E-PARCC
COLLABORATIVE GOVERNANCE INITIATIVE
Syracuse University
Maxwell School of Citizenship and Public Affairs
Program for the Advancement of Research on Conflict and Collaboration

THE EDWARDS AQUIFER
PART B

"At a time when dysfunction marks upper levels of American government and politics, the Edwards region found a way to compromise and meet the needs of a hugely diverse set of interests." - San Antonio Express-News Editorial Board, "Aquifer Plan a Major Success," December 29, 2011

On March 18, 2013, the U.S. Fish and Wildlife Service (FWS) approved the Edwards Aquifer Recovery Implementation Program's (EARIP) Habitat Conservation Plan (HCP).[1] Hailed as a new model to solve complex water and environmental problems, attorney Robert Gulley felt that the experience was the most fulfilling of his career. Settling in to the fact that the decades-long conflict had been resolved by an approved HCP, he began reflecting on what had made this effort successful. He had spent his 30-plus year legal career in the courts attempting to resolve issues and the EARIP accomplished more than he had ever experienced through litigation.

Robert knew that the underlying source of conflict among the stakeholders was the "tragedy of the commons," a phenomenon caused by the region's adherence to the traditional common law rule of capture in sharing a scarce water resource. He also knew that the interdependence among the stakeholders involved was the solution to this challenge. Robert thought about the challenges of managing the Edwards Aquifer ("Aquifer") and began documenting how the

This case was written by Adam Zerrenner of the U.S. Fish and Wildlife Services and Robert Gulley of the Texas Comptroller of Public Accounts and was awarded Honorable Mention in E-PARCC's 2015-2016 Competition for Collaborative Public Management, Governance, and Problem-Solving Teaching Materials. A special thanks to John Sabala for reviewing and editing the case. The findings and conclusions in this case and teaching note are those of the authors and do not necessarily represent the views of the U.S. Fish and Wildlife Service or Texas Comptroller of Public Accounts. The case is intended for classroom discussion and not to suggest either effective or ineffective responses to the situation depicted. It may be copied as many times as needed, provided that the authors and E-PARCC are given full credit. E-PARCC is a project of the Collaborative Governance Initiative, Program for the Advancement of Research on Conflict and Collaboration- a research, teaching and practice center within Syracuse University's Maxwell School of Citizenship and Public Affair. https://www.maxwell.syr.edu/parcc_eparcc.aspx

[1] See Appendix 1: Edwards Aquifer Recovery Implementation Program Habitat Conservation Plan

EARIP stakeholders had overcome the tragedy of the commons problem that had plagued the region for decades.

Context Matters

The term "tragedy of the commons" first appeared in an influential article by Garrett Harden published in the Journal of Science in 1968.[2] In that piece, Hardin described it as a situation where individuals each act rationally in his/her own self-interest, deplete a common natural resource, and negatively impact the long-term interests of all involved, even if the individuals gain in the short-term. The demise of all parties involved occurs when the demand exceeds supply for the common resource. Under Texas's rule of capture, a landowner is free to capture and use as much water as he/she could beneficially use without waste. Given that the rule of capture allowed stakeholders to pump water from the Aquifer unregulated, conflict inevitably ensued as the parties involved feared losing their water supply to competition and a winner-takes-all approach.

For more than two decades, regional stakeholders had made numerous attempts to develop an Aquifer management plan and, while unsuccessful, each attempt was an incremental step toward an ultimate solution. One of the first significant steps occurred in 1988 with the City of San Antonio and the Edwards Underground Water Management District's (EUWD) *Regional Water Resources Plan* where regional stakeholders worked together to develop an Aquifer management plan. One of the key impediments to this plan's success as a regional solution was the lack of a legal authority that would regulate pumping from the Aquifer, given that the rule of capture governed groundwater management in Texas. Another concern was that the agricultural interests in Bandera and Uvalde counties had left the EUWD membership in response to growing fears of losing water for their businesses and livelihoods.

