surface water as part of its GRP. This project has received funding in multiple years since 2015 under the SWIFT program. Future phases of this project are recommended in the 2021 RWP.
- **NHCRWA Transmission Lines:** NHCRWA has participated with CHCRWA in developing transmission infrastructure to receive water from the NEWPP and has implemented the first phase of these efforts. This project received funding in 2015 under the SWIFT program. Future phases of this project are recommended in the 2021 RWP.
- **Old Galveston Road Transmission Improvements:** This transmission project is in the planning phase. This project is included as a recommended project in the 2021 RWP as the Southeast Transmission Line.
- **Pearland Surface Water Treatment Plant Development:** The first 10-mgd phase of the Pearland treatment plant is in development and a second 10-mgd phase is still planned by the project sponsor for completion by 2030. This phase of the project is being partially funded by the DWSRF. This project is recommended in the 2021 RWP.
- **WHCRWA Distribution Expansion:** WHCRWA has worked to implement internal distribution for surface water as part of its GRP. Partial funding for the 2025 phase was received through the SWIFT program in 2015. Future phases of this project are recommended in the 2021 RWP.
- **WHCRWA/NFBWA Transmission Line:** WHCRWA is participating with NFBWA in developing transmission infrastructure to receive water from the NEWPP. Funding is being provided for this project through the WIF program. This project also received funding in 2015 and 2018 under the SWIFT program. This project is recommended in the 2021 RWP.

11.2.6 Reservoir Strategies

- **Allens Creek Reservoir:** BRA and COH are pursuing investigations into the development of Allens Creek Reservoir. This project is recommended in the 2021 RWP.
- **Dow Reservoir and Pump Station Expansion:** Dow Chemical has purchased the property required for the development of the reservoir expansion and is proceeding with permitting and design of the pump station and impoundment. This project is recommended in the 2021 RWP.

11.2.7 Reuse Strategies

- **City of Houston Reuse:** Houston currently uses a portion of its Water Right 5827 at Lake Houston for diversions to the NEWPP and the West Canal. Region H explored alternatives for use of these water supplies in the 2021 RWP and this project is recommended in the 2021 RWP.

- **Montgomery County MUDs #8 and #9 Reuse:** This project involved the development of a new treated water supply through permitting and diversion of treated wastewater discharges and development of associated treatment facilities. TCEQ has approved the permit for MUDs 8 and 9 to use the bed and banks of Lake Conroe to convey their own effluent and contractually purchased effluent from the City of Huntsville. The intake and treatment facilities associated with this project are included in the 2021 RWP as part of the Montgomery County MUDs 8 and 9 GRP Infrastructure project.
- **NFBWA Grand Lakes Reuse:** The first phase of this project has been completed. This project received funding in 2016 from the CWSRF. Additional phases of reuse are included in the 2021 RWP as part of the NFBWA Member District Reuse Infrastructure project.
- **City of Conroe Reuse Project:** This project involved the development of a raw water supply through permitting of treated wastewater discharges from the City of Conroe. TCEQ has approved the permit for the City of Conroe to use the bed and banks of the West Fork of the San Jacinto River to convey a portion of the City's return flows for downstream use. The application of part of this indirect reuse supply to meeting WUG needs is included in the 2021 RWP as part of the recommended Porter SUD GRP.
- **SJRA Conroe Reuse Project:** This project involved the development of a raw water supply through permitting of treated wastewater discharges from the City of Conroe. TCEQ has approved the permit for the City of Conroe to use the bed and banks of the West Fork of the San Jacinto River to convey a portion of the City's return flows for downstream use. The portion of these return flows that is assigned to SJRA are now allocated in the WMS SJRA Reuse Supplies for Manufacturing in the 2021 RWP.
- **Wastewater Reclamation for Municipal Irrigation:** Some projects to develop reclaimed wastewater as a supply for municipal irrigation use have been implemented in Region H since the development of the 2016 RWP. Future phases of this WMS and associated infrastructure projects continue to be recommended in the 2021 RWP.

11.2.8 Permit Strategies

- **BRA System Operations Permit:** The BRA System Operation Permit has been approved by the Texas Commission on Environmental Quality (TCEQ), and contracts have been issued by BRA to customers in Region H and other regions. This strategy is included as a component of multiple WMS in the 2021 RWP to reflect the ongoing need for development of infrastructure by contract recipients in order to utilize the increased supply availability from BRA.

11.2.9 Other Strategies

- **Brazos Saltwater Barrier:** The Brazos saltwater barrier is under further study by Dow Chemical as a potential option for enhancing the useful yield of surface water supplies in the lower end of the Brazos River. This project is recommended in the 2021 RWP. Dow Chemical currently holds a permit for construction of a temporary saltwater barrier in the circumstance of extreme drought.

11.3 COMPARISON TO PREVIOUS REGIONAL WATER PLAN

Each round of regional water planning produces a number of changes through the way in which demands, supplies, and strategies are represented. Some of these adjustments are brought about by updated information where others may be driven by shifts in water availability, regulation, or approach by water providers.

11.3.1 Water Demand Projections

Water demand projections were developed by TWDB during the development of the 2021 RWP. The Region H Population Demands Committee and Non-Population Demands Committee reviewed the preliminary projections provided by TWDB and provided feedback, which was incorporated into the final water demand projections used in the 2021 RWP.

TWDB employed new methodologies to estimate water demands for irrigation, livestock, manufacturing, and steam electric power generation during the 2021 regional planning cycle. Non-population demands in Region H were extensively examined by the Non-Population Demands Committee, with particular attention paid to projections associated with new methodologies. The preliminary draft projections for irrigation demands were substantially lower than those in the 2016 RWP. However, after receiving feedback from the RHWPG, TWDB revised these projections, and irrigation demand projections in the 2021 RWP closely reflect those in the previous plan. Manufacturing is a substantial demand category in Region H and the committee expended great effort to review and verify the demands identified in Brazoria and Galveston Counties. Although TWDB did incorporate some recommendations by the planning group, manufacturing water demands in the 2021 RWP are substantially lower than those in the 2016 RWP due to an assumption of zero growth after 2030. The RHWPG considers these to have underpredicted future water demands in the manufacturing sector in Region H.

