Texas Water Development Board

RIO GRANDE
REGIONAL WATER PLANNING GROUP

2016 Region M Water Plan

Chapter 6: Impacts of Plan and Protection of Resources

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List of Abbreviations

Acre-ft.	acre-feet
ID	Irrigation District
TCEQ	Texas Commission on Environmental Quality
TDS	Total Dissolved Solids
TWDB	Texas Water Development Board
WUG	Water User Group

Chapter 6. Impacts of Plan and Protection of Resources

The 2016 Rio Grande Regional Water Plan (Region M Plan) is consistent with long-term protection of the states water resources, agricultural resources, and natural resources and is based on principles outlined in the Texas Administrative Code Chapter 357. The Region M Plan was developed with an understanding of the importance of coordinated development, management, and conservation of water resources to meet Region M's short and long term water needs. This plan recognizes and respects all laws and existing permits applicable to water use for the state and regional water planning areas. Recommendations regarding the development of groundwater have taken into account the rules and goals of groundwater conservation districts and the conservation goals established through the TWDB.

The Region M Plan identifies strategies recommended to meet the region's projected municipal and livestock needs, and a portion of the irrigation, steam electric power generation, and manufacturing needs at reasonable costs. The non-municipal needs that were not met within the representative drought year model are discussed in the socio-economic impacts analysis, which is included at the end of this chapter. The impacts of voluntary conversion of water rights from irrigation to municipal designation are discussed in more detail in section 6.1.6.

Environmental impacts of each type of water management strategy are discussed here and in Section 5.2.

6.1 Impacts of Water Management Strategies

Impacts of the five major Water Management Strategies recommended in the Regional Water Plan are discussed below.

6.1.1 Reuse

Direct potable and non-potable reuse projects are considered for Region M.

Potable

These strategies result in lower wastewater effluent flows which cause a reduction in organic levels in the receiving streams. However, there is also less water discharged to the local watershed which can reduce the quantity of water available for other users and environmental flows and can reduce assimilative capacity used by downstream wastewater treatment plant dischargers.

Many of the locations where potable reuse was recommended are in the Nueces-Rio Grande Basin, but the source waters are predominantly from the Rio Grande. Impacts of wastewater reuse projects will primarily impact the flows into the drainage network, including the Arroyo Colorado. There are water rights holders along the Arroyo Colorado and other drainage canals in the Nueces Rio-Grande basin that could potentially be impacted, including irrigators, some shrimp farming and other aquaculture.

If potable reuse projects involve the effluent being stored in a raw water reservoir prior to treatment, water quality of the reservoir may be impacted. If membrane treatment, like reverse osmosis, is used as a part of the advanced treatment process to meet potable water quality requirements, options for discharge of the waste stream will need to consider minimizing impacts to the receiving environment.

Non-Potable

Non-potable reuse may have the same impacts of reduced wastewater treatment plant effluent flows as potable reuse. For non-potable reuse used for irrigation, there is a potential to accumulate byproducts, such as salts and other minerals, in the soil which may be present in run-off water.

Environmental Impacts

Potential environment impacts for recommended and alternative reuse strategies have been identified and categorized as described below.

A. Acres Impacted Permanently

Acres Impacted Permanently refers to the total amount of area that will be permanently impacted due to the implementation of a strategy. The following conservative assumptions were made (unless more detailed information for a specific was available):

- The acres impacted for pipelines is equivalent to the right of way easements required, it is assumed 100 ft. for ROW unless otherwise known
- Water treatment plant impacts are estimated using UCM, which is based on the plant capacity

B. Construction Impacted Acreage

Temporary environmental impacts may be seen during construction activities, such as increased air and noise pollution, and land disturbance activities. However, these effects are typical of any construction project. The Construction Impacted Acreage was estimated as 110% (rounded up to a whole number) of the permanently impacted acreage.

C. Wetland Impact

The Wetland Impact refers to the probability that implementation of a water management strategy will affect a wetland. The location of wetlands in the Region was determined using the National Wetlands Inventory located at http://www.fws.gov/wetlands/Data/Mapper.html.

A strategy received a one if all or part of the strategy is located in a wetland or if it is close enough to where construction activities are likely to impact the wetland. All other strategies received zeros. If the exact location of project is unknown it was given a zero because it was assumed that it would be located on a site that would not affect and wetland.

D. Habitat Impacted Acreage

Habitat Impacted Acreage refers to how the strategy will impact the habitat of the local area. The more area that is impacted due to the implementation of the strategy, the more the area's habitat will be disrupted. Therefore it was assumed that the permanent acreage impacted for a WMS is what would impact habitats.

E. Threatened and Endangered Species Count

Threatened and Endangered Species Count refers to how the strategy will impact those species in the area once implemented. This impact was quantified based on the number of federally listed threatened and endangered species located within the county of the strategy. The number of threatened and endangered species came from the Texas Parks and Wildlife Department Rare, Threatened and Endangered Species of Texas database (http://tpwd.texas.gov/gis/rtest/).

F. Cultural Resources Impact

Cultural Resources Impact refers to how the strategy will impact cultural resources located within the area. Cultural resources are defined as the collective evidence of the past activities and accomplishments of people, including locations, buildings and features with scientific, cultural or historic value. It is assumed that no water management strategies negatively affect cultural resources. Mitigation costs are included for strategies that require infrastructure so it is assumed that none would be built in a location or way that disrupts culturally sensitive locations.

G. Reduction in WWTP Effluent (Acre-Ft./Year)

Environmental impacts may be seen due to lower WWTP effluent flows to the discharge streams for wastewater effluent reuse strategies. These impacts could include:

- Decreases to the stream flow/level
- Change in the water quality by reducing the organic levels
- Effects to fish and wildlife that inhabit the streams

A summary of the identified and quantified environmental impacts for reuse projects is presented in Table 6-1.

Table 6-1 Environmental Impacts of Reuse Strategies

Entity	WMS Name	Yield*	A	B	C	D	E	F	G
Brownsville	Non-Potable Water Reuse Pipeline	6,721	116	128	0	116	17	0	6,721
Brownsville	Brownsville Southside WWTP Potable Reuse	4,000	41	45	0	41	17	0	4,000
Harlingen	Harlingen Wastewater Treatment Plant 2 Potable Reuse	1,825	57	63	0	57	17	0	1,825
Harlingen	Non-potable Reuse Project	677	42	46	0	42	17	0	677
La Feria	Non-Potable Wastewater Reuse	174	13	14	0	13	17	0	174
Laguna Madre	Port Isabel Water Reclamation Facility Potable Reuse	820	87	96	1	87	17	0	820
Laguna Madre	Non-potable Reuse	350	14	15	0	14	17	0	350
San Benito	Potable Reuse	1,120	44	48	0	44	17	0	1,120
San Benito	Non-Potable Reuse	1,120	32	35	0	32	17	0	1,120
Agua SUD	East WWTP Direct Potable Reuse - Phase 1	1,050	44	48	0	44	9	0	1,050
Agua SUD	West WWTP Direct Potable Reuse - Phase 1	784	143	157	0	143	9	0	784
Agua SUD	East WWTP Direct Potable Reuse - Phase 2	1,260	0	5	0	0	9	0	1,260
Agua SUD	West WWTP Direct Potable Reuse - Phase 2	1,680	0	15	0	0	9	0	1,680
Agua SUD	Non-Potable Reuse	280	0	2	0	0	9	0	280

Entity	WMS Name	Yield*	A	B	C	D	E	F	G
Edinburg	Reuse Water for Cooling Tower and Landscaping Usage	3,920	43	47	0	43	9	0	3,920
McAllen	South WWTP Potable Reuse	2,000	46	51	0	46	9	0	2,000
McAllen	North WWTP Potable Reuse	1,120	50	55	0	50	9	0	1,120
McAllen	Non-potable Reuse Project	1,950	49	54	0	49	9	0	1,950
Mercedes	Potable Reuse	1,670	32	35	0	32	9	0	1,670
Mission	WWTP Potable Reuse Phase 1	3,920	22	24	0	22	9	0	3,920
Mission	WWTP Potable Reuse Phase 2	7,840	0	2	0	0	9	0	7,840
Pharr	Potable Reuse	6,721	38	42	0	38	9	0	6,721
Pharr	Non-potable Reuse Project	500	34	37	0	34	9	0	500
Weslaco	North WWTP Potable Reuse	1,120	26	29	0	26	9	0	1,120
Weslaco	Scalping Plants	0	1	1	0	1	9	0	0
Laredo	Zacate Creek WWTP Potable Reuse	5,725	54	59	1	54	5	0	5,725
Laredo	Non-potable Reuse Project	2,100	21	23	1	21	5	0	2,100

*First decade of implementation yield (acre-ft./year)

6.1.2 Desalination

The disposal of concentrate from brackish desalination facilities will increase levels of Total Dissolved Solids (TDS) in the receiving streams. Many of the facilities that are currently treating brackish groundwater dispose of concentrate in the drainage canal network in the Nueces-Rio Grande Basin. This network of canals is usually brackish, and discharges into the Laguna Madre, parts of which are naturally hyper-saline. The greatest recent threat to wildlife in the Lower Laguna Madre has been increased inflows of low-salinity water.

As with any groundwater development project, there is potential to affect the quality of the aquifer as more water is drawn from it. Land subsidence may be a by-product of increased groundwater pumping. All groundwater development strategies for both fresh and brackish wells were scaled to fit within the conservation goals for each region of the targeted aquifer.

Seawater desalination facilities would dispose of brine concentrate back into the Gulf of Mexico. Although the waste stream would be highly concentrated with TDS, it would have minimal effects of the Gulf once it was dispersed. Intake and discharge facilities would have to be careful engineered to cause the least disturbance to the natural habitat of species in that location.

Environmental Impacts

Potential environment impacts for recommended and alternative brackish groundwater and seawater desalination strategies have been identified and categorized as described below.

A. Acres Impacted Permanently

Acres Impacted Permanently refers to the total amount of area that will be permanently impacted due to the implementation of a strategy. The following conservative assumptions were made (unless more detailed information for a specific was available):

- The acres impacted for pipelines is equivalent to the right of way easements required, it is assumed 100 ft. for ROW unless otherwise known
- Water treatment plant impacts are estimated using UCM, which is based on the plant capacity
- The impact of wells and wellfields are given by the UCM, which includes 0.5 acres per well

B. Construction Impacted Acreage

Temporary environmental impacts may be seen during construction activities, such as increased air and noise pollution, and land disturbance activities. However, these effects are typical of any construction project. The Construction Impacted Acreage was estimated as 110% (rounded up to a whole number) of the permanently impacted acreage.

C. Wetland Impact

The Wetland Impact refers to the probability that implementation of a water management strategy will affect a wetland. The location of wetlands in the Region was determined using the National Wetlands Inventory located at http://www.fws.gov/wetlands/Data/Mapper.html.

A strategy received a one if all or part of the strategy is located in a wetland or if it is close enough to where construction activities are likely to impact the wetland. All other strategies received zeros. If the exact location of project is unknown it was given a zero because it was assumed that it would be located on a site that would not affect and wetland.

D. Habitat Impacted Acreage

Habitat Impacted Acreage refers to how the strategy will impact the habitat of the local area. The more area that is impacted due to the implementation of the strategy, the more the area's habitat will be disrupted. Therefore it was assumed that the permanent acreage impacted for a WMS is what would impact habitats.

E. Threatened and Endangered Species Count

Threatened and Endangered Species Count refers to how the strategy will impact those species in the area once implemented. This impact was quantified based on the number of federally listed threatened and endangered species located within the county of the strategy. The number of threatened and endangered species came from the Texas Parks and Wildlife Department Rare, Threatened and Endangered Species of Texas database (http://tpwd.texas.gov/gis/rtest/).

F. Cultural Resources Impact

Cultural Resources Impact refers to how the strategy will impact cultural resources located within the area. Cultural resources are defined as the collective evidence of the past activities and accomplishments of people, including locations, buildings and features with scientific, cultural or historic value. It is assumed that no water management strategies negatively affect cultural

resources. Mitigation costs are included for strategies that require infrastructure so it is assumed that none would be built in a location or way that disrupts culturally sensitive locations.

