Programmatic Assessment:
Proposed Rules 31 TAC Chapters 701, 702, 703, 705, 707, 709, 711

Part 3

Prepared for

The Edwards Aquifer Authority

By

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5.4 Hydrologic Models

Computer models are mathematical simulations and simplifications of real-world relationships. Two hydrologic models—one for ground water and one for surface water—have been used to help evaluate differences in impacts among rule-making alternatives.

5.4.1 GWSIM

The GWSIM model (version IV) is commonly used in the Edwards Aquifer to simulate water flow and the response of water levels and spring flows to recharge and pumping. A description of the model, and of its application to this assessment, is provided in Appendix *GWSIM*. Model results should not be taken as quantitatively precise measurements of aquifer responses to management. For all conditions, the model tends to predict water levels that are much lower than those that actually occur; and under drought conditions the predicted spring flows are somewhat higher than may actually occur. Because of these inaccuracies, the value of the model is in comparing alternatives.

Table 5.4.1-A summarizes some of the basic results of the GWSIM simulations that are reported in the appendix. The first simulation is for irrigation, municipal and industrial withdrawals of about 485,000 AFY, which in the model represents existing conditions (Scenario A in the appendix). Next is simulation of a proportional adjustment of these withdrawals to 450,000 AFY, which represents the proposed rules, especially §711.172. The third scenario includes withdrawals by interruptible rights (Scenario L), an alternative discussed in Section 4.5. The fourth shows an unconstrained future, with withdrawals exceeding 600,000 AFY (Scenario D). Additional results of the model are cited in the impact analysis in Chapter 6.

Table 5.4.1-A
Summary of Results from GWSIM
Water levels are given relative to Scenario H; values rounded to nearest foot.

Scenario	**H**	**B**	**L**	**D**
Variable	**Existing 485,000 AFY**	**Cap 450,000 AFY**	**Interruptible rights**	**Unconstrained 608,845 AFY**
Average Water level, Bexar County	Reference	8 feet higher than reference	4 feet higher than reference	48 feet lower than reference
Average Water level, Medina County	Reference	9 feet higher than reference	4 feet higher than reference	43 feet lower than reference
Average Water level, Uvalde County	Reference	12 feet higher than reference	9 feet higher than reference	39 feet lower than reference
Average flow, Comal Springs	116 cfs	148 cfs	131 cfs	29 cfs
Months Comal flows < 200 cfs*	579	516	585	727
Months Comal dry*	150	80	86	527
Average flow, San Marcos Springs cfs	127 cfs	131 cfs	129 cfs	95 cfs
Lowest monthly flow, San Marcos Springs, cfs	46 cfs	56 cfs	55 cfs	0 cfs

*Out of a 780 month period, assuming repeat of recharge conditions 1934-98

5.4.2 GSA4

Surface water effects in the Guadalupe River basin have been taken from the South Central Texas Water Advisory Council (1998), which utilized the GSA4 model; see Appendix *GWSIM*. This model will be important in assessing the effect of retiring permits down to 400,000 AFY, because the Act provides that half the funding for such retirements will come from downstream beneficiaries. For the 450,000 AFY cap, the model predictions have been cited briefly in Section 7.3.

5.5 Economic Models

Four models have been used to indicate the overall economic impact of a 450,000 AFY withdrawal cap, how effects vary among sectors, and the effects of alternate rules: Edwards Simulation (EDSIM), IMPLAN, SAFE and FEESIM. The economic modeling has been limited to areas within the Authority's boundaries.

5.5.1 EDSIM

The EDSIM model (for Edwards Simulation) was developed in the early 1990s by researchers at Texas A&M University as a tool to assess economic implications of Edwards Aquifer management. For this assessment, the model was modified to simulate the direct regional economic effects of a withdrawal cap and associated creation of a marketplace allowing trades of withdrawal rights. A description of the model, and of its application to this assessment, is provided in Appendix *EDSIM*.

Model results should not be taken as quantitatively precise estimates of economic responses to management. For example, the treatment of all irrigators in a particular county and aquifer setting is based on their aggregate average history of cropping patterns and water use, even though individual practices may not conform to these averages. The model is sensitive to important input assumptions, such as the price at which water rights will trade, but current information is such that these inputs can only be approximated.

Table 5.5.1 summarizes some of the results of simulations using this model. The full results are detailed in Appendix *EDSIM*. The first simulation reported is based on 1998 levels of irrigated acreage, but climatic conditions that are a weighted aggregate of 1934-98 conditions. Next are three simulations representing the following conditions:

- Withdrawals by all irrigators are reduced equally, which is the condition that would exist if the Act did not guarantee 2 acre-feet per acre per year (AFAY).
- Irrigators are guaranteed 1.8 acre feet per acre per year, reflecting the concept of interruptible rights discussed in Section 4.5.
- An unconstrained future in which municipal and industrial demand has decreased aquifer levels and increased lifting costs to irrigators. To irrigate the same acreage now costs more, and reduces irrigation income.

None of the simulations reported here include the waiver of irrigation withdrawals that would result from a buy-down of applications; those results are included in Chapter 6.

The model demonstrates that most effects of the cap fall on irrigation. Municipal and industrial withdrawals drop only slightly due to increased costs of water.

Table 5.5.1
Summary of Results from EDSIM

	1998 conditions	Irrigators get 1.8 AFAY	Proposed rule	Unconstrained Future
Water used for irrigation (AFY)	220,800	143,100	147,800	193,900
M&I use (AFY)	307,300	288,300	285,800	480,200
Ag. Production Income ($/yr)	15,587,000	11,812,000	13,040,000	10,290,000
Acre-feet traded to M&I	0	58,800,000	56,300	0
Value of trades to M&I ($/yr)	0	4,261,600	4,496,300	0
Acres converted to dryland farming	0	12,675,000	10,022,000	79,891,000
Regional M&I welfare ($/yr)	615,265,000	612,015,000	602,015,000	961,704,000
Total regional welfare ($/yr)*	630,852,000	621,264,000	630,852,000	972,624,000

*Includes value of trades

5.5.2 IMPLAN

IMPLAN is a generalized input-output model that can be used to calculate how initial changes in one economic sector (such as agriculture) can ripple through the economy through losses of sales, income and employment of resources such as labor, capital and management. Equations specific to the EAA area have been used to apply the IMPLAN algorithm to the issue of how restrictions on irrigation pumping, increased farm costs because of EAA fees, and the potential to market water rights will combine to cause a decline in irrigated acreage, with consequent effects to businesses that sell to or buy from farmers, and to regions that depend wholly or in large part on agricultural production for their economic well-being. Details on the model and its application in this assessment are provided in Appendix *IMPLAN*.

Table 5.5.2 summarizes some of the results of the IMPLAN simulations that are detailed in the appendix. The scenarios in the table are the same as used in Table 5.5.1 above. A basic relationship shown by the model is that initial impacts are felt largely in cotton. The near-term employment effect is a loss of about 169 jobs.

Table 5.5.2
Summary of Results from IMPLAN

	1998 conditions	Irrigators get 1.8 AFAY	Proposed rule	Unconstrained Future
Ag. sales ($)	29,960,000	22,250,000	25,400,000	28,990,000
Cotton sales ($)	11,340,000	4,210,000	4,280,000	10,240,000
Regional ag. output ($)	47,270,000	39,300,000	35,250,000	45,760,000
Ag. Employment (jobs)	1291	1118	1122	1259
Labor income ($)	12,450,000	12,370,000	12,450,000	16,600,000
Gross reg. product impact ($)	34,590,000	29,060,000	29,700,000	33,500,000

5.5.3 SAFE

The Small Area Fiscal Evaluation (SAFE) is a model recently developed at Texas A&M University for this assessment. It is an EXCEL spreadsheet that uses regression equations to calculate local and state government revenues and expenditures as a function of local employment, population, personal income and capital-asset value. The model, and its application to this assessment, is described in Appendix *SAFE*.

Table 5.5.3-A summarizes the SAFE simulations that are detailed in the appendix. Because the model is not yet fully automated, its application to this assessment was limited to a smaller number of cases than either EDSIM or IMPLAN, and it was applied only to Medina County. By assuming all of the effects on government revenues occur in Medina County, the results on a percentage basis are a conservative estimate of what the impact might be to Uvalde or any other county. The estimates reflect only the effect of regulations on agriculture and not, for example, the potentially offsetting effects of urbanization. All values are stated as changes from 1998 baseline conditions. Near-term changes are generally less than 1%. Changes in Uvalde County (and other counties) would be less.

Table 5.5.3
Summary of Results from SAFE Model

	Irrigators get 1.8 AFAY	Proposed Rule
Decline in Medina population	184	180
Increase in unemployment rate	0.0003	0.0003
Increase in outcommuters	11	11
Decrease in school-age children	41	40
Decrease in property tax base	$2,582,900	$2,225,700
Decrease property tax revenue	$12,025	$11,759
Decrease in County sales, hotel, beverage tax revenues	$14,294	$13,976
Decrease in municipal sales, hotel, beverage tax revenues	$32,763	$32,036
Decrease in school tax revenues	$70,990	$69,417

5.6 Endangered Species Requirements

During past litigation, evidence was presented that periods of low flow in both the Comal and San Marcos spring systems are becoming more frequent and more severe. The potential for negative effects on species listed as endangered or threatened was the basis for claims made in the litigation (*for example, Sierra Club v. Lujan et al.*). One outcome of the case is that the court ordered the U.S. Fish and Wildlife Service to make certain determinations relative to minimum springflows and aquifer levels necessary for endangered and threatened species. Table 5.6-A summarizes the Fish and Wildlife Service's findings. Table 5.6-B summarizes data indicating the frequency at which the flow of Comal Springs has dropped below important levels.

As the Fish and Wildlife Service's "take" and "jeopardy" levels, set forth in Table 5.6-A, are based on "best professional judgment," some have questioned their accuracy. The

fact that spring flows lower than the jeopardy levels have been observed in both spring systems indicates that the endangered species are not extirpated at these levels. Studies aimed at refining the fish and Wildlife Service's estimates of flow levels adequate to support the endangered species are underway. Until that time, the values in the table provide an important reference point for assessing effects. It is reasonable to assume that no study will set the jeopardy level at 0 cfs.

The U.S. Fish and Wildlife Service established "take" and "jeopardy" flow levels for the four species that were listed as endangered at the time of the June 15, 1993, letter to the Court. While the Comal Springs riffle beetle, Comal Springs dryopid beetle, and Peck's cave amphipod are not specifically addressed, it is generally agreed that spring flows that are protective of the Fountain darter will also be protective of these species.

Table 5.6-A
Spring Flow Levels Established by the U.S. Fish and Wildlife Service

FEDERALLY LISTED SPECIES	SPRING SYSTEM CASE	To Avoid Take of Animal Species and Avoid Damage to & Destruction of Plant Species	To Avoid Appreciable Reduction of Survival and Recovery = JEOPARDY	To Avoid Adverse Modification of Critical Habitat
		Minimum Spring flow CFS	Minimum Spring flow CFS	Minimum Spring flow CFS
Texas wild-rice	San Marcos⊕❷	100	100	100
Texas wild-rice	San Marcos◊❷		<100♦🕐	<100♦
Fountain darter	Comal⊕❶	200		
Fountain darter	Comal ❶	150		
Fountain darter	Comal⊕❷		150🕐	
Fountain darter	Comal ❷		60🕐	
Fountain darter	San Marcos⊕❷	100	100	100
Fountain darter	San Marcos⊕❷		<100🕐	<100♦🕐
San Marcos Gambusia	San Marcos⊕❶	100		
San Marcos Gambusia	San Marcos⊕❷		100	100
San Marcos Gambusia	San Marcos◊❷		<100♦🕐	<100♦🕐
Texas blind salamander	Edwards aquifer❶	50‡		
Texas blind salamander	Edwards aquifer❷		50‡	
San Marcos salamander	San Marcos⊕❶	60		
San Marcos salamander	San Marcos⊕❷		60	60

❶ ⇒ 15 April 1993 Letter
⇒ With Control of Snail *Marisa*
♦ ⇒ Currently, CFS Undefined

❷ ⇒ 15 June 1993
◊ ⇒ With Edwards Aquifer Management Plan & Control of Exotics
🕐 ⇒ For Short (Undefined) Periods of Time

⊕ ⇒ Given Current [1993] Conditions
‡ ⇒ Refers to San Marcos Springflow

Table 5.6-B Percentage of Time Comal Springs Flow has been Below Important Flow Levels			
Comal Springs Flow	**1928—1950**	**1928—1994**	**1951--1994**
Time Below 200 cfs	0%	14.27%	21.73%
Time Below 150 cfs	0%	8.07%	12.29%
Time Below 60 CFS	0%	2.24%	3.40%

6. Effects Of Draft Proposed Rules On Existing Users

Chapter 6 assesses the effects of the Draft Proposed Rules that are identified in Chapter 3 on existing users, that is persons who are entitled under the Act to apply for and receive an initial regular permit to withdraw water from the Edwards Aquifer. Our focus is on two kinds of rules: 1) the "permitting rules" in Subchapter G of Chapter 711 that limit existing users to a total of 450,000 AFY of uninterruptible withdrawals, and 2) the "fee rules" in Chapter 709 that form the basis for assessing fees to permit holders.

The assessment is organized as follows:

- Section 6.1 describes how the permitting rules define property rights in ground water. It includes our estimates regarding the rights that will be permitted to the different categories of users and our discussion of the water-rights marketplace that will result.
- Section 6.2 describes the general character of the fee rules and the fees we expect permit holders to be charged.
- Section 6.3 quantifies the direct hydrologic effects of the permitting rules.
- Section 6.4 assesses the effects of the permitting and fee rules as now proposed on the general category of irrigation-water users.
- Section 6.5 assesses the effects of the permitting and fee rules as now proposed on the general category of municipal and industrial users.
- Section 6.6 discusses the effect of the permitting and fee rules on existing users who withdraw Edwards water for water-intensive commercial and industrial purposes such as golf courses, aquaculture, nurseries, quarries, cooling water, and industrial process water.
- Section 6.7 assesses effects from those Draft Proposed Rules that have been assessed, other than the permitting and fee rules: §§701, 702, 703, 705, and 707, and Subchapters A-F, H-I, K-M of Chapter 711.

In Chapter 7, we assess the effects of the proposed rules that fall beyond the existing users, for example, the effects on economic sectors that depend on irrigation agriculture and downstream effects that benefit from increased spring flows.

6.1 Property Rights in Ground Water will be Defined

One of the most fundamental impacts of implementing the Act through the Authority's rules will be to define property rights in water for users of the Edwards Aquifer. Section 6.1 discusses this impact as follows.

- Section 6.1.1 describes conceptual changes in how rights in ground water are defined.
- Section 6.1.2 is our assessment of the outcome of the proportional adjustment process.
- Section 6.1.3 predicts the quantities of permitted rights, the quantities of water that will be withdrawn under these rights, and how the quantities compare to historical and unconstrained future uses.
- Section 6.1.4 provides quantitative insights regarding the water-rights marketplace that will result from the Act and rules.

6.1.1 Conceptual Changes in Groundwater Rights

Until passage of the Act, owners of land overlying the Edwards Aquifer had an essentially unrestricted right to drill wells into the aquifer and withdraw water for beneficial use without liability to adjacent well owners for well interference. This right was based on the English Rule and its corollary, the Rule of Capture. With implementation of the Act, rights to groundwater will be explicitly recognized through permits issued by the Authority. These rights will be based on use of groundwater during the historical period, from June 1, 1972, through May 31, 1993.