The Non-Population Demands Committee also reviewed mining and livestock demands and did not recommend any revisions. Livestock demands in Region H are projected to be slightly higher than the water demand shown in the previous plan. Mining demands in the 2021 RWP are identical to those in the 2016 RWP.

Figures comparing 2016 RWP and 2021 RWP values for irrigation, livestock, manufacturing, mining, and steam electric power are shown in *Figure 11-1* through *Figure 11-5*.

Figure 11-1 – Comparison of Irrigation Demand Projections

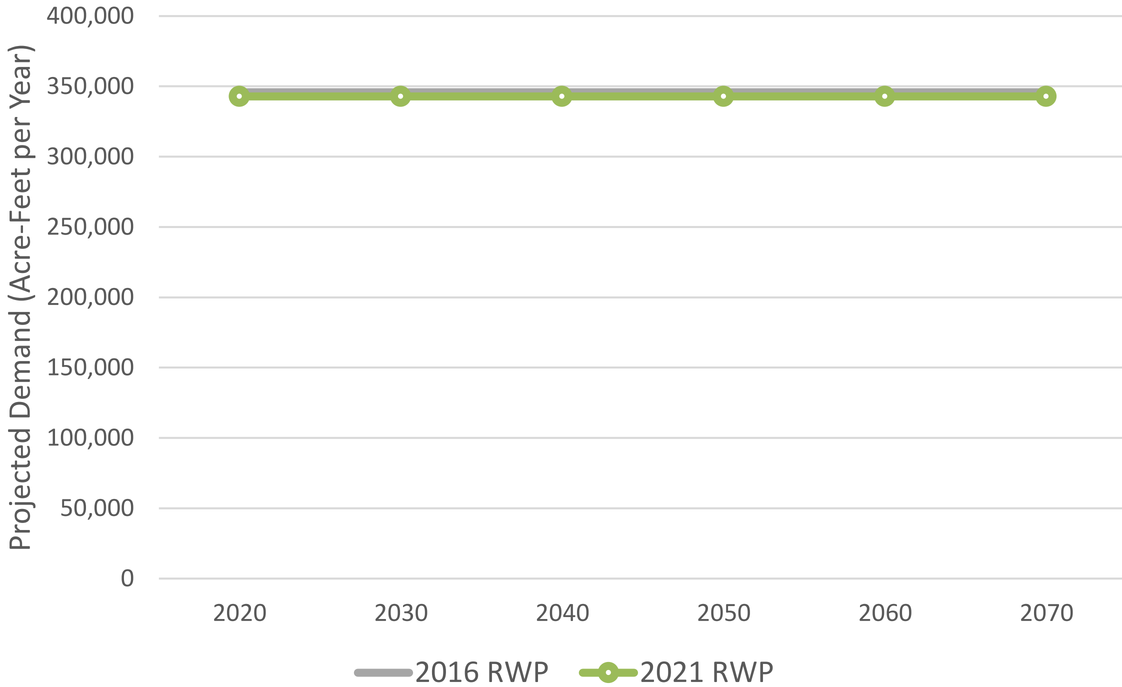


Figure 11-2 – Comparison of Livestock Demand Projections

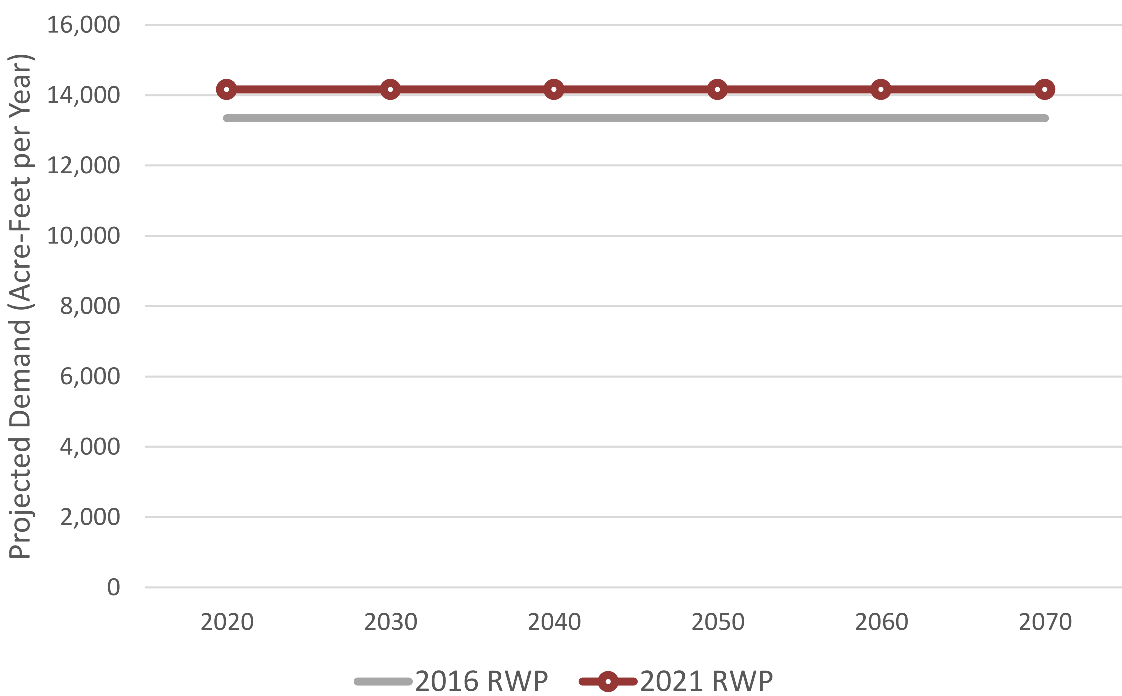


Figure 11-3 – Comparison of Manufacturing Demand Projections

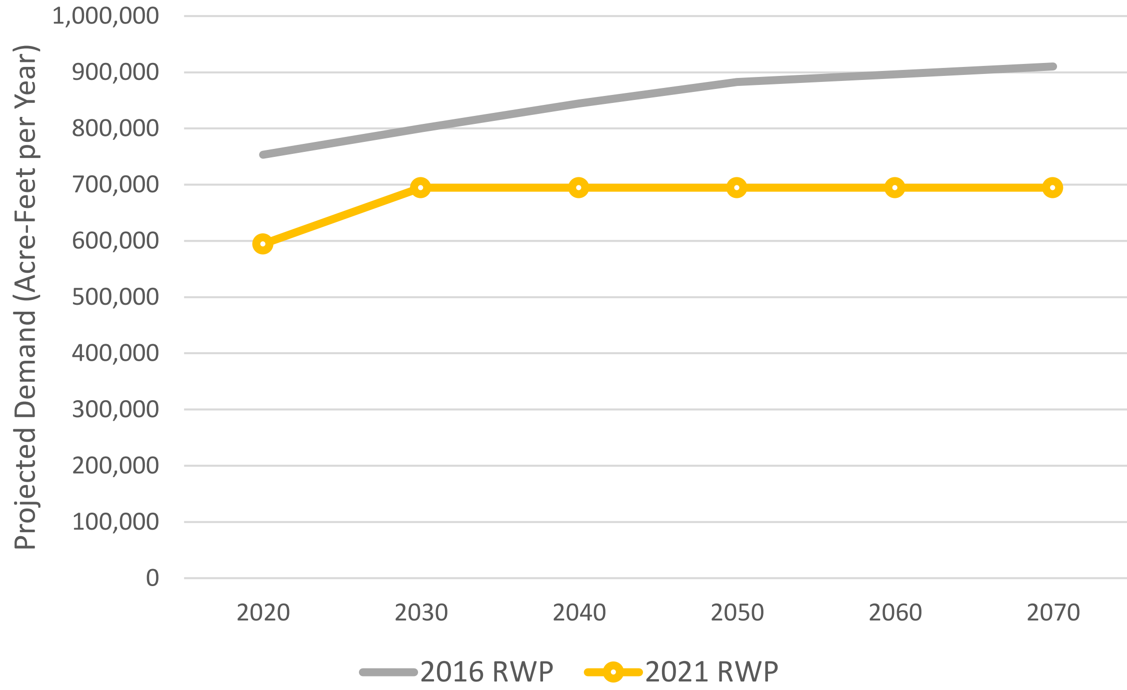


Figure 11-4 – Comparison of Mining Demand Projections

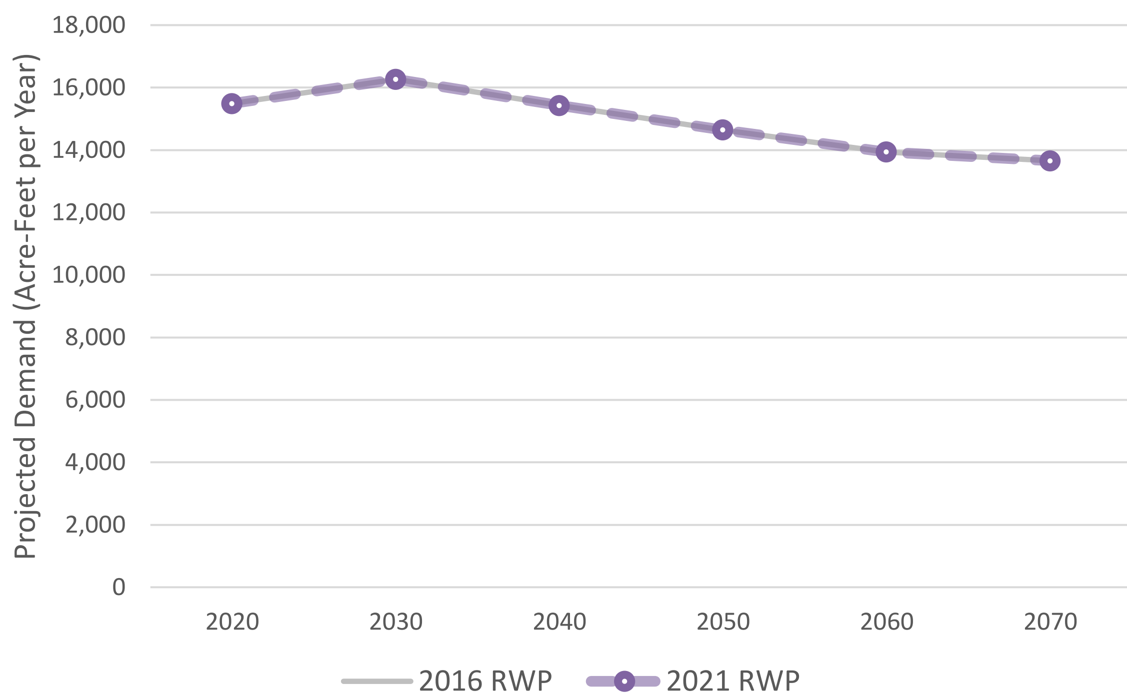
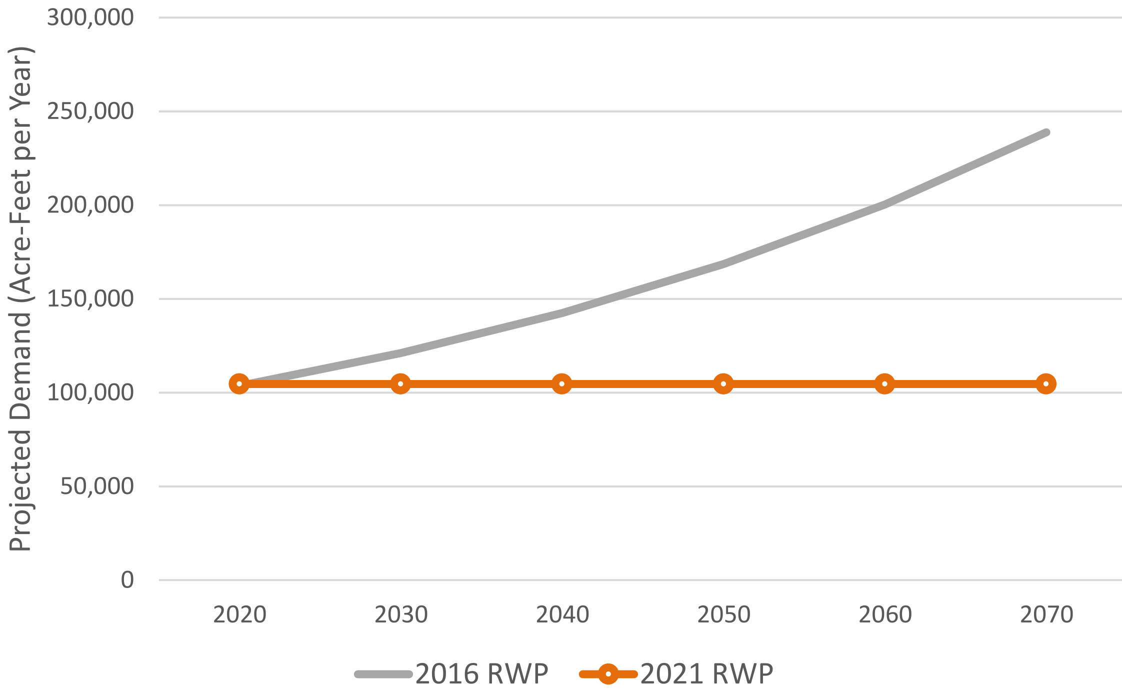
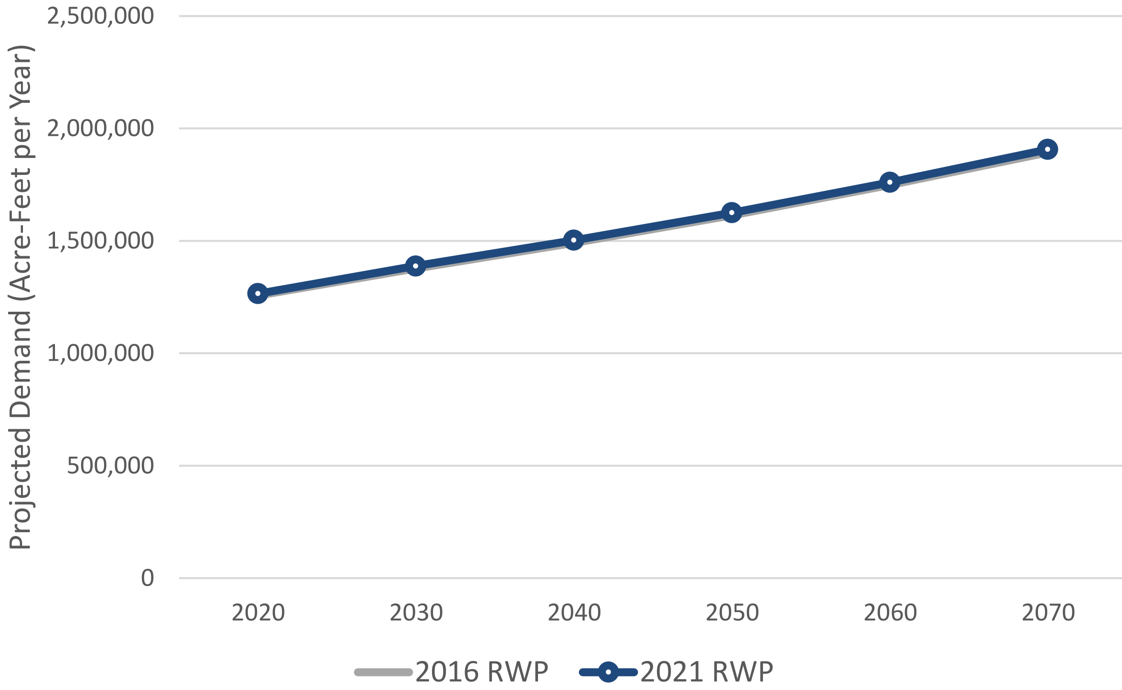


