FINAL REPORT

Study No. 1

Evaluation of Alternate Water Supply Management Strategies Regarding the Use and Classification of Existing Water Rights on the Lower and Middle Rio Grande

Rio Grande Regional Water Planning Study
1st Phase, 3rd Round of Regional Planning

August 28, 2009

prepared for

Rio Grande Regional Planning Group

prepared by

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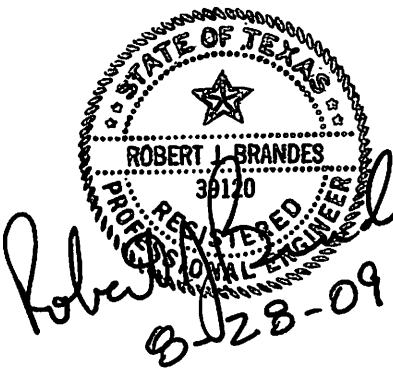

Executive Summary

This study has been undertaken by TRC/Brandes as a subcontractor to NRS Consulting Engineers, the primary consultant to the Rio Grande Regional Planning Group for development and preparation of the Rio Grande Regional Water Plan. This work is part of the first phase of the third round of Regional Water Planning that is administered and conducted by the Texas Water Development Board pursuant to authorization in Senate Bill 1 as passed by the 75th Texas Legislature in 1997.

The primary purpose of this study was to investigate the potential implications of using different methods or procedures in the future for managing and using water rights on the Lower and Middle Rio Grande that are dependent on Amistad and Falcon Reservoirs for their supply. These implications relate primarily to changes in the available water supply from Amistad and Falcon Reservoirs for the different types of water users and uses that might occur as a result of implementing different water management and allocation strategies as may be considered by the Rio Grande Regional Planning Group (RPG).

The Rio Grande Water Availability Model (WAM) developed by the Texas Commission on Environmental Quality (TCEQ) was used extensively in this study to evaluate the effects of potential changes in various aspects of the existing Rio Grande Operating Rules. Specifically, simulations and analyses have been undertaken to investigate the impacts on water availability and the reliability of Amistad-Falcon water supplies of different assumptions regarding changes in future demands from irrigation to all municipal use, modifications to storage allocations in Amistad and Falcon Reservoirs for irrigation and mining water rights and for the domestic-municipal-industrial (DMI) reserve, classifying all municipal water rights the same as Class A irrigation and mining rights with similar water allocation procedures, and modifications to the accounting procedures used by the International Boundary and Water Commission (IBWC) for allotting flows in the Rio Grande at Fort Quitman between the Untied States and Mexico.

Significant findings and recommendations of this study include the following:

- The 2010 firm annual yield of the Amistad-Falcon reservoir system for the United States (Texas water rights) with all water used for municipal purposes is 1,131,500 acre-feet/year, an increase of almost 120,000 acre-feet/year over the Unites States' share of the yield of the reservoir system with the current mix of municipal, industrial, irrigation, mining and other uses under current operating procedures for the Lower and Middle Rio Grande water rights.
- Based on the United States' share of the estimated firm yield of the Amistad-Falcon reservoir system, the projected municipal demands over the next 50 years along the Lower and Middle Rio Grande as presented in the 2006 Rio Grande Regional Plan (about 626,000 acre-feet/year in 2060) can be fully satisfied by converting irrigation/mining water rights to municipal use.

- The historical hydrologic data set incorporated in the TCEQ's current version of the Rio Grande WAM extends from 1940 through 2000, which ends in the middle of what appears to be the critical drought of record for the Lower and Middle Rio Grande; the hydrologic inputs to the WAM should be extended at least through 2005 in order to be able to simulate and analyze the entire 1990s-2000s critical drought period and the associated extreme low-flow conditions when evaluating water availability.
- Modifications to TCEQ's existing Rio Grande Operating Rules regarding storage limits in Amistad and Falcon Reservoirs for irrigation and mining water rights and for the DMI reserve does not result in any appreciable changes in the reliability of the water supply for these rights from the Amistad-Falcon reservoir system.
- Reclassification of all existing municipal water rights on the Lower and Middle Rio Grande to the same as Class A irrigation and mining rights with similar water allocation procedures does not result in any appreciable changes in the reliability of the water supply for these rights from the Amistad-Falcon reservoir system.
- Revising current IBWC water ownership accounting procedures to allot 100% of the flow in the Rio Grande at Fort Quitman to the United States (as stipulated in the 1906 Convention) instead of the 50/50 split with Mexico (as is the current IBWC practice purportedly in accordance with the provisions of the 1944 Treaty) would increase the United States' share of the firm yield of the Amistad-Falcon reservoir system from approximately 1,012,081 acre-feet/year to 1,028,631 acre-feet/year, or about 16,550 acre-feet/year (~1.6%), and this change in current procedures should be pursued.
- Results from the various WAM simulations and analyses performed in this study were discussed and examined by the Rio Grande RPG, and it was generally determined that further evaluations to investigate the implications of using different methods or procedures in the future for operating the Lower and Middle Rio Grande water supply system and Amistad and Falcon Reservoirs as potential water supply strategies in the context of regional water planning were not warranted at this time and should not be pursued.
- Based on the findings herein, it is recommended that further analyses not be undertaken as part of this study with regard to investigating the implications of using different methods or procedures in the future for operating the Lower and Middle Rio Grande water supply system and Amistad and Falcon Reservoirs as potential water supply strategies in the context of regional water planning.

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1.0 Purpose of Study

1.1 Purpose Statement

The primary purpose of this study was to investigate the potential implications of using different methods or procedures in the future for managing and using water rights on the Lower and Middle Rio Grande that are dependent on Amistad and Falcon Reservoirs for their supply as potential water supply strategies in the context of regional water planning that may be considered by the Rio Grande Regional Planning Group (RPG). These implications relate primarily to any changes in the available water supply from Amistad and Falcon Reservoirs for the different types of water users and uses that might occur as a result of implementing such changes in current methods or procedures.

1.2 Rio Grande Water Rights

Water rights on the Rio Grande that are dependent upon Falcon and Amistad Reservoirs for their supply are unique in Texas because of the manner in which they are allocated water under the State's rules, particularly during dry periods. Rather than being subject to the prior appropriation doctrine like all other water rights in Texas whereby allocations of available supplies are based on the relative dates when individual water rights were issued or recognized by the State ("first in time, first in right"), the Lower and Middle Rio Grande water rights are allocated water based on their designated type of use and their authorized annual diversion amount. This class-based system of water rights originated on the Lower Rio Grande below Falcon Reservoir with the decision of the Thirteenth Court of Civil Appeals in the 1969 landmark case styled "State of Texas, et al. vs. Hidalgo County Water Control and Improvement District No. 18, et al.", which is commonly referred to as the Valley Water Case.

Under the Court's decision, municipal water use, which includes use for domestic, industrial, manufacturing, and steam electric power generation purposes, was granted the highest water supply priority and was assured of a firm supply of stored water[1]. A weighted priority system was devised for allocating the remaining supply of stored water to irrigation (and mining) uses.[2] Two classes of irrigation and mining water rights (Class A and Class B) ultimately were established to reflect the nature of a water right claim as filed with the Court and the extent to which the historical usage under a particular water right could be documented and verified during the adjudication process. These two classes of irrigation and mining rights also served as the basis for differentiating the rates at which stored water was to be credited or allocated to individual reservoir storage accounts. Currently, Class A irrigation and mining rights are allocated water at a rate 1.7 times greater than the Class B irrigation and mining rights. Although this weighted priority system for irrigation and mining water users generally has little significance during years when water is abundant, its effect in water-short years is to distribute

[1] In this report, references to "Municipal" water rights or usage also include "Domestic", "Industrial", "Manufacturing", and "Steam Electric Power Generation" water rights or usage.

[2] In this report, references to "Irrigation" water rights or usage also include "Mining" water rights or usage.

the overall shortage among all irrigation and mining water users, with the Class B water rights experiencing the greater shortages.

In 1982, water rights in the Middle Rio Grande Basin; i.e., from Falcon Reservoir upstream to Amistad Reservoir, were adjudicated pursuant to Title 2, Subtitle B, Chapter 11, Subchapter G of the Texas Water Code. As a result of these proceedings, those water users located along the Middle Rio Grande that were dependent upon water stored in Amistad or Falcon Reservoirs were assigned water rights based on the same allocation and accounting principles established in the Valley Water Case. Water users located on tributaries within the Middle Rio Grande Basin were assigned water rights based on the prior appropriation doctrine, with priorities senior to those associated with the water rights dependent on Amistad and Falcon Reservoirs.

It should be noted that all water rights located in Texas within the Rio Grande Basin upstream of Amistad Reservoir (Upper Rio Grande Basin) are subject to the prior appropriation doctrine regardless of type of use. The authorized diversion amounts and priority dates for these upper basin water rights have been determined through adjudication proceedings conducted by the TCEQ and it predecessor agencies; all Upper Rio Grande water rights are senior in priority to those on the Lower and Middle Rio Grande. These upper basin water rights are not the subject of the studies reported herein.

1.3 Rio Grande Operating Rules

As a result of the Valley Water Case, rules have been adopted by the State's water agencies, now the Texas Commission on Environmental Quality (TCEQ), that regulate the operation of the Lower and Middle Rio Grande system and the allocation of water stored in Amistad and Falcon Reservoirs among all Texas users[3]. The rules applied by the TCEQ in administering mainstem water rights on the Lower and Middle Rio Grande affect not only the amount of water that can be diverted from the Rio Grande, but also the operation of the conservation pools in Amistad and Falcon Reservoirs. The current rules provide a reserve of 225,000 acre-feet of storage in Amistad and Falcon Reservoirs for domestic, municipal, and industrial uses, which is referred to as the "DMI reserve" or the "municipal pool". An operating reserve of 75,000 acre-feet also is established to provide for: (1) loss of water by seepage, evaporation and conveyance; (2) emergency requirements; and, (3) adjustments of amounts in storage, as may be necessary by finalization of provisional United States-Mexico water ownership computations made by the International Boundary and Water Commission (IBWC). Under certain conditions of low inflows to the reservoirs, the operating reserve can fall below 75,000 acre-feet, but it cannot be reduced to less than zero.