But perhaps the most significant movement toward resolving this problem was the use of the Endangered Species Act (ESA) in a federal lawsuit aimed at providing continuous spring flows for the region's threatened and endangered species. This lawsuit, filed by downstream water users, springs communities, and the environmental interests, resulted in a ruling that required the State of Texas to maintain continuous spring flow for the federally-listed species at issue.[3] In rendering his decision, Judge Lucius Bunton notified the state that if it failed to develop and implement a plan to accomplish continuous spring flows that the court would intervene in the management of the Aquifer. This watershed event, along with the attempt by Texas Water Commission's Chairman John Hall to ward off the litigation by designating the Aquifer as an

[2] See Garret Hardin, "The Tragedy of the Commons," Science, vol. 162: 3859, at1243-1248 (1968)
[3] *Sierra Club v. Babbitt*

underground river that provided the state with regulatory authority over the Aquifer, set the stage for the Texas Legislature's passage of Senate Bill (S.B.) 1477 that created the Edwards Aquifer Authority (EAA).

In creating the EAA, the legislature gave this body the jurisdiction to regulate water pumped from the Aquifer; to implement critical period management (CPM) restrictions; and to pursue a program "to ensure that the continuous minimum spring flows of the Comal Springs and the San Marcos Springs are maintained to protect endangered and threatened species to the extent required by federal law."[4] The EAA also had the power to issue permits with minimum pumping rights based on average historic use for industrial and municipal users, as well as to issue permits with guaranteed pumping rights for agricultural users. These pumping rights created the legal framework for a water market exchange that allowed one acre-foot of the two acre-feet limit guaranteed for agriculture and all water associated with industrial and municipal permits to be leased or sold amongst users located within the Aquifer.

In the early 2000s, the legislature's charge to the EAA led it to develop an HCP. Unfortunately, this effort failed to gain support from the EAA's governing board, causing the FWS to propose a Recovery Implementation Program (RIP) in 2006 to the regional stakeholders. RIPs are stakeholder-driven programs that have been used by the Department of Interior, of which FWS is a sub-agency, as a way for the federal government to collaborate with stakeholders in managing scarce water resources in the western United States where ESA issues are at the forefront.[5] In May 2007, the Texas Legislature passed S.B. 3, establishing an EARIP requiring the completion of a series of milestones that included a FWS-approved plan that provided minimum continuous spring flows by the year 2012. S.B. 3 further mandated that regional stakeholders participate in the development of the plan. The culmination of these events provided the EARIP stakeholders with the necessary context and tools to succeed.

Developing Trust

To ensure its credibility, the FWS initiated the EARIP as an open and inclusive stakeholder-driven program whose decision making would be transparent. The subsequent passage of S.B. 3 required that the stakeholders complete a Memorandum of Agreement (MOA) by the end of 2007. The purpose of the MOA was a formal initiation of the EARIP *by the stakeholders*.

[4] EAA Act § 1.14(h)

[5] Recovery Implementation Programs were developed under then Secretary Bruce Babbitt to ward off efforts in 1995 to amend the ESA. John D. Echeverria, "No Success Like Failure: The Platte River Collaborative Watershed Planning Process," 25 Wm & Mary Envtl. L. & Pol'y Rev. 559, 567 (2001).

What was not obvious during the development of the MOA was the importance of that document's drafting process as the point where stakeholders began working together and establishing mutual trust. While drafting of the MOA, seemingly small and insignificant gestures became instrumental toward that end. For example, stakeholders began eating lunches together during their meetings, thus humanizing the process and forcing the stakeholders to see each other as people. Over time, these gestures spurred a paradigm shift toward active stakeholder participation in and support for the EARIP process.

The final MOA outlined how the stakeholders would work together and reach consensus on issues as they developed an HCP. In its section on governance, the MOA defined consensus as unanimous support by the Steering Committee and specified the number of votes required to move forward on a particular issue brought up for a vote. The MOA created an 'issues team' to be triggered if a consensus could not be reached. If the issues team could still not achieve consensus, then consensus would be sought by a supermajority vote of 75 percent of the Steering Committee. During the five years that it took to develop the HCP, only two votes ever went to a supermajority vote out of numerous decisions made by the Steering Committee.