Figure 11-5 – Comparison of Steam Electric Power Demand Projections



Population (municipal) demands in the 2016 Region H RWP were based on population projections from a study conducted by HGSD, FBSD, and LSGCD to evaluate regional groundwater availability and management in combination with TWDB-prepared estimates of per-capita demand and passive conservation savings. The population and municipal water demand projections in the 2021 RWP are closely based on those of the previous plan. However, during the development of the 2021 RWP, the definition of a municipal WUG was redefined so that WUGs are more closely aligned with retail water service areas rather than municipal boundaries. As a result of this restructuring by TWDB, population and demand projections for individual WUGs may vary between the 2016 and 2021 RWPs due to the difference in city limits and utility service areas. However, total projected populations by county from the 2016 RWP were maintained by adjusting populations in the County-Other WUGs to account for any adjustments to individual, named WUGs. Furthermore, the redefinition of municipal WUGs allowed for the inclusion of more small water providers outside of incorporated municipalities as individual, named WUGs with specific per-capita demand projections, where previously a County-Other per-capita value had been applied. This refinement contributed to the differences in total municipal demand projections between the 2016 and 2021 RWPs. These results are shown below in *Figure 11-6*.

Figure 11-6 – Comparison of Municipal Demand Projections



Municipal demand projections in the 2021 RWP were similar to those in the 2016 RWP, and the trends in municipal demands by county remained similar as well. Municipal demand projections in Fort Bend and Montgomery Counties increased by as much as 6,860 ac-ft/yr and 5,196 ac-ft/yr, respectively, due primarily to adjustments in WUG delineation and associated updates of per capita demands. A comparison of projected demands in the 2016 and 2021 RWPs by county and water use type can be found in ***Appendix DB***.

11.3.2 Drought of Record, Modeling Assumptions, and Existing Source Supplies

Both groundwater and surface water supplies in Region H are developed using guidelines that are either dictated by regional water planning guidance or applied at the discretion of the RHWPG. These assumptions and approaches vary between the 2016 and 2021 RWPs in a number of ways. However, there are also several similarities in the yield evaluation process that provide continuity between the two plans.

