CHAPTER 3: PLANNING OBJECTIVE AND WATER MANAGEMENT STRATEGIES

I. Planning Constraints

A. Competition with Supply and Demand in Mexico

Seventy-eight percent of the watershed that feeds the Falcon and Amistad Reservoirs, which in turn supply the water for the study area, is in Mexico. Historically, Mexico has not always been able to meet its obligations under the governing Treaty due to drought and its own competing uses for tributary waters. Figure 3-1 shows the estimated volumes of water delivered to the United States from Mexico between 1988 and 2012, averaged over 5-year periods. The terms of the Treaty require a resetting of the 5-year monitoring period whenever the levels in the reservoirs reach conservation stage; therefore, not all of the lines represent 5-year periods. All lines that end below the diagonal red line represent 5-year periods in which Treaty obligations were not met. Some periods are less than 1 year, particularly following heavy rains.

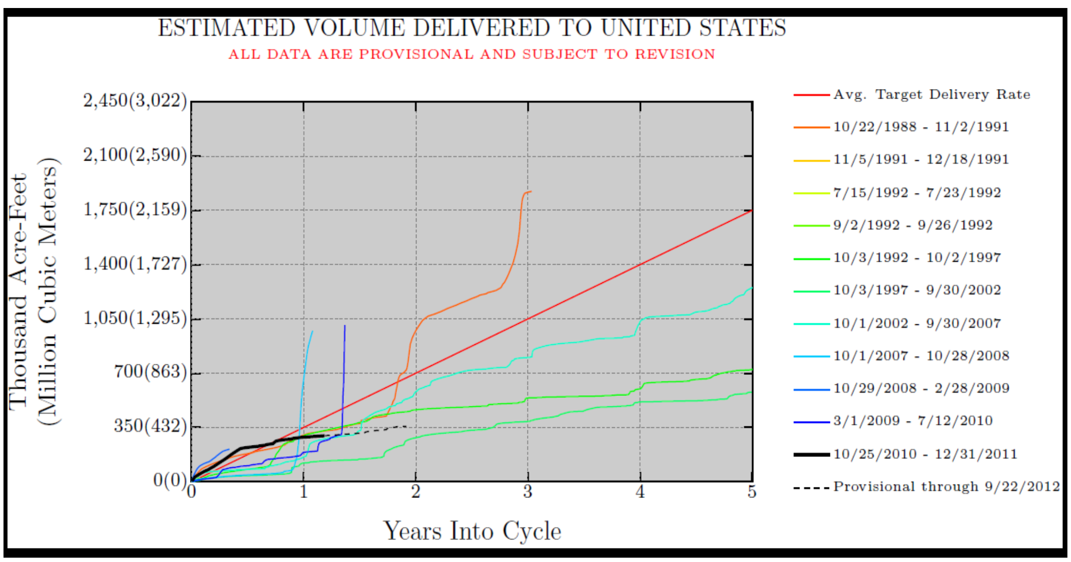

Figure 3-1: Volume of water delivered to the United States under the International Boundary Agreement.
Source: International Boundary and Water Commission.

Conclusion: The reliability of the Rio Grande to meet future needs in the study area is severely compromised by a growing gap between demand and availability and the potential for diminishing supplies due to climate change and competing use from Mexico.

B. Groundwater Supplies

Fresh groundwater supplies are severely limited by the fact that approximately 80% of the wells in the study area yield only brackish supplies according to the Region M Plan. That means that of the 176,355 ac-ft/yr of managed available groundwater (sustainable yield) designated by the study area's Groundwater Management District, about 141,084 acre-feet are brackish.[30]

Recent indicators show that water use for fracking in the study area has increased tenfold over current Region M Plan estimates (42,000 ac-ft/yr compared to 4,200 ac-ft/yr).[31] Supplies for fracking come from some river diversions, but are more dependent on groundwater, primarily fresh groundwater. Although such usage may wane by 2030 when the current oil development boom in the northern portions of the study area may cease, groundwater recharge in the study area is insignificant, and the demand for fracking water is expected to affect fresh groundwater supplies throughout the planning horizon. An assessment of the usage and long term effects of fracking demand is complicated by the fact that water use of oil and gas development is exempt from Texas groundwater regulation.[32]

Conclusion: Brackish groundwater supplies are four times (80 versus 20%) more plentiful than fresh groundwater supplies and have much fewer competing demands.