Applications for more than 800,000 AFY of withdrawals have been filed with the Authority. Although the results of each application will depend on case-specific facts and cannot be assessed, it is expected that some of these claims will be denied. Categories of such denials include the following.

- Applicants who did not file their application in a timely manner will be denied irrespective of whether they had beneficial use of Edwards water during the historical period.
- Applicants who might otherwise qualify for an initial regular permit, but who fail to present convincing evidence to support the application in full, will receive less than their claim or nothing. The potential for this outcome may be affected because at the time historical use occurred applicants may not have known there would be a future need to have convincing records of the use.
- Any application that is based on beneficial use that ceased prior to June 1, 1972, or began after May 31, 1993, will be denied.
- Those portions of applications that are based on withdrawals from an aquifer other than the Edwards Aquifer will be denied.

- Applications that are based on exempt wells will be denied. Such wells can continue to withdraw water but will not have well permits.

Some denials will actually deny aquifer users water and drive them to acquire replacement supplies. Other denials will have no practical effect on the use of water by an applicant, but will deny the applicant some quantity of future marketable water rights.

Persons who obtain initial regular permits will have marketable water rights. These rights will be subject to Authority rules, including rules dictated by Act (for example, no more than 50% of permitted irrigation rights in each case may be transferred, with the balance remaining with the land).

Most municipal and industrial (M&I) applicants, and some irrigators, will receive permits for less water than they currently use (see Section 6.1.2 for quantification). In order to meet current and future growth in demand, such applicants will need to develop or acquire alternative water supplies or adapt to the inevitable impacts arising out of the inability to meet demand. Most irrigators seem unlikely to enter the market as buyers, but rather will alter their irrigation practices according to their permitted rights (see Section 6.4 for details). It is reasonable to expect municipal and industrial applicants to develop alternative supplies and that one way they may do so will be through marketplace transfers of Edwards rights (see Section 6.5).

All of the effects listed above are mandated by the Act. The only discretion given to the Authority lies in the details of the procedures. Therefore, from an assessment perspective, the rules will simply be the instrument through which the legislated impacts will occur.

6.1.2 Outcome of Proportional Adjustment Process

§1.14(b) of the Act requires that the initial regular permits issued by the Authority authorize withdrawals of no more than 450,000 AFY. The 450,000 AFY value is often termed a "**cap**." The cap is implemented by §7111.164 of the Staff Draft Proposed Rules.

Even with some claims denied, it is expected that between 550,000 and 650,000 AFY of withdrawals will be eligible for permitting. Therefore, the cap will force the Authority to proportionally adjust the applications. A necessary part of any assessment of the permitting rules is to estimate the outcome of the proportional adjustment process, that is, how the 450,000 AFY will be allocated to the final permits.

While §1.16(e) of the Act provides only broad directions on how the cap is to be implemented, it does require, and the permitting rules in §711.172 specify that: 1) users of Edwards water during the historical period will receive permits based on their maximum beneficial use during the historical period, if water is available; 2) these maximums will be subject to proportional adjustment if maximum beneficial use of all prospective permits exceeds the cap; and 3) users who have been in operation for more than three years of the historical period will receive permits for not less than a specified statutory minimum.

The Act does not provide for a specific course of action if it turns out that in issuing permits for the quantity of the statutory minimums the result is to exceed the cap. The proposed rules avoid this issue through a voluntary program found in §711.182 by which

applicants may waive some portion of their application in return for compensation. As a backstop, a mandatory compensation program is provided for in §711.176.

Our interpretation of these requirements in the proposed rules is summarized below, in the context of case studies involving hypothetical users of Edwards water.

Introduction to hypothetical cases. Table 6.1.2-A describes nine hypothetical users of Edwards water, each with a different pattern of water use. Assessment of the hypothetical case studies will illustrate how different rules will have different effects on different categories of users. Of the two irrigation cases, one has used more than 2 acre-feet per acre per year (AFAY) while the other has used less. Seven cases illustrate the effects on municipal and industrial applicants with different historical patterns of use.

Table 6.1.2-A
Hypothetical Cases Used to Illustrate the Effects of §711.172

Each case is intended to reflect a different type or pattern of water withdrawal from an Edwards well. The case labels are intended to be descriptive and have no rulemaking significance. Withdrawals are assumed to beneficially used. AFY = acre-feet per year. AFAY = acre-feet per acre per year.	
Case A Intensive irrigation	A 500-acre farm with water-intensive crops in the driest part of the area (for example, a double crop of a vegetable and corn, Uvalde County). During the historical period, annual withdrawals were 2.1 AFAY in one-third of all years, 2.3 AFAY in one-third of all years, and 2.5 AFAY in one-third of all years, or an average of 2.3 AFAY. 2.3 AFAY x 500 acres =1150 AFY.
Case B Irrigation	A 500-acre farm with crops that are not water-intensive and that is located in wetter parts of the area. During the historical period, annual withdrawals were 1.1 AFAY in one-third of all years, 1.3 AFAY in one-third of all years, and 1.5 AFAY in one-third of all years, an average of 650 AFY
Case C M&I steady use.	M&I user whose use varied little during the historical period. During the historical period, annual withdrawals were 800 AFY in one-third of all years, 900 AFY in one-third of all years, and 1000 AFY in one-third of all years, for an average of 900 AFY.
Case D M&I growing use.	Growing community that withdrew 700 AFY in the first year of the 21-year historical record and which increased that withdrawal by 15 AFY in each subsequent year to a total of 1,000 AF in the final year. This is an average of 850 AFY. Case D represents, on a small scale, many of the major water systems in the region.
Case E M&I recent growth.	Community or business that began after the start of the historical period, and had its highest use at the end of the period. An example might be a large resort. Specifically, first use occurred in year 5 at 650 AFY. This continued for 8 years. In year 13, use increased to 1000 AFY and stayed at that level (for example, because a second golf course was opened). Average use for the 17 years of operation was 835 AFY.
Case F Municipal use reduced.	Municipal supplier who withdrew 1,000 AFY in each of the first 15 years of the 21 year historical period, but only 200 AFY in subsequent years due to switch to surface water that conserves Edwards water. This equates to an average of 771 AFY for 21 years.
Case G Industrial use reduced.	Industrial user that withdrew 1,000 AFY for the first five years of the historical period then became substantially inactive (at least with respect to the water-intensive process) and withdrew only 100 AFY since. This equates to an average of 314 AFY for the 21 years
Case H M&I 5 year use.	M&I user who installed a well and began operation in the 17th year of the historical period with a withdrawal of 200 AFY and increased the withdrawal by 200 AFY in each subsequent year of the historical period. Average use for the five years was 600 AFY.
Case I M&I 1-year use.	M&I user who began operation midway in the 21st year of the historical period. When adjusted to a full year of operation, the withdrawal would have been 1,000 acre-feet.

Table 6.1.2-B shows the effects of the permitting process on each user based on assumptions that are detailed below. The assumptions focus on our best judgments about

what will happen, and therefore are based on the expectation that the Authority will: 1) have to make a large proportional adjustment to applications; and 2) will be successful in its program to obtain voluntary waivers of applied-for quantities. We also assume that every permit will go through three phases:

1) A proposed permit that reflects recommendations made by Authority staff. The withdrawal amount contained in this proposed permit becomes the new interim authorization (See Section 6.7.1).

2) An initial regular permit that will be issued once the applicant accepts the staff recommendations or altered through negotiation or a contested case.

3) The same permit as adjusted once all permits have been issued and all quantitative aspects of the permitting process are final.

Table 6.1.2-B
Effects of Proposed Rules on the Hypothetical Cases

Hypothetical case	Maximum Use	Statutory Minimum	After proportional adjustment	After Step-up
A. Intensive irrigation	1250	1150	900	1150
B. Irrigation	1000	1000	720	1000
C. M&I steady use	1000	900	720	900
D. M&I growing use	1000	850	720	850
E. M&I recent growth	1000	835	720	835
F. Muni. Reduced	1000	771	720	771
G. Ind. Reduced	1000	314	720	Stays at 720
H. M&I 5 year use	1000	600	720	Stays at 720
I. M&I 1 year use	1000	none	720	Stays at 720

*All values are in acre-feet per year (AFY)

Determine permit-specific maximums and minimums. Based on facts specific to each application, the Authority will first determine each Applicant's maximum and average use of water during the historical period.

The *maximum* is determined because, if water were available, the Act directs that each existing user would get a permit in the amount of their maximum beneficial use during the historical period. In the proposed rules, this quantity is the starting point for the permitting process. The Act and §711.172 assign one of two values to each user.

- Irrigators who used more than 2 AFAY and all nonirrigators are assigned a value equal to their maximum beneficial use in any one year. Users in operation for less than one year of operation are assigned a value equal to one full year's use.
- All other irrigators are assigned a value of 2 AFAY even if the real maximum historical use fell below that amount.[1]

[1] In this assessment, we have not considered the contention of some applicants that golf courses should qualify for the irrigation guarantee, largely because the Act defines irrigation use in terms of pasture, cropland and orchards. If nonagricultural turf qualifies, then the minimum would presumably apply to City parks, lawns, and so forth which would produce permit quantities even farther above the quantities discussed here.

Values for historical maximums for each hypothetical case are shown in Table 6.1-2-B. The value is the actual maximum historical use for all but Case B; that case is assigned 2 AFAY for each of the 500 acres irrigated historically.

The *minimum* is determined because existing users who have operated for three or more years during the historical period are entitled to no less than a specified quantity of water. The Act and §711.172 assign one of two values to each user.

- All users with three or more years of operation are assigned a minimum that is equal to their average annual use during the years of operation during the historical period.
- Irrigators will have their minimums increased to 2 AFAY for each acre irrigated in any one calendar year of the historical period if such an adjustment results in a larger value.

Values for the minimum for each hypothetical case are shown in Table 6.1-2-B. These are average historical use for all but two cases. Case B had an actual average use of 650 AFY, but in accordance with the Act and rules this is increased to 1,000 AFY, based on 2 AFAY for each of the 500 acres irrigated historically. Case I operated for less than three years and is not entitled to a minimum.

Note that maximums and minimums defined in initial regular permits are not subject to change based on the outcome of other permit applications.

Proportional adjustment. Based on information provided by Authority staff, we estimate nearly 600,000 AFY of historical maximums will be recognized in draft proposed permits, but this may increase to 625,000 AFY or more once all contested cases are resolved. The cap of 450,000 AFY is 72% of the latter amount. In order that no more than 450,000 AFY of withdrawals are permitted, the Authority will proportionally adjust each applicant's historical maximum (§711.172). If the value of maximums is in fact exactly 625,000 AFY, the downward adjustment will be 28%.

In practice, the EAA's calculation of the adjustment factor will be made twice. The first calculation will be an estimate, based on the sum of staff determinations of historical maximum amounts for each permit. The second calculation will be final and will be made once every permit has been issued. This value will be based on the sum of the permit-specific maximums finally recognized. Permits will be conditioned to allow the Authority to replace the initially calculated adjustment with the final adjustment.

In Table 6.1.2-B, only the final adjustment is shown, which is assumed to be 28% downward. Thus, the column "after proportional adjustment" equals the historical maximum use for each applicant, times 0.72.

Step-up amount. In accordance with §711.172, those applicants entitled to a step-up amount will have that step-up quantity explicitly recognized in their initial regular permit. The step-up will be the difference between an applicant's statutory minimum, and the quantity of withdrawal resulting from the proportional adjustment process.

The step-up will be authorized for withdrawal in full, with the condition that this authorization may be modified once all permits are finalized and the proportional adjustment

factor is finalized. The condition will further provide that if the Authority is not able to authorize withdrawal of the full step-up quantity, the applicant will receive compensation in accordance with §711.176. The compensation will not be required (see discussion of buy-down, below). The Authority could not implement compensation until it adopts retirement rules in Subchapter H of Chapter 715. The effects of compensation will be assessed when those retirement rules are assessed.

Buy-down for waiver of application for withdrawal amounts. By definition, the proportional adjustment will reduce applications to 450,000 AFY of withdrawals, and the step-up will add withdrawals to that quantity. A working estimate is that at least 500,000 AFY of withdrawals will be eligible for permitting. To meet the cap, the Authority will undertake a voluntary compensation process as set forth in §711.182. Specifically, applicants will be offered money in return for agreeing to a reduced quantity of withdrawals in their permit, even to the point of a zero quantity. This approach would not affect the applicant's recognized maximum or minimum withdrawal amounts, or their proportional adjustment and step-up amounts, but only the final withdrawal quantity.

Assuming that at least 500,000 AFY of withdrawals will be eligible for permitting, then at least 50,000 AFY of applied-for withdrawals must be waived. The Assessment Team believes the Authority will succeed in the buy-down for many reasons, including the following.

- Large quantities of irrigation rights will be eligible for permitting. These privately held rights would be readily exchanged under marketplace incentives.
- In accordance with the Act, base irrigation groundwater of each irrigator minimum will not be salable in the regular marketplace. The primary market value for this prospective right would be for applicants to abandon the claim if they are sufficiently compensated by the Authority.
- Applicants may settle contested applications in return for full or partial compensation, thus saving the costs of proving up the application. This is especially likely in the case of small applications.
- Presumably the Authority will be price competitive in the voluntary marketplace.

Summary of results. The values contained in the column "after step-up" in Table 6.1.2-B represent our best estimate of how §711.172 will affect representative applicants. Evaluations have been made using larger and smaller estimates of the proportional adjustment factor, and indicate relatively little effect. In large part this is because the majority of applicants will receive a permit for their statutory minimum, regardless of the adjustment. The size of the adjustment primarily affects the quantity of applications that will need to be waived through the buy-down.

- Irrigators who benefit from the step-up process by having their permits increased to 2 AFAY will get a permit for **2 AFAY**. For many such irrigators, this permit will authorize more withdrawals than the irrigator has ever actually used. Case B in Table 6.1.2-B illustrates this impact.

- Users with relatively high average use, and thus a high statutory minimum, can expect uninterruptible rights that will typically be in the range of **75% to 90% of their maximum use**, although some applicants may get a bit more and others less. In Table 6.1.2-B, this outcome is illustrated by Irrigator Case A and four municipal and industrial cases (C, D, E, F).

- Users whose historical use is relatively low or who operated for less than three years in the historical period can expect uninterruptible rights that are **70% to 75% of their maximum use**. If the buy-down succeeds, these are the only applicants whose final permit is determined by the proportional adjustment quantity. Permitted withdrawals for such applicants could be less than 70% if it turns out that total recognized historic maximums substantially exceed 640,000 AFY. In Table 6.1.2-B, Cases G, H and I illustrate such rights.

Note that these calculations assume that all water withdrawn by a user was put to beneficial use. Current Authority practice is to not recognize municipal withdrawals that cannot be accounted for. Even the best municipal utilities typically are unable to account for 8% or more of water used due to pipeline leaks and unmetered uses such as fire fighting. This effectively means that the Authority will reject 8% or more of most municipal claims before the proportional adjustment process even begins. For some utilities, the Authority may reject more than 20% of the amount claimed.

We have not explicitly quantified this effect, because in contested cases applicants will have an opportunity to show that unaccounted-for water should not count as waste. Further, we assume that if water is in fact wasted the utility can undertake conservation actions to reduce demand. Nonetheless, the possibility exists that for some utilities that did use withdrawals beneficially but are unable to prove it, the permit outcomes estimated above are too high by 10% or more.

