WATER DEMAND METHODOLOGY AND PROJECTIONS FOR MINING AND MANUFACTURING

Prepared for:
Texas Water Development Board

Dr. Dan Hardin
1700 North Congress Avenue
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Contract No. 2001-483-397

By

WATERSTONE
Environmental Hydrology and Engineering, Inc.

and

THE PERRYMAN GROUP

3/07/2003

WATERSTONE
Environmental Hydrology and Engineering, Inc.

March 7, 2003

William F. Mullican, III
Deputy Executive Administrator
Office of Planning
Texas Water Development Board
1700 N. Congress Ave.
Austin, TX 78711-3231

Subject: Final Report: Water Demand Methodology and Projections for Mining and Manufacturing, Contract No. 2001-483-397

Dear Mr Mullican,

Per our contract, TWDB Contract No. 2001-483-397, Waterstone is pleased to transmit the following items to you and your team:

1. The Final Report (10 double-sided hard copies: 9 bound and 1 photoready, unbound copy).
2. One electronic copy of the final report.

In response to the TWDB's comments the final report has undergone extensive revisions. A complete response to your letter of December 5th, 2002 are provided in the "Comments and Responses" section of the final report.

Please let us know at your earliest convenience if you encounter any difficulties with any of these items.

Sincerely,
Waterstone Environmental Hydrology and Engineering, Inc.

Carla Johnson
CEO

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TABLE OF CONTENTS

LIST OF TABLES

1.0 INTRODUCTION

This report was prepared for the Texas Water Development Board (TWDB) to provide decadal water demand estimates at the county level for the years 2000 through 2050. Water demand estimates are based on weighted water use coefficients and extrapolated into the future by using gross county product as the explanatory variable. Water use coefficients are derived from historic water use and economic output data. The data and projections for gross county product was prepared by The Perryman Group (TPG), an economic research and analysis firm based in Texas, for the purpose of water resource planning. Water demand was simulated for three scenarios to provide TWDB with an expected demand, a minimum demand and a maximum demand.

The economic forecasts and water demand model described in this report will also serve as a tool for making revisions to water demand estimates as more recent water use data become available. Updated information will provide more realistic projections especially where unforeseeable facility changes have occurred, resulting in dramatic changes to water demand on a county level.

2.0 METHODOLOGY

The methodology used is based on historic water use trends in conjunction with past and future economic output for the 254 counties in Texas for both the manufacturing and mining industries. Water demand is determined by applying each county's water use per unit of output (water use coefficient) to its projected output for each of the two industries. The model assumes that recent past water use trends will continue to persist. It also assumes that a correlation between industry productivity and water use are inherently intertwined. The same water demand forecast methodology is used for both manufacturing and mining, however the water demand projections for manufacturing are further reduced by water use efficiency factors as discussed in section 2.3.1.

The development of the methodology used in this report is guided in part by the 1996 Consensus-based Update to the Texas Water Plan (Volume III, Water Use Planning Data Appendix)[1], Water for Texas – 2002 (Final 2002 State Water Plan)[2], and the National Handbook of Recommended Methods for Water Data Acquisition – Chapter 11 – Water Use (USGS publication)[3]

2.1 Data

2.1.1 Water Use Estimates

The water use survey conducted each year in Texas by the TWDB provides an invaluable resource for water demand forecasting: current data produce more realistic projections. Annual historic water use estimates in the manufacturing and mining industries at the county level are available for the years 1980 and 1984 through 1999 (year 2000 data were not available at the time the report was produced). These numbers were obtained from the TWDB.

2.1.2 Gross County Product

Past values and forecasts of gross county product, at the county level, are reported every 10 years from 1970 to 2050 for mining and manufacturing. Manufacturing values are further detailed at the 2-digit Standard Industrial Classification (SIC) level. The industry type and its corresponding SIC number can be found in Appendix A.

Projections through 2030 are derived using the Texas Econometric Model (Appendix B), while years 2040 and 2050 were extrapolated since long-range patterns are believed to have been established by 2030.

At the time that TPG conducted their economic output study, the gross state product data released from the US Department of Commerce was only available through 1999 (with preliminary estimates for 2000). The subsequent release (after the projections were submitted)

[1] Water for Texas – Today and Tomorrow, A 1996 Consensus-based Update to the Texas Water Plan, Volume III, Water Use Planning Data Appendix, Water Demand/Drought Management Technical Advisory Committee, 1996.
[2] Water for Texas – 2002, Texas Water Development Board, Document No. GP-7-1, 2002.
[3] National Handbook of Recommended Methods for Water Data Acquisition, Chapter 11 - Water Use, USGS, http://water.usgs.gov/pubs/chapter11/, 2002.

showed mining values of $37.6 billion and $29.9 billion for 1999 and 2000, respectively. These rather sizable revisions in the historical series, which mostly reflect the way price indices are constructed for this series, affects the economic output values.