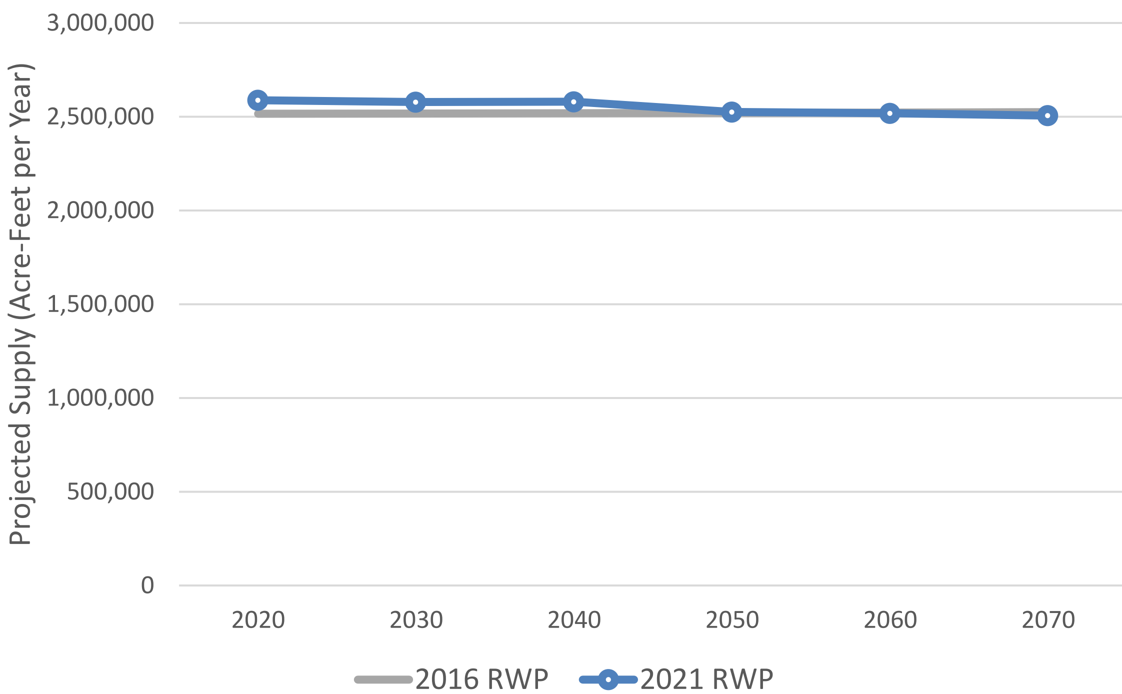
Surface water supplies in Region H are developed based on output from the Texas Commission on Environmental Quality (TCEQ) Water Availability Models (WAMs) for each basin. In addition, the following assumptions were applied in the 2016 and 2021 RWPs.

- In both the 2016 and 2021 RWPs, Region H has used the TCEQ WAM Run 3 as the base model for evaluation of existing water supplies.
- In both the 2016 RWP and 2021 RWPs, Region H has elected to seek TWDB approval to modify the base Run 3 WAMs to include limited return flows. In the Trinity River Basin, this includes wastewater flows from the upper basin after the application of reuse WMS. Region H also

uses a modified WAM developed by the Brazos G RWPG that includes some limited return flows.
- The RHWPG has historically used the drought of the 1950s as a representation of drought of record conditions for all basins in the region. This assumption continues in the 2021 RWP.

Identified surface water supplies in the 2016 and 2021 RWPs are compared in *Figure 11-7*, and a comparison of total water supplies within each county can be found in ***Appendix DB***.

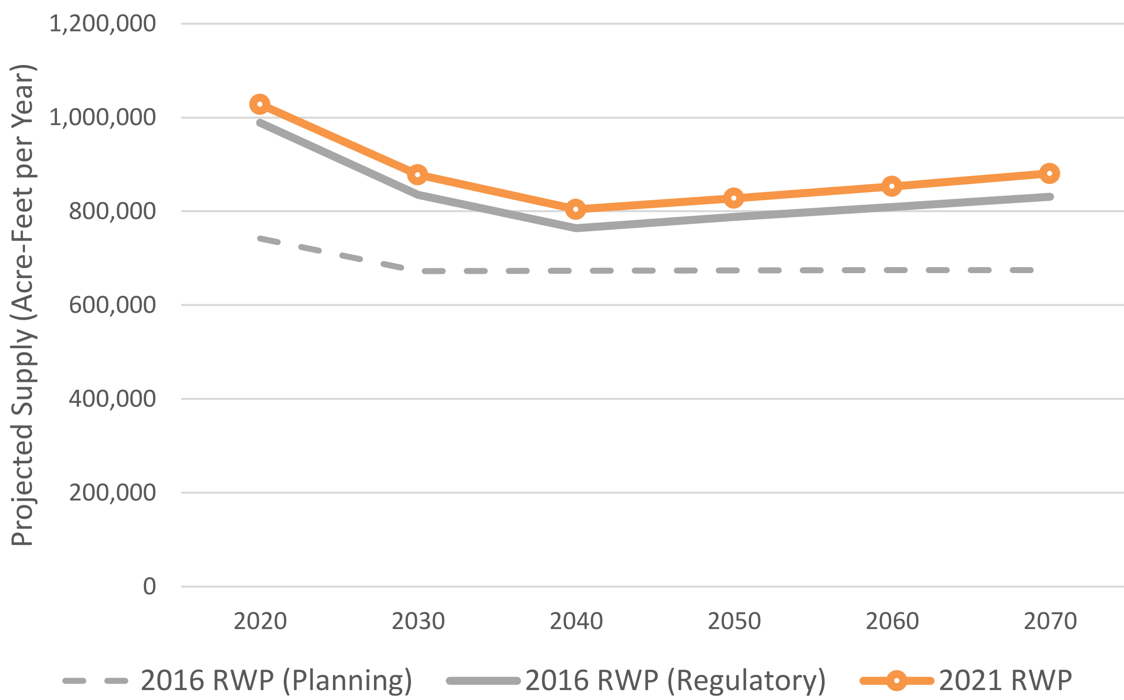
Figure 11-7 – Comparison of Surface Water Supply Projections



The process for determining groundwater availability in the regional plans changed significantly between the 2011 and 2016 RWPs and has continued to evolve during the development of the 2021 RWP. In the 2011 RWP, groundwater availability values were set based on local regulation in each county and the allowable groundwater pumpage for all WUGs receiving surface water. In the development of the 2016 RWPs, TWDB mandated that, where applicable, groundwater availability would be set as the Modeled Available Groundwater (MAG) for each formation included in the Groundwater Management Area (GMA) process. This approach to groundwater availability led to issues in the application of available water supplies to WUGs, as it unrealistically limited the availability of groundwater for some users, particularly in counties where subsidence district regulations drive allowable pumpage rather than MAG values. In the most recent planning cycle, changes to 31 TAC §357.10 and 31 TAC §357.32(d)(3) revised the application of MAG values as source volumes for regional water planning by allowing the designation MAG peak factors, which allow the regional plans to reflect a higher short-term supply availability during drought of record conditions that are still consistent with long-term achievement of desired future conditions. Additionally, TWDB determined that the use of MAG values was not suitable within the jurisdiction of subsidence districts and supply availability in those districts has been revised to align with the district regulatory plans. The process of determining and applying MAG peak factors is discussed in detail in ***Chapter 3***.