G. Volume of Brine (Acre-ft.)

The Volume of Brine quantifies the amount of brine concentrate from the desalination process that is released as surface water discharge. It is assumed that brackish groundwater desalination plants are 80% efficient, so 20% of the amount of water pumped from the aquifer is discharged as brine concentrate. An efficiency of 50% was assumed for seawater desalination.

H. TDS of Brine (mg/L)

The Total Dissolved Solids (TDS) of Brine provides the concentrate of the brine discharge. This number was calculated by assuming that the raw brackish groundwater has a TDS of 3,500 mg/L and the TDS of the seawater is 35,000 mg/L. A TDS of 500 mg/L was used for the finished water for both types of desalination.

A summary of the identified and quantified environmental impacts for desalination projects is presented in Table 6-2.

Table 6-2 Environmental Impacts of Desalination Strategies

Entity	WMS Name	Yield*	A	B	C	D	E	F	G	H
Agua SUD	New Brackish Water Treatment Plant	1,344	3	4	0	3	9	0	269	19,375
Alamo	Brackish Groundwater Desalination Plant	896	2	3	0	2	9	0	179	19,375
Brownsville	Seawater Desalination Demonstration - Pilot	2,800	8	9	1	8	17	0	1,400	86,500
Brownsville	Seawater Desalination Demonstration - Build-Out	28,000	31	34	1	31	17	0	14,000	86,500
Combes	Brackish Groundwater Desalination Plant	125	1	2	0	1	17	0	25	19,375
Donna	Brackish Groundwater Desalination Plant	700	1	2	0	1	9	0	140	19,375
Eagle Pass	Brackish Groundwater Desalination Plant	560	1	2	0	1	5	0	112	19,375
East Rio Hondo WSC	North Cameron Regional WTP Wellfield Expansion	400	1	2	0	1	17	0	80	19,375
El Jardin WSC	Brackish Desalination Plant	560	1	2	0	1	17	0	112	19,375
Elsa	New Brackish Water Treatment Plant	560	1	2	0	1	9	0	112	19,375
Harlingen	Brackish Groundwater Desalination Plant	1,000	1	2	0	1	17	0	200	19,375
Hebbronville	New Brackish Water Treatment Plant	560	1	2	0	1	2	0	112	19,375
La Feria	Water Well with R.O. Unit	1,120	1	2	0	1	17	0	224	19,375
La Villa	New Brackish Water Treatment Plant	560	1	2	0	1	9	0	112	19,375
Laguna Madre	Brackish Groundwater Desalination Plant	2,240	3	4	0	3	17	0	448	19,375
Laguna Madre	Seawater Desalination Plant	1,120	8	9	0	8	17	0	560	86,500

Entity	WMS Name	Yield*	A	B	C	D	E	F	G	H
Laredo	Brackish Groundwater Desalination Plant	5,000	6	7	0	6	5	0	1,000	19,375
Lyford	Brackish Groundwater Well and Desalination	1,120	1	2	0	1	14	0	224	19,375
McAllen	Brackish Groundwater Desalination Treatment	2,688	5	6	0	5	9	0	538	19,375
Mercedes	Brackish Groundwater Desalination Plant	435	1	2	0	1	9	0	87	19,375
Mission	Brackish Groundwater Desalination Plant	2,688	5	6	0	5	9	0	538	19,375
North Alamo WSC	North Cameron Regional WTP Wellfield Expansion	800	1	2	0	1	17	0	160	19,375
North Alamo WSC	Delta Area RO Plant 2 MGD	2,250	3	4	0	3	14	0	450	19,375
North Alamo WSC	La Sara RO Plant, expand well field	1,120	2	3	0	2	14	0	224	19,375
Olmito WSC	Brackish Desalination Plant	560	1	2	0	1	17	0	112	19,375
Primera	RO WTP with Groundwater Well	1,120	4	5	0	4	17	0	224	19,375
RGRWA	Regional Facility Project - Seawater Desal	5,470	41	45	0	41	17	0	2,735	86,500
Rio Grande City	Brackish Groundwater Desalination Plant	560	1	2	0	1	8	0	112	19,375
San Juan	WTP No. 1 Upgrade and Expansion to include BGD	1,792	3	4	0	3	9	0	358	19,375
Santa Rosa	Brackish Desalination Plant	560	1	2	0	1	17	0	112	19,375
Sharyland WSC	Water Well and R.O. Unit at WTP #2	900	2	3	0	2	9	0	180	19,375
Sharyland WSC	Water Well and R.O. Unit at WTP #3	900	2	3	0	2	9	0	180	19,375
Union WSC	Brackish Groundwater Desalination Plant	560	1	2	0	1	8	0	112	19,375
Valley MUD #2	Brackish Groundwater Desalination Plant	100	1	2	0	1	17	0	20	19,375
Weslaco	Brackish Groundwater Desalination Plant	1,630	2	3	0	2	9	0	326	19,375

*First decade of implementation yield (acre-ft./year)

6.1.3 Fresh Groundwater Development

Water quality concerns from fresh groundwater projects are minimal, however as with any groundwater development project, there is potential to affect the quality of the aquifer as more water is drawn from it. As with brackish groundwater development, land subsidence may be a by-product of fresh groundwater pumping. All groundwater development strategies for both fresh and brackish wells were scaled to fit within the conservation goals for each region of the targeted aquifer.

Environmental Impacts

Potential environment impacts for fresh groundwater strategies have been identified and categorized as described below.

A. Acres Impacted Permanently

Acres Impacted Permanently refers to the total amount of area that will be permanently impacted due to the implementation of a strategy. The following conservative assumptions were made (unless more detailed information for a specific was available):

- The acres impacted for pipelines is equivalent to the right of way easements required, it is assumed 100 ft. for ROW unless otherwise known
- Water treatment plant impacts are estimated using UCM, which is based on the plant capacity
- The impact of wells and wellfields are given by the UCM, which includes 0.5 acres per well

B. Construction Impacted Acreage

Temporary environmental impacts may be seen during construction activities, such as increased air and noise pollution, and land disturbance activities. However, these effects are typical of any construction project. The Construction Impacted Acreage was estimated as 110% (rounded up to a whole number) of the permanently impacted acreage.

C. Wetland Impact

The Wetland Impact refers to the probability that implementation of a water management strategy will affect a wetland. The location of wetlands in the Region was determined using the National Wetlands Inventory located at http://www.fws.gov/wetlands/Data/Mapper.html.

A strategy received a one if all or part of the strategy is located in a wetland or if it is close enough to where construction activities are likely to impact the wetland. All other strategies received zeros. If the exact location of project is unknown it was given a zero because it was assumed that it would be located on a site that would not affect and wetland.

D. Habitat Impacted Acreage

Habitat Impacted Acreage refers to how the strategy will impact the habitat of the local area. The more area that is impacted due to the implementation of the strategy, the more the area's habitat will be disrupted. Therefore it was assumed that the permanent acreage impacted for a WMS is what would impact habitats.

E. Threatened and Endangered Species Count

Threatened and Endangered Species Count refers to how the strategy will impact those species in the area once implemented. This impact was quantified based on the number of federally listed threatened and endangered species located within the county of the strategy. The number of threatened and endangered species came from the Texas Parks and Wildlife Department Rare, Threatened and Endangered Species of Texas database (http://tpwd.texas.gov/gis/rtest/).

F. Cultural Resources Impact

Cultural Resources Impact refers to how the strategy will impact cultural resources located within the area. Cultural resources are defined as the collective evidence of the past activities and accomplishments of people, including locations, buildings and features with scientific, cultural or historic value. It is assumed that no water management strategies negatively affect cultural

resources. Mitigation costs are included for strategies that require infrastructure so it is assumed that none would be built in a location or way that disrupts culturally sensitive locations.

A summary of the identified and quantified environmental impacts for recommended and alternative fresh groundwater projects is presented in Table 6-3.

Table 6-3 Environmental Impacts of Fresh Groundwater Strategies

Entity	WMS Name	Yield*	A	B	C	D	E	F
Alamo	Groundwater Well	1,100	1	1	0	1	9	0
County-Other	Expand Groundwater Supply	3,000	0	10	0	0	17	0
County-Other	Additional Groundwater Wells	400	3	6	0	3	8	0
County-Other	Additional Groundwater Wells	1,400	11	22	0	11	5	0
Eagle Pass	New Groundwater Supply	700	1	1	0	1	5	0
Edcouch	New Groundwater Supply	500	1	1	0	1	9	0
Hidalgo	Expand Existing Groundwater Wells	300	1	1	0	1	9	0
Irrigation	Additional Groundwater Wells	300	3	6	0	3	2	0
McAllen	Expand Existing Groundwater Wells	500	1	1	0	1	9	0
Mercedes	Expand Existing Groundwater Wells	560	1	1	0	1	9	0
Military Highway WSC	Expand Existing Groundwater Wells (Cameron County)	625	1	1	0	1	17	0
Military Highway WSC	Expand Existing Groundwater Wells (Hidalgo County)	250	1	1	0	1	9	0
San Benito	Groundwater Supply	1,120	1	1	0	1	17	0
Steam Elec - Nueces-Rio Grande	Additional Groundwater Wells	100	2	4	0	2	9	0
Webb County Water Utility	Expand Existing Groundwater Supply	100	1	1	0	1	5	0
Weslaco	Groundwater Blending	560	1	1	0	1	9	0
Zapata County Waterworks	New Groundwater Supply	1,680	2	2	0	2	7	0

*First decade of implementation yield (acre-ft./year)

6.1.4 Water Infrastructure and Distribution Systems

Water infrastructure and distribution system strategies include recommended improvements to Irrigation District and municipal distribution and transmission systems, new storage reservoirs, and new and upgraded surface water treatment plants. The main impacts from these types of strategies are temporary as they are only seen during construction. Improvements to Irrigation District distribution Systems reduce water loss, which allows for great flows in irrigation canals and can positively impact species that inhabit them.

Environmental Impacts

Potential environment impacts for water infrastructure and distribution systems strategies have been identified and categorized as described below.

A. Acres Impacted Permanently

Acres Impacted Permanently refers to the total amount of area that will be permanently impacted due to the implementation of a strategy. The following conservative assumptions were made (unless more detailed information for a specific was available):

- The acres impacted for pipelines is equivalent to the right of way easements required, it is assumed 100 ft. for ROW unless otherwise known
- Water treatment plant impacts are estimated using UCM, which is based on the plant capacity

B. Construction Impacted Acreage

Temporary environmental impacts may be seen during construction activities, such as increased air and noise pollution, and land disturbance activities. However, these effects are typical of any construction project. The Construction Impacted Acreage was estimated as 110% (rounded up to a whole number) of the permanently impacted acreage.

C. Inundation Acreage

The Inundation Acreage applies to reservoirs only and it equal to the amount of land that will be inundated by the construction of the reservoir.

D. Wetland Impact

The Wetland Impact refers to the probability that implementation of a water management strategy will affect a wetland. The location of wetlands in the Region was determined using the National Wetlands Inventory located at http://www.fws.gov/wetlands/Data/Mapper.html.

A strategy received a '1' if all or part of the strategy is located in a wetland or if it is close enough to where construction activities are likely to impact the wetland. All other strategies received zeros. If the exact location of project is unknown it was given a zero because it was assumed that it would be located on a site that would not affect and wetland.

E. Habitat Impacted Acreage

Habitat Impacted Acreage refers to how the strategy will impact the habitat of the local area. The more area that is impacted due to the implementation of the strategy, the more the area's habitat will be disrupted. Therefore it was assumed that the permanent acreage impacted for a WMS is what would impact habitats.

F. Threatened and Endangered Species Count

Threatened and Endangered Species Count refers to how the strategy will impact those species in the area once implemented. This impact was quantified based on the number of federally listed threatened and endangered species located within the county of the strategy. The number of threatened and endangered species came from the Texas Parks and Wildlife Department Rare, Threatened and Endangered Species of Texas database (http://tpwd.texas.gov/gis/rtest/).