A calibration adjustment was made on the mining economic output to account for the updated 2000 revision by applying a constant factor to the existing forecast. Attachment 2, in the Response to Comments, provides the response by TPG explaining the circumstances requiring this adjustment. The ratio of the "new" to the "old" values for each decade is given below:

Table 2-1: Ratio of New to Old Values of Mining Economic Output

Year	New/Old
2000	0.6626
2010	0.6458
2020	0.6557
2030	0.6655
2040	0.6754
2050	0.6854

2.2 Water Use Coefficient Derivation

The water use coefficients are uniquely determined for each county and industry expressed as acre-feet of water per unit output, where output is gross real product in millions of 1996 dollars. Based on historic water demand and gross real product, a water use coefficient can be determined by taking the ratio of water use and gross real product.

The primary method used in this study determines water use coefficients based on past and current water use trends. Water use coefficients are calculated for individual years from 1996 to 1999. Water use coefficients that appear to reflect an exceptional year and did not follow the water use pattern were removed. It was assumed that some persistence of recent trends will carry over into successive years. This is accounted for by weighing more heavily the more recent water use coefficients. Once determined, the water use coefficient is assumed to remain constant in time.

A second method was used to obtain the water use coefficient for the approximately 20 counties in which historic water use is insensitive to economic output. The water use coefficient was estimated by extrapolation based on past water use patterns instead of assuming the coefficient to be fixed through time. Water use coefficients were derived using selected data from 1990 through 1999. For each county analyzed with the secondary method the data was examined to identify a range of at least five years providing a reasonable trend in water use coefficients. The trends were exponentially declining, similar to the declines exhibited by the efficiency factors. For the secondary method, the use of a non-constant water use coefficient precludes the need for incorporating an efficiency factor: the water use coefficient trend is analogous to the trend represented with efficiency factors. As with the primary method, the variable water use coefficient is combined with the economic forecast data.

2.3 Water Demand Prediction

The water demand model uses historic trends, with emphasis on more recent data to predict the future. The model water use coefficients, water efficiency factors and economic forecasts to produce water demand predictions. A complete explanation of the model and instructions of its usage are provided in Appendix C. Confidence in the water demand projections in the near future can be relatively high, provided that the input parameters have been recently updated.

To obtain water demand projections the projected gross real product is multiplied by the county level, industry specific water use coefficients for the number of desired years. The gross real product serves as the explanatory variable to provide future water use forecasts. Gross real product reflects the value of goods and services produced expressed in constant 1996 dollars. The inherent assumption is made that as industrial output is increased, it will be reflected in increased water use. To ensure reliable water use projections the model results should be viewed on a county basis to verify that the projection magnitudes and trends are reasonable.

2.3.1 Manufacturing

Technological advancements in the future will be accompanied by water conservation and increased water use efficiency in industry. The water use efficiency factors, determined in the Texas Industrial Water Use Efficiency Study (Pequod, 1993), are applied, resulting in lower water demand projections. The Pequod study projected water use efficiency to the year 2010. In the 1996 Consensus-based Update to the Texas Water Plan, these values were updated through the year 2030 and held constant at the 2030 level through the year 2050. These efficiency factors varied for the major water use groups studied. The mean manufacturing water use efficiency values used in the model are shown in Table 2-2.

Table 2-2 Water Use Efficiency Factors

(based on values from the 1996 Consensus-based Update to the Texas Water Plan)

Year	2000	2010	2020	2030	2040	2050
Water Use Efficiency Factor	0.945	0.888	0.823	0.758	0.758	0.758

2.3.2 Mining

Historically, water use efficiency factors are not used. In this study, water use efficiency factors for mining were not used. Further constraints on mining projections may be due to accessible mineral reserves. However, this limitation should be reflected in economic forecast data.

3.0 RESULTS

Water demand forecast methods relate an expected change in one or more explanatory variable to future water use. The various water demand forecasting methods differ by the level of complexity and data requirement. The methodology used in this report is rather data intensive and requires a high level of expertise to provide the gross county product.

3.1 Historic Water Use Trend

There is a great deal of variability in the temporal water use trend for manufacturing at the county level. There appears to be some consistency in the water use trend prior to 1990 and a different trend occurring for the data after 1990. To capture the more recent behavior, the water use coefficients are determined from the 1996-1999 data.

3.2 The Perryman Group Gross County Product

Economic forecast values, produced by TPG, are provided on the attached compact disc in the "Forecasting\Results\TPG_Economic_Forecasts" subdirectory. The baseline projections and representative high and low scenario values are included. All values are expressed as millions of 1996 dollars. The manufacturing data is subdivided into 2-digit SIC codes. Each table provides detailed past and projected gross county product for three scenarios: baseline, high, and low forecasts. In general the productivity trend for both mining and manufacturing is forecasted in the positive direction. This trend is most consistent in the long-term future, with slower growth in the mining industry.

Past values of gross county product are available for 1970, 1980, 1990, and 2000. To obtain water use coefficients for years 1996-1999, it was necessary to interpolate the gross county product from the available data. The year 1970 was omitted since the time frame of interest is much later in time, year 2000 and onwards. For the interpolation of the 1996-1999 years, the output data for 1980-2000 were used.

3.3 County Level Water Demand Forecasts

County level manufacturing and mining water demand forecasts are presented in Appendix D and in electronic format, "Forecast_summary_final.xls", on the attached compact disc in the subdirectory "Forecasting\Results". The baseline demand forecast is accompanied by high and low projections. The table includes projections from the 2002 State Water Plan, "TWDB Forecast", for comparison.