Identified groundwater supplies in the 2016 and 2021 RWPs are compared in *Figure 11-8*, and a comparison of total water supplies within each county can be found in ***Appendix DB***.

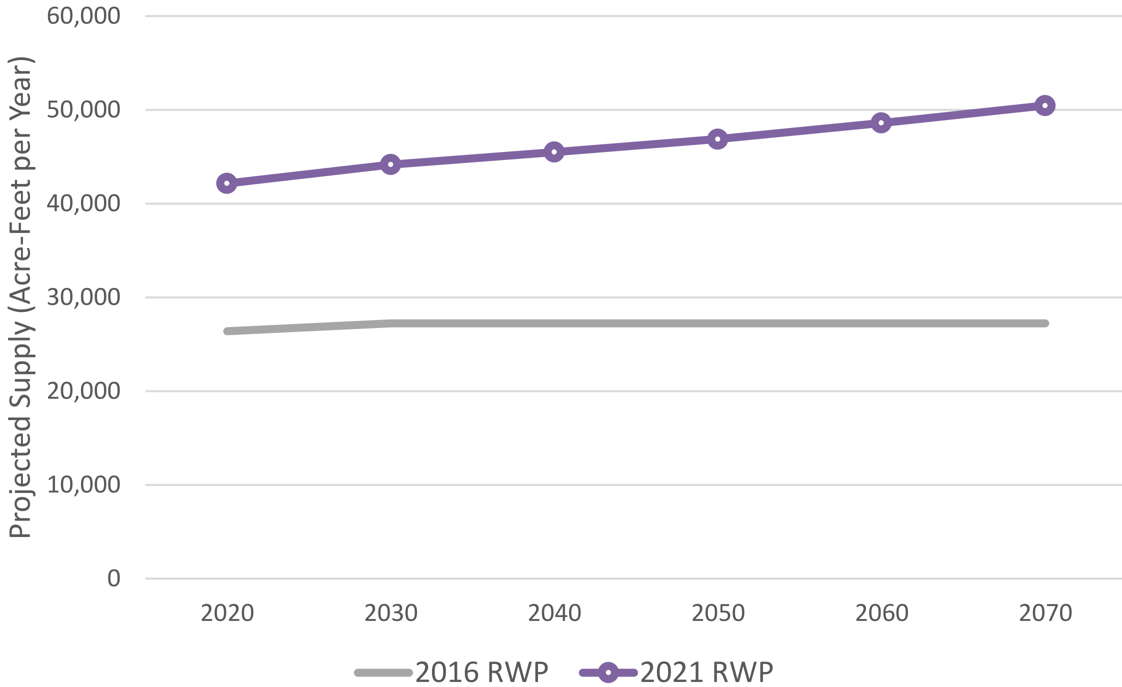
Figure 11-8 – Comparison of Groundwater Supply Projections



Reuse supplies in both the 2016 and 2021 RWPs were developed based on knowledge of existing projects and permits, including the use of supplemental information provided by TWDB.

Identified reuse supplies in the 2016 and 2021 RWPs are compared in *Figure 11-9*, and a comparison of total water supplies within each county can be found in ***Appendix DB***.

Figure 11-9 – Comparison of Reuse Supply Projections



11.3.3 WUG Supplies and Needs

In both the 2016 and 2021 RWPs, care was taken in assigning existing, available supplies based on stakeholder input and knowledge of the regional water supply. It should be noted that needs are not the mere difference between regional demand and regional supply, as water supplies are not uniformly distributed throughout the region and infrastructure is needed in the form of projects in order to make existing, developed sources of water available for end use. Effort was taken in order to realistically curtail supplies available to individual WUGs in order to properly demonstrate local needs and, eventually, the recommended management strategies to address the identified shortfall.

The supplies allocated to WUGs in both the 2016 and 2021 RWPs are shown in *Figure 11-10*. Note that the 2016 supplies include additional groundwater in excess of MAG availability in order to more realistically represent the regulatory availability in the region. Identified WUG needs in the 2016 and 2021 RWPs are shown in *Figure 11-11*. A comparison of allocated existing supplies and identified needs in the 2016 and 2021 RWPs by county and water use type can be found in ***Appendix DB***.