The TCEQ Rio Grande Watermaster administers the water allocations to municipal/domestic, industrial, agricultural and other user storage accounts for the combined United States storage in Amistad and Falcon Reservoirs. Such allocations are based on the United States' share of water considered to be "usable storage" in the combined reservoirs, as reported by the IBWC on the last Saturday of each month. Usable storage is defined as the total amount of United States water stored in the conservation pools of the reservoirs less dead storage, which currently is assumed

[3] "Chapter 303: Operation of the Rio Grande"; 31 Texas Administrative Code, §§ 303.1-303.93; Rules of the Texas Commission on Environmental Quality; October 26, 2006; Austin, Texas.

by the Rio Grande Watermaster to be 4,600 acre-feet. To determine the quantities of water to be allocated to the specified reserves and accounts each month, the following computations are made by the Watermaster:

1) From the amount of water in usable storage, 225,000 acre-feet are deducted to re-establish the reserve for domestic, municipal, and industrial uses, i.e., the DMI or municipal pool;
2) From the remaining storage, the total end-of-month account balances for all Lower and Middle Rio Grande irrigation and mining water rights (allottees) are deducted; and,
3) From the remaining storage, 75,000 acre-feet are deducted to establish the operating reserve for the system.

After the above computations are made, the remaining storage, if any, is allocated to the irrigation and mining accounts. The total allotment for irrigation and mining uses is divided into the Class A and Class B water rights categories. Class A rights receive 1.7 times as much water as that allotted to Class B rights. An irrigation allottee cannot accumulate in storage more than 1.41 times its annual authorized diversion right; this quantity is referred to in this study as the "Storage Factor". If an allottee does not beneficially use water for two consecutive years, its account is reduced to zero until such time as the allottee advises the Watermaster that water is again needed.

If there is not sufficient water in storage in Step 3 above to maintain the operating reserve at a level greater than zero, then the TCEQ rules authorize the Watermaster to make negative allocations of water (on a pro rata basis) from the irrigation and mining accounts containing water at the time in sufficient amounts to reestablish the operating reserve capacity to at least 48,000 acre-feet. When the operating reserve has been restored to 75,000 acre-feet as inflows continue to be stored in Amistad and Falcon Reservoirs, and sufficient water is available, all accounts from which water had been deducted through negative allocations are restored to the amount of water in each account prior to the negative allocation period, and any new allotments are made in accordance with the normal procedures described above.

An important aspect of the class-based water rights system for the Lower and Middle Rio Grande, and the subject of some of the analyses reported herein, is the manner in which water rights are converted from one type of use to another. Because the allocation procedures are different among the different types of water rights, i.e., among DMI, Class A irrigation and Class B irrigation rights, there are specific rules in place that adjust or modify how much water can be used, or diverted, annually when one type of water right is converted to another type. With expanded urbanization and development throughout the Lower and Middle Rio Grande Basins and with the population in these areas rapidly growing, the demand for municipal water is steadily increasing; hence, the typical conversion of existing water rights is from either Class A or Class B irrigation use to municipal use.

Under current TCEQ rules, when a Class A irrigation (or mining) water right is converted to municipal use, the authorized annual diversion amount of the right, expressed in acre-feet/year, is reduced to one-half (0.5) of the amount originally authorized to be used for irrigation. Similarly,

when a Class B irrigation (or mining) water right is converted to municipal use, the authorized annual diversion amount of the right is reduced to four-tenths (0.4) of the amount originally authorized to be used for irrigation. Once an irrigation or mining water right has been amended and converted to a municipal priority, the water right then is allocated stored water in accordance with the normal procedures used for all other municipal (DMI) water rights, i.e., the right assumes the highest priority for allocations.

1.4 Study Rationale

At issue with regard to the studies reported herein is whether the current water supply management rules and the associated water allocation procedures for the Lower and Middle Rio Grande are appropriate considering that 50 to 60 years from now a substantial portion of the water supply from Amistad and Falcon Reservoirs will be used for municipal purposes, rather than irrigation. It could be that alternative procedures for managing the overall reservoir system water supply and/or for allocating water to the different types of water rights may be more desirable from the standpoint of providing more reliable and equitable supplies of water from the reservoirs for all users. Such alternative procedures could represent water supply strategies that the Rio Grande Regional Planning Group may want to consider for recommendation to TCEQ as modifications to the current Rio Grande Operating Rules.

As of May 28, 2008, the total authorized annual diversions, expressed in acre-feet/year, for water rights on the Lower and Middle Rio Grande were distributed among the different types of water rights as indicated in the following table (Rio Grande Watermaster, 2008a):

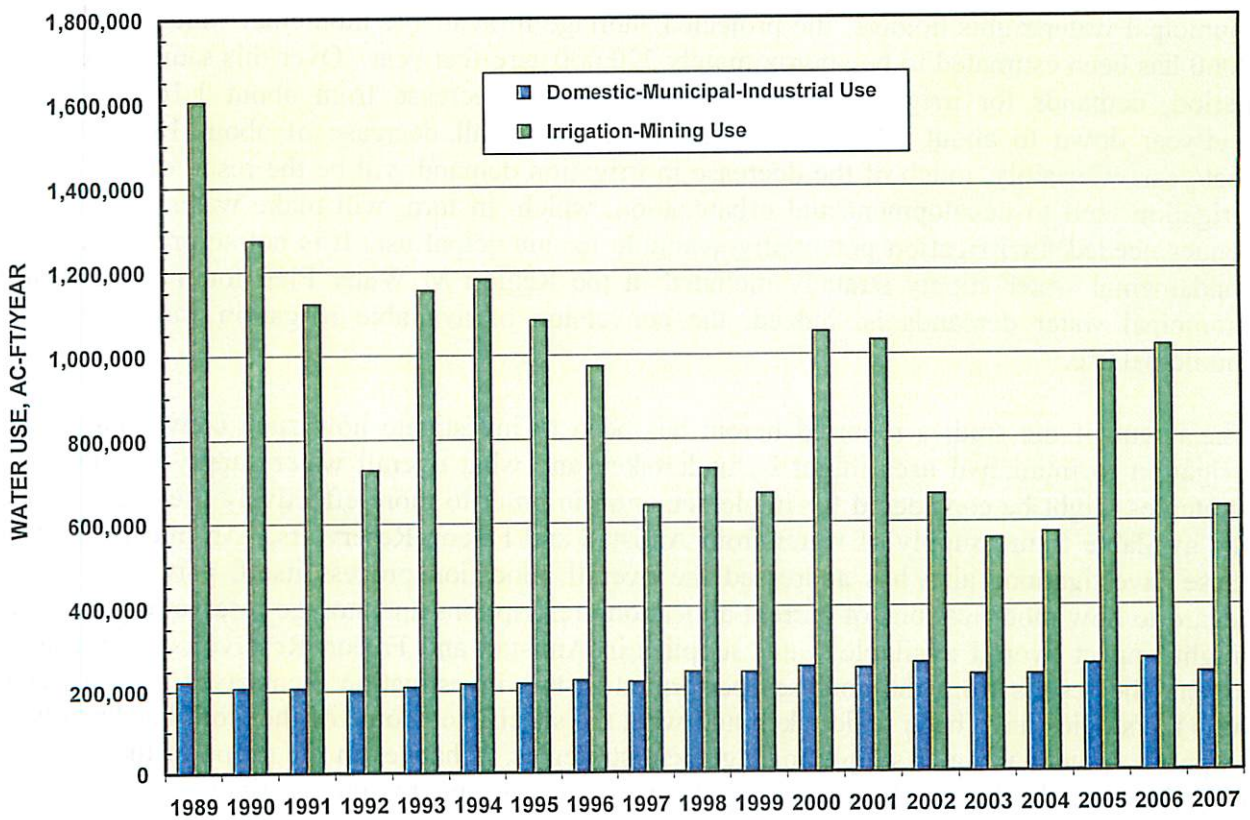
TABLE 1-1 AUTHORIZED ANNUAL DIVERSIONS FOR TEXAS WATER RIGHTS ON THE LOWER AND MIDDLE RIO GRANDE (Acre-Feet/Year)

Lower Rio Grande			1,876,237	88 %
Domestic-Municipal-Industrial Rights	244,149	13 %		
Class A Irrigation/Mining Rights	1,452,758	78 %		
Class B Irrigation/Mining Rights	161,459	9 %		
Middle Rio Grande			234,313	12 %
Domestic-Municipal-Industrial Rights	76,634	29 %		
Class A Irrigation/Mining Rights	162,152	62 %		
Class A Municipal Rights	2,145	1 %		
Class B Irrigation/Mining Rights	19,432	7 %		
Lower and Middle Rio Grande			2,118,729	100 %
Domestic-Municipal-Industrial Rights	320,783	15 %		
Class A Irrigation/Mining Rights	1,614,910	76 %		
Class A Municipal Rights	2,145	0.1 %		
Class B Irrigation/Mining Rights	180,891	9 %		

It is apparent that by far most of the existing water rights on the Lower and Middle Rio Grande are authorized for irrigation use (85%). As shown above, total annual diversions of approximately 1.8 million acre-feet are authorized for irrigation use. Considering that the current TCEQ Rio Grande Operating Rules limit the amount of water that each irrigation (and mining) water right can store in its account in Amistad and Falcon Reservoir to 1.41 times its annual diversion authorization, the total amount of water that can be stored in the reservoir by all esisting irrigation and mining water rights at any given time based on the above quantities is 2,532,079 acre-feet, i.e., 1.41 x 1,795,801 acre-feet.