In general the projected values in the near future (i.e. years 2000 and 2010) from the model and the projections from the 2002 State Water Plan are in agreement for both manufacturing and mining forecasts. However, a number of disagreements do arise for the county forecasts and can differ by as much as an order of magnitude. In many county cases, the long-term water use projections for mining from the 2002 State Water Plan shows a slow reduction in water demand. The forecast from the model instead predicts continued water demand, reflecting the slow but steady increase in output.

An analysis of the large discrepancies between the TWDB forecast (SWP, 2002) and the Waterstone forecasts was conducted. Without knowing the details of how the TWDB water demand forecast was determined, the reasons for the differences between the two forecasts cannot be completely understood. However, it does appear that most discrepancies can be characterized by one of the following situations:

1) The values from the TWDB forecast do not appear to reflect the recent water use patterns. Four such manufacturing examples brought into question by TWDB are Harrison, Comal, Milam, and Williamson.

Harrison	1990	1996	1997	1998	1999	2000	2010	2020	2030	2040	2050
TWDB (actual)	75,039	49,692	46,461	6,323	6,223	--	--	--	--	--	--
TWDB (forecast)	--	--	--	--	--	110,588	135,166	141,913	147,949	161,370	176,471
Waterstone	--	--	--	--	--	11,776	13,780	17,123	20,228	25,458	31,093

Comal	1990	1996	1997	1998	1999	2000	2010	2020	2030	2040	2050
TWDB (actual)	3,248	11,964	8,171	8,650	7,883	--	--	--	--	--	--
TWDB (forecast)	--	--	--	--	--	3,450	3,487	3,548	3,799	4,071	4,351
Waterstone	--	--	--	--	--	9,109	10,990	14,209	17,456	22,718	28,493

Milam	1990	1996	1997	1998	1999	2000	2010	2020	2030	2040	2050
TWDB (actual)	22,047	45,124	42,224	41,325	39,816	--	--	--	--	--	--
TWDB (forecast)	--	--	--	--	--	6,820	6,820	8,250	8,250	8,250	9,800
Waterstone	--	--	--	--	--	39,880	50,311	68,833	89,146	121,036	157,550

Williamson	1990	1996	1997	1998	1999	2000	2010	2020	2030	2040	2050
TWDB (actual)	326	1225	1328	1268	1182	--	--	--	--	--	--
TWDB (forecast)	--	--	--	--	--	368	398	409	405	443	481
Waterstone	--	--	--	--	--	1397	1609.5	2035	2457	2857	3157

In these cases there is a clear trend emerging in water use for the years 1996 through 1999, which should be reflected in the expected water use for year 2000 (at the time the study was made, the 2000 water use values were not available). The TWDB water forecast for the year 2000 appears to have overestimated or underestimated the water demand by a considerable amount. In most of these cases, the water demand projections from the TWDB forecast appear to follow early 1990s water use trends. For example, in Harrison county the water-use has been dropping since 1996 and is an order of magnitude smaller in 1999 than 1990. The TWDB forecast for 2000 shows water-use rate that are in line with the 1990 water-use levels while the Waterstone forecast reflects the recent reduction in water use. Other counties exhibiting this situation for manufacturing include Bell, Brazoria, and Kimble.

2) The greatest discrepancies between the TWDB and Waterstone forecasts appear in later years, after 2030. The water demand forecasts are strongly dependent on the economic output variable. For some counties there exists a high incremental economic output after 2030 resulting in higher water demands. Just a few examples of such counties are Travis, Jefferson, Bosque, McLenna, and Orange for manufacturing.

3) There were some counties where the water use trend appeared to be insensitive to the economic output. There are about a 20 counties, about 10% of all counties, that fall under this category. For these counties a secondary model has been put into place and the water demand forecast has been modified. Some of the counties that use the secondary algorithm are Dallas, Harris, and Bexar.

As a general note, water demand forecasts are susceptible to changes in input parameters. Fluctuations associated with the data used, such as historic water use demand estimates or economic output can cause significant changes in estimates. Attachment 4 discusses the impact of such a situation, and the need for adjustments to the predictions.

4.0 RECOMMENDATIONS

When more detailed information becomes available for use in the water demand forecasting model, additional refinement is recommended. The state of Texas covers an area of more than 250,000 square miles, with a variety of geographic and climatic conditions exist. As a result, water usage rates will vary depending on the region. Performing forecasts on the county level accounts for much of this variation. An additional breakdown of water usage by SIC code would provide an even more detailed analysis. This would not necessarily require using all SIC codes since, in 1999, five of the manufacturing SIC groups accounted for approximately 90% of water usage in manufacturing (2002 Texas Water Plan). The TPG study provided detailed gross county product (output) by SIC code. At some point the TWDB may find it advantageous to use the existing SIC-code level water use estimates to resolve predictions down to the SIC code level. However, as discussed in this report and Waterstone's response to the TWDB comments, there are proprietary issues associated with data at the SIC code level. Since the proprietary issue will probably persist, Waterstone recommends that the TWDB at least lump the data on a regional basis. This level of aggregation would provide sufficient anonymity to resolve the proprietary issue, but at the same time improve upon the resolution of the predictions (Bill Hoffman, City of Austin, personal communication, 2003).