G. Cultural Resources Impact

Cultural Resources Impact refers to how the strategy will impact cultural resources located within the area. Cultural resources are defined as the collective evidence of the past activities and accomplishments of people, including locations, buildings and features with scientific, cultural or historic value. It is assumed that no water management strategies negatively affect cultural

resources. Mitigation costs are included for strategies that require infrastructure so it is assumed that none would be built in a location or way that disrupts culturally sensitive locations.

A summary of the identified and quantified environmental impacts for recommended and alternative irrigation district improvements projects is presented in Table 6-4.

Table 6-4 Environmental Impacts of Irrigation District Improvements Strategies

Entity	WMS Name	Yield*	A	B	C	D	E	F	G
Adam Gardens Irrigation District	Irrigation District Conservation	500	0	4	0	1	0	17	0
Bayview Irrigation District No. 11	Irrigation District Conservation	1,810	0	105	0	1	0	17	0
Brownsville Irrigation District	Irrigation District Conservation	2,616	0	156	0	1	0	17	0
Cameron County Irrigation District No. 16	Irrigation District Conservation	270	0	17	0	1	0	17	0
Cameron County Irrigation District No. 2	Irrigation District Conservation	4,754	0	765	0	1	0	17	0
Cameron County Irrigation District No. 6	Irrigation District Conservation	7,402	0	298	0	1	0	17	0
Cameron County Water Improvement District No. 10	Irrigation District Conservation	395	0	24	0	1	0	17	0
Delta Lake Irrigation District	Irrigation District Conservation	6,166	0	635	0	1	0	14	0
Donna Irrigation District	Irrigation District Conservation	532	0	77	0	1	0	9	0
Engleman Irrigation District	Irrigation District Conservation	831	0	55	0	1	0	9	0
Harlingen Irrigation District	Irrigation District Conservation	1,137	0	40	0	1	0	17	0
Hidalgo County Drainage District 1	Delta Watershed Project - Edinburg Lake	3,739	428	535	428	1	428	9	0
Hidalgo County Drainage District 1	Delta Watershed Project - New Reservoir	2,278	387	484	387	0	387	9	0
Hidalgo and Cameron Counties Irrigation District No. 9	Irrigation District Conservation	2,948	0	655	0	1	0	17	0
Hidalgo County Irrigation District No. 1	Irrigation District Conservation	13,111	0	666	0	1	0	9	0
Hidalgo County Irrigation District No. 13	Irrigation District Conservation	194	0	8	0	1	0	9	0
Hidalgo County Irrigation District No. 16	Irrigation District Conservation	485	0	43	0	1	0	9	0
Hidalgo County Irrigation District No. 2	Irrigation District Conservation	4,077	0	178	0	1	0	9	0
Hidalgo County Irrigation District No. 5	Irrigation District Conservation	1,215	0	63	0	1	0	9	0
Hidalgo County Irrigation District No. 6	Irrigation District Conservation	3,237	0	168	0	1	0	9	0
Hidalgo County Water Control and Improvement District No. 18	Irrigation District Conservation	119	0	7	0	1	0	9	0

Entity	WMS Name	Yield*	A	B	C	D	E	F	G
Hidalgo County Water Improvement District No. 3	Irrigation District Conservation	2,284	0	110	0	1	0	9	0
Hidalgo Municipal Utility District No. 1	Irrigation District Conservation	180	0	10	0	1	0	9	0
La Feria La Feria Irrigation District No. 3	Irrigation District Conservation	2,064	0	622	0	1	0	17	0
Maverick County Water Control and Improvements District	Irrigation District Conservation	10,780	0	520	0	1	0	5	0
Santa Cruz Irrigation District No. 15	Irrigation District Conservation	2,899	0	56	0	1	0	9	0
Sharyland/ Hidalgo County Improvement District No. 19	Irrigation District Conservation	554	0	32	0	1	0	9	0
United Irrigation District	Irrigation District Conservation	7,093	0	145	0	1	0	9	0
United Irrigation District	Off-Channel Reservoir	2,000	50	100	45	1	50	9	0
Valley Acres Irrigation District	Irrigation District Conservation	510	0	30	0	1	0	17	0

*First decade of implementation yield (acre-ft./year)

A summary of the identified and quantified environmental impacts for recommended and alternative municipal infrastructure is presented in Table 6-5.

Table 6-5 Environmental Impacts of Municipal Infrastructure Strategies

Entity	WMS Name	Yield*	A	B	C	D	E	F	G
East Rio Hondo WSC	Harlingen WW Interconnect	112	56	62	0	0	56	17	0
McAllen	Raw Water Line Project	800	15	17	0	0	15	9	0
Rio Hondo	Emergency Interconnects	70	30	33	0	0	30	17	0
Brownsville Public Utilities Board	Banco Morales Reservoir	3,835	60	75	60	0	60	17	0
Brownsville Public Utilities Board	Resaca Restoration	877	40	50	40	0	40	17	0
Brownsville Public Utilities Board	Brownsville/Matamoros Weir and Reservoir	19,176	300	375	300	0	300	17	0
Manufacturing - Rio Grande	Transfer of Surplus from Eagle Pass	70	0	0	0	0	0	5	0
RGRWA	Regional Facility Project - Groundwater, Surface Water, and Reuse	20,000	216	324	216	0	216	17	0
Donna	WTP Expansion & Urbanized Water Rights	950	25	28	0	0	25	9	0
East Rio Hondo WSC	Surface Water Treatment Plant (Phase I)	11,200	67	74	0	0	67	17	0
Elsa	WTP Expansion and Interconnect to Engleman ID	2,240	35	39	0	0	35	9	0
Laredo	Expansion of El Pico WTP (Phases 1-4)	28,000	13	14	0	0	13	5	0

Entity	WMS Name	Yield*	A	B	C	D	E	F	G
North Alamo WSC	NAWSC Converted WR and Water Treatment Plant No. 5 Expansion	1,120	5	6	0	0	5	9	0
North Alamo WSC	NAWSC Converted WR and Delta WTP Expansion	4,480	5	6	0	0	5	9	0
Roma	Water Right Purchase and Regional Water Treatment Plant	1,500	5	6	0	1	5	8	0

*First decade of implementation yield (acre-ft./year)

6.1.5 Conservation

Conservation strategies, including Advanced Municipal Conservation, Implementation of Best Management Practices for Industrial users, and Irrigation Conservation, focus on decreasing water usage, which results in lowered flow to wastewater treatment plants. However, wastewater influent flow typically has the same amount of organic waste, which can require wastewater treatment plant upgrades to maintain target organic levels in the receiving stream.

Environmental Impacts

Potential environment impacts for conservation strategies have been identified and categorized as described below.

A. Acres Impacted Permanently

Acres Impacted Permanently refers to the total amount of area that will be permanently impacted due to the implementation of a strategy. The following conservative assumptions were made (unless more detailed information for a specific was available):

- The acres impacted for pipelines is equivalent to the right of way easements required, it is assumed 100 ft. for ROW unless otherwise known
- Water treatment plant impacts are estimated using UCM, which is based on the plant capacity

B. Construction Impacted Acreage

Temporary environmental impacts may be seen during construction activities, such as increased air and noise pollution, and land disturbance activities. However, these effects are typical of any construction project. The Construction Impacted Acreage was estimated as 110% (rounded up to a whole number) of the permanently impacted acreage.

C. Wetland Impact

The Wetland Impact refers to the probability that implementation of a water management strategy will affect a wetland. The location of wetlands in the Region was determined using the National Wetlands Inventory located at http://www.fws.gov/wetlands/Data/Mapper.html.

A strategy received a one if all or part of the strategy is located in a wetland or if it is close enough to where construction activities are likely to impact the wetland. All other strategies received zeros. If the exact location of project is unknown it was given a zero because it was assumed that it would be located on a site that would not affect and wetland.

D. Habitat Impacted Acreage

Habitat Impacted Acreage refers to how the strategy will impact the habitat of the local area. The more area that is impacted due to the implementation of the strategy, the more the area's habitat will be disrupted. Therefore it was assumed that the permanent acreage impacted for a WMS is what would impact habitats.

E. Cultural Resources Impact

Cultural Resources Impact refers to how the strategy will impact cultural resources located within the area. Cultural resources are defined as the collective evidence of the past activities and accomplishments of people, including locations, buildings and features with scientific, cultural or historic value. It is assumed that no water management strategies negatively affect cultural resources. Mitigation costs are included for strategies that require infrastructure so it is assumed that none would be built in a location or way that disrupts culturally sensitive locations.

A summary of the identified and quantified environmental impacts for recommended and alternative advanced municipal conservation projects is presented in Table 6-6. Additionally, it should be noted that because conservation reduces demand, this type of strategy decreases the amount of water that is discharged from a WWTP.

Table 6-6 Environmental Impacts for Advanced Municipal Conservation Strategies

Entity	WMS Name	Yield*	A	B	C	D	E
Agua SUD	Advanced Municipal Water Conservation	131	0	0	0	0	0
Alamo	Advanced Municipal Water Conservation	159	0	0	0	0	0
Alton	Advanced Municipal Water Conservation	70	0	0	0	0	0
Brownsville	Advanced Municipal Water Conservation	1,081	0	0	0	0	0
Combes	Advanced Municipal Water Conservation	5	0	0	0	0	0
County-Other	Advanced Municipal Water Conservation	230	0	0	0	0	0
County-Other	Advanced Municipal Water Conservation	52	0	0	0	0	0
County-Other	Advanced Municipal Water Conservation	309	0	0	0	0	0
County-Other	Advanced Municipal Water Conservation	121	0	0	0	0	0
County-Other	Advanced Municipal Water Conservation	31	0	0	0	0	0
County-Other	Advanced Municipal Water Conservation	17	0	0	0	0	0
Donna	Advanced Municipal Water Conservation	4	0	0	0	0	0
Eagle Pass	Advanced Municipal Water Conservation	208	0	0	0	0	0
East Rio Hondo WSC	FM 2925 Water Transmission Line	30	142	178	0	142	0

Entity	WMS Name	Yield*	A	B	C	D	E
East Rio Hondo WSC	Municipal (UV Disinfection FM 510 WTP)	11	0	0	0	0	0
East Rio Hondo WSC	Advanced Municipal Water Conservation	1	0	0	0	0	0
Edcouch	Advanced Municipal Water Conservation	1	0	0	0	0	0
Edinburg	Advanced Municipal Water Conservation	8	0	0	0	0	0
El Cenizo	Advanced Municipal Water Conservation	29	0	0	0	0	0
El Jardin WSC	Distribution Pipeline Replacement	11	0	394	0	0	0
El Jardin WSC	Advanced Municipal Water Conservation	37	0	0	0	0	0
Elsa	Advanced Municipal Water Conservation	11	0	0	0	0	0
Harlingen	Advanced Municipal Water Conservation	401	0	0	0	0	0
Hebbronville	Advanced Municipal Water Conservation	1	0	0	0	0	0
Hidalgo	Advanced Municipal Water Conservation	11	0	0	0	0	0
Hidalgo MUD No. 1	Advanced Municipal Water Conservation	56	0	0	0	0	0
La Feria	Rainwater Harvesting	24	0	0	0	0	0
La Feria	Advanced Municipal Water Conservation	25	0	0	0	0	0
La Grulla	Advanced Municipal Water Conservation	11	0	0	0	0	0
La Joya	Advanced Municipal Water Conservation	56	0	0	0	0	0
La Villa	Advanced Municipal Water Conservation	17	0	0	0	0	0
Laguna Vista	Advanced Municipal Water Conservation	182	0	0	0	0	0
Laredo	Advanced Municipal Water Conservation	2,600	0	0	0	0	0
Los Indios	Advanced Municipal Water Conservation	2	0	0	0	0	0
McAllen	Advanced Municipal Water Conservation	1,674	0	0	0	0	0
Mercedes	Advanced Municipal Water Conservation	80	0	0	0	0	0
Military Highway WSC	Advanced Municipal Water Conservation	133	0	0	0	0	0
Mission	Advanced Municipal Water Conservation	925	0	0	0	0	0
North Alamo WSC	Advanced Municipal Water Conservation	860	0	0	0	0	0
Olmito WSC	Advanced Municipal Water Conservation	22	0	0	0	0	0
Palm Valley	Advanced Municipal Water Conservation	8	0	0	0	0	0