6.1.3 Quantification of Total Permitted Rights

To predict the regional impacts of §711.172 and supporting components of the rules, it is necessary to predict the total quantity of permits that will be granted and estimate the actual pumping that will occur as a result of the permits. If one assumes that the permitting outcome from the voided rules (Appendix *MATRIX*) is a first approximation of the allocation of this pumping among applicants, then the result would be:

- Irrigation applicants would be entitled to 236,000 acre-feet of the 500,000 eligible to get permitted, or 48% of the total. Buy-downs, however, will reduce this to 186,000. AFY, or 37% of the 450,000 AFY withdrawal cap.

- Municipal and industrial water applicants would get about 49 264,000 of the 500,000 AFY eligible to get permitted, which is divided 241,000 AFY to municipal users and 23,000 to industrial users. These applicants will not participate in the buy-down. After the buy-down, this segment will hold 59% of the rights before water marketing begins.

- Industrial applicants would get about 5% of the allocation (roughly 23,000 AFY).

Actual values may vary. In particular, the voided rules tended to come down more heavily on municipal and industrial applicants than the rules now proposed, and the voluntary buy-down is most likely to bring about waivers of irrigation withdrawals. Therefore, the actual allocations may be slightly more favorable to municipal and industrial applicants than shown above. As a first approximation, 150,000 to 200,000 AFY of irrigation rights and 250,000 to 300,000 AFY of municipal and industrial rights are plausible.

The allocation to irrigation applicants will likely exceed the amount of water that has been withdrawn for irrigation in recent years (see discussion in Section 5.1.2). Conversely, the allocation for municipal and industrial use is certain to be lower than current demand. A reasonable expectation is that the municipal and industrial allocation will be fully used, but the irrigation allocation may not be fully used. If so, actual pumping of uninterruptible rights may initially be less than 450,000 AFY.

Over time, the development of a marketplace (see Section 6.1.4) will shift rights from irrigation to the municipal and industrial sectors. However, given that the Act specifically requires that one half of the irrigation rights originally permitted are appurtenant to the land, and assuming that not all such rights are waived during the buy-down, some irrigation allocations may remain unused well into the future. Even though actual withdrawals from rights are likely to average less than 450,000 AFY, all subsequent projections of impacts to water levels and spring flows assume pumping equal to 450,000 AFY.

Use of withdrawal rights. The use of withdrawal rights will reflect at least two considerations: 1) the extent to which such rights may be interrupted during droughts, and 2) the relationship of the rights to demand. For purposes of this assessment, we estimate that withdrawal rights in initial regular permits will be usable at a rate equal to 94% of their face value. This is based on the following.

- The Authority's current planning assumes a maximum sustained reduction of rights of 15% during the drought of record. The reduction would be lower during less severe droughts, and no reduction would be needed in nondrought periods.
- Inspection of historical data suggest that droughts sufficient to force a reduction of pumping in the area of heaviest municipal demand may occur in 60% of all months.
- Assuming that during the 60% of drought months, the average reduction is 10%, then the net reduction in use will average 6% of the total withdrawal cap, or 27,000 AFY.

6.1.4 Quantifications with respect to the marketplace

In anticipation of the permitting rules in §711.172, a marketplace in Edwards Aquifer water rights has already begun to develop. Factors motivating the market place are noted in subsequent sections, but the essential factor is that market economics stimulate most municipal and industrial users, and some irrigators, to buy rights while simultaneously encouraging many irrigators and some industrial users to sell rights. A few quantitative attributes of the anticipated marketplace in uninterruptible rights are presented in Table 6.1.4 as background to discussions in subsequent sections. The principal conclusion reached is that

a large market exists for transfer of irrigation water rights to municipal and industrial purposes. The only two limits to this market would seem to be: 1) how much water is available at a given price 2) the presumption that the base acre-foot of irrigation rights cannot transfer.

Table 6.1.4
Quantitative Attributes Of The Anticipated Marketplace In Withdrawal Rights*

1.	Buyers will be seeking water: a) to replace Edwards pumping that is cut by the permitting process, including water lost due to the proportional adjustment and water lost due to findings by the Authority that certain withdrawals were not beneficially used; and b) to provide water for growing demands.
2.	Replacement water needs can be approximated by comparing recent municipal and industrial pumping, against the assumed allocation of uninterruptible rights. 1998 municipal and industrial pumping totaled about 308,000 AFY (see Appendix REGION). The assumed allocation of Edwards rights to the municipal and industrial sectors calculated previously is at least 265,000 AFY. If we assume that most buyers will, as a minimum, seek to acquire Edwards rights to replace the Edwards pumping they lose through regulation, there is a market for at least 43,000. AFY.
3.	The market to meet growing future needs depends on buyer policies. Based on demand forecasts, the potential market is several hundred thousand AFY. However, the largest utility, the San Antonio Water System, has a stated policy to meet growth demands from non-Edwards sources; and the second largest utility, the Bexar Metropolitan Water District, also is concentrating its supply efforts on non-Edwards sources. If this policy holds, then it is possible that the ultimate demand for Edwards water by municipal and industrial users will not exceed 100,000 AFY. Shorter-term growth, however, will probably have to-be supplied from the Edwards to some extent.
4.	The number of industrial users that may enter the marketplace is not known, but presumably demand from these users would total several thousand AFY. This is because several of the owners of larger industrial permits are now out of business or have a recent history of using less water than their Edwards claim would entitle them to. Industrial sales, therefore, could reduce the market for irrigation rights.
5.	The Act and rules specify that half the irrigation right is appurtenant to the land. Therefore, typically only 1 AFAY will be available in the market. In recent years, 80,000 acres have been actively irrigated; applications have been filed for more than 150,000 acres. In 1998, a dry year, irrigation pumping reported to the Authority was just over 131,000 AFY. This represents a bit more than 1.5 AFAY on active acres. Collectively all these facts indicate that some transfer of irrigation rights can occur without curtailing irrigation activity because of the following factors. • Some transfers will be from land not currently irrigated. • Some transfers will involve water not currently used. • Some irrigation will continue using the base irrigation right.
8	The Authority is a customer--and the only customer--for the assumed base acre-foot right on 115,000 acres. The total market is perhaps 50,000 AFY or more during the buy-down of applications discussed in this assessment and another 50,000 AFY by 2008 when the Authority complies with the requirement of the Act that withdrawals be reduced to 400,000 AFY. These numbers suggest that the Authority could conceivably meet 35,000 AFY of the buy-down requirement, or 70%, solely from base irrigation applications that have not been used in recent years.

*All the quantifications are approximate and intended to inform readers of the overall magnitude of what may occur.

Unit prices. Any economic assessment that relates to water rights must make assumptions about the price paid for rights. At this time, the Edwards marketplace has not matured to the point that prices are firm. It is probably unwise to make estimates of prices, because if the estimates are higher than the real market they may serve to artificially stimulate real prices upwards, whereas if they are lower than the real market observers may believe that the resulting economic analysis is flawed. The only solution is to state our

assumptions explicitly and ask readers to adjust the resulting impact estimates upwards or downwards, depending on what they believe the real market values to be.

For withdrawal rights, we rely on the fact that some actual transfers have occurred at a capital cost of $700/acre-foot of water right that can be withdrawn in perpetuity. That price, when amortized over 30 years at 6% interest, equates to an annual cost of about $50 per acre-foot of rights. We recognize some transfers may have occurred at higher prices, but also that prices in the past may have been too high because, in practice, a portion of the right obtained will prove to be interruptible because of critical period rules yet to be adopted. Note also that some unused industrial rights may enter the market. There is currently an active leasing market at an annual payment of $80/acre-foot.

To buy down permit applications to the 450,000 AFY level, we have estimated the cost at approximately $2,500,000 per year based on the following assumptions.

- The total quantity of rights acquired would be 50,000 AFY.
- The assumed price would be $700 per AFY.
- The acquisition would be financed by revenue bonds amortized over a 30-year period at 6%, or through equivalent structured settlements with individual applicants.
- Based on the above assumptions, the acquisition cost would be $50 per AFAY for each of the next 30 years.

The price of $50 assumes the buy-down will acquire only the 1.0 AFAY of each irrigation right that must stay with the land. That right has two possible uses: irrigation, or sale to the Authority for retirement. No such purchases have occurred, but given that there is only one buyer for the base right, the price will be less than for transferable rights. The value of $50 per acre-foot is the annual equivalent of

6.2 Costs Imposed by Aquifer-management Fee Rules

The results shown in this section were calculated with an Excel spreadsheet model, found in Table 6.2 on page 13. Because aquifer-management fees for agricultural users and nonagricultural users are treated differently under §1.29(e) of the Act, they are calculated separately here. Special retirement fees may be imposed if the Authority implements the mandatory compensation of §711.176, and will be imposed when permitted withdrawals are reduced to 400,000 AFY, which the Act requires by the beginning of 2007. Special retirement fees will be assessed when key implementing rules are proposed for Subchapter H of Chapter 715, relating to Regular Permit Retirements.

In practice, aquifer-management fees are already charged. Nonetheless, for purposes of the assessment we consider such fees to be a new impact of §709.62 and §709.64 of the rules. Moreover, when the permits are in place the total quantity of water rights against which fees are charged will be reduced, resulting in an increase in fees for each acre-foot that remains. Key considerations and assumptions for estimating the fees are summarized in Table 6.2 Based on this table, the aquifer-management fee per AFY for nonirrigation uses is calculated to be $ 30.29 initially and $24.30 after water marketing has occurred to transfer a

greater share of the withdrawal rights to the M&I sector. For irrigators, the fee would be $5.50 initially and $4.37 after water marketing has occurred.

Definitions in §709.1 define agricultural use as synonymous with irrigation use. As a result, all other agriculture users pay higher aquifer-management fees. Nonagricultural users pay fees based on authorized use, while agricultural users pay based on water used. The following process describes the fee-setting procedures found in §709.19 and §709.21.

1) §709.19 requires that for the first year in which fees are assessed under this process, the total budget requirements for management of the authority be divided by the total nonagricultural acre-feet permitted to arrive at a nonagricultural aquifer-management fee.

2) This fee is then multiplied by 0.18 to arrive at the aquifer-management fee for agriculture users.

3) Since total agriculture groundwater use will not be known in December when the annual budgeting and fee setting is done, the agriculture component of the total fee collections cannot be relied on to meet the next year's budget needs. Thus the agriculture fees get collected in the next year to be carried forward for the following year's budget. If agency requirements are relatively flat, this results in the next year's nonagricultural burden being somewhat less, and that results in smaller fees for agricultural users the following year. The ripple-through effect of the lag in collecting agricultural fees is illustrated by the model's carrying the calculation forward for four years. An average of the four years is then calculated.

The calculation for a given year is affected by several variables. One is the total amount of the Authority's budget. Although any expenditure of Authority money could potentially be considered an impact of this rule, we have not considered the absolute budget level to be part of this assessment of fee rules. Spending impacts of other rules that affect aquifer-management fees are addressed as an impact of those rules. The Authority has other minor sources of revenue that are not considered here. We have assumed a $9,200,000 revenue requirement from the aquifer management fees over first five years that the rules are in effect. If all or nearly all of the costs of contested case hearing were incurred in one year, the budget would need to be somewhat higher that year. Costs may go down somewhat once rules and permits are finalized, but these effects are assumed to be offset by inflation.

A second key variable is the relative proportion of agricultural and nonagricultural uses of the aquifer. As water marketing occurs over time, the share of nonagricultural use grows and the calculation of the nonagricultural fee will have a larger divisor and thus a smaller fee per acre-foot. Both agricultural fees per acre-foot and total collections from the agriculture sector decline. We have assumed that initially there will be 265,000 acre-feet of nonagricultural water rights and 235,000 acre-feet of agricultural water rights. After water marketing has occurred, the split goes to 312,000 nonagricultural and 138,000 agricultural. Although water marketing may exceed the numbers depicted here, the assumption is that municipal and industrial users would lease any rights not needed for present demand back to irrigators.

Table 6.2 Projection of Aquifer Management Fees					
Year	1	2	3	4	5
Budget requirements, net of other sources ($)	9,200,000	9,200,000	9,200,000	9,200,000	9,200,000
Add: debt service on compensation for applications ($)	-	2,542,712	2,542,712	2,542,712	2,542,712
Less: balance forward ($)	-	(1,149,585)	(785,242)	(827,670)	(820,845)
Add: allowance for nonpayment ($)	187,755	216,186	223,622	222,756	222,895
Budget requirements from fees ($)	9,387,755	10,809,313	11,181,091	11,137,798	11,144,762
Less: beginning balance ($)	-	(1,149,585)	(785,242)	(827,670)	(820,845)
Net requirements ($)	9,387,755	9,659,729	10,395,849	10,310,129	10,323,917
Non-Ag permits and authorizations (AFY)	324,852	310,000	312,000	312,000	312,000
Non-Ag fee/AFY ($)	28.90	31.16	33.32	33.05	33.09
Non-Ag fees collected ($)	9,387,755	9,659,729	10,395,849	10,310,129	10,323,917
Ag use, average (AF)	221,000	140,000	138,000	138,000	138,000
Ag fee/AF used ($)	5.20	5.61	6.00	5.95	5.96
Ag fees collected in budget year for use next year ($)	1,149,585	785,242	827,670	820,845	821,943

The definitions in the fee rules have a significant impact on certain users in this rule. The Act prescribed that aquifer management fees for agricultural users be no more than 20% of nonagricultural users but did not define agriculture. It specifically referred to irrigation and irrigators in many instances and made important distinctions between irrigation use and other agricultural activities. The Authority, in §709.1, defined agriculture as irrigation only. Thus, aquaculture and activities related to agriculture, such as on-farm carrot washing, are subject to the higher nonagricultural aquifer management fee.

6.3 Hydrologic Effects of the Permitting Rules

Our assessment of the hydrologic impacts of the permitting rules has focused on the issue of whether instituting a cap on withdrawals in accordance with §711.172 at 450,000 AFY benefits the aquifer and provides protection of springflows. The effect of the cap is compared to current pumping rates in Section 6.3.1 and to unconstrained future pumping rates in Section 6.3.2. We also have briefly considered the effects of the marketplace, assuming that it will cause a net eastward shifting of pumping from western irrigation counties to eastern urban counties (Section 6.3.3).

Our principal measures of hydrologic impact are: a) average and low flows at Comal and San Marcos springs; b) aquifer water levels at key index wells; and c) the frequency with which water levels that may trigger drought-management actions occur.