Historical annual water use by domestic, municipal and industrial water rights and by irrigation and mining water rights from Amistad and Falcon Reservoirs over the period 1989 through 2007 is illustrated graphically in Figure 1-1 (Rio Grande Watermaster, 2008b). As shown, the combined use for DMI purposes has gradually risen over this 19-year period and currently is on the order of about 260,000 acre-feet/year. The average annual use for irrigation and mining during this period was approximately 940,000 acre-feet/year, and as noted, the annual usage has varied considerably primarily in response to seasonal and annual rainfall conditions and available storage in Amistad and Falcon Reservoirs. The maximum usage for irrigation and mining purposes was about 1.6 million acre-feet in 1989, and the lowest annual use reported was about 560,000 acre-feet in 2003.

FIGURE 1-1 HISTORICAL WATER USE BY LOWER AND MIDDLE RIO GRANDE WATER RIGHTS



These historical use quantities indicate that considerably less water has been used for irrigation and mining purposes than is authorized for use under existing water rights (1,795,801 acre-feet/year as per Table 1-1), and they could be interpreted to suggest that there are more authorized diversions for irrigation and mining use than are actually needed. This is not necessarily the case because of the procedures that are used to allocate excess stored water in Amistad and Falcon Reservoirs to the irrigation and mining accounts at the end of each month and the limit on the amount of water each account can store in Amistad and Falcon Reservoirs. Since the allocations are made on a pro rata basis in proportion to the annual authorized diversion amounts for all of the irrigation water rights, having more annual diversion authorized under a particular water right than what actually may be used for irrigation in a given year provides for a more reliable water supply year in and year out. This is not to say, however, that occasionally there are irrigation water rights, or portions of irrigation water rights, that are deemed by the owners to not be needed or usable in the future. These are the water rights, of course, that are potentially available for acquisition and use by municipal users as their demands for water grow in response to increasing population and urban development. Such acquired irrigation rights must first be amended by the State (TCEQ) to convert their authorized type of use from irrigation to municipal use.

Based on the 2006 Region M Water Plan (Rio Grande Regional Water Planning Group, 2005), total municipal water demands for the entire eight-county region are projected to increase from about 280,000 acre-feet/year in 2010 to about 626,000 acre-feet/year in 2060, an overall increase of about 346,000 acre-feet/year. Taking into account existing surplus supplies among some municipal water rights holders, the projected shortage in available municipal water supplies by 2060 has been estimated to be approximately 320,000 acre-feet/year. Over this same 2010-2060 period, demands for irrigation water are projected to decrease from about 1,164,000 acre-feet/year down to about 982,000 acre-feet/year, an overall decrease of about 182,000 acre-feet/year. Certainly, much of the decrease in irrigation demand will be the result of the loss of irrigation land to development and urbanization, which, in turn, will make water which is no longer needed for irrigation potentially available for municipal use. It is not surprising that the fundamental water supply strategy included in the Region M Water Plan for meeting future municipal water demands is, indeed, the conversion of available irrigation water rights to municipal use.

The intent of the studies reported herein has been to investigate how such conversions from irrigation to municipal uses might be undertaken and what overall water supply management strategies might be considered for implementation in order to more effectively use and enhance the available future supply of water from Amistad and Falcon Reservoirs. An integral part of these investigations also has addressed the overall allocation process itself, particularly with regard to how modifications of current allocation prescriptions and storage reserve requirements might impact overall available water supplies in Amistad and Falcon Reservoirs. To a large extent, the results from the analyses performed in this investigation themselves have dictated how the studies have been undertaken and what the specific outcome of the work has been with respect to potential water supply management strategies. Changes in the scope of the analyses have been made during the course of the work to respond to interim findings, and results presented in this report reflect these scope modifications.

2.0 Methodology

The approach taken for performing the analyses of the potential implications of using different methods or procedures in the future for managing and using water rights on the Lower and Middle Rio Grande has focused on application of the existing WAM for the Rio Grande Basin, appropriately modified to represent desired changes in the allocation and management procedures used for water rights and reservoir and basin operations.

2.1 Rio Grande WAM

For a specified sequence of monthly hydrologic and climatic conditions, the Rio Grande WAM simulates the allocation of prescribed amounts of water within the basin to water users and water rights holders in Texas and Mexico. Allocations to individual Texas water rights, i.e. for diversion and/or storage, are subject to either the class-based system for Amistad-Falcon rights or the prior appropriation doctrine as it is applied for water rights upstream of Amistad Reservoir and on downstream tributaries. A modified system of priority dates is used in the model to implement international treaty obligations for assigning ownership of Rio Grande water between the United States and Mexico, to represent the natural-priority system (whereby water is appropriated by upstream users first) used for allocating Mexican flows to water rights in Mexico, known as "concessions", and to reflect the class-based priority system and the prior appropriation doctrine used for apportioning water among Texas water rights

The Rio Grande WAM utilizes a network of control points with interconnected links to describe flow paths and the locations of inflows, diversion points, reservoirs, and return flows. Computations within the model are performed on a monthly basis using monthly time series values of specified flows, reservoir net evaporation rates, and water demands subject to prescribed water rights conditions and reservoir system operating rules. Results from the model include monthly diversion and storage amounts for each water right (Texas and Mexico) and remaining unappropriated water at selected locations throughout the basin. [4]

Monthly historical naturalized flows are used in the Rio Grande WAM as the hydrologic input for evaluating water availability. Naturalized flows represent historical streamflow conditions, including typical wet, dry, and normal flow periods, without the influence of man's historical activities as they relate to water rights and water use. In essence, naturalized flows exclude the effects of historical diversions, return flows, and reservoir storage and evaporation. For the Rio Grande WAM, the naturalized flow database covers the 61-year period from January 1940 through December 2000. This period includes the droughts of the 1950s and 1990s, both of which represent extreme drought conditions for most of the Rio Grande Basin.

Because all of the Rio Grande Basin below the New Mexico state line, including the Mexican portion of the basin, is included in the Rio Grande WAM, essential provisions of existing

[4] It should be noted that demands for Mexico that are included in the current version of the Rio Grande WAM have not been modified for purposes of this study. These demands for Mexico are described and quantified in the Rio Grande WAM report, which is referenced in Section 5.0 of this report.

international agreements between the United States and Mexico regarding the ownership of the water flowing in the Rio Grande are incorporated into the model. These agreements include the 1944 Treaty, which addresses the ownership of water downstream of Fort Quitman, Texas, and the 1906 Convention, which divides the water between the United States and Mexico above Fort Quitman. One of the most important aspects of this process involves the transfer of ownership of Mexican water from certain Mexican tributaries of the Rio Grande to the United States. This ownership transfer stems from a provision of the 1944 Treaty which states that one-third of the flow reaching the Rio Grande from Mexico through the Rio Conchos, Arroyo de las Vacas, Rio San Diego, Rio San Rodrigo, Rio Escondido, and Rio Salado must be transferred to United States ownership in the river. Consistent with current accounting procedures, this is accomplished in the WAM after all of Mexico's demands and reservoirs on these tributaries have been satisfied to the extent water is available. One-third of the remaining flow at the mouths of each of these six tributaries then is diverted and subsequently discharged as return flows to the United States segment of the river. Demands for water along the Rio Grande by both the United States and Mexican water users downstream of these Mexican tributaries then are simulated in the model based on each country's ownership of water flowing in the river. It is important to note that the 1944 Treaty provision requiring a minimum five-year average of 350,000 acre-feet/year to be delivered to the United States from the above six Mexican tributaries is not stipulated in the WAM because of uncertainties regarding how this provision is actually implemented and enforced in current practice. Consequently, in the WAM the only Mexican tributary water transferred to the United States is one-third of the flow of the six named tributaries after all upstream Mexican demands have been exercised, which can be less than a combined average of 350,000 acre-feet/year.

Another aspect of the international distribution of Rio Grande flows between the United States and Mexico relates to the equal split of the flows in the Rio Grande at Fort Quitman. It should be pointed out that the equal split of the Fort Quitman flows is the procedure currently employed by the International Boundary and Water Commission (IBWC) in its accounting of United States and Mexican ownership of water flowing in the Rio Grande. This procedure does not appear to be consistent, however, with language adopted by the 1906 Convention, which states that except for the delivery of Rio Grande Project water to Mexico at the Acequia Madre (Mexico's intake canal at Juarez), all water flowing in the Rio Grande above Fort Quitman is owned by the United States. This would suggest that the United States owns all of the river water passing Fort Quitman, but this is not how the current accounting is performed by IBWC. The implications of this interpretation have been evaluated as part of this study.

2.2 General Approach

The analyses undertaken pursuant to this study generally were accomplished through a systematic sequence of activities as listed below:

1) Acquisition and review of latest version of TCEQ Rio Grande WAM.

2) Identification of potential changes to Rio Grande Operating Rules or other aspects of the Rio Grande system as part of possible water management strategies.

3) Modification of the Rio Grande WAM to incorporate simplified representations of all Texas water rights on the Lower and Middle Rio Grande by sub-basin and by class of water use.

4) Modification of the Rio Grande WAM to represent potential changes to Rio Grande Operating Rules or other aspects of the Rio Grande system as possible water management strategies.

5) Evaluation of potential changes to Rio Grande Operating Rules or other aspects of the Rio Grande system as possible water management strategies using modified versions of the WAM.

6) Review and discussion of results from the WAM analyses with Region M representatives, Rio Grande water users, and other water interests, and identification of other analyses to be undertaken.

7) Evaluation of additional changes to Rio Grande Operating Rules or other aspects of the Rio Grande system as possible water management strategies using modified versions of the WAM.

8) Review and discussion of results with Region M representatives, Rio Grande water users, and other water interests, identification of other analyses to be undertaken, and description of possible changes to Rio Grande Operating Rules or other aspects of the Rio Grande system for consideration by the Rio Grande RPG as water management strategies.

During the course of the work, preliminary results from one or more of these activities formed the basis for proceeding with other analyses. Final results reflect a summary of the relevant findings from these analyses. All analyses were performed using variations of the TCEQ Rio Grande WAM, appropriately modified to incorporate simplified water rights representations in the model and to represent desired changes in allocation and management procedures used for water rights and reservoir and basin operations.