Entity	WMS Name	Yield*	A	B	C	D	E
Palmhurst	Advanced Municipal Water Conservation	57	0	0	0	0	0
Palmview	Advanced Municipal Water Conservation	21	0	0	0	0	0
Penitas	Advanced Municipal Water Conservation	5	0	0	0	0	0
Pharr	Advanced Municipal Water Conservation	167	0	0	0	0	0
Port Isabel	Advanced Municipal Water Conservation	52	0	0	0	0	0
Primera	Advanced Municipal Water Conservation	9	0	0	0	0	0
Progreso	Advanced Municipal Water Conservation	7	0	0	0	0	0
Rancho Viejo	Advanced Municipal Water Conservation	50	0	0	0	0	0
Raymondville	Advanced Municipal Water Conservation	34	0	0	0	0	0
Rio Bravo	Advanced Municipal Water Conservation	41	0	0	0	0	0
Rio Grande City	Advanced Municipal Water Conservation	173	0	0	0	0	0
Rio Grande City	Rio Grande City Water Meter Replacement	370	0	1	0	0	0
Rio WSC	Advanced Municipal Water Conservation	29	0	0	0	0	0
Roma	Advanced Municipal Water Conservation	93	0	0	0	0	0
San Benito	Advanced Municipal Water Conservation	146	0	0	0	0	0
San Juan	Advanced Municipal Water Conservation	15	0	0	0	0	0
San Perlita	Advanced Municipal Water Conservation	14	0	0	0	0	0
San Ygnacio MUD	Advanced Municipal Water Conservation	6	0	0	0	0	0
Santa Rosa	Advanced Municipal Water Conservation	1	0	0	0	0	0
Sharyland WSC	Advanced Municipal Water Conservation	231	0	0	0	0	0
South Padre Island	Advanced Municipal Water Conservation	248	0	0	0	0	0
Sullivan City	Advanced Municipal Water Conservation	13	0	0	0	0	0
Union WSC	Automatic Meter Reading System	88	0	1	0	0	0
Union WSC	Advanced Municipal Water Conservation	25	0	0	0	0	0
Weslaco	Advanced Municipal Water Conservation	241	0	0	0	0	0
Zapata County Waterworks	Advanced Municipal Water Conservation	81	0	0	0	0	0

*First decade of implementation yield (acre-ft./year)

Table 6-7 Environmental Impacts for Implementation of BMP Strategies

Entity	WMS Name	Yield*	A	B	C	D	E
Manufacturing - Nueces-Rio Grande	Implementation of BMP	471	0	1	0	0	0
Steam Elec - Nueces-Rio Grande	Implementation of BMP	152	0	1	0	0	0
Mining - Nueces-Rio Grande	Implementation of BMP	26	0	1	0	0	0
Steam Elec - Nueces-Rio Grande	Implementation of BMP	1,415	0	1	0	0	0
Manufacturing - Nueces-Rio Grande	Implementation of BMP	546	0	1	0	0	0
Mining - Nueces-Rio Grande	Implementation of BMP	264	0	1	0	0	0
Mining - Rio Grande	Implementation of BMP	21	0	1	0	0	0
Mining - Nueces-Rio Grande	Implementation of BMP	8	0	1	0	0	0
Mining - Rio Grande	Implementation of BMP	1	0	1	0	0	0
Mining - Rio Grande	Implementation of BMP	159	0	1	0	0	0
Mining - Nueces	Implementation of BMP	40	0	1	0	0	0
Manufacturing - Rio Grande	Implementation of BMP	9	0	1	0	0	0
Mining - Rio Grande	Implementation of BMP	44	0	1	0	0	0
Mining - Nueces-Rio Grande	Implementation of BMP	13	0	1	0	0	0
Manufacturing - Rio Grande	Implementation of BMP	1	0	1	0	0	0
Mining - Rio Grande	Implementation of BMP	672	0	1	0	0	0
Mining - Nueces	Implementation of BMP	310	0	1	0	0	0
Steam Elec - Rio Grande	Implementation of BMP	130	0	1	0	0	0
Mining - Nueces-Rio Grande	Implementation of BMP	52	0	1	0	0	0
Manufacturing - Nueces	Implementation of BMP	2	0	1	0	0	0
Manufacturing - Nueces-Rio Grande	Implementation of BMP	14	0	1	0	0	0
Mining - Nueces-Rio Grande	Implementation of BMP	5	0	1	0	0	0
Mining - Rio Grande	Implementation of BMP	91	0	1	0	0	0

*First decade of implementation yield (acre-ft./year)

6.1.6 Conversion of Surface Water Rights through Urbanization

This strategy is for voluntary conversion of Irrigation Water Rights to Municipal Water Rights as land is converted from agricultural and rural uses to urban uses. The intent of this strategy is to provide additional Municipal and Industrial water from the areas that are already being urbanized, and not to take any additional Irrigation Water Rights from land that would still require them.

For the purpose of this plan, it was assumed that the increase in Municipal Water Demand is proportional to the decrease in Irrigation Demand. The urbanization rate was calculated for each county based on the rate at which Irrigation Demand decreases. The reduction in agricultural supplies, called ‘exclusion,’ and the increase in DMI supplies were estimated using a conservative estimate of the rate of conversion of water rights or exclusion, 75% of the projected urbanization rate.

The 2020 urbanization rate is 0.7 times the 2030 rate to account for the seven years between when the numbers were projected (in 2013) and 2020. Table 6-8 shows the projected agricultural demands, the rate at which water rights are converted in each county, the reduction in irrigation supplies, and the reduction in irrigated acreage, assuming that each acre of land that is irrigated has an associated 2.5 acre-feet of water rights. Although there is measured historical urbanization for Jim Hogg and Webb Counties, these measurements were not considered statistically reliable based on the amount of total urbanization water rights. No urbanization was projected for Webb County.

Table 6-8 Urbanization Rates and Available Converted Water Rights per County (Acre-feet/year)

	2020	2030	2040	2050	2060	2070
Cameron County						
Agricultural Demands	355,962	339,470	322,622	305,522	288,601	288,601
Exclusion Rate	1.82%	3.47%	3.72%	3.98%	4.15%	0.00%
Reduction in Agricultural Supplies (Cumulative)	4,852	12,633	21,149	29,929	38,756	38,757
Reduction in Irrigated Acreage (Cumulative)	4,039	11,593	19,403	27,434	35,492	35,492
Hidalgo County						
Agricultural Demands	639,676	609,754	577,457	540,797	502,563	502,563
Exclusion Rate	1.84%	3.51%	3.97%	4.76%	5.30%	0.00%
Reduction in Agricultural Supplies (Cumulative)	7,015	18,280	31,272	46,184	61,968	61,955
Reduction in Irrigated Acreage (Cumulative)	5,815	16,687	28,566	42,238	56,739	56,739
Jim Hogg County						
Agricultural Demands	439	413	398	414	451	451
Exclusion Rate	2.33%	4.44%	2.72%	-3.02%	-6.70%	0.00%
Reduction in Agricultural Supplies (Cumulative)	0	0	0	0	0	0
Reduction in Irrigated Acreage (Cumulative)	0	0	0	0	0	0
Maverick County						
Agricultural Demands	52,993	51,886	50,903	49,951	49,076	49,076
Exclusion Rate	0.82%	1.57%	1.42%	1.40%	1.31%	0.00%
Reduction in Agricultural Supplies (Cumulative)	627	1,490	2,381	3,270	4,117	4,129
Reduction in Irrigated Acreage (Cumulative)	444	1,282	2,031	2,759	3,432	3,432
Starr County						
Agricultural Demands	13,483	11,085	8,646	6,192	3,714	3,714
Exclusion Rate	7.00%	13.34%	16.50%	21.29%	30.01%	0.00%
Reduction in Agricultural Supplies (Cumulative)	753	2,031	3,415	4,896	6,529	6,519
Reduction in Irrigated Acreage (Cumulative)	291	806	1,358	1,950	2,607	2,607
Webb County						
Agricultural Demands	7,612	7,612	7,612	7,612	7,612	7,612
Exclusion Rate	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Reduction in Agricultural Supplies (Cumulative)	0	0	0	0	0	0
Reduction in Irrigated Acreage (Cumulative)	0	0	0	0	0	0
Willacy County						
Agricultural Demands	69,253	69,074	68,936	68,814	68,741	68,741

	2020	2030	2040	2050	2060	2070
Exclusion Rate	0.10%	0.19%	0.15%	0.13%	0.08%	0.00%
Reduction in Agricultural Supplies (Cumulative)	309	422	690	980	1,262	1,290
Reduction in Irrigated Acreage (Cumulative)	81	236	356	461	524	524
Zapata County						
Agricultural Demands	4,717	4,455	4,215	3,981	3,800	3,800
Exclusion Rate	2.19%	4.17%	4.04%	4.16%	3.41%	0.00%
Reduction in Agricultural Supplies (Cumulative)	81	215	345	474	577	577
Reduction in Irrigated Acreage (Cumulative)	83	238	383	525	637	637
Total Reduction in Agricultural Supplies (Cumulative)	**13,638**	**35,071**	**59,252**	**85,734**	**113,210**	**113,227**
Total Reduction in Irrigated Acreage (Cumulative)	**10,754**	**30,843**	**52,096**	**75,368**	**99,431**	**99,431**

The TCEQ rules establish conversion ratios of 2 acre-ft. of Class A Irrigation Water Rights and 2.5 Class B Water Rights to 1 acre-ft. of Municipal Water Rights. Therefore, if the infrastructure that was previously used to convey an amount of water associated with Irrigation Water Rights is later used to convey water for the converted Municipal Water Rights, a lesser amount of water would be seen. This would result in less available push water. Due to the efficiencies associated with the current condition of Irrigation District (ID) conveyance systems, more water would need to be diverted in order to convey the appropriate amount to the end user. However, if the recommended improvements to ID conveyance systems are implemented, this effect would be minimized.

Environmental Impacts

Potential environment impacts for conversion and purchase of surface water rights strategies have been identified. The largest impact from urbanization of irrigation water rights is the land that is no longer irrigated. Table 6-8 quantifies the amount of acreage per county. The reduction of irrigated acreage was estimated as the amount of urbanized water rights divided by 2.5, based on the standard authorization per acre. It was assumed that the permanent acreage impacted is the same as would impact habitats in the local area.

6.1.7 Biological Control of Arundo Donax

The strategy for biological control of Arundo Donax will have positive impacts to the Rio Grande because it is aimed to reduce an invasive species and make more water available for the river.

6.2 Protection of Resources

All of the recommendations in the Regional Water Plan are consistent with the laws and requirements that protect the water within the Region. The amount of water used for recommended strategies are within the limitations of the Water Availability Model for surface water and the Groundwater Availability Model.

6.2.1 Surface Water Resources

The Rio Grande River Valley supports a wide variety of natural resources. Although there are no required minimum environmental flows for the river, it is important to refrain from negatively impacting the Rio Grande and harming the native wildlife. Based on the cursory evaluations performed to date, the recommended strategies would not significantly alter the water quality of the river system. The net amount of water diverted from the Rio Grande will not be increased by the implementation of the recommended strategies. It is not anticipated that any recommendations would result in major threats to agriculture, natural resources, or navigation. Some strategies, like biological control of Arundo Donax, may allow for native species to be reestablished along waterways that had been overtaken by this invasive species.

The RWPG considered the Texas Clean Rivers Program and the Federal Clean Water Act, which aim to protect the water quality of surface water sources. All of the recommended and alternative WMS are consistent with their goals.

In 1991, the Texas Legislature created the Texas Clean Rivers Program (CRP) in order to address water quality concerns in a coordinated manner.[1] CRP conducts water quality monitoring, assessment, and public outreach across the state through partnerships between TCEQ and local agencies. The International Boundary and Water Commission (USIBWC) administers the CRP in the Rio Grande Basin, and the Nueces River Authority administers both the Nueces and Nueces-Rio Grande Basins. The programs include regular water sampling, and coordination with other agencies and residents to identify and evaluate water quality issues. The Region M Planning Group has considered the issues identified through the Texas CRP and Clean Water Act, which are discussed below.