As a method of quality assurance on future predictions made using the water demand forecasting model, Waterstone recommends establishing some form of simple conceptual model for each county. These simple models would summarize industries and water usage in each county, providing perspective on any predictions of water demand. Reviewing such models as a formal step in prediction assessment would incorporate a basic level of intuition into the process. Waterstone believes that such intuition would greatly improve the process of generating reasonable predictions.

For the accuracy of future predictions made using the water demand forecasting model, the input parameters should be continually updated when current water use estimates are made available. The more recent the water use estimates, the more reliable the forecast. Updates to prediction parameters, in conjunction with the county level conceptual models discussed above, may also provide insight as to possible refinements.

Predicting water demand usage is not an exact science. There are many circumstances that will affect the way that water is used. Droughts, government legislation, and water price increases can all lead to unexpected changes. Uncertainty increases dramatically with increasing periods of projection. Despite the uncertainty, Waterstone believes that prediction is a powerful tool for planning and for assessing policy. The predictions are based on the best available data and should be used to plan for the future.

Appendix A

APPENDIX A

	SIC #
Mining	
Oil and Gas Extraction	13
Coal Mining	12
Metal Mining	10
Nonmetallic Minerals, Except Fuels	14
Construction	
General Building Contractors	15
Heavy Construction Contractors	16
Special Trade Contractors	17
Total Trade	
Wholesale Trade	50 &51
Retail Trade	
Building Materials and Farm Equipment	52
General Merchandise Stores	53
Food Stores	54
Automotive Dealers and Service Stations	55
Apparel and Accessory Stores	56
Furniture and Home Furnishings Stores	57
Eating and Drinking Places	58
Miscellaneous Retail Stores	59
Finance, Insurance, and Real Estate	
Banking & Non-bank Credit Institutions	60 & 61
Security, Commodity Brokers, and Services	62
Insurance Carriers	63
Insurance Agents, Brokers, and Services	64
Real Estate	65
Holding and Other Investment Companies	67
Total Manufacturing	
Nondurable Goods	
Food and Kindred Products	20
Tobacco Products	21
Textile Mill Products	22
Apparel and Other Textile Products	23
Paper and Allied Products	26
Printing and Publishing	27
Chemicals and Allied Products	28
Petroleum and Coal Products	29
Rubber and Misc. Plastics Products	30
Leather and Leather Products	31

Durable Goods	
Lumber and Wood Products	24
Furniture and Fixtures	25
Primary Metal Industries	33
Fabricated Metal Products	34
Nonelectrical Machinery	35
Electric and Electronic Equipment	36
Trans. Equipment Excl. Motor Vehicles	37
Motor Vehicles and Equipment	37
Stone, Clay, and Glass Products	32
Instruments and Related Products	38
Miscellaneous Manufacturing Industries	39
Services	
Hotels and Other Lodging Places	70
Personal Services	72
Private Households	88
Miscellaneous Business Services	73
Auto Repair, Services, and Garages	75
Miscellaneous Repair Services	76
Amusement and Recreation Services	79
Motion Pictures	78
Medical and Other Health Services	80
Legal Services	81
Private Educational Services	82
Social Services	83
Museums	84
Nonprofit Membership Organization	86
Engineering $ Management Services	87
Miscellaneous Services	89
Government and Government Enterprises	
Total Federal Government	
Federal, Civilian	91, 92, 93
Federal, Military	97
State and Local	94, 95, 96
Trans., Communication, and Public Utilities	
Transportation	41
Railroad Transportation	40
Trucking and Warehousing	42
Water Transportation	44
Local and Interurban Passenger Transit	43
Transportation by Air	45
Pipeline Transportation	46
Transportation Services	47
Communication	48
Electric, Gas, and Sanitary Services	49

Agriculture

Farm	01
Nonfarm Agriculture	02
Agricultural Services	07
Forestry	08
Fisheries	09
Other Agricultural	

Appendix B

APPENDIX B

ECONOMIC OUTPUT TECHNICAL EXPLANATION

The models used in developing the Perryman Economic Forecast are formulated in an internally consistent manner and are designed to permit the integration of relevant global, national, state, and local factors into the projection process. They are the result of more than 20 years of continuing research in econometrics, economic theory, statistical methods, and key policy issues and behavioral patterns, as well as intensive, ongoing study of all aspects of the global, US, and Texas economies.

The remainder of this Technical Appendix describes the forecasting process in a comprehensive manner, focusing on both the modeling and the supplemental analysis. The overall methodology, while certainly not ensuring perfect foresight, permits an enormous body of relevant information to impact the economic outlook in a systematic manner.

Model Logic and Structure

The expanded version of the Texas Econometric Model, developed and maintained by The Perryman Group, revolves around a core system which projects output, income, and employment by industry in a simultaneous manner. For purposes of illustration, it is useful to initially consider the employment functions. Essentially, employment within the system is a derived demand relationship obtained from a neo-Classical production function. The expressions are augmented to include dynamic temporal adjustments to changes in relative factor input costs, output and (implicitly) productivity, and technological progress over time. Thus, the typical equation includes output, the relative real cost of labor and capital, dynamic lag structures, and a technological adjustment parameter. The functional form is logarithmic, thus preserving the theoretical consistency with the neo-Classical formulation.