3.0 Study Results

Results from the analyses performed in this study are summarized and discussed by major activity in the following sections.

3.1 Rio Grande WAM Simplified Water Rights Representation

To simplify the modifications to the WAM that may be required to facilitate analyzing some of the potential changes in allocation and management procedures used for water rights and reservoir and basin operations, all of the individual Texas water rights included in the basic TCEQ Rio Grande WAM for the Lower and Middle Rio Grande were combined according to their various classes of use. This resulted in having only three individual water rights representing all of the domestic-municipal-industrial class, the Class A irrigation/mining class, and the Class B irrigation/mining class for the Lower Rio Grande and for the Middle Rio Grande, with the specified diversion amounts for each of these individual water rights equal to the sum of the annual diversion amounts for all of the water rights comprising each of the three different classes of rights. This simplification could be implemented because all water rights in a particular class are simulated in the WAM using the exact same procedure, with each individual water right being allocated its share of available water based on its annual authorized diversion amount as a proportional share of the total annual authorized diversion amount for all water rights in the use class. This modification to the WAM substantially reduced the time required to change the specified annual diversion amounts for all water rights on the Lower and Middle Rio Grande as required for some of the analyses.

Listed in the following table are the total annual diversion amounts, expressed in acre-feet/year, assigned to each of the combined water rights for the different use classes for water rights on the Lower and on the Middle Rio Grande as represented in the modified version of the TCEQ Rio Grande WAM used in this study. These combined total annual diversion amounts as used in the WAM are slightly different from those previously presented because they reflect authorized water rights conditions as of June 5, 2005, instead of May 28, 2008.

TABLE 3-1 AUTHORIZED ANNUAL DIVERSIONS FOR TEXAS WATER RIGHTS ON THE LOWER AND MIDDLE RIO GRANDE AS INCLUDED IN THE RIO GRANDE WAM

Lower Rio Grande	
Combined Domestic-Municipal-Industrial Right	247,046
Combined Class A Irrigation/Mining Right	1,463,044
Combined Class B Irrigation/Mining Right	166,147
Middle Rio Grande	
Combined Domestic-Municipal-Industrial Rights	62,430
Combined Class A Irrigation/Mining Rights	152,045
Combined Class B Irrigation/Mining Rights	17,693

3.2 *Preliminary WAM Analyses*

Preliminary analyses were made with the modified WAM to provide initial results for discussion with the Rio Grande RPG and other water interests. For these analyses, different assumptions were made with regard to water rights on the Lower and Middle Rio Grande, and varying types of results were produced. These WAM simulations are described and discussed in the following sections.

1) Using the simplified version of the TCEQ Rio Grande WAM as described above, the annual diversion amounts for all Texas water rights were assumed to be used only for municipal purposes (no irrigation or mining use), and the resulting firm yield of the Amistad-Falcon reservoir system for the United States was determined to be 1,131,500 acre-feet/year. With the annual diversion amounts for all current municipal water rights (as represented in the TCEQ Rio Grande WAM) set equal to their authorized amounts and the diversion amounts for the current irrigation/mining rights reduced as necessary to achieve a firm yield condition, the resulting firm yield of the Amistad-Falcon system was determined to be 1,012,081 acre-feet/year. Both of these WAM simulations produced a minimum storage of approximately 390,000 acre-feet in the reservoirs during the critical drought period, reflecting somewhat the maintenance of the DMI reserve and the operating reserve as required under the current Rio Grande Operating Rules. It should be noted that the critical drought period for the reservoir system begins in August 1992 and extends through the end of the simulation period, i.e., December 2000. The firm yield results from these two simulations indicate that the Amistad-Falcon reservoir system is more efficient at producing a firm supply of water solely for municipal use (by about 119,500 acre-feet/year) than for multiple types of uses with monthly water allocations made to the irrigation/mining accounts. This is significant considering that the current trend in the Lower and Middle Rio Grande basins is to convert irrigation/mining water rights to municipal water rights as population growth and urbanization continue to require additional municipal water and as agricultural operations continue to decline. It is also significant to note, as expected and as previously demonstrated in the 2006 Region M Plan, that the total authorized diversions from Amistad and Falcon Reservoirs as currently stipulated in Texas water rights (2,118,729 acre-feet/year in Table 1-1) substantially exceeds the firm supply of water from the reservoirs under either present water rights conditions or with all water rights converted to municipal use. This, of course, is precisely why the irrigation and mining rights are subject to the storage allocation and supply curtailment procedures contained in the TCEQ Rio Grande Operating Rules.

2) Again, using the simplified version of the TCEQ Rio Grande WAM, all current irrigation and mining water rights were assumed to be converted to municipal rights, producing a total municipal demand of 1,200,341 acre-feet/year (with zero irrigation/mining demand). As expected, because this total municipal demand is greater than the municipal firm yield of the Amistad-Falcon reservoir system determined in Item 1 above (1,131,500 acre-feet/year), shortages in the available water supply were simulated. These occurred during the years 1971 and 2000 of the WAM 1940-2000 simulation period. This result, coupled

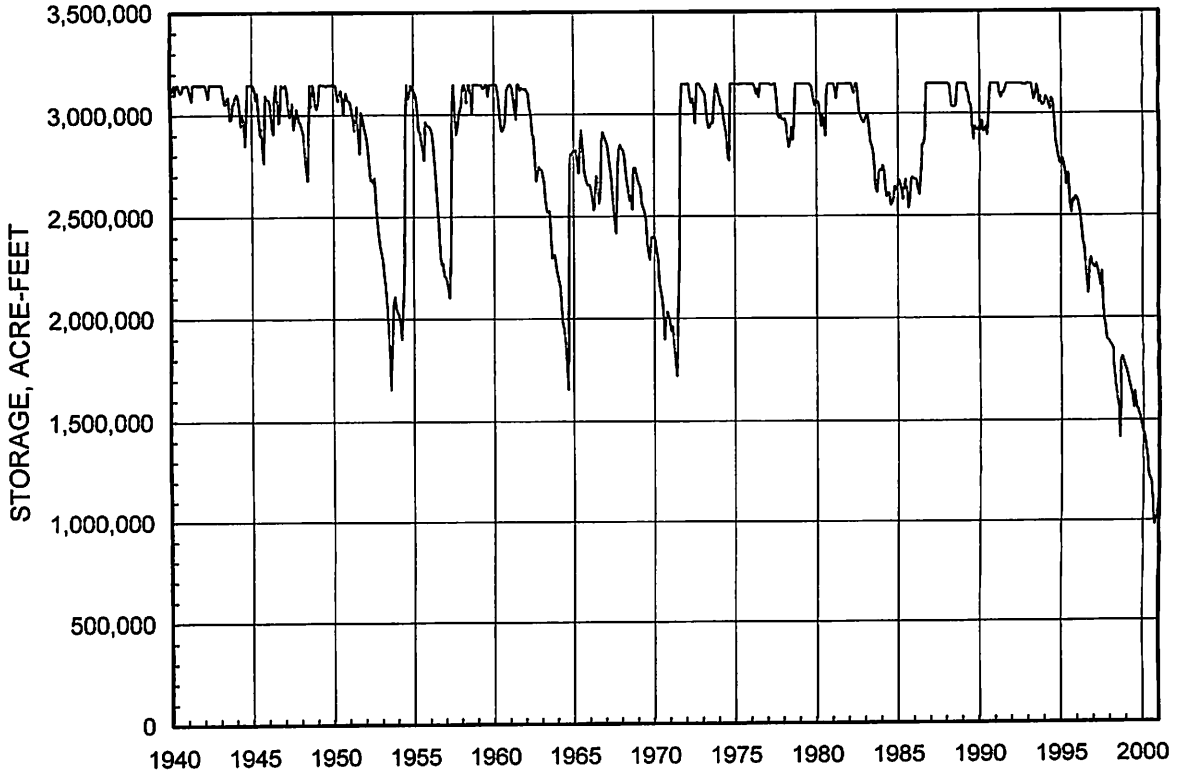
with that from Item 1 above, suggests that all of the annual diversions currently authorized in the existing irrigation and mining water rights on the Lower and Middle Rio Grande cannot be converted to municipal use in the future with the assurance that a firm supply of water will be available from Amistad and Falcon Reservoirs.

3) A final WAM simulation was made to demonstrate the behavior of the Amistad-Falcon reservoir system under current water rights authorizations (as represented in the TCEQ Rio Grande WAM) but with all Texas demands on the Lower and Middle Rio Grande specified in accordance with what might be considered to be typical demand conditions consistent with recent history. For this purpose, the actual 1992 demands were suggested by RPG members (see Figure 1-1), and the WAM was modified to reflect these demands as follows:

Municipal	201,434	acre-feet/year
Irrigation/Mining	728,365	acre-feet/year
Total Demand	929,799	acre-feet/year

As expected, with this level of total demand, no shortages in the available supply from the reservoirs were simulated because this total demand is less than the firm yield of the reservoir system determined in Item 1 above (1,012,081 acre-feet/year). The monthly variation of the combined storage in Amistad and Falcon Reservoir from this simulation is illustrated by the graph in Figure 3-1, and as shown, never approaches zero.

FIGURE 3-1 VARIATION OF AMISTAD-FALCON STORAGE FROM WAM OPERATED WITH 1992 ACTUAL DEMANDS FOR LOWER AND MIDDLE RIO GRANDE WATER RIGHTS



It is significant to note that the most severe drought indicated for Amistad and Falcon Reservoir based on the combined reservoir storage plotted on the graph in Figure 3-1 is that of the 1990s and early 2000s, rather than that of the 1950s as is often assumed. In fact, it is apparent from the graph that the end of the WAM simulation period (December 31, 2000) occurs in the middle of the most severe drought period since the storage in the two reservoirs is still falling at the end of the year 2000. This is important because with its current 1940-2000 flow data set, the Rio Grande WAM is not capable of representing water availability conditions throughout the duration of the most severe drought of record for the Rio Grande Basin, an obvious limitation when evaluating reservoir yield and other drought-driven water supply conditions. This situation should be corrected by extending the period of record for the WAM simulations through at least 2005 when both Amistad and Falcon Reservoirs were completely full, thus ending the 1990s-2000s drought period.