The 1972 Federal Water Pollution Control Act, now called the Clean Water Act, is the federal law that establishes the framework for monitoring and control of point-source discharges through National Pollutant Discharge Elimination System (NPDES), requires cities to obtain permits for stormwater or non-point-source discharges, and authorizes federal assistance for public owned treatment works.[2] The Clean Water Act has a national goal of "fishable, swimmable" water bodies, and states are required to identify any waters that do not meet this goal and develop total maximum daily loads (TMDLs) for them. TMDLs are intended to guide watershed management, and are the basis of the monitoring and identification of river segments as impaired that is undertaken in the CRP.

Rio Grande water quality within Region M is evaluated in 4 segments over the Middle Rio Grande Sub-Basin, and three segments in the Lower Rio Grande Sub-Basin. From Amistad Dam south to the confluence with the Rio Salado from Mexico, the river is impaired for contact recreation due to high bacteria below, nitrates and low dissolved oxygen (DO), and concern for toxicity and bacteria near Laredo as a result of urban runoff and discharges outside of U.S. jurisdiction. Manadas Creek, an unclassified water body northwest of Laredo, has high bacteria and chlorophyll-a due to urban runoff and high metal content due to industrial activity. Falcon Reservoir is not impaired, but there is concern for toxicity near Zapata. San Felipe Creek is impaired for bacteria, but has a positive effect on the Rio Grande water quality. The Lower Rio Grande Sub-Basin is separated into the freshwater stream and the stream impacted by tidal flows. The freshwater portion, which runs from Falcon Reservoir to downstream of Brownsville, is

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[1] International Boundary and Water Commission, US Section Texas Clean Rivers Program. 2015 Basin Highlights Report, Texas Rio Grande Basin Program Update, May 2015. Accessed online: http://www.ibwc.state.gov/CRP/Publications.html
[2] USEPA Clean Water Act website: http://www.epa.gov/agriculture/lcwa.html

impaired in small reaches from consistently high bacteria counts near urban areas. Additionally, there are concerns across the entire segment for fish consumption due to elevated mercury levels. The tidal stream portion has no impairments but there can be high chlorophyll-a levels.

The Arroyo Colorado is the major drainage-way for approximately two dozen cities in this area, and almost 300,000 acres of farmland. The Arroyo Colorado includes the TCEQ Classified Stream Segment 2201 and 2202, which are impaired for high bacteria, and experience high nutrient concentrations. Segment 2201 is also impaired for low DO.

Regular monitoring of water quality as a result of these programs draws attention to the need for continued assessment and evaluation of water data and integrated regional approaches to managing the watersheds to meet quality goals.

6.2.2 Groundwater Resources

The major aquifer that underlies Region M is the Gulf Coast, which runs the extent of the Texas coast and Hidalgo, Starr, Jim Hogg, and the western portions of Willacy and Cameron Counties. This aquifer is predominantly brackish, with irregular pockets of fresh and very saline water. The Carrizo – Wilcox Aquifer also spans Texas and extends through Webb and part of Maverick Counties. All of the recommended groundwater development was guided by the conservation goals established for each aquifer through the process of establishing desired future conditions.

The minor and alluvial aquifers in the region may produce significant quantities of water that supply relatively small areas, including the Rio Grande Alluvium, the Laredo Formation, and the Yegua-Jackson aquifer. In order to better manage the region's resource, the relationship between the region's surface water and groundwater should be investigated.

Table 6-9 Managed Available Groundwater for Significant Aquifers in Region M (Acre-feet/year)

Aquifer	2020	2030	2040	2050	2060	2070
Carrizo-Wilcox Aquifer	2,959	2,940	2,593	2,486	2,448	2,448
Gulf Coast Aquifer	147,441	147,441	147,441	147,441	147,441	147,441
Yegua-Jackson Aquifer	27,998	27,998	27,998	27,998	27,998	27,998
Total	**178,398**	**178,379**	**178,032**	**177,925**	**177,887**	**177,887**

6.3 Impacts on Water Resources of the State

The primary source of water in Region M, the Rio Grande, is shared with Mexico but predominantly isolated from users outside of the region, with the exception of a Val Verde and Kinney Counties near the Amistad Reservoir. In this area, there is some indication that groundwater development may impact spring flows that are critical to the reservoir.

Drilling and marketing of groundwater in locations which may impact surface water, especially near the Amistad Dam pose a threat to the Region's primary water source. Water marketing companies are actively seeking water sources to be sold to entities in need of new water sources. Recently there has been substantial interest in groundwater in and around Val Verde County. In this particular area, there is strong evidence of interaction between groundwater and surface water, as well as continued study. The pumping of groundwater in the Devils and Pecos river basins have been shown to directly impact these streamflows and the flows in Goodenough

Springs, which play a significant role in supplying water for Region M. Any reduction in the water supply in the Amistad Reservoir presents a threat to the whole region, but particularly to irrigators, which would absorb reductions in supply under current reservoir system operation.

The flows into the Laguna Madre have been modeled as separated between the upper portion (outside of Region M) and the lower portion (largely adjacent to Region M). Concerns with balancing the volume and salinity of inflows will need to be managed across the entire estuary, which will require coordination among the regions that discharge into the estuary and with TCEQ.

Groundwater supplies in Region M rely primarily on aquifers that may extend across the state, but have a limited degree of conductivity. The majority of the water use in Region M is along the Rio Grande, which is separated by a significant distance from the next major cities to the north. There are no known negative impacts on groundwater outside of Region M that would result from the strategies recommended in this Plan.

6.4 Impacts of Voluntary Redistribution of Water from Rural and Agricultural Areas

The recommended WMS in the 2016 RWP that involve voluntary redistribution of water from rural and agricultural areas are the strategies that include converting irrigation water rights to Domestic, Industrial, and Municipal (DMI) water rights. Water rights on the Rio Grande are divided into two major types: DMI rights, and irrigation and mining rights (which are sub-divided into Class A and B). The irrigation and mining rights are allocated after the DMI rights are fulfilled and a certain amount of water is held as an operating reserve. In times of drought, irrigation and mining water rights holders may only have portion of the maximum authorized diversion associated with their water rights. A reliability factor for Class A and B water rights determines the percentage of an irrigation and mining water right that will be fulfilled, based on the total amount of available water and the distribution of DMI, Class A, and Class B water rights. As more water rights are converted from irrigation to DMI, these reliability factors change. Table 6-10 compares the Class A and B reliabilities for the Drought of Record with the current distribution of water rights "Non-urbanization" and with the recommended conversions "Urbanization".

Table 6-10 Class A and B Water Rights Reliability Factors with and without Urbanization

Reliability Case	2020	2030	2040	2050	2060	2070
Class A Reliability (Non-Urbanization)	43.0%	42.9%	42.9%	42.8%	42.7%	42.6%
Class B Reliability (Non-Urbanization)	33.6%	33.6%	33.5%	33.5%	33.4%	33.3%
Class A Reliability (Urbanization)	42.9%	42.9%	42.7%	42.5%	42.4%	42.3%
Class B Reliability (Urbanization)	33.6%	33.5%	33.4%	33.3%	33.1%	33.0%

Additional impacts that would occur due to distribution of water from agricultural to municipal use may be seen by customers of the IDs. Because IDs are responsible for supplying irrigation water, if a smaller supply is sent to irrigators there may be less water in the ID distribution systems. This could reduce the amount of push water available to convey water to users farther away from the Rio Grande and may also change the timing of when water is supplied, if less irrigations are requested.

6.5 Socioeconomic Impacts of Shortages

The following WUGs have remaining water needs that are unmet by the recommended Water Management Strategies presented in Chapter 5:

- Cameron County Irrigation
- Hidalgo County Irrigation
- Hidalgo County Mining
- Maverick County Irrigation
- Maverick County Mining
- Starr County Irrigation
- Starr County Mining
- Webb County Irrigation
- Webb County Mining
- Willacy County Irrigation
- Zapata County Irrigation

A Socioeconomic Impact Analysis of unmet needs has been provided by TWDB and is included here.

Socioeconomic Impacts of Projected Water Shortages

for the Region M Regional Water Planning Area

Prepared in Support of the 2016 Region M Regional Water Plan

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Executive Summary

Evaluating the social and economic impacts of not meeting identified water needs is a required part of the regional water planning process. The Texas Water Development Board (TWDB) estimates those impacts for regional water planning groups, and summarizes the impacts in the state water plan. The analysis presented is for the Region M Regional Water Planning Group.

Based on projected water demands and existing water supplies, the Region M planning group identified water needs (potential shortages) that would occur within its region under a repeat of the drought of record for six water use categories. The TWDB then estimated the socioeconomic impacts of those needs—if they are not met—for each water use category and as an aggregate for the region.

The analysis was performed using an economic modeling software package, IMPLAN (Impact for Planning Analysis), as well as other economic analysis techniques, and represents a snapshot of socioeconomic impacts that may occur during a single year during a drought of record within each of the planning decades. For each water use category, the evaluation focused on estimating income losses and job losses. The income losses represent an approximation of gross domestic product (GDP) that would be foregone if water needs are not met.

The analysis also provides estimates of financial transfer impacts, which include tax losses (state, local, and utility tax collections); water trucking costs; and utility revenue losses. In addition, social impacts were estimated, encompassing lost consumer surplus (a welfare economics measure of consumer wellbeing); as well as population and school enrollment losses.

It is estimated that not meeting the identified water needs in Region M would result in an annually combined lost income impact of approximately $1 billion in 2020, increasing to $5.4 billion in 2070 (Table ES-1). In 2020, the region would lose approximately 12,000 jobs, and by 2070 job losses would increase to approximately 85,500.

All impact estimates are in year 2013 dollars and were calculated using a variety of data sources and tools including the use of a region-specific IMPLAN model, data from the TWDB annual water use estimates, the U.S. Census Bureau, Texas Agricultural Statistics Service, and Texas Municipal League.

Table ES-1: Region M Socioeconomic Impact Summary

Regional Economic Impacts	2020	2030	2040	2050	2060	2070
Income losses ($ millions)*	$954	$1,168	$1,762	$2,502	$3,771	$5,359
Job losses	12,034	14,838	23,391	36,426	58,434	85,529
Financial Transfer Impacts	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Tax losses on production and imports ($ millions)*	$106	$121	$170	$220	$313	$433
Water trucking costs ($ millions)*	-	$0	$0	$1	$0	$1
Utility revenue losses ($ millions)*	$89	$150	$224	$316	$372	$507
Utility tax revenue losses ($ millions)*	$1	$2	$4	$5	$6	$9
Social Impacts	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Consumer surplus losses ($ millions)*	$31	$55	$95	$160	$252	$376
Population losses	2,209	2,724	4,295	6,688	10,728	15,703
School enrollment losses	409	504	795	1,237	1,985	2,905

***** *Year 2013 dollars, rounded. Entries denoted by a dash (-) indicate no economic impact. Entries denoted by a zero ($0) indicate income losses less than $500,000.*

1 Introduction

Water shortages during a repeat of the drought of record would likely curtail or eliminate certain economic activity in businesses and industries that rely heavily on water. Insufficient water supplies could not only have an immediate and real impact on existing businesses and industry, but they could also adversely and chronically affect economic development in Texas. From a social perspective, water supply reliability is critical as well. Shortages could disrupt activity in homes, schools and government and could adversely affect public health and safety. For these reasons, it is important to evaluate and understand how water supply shortages during drought could impact communities throughout the state.

Administrative rules (31 Texas Administrative Code §357.33 (c)) require that regional water planning groups evaluate the social and economic impacts of not meeting water needs as part of the regional water planning process, and rules direct the TWDB staff to provide technical assistance upon request. Staff of the TWDB's Water Use, Projections, & Planning Division designed and conducted this analysis in support of the Region M Regional Water Planning Group.