6.3.1 Effects of a 450,000 AFY Cap Compared to Current Pumping

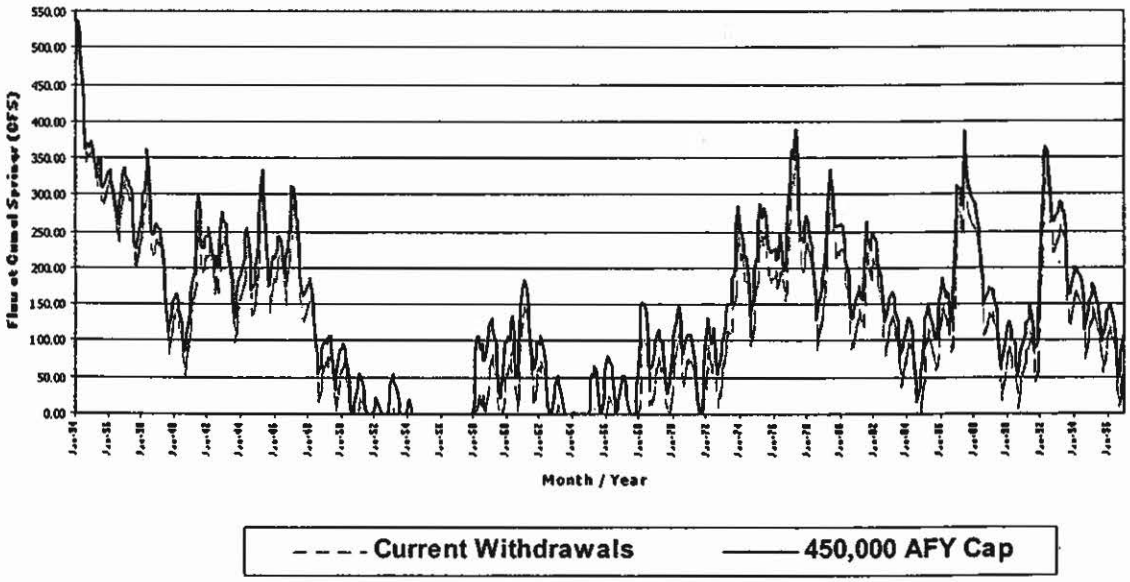
Comparison to current withdrawals. In 1998, a dry year, withdrawals from the Edwards Aquifer other than by stock and domestic wells totaled 440,000 AFY. The highest reported pumping—about 500,000acre-feet each year—by municipal, industrial and irrigation wells occurred in 1988 and 1989. For the 10 years ending in 1998, during which the area's population reached record numbers, the withdrawals from wells of the type likely to get permits averaged just over 400,000 AFY. Based on these estimates, it is not clear that a

withdrawal limit for initial regular permits of 450,000 AFY will cause pumping rates to decrease on average, although the cap would have an impact in some years.

A conservative assumption is that current pumping levels without a cap might equal about 485,000 AFY (excluding stock and domestic wells); this is the quantity of withdrawals the Authority estimated could qualify for permits under its voided rules. Appendix GWSIM reports on the results of simulations that assume withdrawals of nearly 485,000 AFY (Scenario A) and 450,000 AFY (Scenario B); the difference between the runs is an indication of possible near-term effects of the withdrawal limit. Selected results are included in Table 5.4.1-A and in the Appendix.

- Effect on spring flows. As discussed in Section 5.4, GWSIM outputs are somewhat inaccurate in absolute terms and tend to under predict the effect on spring flows, but the relative values may be reasonably used for comparison. The results of such comparisons indicate the following. Figure 6.3.1-A illustrates flows at Comal Springs for the two levels of pumping. Spring flow is clearly higher when withdrawals are lower. The comparison in Table 5.4.1-A indicates an average difference of more than 30 cfs, or more than 20,000 AFY.
- The effect at San Marcos springs is much smaller, about 3.5 cfs.
- The effects also are seen with respect to extreme flow conditions. One comparison is how often flow at Comal Springs would exceed 200 cfs if a cap were in place. The model estimates that over a period of 780 months the spring

Figure 6.3.1-A Effects of 450,000 AFY Cap on Comal Springflow



flow would exceed this amount during an additional 63 months, an increase over that experienced under current pumping rates of 8 percent.

- At the higher current pumping rate, Comal Springs is dry an additional 70 months, a difference of about 9%.

- The minimum spring flow at San Marcos is about 10 cfs less with the higher rate of withdrawals.

Effects on water levels. The GWSIM predictions of aquifer levels do not provide accurate absolute values, but alternative pumping rates can be compared in relative terms. At J-17, the difference in effects between the 450,000 AFY level and approximately 485,000 AFY level is more than 8 feet on average. The difference is on the order of 14 or 15 feet at the Hondo index well and J-27, in Uvalde County.

Using a rule of thumb that it costs 15 cents to lift an acre-foot of water an extra foot, and assuming a 10-foot difference overall, the total regional decrease in pumping costs resulting from the cap would be $675,000 per year.

Effects on critical periods. The term "critical period" is used here to refer to times of drought when aquifer water levels or spring flows drop low enough to trigger some interruption of withdrawals otherwise allowed by initial regular permits. By restricting withdrawals to 450,000 AFY, and causing higher water levels than if pumping were not so restricted, §711.172 will cause the thresholds for implementation of critical-period rules to be reached less frequently. GWSIM outputs do not reliably predict actual water levels, and therefore the model water-level outputs cannot be used to predict this effect. Using Comal spring flows as an indicator, and assuming a threshold of 200 cfs, the critical-period rules would be triggered 8% less often with the cap in place. The 60 cfs discharge at Comal Springs, which is the lowest target flow identified by FWS, would be reached about 12% less often. We are not able to predict the frequency and duration of critical periods in detail, because it is expected that such periods will be defined by water levels and index wells, and GWSIM does a poor job of predicting such levels.

6.3.2 Effects of a 450,000 AFY Cap to Unconstrained Pumping

Comparison to unconstrained future. An important effect of the initial cap is to constrain future pumping increases. Appendix GWSIM reports on the results of two simulations that assume unconstrained growth in withdrawals by municipal and industrial users. The higher projection of the two predicts the impacts if pumping were to reach just over 600,000 AFY. This is compared below to the predicted effects of withdrawing 450,000 AFY.

Effect on spring flows. As discussed in Section 5.4, GWSIM outputs are somewhat inaccurate in absolute terms and tend to under predict spring-flow effects, but the relative values are reasonably used for comparison purposes.

Figure 6.3.1-A illustrates flows at Comal Springs for an unregulated future and a regulated future. The difference is pronounced.

- Based on Table 5.4.1-A, an unconstrained future would drop the average flow at Comal Springs to less than 30 cfs. This is nearly 120 cfs less than the average flow that would occur with a cap in place. The difference is more than 85,000 AFY.
- The average effect at San Marcos springs is about 20 cfs.

- Comal Springs would be dry more than 67% of the time without the cap. Note that GWSIM probably under predicts this effect. This compares to 10% of the time with the cap in place. (Neither estimate considers management during critical periods.)
- If the drought of record were repeated, Comal Springs would be dry almost continuously for about 30 years.
- In the most severe drought, San Marcos Springs would be dry at the unconstrained pumping rate.

It is fair to say that an unconstrained future would effectively eliminate Comal Springs as an important source of water and severely impact San Marcos Springs during droughts. The proposed rules are designed to avoid this future, but the initial withdrawal cap by itself falls well short of meeting the target flows required by the U.S. Fish and Wildlife Service.

Effects on water levels. The GWSIM predictions of aquifer water levels do not provide accurate absolute values, but alternative pumping rates can be compared in relative terms. Throughout the aquifer, the effect of pumping more than 600,000 AFY would drop aquifer levels by 45 to 55 feet on average, compared to pumping with a cap of 450,000 AFY.

Effects on critical periods. The unregulated future presumably would mean no management of the aquifer during critical periods. That an unconstrained future would put the aquifer into a perennial drought condition would have no effect on aquifer management. Quantitative effects of an unconstrained future on drought management are not relevant and not assessed.

6.3.3 Hydrologic Effects of the Marketplace

If, as predicted here, the imposition of a withdrawal cap will motivate marketplace transfers of water rights from the irrigation to the municipal and industrial sectors, then over time more of the authorized 450,000 AFY will be withdrawn from the eastern region of the aquifer near San Antonio and along the I-35 corridor.

Appendix *GWSIM* reports on simulations that assess the relative effects of this shift on spring flows and water levels (for example, Scenario G, which concentrates pumping in the east, and Scenario F, which concentrates it in the west). Some of the evident impacts are as follows.

- Concentrating pumping in the eastern part of the area would reduce average spring flows at Comal Springs by perhaps 10 cfs and at San Marcos Springs by 2 cfs.
- The changes in flow would be paralleled by a small increase in the number of months when Comal Springs is dry and in the number of months during which critical-period rules would be in effect.
- Aquifer water levels would be lower in the eastern area by about 3 feet, but would be higher in Medina County (3 feet) and Uvalde County (20 feet).

These effects are relatively small. Moreover, any such reduction in spring flows is offset by the larger effects of the overall cap (see Sections 6.3.2 and 6.3.3). From the perspective of protecting spring flows, the small adverse effects shifting pumping concentrations would seem to be a reasonable outcome, given the much larger benefits that arise from constraining overall withdrawal rates. If irrigation rights were converted to municipal use in place, and water transported by pipeline from western to eastern areas, these effects would not occur.

6.4 Direct Economic Effects of the Rules on the Irrigation Economy

6.4.1 Overview of Effects

By implementing the Act, the proposed permitting rules will have a generally adverse impact on the irrigation sector of the overall regional economy, but may bring substantial benefits to individual owners of irrigation-water rights. The factors we considered in assessing these effects are summarized in Table 6.4.1-A.

The essential point arising from this table is that individual circumstances among irrigators will vary so greatly that there is no one outcome of the rules. Individual permit holders will have their own reasons for deciding to continue irrigation (perhaps with some change in practices), market their water rights, cease irrigating but hold onto their rights, or adopt some combination of the possible alternatives.

The many and dynamic factors that may affect actual irrigation activity in the future are beyond the scope of this assessment. Only the impacts of a reduction in available water have been considered. User-specific effects are beyond the scope of any assessment method.

Prediction of Direct Effects

The EDSIM model described briefly in Section 5.5, and more extensively in Appendix *EDSIM*, was developed by economists at Texas A&M University for the specific purpose of simulating many of the factors discussed above and predicting how the irrigation economy will respond to Authority regulation. The model deals principally with economic factors and regulatory limits, and not with factors, such as personal situation and availability of alternate supplies, that are likely to vary among users.

Table 6.4.2-A. Factors Responsible for Effects of Permitting Rules on Irrigation.	
Changes in condition for individual irrigators	
1.	Individual irrigators will receive an initial regular permit for at least 2 AFAY. Irrigators who used more will no longer be able to pump as much as they can beneficially use.
3.	The regulations will create a marketplace in which farmers can sell or lease some or all of their irrigation rights. For each acre with a permitted right, 50% of the right is appurtenant to the land. It is assumed that some owners will market all or a portion of the rights that are not appurtenant to the land to municipal and industrial users and a few very high-value irrigators. The Authority itself will be the only market for the base irrigation right, through the voluntary compensation program.
Individual circumstances that bear on the significance of these effects	
	The effects of these changes will depend on the circumstances of each irrigator, and thus may be different for each individual farm enterprise. Among the many factors that will affect a specific irrigator are the following.
1.	How the permitted water supply matches the needs of the farm. In some cases, the allocation will exceed crop irrigation requirements, creating "paper" water that can be sold or leased with no adverse effect on irrigation. In other cases, the allocation may be close to demand, so that there is no margin of safety. The result would be increased risk of inadequate water in dry years. And in some cases, the supply may be plainly inadequate when compared to the needs of crops historically planted or to the future needs of an orchard that is not yet mature.
2.	The price that can be obtained if rights are sold or leased to municipal and industrial users compared to the marginal value of water used for irrigation. For water actually used in irrigation, that marginal value has been approximated at an average of $40/AFY (BBC, 1996); for paper water it is essentially zero. A related factor is the perception about future prices. If it is believed that prices may escalate, owners may wish to continue farming and market their rights later or only through leases with fixed terms. If it is believed that the market for rights will be satisfied quickly, the opposite decision could be made. Another factor is whether or not there may be additional financial incentives to cease irrigation, such as the federal Crop Reserve Enhancement Program (CREP) discussed in Section 2.3.
3.	Other costs and benefits of the rule. Fees could represent 6% or more of the marginal value of water throughout the region of $109. This cost may be offset to some extent by reduced pumping costs in areas (especially where irrigation transfers occur) where aquifer levels could be higher in the future. Specifically, irrigating from medium- and low-lifting cost wells in Uvalde County actually becomes more profitable by 4% or 5%.
4.	The extent to which a market in water rights exists. The largest potential buyer, the San Antonio Water System and its partners in the Regional Water Resources Development Group, have indicated an interest in obtaining only sufficient rights to offset what is lost through the rulemaking process. They anticipate meeting growth in demand with non-Edwards water. The second largest buyer, the Bexar Metropolitan Water District, is also focusing on non-Edwards supply. Significant quantities of industrial rights may be available in the marketplace. The long-term market will depend on the extent to which municipal suppliers do in fact use Edwards rights to meet growth in demand.
6.	The ability of farmers to modify water-use patterns in cost-effective ways. For example, replacing flood-irrigation systems with center-pivot systems can reduce water demand, energy use, and labor costs without changing cropping patterns or yields, though there will be at least a 21%loss of acreage in field corners. The net benefits of replacing systems still must justify the investment. Factors such as the availability of low-interest conservation loans (for example, the federal EQUIP program and a similar San Antonio Water System program) can substantially improve the value of this approach for individual farmers. Overhead irrigation of certain vegetables has its limitations in any event because at certain points in the crop cycle, rain or overhead irrigation can cause spotting on the finished product and detrimental effects on price. Other approaches to changing water use include changing the crop mix, eliminating double cropping, and reducing the acreage planted, all of which can affect revenues.

Continued on next page

Table 6.4.2-A continued	
7.	Whether users have access to other water supplies (for example, surface water from Medina Lake or ground water from the Austin Chalk formation); have more than one farm and an ability to concentrate reduced water rights on the best fields; or are situated where conversion to dryland farming or grazing is viable. We have assumed that irrigators cannot compete with municipalities in the water rights marketplace and that the option of acquiring additional water rights for use in irrigation will be affordable only for a limited number of farmers who grow high-value crops.
8.	Whether farmers may use their land in other ways. Much irrigated land is within commuting distance of San Antonio and is subject to pressures for urban or suburban, development.
9.	A wide variety of external factors that affect profitability. These include prices for the crop mix being grown, location of buyers (hence transportation costs), government farm programs, competition with foreign producers, and lending policies of financial institutions. To some extent this simply recognizes that owners of profitable farms will more likely to continue irrigating than owners of marginal farms. But more fundamentally, it recognizes making irrigation profitable depends on many factors beyond the control of individual farmers, only some of whom are potentially affected by the Authority rules.
10.	Personal intangibles. Whether the owner is a working farmer, absentee landlord, part of a family with a strong farming tradition or approaching retirement age are examples of factors that may affect an owner's interest in marketing a right or the time at which the right is offered for sale.

The most important results of the EDSIM model are summarized below. Except as noted, all simulations assumed that irrigation users would have a permit equal to 2 AFAY of uninterruptible rights. Income and other aspects of dryland agriculture were not modeled. The model runs referred to in Table 6.4.2-B are identified in Appendix EDSIM.

Table 6.4.2-B
Description of EDSIM Model Runs

Model Run	Simulation Name
Current conditions, no regulations	98Base
Irrigators get full 2 AFAY right and Authority is in market for base acre-foot; irrigators pay 18% of M&I fees	98450+sec+ex+ag20
Regulation, but market transfers banned	98450+sec+noex
50% growth in M&I pumping, no regulations	50Base
50% growth in M&I pumping, regulations	50450agmax18

Decline in irrigated acreage. Given current (1998) irrigated acreage within the EAA area of 79,891 acres, the model predicts a decline to 69,869 acres after the rules take effect, a reduction of 10,022 acres, or about an 12.5% reduction. In comparison, a model scenario that did not allow marketplace transfers predicted a reduction to 71,706 acres, or 8,185 acres less than at present. Thus, the marketplace fails to explain the bulk of the reductions. Inspection of the model output sheets (Appendix *EDSIM*) data indicates that almost all the reductions are of acres that are double-cropped. For these acres, the effect of the rules is to restrict water supply to less than demand, forcing a change in cropping practices. These effects are overstated to the extent that some irrigators may receive a permit for more than 2 AFAY.