3.3 *Additional WAM Analyses*

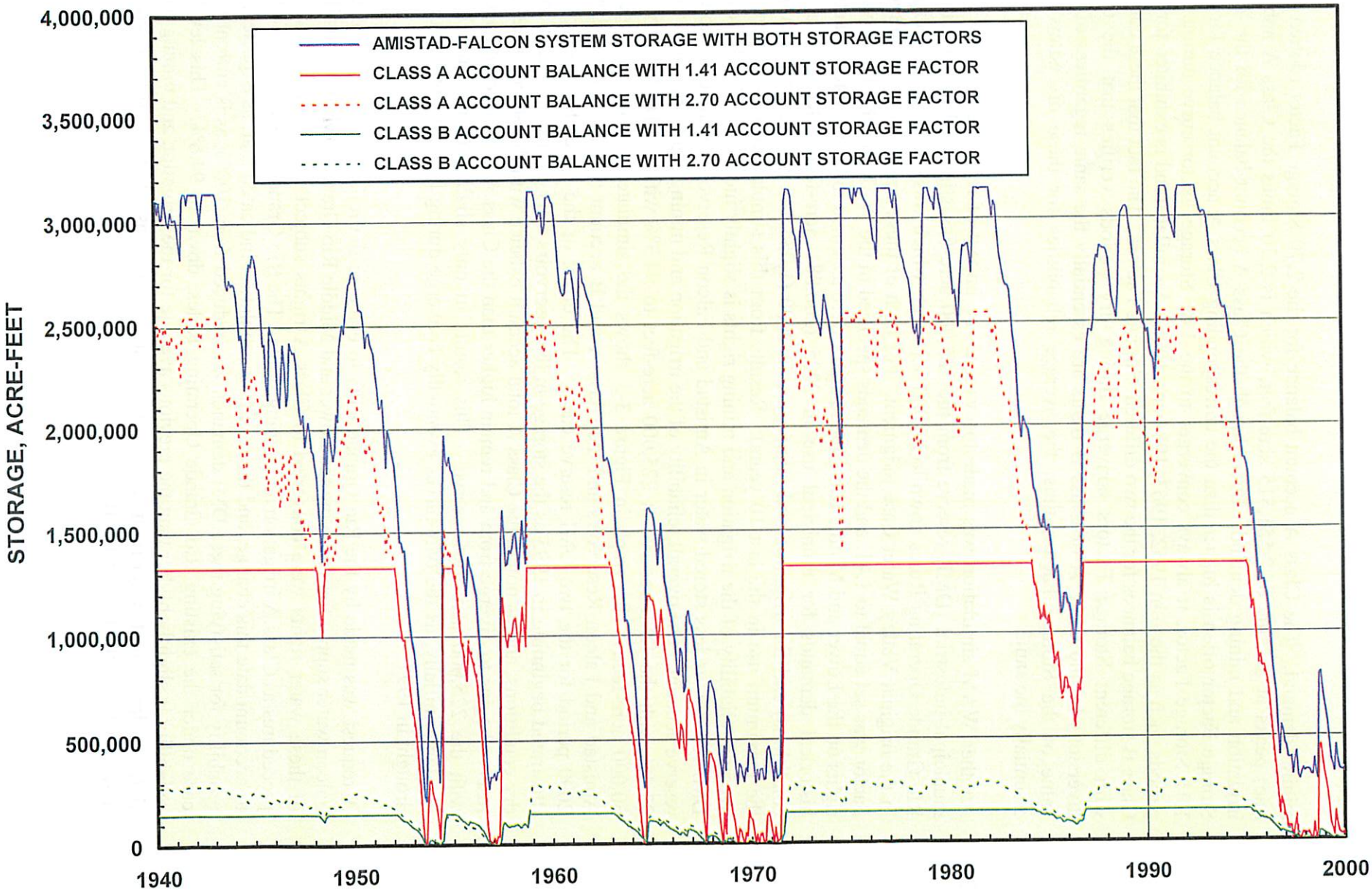
Results from the preliminary WAM simulations described above were presented to the Rio Grande RPG at its November 2007 meeting and then discussed in a special meeting of RPG members and water interests in Harlingen in February 2008. The outcome of this latter meeting was a list of additional analyses and WAM simulations that were identified as potentially being the most useful to further investigating the implications of using different methods or procedures in the future for operating the Lower and Middle Rio Grande water supply system with regard to Amistad and Falcon Reservoirs and to evaluating certain aspects of the international agreements between the United States and Mexico for allocating waters of the Rio Grande. These additional analyses and simulations and their results are described in the following sections.

1) As noted earlier, the Rio Grande Operating Rules stipulate that the amount of water that each irrigation (and mining) water right can store in its account in Amistad and Falcon Reservoir is limited to 1.41 times its annual diversion authorization. Applying this Storage Factor to the total amount of annual diversions currently authorized for Lower and Middle Rio Grande irrigation/mining water rights, the total amount of water that can be stored in the reservoir by all irrigation and mining water rights at any given time is 2,532,079 acre-feet. By the year 2010, the combined conservation storage capacity for the United States in Amistad and Falcon Reservoirs is projected to be 3,146,545 acre-feet (Rio Grande RPG, 2005). According to the current Rio Grande Operating Rules for determining monthly allocations to irrigation and mining storage accounts, the dead storage (4,600 acre-feet), the DMI reserve (225,000 acre-feet), and the operating reserve (75,000 acre-feet) must first be subtracted from the total storage in Amistad and Falcon Reservoirs before establishing the total allocation amount. When the reservoirs are full (2010 conditions), this leaves a total of 2,841,945 acre-feet as the maximum amount of storage physically available in the reservoirs for irrigation and mining accounts. This amount exceeds the maximum allowable amount (2,532,079 acre-feet) that can be stored in the existing irrigation and mining accounts based on the 1.41 Storage Factor by 309,866 acre-feet. This suggests that the Storage Factor could be increased to fully utilize the entire storage capacity of the reservoirs for the irrigation and mining accounts. Based on the total amount of annual diversions currently authorized for Lower and

Middle Rio Grande irrigation/mining water rights (1,795,801 acre-feet) and the maximum available storage in the reservoirs for irrigation and mining accounts under 2010 storage conditions (2,841,945 acre-feet), the maximum value of the Storage Factor is calculated to be 1.58. Considering the maximum annual diversion by all active irrigation and mining water rights during the last 10 years (1,054,397 acre-feet in 2000, Figure 1-1), the Storage Factor is calculated to be 2.70. Thus, there appears to be potential for increasing the available storage capacity in Amistad and Falcon Reservoirs for irrigation and mining accounts under the Rio Grande Operating Rules.

2) To evaluate the extent to which the available supplies of water from Amistad and Falcon Reservoirs for the irrigation and mining water rights might be extended with increased values of the Storage Factors, WAM simulations were made with the Storage Factors equal to 1.41 (existing rules), 1.58 (considering all irrigation and mining water rights and the 2010 maximum available storage in the reservoirs), and 2.70 (considering the maximum irrigation and mining maximum usage in the last 10 years and the 2010 maximum available storage in the reservoirs). The demands specified in the WAM for the Texas water rights on the Lower and Middle Rio Grande for these simulations were assumed to be equal to the actual historical demands for municipal use in 2005 (260,881 acre-feet reflecting current conditions) and for irrigation and mining use in 2000 (1,054,397 acre-feet representing the maximum use in the last 10 years). Surprisingly, the results from these WAM simulations produced essentially the same reliability for the irrigation and mining demands for all three values of the Storage Factor, an average value of 93.4%. Upon reflection, these results appear to be correct because regardless of the maximum amount of designated storage available for the irrigation and mining accounts in the reservoirs, they still have access to any storage in excess of this amount through the monthly allocation process stipulated in the Rio Grande Operating Rules. Essentially, any water in storage in the reservoirs that exceeds the maximum allowable total storage for the irrigation and mining accounts based on the Storage Factor is automatically transferred to the irrigation and mining accounts as storage in the reservoir falls. Since these calculations are performed monthly, as storage in the reservoirs falls during dry periods, the storage in the reservoir and the total storage for the irrigation and mining accounts eventually converge and thereafter follow the same exact trend. Hence, the available supply of water for the irrigation and mining users is exactly the same before and after this point in the storage trace of the reservoirs, and, consequently, the reliability of the water supply is the same regardless of the value of the Storage Factor that is used. This concept is illustrated by the simulated monthly storage in Amistad and Falcon Reservoirs and the Class A and B account balances over the 1940-2000 simulation period shown on the graph in Figure 3-2. As indicated, the Class A and B account balances are depicted for two Storage Factors – 1.41 and 2.70 – with the higher account balance corresponding to the higher 2.70 Storage Factor. As the storage in Amistad and Falcon Reservoirs falls during dry conditions (solid blue line), the account balances for the Class A and B irrigation/mining water rights also fall, with the higher curves corresponding to the 2.70 Storage Factor (dotted red and green lines) eventually converging with the lower curves corresponding to the 1.41 Storage Factor (solid red and green lines). As illustrated, the Class A account balance for the 1.41 Storage Factor (solid red line) peaks at a value of 1,334,768 acre-feet, which is 1.41 times the Class A annual irrigation and

FIGURE 3-2 RESERVOIR STORAGE AND CLASS A & B ACCOUNT BALANCES
ASSUMING 2005 DMI DEMANDS AND 2000 IRRIGATION/MINING DEMANDS
WITH 1.41 AND 2.70 ACCOUNT STORAGE FACTORS



mining demand. The Class A account balance for the 2.70 Storage Factor (dotted red line) peaks at a value of 2,551,515 acre-feet, which is 2.70 times the Class A annual irrigation and mining demand. Even though the Class A account balance for the 2.70 Storage Factor often is higher than the corresponding Class A account balance for the 1.41 Storage Factor, it always converges to the 1.41 Storage Factor curve during dry periods such as those in 1952, 1963, 1984 and 1995. A similar trend is exhibited for the Class B storage balances for the two different Storage Factors. The fact that these curves with different Storage Factors converge during dry periods verifies that the total diversions by the Class A or Class B rights are essentially the same regardless of the value of the Storage Factor; thus, the average reliabilities for these diversions are essentially the same.