This document summarizes the results of the analysis and discusses the methodology used to generate the results. Section 1 summarizes the water needs calculation performed by the TWDB based on the regional water planning group's data. Section 2 describes the methodology for the impact assessment and discusses approaches and assumptions specific to each water use category (i.e., irrigation, livestock, mining, steam-electric, municipal and manufacturing). Section 3 presents the results for each water use category with results summarized for the region as a whole. Appendix A presents details on the socioeconomic impacts by county.

1.1 Identified Regional Water Needs (Potential Shortages)

As part of the regional water planning process, the TWDB adopted water demand projections for each water user group (WUG) with input from the planning groups. WUGs are composed of cities, utilities, combined rural areas (designated as county-other), and the county-wide water use of irrigation, livestock, manufacturing, mining and steam-electric power. The demands are then compared to the existing water supplies of each WUG to determine potential shortages, or needs, by decade. Existing water supplies are legally and physically accessible for immediate use in the event of drought. Projected water demands and existing supplies are compared to identify either a surplus or a need for each WUG.

Table 1-1 summarizes the region's identified water needs in the event of a repeat of drought of the record. Demand management, such as conservation, or the development of new infrastructure to increase supplies are water management strategies that may be recommended by the planning group to meet those needs. This analysis assumes that no strategies are implemented, and that the identified needs correspond to future water shortages. Note that projected water needs generally increase over time, primarily due to anticipated population and economic growth. To provide a general sense of proportion, total projected needs as an overall percentage of total demand by water use category are presented in aggregate in Table 1-1. Projected needs for individual water user groups within the aggregate vary greatly, and may reach 100% for a given WUG and water use category. Detailed water needs by WUG and county appear in Chapter 4 of the 2016 Region M Regional Water Plan.

Table 1-1 Regional Water Needs Summary by Water Use Category

Water Use Category		2020	2030	2040	2050	2060	2070
Irrigation	Water Needs (acre-feet per year)	657,300	607,831	556,409	501,777	446,690	447,280
	% of the category's total water demand	57%	56%	53%	51%	48%	48%
Livestock	Water Needs (acre-feet per year)	-	-	-	-	-	-
	% of the category's total water demand	-	-	-	-	-	-
Manufacturing	Water Needs (acre-feet per year)	2,539	3,398	4,253	5,004	6,002	7,077
	% of the category's total water demand	24%	30%	35%	39%	43%	47%
Mining	Water Needs (acre-feet per year)	5,290	4,641	5,488	5,565	5,758	6,337
	% of the category's total water demand	31%	28%	37%	43%	55%	61%
Municipal	Water Needs (acre-feet per year)	49,531	87,413	133,436	192,244	253,435	313,869
	% of the category's total water demand	16%	24%	31%	39%	46%	51%
Steam-electric power	Water Needs (acre-feet per year)	2,984	5,635	8,866	12,805	17,608	23,501
	% of the category's total water demand	18%	28%	38%	46%	54%	60%
Total water needs (acre-feet per year)		**717,644**	**708,918**	**708,452**	**717,395**	**729,493**	**798,064**

2 Economic Impact Assessment Methodology Summary

This portion of the report provides a summary of the methodology used to estimate the potential economic impacts of future water shortages. The general approach employed in the analysis was to obtain estimates for income and job losses on the smallest geographic level that the available data would support, tie those values to their accompanying historic water use estimate (volume), and thereby determine a maximum impact per acre-foot of shortage for each of the socioeconomic measures. The calculations of economic impacts were based on the overall composition of the economy using many underlying economic "sectors." Sectors in this analysis refer to one or more of the 440 specific production sectors of the economy designated within IMPLAN (Impact for Planning Analysis), the economic impact modeling software used for this assessment. Economic impacts within this report are estimated for approximately 310 of those sectors, with the focus on the more water intense production sectors. The economic impacts for a single water use category consist of an aggregation of impacts to multiple related economic sectors.

2.1 Impact Assessment Measures

A required component of the regional and state water plans is to estimate the potential economic impacts of shortages due to a drought of record. Consistent with previous water plans, several key variables were estimated and are described in Table 2-1.

Table 2-1 Socioeconomic Impact Analysis Measures

Regional Economic Impacts	Description
Income losses - value added	The value of output less the value of intermediate consumption; it is a measure of the contribution to GDP made by an individual producer, industry, sector, or group of sectors within a year. For a shortage, value added is a measure of the income losses to the region, county, or WUG and includes the direct, indirect and induced monetary impacts on the region.
Income losses - electrical power purchase costs	Proxy for income loss in the form of additional costs of power as a result of impacts of water shortages.
Job losses	Number of part-time and full-time jobs lost due to the shortage.
Financial Transfer Impacts	**Description**
Tax losses on production and imports	Sales and excise taxes (not collected due to the shortage), customs duties, property taxes, motor vehicle licenses, severance taxes, other taxes, and special assessments less subsidies.
Water trucking costs	Estimate for shipping potable water.
Utility revenue losses	Foregone utility income due to not selling as much water.
Utility tax revenue losses	Foregone miscellaneous gross receipts tax collections.
Social Impacts	**Description**
Consumer surplus losses	A welfare measure of the lost value to consumers accompanying less water use.
Population losses	Population losses accompanying job losses.
School enrollment losses	School enrollment losses (K-12) accompanying job losses.

2.1.1 Regional Economic Impacts

Two key measures were included within the regional economic impacts classification: income losses and job losses. Income losses presented consist of the sum of value added losses and additional purchase costs of electrical power. Job losses are also presented as a primary economic impact measure.

Income Losses - Value Added Losses

Value added is the value of total output less the value of the intermediate inputs also used in production of the final product. Value added is similar to Gross Domestic Product (GDP), a familiar measure of the productivity of an economy. The loss of value added due to water shortages was estimated by input-output analysis using the IMPLAN software package, and includes the direct, indirect, and induced monetary impacts on the region.

Income Losses - Electric Power Purchase Costs

The electrical power grid and market within the state is a complex interconnected system. The industry response to water shortages, and the resulting impact on the region, are not easily modeled using traditional input/output impact analysis and the IMPLAN model. Adverse impacts on the region will occur, and were represented in this analysis by the additional costs associated with power purchases from other generating plants within the region or state. Consequently, the analysis employed additional power purchase costs as a proxy for the value added impacts for that water use category, and these are included as a portion of the overall income impact for completeness.

For the purpose of this analysis, it was assumed that power companies with insufficient water will be forced to purchase power on the electrical market at a projected higher rate of 5.60 cents per kilowatt hour. This rate is based upon the average day-ahead market purchase price of electricity in Texas from the recent drought period in 2011.

Job Losses

The number of jobs lost due to the economic impact was estimated using IMPLAN output associated with the water use categories noted in Table 1-1. Because of the difficulty in predicting outcomes and a lack of relevant data, job loss estimates were not calculated for the steam-electric power production or for certain municipal water use categories.

2.1.2 Financial Transfer Impacts

Several of the impact measures estimated within the analysis are presented as supplemental information, providing additional detail concerning potential impacts on a sub-portion of the economy or government. Measures included in this category include lost tax collections (on production and imports), trucking costs for imported water, declines in utility revenues, and declines in utility tax revenue collected by the state. Many of these measures are not solely adverse, with some having both positive and negative impacts. For example, cities and residents would suffer if forced to pay large costs for trucking in potable water. Trucking firms, conversely, would benefit from the transaction. Additional detail for each of these measures follows.

Tax Losses on Production and Imports

Reduced production of goods and services accompanying water shortages adversely impacts the collection of taxes by state and local government. The regional IMPLAN model was used to estimate reduced tax collections associated with the reduced output in the economy.

Water Trucking Costs

In instances where water shortages for a municipal water user group were estimated to be 80 percent or more of water demands, it was assumed that water would be trucked in to support basic consumption and sanitation needs. For water shortages of 80 percent or greater, a fixed cost of $20,000 per acre-foot of water was calculated and presented as an economic cost. This water trucking cost was applied for both the residential and non-residential portions of municipal water needs and only impacted a small number of WUGs statewide.

Utility Revenue Losses

Lost utility income was calculated as the price of water service multiplied by the quantity of water not sold during a drought shortage. Such estimates resulted from city-specific pricing data for both water and wastewater. These water rates were applied to the potential water shortage to determine estimates of lost utility revenue as water providers sold less water during the drought due to restricted supplies.

Utility Tax Losses

Foregone utility tax losses included estimates of uncollected miscellaneous gross receipts taxes. Reduced water sales reduce the amount of utility tax that would be collected by the State of Texas for water and wastewater service sales.

2.1.3 Social Impacts

Consumer Surplus Losses of Municipal Water Users

Consumer surplus loss is a measure of impact to the wellbeing of municipal water users when their water use is restricted. Consumer surplus is the difference between how much a consumer is willing and able to pay for the commodity (i.e., water) and how much they actually have to pay. The difference is a benefit to the consumer's wellbeing since they do not have to pay as much for the commodity as they would be willing to pay. However, consumer's access to that water may be limited, and the associated consumer surplus loss is an estimate of the equivalent monetary value of the negative impact to the consumer's wellbeing, for example, associated with a diminished quality of their landscape (i.e., outdoor use). Lost consumer surplus estimates for reduced outdoor and indoor use, as well as residential and commercial/institutional demands, were included in this analysis. Consumer surplus is an attempt to measure effects on wellbeing by monetizing those effects; therefore, these values should not be added to the other monetary impacts estimated in the analysis.

Lost consumer surplus estimates varied widely by location and type. For a 50 percent shortage, the estimated statewide consumer surplus values ranged from $55 to $2,500 per household (residential use), and from $270 to $17,400 per firm (non-residential).

Population and School Enrollment Losses

Population losses due to water shortages, as well as the related loss of school enrollment, were based upon the job loss estimates and upon a recent study of job layoffs and the resulting adjustment of the labor market, including the change in population.[1] The study utilized Bureau of Labor Statistics data regarding layoffs between 1996 and 2013, as well as Internal Revenue Service data regarding migration, to model an estimate of the change in the population as the result of a job layoff event. Layoffs impact both out-migration, as well as in-migration into an area, both of which can negatively affect the population of an area. In addition, the study found that a majority of those who did move following a layoff moved to another labor market rather than an adjacent county. Based on this study, a simplified ratio of job and net population loses was calculated for the state as a whole: for every 100 jobs lost, 18 people were assumed to move out of the area. School enrollment losses were estimated as a proportion of the population lost.

2.2 Analysis Context

The context of the economic impact analysis involves situations where there are physical shortages of surface or groundwater due to drought of record conditions. Anticipated shortages may be nonexistent in earlier decades of the planning horizon, yet population growth or greater industrial, agricultural or other sector demands in later decades may result in greater overall demand, exceeding the existing supplies. Estimated socioeconomic impacts measure what would happen if water user groups experience water shortages for a period of one year. Actual socioeconomic impacts would likely become larger as drought of record conditions persist for periods greater than a single year.

2.2.1 IMPLAN Model and Data

Input-Output analysis using the IMPLAN (Impact for Planning Analysis) software package was the primary means of estimating value added, jobs, and taxes. This analysis employed county and regional level models to determine key impacts. IMPLAN is an economic impact model, originally developed by the U.S. Forestry Service in the 1970's to model economic activity at varying geographic levels. The model is currently maintained by the Minnesota IMPLAN Group (MIG Inc.) which collects and sells county and state specific data and software. The year 2011 version of IMPLAN, employing data for all 254 Texas counties, was used to provide estimates of value added, jobs, and taxes on production for the economic sectors associated with the water user groups examined in the study. IMPLAN uses 440 sector-specific Industry Codes, and those that rely on water as a primary input were assigned to their relevant planning water user categories (manufacturing, mining, irrigation, etc.). Estimates of value added for a water use category were obtained by summing value added estimates across the relevant IMPLAN sectors

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[1] Foote, Andrew, Grosz, Michel, Stevens, Ann. "Locate Your Nearest Exit: Mass Layoffs and Local Labor Market Response." University of California, Davis. April 2015. http://paa2015.princeton.edu/uploads/150194

associated with that water use category. Similar calculations were performed for the job and tax losses on production and import impact estimates.