C. Temporal Aspects

The study area's warm climate provides for a year-round growing season. In addition, M&I demand (which includes landscape watering and residential/ commercial uses) varies little year round. Because the demands are constant, irrigation districts that serve agricultural, municipal, and industrial demand report

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[30] 2011 Region M Plan, Chapter 4, Section 4.5.7.1 Strategy Description. The section states that about 80% of the 822 wells contain TDS that exceeds 1,000 mg/L. The volume of brackish water is not known, but it is assumed to be 80% of the available groundwater.

[31] This trend has been noted by the TCEQ Watermaster at Region M and RGRWA board meetings.

[32] Under Texas Water Code §36.117, production or injection wells drilled for oil and gas are exempted from regulation.

difficulty diverting water flows in order to perform both maintenance and system improvements. Since demand for the Rio Grande waters exceeds supply year round, there is no season when the supply balance will not need amelioration.

The planning horizon for this Basin Study is through the year 2060. While assessments of supply imbalance are based on the planning horizon, imbalances already exist and are expected to worsen between now and 2060.

Conclusion: The planning objective should require a solution that provides a year-round source of water that provides for solution(s) as soon as they can be practically available, but with a goal of being operational and feasible throughout the planning horizon.

D. Locational Aspects

The largest municipal, manufacturing, and mining users are further down river in Hidalgo and Cameron Counties and upriver in Webb County (figure 3-2). The majority of the demand in Webb County was from the city of Laredo, which is not an RGRWA member, and they have opted out of this study. There are over 100 miles and two other counties between Webb County and the nearest of the three counties specified by RGRWA. Demand from these users is expected to grow rapidly during the planning horizon, while demand from the agricultural group is expected to decline due to projected urbanization (table 3-1).

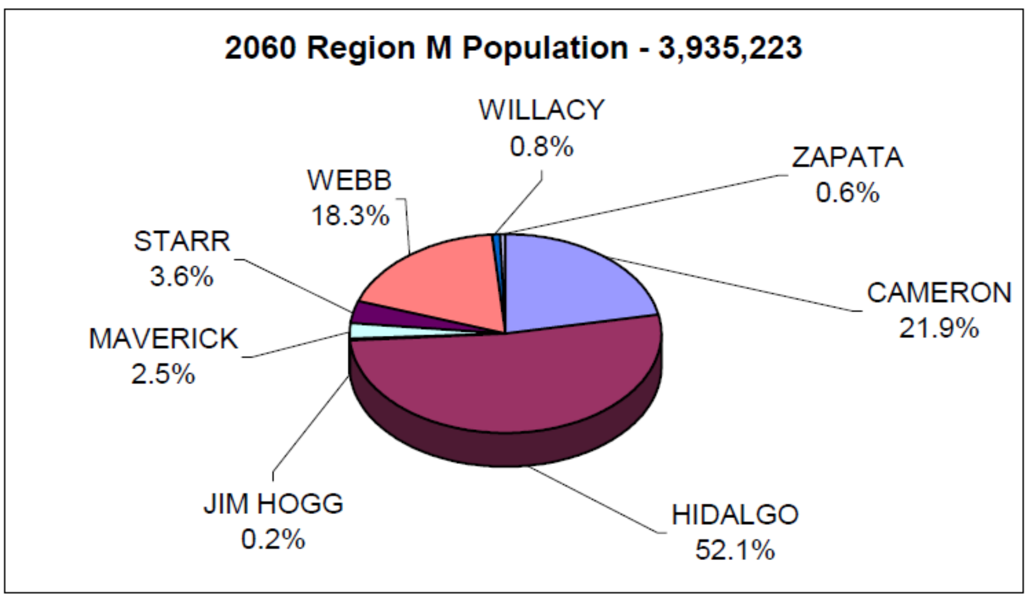

Figure 3-2: 2060 projected Region M population by county.

Table 3-1: Municipal, livestock, steam-electric, and manufacturing demand distribution among Region M counties

County	Domestic, municipal, and industrial demand (ac-ft/yr)					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Cameron	97,772	116,386	135,962	155,561	175,228	194,212
Hidalgo	133,510	168,469	205,661	246,179	290,700	337,115
Jim Hogg	1,421	1,484	1,534	1,574	1,562	1,523
Maverick	9,965	11,399	12,771	13,987	15,121	16,072
Starr	14,913	17,555	20,291	23,060	25,807	28,457
Webb, not including Laredo	6,537	7,346	8,792	10,404	12,196	14,141
Willacy	3,610	3,913	4,191	4,418	4,576	4,658
Zapata	2,777	3,077	3,377	3,660	3,915	4,104
Total	**270,505**	**329,629**	**392,579**	**458,843**	**529,105**	**600,282**

Source: TWDB State Water Plan 2012.