The MOA also expanded the number of voting Steering Committee members to 26 from the original 21 members mandated by S.B. 3. This expansion ensured a regional cross-section of interests such that no one interest group could dominate the decision-making process. It also added to the EARIP's credibility. Ultimately, taking the time to determine how to achieve consensus through the MOA and resist the temptation to immediately begin solving the problem proved critical to the EARIP's success by instilling a culture of trust, mutual respect, and reliance.

The MOA process did not immediately heal the years of acrimony and mistrust, but it was a start - a good start. The debate over determining spring flow targets loomed ominously ahead. It would prove contentious and difficult but the atmospherics had changed. As that debate headed toward impasse later in the EARIP process, the participants in the earlier MOA process reached back and told the stakeholders, "Look, we've come too far to fail." They were right. There would be difficult times as the stakeholders wrestled with issues such as costs, but the trust was there, the momentum was behind them. They had, indeed, come too far to fail.

Science

S.B.3 required that the Steering Committee establish an Expert Science Subcommittee (SSC) that would evaluate: 1) the option of designating a separate San Marcos Pool from the San Antonio Pool and how this possible designation would alter the management of the Aquifer; 2) the necessity of maintaining minimum spring flows to protect the federally-listed species; and 3) whether adjustments in the CPM for the San Marcos Springs flow for the San Antonio Pool

should be made. Each issue was controversial so the need for credible science for the Steering Committee's decision-making proved critical. Adding to this challenge was that many scientists that the Steering Committee selected to serve on the SSC had held prior positions aligned with certain stakeholder interests.

The EARIP stakeholders took important steps to help overcome these potential barriers. First, they required that all SSC meetings were open for anyone to attend. The Steering Committee also required SSC work products would be scientifically peer-reviewed by an independent third party to ensure scientific credibility and that the information provided to the Steering Committee was the best available science. Finally, the stakeholders separated the SSC's scientific work from policy, allowing the SSC to focus solely on science. The EARIP was also fortunate to receive $1.7 million from the Legislature to support scientific efforts, which helped the Steering Committee reduce key areas of scientific uncertainty and have a greater scientific understanding of the Aquifer and species.

The SSC's first report recommended: 1) not separating the San Antonio Pool from the possible San Marcos Pool; 2) that minimum spring flows be required for endangered species; and 3) that CPM trigger levels not be changed at that time. Following these recommendations, S.B. 3 required that the SSC investigate species needs in relation to spring flows, Aquifer conditions and recharge, and pumping withdrawals. S.B. 3 also directed the SSC to use this information to provide withdrawal and CPM recommendations for species protection. The final SSC report was highly controversial as it recommended that pumping should be reduced by 85 percent to maintain the required flows for species. Just as important, but not included in the SSC report, was that it did not incorporate other measures to conserve the species that ultimately became part of the EARIP's HCP. Examples of such actions included habitat restoration and the management of recreational activities at the springs to protect the species.

The success of the SSC led to three additional subcommittees and 16 working groups to support the EARIP (**Table A**). Independent scientific peer review was used again during the EARIP process, which ultimately led to the EARIP contracting with the National Academy of Sciences to evaluate the science during the first phase of the HCP. The final HCP was split into two phases over the course of the 15-year permit and used a scientific decision-making process known as "adaptive management."[6] Adaptive management is used when scientific uncertainty exists and it promotes learning through doing and then adjusting management choices when scientific uncertainty is better understood. The first phase of the HCP spanned the first seven years and would use the National Academy of Sciences peer review focusing on species flow needs and Aquifer management to better inform the decision-making for the second phase. Adaptive management became a key ingredient of the HCP upon which the Steering Committee

[6] *See* The U.S. Department of Interior Technical Guide, "Adaptive Management" (2009)

reached consensus and third-party scientific peer review and adaptive management played a major role in the process.

Table A. EARIP subcommittees and workgroups.