3) Another WAM simulation was made to evaluate the impact of reducing the domestic-municipal-industrial (DMI) reserve from the 225,000 acre-feet stipulated in the current Rio Grande Operating Rules down to 60,000 acre-feet, which was the amount specified in the original Valley Water Case judgment. For both of these simulations, the Storage Factor was set equal to 1.41, and the demands specified in the WAM for the Texas water rights on the Lower and Middle Rio Grande again were assumed to be equal to the actual historical demands for municipal use in 2005 (260,881 acre-feet reflecting current conditions) and for irrigation and mining use in 2000 (1,054,397 acre-feet representing the maximum use in the last 10 years). Results from this simulation indicate that the average reliability of the irrigation and mining rights is slightly increased with the lower DMI reserve, as less stored water in Amistad and Falcon Reservoirs is allocated to this reserve account. The overall reliability of the irrigation and mining rights increased from 93.4% with the DMI reserve at 225,000 acre-feet to 94.3% with the DMI reserve at 60,000 acre-feet. The graph in Figure 3-3 shows the simulated monthly storage in Amistad and Falcon Reservoirs and the Class A and B account balances for the 1990-2000 period for the two DMI reserve cases. The effect of the lower DMI reserve is illustrated beginning in 1995 as the storage in the reservoirs falls during the initiation of dry conditions, and as noted, the Class A total account balance with the 60,000 acre-foot reserve begins to diverge from and remain higher than the Class A total account balance with the 225,000 acre-foot reserve. This results in only slightly more water being available initially, as the two curves eventually converge during the extreme part of the drought in 1997.

4) A request was made by the Rio Grande RPG to evaluate the reliability of the Amistad-Falcon water supply for satisfying the Lower and Middle Rio Grande DMI demands if all of these water rights were converted to Class A rights subject to the same allocation procedures as Class A irrigation and mining rights. The Rio Grande WAM was modified to accommodate this change, and the resulting simulation indicated that, as expected, the reliability for satisfying these DMI demands was reduced from 100%, as is currently the case under the existing Rio Grande Operating Rules, down to 94.6%. This level of reliability is slightly higher than the previous average for the irrigation and mining water rights under current water rights conditions because in this case there is no firm demand associated with the DMI water rights.

5) The issue of how flows in the Rio Grande at Fort Quitman are divided between the United States and Mexico has been of concern to Texas Rio Grande water users and other interests because of the apparent inconsistencies in language regarding this distribution in two historical agreements between the United States and Mexico; the 1906 Convention and the 1944 Treaty. Article I of the 1906 Convention states that "....the United States shall deliver to Mexico a total of 60,000 acre-feet of water annually in the bed of the Rio Grande at the point where the head works of the Acequia Madre, known as the Old Mexican Canal, now exist above the city of Juarez, Mexico." Article IV states that "The delivery of water as herein provided is not to be construed as a recognition by the United States of any claim on the part of Mexico to the said waters; and it is agreed that in consideration of such delivery of water, Mexico waives any and all claims to the waters of the Rio Grande for any purpose whatever between the head of the present Mexican Canal and Fort Quitman, Texas .....". The 1944 Treaty between the United States and Mexico, which, among other things, establishes ownership of waters flowing in the Rio Grande between the two countries from Fort Quitman downstream to the Gulf of Mexico, states in Article 4 of Section II that inflows to the Rio Grande below Fort Quitman from certain named tributaries are allotted to each of the two countries in specified proportions and that each country is allotted "One-half of all flows not otherwise allotted by this Article occurring in the main channel of the Rio Grande (Rio Bravo), including the contributions from all the unmeasured tributaries, which are those not named in this Article, between Fort Quitman and the lowest major international storage dam." Historically, in its accounting for ownership of waters of the Rio Grande, the IBWC has imposed the 50/50 language in the 1944 Treaty on the division of the flows in the Rio Grande at Fort Quitman so as to equally apportion them between the United States and Mexico. In direct contradiction, the 1906 Convention specifically states that "....Mexico waives any and all claims to the waters of the Rio Grande for any purpose whatever between the head of the present Mexican Canal and Fort Quitman, Texas .....". In this study, members of the Rio Grande RPG requested that the effect of distributing flows in the Rio Grande at Fort Quitman equally between the two countries as is the current practice be evaluated relative to allotting all of the flow to the United States in accordance with the 1906 Convention. First of all, it is important to understand that while the quantity of flow in the Rio Grande at Fort Quitman historically has varied considerably, it is not insignificant. Figure 3-4 is a bar chart showing the annual flows measured at Fort Quitman from 1925 through 2007. As shown, the minimum has been near zero and the maximum has exceeded a million acre-feet, with the average being approximately 117,000 acre-feet/year. Half of the time the flow is greater than about 88,000 acre-feet/year. For purposes of evaluating the effect of the different flow allocations at Fort Quitman, the Rio Grande WAM first was operated as it is currently structured in accordance with IBWC's current accounting practice, i.e., the 50/50 split of the Fort Quitman flows, and the United States' share of the firm yield of the Amistad-Falcon reservoir system was determined to be 1,012,081 acre-feet/year. The structure of the WAM then was modified to allot all of the flow in the Rio Grande at Fort Quitman to the United States, and this simulation produced a firm yield from the Amistad-Falcon reservoir system for the United States of 1,028,631 acre-feet/year, an increase of 16,550 acre-feet/year over the 50/50 allocation. Clearly, these results demonstrate that changing IBWC's accounting practices with regard to the allotment of flows in the Rio Grande at

Fort Quitman to be consistent with what appears to be the proper interpretation of language in the 1906 Convention would be a benefit to the Texas water rights that are dependent on the Amistad-Falcon reservoir system for their supplies.

Results from these additional WAM simulations and analyses as described above were presented to the Rio Grande RPG at its May 2008 meeting. Members discussed the general findings and generally determined that further evaluations to investigate the implications of using different methods or procedures in the future for operating the Lower and Middle Rio Grande water supply system with regard to Amistad and Falcon Reservoirs or the effects of alternative international accounting practices as potential water supply strategies in the context of regional water planning were not warranted at that time and should not be undertaken. Based on this general assessment, no further analyses were performed as part of this study.

FIGURE 3-3 RESERVOIR STORAGE AND CLASS A & B ACCOUNT BALANCES
ASSUMING 2005 DMI DEMANDS AND 2000 IRRIGATION/MINING DEMANDS
WITH 225,000 AC-FT AND 60,000 AC-FT DOMESTIC-MUNICIPAL-INDUSTRIAL RESERVES