Conclusion: The planning objective should require a solution that provides water supplies in one or more of the following counties: Cameron, Willacy and Hidalgo.

E. Quantitative Aspects

To be effective, the planning objective for this Basin Study should also define the minimum quantity of water to be supplied by the selected alternative(s). The WAM baseline and climate simulation showed the volumes that are likely to be delivered in a range of evaporation and flow scenarios, including a baseline for comparison. The volume reliabilities are expressed as percentages of each class of water right that would be delivered under that climate scenario. A comparison of the volume to be diverted under the baseline scenario, 1,466,696 acre-feet, and the volume that is predicted to be delivered under the median climate variability scenario, 1,380,258 acre-feet, indicates a difference of 86,438 acre-feet. It is proposed that this be an approximate minimum volume of water supplied by the selected strategy/strategies.

Conclusion: The projected difference between the baseline and median climate scenarios, approximately 86,438 acre-feet, will serve as a minimum of water to be supplied by the selected water management strategy (WMS).

Based on the above discussion, the following goals are recommended in formulating a planning objective:

- **Reduce dependency on the Rio Grande:** The overappropriation of Rio Grande water rights, climate variability-affected Rio Grande supply projections, anticipated decreased firm yield of its reservoirs, projected worsening supply imbalance, and increasing competing demand from Mexico result in the need for supply alternatives that reduce dependency on the Rio Grande.

- **Preserve existing water rights:** The overappropriation of current supplies and the primacy of DMI rights over agricultural rights are exacerbated by the interdependent relationship of irrigation "push water" needed to enable delivery. Furthermore, recognition of valid uses that contributes to the health and economic vitality of the study area result in a guiding principle against adoption of an alternative that would benefit one user group to the detriment of another user group.

- **Preserve downstream flows for irrigation/push water/environmental reasons:** While not a regulatory requirement, the preservation of downstream flows for environmental and other users is a worthwhile constraint in itself and especially valuable in an area prone to drought and possible reduced flows from climate change.

- **Contain actions that are within the reasonable control of study sponsors:** The strategies selected by members of this Basin Study must involve relatively low risk in terms of being within the discretion of study partners to implement. For example, although a Treaty is in place, past performance and jurisdictional barriers indicate that there is high risk in involving alternatives that call for operational changes in Mexico.

II. Planning Objective

Based on the findings, conclusions, and constraints described above, the following planning objective emerges that defines the parameters of *where, how measured, and for whom* alternative sources should be developed:

> Alleviate projected water supply imbalances in the study area by developing one or more alternatives in Cameron, Willacy, and Hidalgo Counties that will (1) provide a minimum of 86,438 acre-feet of water year round by 2060; (2) protect existing water rights; (3) be compatible with regulations, policies, and environmental law; and (4) contain actions that are within the reasonable control of study sponsors.

III. Water Management Strategies from the Region M Plan

The relationship is strong between the Region M Plan[33] and this Basin Study. The Regional Plan is the product of stakeholder vetted information compiled by subject matter experts. In addition, all previous chapters of this Basin Study have been vetted as technical memoranda through the Region M Planning Team at their public meetings. The 2010 Region M Plan, as endorsed by the State of Texas and incorporated into the State Water Plan, recommends a portfolio of WMSs to ameliorate supply imbalances in the study area (figure 3-3). Because the WMSs were formulated to address the future supply imbalances that are incorporated into this Basin Study, and have been previously subjected to rigorous analysis based on local capabilities, they represent an excellent starting point for meeting the third requirement of this Basin Study: development of appropriate adaptation and mitigation strategies to meet future water demands.