The income segment of the model is divided into wage and non-wage components. The wage equations, like their employment counterparts, are individually estimated at the two-digit Standard Industrial Classification (SIC) level of aggregation. Hence, income by place of work is measured for approximately 70 distinct production categories. The wage equations measure real compensation, with the form of the variable structure differing between "basic" and "non-basic."

The basic industries, comprised primarily of the various components of Mining, Agriculture, and Manufacturing, are export-oriented, i.e., they bring external dollars into the area and form the core of the economy. The production of these sectors typically flows into national and international markets; hence, the labor markets are influenced by conditions in areas beyond the borders of the particular region. Thus, real (inflation-adjusted) wages in the basic industry are expressed as a function of the corresponding national rates, as well as measures of local labor market conditions (the reciprocal of the unemployment rate), dynamic adjustment parameters, and ongoing trends.

The "non-basic" sectors are somewhat different in nature, as the strength of their labor markets is linked to the health of the local export sectors. Consequently, wages in these industries are related to those in the basic segment of the economy. The relationship also includes the local labor market measures contained in the basic wage equations.

Note that compensation rates in the export or "basic" sectors provide a key element of the interaction of the regional economies with national and international market phenomena, while the "non-basic" or local industries are strongly impacted by area production levels. Given the wage and employment equations, multiplicative identities in each industry provide expressions for total compensation; these totals may then be aggregated to determine aggregate wage and salary income. Simple linkage equations are then estimated for the calculation of personal income by place of work.

The non-labor aspects of personal income are modeled at the regional level using straightforward empirical expressions relating to national performance, dynamic responses, and evolving temporal patterns. In some instances (such as dividends, rents, and others) national variables (for example, interest rates) directly enter the forecasting system. These factors have numerous other implicit linkages into the system resulting from their simultaneous interaction with other phenomena in national and international markets which are explicitly included in various expressions.

The output or gross area product expressions are also developed at the two-digit SIC level. Regional output for basic industries is linked to national performance in the relevant industries, local and national production in key related sectors, relative area and national labor costs in the industry, dynamic adjustment parameters, and ongoing changes in industrial interrelationships (driven by technological changes in production processes).

Output in the non-basic sectors is modeled as a function of basic production levels, output in related local support industries (if applicable), dynamic temporal adjustments, and ongoing patterns. The interindustry linkages are obtained from the input-output (impact assessment) system which is part of the overall integrated modeling structure maintained by The Perryman Group. Note that the dominant component of the econometric system involves the simultaneous estimation and projection of output, income, and employment at a disaggregated industrial level.

Several other components of the model are critical to the multi-regional forecasting process. The demographic module includes (1) a linkage equation between wage and salary (establishment) employment and household employment, (2) a labor force participation rate function, and (3) a complete age-cohort-survival population system with endogenous migration. Given household employment, labor force participation (which is a function of economic conditions and evolving patterns of worker preferences), and the working age population (from the age-cohort-survival model), the unemployment rate and level become identities.

The population system uses Census information, fertility rates, and life tables to determine the "natural" changes in population by age group. Migration, the most difficult segment of population dynamics to track, is estimated in relation to relative regional and extra-regional economic conditions over time. Because evolving economic conditions determine migration in the system, population changes are allowed to interact simultaneously with overall economic conditions.

Retail sales is related to income, interest rates, dynamic adjustments, and patterns in consumer behavior on a store group basis. Inflation at the state level relates to national patterns, indicators of relative economic conditions, and ongoing trends.

A final significant segment of the forecasting system relates to real estate absorption and activity. The short-term demand for various types of property is determined by underlying economic and demographic factors, with short-term adjustments to reflect the current status of the pertinent building cycle. In some instances, this portion of the forecast requires integration with the Multi-Regional Industry-Occupation System which is maintained by The Perryman Group.

The overall Texas Econometric Model contains numerous additional specifications, and individual expressions are modified to reflect alternative lag structures, empirical properties of the estimates, simulation requirements, and similar phenomena. Nonetheless, the above synopsis offers a basic understanding of the overall structure and underlying logic of the system.

Model Simulation and Multi-Regional Structure

The initial phase of the simulation process is the execution of a standard non-linear algorithm for the state system and that of each of the individual sub-areas. The external assumptions are derived from scenarios developed through national and international models and extensive analysis by The Perryman Group.

Once the initial simulations are completed, they are merged into a single system with additive constraints and interregional flows. Using information on minimum regional requirements, import needs, export potential, and locations, it becomes possible to balance the various forecasts into a mathematically consistent set of results. This process is, in effect, a disciplining exercise with regard to the individual regional (including metropolitan and rural) systems. By compelling equilibrium across all regions and sectors, the algorithm ensures that the patterns in state activity are reasonable in light of smaller area dynamics and, conversely, that the regional outlooks are within plausible performance levels for the state as a whole.

The iterative simulation process has the additional property of imposing a global convergence criterion across the entire multi-regional system, with balance being achieved simultaneously on both a sectoral and a geographic basis. This approach is particularly critical on non-linear dynamic systems, as independent simulations of individual systems often yield unstable, non-convergent outcomes.

It should be noted that the underlying data for the modeling and simulation process are frequently updated and revised by the various public and private entities compiling them. Whenever those modifications to the database occur, they bring corresponding changes to the structural parameter estimates of the various systems and the solutions to the simulation and forecasting system. The multi-regional version of the Texas Econometric Model is automatically re-estimated and simulated with each such data release, thus providing a constantly evolving and current assessment of state and local business activity.