Note that the value added estimates, as well as the job and tax estimates from IMPLAN, include three components:

- *Direct effects* representing the initial change in the industry analyzed;
- *Indirect effects* that are changes in inter-industry transactions as supplying industries respond to reduced demands from the directly affected industries; and,
- *Induced effects* that reflect changes in local spending that result from reduced household income among employees in the directly and indirectly affected industry sectors.

2.2.2 Elasticity of Economic Impacts

The economic impact of a water need is based on the relative size of the water need to the water demand for each water user group (Figure 2-1). Smaller water shortages, for example, less than 5 percent, were anticipated to result in no initial negative economic impact because water users are assumed to have a certain amount of flexibility in dealing with small shortages. As a water shortage deepens, however, such flexibility lessens and results in actual and increasing economic losses, eventually reaching a representative maximum impact estimate per unit volume of water. To account for such ability to adjust, an elasticity adjustment function was used in estimating impacts for several of the measures. Figure 2-1 illustrates the general relationship for the adjustment functions. Negative impacts are assumed to begin accruing when the shortage percentage reaches the lower bound b1 (10 percent in Figure 2-1), with impacts then increasing linearly up to the 100 percent impact level (per unit volume) once the upper bound for adjustment reaches the b2 level shortage (50 percent in Figure 2-1 example).

Initially, the combined total value of the three value added components (direct, indirect, and induced) was calculated and then converted into a per acre-foot economic value based on historical TWDB water use estimates within each particular water use category. As an example, if the total, annual value added for livestock in the region was $2 million and the reported annual volume of water used in that industry was 10,000 acre-feet, the estimated economic value per acre-foot of water shortage would be $200 per acre-foot. Negative economic impacts of shortages were then estimated using this value as the maximum impact estimate ($200 per acre-foot in the example) applied to the anticipated shortage volume in acre-feet and adjusted by the economic impact elasticity function. This adjustment varied with the severity as percentage of water demand of the anticipated shortage. If one employed the sample elasticity function shown in Figure 2-1, a 30% shortage in the water use category would imply an economic impact estimate of 50% of the original $200 per acre-foot impact value (i.e., $100 per acre-foot).

Such adjustments were not required in estimating consumer surplus, nor for the estimates of utility revenue losses or utility tax losses. Estimates of lost consumer surplus relied on city-specific demand curves with the specific lost consumer surplus estimate calculated based on the relative percentage of the city's water shortage. Estimated changes in population as well as changes in school enrollment were indirectly related to the elasticity of job losses.

Assumed values for the bounds b1 and b2 varied with water use category under examination and are presented in Table 2-2.

Figure 2-1 Example Economic Impact Elasticity Function (as applied to a single water user's shortage)

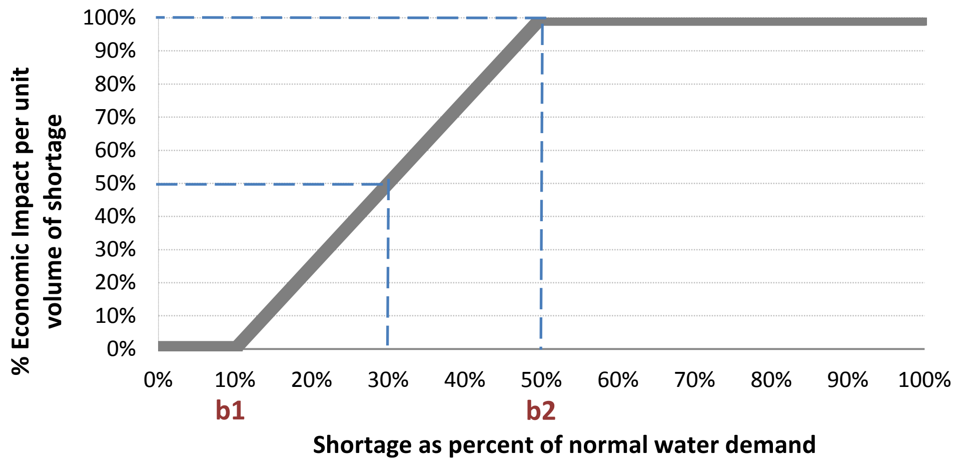

Table 2-2 Economic Impact Elasticity Function Lower and Upper Bounds

Water Use Category	Lower Bound (b1)	Upper Bound (b2)
Irrigation	**5%**	**50%**
Livestock	**5%**	**10%**
Manufacturing	**10%**	**50%**
Mining	**10%**	**50%**
Municipal (non-residential water intensive)	**50%**	**80%**
Steam-electric power	**20%**	**70%**

2.3 Analysis Assumptions and Limitations

Modeling of complex systems requires making assumptions and accepting limitations. This is particularly true when attempting to estimate a wide variety of economic impacts over a large geographic area and into future decades. Some of the key assumptions and limitations of the methodology include:

1. The foundation for estimating socioeconomic impacts of water shortages resulting from a drought are the water needs (potential shortages) that were identified as part of the regional water planning process. These needs have some uncertainty associated with them, but serve as a reasonable basis for evaluating potential economic impacts of a drought of record event.

2. All estimated socioeconomic impacts are snapshot estimates of impacts for years in which water needs were identified (i.e., 2020, 2030, 2040, 2050, 2060, and 2070). The estimates are independent and distinct "what if" scenarios for each particular year, and water shortages are assumed to be temporary events resulting from severe drought conditions. The evaluation assumed that no recommended water management strategies are implemented. In other words, growth occurs, future shocks are imposed on an economy at 10-year intervals, and the resulting impacts are estimated. Note that the estimates presented were not cumulative (i.e., summing up expected impacts from today up to the decade noted), but were simply an estimate of the magnitude of annual socioeconomic impacts should a drought of record occur in each particular decade based on anticipated supplies and demands for that same decade.

3. Input-output models such as IMPLAN rely on a static profile of the structure of the economy as it appears today. This presumes that the relative contributions of all sectors of the economy would remain the same, regardless of changes in technology, supplies of limited resources, and other structural changes to the economy that may occur into the future. This was a significant assumption and simplification considering the 50-year time period examined in this analysis. To presume an alternative future economic makeup, however, would entail positing many other major assumptions that would very likely generate as much or more error.

4. This analysis is not a cost-benefit analysis. That approach to evaluating the economic feasibility of a specific policy or project employs discounting future benefits and costs to their present value dollars using some assumed discount rate. The methodology employed in this effort to estimate the economic impacts of future water shortages did not use any discounting procedures to weigh future costs differently through time.

5. Monetary figures are reported in constant year 2013 dollars.

6. Impacts are annual estimates. The estimated economic model does not reflect the full extent of impacts that might occur as a result of persistent water shortages occurring over an extended duration. The drought of record in most regions of Texas lasted several years.

7. Value added estimates are the primary estimate of the economic impacts within this report. One may be tempted to add consumer surplus impacts to obtain an estimate of total adverse economic impacts to the region, but the consumer surplus measure represents the change to the wellbeing of households (and other water users), not an actual change in the flow of dollars through the economy. The two categories (value added and consumer surplus) are both valid impacts but should not be summed.

8. The value added, jobs, and taxes on production and import impacts include the direct, indirect and induced effects described in Section 2.2.1. Population and school enrollment losses also indirectly include such effects as they are based on the associated losses in employment. The remaining measures (consumer surplus, utility revenue, utility taxes, additional electrical power purchase costs, and potable water trucking costs), however, do not include any induced or indirect effects.

9. The majority of impacts estimated in this analysis may be considered smaller than those that might occur under drought of record conditions. Input-output models such as IMPLAN only capture "backward linkages" on suppliers (including households that supply labor to directly affected industries). While this is a common limitation in these types of economic impact modeling efforts, it is important to note that "forward linkages" on the industries that use the outputs of the directly affected industries can also be very important. A good example is impacts on livestock operators. Livestock producers tend to suffer substantially during droughts, not because there is not enough water for their stock, but because reductions in available pasture and higher prices for purchased hay have significant economic effects on their operations. Food processors could be in a similar situation if they cannot get the grains or other inputs that they need. These effects are not captured in IMPLAN, which is one reason why the impact estimates are likely conservative.

10. The methodology did not capture "spillover" effects between regions – or the secondary impacts that occur outside of the region where the water shortage is projected to occur.

11. The model did not reflect dynamic economic responses to water shortages as they might occur, nor does the model reflect economic impacts associated with a recovery from a drought of record including:
    a. The likely significant economic rebound to the landscaping industry immediately following a drought;
    b. The cost and years to rebuild liquidated livestock herds (a major capital item in that industry);
    c. Direct impacts on recreational sectors (i.e., stranded docks and reduced tourism); or,
    d. Impacts of negative publicity on Texas' ability to attract population and business in the event that it was not able to provide adequate water supplies for the existing economy.

12. Estimates for job losses and the associated population and school enrollment changes may exceed what would actually occur. In practice, firms may be hesitant to lay off employees, even in difficult economic times. Estimates of population and school enrollment changes are based on regional evaluations and therefore do not accurately reflect what might occur on a statewide basis.

13. The results must be interpreted carefully. It is the general and relative magnitudes of impacts as well as the changes of these impacts over time that should be the focus rather than the absolute numbers. Analyses of this type are much better at predicting relative percent differences brought about by a shock to a complex system (i.e., a water shortage) than the precise size of an impact. To illustrate, assuming that the estimated economic impacts of a drought of record on the manufacturing and mining water user categories are $2 and $1 million, respectively, one should be more confident that the economic impacts on manufacturing are twice as large as those on mining and that these impacts will likely be in the millions of dollars. But one should have less confidence that the actual total economic impact experienced would be $3 million.

3 Analysis Results

This section presents a breakdown of the results of the regional analysis for Region M. Projected economic impacts for six water use categories (irrigation, livestock. municipal, manufacturing, mining, and steam-electric power) are also reported by decade.

3.1 Overview of the Regional Economy

Table 3-1 presents the 2011 economic baseline as represented by the IMPLAN model and adjusted to 2013 dollars for Region M. In year 2011, Region M generated about $42 billion in gross state product associated with 667,000 jobs based on the 2011 IMPLAN data. These values represent an approximation of the current regional economy for a reference point.

Table 3-1 Region M Economy

Income ($ millions)*	Jobs	Taxes on production and imports ($ millions)*
$41,531	**667,281**	**$3,392**

[1]*Year 2013 dollars based on 2011 IMPLAN model value added estimates for the region.*

The remainder of Section 3 presents estimates of potential economic impacts for each water use category that could reasonably be expected in the event of water shortages associated with a drought of record and if no recommended water management strategies were implemented.

3.2 Impacts for Irrigation Water Shortages

All 8 counties in the region are projected to experience water shortages in the irrigated agriculture water use category for one or more decades within the planning horizon. Estimated impacts to this water use category appear in Table 3-2. Note that tax collection impacts were not estimated for this water use category. IMPLAN data indicates a negative tax impact (i.e., increased tax collections) for the associated production sectors, primarily due to past subsidies from the federal government. Two factors led to excluding any reported tax impacts: 1) Federal support (subsidies) has lessened greatly since the year 2011 IMPLAN data was collected, and 2) It was not considered realistic to report increasing tax revenue collections for a drought of record.

Table 3-2 Impacts of Water Shortages on Irrigation in Region

Impact Measure	2020	2030	2040	2050	2060	2070
Income losses ($ millions)*	$109	$101	$93	$82	$72	$72
Job losses	4,249	3,937	3,617	3,210	2,802	2,807

**** Year 2013 dollars, rounded. Entries denoted by a dash (-) indicate no economic impact. Entries denoted by a zero ($0) indicate income losses less than $500,000.***

3.3 Impacts for Livestock Water Shortages

None of the 8 counties in the region are projected to experience water shortages in the livestock water use category for one or more decades within the planning horizon. Estimated impacts to this water use category appear in Table 3-3. Note that tax impacts are not reported for this water use category for similar reasons that apply to the irrigation water use category described above.