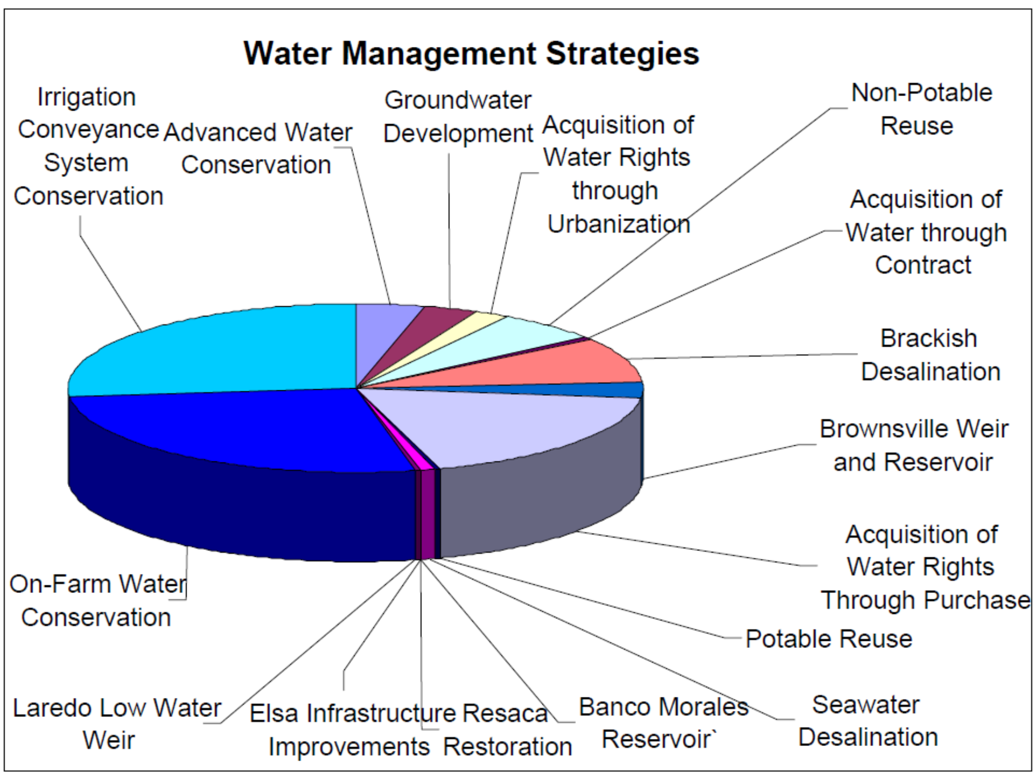

Figure 3-3: Region M Plan-recommended WMS potential supply contribution.

[33] The Texas State and Regional Planning Process is described in chapter 1, section A, subsection 1: "Local Planning Process."

These WMSs represent conservation efforts and capital projects addressing reuse, groundwater sources, and optimization of the surface water distribution system. The amount of water to be supplied by these WMSs, as estimated by the Region M Planning Group, was based on the shortfalls expected by each WUG associated with the WMS. These projected supplies are not incorporated into the WAM Model, and had no influence on the projected future water rights reliabilities.

The study is limited by scope and budget to investigate those strategies that specifically address the potential for climate change, which has been indicated by the study. Using the planning objective described in this technical memorandum, a selection of WMSs that meet those specific constraints have been investigated further in the study. One of the key constraints is that the selected WMS must reduce dependency on the Rio Grande. The growing need to develop alternative water sources within control of the study partners was expressed by RGRWA and confirmed by the study analysis.

Nevertheless, the most robust solution to the expected shortages in the study area will also include the continued development of the range of strategies recommended by Region M, many of which would increase the efficiency of the use of Rio Grande supplies. Together, the study may enable development of water sources independent of the Rio Grande, and the development of the other WMSs in the State Plan may provide more efficient use of Rio Grande supplies.

A. Evaluation Criteria

The WMSs that best meet the planning objective of the study are evaluated in the discussion below. Each major component of the planning objective has been matched to a major criterion of the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (P&Gs) (U.S. Water Resources Council, 1983), which govern the planning of all Federal water projects. Although the WMSs are not Federal projects, the policies established by these P&Gs are appropriate for use in this Basin Study. These criteria are:

- **Effectiveness:** The extent to which an alternative reliably meets the planning objective by alleviating a specified problem and achieving goals.

- **Acceptability:** The workability and viability of an alternative with respect to how compatible it is with authorities, regulations, policies, and environmental law.

- **Completeness:** The extent to which an alternative accounts for all necessary investments or other actions to ensure realization of goals.

- **Efficiency:** The extent to which an alternative is cost effective. We will introduce this criterion after the initial screening undertaken in this planning objective rationale and then determine how well the alternatives that meet the planning objective also meet the efficiency criterion.