Decrease in water withdrawn for irrigation. The model estimates 221,343 AFY of water use for the 1998 level of acreage, assuming a weighted mix of dry and wet years that reflects conditions during the historical period, 1934-98. With the proposed rule, this would decline to 143,642 AFY. The absolute values are not entirely consistent with Authority

records of water use, but the proportional change should be reasonably representative of what may occur. This change represents a reduction in water use of 35%.

Thus the rules are predicted to reduce irrigation withdrawals by more than one-third. More than half the effect occurs in Uvalde County due to the impact on double cropping. Effects in other counties are probably more related to marketplace transfers or changes in pumping rates (see subsequent discussion).

Decline in irrigation income. For the 1998 weather conditions, the estimated income from irrigation farming is $15,587,000. With the proposed rules in place, this declines to $13,040,000. The irrigation income loss is $2,547,000, or 16%. This measure of direct effects does not encompass the whole economic story, for reasons discussed below and in Chapter 7.

Market transfers of water rights. The model shows about 500 AFY of irrigation rights transferring within the agricultural community, presumably to very high value vegetable crops and double cropping users. Another 56,300 AFY transfers to municipal and industrial uses. Those transfers are summarized in Table 6.4.2-C.

Table 6.4.2-C
EDSIM Estimates of Market Transfers of Water Rights under Proposed Rule (AFY)

County	Transferred out of irrigation	Transferred to municipal use
Uvalde	29,200	800
Medina	17,700	1,200
Bexar	9,400	46,500
Comal*	0	5000
Hays*	0	2,800
Total	56,300	56,300

* Model includes irrigated acreage from these counties in the Bexar County total.

Transfers from Uvalde and Medina Counties to Bexar and other I-35-Corridor counties clearly dominate the marketplace. As noted previously, much of the decline in actual irrigated acreage and withdrawals is accounted for by farmers double cropping approximately half as many acres as before. This indicates that the transfer of substantial water rights has had little impact on actual irrigation activity.

That result is expected, given that claims for Edwards rights have been filed for more than 150,000 acres, and some 130,000 acres are provisionally verified as having been irrigated during the historical period. A great deal of farmland that is not actively irrigated at present may nonetheless get water rights. The existence of such "paper" water is consistent with the other model results and indicates that many marketplace transfers will involve inactive rights.

One effect of transferring inactive rights is that the paper rights will be exercised by their new municipal- and industrial-sector owners through withdrawals from Edwards wells. The effects of the rules will largely offset this effect, especially the proportional adjustment process, of reducing permitted withdrawals from these wells.

Voluntary buy-down. The model predicts 43,600 AFY of applications will be bought by the Authority at $30 per year in order to achieve the 450,000 AFY withdrawal limitation. Some may consider this price to be too low. The fact is there is generally no other alternative for an applicant to monetize that asset, and sellers will ultimately compete with each other to set the price at whatever level develops. The important point to understand with respect to the buy-down is that EDSIM achieved this result with an input assumption that sellers would sell for the marginal value of water plus $30, and found the marginal value of water on 43,600 AFY to be $0.

Water payments. The model simulates that the transfer of irrigated acreage will result in payments of $4,551,600 per year from buyers to sellers. This is just over $80.00per acre-foot, whereas the model assumed transactions starting at $50.00 per acre-foot. Therefore, the simulation results indicate that the market prices will be higher as greater quantities are demanded by municipal and industrial users, though they will still be lower than the $80.00 that is currently representative of short-term leases. Within the agricultural community, those who lose income tend to be the active farmers who continue farming, and those who gain income tend to be those with dormant rights.

Change in returns. The EDSIM results include estimates of financial return to land and fixed assets per acre of irrigated land. Returns for the 1998 condition range from $116 to $173 per acre, and are highest in areas where the costs to lift water are lowest. The return in Bexar County is slightly greater than in Uvalde County, while returns in Medina County falls between the two. With regulation, these returns drop as much as $86 per acre. The impacts are especially felt in Bexar County, because there the marketplace allows pumping to increase as withdrawal rights transfer from the west, so that pumping lifts also increase. Returns increase in low and medium lift areas of Uvalde County.

Change in risk. One EDSIM outcome is an estimate of the variation in income that occurs between wet and dry years. This variation is a measure of the relative risks that farmers experience because of unforeseeable weather. With the rules in place, the risk increases by more than 4%, because restrictions in water supply imposed by the rule expose irrigation enterprises to greater economic risks than if pumping were not constrained.

Comparison to effects of unconstrained growth. In the absence of regulation, municipal and industrial pumping is assumed to increase in response to population and economic growth. That pumping would lower aquifer levels and increase pumping costs to irrigators. The model indicates that a 50% increase in pumping for municipal and industrial consumption over the next 25 or so years would result in no reduction of irrigated acreage, but that irrigation withdrawals would decline to 193,900 AFY and income would decline to $10,920,000 from $15,587,000. Detailed inspection of these results confirms that, under these assumptions, the effect is entirely due to increased lift costs.

This result indicates that in terms of income, the agricultural community will be as affected in the long term by the lack of regulation as it will be in the short term by regulation. One difference is that without regulation, there will be no offsetting benefits from the marketplace for water rights.

EDSIM does not incorporate numerous other factors, such as demand for land related to urban growth, changes in federal programs, and foreign competition, that could contribute

to a decline in irrigation over time. If these factors prove important, then the impact of unregulated growth on the aquifer could be greater than the models have indicated.

Comparison to effects of growth, with EAA regulation. With regulation, the model satisfies the demands of municipal and industrial growth by marketplace transfers of water rights. The model indicates that an increase in municipal and industrial pumping of 50% over the next 25 years or so will absorb most of the rights for irrigated acreage (see Table 6.4.2-D). Of the approximately $8.2 million reduction in irrigation income, only about $3.5 million is a net impact of the rules. In an unconstrained future, the lifting costs associated with the lower aquifer level would reduce irrigation income by to approximately $10.9 million, not including income from water sales or leases.

Table 6.4.2-D
EDSIM Prediction of Effects of M&I Demand Growth If Satisfied From Irrigation Marketplace

	Current conditions	Future conditions
Irrigation withdrawals, AFY	220,800	56,500
# of acres irrigated	79,991	20,097
Irrigation income	$15,587,000	$7,399,000

These results suggest that the greater impact of the permitting rules will be in the more distant future. Note that irrigation withdrawals and acreage drop to about 25% of current conditions and income drops to 47% of current levels, reflecting the fact that the most productive acres are not bid out of production by the water prices paid by municipal and industrial users.

Major water suppliers such as the San Antonio Water System and Bexar Metropolitan Water District have expressed policies of limiting their marketplace acquisitions of water. If they do not limit their Edwards dependency, then even if the results are not as great as those shown in the table, irrigation will gradually decline. Assuming the model estimates are reasonable, by the time municipal and industrial pumping from the Edwards has increased by 50%, barely one-quarter of the acres now being irrigated would still be active. Since the remaining acres would mostly be devoted to high-value crops, the reduction of income would be less—to about half the current levels.

Summary. Within the agricultural community, the permitting rules will adversely impact farmers who now use the most water, and who will be most affected by withdrawal restrictions. The rules will tend to benefit those who own farms where irrigation is no longer practiced and who can market their water rights without any loss in income. The 24% decline in income will certainly be significant, but in purely monetary terms it will be offset for the region as a whole by payments to those who market their rights.

The analysis indicates that in the absence of regulation, irrigation will be stressed by increased municipal and industrial pumping. However, those impacts will be farther into the future than the impacts of regulation, which will be immediate once the rules are in force. The analysis also indicates that with regulation even greater long-term impact is possible depending on the extent that municipal and industrial users rely on the Edwards marketplace to satisfy their growth needs.

6.5 Economic impacts of §711.172 and Supporting Rules on M&I Users

6.5.1 Overview of Effects

Section 6.5 considers impacts of the permitting rules on municipal and industrial users in the EAA region. The proposed rules will have a generally adverse impact on these users, but may bring substantial benefits to individual owners of industrial rights in one or more of the following ways:

- The right to withdraw water will be subject to limitations. Under the assumptions described in Chapter 4, all municipal and industrial users would receive a permit for withdrawals substantially less than their maximum during the historical period. Using Table 6.1.2-B as a guide, typical municipal or industrial users' withdrawal rights will be 70 to 90% of their maximum historical use.
- Additional costs, including annual EAA fees that are now $18 per acre-foot of authorized withdrawal, will increase when permits are issued and fees are no longer collected on the basis of interim authorizations. In the future, costs are estimated to range between $32 and $36 per year for each acre-foot permitted (see Section 6.2) Compared to an unregulated future, aquifer levels will be higher and pumping lifts and energy costs will be less.

The effects of the rules will depend on the circumstances of each user. The basic issues are whether or not the permitted supply is adequate to meet existing and projected needs, and whether or not the user can easily pass on increased costs.

Some users who have reduced their Edwards withdrawals over time, and for whom a permit at 70 to 90% of historical maximum use may meet or exceed current and foreseeable needs, may actually experience a windfall from the market. That potential benefit is not further assessed in this document.

The vast majority of users, including almost all municipal suppliers, will find the Edwards withdrawal rights in their initial regular permits to be inadequate to meet current needs. For many utilities, the gap between need and permitted withdrawal will widen as population and water demand increase in the future. Users who experience shortfalls can be expected to invest in new water supplies, and, based on information now available, such supplies are available. The issue for them is thus one of cost and project lead times.

Most municipal and industrial users are utilities that charge rates to their customers. Generally, the increased cost of water can be passed on to these customers, because municipal water uses generally have a high economic and social value. Put simply, cities typically can afford to pay for water. We have identified no communities that would by choice or necessity go short of water to avoid rate increases. Still, the rate increase would be considerably greater than would occur in the absence of regulation, and this is a definite effect of the Act and rules.

6.5.2 Estimate of Rate Increases based on a Hypothetical Case

To assess the effects of the permitting rules in §711.172 and the fee rules in §§709.19-21on municipal water rates, we have developed a hypothetical case study. The

example is based on a water system that has a steadily growing demand for water (Case D in Table 6.1.2-B). We assume that this utility will need to acquire water supplies to: 1) replace the lost Edwards supplies that it had developed historically and 2) meet its future needs. The utility also will experience new costs in the form of EAA aquifer-management fees; and may get some benefits from regulation through slightly higher aquifer levels and lower pumping costs.

Our assumptions about the hypothetical utility are detailed in Table 6.5.2-A. The assessment below uses these costs to evaluate two specific scenarios. In both scenarios, the assessment projects the utility budget as it will exist five years from now after the utility has: 1) experienced 10% growth in both demand and customer base; 2) put aquifer-management fees in its budget; 3) obtained Edwards Aquifer water rights sufficient to replace rights lost due to regulation; and 4) invested in new supplies sufficient to meet demand 25 years into the future. Thus the resulting estimates of rates are for the year 2005 but include costs for future expansion.

Table 6.5.2-B compares the change in costs and revenue requirement for a hypothetical utility, which must choose between acquiring water supplies for future growth from Edwards water rights or developing a more costly alternative.

Table 6.5.2-A
Assumptions Used to Assess Effects over a Five-Year Period, on a Municipal Water Utility that Develops Alternative Water Supplies Once Edwards Pumping is Capped

Existing characteristics of utility.	Existing demand is 1,000 AFY, including 100 AFY of unaccounted-for water. There are 2400 hookups serving 6,000 people. The average monthly water bill is $12.50. The annual revenues are thus $360,000. Revenues are sufficient to pay all costs. The existing supply is Edwards wells. The Edwards supply costs $80/acre-foot to produce, of which $20 is for operations. The remaining utility budget ($117/hookup/year) is for water storage and distribution, hydrants, customer service, unaccounted-for water, water conservation, and administration.
Projected demand.	Demand is growing at 20 AFY (2 percent) per year and will reach 1100 AFY in 5 years, and 1500 AFY in 25 years. Customer accounts grow in parallel. In 5 years there will be 2640 accounts, and in 25 years there will 3600 accounts. Each account is assumed to add $150/year in revenue, if there are no rate increases, and $117/year in nonsupply costs. In this part of the assessment, we ignore growth in demand between the close of the historical period and the present.
Assumptions about the outcome of regulation.	Based on maximum use in the historical period, the user applies for 1,000 AFY and is able to demonstrate that the 100 AFY of unaccounted water was not waste. The user claims a statutory minimum guarantee of 850 AFY based on average historical use, and this is the quantity authorized for withdrawal in the interim regular permit. (See Case D in Table 6.1.2-B, intermediate estimate.) The 850 AFY of uninterruptible rights are calculated to have a firm yield of roughly 94% of face value, or 799 AFY. The utility therefore needs 201 AFY of water to get back to the 1,000 AFY it started with.
Fee costs.	The EAA aquifer management fee is assumed to be $33/AFY for each acre-foot of permitted rights, including interruptible rights and any rights acquired in the marketplace. For the 850 AFY of permitted rights, this is an annual cost of $28,050.
Program to acquire water supplies.	The utility has an immediate need for 201 AFY to restore its firm water supply to 1,000 AFY. It also must be fully prepared to meet short-term growth demands of 100 AFY. It needs to invest in 400 AFY of additional water to meet the 25-year demand requirement.

Continued on next page

Table 6.5.2-A continued	
Costs of acquiring Edwards water supplies	Edwards rights are assumed to be available in the marketplace for an equivalent price of $80/AFY. Because firm yield is estimated to be 94% of face value, 106 AFY of rights are required for each 100 AFY of demand. Thus 212 AFY must be acquired to yield 201 AFY. These rights would cost $17,120/yr for rights and $6,966/yr for fees, or $24,086/yr total. The costs of items such as wells and treatment are assumed to be built in to the existing utility budget, as the indicated amount of Edwards water is already being produced. For growth, each 100 AFY of firm supply derived from the Edwards would cost $8,480 to buy 106 AFY of rights, $3,498 in annual aquifer management fees, and $8000 in annual costs to actually produce the water. This is $11,498/year in fixed costs to which must be added another $8,000/year if the water is actually produced for a total of $19,498/AFY. Acquiring a 25-year supply in advance of need would cost ($11,498 *5=) $57,490/yr.
Costs of acquiring non-Edwards supplies	These costs are highly variable depending on the alternatives selected, and are relatively large in the short-term because the utility is investing in supplies that will not be fully used before the five-year planning horizon. Options range from less than $500/AFY to more than $1,000/AFY. Here we assume $750 as the annual cost to the utility for each acre-foot of non-Edwards supply it develops. This cost is assumed to include $180/AFY for variable operating and maintenance costs, $70 in fixed operating and maintenance costs and $500 to amortize a capital investment. To restore its firm supply to 1,000 AFY, by acquiring 201 AFY, the utility would pay $150750/year. Each additional 100 AFY will incur $57,000/year in fixed costs, and additional $18,000/year if the water is actually produced. To acquire the 500AFY needed for growth would thus cost $375,000, exclusive of variable production costs.
Savings from regulation.	With regulation, pumping lifts would be reduced by about 3 feet, which is estimated to save $.45 AFY of Edwards supply pumped. Applied to 1000 AFY of Edwards water, this is a savings of $450/year.
Other considerations.	These values do not account for increases in utility costs that may be associated with storage, distribution, and other facilities. Wastewater costs are not included. We have not accounted for revenues that may be acquired through hook-up fees, development charges, or stand-by charges. Nor have we accounted for potential cost reductions that may result if new supplies are funded through low-interest, government-supported loans or the effects of rates and other programs on water demand.