Subcommittees
Science Subcommittee
Recharge Subcommittee
Public Outreach Subcommittee
Ecosystem Restoration Subcommittee
Work Groups
Additional Studies Work Group
Phase I Implementation Work Group
Conservation Work Group
Environmental Restoration and Protection Work Group
Funding Work Group
Recreation Work Group
Refugia Work Group
Agricultural Water Enhancement Program Work Group
Covered Species Work Group
Restoration Work Group
Low Impact Development Work Group
Implementing Agreement Drafting Work Group
SAWS ASR Work Group
MOA Work Group
Facilitation Work Group

Leadership

Robert was a lynchpin for the stakeholders, helping them work together and stay focused on completing an HCP. He had accepted the position knowing the high likelihood that the EARIP would fail and that he would be an easy scapegoat. Nonetheless, both he and stakeholders ultimately defied the odds. His professional background as a former Department of Justice attorney specializing in ESA cases proved invaluable. This expertise allowed Robert to serve as a credible legal expert to help shift the stakeholders' focus away from what had historically been considered a water problem to thinking of it as an ESA problem. He did this by shaping a vision that included what the completed HCP would look like and by simplifying the complexities of the ESA to show stakeholders that they could achieve a solution that would ultimately result in a permit from the FWS. This paradigm shift was critical because determining the protections that federally-listed species required was a scientific and legal problem that was far more straightforward to grasp than resolving how much water any stakeholder should have at the potential expense of another.

During one EARIP meeting, as the process seemed destined to collapse, a stakeholder stated that, "We have come too far to fail!" This simple but powerful statement gave the other stakeholders the momentum to carry on and was but one of many examples of the leadership by numerous participants that helped the EARIP to succeed. Other examples include: spearheading the resolution of specific issues as part of the issue team process; participating and leading the Steering Committee, subcommittees, and working groups; or taking positions that may have had tenuous support in one's organization. Leadership also came in the form of helping to end the unconstructive conflict between organizations that had led to gridlock and impasse in the past. Through compromise and collaboration, the stakeholders were able to change the overall culture of their interactions and helped them improve their working relationships.

Financing the nearly $300 million HCP program was also an act of leadership. At the start of the EARIP, the preferred funding options were either federal appropriations historically provided to other RIPs or a state sales tax specific to the Aquifer region. During the EARIP process, both of these options proved infeasible due to the scrutiny placed on the federal budget process owing to the country's economic climate at the time and Texas' political history of opposing any tax increases. Once these options were unavailable, the search for funding shifted to the municipal and industrial users of the Aquifer, as well as the downstream users in the Guadalupe River basin.[7] Stakeholders who worked for organizations financing the HCP, such as San Antonio Water Systems, the Edwards Aquifer Authority, and Guadalupe Blanco River Authority led

[7] Agricultural users of the Edwards Aquifer that make up approximately 30 percent of the total water withdrawn annually are capped at paying no more than two dollars per acre-foot of water.

efforts to communicate the HCP's importance to their own organizations so that the public would ultimately support an increase in their water utility bills (**Exhibit 1**).

Moreover, by passing S.B. 3, the state legislature exhibited leadership, particularly given the slim chance that the EARIP would succeed. S.B. 3 proved vital to the EARIP's success because it established specific milestones that kept the stakeholders focused on results and balanced this accountability by allowing the EARIP to be stakeholder-driven (**Table B**).

Table B. S.B. 3 tasks and deadlines for EARIP.

S.B. 3 Deadline	Task
September 30, 2007	Establish a Steering Committee
October 31, 2007	Hire a program manager
December 31, 2007	Enter into a Memorandum of Agreement
December 31, 2007	Appoint an expert Science Subcommittee
December 31, 2008	Science Subcommittee submits initial recommendations to Steering Committee
No Deadline	Establish a Recharge Facility Feasibility Subcommittee
December 31, 2009	Enter into Implementing Agreement to develop Program Document
December 31, 2012	Submit Program Document to FWS for approval

Federal Government Collaboration

When the FWS initiated the EARIP, the agency took an important first step by offering collaboration training to the stakeholders. Beyond the training itself, this step was significant because it established the initial environment for how the stakeholders and FWS would work together. Contrary to popular belief, the FWS never mandated how the process should work or what the HCP should include, but rather, the FWS attended every meeting and helped to educate and guide the stakeholders on the ESA regulatory processes and requirements necessary to be issued a federal permit.