The Final Forecast

The process described above is followed to produce the preliminary forecast. Through the comprehensive multi-regional modeling and simulation process, a systematic analysis is generated which accounts for both historical patterns in economic performance and inter-relationships and best available information on the future course of pertinent external factors. While the best available techniques and data are employed in this effort, they are not capable of directly capturing "street sense," i.e., the contemporaneous and often non-quantifiable information that can materially affect economic outcomes. In order to provide a comprehensive approach to the prediction of business conditions, it is necessary to compile and assimilate extensive material regarding "what's happenin'" both across the state of Texas and elsewhere.

This critical aspect of the forecasting methodology includes activities such as (1) daily review of hundreds of financial and business publications and electronic information sites; (2) review of all major newspapers in the state on a daily basis; (3) dozens of hours of direct telephone interviews with key business and political leaders in all parts of the state; (4) face-to-face discussions with representatives of major industry groups; and (5) frequent site visits to the various regions of the state. The insights arising from this "fact finding" are analyzed and evaluated for their effects on the likely course of the future activity.

Another vital information resource stems from the firm's ongoing interaction with key players in the international, domestic, and state economic scenes. Such activities include visiting with corporate groups on a regular basis and being regularly involved in the policy process at all levels. The firm is also an active participant in many major corporate relocations, economic development initiatives, and regulatory proceedings.

Once organized, this information is carefully assessed and, when appropriate, independently verified. The impact on specific communities and sectors that is distinct from what is captured by the econometric system is then factored into the forecast analysis. For example, the opening or closing of a major facility, particularly in a relatively small area, can cause a sudden change in business performance that will not be accounted for by either a modeling system based on historical relationships or expected (primarily national and international) factors.

The final step in the forecasting process is the integration of this material into the results in a logical and mathematically consistent manner. In some instances, this task is accomplished through "constant adjustment factors" which augment relevant equations. In other cases, anticipated changes in industrial structure or regulatory parameters are initially simulated within the context of the Texas Multi-Regional Impact Assessment System to estimate their ultimate effects by sector. Those findings are then factored into the simulation as constant adjustments on a distributed temporal basis. Once this scenario is formulated, the extended system is again balanced across regions and sectors through an iterative simulation algorithm analogous to that described in the preceding section.

There are those who maintain that the best forecasts are generated by complex models that capture the interactive forces that drive economic activity. There are others who claim that the optimal approach is to rely on the informed judgment of those who are involved in the process. On this issue, I stand firmly in the middle. I have long held that well-developed models are invaluable tools. They impose logic and consistency on millions of interrelated phenomena and, when properly structured, provide key insights into the ways in which changes in part of the economy work through the entire system. On the other hand, I realize that the knowledge on the streets (both Main and Wall) is equally essential to reliable forecasting. I view my mission for my clients and subscribers as providing the best information I possibly can. I can only do that by combining the two approaches.

As much as some of my colleagues in the quantitative world hate to admit it, there is an irrefutable rationale in statistical theory for using judgmental, non-quantitative information in the preparation of forecasts. Specifically, the desirable property of statistical efficiency (minimum variance) can only be achieved if a prior condition, known as statistical sufficiency, is satisfied. Statistical sufficiency, in turn, requires that all relevant information be used, be it an economic time series published by a government agency or the thoughts and insights of a local building contractor. It's really pretty simple: the more relevant the information, the better the forecast.

Synopsis

No forecasting technique is perfect. There are no guarantees. Wars, assassinations, natural disasters, technological breakthroughs, and countless other factors can alter the course of the economy in a heartbeat. Subtle changes in the underlying structure of the economy may not be perceptible in the data for decades, and the future policy environment is anything but certain. Consumer and business expectations can shift with the wind, responding to things far removed from local conditions. At The Perryman Group, we don't promise perfect forecasts. To do so would be patently foolish. We do pledge, however, to use the best information and systems available to provide a reasonable, rational picture of the future course of economic activity. Our expanded modeling systems reflect this commitment which has been consistent and unyielding over the course of the past two decades.

Appendix C

APPENDIX C

The models for the baseline water demand, and the minimum and maximum ranges of demand, are found in the EXCEL spreadsheets, Forecast_base_final.xls, Forecast_lo_final.xls, and Forecast_hi_final.xls, respectively, on the attached compact disc, in the subdirectory "Forecasting\Results". Each file contains the supporting data in individual worksheets, required to determine manufacturing and mining water demand projections. In the table below, the worksheet title and its contents are described.