Figure 6.5.2-B
Impact of Rules on Water Costs
Assuming Growth with and Without Edwards Supplies

	Growth from Edwards Supplies	Growth from Non-Edwards Supplies
Current revenue	$360,000	$360,000
Fee costs on permitted supply @ $33/AFY:	28,050	28,050
Costs to restore Edwards supply to 1000 AFY:	24,060	22,470
Investment now in water suppliers for the next 25 years:	59,780	285,000
Costs for producing new Edwards water for next 5 years:	8,000	18,000
Savings in pumping costs:	(450)	(450)
Total revenue requirement under rules	$479,800	$713,525
Cost/residential bill/month--base case--	12.50	12.50
Cost/residential bill/month—with rules	16.25	24.17
% Increase	30%	93%

The case is based on demand of 1,000 AFY. All the assumptions are designed to be scaled up or down proportionally. If we analyzed a utility with 100,000 AFY of demand, we would simply multiply all the demand-dependent assumptions in the table by 100.

The hypothetical case will not represent actual conditions for any one utility. However, the assumptions are believed to be generally consistent with actual conditions in the EAA area, including the costs of water and the rate of growth. If there is a bias in the assessment, it is that we have assumed existing water rates that are near the low end of current rates. This ensured that our assessment did not under predict impacts. For customers of most utilities, whose actual rates are higher than those assumed here, the impact of regulation will be less in percentage terms.

Low-range estimate: Growth from Edwards Supplies. In the first scenario, all the future water supply is obtained through the Edwards marketplace, and the utility buys now the rights it needs for 25 years. Table 6.5.2-B summarizes a calculation that shows the effect of this option in the utility's annual budget at the end of a five-year planning period.

The total revenue increase required is illustrated to be $106,920, or 30%. The total cost would be shared among 2,640 customers, and would be $176.86 per year, which equals a monthly value of $14.74. Compared to the assumed existing water rate of $12.50/month, this is an increase of $2.24/month or 18%. The rate increase is less than the total cost increase percentage, because it assumed that the water system has a growing number of customers to share the cost.

This is a reasonable estimate of *low-end* rate impact for a utility that only has access to Edwards water or that chooses to rely entirely on an Edwards supply. The costs would be less if the utility chooses to buy only enough rights to meet its immediate demands. Note that if the community is in a rural irrigation economy, it may to some extent cannibalize its own economic base. This effect can sometimes be offset, at least in part, by programs to reuse wastewater as irrigation water.

High-range estimate: incremental supplies from non-Edwards source. In the second option, the Edwards rights lost to regulation are replaced by water obtained in the Edwards marketplace, so that the user has 1,000 AFY of reliable Edwards supply. All the growth in demand is satisfied from a non-Edwards supply that requires considerable initial investment.[2] Table 6.5.2-B shows the effect of this option in the utility's annual budget at the end of a five-year planning period.

For this option, total costs almost double. The total cost would be shared among 2,640 customers, and would be $267.53/year per customer, or $22.29/month. Compared to the assumed existing water rate of $12.50/month, this is an increase of $9.79/month or 78%.

The following tables summarize an analysis of the hypothetical cases presented in Table 6.5.2-C and present the capital cost to the utility of the replacement supplies on a per-household basis, assuming the average household uses 2,400 gallons per month. Table 6.5.2-

[2] Discussions during the informal scoping suggested that if non-Edwards supplies cost $700/AF, then Edwards rights should trade at not much less. There are many factors that influence the price of water rights in the marketplace, with the cost of alternative supplies being just one. Also, the fact that Edwards rights are subject to regulation and curtailment during drought is one factor that suggests less than that of non-Edwards resources.

D shows the monthly revenue requirement of replacement projects assuming those capital costs are 30 years at 6% and that incremental O&M costs of the alternative non-Edwards supplies is $250 per acre-foot. In each case, the costs are lowest for Case C and highest for Case I, with the other cases falling in between.

Table 6.5.2-C
Estimates of Capital Costs of Replacement Water Supplies
(In $ per acre foot)

Supply Source	Capital Cost per Household for Capacity Acquired
Edwards--low case	250
Edwards--high case	320
Non-Edwards--low case	1,580
Non-Edwards—high case	2,000

Table 6.5.2-D
Estimated Additional Costs and Revenue Requirements
To Replace and Add Supplies per Household per Month
($)

Supply Source	Year 1	Year 2	Year 3	Year 4	Year 5
Edwards--low case	0.30	0.60	0.90	1.20	1.50
Edwards--high case	0.44	0.88	1.32	1.76	2.20
Non-Edwards—low case	2.00	4.00	7.00	9.00	11.00
Non-Edwards--high case	3.00	6.00	9.00	12.00	15.00

Discussion. We believe the two illustrations above represent a reasonable range of rate impacts for utilities that can or must sever their reliance on the Edwards as a sole source of supply. The near-term cost would be less if the utility were able to postpone some of the costs of its non-Edwards supply. It would be more if the utility invests in a higher-cost alternative than assumed here. We have assumed that no other aspect of the operation will change, which serves to isolate the impact of these rates from other effects that may occur.

With either option the utility could elect to collect the all or some of the cost of growth supplies in the form of an impact fee on new customers. In this way, growth that is more costly than the average service gets borne by the newcomers in the form of higher tap fees or other fees attached to new construction. This type of approach would lessen the rate impact on existing customers. Whether a utility chooses this approach depends on local philosophies about encouraging or discouraging growth.

The calculations demonstrate that it will be more expensive for utilities to acquire non-Edwards supplies than to enter the Edwards marketplace. Considering only economics, one would predict that most or all irrigation rights would transfer to municipal and industrial use over time. The principal constraint against this outcome is the policies of the largest utilities to diversify their water sources and limit their impacts on the irrigation economy. If these policies hold, then the majority of water customers in the region are likely to experience rate increases in the higher range.

Note that the monthly utility bill of $12.50 is very near the low end of what is actually observed in the area today. For communities with higher existing rates, the percentage increase in rates should be less than described above. These rate impacts should diminish in importance as the capital cost of the investment in the 25-year supply is spread over an expanding customer base. On the other hand, if growth continues into the future, the next water supplies are likely to be more expensive. The net result is difficult to predict, but on balance it is reasonable to expect that the long-term impacts are likely to be less than the short-term effects calculated here.

Obviously, presenting only two alternative budgets for a single hypothetical utility does not capture all the prospective impacts of regulations on utilities. However, based on our understanding of water-planning activities in the area, a projection that regulations will cause water rates to increase by 20% to 80% in the next 5 years appears reasonable, with a doubling of rates being a plausible worst-case scenario.

Information provided to us by the two largest water suppliers, the San Antonio Water System (SAWS) and the Bexar Metropolitan Water District, is consistent with this projection. For example, in its 1998 Water Resources Plan, SAWS estimated the cost of new water supplies at about $20/year per capita in the near term, and that would equal $5 to $8 per hookup per month. The higher value is in the range of the estimates given above.

To put the cost increases in perspective, they represent 5 to 10 cents per person per day. The resulting bills, of $15 to $22/month per customer, can be compared to water costs being paid by other Texas cities; see Table 6.5.2-E. Existing rates are in the mid-range of the predicted rates for utilities in the EAA area. Based on the comparison, it does not appear that unusually high costs will put suppliers the EAA area at a competitive disadvantage. Indeed, one interpretation of the results presented here is that the permitting rules will have the effect of bringing water supply costs in the San Antonio area up to state averages.

This analysis does not consider that with increased rates demand will decline somewhat because of price-elasticity relationships. Experienced utilities are generally able to take this factor into account and use it to delay the development of new supplies. Reductions in use may save on rates for individual customers, but the utility may have to increase its overall rates to pay for fixed costs. This will result in relatively little net change in what individual customers pay each month, even if they conserve water.

Net effect of regulation on regional economic welfare. EDSIM simulates the costs to municipal and industrial users of marketplace purchases, Authority fees, and changes in pumping lifts. The net increase in water costs calculated to cause a slight decrease in municipal and industrial water use due to price-elasticity. Probably that decrease would be in noneconomic uses such as lawn watering. But assuming that the economy is affected in proportion to the decrease in use, EDSIM estimates a decline in the municipal and industrial sectors of the economy from $631 million per year to $619million, a decline of $11 million. When the transfer payments to agriculture are included, the regional economic loss is projected to be $7.5 million.

6.6 Effects on Other Users

In general, users not described in Sections 6.4 or 6.5 are military, commercial, industrial, or institutional entities that acquire some or all of their water needs from their own Edwards wells. In most cases, their water requirements are stable, and they do not need to plan for substantial growth in demand. Under these circumstances, implementing the regulations will cut such users' Edwards supply to a value that provides uninterruptible rights of 70% to 90% of historical maximum use and require them to pay aquifer-management fees.

Some users may be able to accommodate this cut by adopting water-conservation measures or simply because their need for water has diminished over time (as, for example, a military base that has been downsized). Others will need to replace the lost supply, either by buying water from a major purveyor such as the San Antonio Water System (SAWS) or by entering the marketplace and buying Edwards water rights.

The general cost to this group of users can be estimated for a hypothetical applicant who has used 1,000 AFY historically, and whose initial regular permit is 800 AFY.

- Users in this category will typically have a much lower cost water supply, because of limited investment in distribution systems, standalone storage and fire protection, and administrative costs (for example, for billing, customer service). An annual cost of half the hypothetical municipal utility is assumed, or $180/AFY. This equals $180,000/year.
- We assume the applicant needs to acquire 200 AFY of Edwards water rights (that is, there will be some rationing of water during droughts), at a cost of $80/AFY or $16,000/year.
- A new cost would be aquifer-management fees of $25/AFY for the 100 AFY of permitted and acquired rights, or $2,500/year.
- Pumping costs could be reduced by $450/year due to the benefits of regulation in protecting pumping lifts.

The net effect is that source-of-supply water costs would increase by $3,650/year or just over a 20% increase compared to the cost prior to regulation.

Information provided by SAWS suggests that water rates for large commercial customers may increase to $1.60/thousand gallons in the next 10 years, or more than $500 per acre-foot. If the hypothetical user bought its incremental supply from SAWS, instead of acquiring marketplace rights, the cost would be more than $15,000 per year.

The EDSIM model calculates a municipal and industrial welfare value of more than $2,000 per acre-foot of water used. In theory, the economic value of the 100 AFY withdrawn by the hypothetical user should exceed $200,000. If so, most users may find an increased cost of $3,650 per year to be affordable.

Possible exceptions may include businesses for which a water supply is essential, but whose ability to pass costs on to customers is limited. Among them might be golf courses, aquaculture enterprises, nurseries, quarries, industries that need cooling water, and industries that need water for manufacturing processes. The Assessment Team invites comments from

users who believe that their economic status will be significantly impacted by the proposed rules.

Table 6.5.2-E.
Average Monthly Cost of Water for Large Cities in Texas, 1999

City	Population	Residential Bill (10,000 gal)	Commercial Bill (50,000 gal)
More than 200,000			
Houston	1,630,553	$27.55	$115.97
Dallas	1,030,150	$17.79	$77.64
San Antonio	972,400	$13.12	$59.09
Austin	613,458	$25.36	$125.42
El Paso	596,800	$14.51	$81.98
Fort Worth	484,506	$23.29	$99.09
Arlington	283,458	$25.20	$147.85
Corpus Christi	257,453	$19.19	$89.47
Plano	204,845	$14.92	$51.72
Garland	201,824	$18.73	$81.38
MORE THAN 200,000 Averages		$19.97	$92.96
100,000 - 200,000			
Lubbock	195,367	$22.86	$100.44
Irving	175,000	$23.95	$129.55
Laredo	166,000	$12.60	$57.40
Pasadena	157,615	$15.35	$57.75
Amarillo	127,500	$20.87	$107.27
Mesquite	116,350	$22.60	$102.60
Beaumont	114,000	$19.01	$82.61
Abilene	112,000	$15.85	$71.05
Grand Prairie	110,000	$30.26	$113.26
Waco	104,863	$20.35	$94.75
Wichita Falls	103,312	$16.88	$63.43
100,000 - 200,000 Averages		$20.05	$89.10
75,001 - 100,000			
Carrollton	97,500	$33.65	$168.41
Midland	97,458	$37.15	$133.15
Odessa	94,223	$26.08	$121.38
San Angelo	90,467	$17.38	$73.29
McAllen	84,021	$12.30	$52.30
Richardson	79,800	$23.43	$104.38
Killeen	78,313	$20.67	$91.87
Tyler	78,090	$21.96	$83.10
75,001 - 100,000 Averages		$24.08	$103.49

6.7 Effects of Other Proposed Rules

6.7.1 Direct Effects of Other Proposed Rules in Chapter 711

In accordance with Subchapter D, each applicant's interim authorization amount will be reduced to the amount contained in its proposed permit, inclusive of any step-up amount, beginning in the year following proposal of the permit by the Authority's General Manager. While this will reduce the fees paid by a typical applicant, it also will reduce their withdrawal authorization, with effects comparable to that of the ultimate permit. For some applicants this will come prior to resolution of contested issues, and has the potential to reduce withdrawals to less than will ultimately be authorized. However, applicants may enter into a contract with the Authority that will allow withdrawals at a higher rate. The contract option is intended to have the effect of ensuring that withdrawals are not reduced except with the agreement of the applicant or the explicit decision of the full Board, following formal procedures. One effect of the rule will be to continue to authorize, on an interim basis, withdrawals in excess of 450,000 AFY. This effect could continue for each of the first five years, unless and until such time as the initial permitting process is completed.

Subchapter E contains provisions that will limit the marketable water rights of applicants who co-mingle Edwards supplies with supplies from other aquifers. The limit is intended to reflect actual use of Edwards water. This may be perceived by such applicants as denying them a full 2 AFAY Edwards water right for each acre of land that received Edwards water.

Subchapter F, establishing permit conditions, makes withdrawals in every permit subject to future curtailments during drought, or as part of the equal percentage reduction to a total of 400,000 AFY of permitted withdrawals that the Act requires be accomplished by 2008. The rules that will effectuate such reductions or curtailments generally have not been proposed, and will be assessed when they are completed in draft form.

Subchapter L implements provisions of the Act that restrict the transfer of the base irrigation right, which is one-half the full right and thus typically 1 acre-foot per acre per year. However, provisions are included in the rule that will allow full marketplace transfer of the base right where it is offset by conservation of water; and a more limited transfer within the County of origin if the right is otherwise too restricted to be viable.

Subchapter M contains the requirement to install meters, an unavoidable cost to provide information necessary for enforcement of the rules and management of the aquifer and will impose an average annual cost of approximately $50 per meter on all owners of permitted wells.

6.7.2 Impacts Related to Administrative Burden

Numerous rules in combination will create an administrative burden on the regulated community. These rules include the following.

- Chapter 707 Subchapter D: Requirements to File Applications and Registrations
- Chapter 707 Subchapter E: Requirements for Applications and Registrations
- Chapter 707 Subchapter F: Actions on Applications and Registrations by the Authority"

- Chapter 707 Subchapter G: Contested-case hearings on Applications
- Chapter 709 Subchapter B: Registration Fees
- Chapter 709 Subchapter C: Permit Application Fees
- Chapter 709 Subchapter D: Aquifer-management fees
- Chapter 709 Subchapter E: Permit Retirement Fees
- Chapter 711 Subchapter B: General Provisions
- Chapter 711 Subchapter C: Exempt Wells
- Chapter 711 Subchapter E: Permitted Wells
- Chapter 711 Subchapter F: Standard Groundwater Withdrawal Conditions
- Chapter 711: Subchapter L: Transfers

Although any particular rule might carry a very small administrative requirement, we view the programmatic impact of all the administrative-requirement rules taken together as the appropriate measurement in this rulemaking context. In order to assess these rules, we considered a typical operator of one well over the next five years. Although reporting forms are not incorporated into the rules, the rules are sufficiently specific to make the draft forms presently used by the Authority representative of almost any other form that might be later adopted.