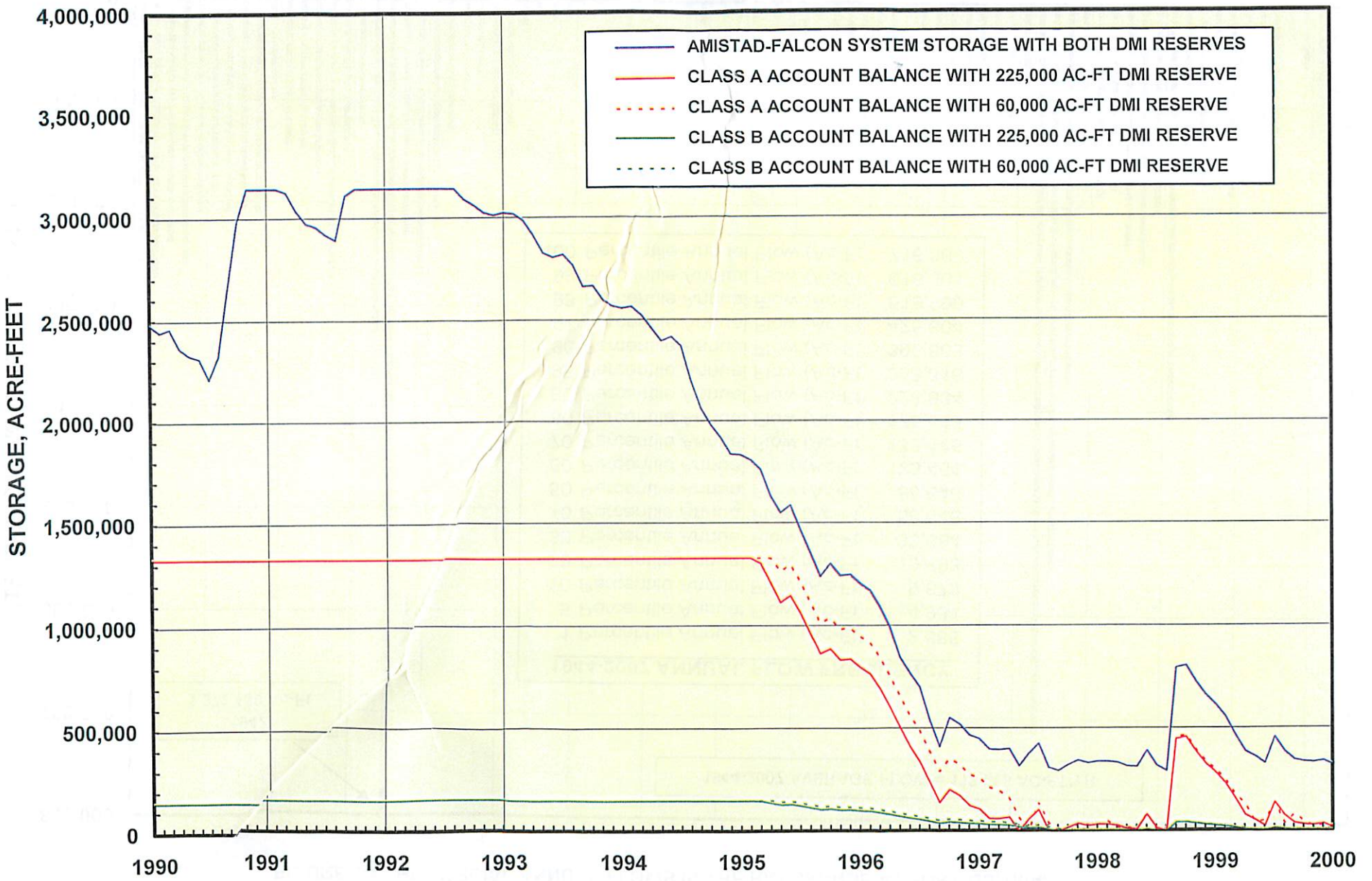
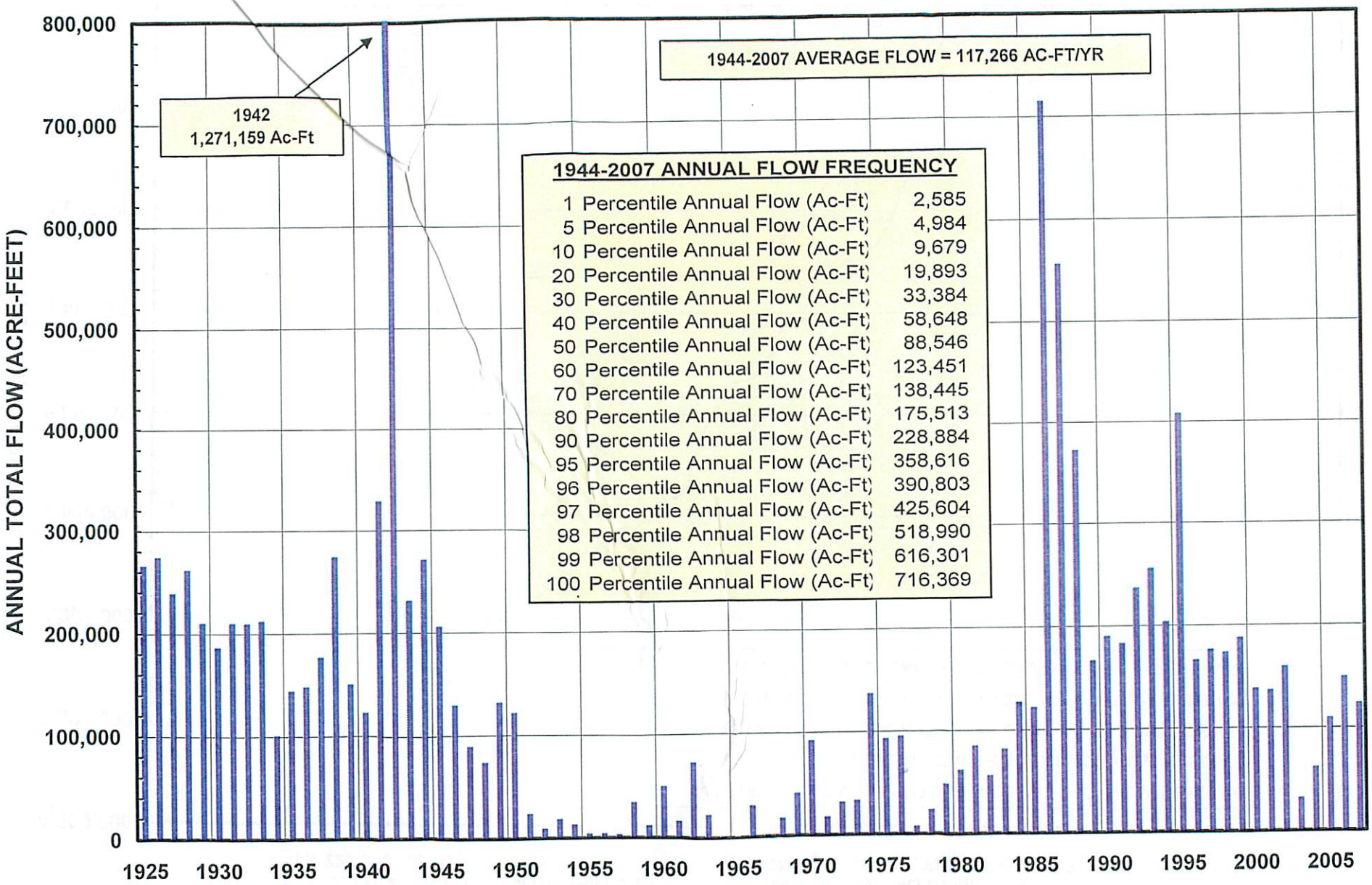


FIGURE 3-4 HISTORCIAL ANNUAL FLOWS IN THE RIO GRANDE AT FORT QUITMAN



4.0 Findings and Recommendations

Based on the analyses performed in this study and the results obtained, the following summarizes the principal findings and recommendations:

- The United States' share of the firm annual yield of the Amistad-Falcon reservoir system, assuming 2010 reservoir storage conditions, current domestic-municipal-industrial (DMI) authorized diversions (approximately 320,000 acre-feet/year) with the remainder of the yield used for irrigation and mining purposes, is 1,012;081 acre-feet/year based on simulations with the current TCEQ Rio Grande WAM.
- The United States' share of the 2010 firm annual yield of the Amistad-Falcon reservoir system assuming that all water is used for municipal purposes is 1,131,500 acre-feet/year based on simulations with the Rio Grande WAM, an increase of almost 120,000 acre-feet/year over current system operations.
- Based on the United States' share of the estimated firm yield of the Amistad-Falcon reservoir system, the projected municipal demands over the next 50 years along the Lower and Middle Rio Grande as presented in the 2006 Rio Grande Regional Plan (about 626,000 acre-feet/year in 2060) can be fully satisfied by converting irrigation/mining water rights to municipal use.
- The historical hydrologic data set incorporated in the current version of the Rio Grande WAM extends from 1940 through 2000, which ends in the middle of what appears to be the critical drought of record for the Lower and Middle Rio Grande; the hydrologic inputs to the WAM should be extended at least through 2005 in order to be able to simulate and analyze the entire 1990s-2000s critical drought period conditions when evaluating water availability.
- TCEQ's current Rio Grande Operating Rules limit the amount of storage in the Amistad-Falcon reservoir system for irrigation and mining accounts to a factor of 1.41 times the annual authorized diversions of these water rights. This factor is referred to in this report as the Storage Factor.
- Based on current irrigation/mining water rights on the Lower and Middle Rio Grande and the projected maximum storage capacity of Amistad and Falcon Reservoirs in 2010, the Storage Factor for irrigation and mining water rights could be increased to 1.58.
- The long-term overall reliability of the Amistad-Falcon water supply for the United States under existing Rio Grande Operating Rules for satisfying current irrigation/mining demands along the Lower and Middle Rio Grande is approximately 93.4% based on Rio Grande WAM simulations.
- Based on analyses performed with modified versions of the Rio Grande WAM, increasing the Storage Factor above the current value of 1.41 does not improve the reliability of the Amistad-Falcon water supply for satisfying irrigation/mining demands along the Lower and Middle Rio Grande.

- Based on analyses performed with modified versions of the Rio Grande WAM, reducing the DMI reserve from the current amount of 225,000 acre-feet as stipulated I the Rio Grande Operating Rules to 60,000 acre-feet only slightly increases the long-term reliability of the Amistad-Falcon water supply for satisfying irrigation/mining demands along the Lower and Middle Rio Grande – from 93.4% to 94.3%.
- Converting all DMI water rights to Class A water rights subject to the same allocation procedures as Class A irrigation and mining rights results in the reliability of the Amistad-Falcon water supply for these rights being reduced from 100%, as is currently the case under the existing Rio Grande Operating Rules, down to 94.6%, which is slightly higher than the previous 93.4% average for the irrigation and mining water rights under current water rights conditions because in this case there is no firm demand associated with the DMI water rights.
- Revising current IBWC water ownership accounting procedures to allot 100% of the flow in the Rio Grande at Fort Quitman to the United States (as stipulated in the 1906 Convention) instead of the 50/50 split with Mexico (as is the current IBWC practice purportedly in accordance with the 1944 Treaty) would increase the United States' share of the firm yield of the Amistad-Falcon reservoir system from approximately 1,012,081 acre-feet/year to 1,028,631 acre-feet/year, or about 16,550 acre-feet/year (~1.6%), and this change in current procedures should be pursued.
- Results from the various WAM simulations and analyses performed in this study were discussed and examined by the Rio Grande RPG, and it was generally determined that further evaluations to investigate the implications of using different methods or procedures in the future for operating the Lower and Middle Rio Grande water supply system and Amistad and Falcon Reservoirs as potential water supply strategies in the context of regional water planning were not warranted at this time and should not be pursued.
- Based on the findings herein, it is recommended that further analyses not be undertaken as part of this study with regard to investigating the implications of using different methods or procedures in the future for operating the Lower and Middle Rio Grande water supply system and Amistad and Falcon Reservoirs as potential water supply strategies in the context of regional water planning.

5.0 References

Rio Grande Watermaster (May 2008a); Email and summary table of authorized annual diversions for Lower and Middle Rio Grande water rights; provided to R. J. Brandes Company; Harlingen, Texas.

Rio Grande Watermaster (May 2008b); Summary table of historical water use by Lower and Middle Rio Grande water rights; provided to R. J. Brandes Company; Harlingen, Texas.

Rio Grande Regional Planning Group (January 2005); "2006 Rio Grande Regional Water Plan – Final Plan"; Austin, Texas.

R. J. Brandes Company, *et al* (March 2004); "Water Availability Report for the Rio Grande Basin – Water Availability Assessment"; report to the Texas Commission on Environmental Quality; Austin, Texas.