The demonstrated future water supply imbalance that needs to be addressed, and the planning constraints that are specific to the study area, are addressed by the evaluation criterion in the following manner:

1. Effectiveness

Effectiveness measures the extent to which an alternative reliably meets the planning objective by alleviating a specified problem and achieving goals. Specifically, effectiveness was measured in terms of improving reliability by reducing dependency on the Rio Grande River. In addition, the temporal (year round) and locational (Cameron, Willacy, and Hidalgo Counties) aspects described above were considered.

2. Acceptability

Acceptability measures the workability and viability of an alternative with respect to how compatible it is with authorities, regulations, policies, and environmental law. Specifically, acceptability was measured in terms of protecting existing water rights and in meeting the planning objective to preserve downstream flow.

3. Completeness

Completeness measures the extent to which an alternative accounts for all necessary investments or other actions to ensure realization of goals. Completeness was measured in terms of implementation potential within the reasonable control of study sponsors.

B. Water Management Strategies

1. Role of Conservation

The State Water Plan contains two conservation-based WMSs for the study area: advanced water conservation and on-farm and irrigation water system conservation.

a. Advanced Water Conservation

Advanced water conservation methods were analyzed and evaluated by Region M based on the best management strategies developed by the Texas Water

Development Board Water Conservation Implementation Task Force. As defined in the Best Management Strategies Guide,[34] strategies for municipal water users included a residential clothes washer incentive program, school education, public information, landscape irrigation conservation and incentives, and water wise landscape design and conversion programs, among others.

After conversations with various municipal water users in the region, it was determined that the most feasible advanced conservation methods were public information, school education, and the installation of higher efficiency residential clothes washers.

- **Public information/school education**

  Advanced water conservation through public information and school education is both a short-term and long-term conservation measure. In the short term, individuals may realize the benefit of water conservation themselves, resulting in increased water savings. In the long term, the affected individual may encourage additional water conservation among peers and family alike. This strategy is especially effective when combined with other conservation measures.

- **Residential clothes washers**

  In 2001, the Unites States Department of Energy adopted a two-step phase-in of higher efficiency standards for residential clothes washers. In 2004, all clothes washers manufactured were required to be 20% more efficient than the previous standard. In 2007, all clothes washers manufactured were required to be 35% more efficient than the previous standard. Water conservation will be a direct result of increased efficiency.

  Because this WMS is dependent on the compliance of individual citizens, landowners, and commercial interests, and is not directly under the control of the Basin Study partners, this WMS would be better pursued through other opportunities as a component of a portfolio of strategies specifically targeted to alleviate the predicted supply imbalance in the study area. In fact, there are a number of Government-funded programs, such as Reclamation's WaterSMART Water and Energy Efficiency Grants, with the potential to implement conservation programs. In addition, conservation by municipal utilities are incorporated in the State-required water conservation plans of municipal water providers in Texas.[35]

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[34] Texas Water Development Board Water Conservation Implementation Task Force, Report 362, "Water Conservation Best Management Practices Guide." November 2004.

[35] http://www.twdb.texas.gov/conservation/municipal/plans/index.asp

b. On-farm and Irrigation System Water Conservation

On-farm water conservation offers a large potential to reduce the volume of water used for irrigation in agriculture. Technologies and methods currently available for on-farm water conservation include conversion to plastic pipe, low energy precision application, irrigation scheduling using an evapotranspiration network, drip irrigation, metering, unit pricing of water, use of water efficient crops, and other options.

The Irrigation Technology Center (ITC) of Texas A&M University was responsible for providing data for this WMS. The data were gathered by investigating both the effects of on-farm conservation in this region and the extent to which irrigation demands could be reduced through adoption of on-farm water conservation measures. These measures included farm-level water measurement and metering, replacement of field ditches canals with poly pipe, and adoption of improved water management practices and irrigation technologies. It should be noted that the investigation conducted by Texas A&M University provides documentation that 54% of agricultural water delivered within the region is measured or metered on a farm-level. Also, 36% of the agricultural water applied in the region is through poly or gated pipe, and 30% is applied using advanced water management practices and/or improved irrigation technology.

Water saving estimates were prepared for two scenarios: on-farm water savings without improvements to irrigation conveyance and distribution facilities and on-farm savings with such improvements. The amount of water that reaches the field turnout is partially dependent upon conveyance efficiency, which also influences the type of on-farm water conservation measures that can be applied.