We then considered the likelihood that over the five years the operator might have to make repairs, replace meters, or transfer the withdrawal rights. In addition to the time and cost of gathering data and filling out forms, we also considered agency response times allowed or required under these rules and any potential impact for regulatory lag to impair reasonable access to the rights envisioned by the permits or authorizations of these rules. Assumptions regarding administrative time, out-of-pocket costs, and a discussion of other potential impacts are found in Appendix *BURDEN*. The administrative burdens of these rules are summarized in Table 6.7.2-A.

The declaration of historical use under these rules is required to already have been on file on the effective date of these rules, thus these rules impose no additional burden on an applicant. Most of these forms will be encountered at most once in a five-year period, with the exception of the annual water use report. These administrative burdens, taken together or by themselves, do not give rise to a material impact of these rules.

There are two important limitations of the assessment summarized in the table. First, it does not consider impacts of permit limitations or of fees, which are addressed earlier in this chapter, nor does it consider procedural impacts on those involved in Authority proceedings. Second, many provisions of these rules refer to other rules that have not yet been provided to the Assessment Team. We cannot and have not assessed the impact of the other rules at this time. When these rules become available, we will assess their impact by updating Appendix *BURDEN* to include the new rules in a cumulative assessment of their impact.

Table 6.7.2-A Administrative Burdens of Rules			
	Form Length, Pages	**Estimated Time Burden, hours**	**Additional Costs**
Well Registration Permit *§707.401 and §707.306*	2	1	$10 processing fee
Declaration of Historical Use *§707.405*	3	n.a.	$25 application fee
Annual Water Use Report	< 1	5	Aquifer-management fees
Meter Registration Form *§707.401 and §707.310*	1	1	$25 application fee
Notice of Tran7sfer/ *§707.401 and §707.414*	3	4	$25 application fee
Well Construction Application *§707.401 and §707.305*	4	7	$35 total--$25 for well construction and $10 for well application
Exempt Well Status *§707.401 and §707.308*	2	2	$25 application fee
Monitoring Well Operation Permit *§707.401 and §707.417*	2	1	$25 application fee
Term Permit *§2707.401 and §707.407*	4	5	$25 application fee
Emergency Permit *§707.401 and §707.408*	3	1	$25 application fee

6.7.3 Specific Effects of the Contested Case Process

Beyond determining permit amounts, the proposed procedural rules have significant impacts on certain aquifer users. Under §707.610 of the proposed procedure rules, the burden of proof in a contested case hearing is on applicants to establish by convincing evidence that they are entitled to their claimed withdrawals. Under §707.602, any other applicant or permittee can request a contested case hearing. §707.606 establishes that a request for a contested case hearing shall be granted by the board if it meets other procedural requirements and "is supported by competent evidence." §707.603 requires that the request for a contested case hearing must "provide evidence of specific facts which the person believes gives rise to the need for a contested case hearing."

Without further restrictions these provisions taken together have potentially large adverse impacts, particularly on small users for whom a contested case hearing can represent costs that are substantial relative to the value of the resulting permit. The requirement for convincing evidence was established after the end of the period for which the evidence is required. Thus users thus had no warning of the subsequent requirement to furnish detailed records of their operation. The necessary evidence may not exist for some applicants.

The potential burden will depend considerably on the willingness of other parties to bear the costs of contesting a case. In the discussion that follows, we point out the economic

incentives for the San Antonio Water System (SAWS) to do so. This discussion is not intended to characterize SAWS' motivation for the many cases it has contested, but to show how the rules make it advantageous to do so.

Specifically, SAWS has ample financial resources to challenge other permits and will be rewarded if it is successful, since some one-third of whatever withdrawal rights are denied will be reallocated to the SAWS permit (assuming the SAWS claims are largely successful). Any application that SAWS can get denied at a legal cost of $200 per AF denied has the same value as buying an AF at $600. SAWS would therefore acquire these rights at a rate somewhat below that which it has recently been willing to pay in market transactions. From SAWS' standpoint, getting rights to nontransferable irrigation groundwater denied is as productive as getting rights to the transferable portion denied. The economics for irrigators, however, are different. If we assume that the cost of a contested case hearing is the same for both sides, irrigators cannot afford as much per acre-foot in legal costs to gain a permit as SAWS can to contest one. The agricultural productivity of the nontransferable irrigation water, according to the scenarios examined in EDSIM, would often not be worth the cost of a contested case hearing.

The absolute size of SAWS, the applicant's burden of proof, and the motivation of the parties involved, suggests that inevitably some irrigators and other aquifer users who historically enjoyed use of the aquifer under the right of capture will be denied use of the aquifer in the future. The other potential negative impacts of the inherent conflicts built into the process include clogged hearing dockets, expenditures of legal fees by contestants that could have been more beneficially spent paying irrigators, and negotiated reductions in irrigators' permitted withdrawal amounts to avoid the high legal fees.

All of the negative impacts of these rules to small applicants produce mirror-image advantages to SAWS and, by extension, to other applicants whose permits will grow as other permits are denied. Each applicant benefits from SAWS' efforts to contest all other minimums since each applicant benefits from having every other average historical minimum set as low as possible. The benefit of the rule as written should be a reduction in the aggregate average historical minimum withdrawals that form the basis for the permits. Table 6.7.3-A shows the estimated cost to all parties of a typical contested case.

Table 6.7.3-A
Estimated Cost of a Typical Contested Case Hearing
(In $, except fact witness time in hours)

	Attorney Fees	Witness Fees	ALJ* Cost	Staff Cost	Total Costs	Applicant/ Fact Witness Time (hours)
Rate/hour	180	150	70	40		
SAWS	4,500	1,800	700	240	7,240	
Other Applicants	10,000	1,500			1,500	20
General Manager	4,500	1,500	700	720	7,420	
Total cost per hearing	19,000	4,800	1,400	960	26,160	20

Source: Personal contact with Agatha Wade of SAWS; Steve Walthour of EAA ; Ed Vaughn, Private Attorney

In the permit process under the old rules, approximately 500 applications were contested. Estimates of how many of these applications will actually go to hearing vary. Assuming 250 go to hearing at the above average cost per case, the total cost to all the parties are as shown in Figure 6.7.3-B below.

Table 6.7.3-B
Estimated Cost Of All Contested Case Hearings
($ In 000s)

	Attorney Fees	Witness Fees	ALJ* Cost	Staff Cost	Total Costs	Applicant/ Fact Witness Time (hours)
SAWS	$ 1,125	$ 450	$ 175	$ 0-	$ 1,750	
Other Applicants	2,500	375	0-	0-	2,875	5000
General Manager	1,125	375	175	180	1,855	
Total	$ 4,750	$ 1,200	$ 350	$ 180	$ 6,480	

Source: Personal contact with Agatha Wade of SAWS, Steve Walthour of EAA , Ed Vaughn, Private Attorney

Of course, the most severe impact of the contested case process to certain applicants will be denial of a permit, which is a real concern for a number of applicants. At least some are likely to fail to meet the burden of proof required to establish historical use. We have discussed this possibility, for instance, with Montelleros Nursery, a wholesale nursery operator whose permits the Authority proposes to deny because staff does not believe it has provided sufficient evidence to support its claim.

Although we have no opinion on the ultimate outcome of the Montelleros application, we believe it is an informative example of a water-intensive business that faces the worst possible outcome of the permit process. If this application is denied in its entirety, the nursery will have to replace an interim authorization of 390 AFY with a purchased right plus whatever is necessary for growth. If we assume that right will cost $1,000 per AFY and that the business will require a 440 AFY right, the nonrecurring capital investment will be $440,000. Such a purchase could be financed with a five-year note at 10% interest for approximately $116,000. These would be significant and undesirable effects for a business with annual revenues reportedly of $4,000,000 to $5,000,000 and 65 employees. In an otherwise bad economic climate, such costs could determine success or failure, but by themselves they should not endanger an otherwise-viable business.

6.7.4 Rules with no Substantive Effect

Certain procedural rules necessary for the administration of the Authority have no effect on the regulated community or the economy, other than through aquifer-management fees. The impacts of the costs of these functions, which are ultimately borne by the aquifer users, are assessed in aggregate elsewhere in this assessment. Proposed rules with no substantive effect are:

- Chapter701: General Provisions
- Chapter 702: General Definitions
- Chapter 703: Rulemaking Procedures (subject to prior assessment)
- Chapter 705: Jurisdiction

- Chapter 707 Subchapter A: Definitions
- Chapter 707 Subchapter B: General Provisions
- Chapter 707 Subchapter C: Meetings before the Board

7. Indirect Effects of Rules

Chapter 7 assesses those effects of the Draft Proposed Rules identified in Chapter 3 as indirect or secondary. Such effects ripple out from the direct effects, discussed in Chapter 6, of the rules on the aquifer and existing users. Chapter 7 is organized as follows:

- Section 7.1 considers one of the most important outcomes of a successful permitting process: Initial compliance with legal mandates.
- Section 7.2 considers the secondary economic effects of the rules. These are primarily associated with the predicted reduction in irrigation agriculture because of withdrawal limitations and development of a market for water rights. Secondary effects are those felt by businesses that supply irrigators, businesses that buy from irrigators, and governments that serve economies dominated by agriculture. Effects related to increased water costs in the municipal and industrial sector also may occur.
- Section 7.3 considers the downstream effects of the rules, including the extent to which the protection of spring flows described in Section 6.3 will benefit endangered species, enhance recreational uses of the springs, and increase water supplies in the Guadalupe River Basin.
- Section 7.4 considers an array of environmental impact issues that are appropriately part of any major assessment.

7.1 Initial Compliance with Legal Mandates

Adopting the permitting rules will be the first concrete step toward complying with the federal court decisions and state legislation that created the Authority. Such initial compliance yields at least two intangible benefits. One benefit is legal. As discussed in Section 2.1.3, direct federal control over Edwards pumping has been stayed to give the Authority the opportunity to do its job.

The second benefit is certainty. Controversies over the Edwards Aquifer, and the lack of strong management to resolve those controversies, have led to uncertainty regarding the water future of the region. Existing users do not know what rights they can count on and what costs they may incur to acquire or maintain water supplies. Discussions with the staff of the San Antonio Economic Development Foundation indicate that uncertainty about the future of water development has been a bigger problem in recruiting new industry than the absolute price of water. Many persons contacted while the scope of this document was being informally established indicated concern at which the Act is being implemented. These persons generally viewed the initial permitting rules (especially §711.172) as an important concrete step toward implementation. The comments were consistent with the South Central Texas Water Advisory Committee (SCATWAC) report, which stated, "...before one can manage water usage, it is necessary to quantify the initial rights of the aquifer users. It is not

possible to administer a plan or enforce limitations unless there is a base amount to work against."[1]

In summary, effective implementation of the Act through rulemaking should yield benefits by bringing order to management of the Edwards Aquifer, defining the secure rights of existing users, and otherwise reducing the current atmosphere of uncertainty. Such benefits, of course, are associated with many other costs and benefits that are discussed elsewhere in this assessment.

7.2 Indirect Socioeconomic Effects Within the EAA Boundaries

Several indirect economic effects will result from the proposed rules. The effects derive primarily from §11.172 and are discussed as follows.

- Section 7.2.1 considers indirect effects on employment and the agricultural sector resulting from the reduction in irrigation that will occur once a withdrawal cap is in place.
- Section 7.2.2 describes certain demographic and lifestyle changes that are likely to result from the proposed rules.
- Section 7.2.3 describes how the reduction in irrigation agriculture will affect the fiscal resources of local governments.
- Section 7.2.4 briefly reviews the effects of increased municipal water rates.
- Section 7.2.5 briefly discusses indirect effects on self-supplied commercial and industrial users.

7.2.1 Indirect Effects of Agriculture and Agricultural Employment

Section 5.5.2 and Appendix *IMPLAN* describe a generalized input-output model, IMPLAN, used to calculate how changes in irrigation agriculture caused by Section 711.172 will ripple through the economy as reductions in sales, income, and certain types of employment. Important economic results of the IMPLAN model are summarized below; demographic and social changes are described in Section 7.2.2.

Except as noted, all simulations assumed that irrigation users would have a permit equal to 2.0 AFAY of uninterruptible rights. No consideration was given to curtailment during droughts. The model assumes that the least profitable irrigated acres will convert to dryland farming in response to water deficits. The model runs referred to below are identified in Table 7.2.1-A. (See Appendix *EDSIM* for expanded definitions of each scenario.)

[1] South Central Texas Water Advisory Committee, 1998 Assessment Report

Table 7.2.1-A EDSIM Model Runs	
Model Run	**Simulation**
Current conditions, no regulations	"98 Base"
Proposed rule	98450+sec+ex+ag20
50% growth in M&I pumping, no regulations	"50450"
50% growth in M&I pumping, regulations	"50450agmax50"

Agricultural sales. Table 7.2.1-B shows EDSIM estimates of the revenue for irrigated crops. The effect of a withdrawal cap, including limits in pumping and the creation of a market for water rights, would be to reduce revenue of $30 million by $8.5 million per year, a loss of 28%. Most of this reduction is in cotton, which goes from 38% of the total revenues in the baseline case to 16% with the above assumptions applied.

Table 7.2.1-B
EDSIM Estimates Of Revenues For Irrigated Crops
Under Existing Conditions And Proposed Rules
($ millions)

Crop	Existing Condition	With Rule In Place	Change
Cotton	11.34	4.28	-7.06
Vegetables	6.94	6.77	-0.16
Feed grains	5.96	4.88	-1.06
Food grains	5.21	5.92	0.71
Other*	0.51	0.49	-0.03
Total	29.96	22.36	-7.58

*Hay, oil seeds, fruits Columns may not balance due to rounding

Other monetary indicators. IMPLAN provides several other indicators of secondary impacts, including those on regional output and gross regional product. Regional output is the total output including sales to and purchases from irrigated lands. Gross regional product is a measure of value added by agriculture. The effect of the rules on these indicators is presented (along with other variables) in Table 7.2.1-C.

Table 7.2.1-C
Estimate Of Financial And Employment Indicators
IMPLAN Model Before And After Rule Adoption
($ millions)

Variable	Existing Condition	With Rule In Place	Change
Regional ag. Output ($ millions)	47.27	35.25	-12.01
Gross regional product impact($ millions)	34.59	26.09	-8.50
Agriculture sectors employment (# jobs)	1291	1122	-169
Ag. Sectors labor income ($ millions)	17.15	12.45	-4.71

These changes generally reflect a decline in the irrigation sector that is in proportion to the decline in direct agricultural income. The 1291 baseline jobs generate an average of $13,284 in income. The jobs remaining with the rule in place generate $11,096 each. This is a marked drop in income for those who remain employed.

Secondary impacts from alternative scenarios are also in proportion to the direct effects predicted by EDSIM.

- Over time, the model predicts small secondary effects in the event of no regulation, because municipal and industrial pumping would substantially lower aquifer water levels thereby reducing irrigation income.
- Over time, regulation would generate large secondary effects if municipal and industrial users substantially increase their withdrawals by acquiring irrigation rights that substantially exceed those assumed in this study.