Figure 11-10 – Comparison of WUG Allocations

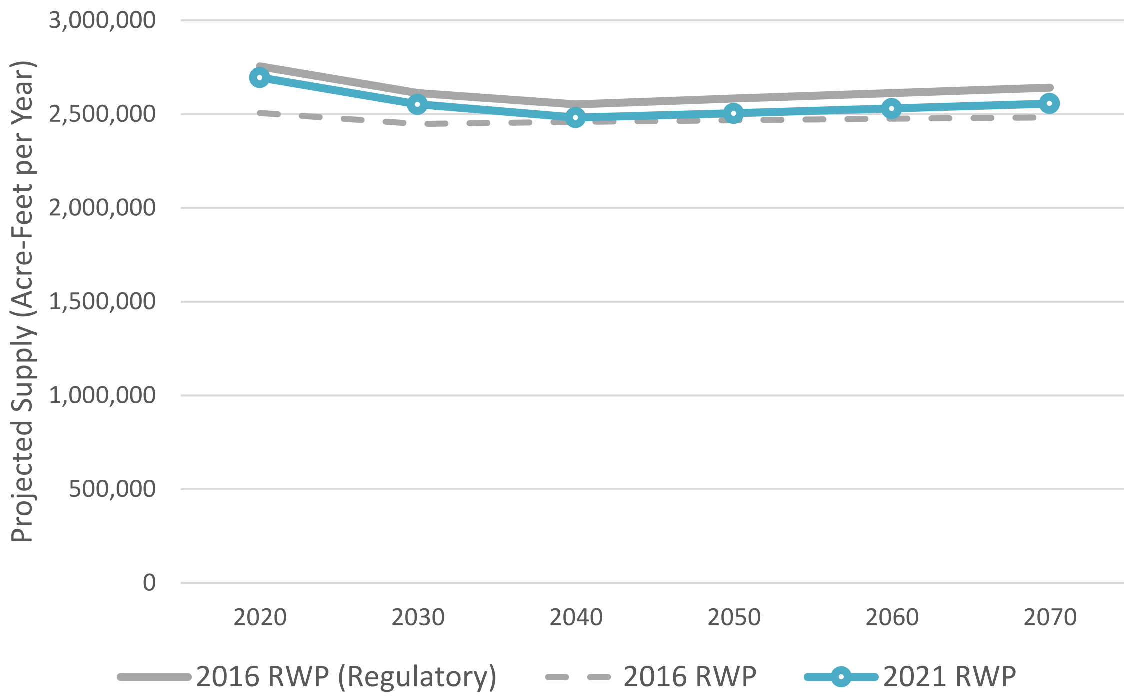
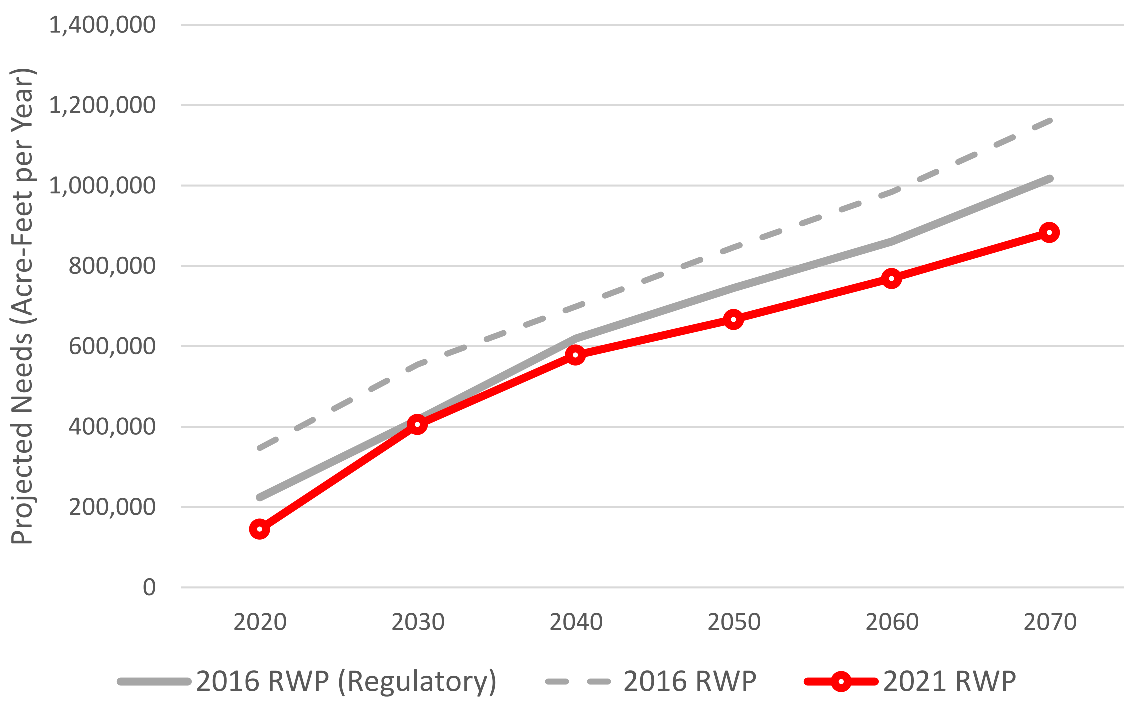


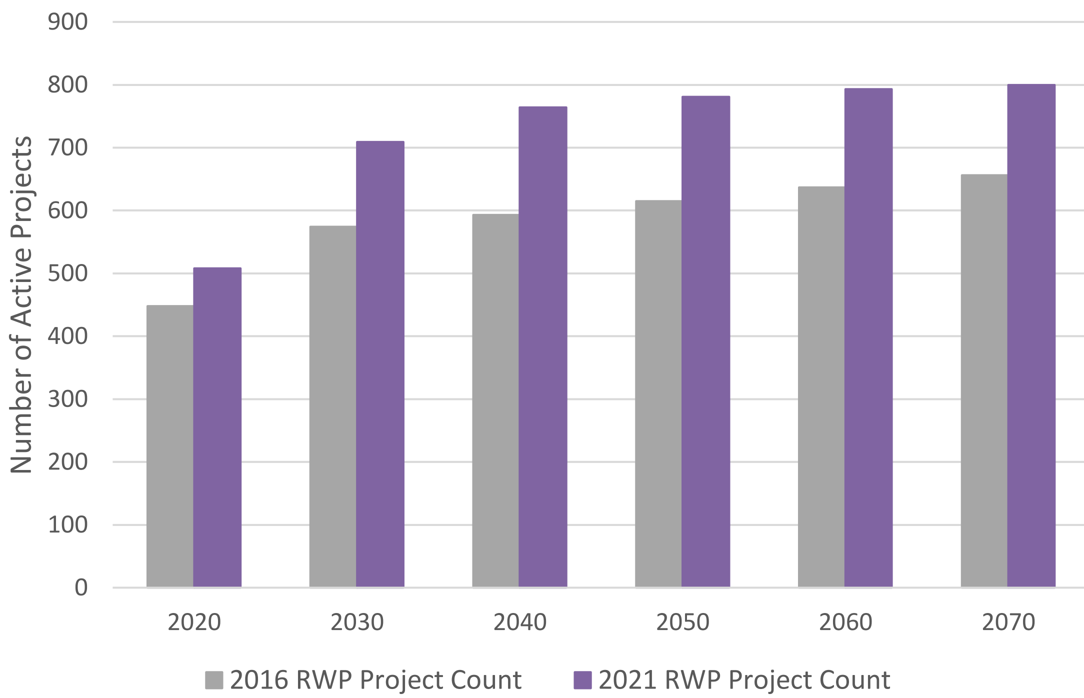
Figure 11-11 – Comparison of Identified WUG Needs