The FWS also provided analytical tools to assist the stakeholders in meeting those requirements, including decision analysis and modeling tools to evaluate how federally-listed species survive under various potential management strategies. Further, the FWS also encouraged a systemic evaluation of all the factors that impact different federally-listed species

beyond just spring flow. This holistic approach helped to create a more comprehensive solution for protecting federally-listed, allowing the stakeholders to better evaluate potential tradeoffs, such as protecting species from human disturbance when spring flows were low, rather than depending on the need for possible greater spring flow protection. This approach enabled stakeholders to take ownership of both the process as well as the solution and gave them the confidence that they were on the right track.

Sword of Damocles

The two most powerful motivators during the EARIP process were both the threat of government intervention and the Texas droughts. These motivators were, in effect, like the Sword of Damocles to the stakeholders.[8] In the 1993 federal court decision, when Judge Bunton ruled in favor of the Sierra Club he stated, "The next session of the Texas Legislature offers the last chance for adoption of an adequate state plan before the 'blunt axes' of Federal intervention have to be dropped." Ultimately, it took the stakeholders 20 years to develop an HCP that would meet the needs of the federally-listed species, but the specter of federal intervention and possible loss of local control loomed over many of the stakeholders, forcing them to finally reach an agreement.

The threat of state intervention by the Texas Legislature also concerned stakeholders. In response to Judge Bunton's decision, the legislature created the EAA and mandated that the EAA implement a plan to protect the federally-listed species. In 2007, the legislature passed S.B. 3 mandating the participation of numerous stakeholders, and establishing milestones with deadlines, including the 2012 deadline to complete a plan that would maintain continuous spring flow. If the stakeholders failed to meet these milestones, they risked ceding control to state legislators.

The south-central Texas area has a long history of drought and, for Robert, became apparent that drought was the most powerful stakeholder in the room and only by working together could the stakeholders defend against it. In 1927, a National Weather Service meteorologist described Texas as "a land of perennial drought broken by the occasional devastating flood."[9] Almost all the stakeholders had lived through these droughts, including some who had lived through the devastating drought of record of the 1950s, so they knew first-hand the economic damage that occurs from lack of water. If the stakeholders failed to find a solution, the stakeholders risked not only the possible loss of local control, but also the entire region's water

[8] Story of a fourth century B.C. tyrant of Syracuse who had a sword above his throne, signifying the foreboding nature the tyrant's position.

[9] See Appendix 2: Editorial Cartoon, The Orlando (Fla) Sentinel, Tribune Media Services, 1998

security.

Best Experience of My Career

After reflecting on what led to the EARIP success and the stakeholders' ability to overcome the tragedy of the commons problem, what most intrigued Robert was how the region's culture had shifted from one characterized by conflict and acrimony to one of collaboration and problem-solving. Given the long history of fighting over the Aquifer, he wondered if a stakeholder-driven solution was sustainable over the long-term or if the region would revert to its decades' old past of fighting and litigation. To make things worse, the region's human population continued to grow at some of the fastest rates in the country and the region was in what many believed may be another drought of record (**Exhibit 2**). Climate predictions indicated that water availability could drop by as much as 15 percent, largely due to hotter weather and precipitation patterns that called for longer dry spells followed by periods of even more intense rain.

At the age of 68, Robert retired from what he considered to be the best experience of his career. He had helped the stakeholders develop a solution to the 70-year water conflict and hoped the solution would be successfully implemented upon his departure.

Exhibit 1. San Antonio Water System residential water class rates inside city limits from 2009 to 2013.[10]