According to the Texas Project for AgWater Efficiency,[36] as much as 80% of all agricultural conservation in the Lower Rio Grande area occurs within irrigation district conveyances. For example, insufficient "head" at the delivery point, also related to previous "push water" discussions in this Basin Study, can make it difficult to deliver irrigation water evenly over the span of a field no matter what irrigation methods or technologies are used. Approximately 50% of the area experiences insufficient head. Similarly, certain irrigation technologies, such as drip and microirrigation, require near continuous delivery of relatively small amounts of water. Most existing irrigation conveyance and distribution systems were designed to deliver large volumes of water over relatively short time periods.

Diminishing agricultural land use in the study area by 2060 could result in much smaller potential savings than projected by the Region M Plan. The region's annual demand for irrigation water is projected to decrease from 1,163,633 ac-ft/yr in 2010 to 981,749 ac-ft/yr in 2030 and then are projected to remain flat through 2060 (see table 3-1). This lower demand estimate arises

[36] http://texasawe.org/

primarily from the anticipated spreading urbanization, which is predicted to reduce irrigable acreage, primarily in Cameron and Hidalgo Counties, and other factors including costs, economics, and competition. Conversion of irrigation rights to municipal and domestic use also carries a reduction in the allocation amount according to water right class. Consequently, total water demand for irrigation in the region is projected to fall over time from the current 82.9% of the overall water demand to 59.1% by 2060. The conversion from irrigation to municipal use is one of the key factors driving the decline described above.

As noted in the Region M Plan, many of the related on-farm and irrigation system actions require legislative acts enabling funding or changes in past congressional funding obligations for which there has been a longstanding history of insufficient action. For example, the Lower Rio Grande Valley Water Resources Conservation and Improvement Act of 2000, as amended, authorized $55 million in Federal cost-sharing funds for water conservation improvement projects to be undertaken by irrigation districts in the study area. However, congressional appropriations of funds have virtually ceased, and although about $19.8 million in matching funds have been paid, about $4.7 million is currently owed to the districts, and a number of authorized projects remain yet to be accomplished.

This conservation-based WMS would also be better pursued through other opportunities; it is a vital component of a portfolio of strategies specifically targeted to alleviate the predicted supply imbalance in the study area. As is the case of the advanced water conservation WMSs, there are a number of Government-funded programs, such as Reclamation's WaterSMART Water and Energy Efficiency Grants, with the potential to implement conservation programs.

2. Strategies Receiving Further Evaluation

The following WMSs were evaluated according to the planning constraints as represented by three criteria: effectiveness, acceptability, and completeness.

a. Reuse

EFFECTIVENESS	Reuse is an effective way to utilize existing reliable supply streams of water and alleviate the supply imbalance.
ACCEPTABILITY	Protects downstream flows and water rights. Effluent from existing water treatment plants is not returned to the Rio Grande.
COMPLETENESS	This WMS is within the reasonable control of the study partners via existing financial, managerial, and engineering mechanisms.

Reuse can be divided into direct versus indirect and potable versus non-potable. As a WMS, reuse of reclaimed water provides a water supply benefit when reclaimed water is treated and reused rather than being disposed of.

Reuse depends on effluent, and the most likely source would be municipal treatment plants. Although the waters treated in these plants likely came from the Rio Grande, the water usage of municipalities is predicted to increase dramatically, and effluent as a source is thus considered very reliable. Reuse could transform effluent that is currently discharged to the Arroyo Colorado into a supplemental supply stream that could be returned to the Rio Grande. No reuse options that require dilution with Rio Grande waters are included in this discussion, but the selected indirect reuse strategies could use the Rio Grande as a conveyance for recycled water.

The climate-affected supply reliability analysis discussed in this Basin Study is based on WAM Run 3, which represents the full authorization simulation which assumes that all water users utilize their full maximum water rights authorization with no return flows. It is used by the State of Texas to evaluate applications for perpetual water rights and amendments and regional water planning supplies. The effluent from existing treatment plants is conveyed through the Arroyo Colorado and, thus, not an inflow to the Rio Grande. This simulation does not include any quantification of municipal return flows (water treatment plant effluent), which would require further investigation.

Direct potable reuse of reclaimed water refers to the intentional reuse of highly treated wastewater effluent as a source for potable uses (“toilet to tap”). While it is technically feasible to produce potable quality water from municipal wastewater effluent, direct potable reuse is just recently beginning to gain regulatory and public acceptance. This strategy will likely become more and more feasible over time both as the costs decrease and public and regulatory acceptance increase.