Worksheet Title	Worksheet Content
man_data	manufacturing projections from 2002 Texas Water Plan
min_data	mining projections from 2002 Texas Water Plan
tpg(_lo)(_hi)	TPG gross real product values
Twdb	historic water use estimates
Manuf	manufacturing model
Mining	mining model
man_summary	manufacturing forecast for all counties
min_summary	mining forecast for all counties

The county to be modeled is referenced by its county index number. This number is entered in the top left hand corner and is defined as the county number less one. The input of the county index number will automatically reference the corresponding historic water use and gross real product values from the other worksheets. Plots of the historic water use and gross real product are then displayed. The third plot is a comparison of the two data sets in the range where the water use coefficient are determined. Below these plots are various curve fits to TPG data between 1980 and 2000. Given that there are only three data points, the suggested curve fit is the polynomial curve. However, when appropriate, a linear or exponential curve fit can be used instead. Enter '1' to select a linear fit, '2' for a polynomial fit and '3' to use an exponential. Once the output values have been interpolated, the water use coefficient is calculated and the water demand projections are made for both the primary and secondary models. For the manufacturing data, the projections are further modified by the efficiency factor found in Table 1.

Two short macros have been written to automate the process of entering the county index number and collecting the data into one worksheet. The macros 'allmanf' and 'allming' will create a full summary of the resulting forecasts in the worksheets man_summary and min_summary, respectively.

The secondary algorithm is used when the observed water use trend is insensitive to economic output. This is determined on a county by county basis. When such a situation arises, the water use coefficients are calculated for a decade and the water use coefficients are ordered from low to high. The range of years that produce exponentially declining water use coefficient are then used to arrive at water demand forecast values.

Appendix D

Water Demand Forecasts By County
In Acre-Feet/Year (continued)

			MANUFACTURING							MINING					
	CNTY	NAME	2000	2010	2020	2030	2040	2050		2000	2010	2020	2030	2040	2050
BASELINE	58	DAWSON	27	31	39	45	55	66	BASELINE	492	480	577	621	667	713
LOW	58		27	20	25	28	35	41	LOW	492	384	462	497	533	570
HIGH	58		27	42	52	61	76	91	HIGH	492	576	692	746	800	855
TWDB Forecast	58		46	47	47	47	49	51	TWDB Forecast	1,635	1,336	1,092	892	729	595
BASELINE	59	DEAF SMITH	1,366	1,578	1,908	2,191	2,677	3,196	BASELINE	0	0	0	0	0	0
LOW	59		1,366	1,214	1,464	1,678	2,049	2,446	LOW	0	0	0	0	0	0
HIGH	59		1,366	1,943	2,353	2,703	3,305	3,946	HIGH	0	0	0	0	0	0
TWDB Forecast	59		537	575	603	626	679	730	TWDB Forecast	0	0	0	0	0	0
BASELINE	60	DELTA	0	0	0	0	0	0	BASELINE	0	0	0	0	0	0
LOW	60		0	0	0	0	0	0	LOW	0	0	0	0	0	0
HIGH	60		0	0	0	0	0	0	HIGH	0	0	0	0	0	0
TWDB Forecast	60		8	8	8	8	8	8	TWDB Forecast	0	0	0	0	0	0
BASELINE	61	DENTON	768	997	1,399	1,867	2,616	3,489	BASELINE	133	189	249	296	349	407
LOW	61		768	565	787	1,045	1,458	1,938	LOW	133	144	190	226	266	310
HIGH	61		768	1,429	2,011	2,690	3,774	5,040	HIGH	133	234	309	367	431	504
TWDB Forecast	61		799	943	1,067	1,172	1,418	1,699	TWDB Forecast	146	138	144	154	166	182
BASELINE	62	DEWITT	67	79	98	116	145	178	BASELINE	109	154	216	271	337	414
LOW	62		67	49	60	70	87	106	LOW	109	107	149	188	233	287
HIGH	62		67	109	136	161	204	251	HIGH	109	202	282	355	441	542
TWDB Forecast	62		108	126	146	170	195	223	TWDB Forecast	161	106	70	50	44	44
BASELINE	63	DICKENS	0	0	0	0	0	0	BASELINE	32	43	51	53	56	59
LOW	63		0	0	0	0	0	0	LOW	32	22	25	27	28	29
HIGH	63		0	0	0	0	0	0	HIGH	32	65	76	80	84	88
TWDB Forecast	63		0	0	0	0	0	0	TWDB Forecast	215	176	144	117	96	78