	2013	2012	2011	2010	2009
Service availability charge by meter size					
5/8"	$7.14	$7.14	$6.91	$6.91	$6.77
3/4"	10.1	10.1	9.68	9.68	8.59
1"	15.75	15.75	15.23	15.23	12.49
1-1/2"	30.09	30.09	29.10	29.10	22.25
2"	47.28	47.28	45.73	45.73	32.95
3"	87.44	87.44	84.56	84.56	61.27
4"	144.78	144.78	140.02	140.02	100.30
6"	288.17	288.17	278.69	278.69	197.89
8"	460.22	460.22	445.09	445.09	314.96
10"	660.95	660.95	639.22	639.22	451.57
12"	1234.47	1234.47	1,193.88	1,193.88	841.86
Usage (per 100 gallons)					
Standard:					
First 7,481 gallons					0.0906
Next 5,236 gallons					0.1309
Next 4,488 gallons					0.2058
Over 17,205 gallons					0.3288
Seasonal:					
First 7,481 gallons					0.0906
Next 5,236 gallons					0.1423
Next 4,488 gallons					0.2217
Over 17,205 gallons					0.4246
Usage (per 100 gallons)					
Standard:					
First 5,985 gallons	0.0948	0.0948	0.0917	0.0917	
Next 6,732 gallons	0.1372	0.1372	0.1327	0.1327	
Next 4,488 gallons	0.1935	0.1935	0.1871	0.1871	
Over 17,205 gallons	0.3388	0.3388	0.3277	0.3277	
Seasonal:					
First 5,985 gallons	0.0948	0.0948	0.0917	0.0917	
Next 6,732 gallons	0.1492	0.1492	0.1443	0.1443	
Next 4,488 gallons	0.2219	0.2219	0.2146	0.2146	
Over 17,205 gallons	0.4597	0.4597	0.4446	0.4446	

[10] *See* San Antonio Water System, "Comprehensive Annual Financial Report for the Years Ended December 31, 2014 and 2013," April 2015, at 96.

Exhibit 2. Annual estimated Edwards Aquifer groundwater discharge and recharge by use from 1990 to 2013 (measured in thousands of acre-feet). [11]

Year	Irrigation	Municipal	Domestic / Stock	Industrial / Commercial	Springs	Total Discharge	Estimated Groundwater Recharge
2003	79.6	237.2	13.7	31.7	621.5	983.7	669
2004	55.4	220.3	13.8	28.1	622.9	940.5	2176.1
2005	85.3	255.1	13.8	34.3	647.1	1035.6	764
2006	149.1	259.1	13.8	34.5	312.0	768.5	201.6
2007	42.5	236.0	13.8	27.6	620.6	940.5	2162.3
2008	112.7	273.6	13.5	28.8	417.1	845.7	212.9
2009	108.9	247.5	13.6	25.7	288.0	683.7	210.9
2010	72.7	259.9	13.6	26.4	490.0	862.6	813.5
2011	124.7	265.5	13.6	23.3	265.2	692.3	112.0
2012	90.6	257.9	13.7	22.6	302.3	687.1	313.5
2013	76.3	239.5	13.7	26.3	232.8	588.6	182.6
Mean	90.7	250.2	13.7	28.1	438.1	820.8	710.8
Median	85.3	255.1	13.7	27.6	417.1	845.7	313.5

[11] *See* Edwards Aquifer Authority, "Edwards Aquifer Authority Hydrological Data Report for 2013," December 2014, at 25 and 36.

APPENDIX 1. EDWARDS AQUIFER RECOVERY IMPLEMENTATION PROGRAM HABITAT CONSERVATION PLAN

The five permit holders of the EARIP HCP included the Edwards Aquifer Authority, San Antonio Water Systems, City of New Braunfels, City of San Marcos, and Texas State University. The duration of the HCP would last 15 years and its implementation would be divided into two phases. The annualized cost for the plan's first phase was approximately $18 million dollars per year for the first seven years (**Table A**). During the first phase, the anticipated costs were estimated to be greater due to habitat restoration and protection measures that were put in place. Per the plan's provisions, the costs would be paid almost entirely by municipal and industrial users as agricultural costs were capped at $2 dollars per acre-foot.[12] Downstream surface water rights holders that benefit from the spring flow from Comal and San Marcos Springs would pay $736,000 dollars a year.

In the first phase, habitat protection measures to increase the populations and survivability of the species would be implemented immediately at Comal and San Marcos Springs. These measures included: habitat restoration and replacement with native vegetation favored by the listed species; maintenance of dissolved oxygen through removal of decaying aquatic vegetation during low flows; sediment removal; predator control; and fountain darter gill parasite control.

The minimization of the impacts of recreation at low flows would be accomplished through the Texas Parks and Wildlife Department's creation of scientific study areas. Access to sensitive habitat, such as areas of Texas wild-rice habitat, would be limited during such periods as drought. Water quality measures included: an incentive program for low impact developments; support for a ban of coal tar sealant bans that can degrade water quality; and expanded water quality monitoring. The HCP also required an establishment of a refugia that would keep the species in captivity in the event of a catastrophic contamination event or if the springs flow levels dropped and were no longer able to support the resident species in the wild.