RESPONSE TO JUNE 23, 2009 TWDB COMMENTS

Study No. 1

Evaluation of Alternate Water Supply Management Strategies Regarding the Use and Classification of Existing Water Rights on the Lower and Middle Rio Grande

Please be advised that the Draft Report originally submitted to the TWDB for Study No. 1 has been substantially revised and expanded to provide a more thorough discussion of the work performed and the results produced. The data, results, and graphics presentations included in the original Study No. 1 Draft Report have not been changed in the revised final version of the report, but more explanation of the basis for the analyses performed in the study and additional interpretative information regarding results are presented.

Following are responses to the several comments provided by the TWDB dated June 23, 2009, grouped according to General Comments and Specific Comments. Numbering of comments by the TWDB is preserved herein for reference purposes. The TWDB comments are attached to this document as Attachment 1.

General Comments

1. All data, maps, and functioning analytical models either are contained in the revised Final Report or have been previously provided to the TWDB.
2. The title of the report for Study No. 1 has been revised to reflect the purpose of the study.
3. The required sections of the report have been provided in the revised Final Report, as well as a table of contents and lists of figures and tables.

Specific Comments

1. The referenced results and recommendations are documented and discussed in the revised Final Report, particularly with regard to current conversion practices in Section 1.3 and the effect of irrigation-to-municipal conversions of water rights in Section 3.2 (Items 1 and 2) and Section 3.3 (Item 4).
2. Study results pertaining to potential rule changes and effects on water availability are presented and discussed in Section 3.2 (Items 1 and 2, Conversions) and Section 3.3 (Items 1 and 2, Storage Factor; Item 3, DMI Reserve; and Item 4, Conversions).
3. Descriptive information regarding the simplified water rights representations is contained in Section 3.1.
4. Changes made to the WAM for purposes of this study are described in the revised Final Report under those sections pertaining to the specific changes in the Rio Grande Operating Rules and international ownership accounting that were analyzed.

5. Information regarding the impacts of the specific changes in the Rio Grande Operating Rules and international ownership accounting that were analyzed in this study are discussed in the relevant sections of the document as they may pertain to water supply reliabilities, river flows, and reservoir storage.

6. References to discussions of study results with the Rio Grande RPG and other water users and the outcome of these discussions are provided in the revised Final Report at the beginning and end of Section 3.3 and in Section 4.0.

7. As noted in the revised Final Report, following the development of preliminary results and information from the study (Section 3.2) and the discussion of these preliminary results with the Rio Grande RPG, several additional analyses were undertaken at the request of the RPG. These are described in Section 3.3.

8. References to water rights diversions and to demands in the revised Final Report are not necessarily used interchangeably and when either reference is used, it is described as considered appropriate.

9. Considering that the revised Final Report now includes substantial descriptive information regarding the analyses performed, responses to these comments now are believed to either be adequately addressed in the report or not necessary because the referenced information is no longer applicable.

10a. Only total United States demands on the Amistad-Falcon reservoir system now are discussed in the revised Final Report. Mexico's demands on the system are not changed from those specified in the WAM. These demands are described and quantified in the Rio Grande WAM report, which is referenced in Section 5.0 of the revised Final Report.

10b. Discussions of the analyses undertaken in this study presented in the revised Final Report identify the specific parameters that have been changed for purposes of the study and the results from the WAM that have been used to evaluate impacts. A complete discussion of all of the parameters included in the Rio Grande WAM and the various forms of output is contained in the Rio Grande WAM report, which is referenced in Section 5.0 of the revised Final Report.

10c. Other than a recommendation to pursue changing the accounting procedure used by the IBWC with regard to the distribution of Rio Grande flows at Fort Quitman between the United States and Mexico, no water management strategies are recommended in the revised Final Report.

11a. Done, no change.

11b. Discussion of these terms is provided in Sections 1.2 and 1.3.

11c. This explanation is provided in Section 3.3, Item 2.

12. As noted at the beginning of Section 3.3 of the revised Final Report, the Rio Grande RPG requested certain additional analyses after reviewing and discussing preliminary results. One of these analyses was to evaluate the impact of IBWC's current accounting practice with regard to the distribution of Rio Grande flows at Fort Quitman relative to language in the 1906 Convention. This work was undertaken by TRC/Brandes pursuant to the Study No. 1 effort as a potential water management strategy for increasing the available supply of water from the Rio Grande for Texas users.

13. The underlying basis for the original Conclusion No. 3 is discussed in the revised Final Report and is supported with the revised findings Nos. 1, 2 and 3. The first part of the original Conclusion No. 10 is no longer a stated finding in the revised Final Report, the second part is as noted by the last and second to last findings in the revised Final Report.

ATTACHMENT 1
TWDB Contract No. 0704830698

TWDB Comments on Draft Final Phase 1 Special Studies Reports
Rio Grande (M) Region-Specific Studies #1-3

#1 – Surface Water Right Management Evaluation (Cost = $41,838)
#2: Classify Individual Irrigation Districts as Water User Groups or Wholesale Water Providers (Cost = $45,150)
#3: Analyze Results of Demonstration Projects (Cost = $28,040)

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(1) General: Please submit all data, maps, and functioning analytic models in an appropriate electronic format along with the final double-sided reports for each study as stated in the contract between TWDB and Region M.

(2) General: Please revise the titles of final reports #1 & #2 to reflect each study's purpose.

(3) General: The contract Scope of Work (SOW) Deliverables sections state that each report will include *"the following sections: Executive Summary, Purpose of Study (including <u>how</u> the study supports regional water planning), Methodology, Results, and Recommendations."* Please include all of these sections in each of the final reports. Also, please consider providing a Table of Contents and numbering the figures and tables in the final reports.

<u>Study #1: Evaluation of Alternate Water Supply Management Strategies Regarding the Use and Classification of Existing Water Rights on the Lower and Middle Rio Grande</u>

1. The contract SOW Deliverables section states that the results will include *"information on how water right conversions from irrigation to municipal uses might be undertaken, what overall water supply management strategies might be considered by the Planning Group for implementation in order to more effectively use and enhance the available future supply of water from Amistad and Falcon Reservoirs."* Please document and discuss these results and recommendations in the final report.
2. The contract SOW, Task B states *that potential changes to operating rules will be identified for possible inclusion as potential feasible water management strategies (WMSs)* through the completion of the 6 specific SOW subtasks. Please document all work related to these subtasks and discuss the identification process for both rule changes and potential WMSs in the final report. Also, please specify what potential WMSs were identified.
3. The contract SOW, Task C states that *modifications to the existing WAM* (Water Availability Model) *will be made to incorporate simplified water rights representations and other procedures in order to facilitate more efficient modeling and evaluation of the potentially feasible WMSs.* Please document and discuss all work related to the 7 subtasks in the final report.
4. The contract SOW, Task D states that *modifications will be made to the Task C WAM to incorporate the potentially feasible WMSs identified in Task B.* Please document and discuss this process in the final report.
5. The contract SOW, Task E states that *WMSs will be evaluated with respect to water supply reliabilities, river flows, and reservoir storage.* Please include this evaluation and discuss the impacts on river flows, reservoir storage, and water supply availabilities in the final report.
6. The contract SOW, Tasks F & H state *that results will be reviewed with the Rio Grande Regional Water Planning Group (RGRWPG) and other water users for the WMSs evaluated in Tasks E & G.* Please include the results of these reviews and discussions in the final report.
7. The contract SOW, Task G states *that up to two additional WMSs identified in Task F will be evaluated using the Task C-modified WAM.* Please include these evaluations in the final report.

8. Throughout the draft report (e.g. - page 3 data values): The terms "Water Rights Diversion" and "Demands" seem to be used interchangeably; however these concepts are different from one another. Please review and reconcile, if appropriate, in the final report.
9. Pages 2-3, Preliminary Analyses section:
    a. Please clarify rationale for using simulation data from years 1992, 2000, and 2005;
    b. Please clarify the difference between the 2 model run scenarios: (1) "with only municipal demands" and (2) "with all current irrigation rights converted to municipal demands";
    c. Please define "reduced irrigation demands" for run scenario (1);
    d. Please provide firm yield results and define the value 1,200,341AFY, for run scenario (2);
    e. Please define "storage factor" and specify how it is computed;
    f. Please complete SOW subtask (B.a.) by running the WAM with at least 2 more changes for this model parameter (conversion rates). Testing a minimum of 3 different conversion rates is required to sufficiently define and demonstrate a relationship between the conversion rate and supply and availability. Only one conversion rate was examined - all current irrigation rights converted to municipal demands (page 2, #2). Also, please provide the firm yield for this scenario. This comment also applies to page 5, subtask B.c.
10. Page 5, Common Assumptions and Results sections – Please address in the final report:
    a. Please review and reconcile, if appropriate, the total US and Mexico demands on Amistad-Falcon reservoir system in the final report.
    b. Please define the parameters that can be used as variables within the WAM for the Rio Grande and clarify what values are direct results from the model versus external calculations using model results. (i.e. diversions and reserves vs. storage factor, etc.).
    c. Please clarify which recommended WMSs the following 5 model runs belong to – 2 runs on changed storage factors (2.7 & 1.58); 1 run on changed DMI reserve (60,000AFY); and, 1 run on changed use (all DMI becomes agriculture). Also, please provide the rationale for the last 2 scenarios.
11. Figures on pages 6 and 7 – Please address in the final report:
    a. Please review and reconcile, if appropriate, numerical values in both figure legends.
    b. Please define the terms "Class A Municipal", "Class B Municipal" and "account balance".
    c. Please provide an explanation for why the storage factor does not seem to affect storage content for the "System" pair, even though the "Class A" and "Class B" pair results indicate that an increase in storage factor results in an increase in storage content.
12. Page 15: In the final report, please clarify the original author of this material and how it relates to the scope of work.
13. Page 16, draft report conclusions list – Please clarify conclusions #3 and #10.