Non-potable direct reuse is defined as the application of wastewater effluent directly from the waste treatment plant to the point of use for non-potable purposes such as irrigation without co-mingling with State waters. This strategy requires a detailed assessment of the type and location of demands for non-potable water.[37] Users are categorized based on the level of treatment required for that application. This strategy is most likely to be successfully implemented by the end user, be it a municipality or industry, and not the best aligned with the scope of the study.

With indirect reuse, treated recycled water is returned to the environment and mixes with other waters for an extended period of time. The blended water may be diverted to a water treatment plant before it is distributed. The mixing and

[37] Type I and Type II reclaimed water categories are outlined in TCEQ §§210.33. Type I requires a higher standard of treatment; therefore, any Type I reclaimed water may also be utilized for any of the Type II uses. Specific quality standards for both reclaimed water categories are outlined in TCEQ §§210.33. The treatment required for each use is dependent on the initial effluent water quality, but typically primary effluent can only be used for Type II applications, and secondary effluent can only be used for both Type I and Type II applications. The cost of treatment is significantly higher for Type I water.

travel time provides several benefits: (1) sufficient time to ensure that the treatment system has performed as designed with no failures, (2) opportunity for additional treatment through natural processes such as sunlight and filtration through soil, and (3) increased public confidence that the water source is safe. Indirect reuse is currently practiced around the country and elsewhere in Texas where surface water supplies are deliberately augmented with treated wastewater effluent or reclaimed water.

b. Brackish Groundwater Desalination

EFFECTIVENESS	Reduces dependency on the Rio Grande by developing a new water source that can be located throughout the desired areas.
ACCEPTABILITY	Protects downstream flows and water rights. Existing brackish desalination plants in Texas and in the study area have demonstrated that they can be built within regulations, policies, and environmental law.
COMPLETENESS	This WMS is within the reasonable control of the study partners via existing financial, managerial, and engineering mechanisms.

Desalination of brackish groundwater is most commonly accomplished through reverse osmosis (RO). A full-scale RO system to treat brackish groundwater would require pretreatment, which would include a cartridge filtration system to remove minimal suspended solids. Acid and a silica scale inhibitor would also be added to prevent scale formation. A full-scale system would be expected to have a membrane life of approximately 5 years. Chemical cleaning of the membrane would be required approximately one to four times per year.

Concentrate from the RO system must be disposed of in an environmentally acceptable manner. Most of the current or proposed systems utilize drainage canal discharge, which ultimately will discharge into the Laguna Madre or the Gulf of Mexico. Other options include disposal to a sewer system and deep well injection.

c. Seawater Desalination

EFFECTIVENESS	Reduces dependency on the Rio Grande by developing a new, reliable water source.
ACCEPTABILITY	Protects downstream flows and water rights. Existing seawater desalination plants in the United States and a pilot project in Texas have demonstrated that they can be built within regulations, policies, and environmental law.
COMPLETENESS	This WMS is within the reasonable control of the study partners via existing financial, managerial, and engineering mechanisms.

There are several types of desalination methods to treat seawater. In addition to membrane technologies, methods include thermal processes such as multistage flash distillation, multiple-effect distillation, and vapor compression. These energy-intensive processes are more common in the Middle East where fuels are more abundant.

Membrane technologies are more prevalent today using RO. This process is also energy intensive when semipermeable membranes are used. For higher TDS found in seawater, high pressures are used to separate the seawater into fresh water and a concentrated byproduct. The RO process is the most common form of desalination of seawater. A typical pressure for seawater with 35,000 mg/L TDS could be in excess of 1,000 pounds per square inch (psi). That compares to less than 200 psi for 3,000 mg/L TDS groundwater. The higher TDS plants yield less than 50% of the water supplied. The remaining 50% is the concentrated byproduct. This compares to approximately 80% with the lower brackish water facilities. Surface water intakes will require additional pretreatment of suspended solids prior to the RO treatment.

d. Fresh Groundwater Development

EFFECTIVENESS	Reduces dependency on the Rio Grande by developing a new water source that can be located throughout the desired areas.
ACCEPTABILITY	Protects downstream flows and water rights. Existing well technology is proven. Can be built within regulations, policies, and environmental law.
COMPLETENESS	This WMS is within the reasonable control of the study partners via existing financial, managerial, and engineering mechanisms.