During the first phase of the HCP, a series of spring flow protection measures were in place to ensure the continuous minimum spring flow during a repeat of the drought of record (**Table B**). These measures include a voluntary irrigation suspension program during severe drought; a regional municipal conservation program; the storage of water at the San Antonio Water System's Aquifer Storage Recovery facility to offset pumping during a severe drought; and emergency Stage V Critical Period Management cutbacks.

[12] EAA Act §1.29

All of these measures were being evaluated through a comprehensive monitoring program and with adjustments made through the adaptive management process. The adaptive management process included an applied research program to test the assumptions underlying the biological goals and objectives that were established for each of the species covered by the HCP. The research was too focused on the biological effects of low flows on species and habitat. In addition, the existing Aquifer groundwater model would be improved and a mechanistic ecological model would be developed to evaluate all of the impacts on habitat and the species.

In the second phase, the EARIP would implement any additional measures needed to achieve the biological goals for the species. The decision regarding additional measures would be based on the best available science at that time and relied heavily on information developed during the adaptive management process and scientific peer reviews conducted by the National Academy of Sciences.

The HCP established a presumptive measure for the second phase, should it be determined that additional measures were necessary to achieve the biological goals and stakeholders could not agree on other alternatives to ensure minimum continuous spring flow for the species. The presumptive measure involved the continuation of the first phase measures with the expanded use of the San Antonio Water System's Aquifer Storage Recovery facility. If expanding the availability of the Aquifer Storage Recovery facility could not fully meet the additional spring flow necessary to meet the minimum flow objectives, the balance would be obtained through alterations to the conservation measures, including an increase in the emergency Stage V withdrawal reductions.

Table A. Average annualized costs for phase 1 (year 1 through 7) and phase 2 (8 through 15) implementation.

	Phase 1	Phase 2
Spring Flow Measures		
SAWS ASR		
Acquisition of Water Leases	$4,759,000	$4,759,000
Operations and Maintenance for Use of ASR	$2,194,000	$2,194,000
Regional Water Conservation Program	$1,620,679	$1,048,156
Voluntary Irrigation and Suspension Program	$4,172,000	$4,172,000
Habitat and Water Quality Measures		
Comal Springs	$1,272,857	$870,000
San Marcos Springs	$1,295,143	$918,000
Modeling and Research	$892,857	$25,000
Refugia	$1,678,597	$1,678,597
Administrative and Management	$750,000	$750,000
Average Annualized Cost	$18,635,133	$16,428,253

Table B. Spring flow statistics at Comal and San Marcos Springs under a no HCP option, the Edwards Aquifer Recovery Implementation Program Habitat Conservation Plan Phase 1 and Phase 2, and historical statistics that include the 1950s drought of record.

Comal Spring Flow Statistics (Evaluated for 1947-2000)		Scenario			
		No Action	HCP – Phase 1	HCP – Phase 2	Historical
Minimum Monthly (cfs)		0	27	47	0
Minimum Rolling 6 Monthly Average (cfs)		0	39	54	2
Long-Term Average (cfs)		178	196	196	274
Number of Months Below	150	221	185	185	69
	120	157	127	125	51
	80	99	53	53	26
	45	62	7	0	12
	30	54	2	0	7
	0	38	0	0	4

San Marcos Spring Flow Statistics (Evaluated for 1947-2000)		Scenario			
		No Action	HCP – Phase 1	HCP – Phase 2	Historical
Minimum Monthly (cfs)		2	51	52	54
Minimum Rolling 6 Monthly Average (cfs)		12	53	55	60
Long-Term Average (cfs)		153	155	155	168
Number of Months Below	100	121	114	114	*
	80	52	48	47	*
	50	19	0	0	*
	30	7	0	0	*
	10	3	0	0	*

APPENDIX 2. THE ORLANDO (FLA.) SENTINEL CARTOON DEPICTING THE CYCLES OF DROUGHT AND RAIN INFLUENCED BY THE EL NINO EFFECT.