Table 3-3 Impacts of Water Shortages on Livestock in Region

Impact Measures	2020	2030	2040	2050	2060	2070
Income losses ($ millions)*	-	-	-	-	-	-
Jobs losses	-	-	-	-	-	-

**** Year 2013 dollars, rounded. Entries denoted by a dash (-) indicate no economic impact. Entries denoted by a zero ($0) indicate income losses less than $500,000***

3.4 Impacts for Municipal Water Shortages

All 8 counties in the region are projected to experience water shortages in the municipal water use category for one or more decades within the planning horizon. Impact estimates were made for the two subtypes of use within municipal use: residential, and non-residential. The latter includes commercial and institutional users. Consumer surplus measures were made for both residential and non-residential demands. In addition, available data for the non-residential, water-intensive portion of municipal demand allowed use of IMPLAN and TWDB Water Use Survey data to estimate income loss, jobs, and taxes. Trucking cost estimates, calculated for shortages exceeding 80 percent, assumed a fixed cost of $20,000 per acre-foot to transport water for municipal use. The estimated impacts to this water use category appear in Table 3-4.

Table 3-4 Impacts of Water Shortages on Municipal Water Users in Region

Impact Measures	2020	2030	2040	2050	2060	2070
Income losses[1] ($ millions)*	$130	$198	$517	$1,121	$2,122	$3,335
Job losses[1]	2,545	3,882	10,134	21,988	41,616	65,394
Tax losses on production and imports[1] ($ millions)*	$12	$18	$48	$103	$195	$307
Consumer surplus losses ($ millions)*	$31	$55	$95	$160	$252	$376
Trucking costs ($ millions)*	-	$0	$0	$1	$0	$1
Utility revenue losses ($ millions)*	$89	$150	$224	$316	$372	$507
Utility tax revenue losses ($ millions)*	$1	$2	$4	$5	$6	$9

[1] Estimates apply to the water-intensive portion of non-residential municipal water use.
**** Year 2013 dollars, rounded. Entries denoted by a dash (-) indicate no economic impact. Entries denoted by a zero ($0) indicate income losses less than $500,000.***

3.5 Impacts of Manufacturing Water Shortages

Manufacturing water shortages in the region are projected to occur in 6 of the 8 counties in the region for at least one decade of the planning horizon. Estimated impacts to this water use category appear in Table 3-5.

Table 3-5 Impacts of Water Shortages on Manufacturing in Region

Impacts Measures	2020	2030	2040	2050	2060	2070
Income losses ($ millions)*	$161	$301	$478	$659	$929	$1,214
Job losses	1,922	3,711	5,996	8,331	11,839	15,612
Tax losses on production and Imports ($ millions)*	$12	$23	$36	$49	$69	$89

**** Year 2013 dollars, rounded. Entries denoted by a dash (-) indicate no economic impact. Entries denoted by a zero ($0) indicate income losses less than $500,000.***

3.6 Impacts of Mining Water Shortages

Mining water shortages in the region are projected to occur in 5 of the 8 counties in the region for at least one decade of the planning horizon. Estimated impacts to this water use type appear in Table 3-6.

Table 3-6 Impacts of Water Shortages on Mining in Region

Impact Measures	2020	2030	2040	2050	2060	2070
Income losses ($ millions)*	$531	$524	$575	$450	$329	$249
Job losses	3,318	3,308	3,643	2,897	2,177	1,717
Tax losses on production and Imports ($ millions)*	$77	$75	$83	$64	$46	$34

**** Year 2013 dollars, rounded. Entries denoted by a dash (-) indicate no economic impact. Entries denoted by a zero ($0) indicate income losses less than $500,000.***

3.7 Impacts of Steam-Electric Water Shortages

Steam-electric water shortages in the region are projected to occur in 3 of the 8 counties in the region for at least one decade of the planning horizon. Estimated impacts to this water use category appear in Table 3-7.

Note that estimated economic impacts to steam-electric water users:

- Are reflected as an income loss proxy in the form of the estimated additional purchasing costs for power from the electrical grid that could not be generated due to a shortage;
- Do not include estimates of impacts on jobs. Because of the unique conditions of power generators during drought conditions and lack of relevant data, it was assumed that the industry would retain, perhaps relocating or repurposing, their existing staff in order to manage their ongoing operations through a severe drought.
- Does not presume a decline in tax collections. Associated tax collections, in fact, would likely increase under drought conditions since, historically, the demand for electricity increases during times of drought, thereby increasing taxes collected on the additional sales of power.

Table 3-7 Impacts of Water Shortages on Steam-Electric Power in Region

Impact Measures	2020	2030	2040	2050	2060	2070
Income Losses ($ millions)*	$24	$44	$100	$190	$319	$489

**** Year 2013 dollars, rounded. Entries denoted by a dash (-) indicate no economic impact. Entries denoted by a zero ($0) indicate income losses less than $500,000.***

3.8 Regional Social Impacts

Projected changes in population, based upon several factors (household size, population, and job loss estimates), as well as the accompanying change in school enrollment, were also estimated and are summarized in Table 3-8.

Table 3-8 Region-wide Social Impacts of Water Shortages in Region

Impact Measures	2020	2030	2040	2050	2060	2070
Consumer surplus losses ($ millions)*	$31	$55	$95	$160	$252	$376
Population losses	2,209	2,724	4,295	6,688	10,728	15,703
School enrollment losses	409	504	795	1,237	1,985	2,905

**** Year 2013 dollars, rounded. Entries denoted by a dash (-) indicate no economic impact. Entries denoted by a zero ($0) indicate income losses less than $500,000.***

Appendix A - County Level Summary of Estimated Economic Impacts for Region M

County level summary of estimated economic impacts of not meeting identified water needs by water use category and decade (in 2013 dollars, rounded). Values presented only for counties with projected economic impacts for at least one decade.

**** Entries denoted by a dash (-) indicate no economic impact. Entries denoted by a zero ($0) indicate income losses less than $500,000***

		Income losses (Million $)*						Job losses						Consumer Surplus (Million $)*					
County	Water Use Category	2020	2030	2040	2050	2060	2070	2020	2030	2040	2050	2060	2070	2020	2030	2040	2050	2060	2070
CAMERON	IRRIGATION	$35	$32	$29	$25	$21	$21	1,324	1,214	1,105	934	769	773	-	-	-	-	-	-
CAMERON	MANUFACTURING	$25	$93	$189	$292	$452	$647	345	1,304	2,654	4,083	6,325	9,065	-	-	-	-	-	-
CAMERON	MUNICIPAL	$65	$89	$136	$198	$273	$356	1,284	1,736	2,667	3,889	5,349	6,989	$12	$16	$21	$31	$44	$65
CAMERON	STEAM ELECTRIC POWER	$24	$31	$39	$48	$60	$71	-	-	-	-	-	-	-	-	-	-	-	-
CAMERON Total		**$150**	**$245**	**$394**	**$563**	**$804**	**$1,096**	**2,952**	**4,254**	**6,425**	**8,906**	**12,443**	**16,827**	**$12**	**$16**	**$21**	**$31**	**$44**	**$65**
HIDALGO	IRRIGATION	$64	$59	$54	$48	$42	$42	2,541	2,351	2,145	1,910	1,666	1,669	-	-	-	-	-	-
HIDALGO	MANUFACTURING	$129	$200	$281	$358	$466	$554	1,494	2,318	3,246	4,145	5,398	6,414	-	-	-	-	-	-
HIDALGO	MINING	$14	$23	$29	$36	$44	$53	132	213	271	332	403	493	-	-	-	-	-	-
HIDALGO	MUNICIPAL	$0	$30	$284	$806	$1,716	$2,823	10	581	5,561	15,808	33,647	55,356	$6	$20	$49	$97	$170	$268
HIDALGO	STEAM ELECTRIC POWER	-	$13	$61	$141	$260	$418	-	-	-	-	-	-	-	-	-	-	-	-
HIDALGO Total		**$208**	**$325**	**$708**	**$1,390**	**$2,528**	**$3,890**	**4,177**	**5,463**	**11,223**	**22,195**	**41,114**	**63,931**	**$6**	**$20**	**$49**	**$97**	**$170**	**$268**
JIM HOGG	IRRIGATION	$0	$0	$0	$0	$0	$0	-	-	-	-	-	-	-	-	-	-	-	-
JIM HOGG	MUNICIPAL	-	-	-	-	-	-	-	-	-	-	-	-	-	$0	$0	$0	$0	$0
JIM HOGG Total		**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**$0**	**$0**	**$0**	**$0**	**$0**
MAVERICK	IRRIGATION	$0	$0	$0	$0	$0	$0	8	7	6	5	5	5	-	-	-	-	-	-
MAVERICK	MANUFACTURING	$7	$7	$8	$8	$9	$9	83	89	94	98	106	113	-	-	-	-	-	-
MAVERICK	MINING	$339	$499	$541	$407	$272	$175	2,094	3,085	3,346	2,513	1,684	1,081	-	-	-	-	-	-
MAVERICK	MUNICIPAL	-	-	-	-	-	-	-	-	-	-	-	-	-			$0	$0	$0
MAVERICK Total		**$346**	**$507**	**$549**	**$415**	**$281**	**$184**	**2,186**	**3,181**	**3,446**	**2,617**	**1,794**	**1,199**	**-**	**-**	**-**	**$0**	**$0**	**$0**
STARR	IRRIGATION	$0	$0	-	-	-	-	11	3	-	-	-	-	-	-	-	-	-	-
STARR	MANUFACTURING	-	-	$0	$0	$1	$1	-	-	-	2	3	6	-	-	-	-	-	-
STARR	MINING	-	$1	$4	$8	$13	$21	-	9	27	52	89	143	-	-	-	-	-	-
STARR	MUNICIPAL	$48	$59	$70	$84	$95	$104	943	1,150	1,379	1,646	1,856	2,036	$8	$11	$15	$20	$22	$24
STARR Total		**$48**	**$60**	**$74**	**$92**	**$108**	**$126**	**954**	**1,162**	**1,405**	**1,699**	**1,949**	**2,185**	**$8**	**$11**	**$15**	**$20**	**$22**	**$24**
WEBB	IRRIGATION	$0	$0	$0	$0	$0	$0	1	1	1	1	1	1	-	-	-	-	-	-
WEBB	MANUFACTURING	-	-	$0	$1	$2	$3	-	-	2	4	8	14	-	-	-	-	-	-
WEBB	MINING	$178	-	-	-	-	-	1,092	-	-	-	-	-	-	-	-	-	-	-

		Income losses (Million $)*						Job losses						Consumer Surplus (Million $)*					
County	Water Use Category	2020	2030	2040	2050	2060	2070	2020	2030	2040	2050	2060	2070	2020	2030	2040	2050	2060	2070
WEBB	MUNICIPAL	$15	$20	$23	$27	$31	$34	302	382	459	532	602	666	$6	$8	$9	$11	$13	$15
WEBB Total		**$193**	**$20**	**$24**	**$28**	**$32**	**$37**	**1,395**	**383**	**461**	**537**	**612**	**681**	**$6**	**$8**	**$9**	**$11**	**$13**	**$15**
WILLACY	IRRIGATION	$9	$9	$9	$9	$9	$9	362	361	360	359	361	359	-	-	-	-	-	-
WILLACY	MUNICIPAL	-	-	-	-	-	$2	-	-	-	-	-	38	$0	$0	$0	$0	$0	$0
WILLACY Total		**$9**	**$9**	**$9**	**$9**	**$9**	**$11**	**362**	**361**	**360**	**359**	**361**	**397**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
ZAPATA	IRRIGATION	$0	$0	$0	$0	$0	$0	1	1	-	-	-	-	-	-	-	-	-	-
ZAPATA	MUNICIPAL	$0	$2	$4	$6	$8	$16	6	33	69	113	161	309	$0	$0	$1	$1	$2	$3
ZAPATA Total		**$0**	**$2**	**$4**	**$6**	**$8**	**$16**	**8**	**34**	**69**	**113**	**161**	**309**	**$0**	**$0**	**$1**	**$1**	**$2**	**$3**
Regional Total		**$954**	**$1,168**	**$1,762**	**$2,502**	**$3,771**	**$5,359**	**12,034**	**14,838**	**23,391**	**36,426**	**58,434**	**85,529**	**$31**	**$55**	**$95**	**$160**	**$252**	**$376**