7.2.2 Impacts on Population and Lifestyle

Section 5.5.3 and Appendix *SAFE* describe the model known as SAFE, used in this assessment to calculate how changes in irrigation agriculture caused by Section 711.172 and §§709.19-21 will ultimately affect government fiscal resources. The current application of the model assumes that all effects occur in Medina County. The result overstates the effects because: 1) they will actually be spread over several counties, and 2) Medina County has the smallest economic base and will thus experience the greatest relative impact of change. The impact on other counties will be proportionally less.

One step in the model is to predict demographic and related changes that impact tax revenues. Thus, the model enables some insights regarding the socioeconomic effects of the rule. Our assessment considered the same scenarios described above for the IMPLAN model. The model results, summarized in Table 7.2.2-A, generally show changes of less than 1 percent compared to the baseline. With such small effects from a procedure that intentionally exaggerated the impacts as described above, there was no need for additional assessments of the impacts on individual counties when they bore only their proportionate share of the irrigation reductions.

Table 7.2.2-A
SAFE Estimates Of Demographic And Lifestyle Effects In Medina County Under Existing Conditions And Proposed Rules

Variable	Existing Condition	With Rule In Place	%Change
Population	29,095	-180	-0.60%
School age children	8,751	-40	-0.5%
Per capita income	$23,209	$81.20	0.28%
Net commuters out	4,185	-32	-0.80%
Unemployment rate	3.42%	0.0003%	0.8%

7.2.3 Fiscal Impact on Local Government

The SAFE model also predicts small effects on government fiscal resources. These are summarized in Table 7.2.3-A.

Table 7.2.3-A
Safe Model Estimates of Fiscal Effects
Assuming All Impacts are In Medina County
($ millions)

Variable	Existing Condition	Change With Rule in Place	% Change
Property tax base	859	-2.5	-.03
Property tax revenues	40	-.0118	-.03
County sales, hotel, beverage tax revenues	2.15	-.0114	-.7
Municipal sales, hotel, beverage tax revenues	7.73	-.032	-.6
School revenues	24.234	-.069	-.3

7.2.4 Effects of Higher Municipal Water Rates

Customers of water utilities, both in this region and elsewhere, will experience higher rates for a number of reasons unrelated to these rules. Perhaps the most significant factors affecting future rate increases are new EPA standards for toxic metals and other substances that will require significantly enhanced treatment. On a national scale, treatment costs will become a larger factor in determining the overall cost of water and will serve to dampen somewhat the importance of raw water cost to the total delivered cost of water. As growth in the region forces suppliers to turn increasingly to non-Edwards sources, the region's rate structure will be characterized as a mixture of 1) a cheaper-than-average base supply consisting of some 300,000-350,000 AFY of Edwards water and 2) a balance consisting of new supplies that cost more than the average. The combination of the two will move the region's water rates more toward the average bill in the state, shown in Table 6.5.2-C.

Figure 7.2.4 shows part of a rate forecast by the San Antonio Water System (SAWS) for its average residential and commercial customers. These forecasts are very much in line with the projections shown in the rate illustrations in Chapter 6. We have identified no group of users for whom the rate increases will be economically intolerable. SAWS did not project a 2005 number, but if we assume here that it is the same as the 2010 number for a household of four, these increases amount to less than $.08 per day per residence.

Table 7.2.4 SAWS Water Rate Projection (Constant $)				
	Residential		Commercial	
	10,000 gals/month ($)	% Increase	54,700 gals/mo. ($)	% Increase
1998	12.29		55.77	
2003	18.10	47.3	81.98	47.0
2010	21.34	73.6	88.22	58.2

Source: SAWS Water Resource Plan, 1998

Water rarely is a large budget item for businesses other than such local service providers as restaurants, hotels, laundries, and car washes. Cost increases affect their competitors at the same rate. Such businesses will manage to do one of three things.

- Absorb the cost increase,
- Pass it on to customers, or
- Reduce consumption enough to avoid either outcome.

Higher water costs and competitive forces will make conservation a high priority for many businesses and cause them to reduce their reliance on the most expensive sources of water. Over time, this will reduce overall demand for water, but the Edwards supply, because it will remain the cheapest, will nearly always be fully used. Some price increases to consumers of these services will probably occur, but we do not believe they will be noticeable in most cases.

Rate increases will to some extent be exported out of the region. To the extent that hotels, recreational attractions, golf courses, and restaurants are patronized by visitors from outside the region, the impact of price increases will be exported. Any cost increases incurred on military contracts would be either passed on the federal government through cost-plus contracts or as higher costs when fixed-price contracts are rebid. Our interviews with economic-development professionals in San Antonio indicated that uncertainty of supply, rather than the cost of water, was the big issue affecting industrial site selection. Given the many other compelling cost advantages of the San Antonio region, and its extensive draw as a tourist attraction, we do not believe the region will become economically uncompetitive because of this action.

The motivation to conserve water will change some practices and business patterns, however. More xeriscaping and a reduced emphasis on lush lawns will probably have an adverse effect on sprinkler systems sales, while water-saving appliances should become more popular. As the rewards for running a tighter system get higher, leak repair and associated construction will become larger items in city budgets. Meter repair and replacement programs will benefit certain companies while water well drillers will survive on maintenance work, replacement wells, and drilling in other aquifers.

7.2.5 Effects of Higher Costs and Lower Availability on Self-supplied M&I Users

Our networking has identified one aquaculture user whose business economics are likely to be substantially altered. This company had a business plan that envisioned a 20,000,000-pound fish farm and processing facility that would have required 46,000 AFY or more of Edwards water. We have made no independent investigation as to whether the plan to finance and build the operation was viable or whether, once built, it would be profitable. Under the assumption that it would have been viable, the business plan projected employment of 250 persons, most of them economically disadvantaged Hispanics. Under these rules and assumptions the Authority has used in the past regarding maximum historical use, this operation would receive a permit in the range of 14,000 to 15,000 AFY. Discussions with the president of the company indicate that this reduction in available water would by itself severely restrict the fish production and probably render processing unfeasible. Processing provides the bulk of the project's potential employment; thus the rules would prevent development of between 200 and 220 of these jobs, assuming that they would have developed without the permitting rules of §711.178 and the fee rules of §§709.19-21. A remaining issue is whether the fish-farming operation would be viable at the scale permitted by a water right of this size. If not, the impacts would include an additional 20 to 30 jobs.

Perhaps a more widespread issue is the impact of not receiving a permit at all, which is a real concern for a number of applicants whose permits the Authority proposes to deny. Our analysis in Section 7.6.3 of a worst-case scenario in which a water-intensive business was denied a permit, indicates that it would be unusual to find a business or industry, other than those specifically considered in this chapter, whose employment dropped significantly because its right was significantly reduced.

7.3 Downstream Effects

7.3.1 Effects on Spring Flow-dependent Endangered Species and Habitats

Section 5.6 presents information that summarizes judgments made by the U.S. Fish and Wildlife Service (FWS) regarding levels of flow at San Marcos and Comal Springs necessary to protect endangered and threatened species. We consider these values to be relevant for assessing the effects of regulation.

Our assessment of effects on spring flows (Section 6.3) indicates that Section 711.172 and other proposed rules are highly beneficial when compared to an unconstrained future that would eventually cause Comal Springs to be dry for decades on end and dry up San Marcos Springs during a drought equivalent to the drought of record. Regardless of controversies over the FWS numbers, it cannot be questioned that such effects would be devastating to the natural habitats and populations of the species. These species could only survive, if, indeed they survived at all, in artificial habitats. Based on our experience with the Endangered Species Act as it is now written and enforced, such impacts would not be tolerated.

On the other hand, the proposed rules by themselves do not prevent Comal Springs from drying during droughts, nor do they fully protect flow at San Marcos Springs. This is not inconsistent with the intent of the Act, because the permitting rules are simply the first

step and a necessary predicate for additional regulations that the Act prescribes. Those regulations include reduction of withdrawals to 400,000 AFY by 2008, special management actions during critical periods (droughts), and actions by 2012 sufficient to maintain continuous spring flows at Comal Springs and the San Marcos Springs—all rules that will be proposed and assessed at a later date.

7.3.2 Effects on Spring-dependent Recreation and Commercial Activity

Tourist attractions are affected by Edwards Aquifer spring flows in two different ways. Certain attractions benefit from pumping restrictions and higher spring flows. Water recreation facilities along the San Marcos and Comal Rivers directly benefit from higher flows, since faster river water affords more exciting tubing, canoeing, and rafting. Water recreation below Canyon Dam benefits indirectly from higher flow from Comal Springs since more water can be stored behind Canyon Dam for later release, significantly extending the period of desirable River conditions.

San Antonio attractions that use water from the aquifer will be adversely affected by withdrawal restrictions. The two most notable water-dependent recreational attractions in San Antonio are the River Walk (Paseo de Rio) and Sea World. The River Walk is located on the San Antonio River, whose flow has been enhanced by a mechanical system pumping water from the Edwards Aquifer into the river. Similarly, Sea World pumps substantial amounts of Edwards water for its needs. Withdrawal restrictions will affect these attractions as they will other aquifer users: they will experience higher costs and water supplies will be less reliable. In response to this, recycling plans are already underway to replace Edwards water with recycled water from other sources.

7.3.3 Effects on Users of Surface Water Rights in the Guadalupe Basin

Appendix *SURFACE* summarizes findings presented in the 1998 Assessment Report of the South Central Texas Water Advisory Committee (SCTWAC). The SCTWAC Report discussed in limited ways the impacts to the Nueces and San Antonio Basins, but the information contained in the report suggests that permitting decisions would have little or no effects in those basins. Results of the GSA-4 model were used to estimate the downstream effects of withdrawal limits imposed by the Authority.

The SCWTAC report concluded that a withdrawal limit of 450,000 AFY is not fully protective of downstream water rights, especially during a repeat of a drought similar to the drought of the 1950s. Water rights in the Comal River would be affected the most, with no water available for diversion for a period of more than two years. For purposes of this assessment, the key comparison is to a hypothetical future condition in which Edwards pumping is not constrained. While this scenario was not simulated by SCWTAC, their report does contain information indicating that a change in withdrawal rates of several hundred thousand AFY will have significant impacts. Increased shortages would be felt throughout the system, but especially in the upper reaches, including Canyon Reservoir. These impacts will be reduced with the withdrawal cap in place.

A more detailed assessment of downstream impacts will be appropriate for the 400,000 AFY cap, because downstream users are required to pay for part of the cost of meeting that cap. The SCWTAC report indicates that a 450,000 AFY is a beneficial start in protecting downstream interests but is not by itself sufficient.

The simulations also indicate that changes in spring flow resulting from a 450,000 AFY cap will be small compared to the overall water budget of the river system as it discharges into Guadalupe Bay. Thus, withdrawal limits imposed by the Edwards Aquifer Authority will yield relatively small benefits to the fish harvest or the bay and estuary ecosystems.

7.3.4 Effects on Bays and Estuaries

Edwards Aquifer spring flows are a component of the freshwater inflows to San Antonio Bay and the Guadalupe Estuary, where they help support a highly productive coastal fishery. The Texas Water Development Board has used a computer program to study the relationships between various hydrologic and ecosystem variables and calculate month-by-month inflow requirements based on predefined management objectives. Using inflow figures for the years 1941 to 1987, and corresponding fishery harvests, the recommended freshwater inflow target for maximum harvest yields a solution of 1,147,360 AFY, with peak discharges occurring in the spring. This compares very well with the average inflow of 1,147,000 AFY.

SCTWAC (1998) contains an assessment regarding the extent to which changes in Edwards Aquifer spring flow discharges could affect the inflows to the bays and estuaries (see Appendix *SURFACE*). When aquifer withdrawal rates of 200,000 AFY, 400,000 AFY, and 450,000 AFY were modeled, almost no difference was observed in the number of months of optimal flow that would have occurred in the historical period. The number of months of optimal flow into the estuary was only 8.5% lower with 450,000 AFY of withdrawals than with 200,000 AFY of withdrawals. By analogy, the effects of no regulation, and allowing a substantial increase in withdrawals would be small.

7.4 Environmental Impacts

7.4.1 Water Quality in the Edwards Aquifer

During past litigation, and in other forums, some have raised concerns that excessive withdrawals from the Edwards Aquifer could lower aquifer levels to the point that the "bad water line" would migrate into the freshwater zone, bringing salts and possibly toxic substances into the drinking water supply. Various studies have suggested that the control of the bad water line is geologic, rather than hydraulic, in which case this effect would likely to be minor, if it did occur. However, there is no actual experience at very low aquifer levels to confirm this theory, and even minor effects might be significant if they occur near a major spring.

To the extent that migration of the bad water line would pose a real problem, Section 711.172 yields a benefit because capping aquifer pumping forecloses a future in which

aquifer levels would reach and stay below historical levels. By themselves (that is, absent critical-period rules), the initial permitting does not prevent water levels from declining below historic lows during severe droughts.

7.4.2 Public Health and Safety

The proposed permitting rules allow substantial withdrawals of Edwards Aquifer water and include provisions for emergency permits to sustain supplies needed for public health and safety purposes. We have no basis for supposing that adverse effects to public health and safety will result from the rules. Authority rules that eventually protect the quality of water in the aquifer will probably be seen to have public health benefits. However, we have thus far not identified any specific public health or safety benefits from the proposed rules.

7.4.3 Environmental Quality

The proposed rules will favor a reduction in the amount of irrigated land and the subsequent loss of associated aesthetic and cultural values. For example, losses of tailwater environments may reduce habitats for some species. Where irrigated lands are converted to a grazing use, the gradual encroachment of brush may produce increase certain types of wildlife habitat. In urban areas, landscaping will increasingly use xeric plants and inert materials, which may be perceived as attractive by some and unattractive by others.

Indirectly, the rules will stimulate the development of alternative water supplies by the San Antonio Water System, the Bexar Metropolitan Water District, and others. Developing these alternatives may have substantial impacts in their own right, but such impacts are outside the scope of the current assessment.

The proposed rules will result in higher aquifer levels and lower pumping lifts than would be the case were no rules are adopted. This will conserve energy and reduce the negative impacts of energy production.

Except as described above, we have identified no impacts associated with the rules that would affect air resources, noise, cultural resources, energy use, chemical use, or management of toxic materials.

7.4.4 Environmental Justice and Equity

While the EAA region contains a large population of ethnic minorities, we have not identified any effects that fall unevenly on this population as such. The increases in water rates described in Section 6.5 will, in terms of percent of income, be hardest on low-income families. This effect will be mitigated in substantial part by the fact that such individuals use less water than the average, and almost all utility billing structures in the region are designed to have the greatest effects on larger users.

The employment effects fall disproportionately on Hispanic agricultural and food-processing workers near the very lowest end of the pay scale. However, to the extent these rules establish a framework for future water development in the region and help to establish certainty about a key infrastructure component, they should encourage growth in other

segments of the economy. Such growth will benefit these disadvantaged groups by helping to bring about a net growth in employment opportunities and higher average pay scales.

7.4.5 Cumulative Impacts

The total effect of the Authority rules will not be known until other key parts of the rules are defined, especially the rules that provide temporary restrictions on withdrawals during critical periods, the rules that provide for retirement of rights to meet the 400,000 AFY cap, and the rules that meet the mandate to protect continuous spring flows at federally specified levels by 2012.

In subsequent assessments, we will assess any proposed rules by adding their effects to those identified in this document, thus providing a cumulative analysis for the incremental rules package. An assessment that assumes all rules are in place would be difficult because much remains unknown. What is important to understand at this time is that the effects identified here are only a beginning.

8. References

A power failure at the offices of Research & Planning Consultants made it impossible to produce this section of the report for this publication. It will be produced in a separate supplement to this document. Readers who require that data should request a copy by contacting:

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