11.3.4 Recommended and Alternative Water Management Strategies

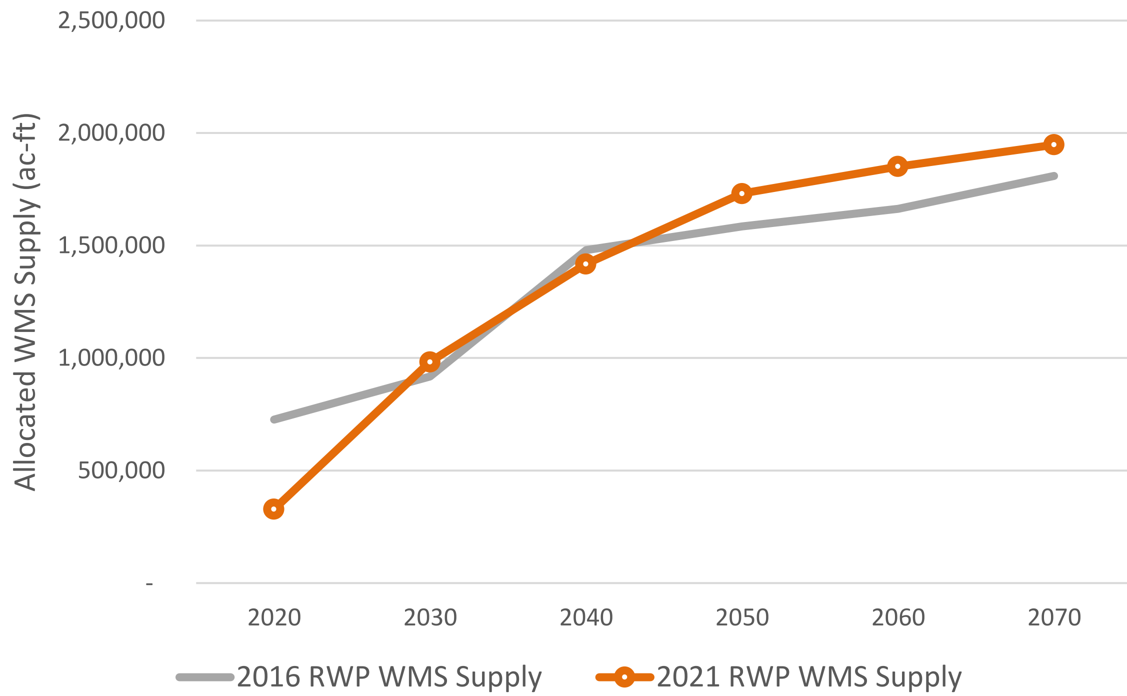
In total, the RHWPG has recommended 61 WMS and 822 capital projects for the 2021 RWP, compared to 58 WMS and 656 capital projects identified in the 2016 RWP; the 2016 RWP included an additional 62 projects not associated with a capital cost. For purposes of this comparison, all components of a grouped WMS within TWDB's DB22 database are considered a single WMS. The number of capital projects identified in each RWP and actively associated with supply volumes in each decade are shown below in *Figure 11-12*.

Figure 11-12 – Comparison of Number of Active Projects



Allocations of WMS supplies in the 2021 RWP differ from those in the 2016 RWP for a number of reasons, including differences in projected WUG demands, establishment of new existing contracts between water providers and WUG customers, implementation of 2016 WMSs as existing supplies, changes in recommended WMS, and changes to associated project schedules. The WMS supply volumes allocated in each RWP are shown below in *Figure 11-13*.

Figure 11-13 – Comparison of Allocated WMS Supply Volumes



11.4 REGIONALIZATION OF WATER MANAGEMENT STRATEGIES IN REGION H

Regional water planning groups are required by statute to prepare long-term regional water supply plans which consider ongoing local and regional planning efforts and which are consistent with plans developed by other regions throughout the state. Furthermore, regional water plans are required to meet projected water needs with strategies that, among other requirements, are cost-effective. Strategies which meet needs of multiple WUGs are typically more cost-effective than localized strategies due to economy of scale and the reduced unit cost of planning, designing, and constructing one larger facility rather than multiple smaller projects.

Regional strategies that meet the needs of multiple WUGs and achieve economies of scale are common in Region H. Several of the major water providers in Region H are Regional Water Authorities, which were created by the Texas Legislature to lead water planning and groundwater conversion efforts. Additionally, COH has developed important relationships with the regional water authorities and river authorities to coordinate interbasin transfers from the Trinity and Brazos River Basins to the largest demand centers in Region H. The Gulf Coast Water Authority also provides water to numerous municipal, agricultural, and industrial users in the southwestern part of Region H through the use of an extensive canal network, numerous supply sources, and planned projects for large-scale infrastructure. Many of these large-scale, cooperative strategies and projects have been prompted by the requirements of the FBSD and HGSD to significantly reduce groundwater use. The 2021 Region H RWP includes numerous strategies sponsored by these major water providers and other entities to develop long-term water supplies on a large geographic scale, sometimes including projects that span multiple counties and basins. Of the projects and strategies recommended in the 2021 RWP, 6 projects and 11 WMS involve multiple sponsors and/or wholesale water providers, and 28 recommended strategies would meet needs of multiple WUGs. These and other metrics of cooperative strategies in the 2021 RWP are compared to the 2016 RWP in *Table 11-1*. Overall, the number of strategies and projects which are sponsored by multiple entities, use more than one water supply source, or serve supply to multiple WUGs have increased since the 2016 RWP. These results highlight the continued importance of regional approaches in Region H.

Table 11-1 – Assessment of Progress in Developing Regional Water Supplies and Strategies

Summary of Recommended WMS, Projects, and Providers in Region H	2016 RWP	2021 RWP
WMS[1] supplying multiple WUGs	24	28
WMS[1] with multiple sponsors / sellers	10	11
WMS[1] using multiple water sources	17	19
WMS[1] involving at least one transfer	32	43
Projects[2] with multiple sponsors	6	6
Region H wholesale water providers[3] serving multiple WUGs	40	51

[1] Excludes Municipal Conservation, Water Loss Reduction, and Expanded Use of Groundwater, which are employed on a localized, single-WUG basis.

[2] Limited to projects with non-zero capital costs that are required to implement WMS.

[3] Wholesale water providers here refer to any entity, which may or may not also qualify as a WUG, which sells water on a wholesale basis, including sales to non-municipal WUGs.