The Gulf Coast aquifer contains fresh and brackish groundwater. The southern Gulf Coast Groundwater Availability Model indicates that groundwater is available from the aquifer in this area. Well production estimates range from 0.29 to 0.86 MGD (200 to 600 gallons per minute). The quality of the groundwater is expected to meet most standards for public water supplies and requires minimal treatment. If required, the groundwater may be mixed with treated surface water to improve water quality.

About 80% of 822 wells contain TDS measurements that exceed 1,000 mg/L. The average for all of the results is 2,204 mg/L, and the median for all of the results is 1,618 mg/L. Based on the groundwater quality assessment completed for the Gulf Coast aquifer, it is expected that about 20% of the wells in Region M would contain fresh water and about 80% would contain brackish water. The GAM does not estimate the volume of brackish groundwater in storage.

Therefore, it is assumed that the 80% of the available groundwater supplies will be brackish (>1,000 mg/L TDS) and about 20% would be fresh water (<1,000 mg/L TDS).[38]

The amount of fresh groundwater available is directly in competition with use for fracking. Although availability may be lower than expected, the fact that it does not depend on the Rio Grande, and would potentially require less treatment than brackish groundwater or seawater, makes fresh groundwater worthy of further consideration.

3. Implications for International Cooperation

The Good Neighbor Environmental Board (GNEB) was created in 1992 by the Enterprise for the Americas Initiative Act, P.L. 102-532. The purpose of the board is to "advise the President and the Congress on the need for implementation of environmental and infrastructure projects (including projects that affect agriculture, rural development, and human nutrition) within the States of the United States contiguous to Mexico in order to improve the quality of life of persons residing on the United States side of the border." In its 8th report (2005), *Water Resources Management on the U.S.-Mexico Border*, the GNEB identified numerous challenges of working in international watersheds. As the 8th report noted, "Effective management of water resources is less than straightforward virtually everywhere, but in the U.S.-Mexico border region, it might be said that the task is particularly challenging. An arid climate, the presence of poverty, rapid population growth, aging infrastructure, an international border, and laws in both countries that were put into place in earlier times under different circumstances are just a few of the potential roadblocks."

Those challenges remained in 2012, when the 15th report recommended that Interior (including Reclamation), the USDA, the U.S. section of the IBWC, and the United States Environmental Protection Agency (EPA) continue to take a cooperative binational approach to watershed level management. This specifically includes the IBWC continuing to lead discussions with Mexico on finding common areas for the sustainable management of shared water resources, including protection of the quality of life and the environment in both countries. The IBWC has been a regular attendee and participant at the regularly scheduled Basin Study presentations at meetings of the RGRWA Board of Directors, which were held monthly during the first year of the study, and every other month since. In addition, the Basin Study Manager presented the project findings on supply, demand, and predicted climate change for the study area at a meeting of the IBWC on October 10, 2012.

[38] 2011 Region M Plan, Chapter 4, Section 4.5.7.1 Strategy Description.

As stated in *Climate Vulnerability and Adaptive Strategies Along the Rio Grande/ Rio Bravo Border of Mexico and the United States,*[39] and also as found by this Basin Study, decreasing runoff and streamflow in Mexico's arid north bordering the Rio Grande threaten not only Mexican irrigation and food production but also Treaty-obligated deliveries to the Rio Grande. We believe that the portfolio of solutions offered by this Basin Study are good examples of proactive climate change adaptation strategies that also meet the international cooperation goals established by the GNEB. Developing solutions that are not dependent on the Rio Grande as a water source not only make sense for the study area in meeting the planning objective, they also alleviate future competition for waters that are largely sourced from Mexico and are vulnerable in terms of both climate change and increased demand from both sides of the river.

C. Evaluation Outcome

The goal of this study is to find a WMS that will best address the needs in the study area. The increasing demand from DMI users, which demand high reliability, can be best met by sources that are less impacted by a variable climate. The results of this study incorporating comprehensive hydrological, water rights, and climate modeling lend credence to the RGRWA's stated desires to find supply solutions that are not dependent on the Rio Grande.

Finally, it is worthy of reiteration that the most robust solution to the expected shortages in the study area will also include the continued development of the range of strategies recommended by Region M, many of which would increase the efficiency of the use of Rio Grande supplies when implemented by WUGS and government entities at all levels.

[39] Hurd, Brian. Universities Council on Water Resources, Journal of Contemporary Water Research & Education, Issue 149. December 2012.