BASELINE	64	DIMMIT	0	0	0	0	0	0	BASELINE	690	845	1,110	1,298	1,502	1,724
LOW	64		0	0	0	0	0	0	LOW	690	610	802	938	1,085	1,245
HIGH	64		0	0	0	0	0	0	HIGH	690	1,079	1,418	1,659	1,920	2,202
TWDB Forecast	64		11	11	12	13	14	15	TWDB Forecast	1,003	817	906	916	926	950
BASELINE	65	DONLEY	0	0	0	0	0	0	BASELINE	22	30	37	40	43	46
LOW	65		0	0	0	0	0	0	LOW	22	15	18	20	21	23
HIGH	65		0	0	0	0	0	0	HIGH	22	46	55	60	64	69
TWDB Forecast	65		0	0	0	0	0	0	TWDB Forecast	24	25	26	27	30	33
BASELINE	66	DUVAL	0	0	0	0	0	0	BASELINE	4,357	6,078	7,468	8,271	9,078	9,896
LOW	66		0	0	0	0	0	0	LOW	4,357	5,351	6,575	7,282	7,992	8,712
HIGH	66		0	0	0	0	0	0	HIGH	4,357	6,805	8,361	9,260	10,163	11,079
TWDB Forecast	66		0	0	0	0	0	0	TWDB Forecast	5,012	3,669	3,053	2,993	2,996	3,027
BASELINE	67	EASTLAND	35	41	51	60	75	92	BASELINE	66	102	121	130	138	147
LOW	67		35	24	30	36	45	55	LOW	66	90	107	115	122	130
HIGH	67		35	57	71	84	106	128	HIGH	66	114	135	145	154	164
TWDB Forecast	67		16	17	18	18	19	21	TWDB Forecast	180	120	93	86	85	77
BASELINE	68	ECTOR	2,403	2,689	3,247	3,731	4,186	4,548	BASELINE	5,816	7,183	9,372	11,040	12,879	14,917
LOW	68		2,403	2,030	2,439	2,791	3,121	3,383	LOW	5,816	5,663	7,389	8,703	10,153	11,760
HIGH	68		2,403	3,349	4,054	4,671	5,251	5,713	HIGH	5,816	8,704	11,356	13,376	15,604	18,073
TWDB Forecast	68		2,152	2,339	2,413	2,457	2,602	2,725	TWDB Forecast	7,613	7,294	6,892	6,697	6,604	6,565
BASELINE	69	EDWARDS	0	0	0	0	0	0	BASELINE	4	5	7	8	10	11
LOW	69		0	0	0	0	0	0	LOW	4	3	4	4	5	5
HIGH	69		0	0	0	0	0	0	HIGH	4	8	11	12	14	16
TWDB Forecast	69		0	0	0	0	0	0	TWDB Forecast	8	6	4	3	1	0
BASELINE	70	ELLIS	3,761	4,091	4,862	5,541	6,130	6,485	BASELINE	90	134	176	209	246	287
LOW	70		3,761	2,569	3,055	3,482	3,853	4,080	LOW	90	74	98	116	137	160
HIGH	70		3,761	5,614	6,670	7,601	8,407	8,890	HIGH	90	193	254	302	355	414
TWDB Forecast	70		4,313	4,684	4,925	5,163	5,402	5,639	TWDB Forecast	110	120	135	150	165	182
BASELINE	71	EL PASO	11,597	13,482	16,695	19,654	24,641	29,983	BASELINE	184	281	378	459	550	654
LOW	71		11,597	8,834	10,712	12,359	15,236	18,304	LOW	184	171	230	279	334	398
HIGH	71		11,597	18,129	22,678	26,949	34,045	41,661	HIGH	184	391	526	638	766	911
TWDB Forecast	71		14,786	16,192	17,145	17,904	19,142	20,332	TWDB Forecast	246	110	56	28	10	3
BASELINE	72	ERATH	84	101	132	164	196	224	BASELINE	0	0	0	0	0	0
LOW	72		84	54	71	87	104	118	LOW	0	0	0	0	0	0
HIGH	72		84	147	194	240	288	329	HIGH	0	0	0	0	0	0
TWDB Forecast	72		95	103	109	113	129	141	TWDB Forecast	0	0	0	0	0	0
BASELINE	73	FALLS	4	4	5	6	7	8	BASELINE	158	240	322	388	462	547
LOW	73		4	3	3	4	4	5	LOW	158	120	161	194	231	273
HIGH	73		4	6	7	7	9	11	HIGH	158	361	482	582	694	820
TWDB Forecast	73		0	0	0	0	0	0	TWDB Forecast	150	111	94	88	84	86
BASELINE	74	FANNIN	752	924	1,218	1,515	1,990	2,508	BASELINE	34	66	85	98	112	127
LOW	74		752	581	759	936	1,221	1,532	LOW	34	41	53	61	70	80
HIGH	74		752	1,267	1,676	2,094	2,758	3,484	HIGH	34	91	116	134	154	175
TWDB Forecast	74		39	44	49	54	59	66	TWDB Forecast	0	0	0	0	0	0
BASELINE	75	FAYETTE	126	156	207	262	350	449	BASELINE	42	61	76	86	97	108
LOW	75		126	92	123	155	207	266	LOW	42	42	53	60	67	74
HIGH	75		126	219	292	369	493	632	HIGH	42	80	100	113	127	141

Appendix D
Water Demand Forecasts By County
In Acre-Feet/Year

	CNTY	NAME	MANUFACTURING 2000	2010	2020	2030	2040	2050		MINING 2000	2010	2020	2030	2040	2050
BASELINE	1	ANDERSON	180	209	259	304	379	456	BASELINE	342	414	526	603	685	774
LOW	1		180	138	170	196	244	292	LOW	342	349	443	508	577	652
HIGH	1		180	279	349	411	513	619	HIGH	342	479	609	696	793	896
TWDB Forecast	1		153	164	172	179	194	208	TWDB Forecast	252	168	93	61	40	31
BASELINE	2	ANDREWS	11	12	16	19	23	28	. BASELINE	1,389	1,992	2,392	2,577	2,764	2,955
LOW	2		11	6	8	9	12	14	LOW	1,389	1,577	1,894	2,040	2,189	2,340
HIGH	2		11	18	23	28	35	43	HIGH	1,389	2,406	2,890	3,114	3,340	3,571
TWDB Forecast	2		36	38	39	39	45	51	TWDB Forecast	4,364	2,646	1,654	1,328	1,134	1,103
BASELINE	3	ANGELINA	20,099	23,639	29,528	34,961	44,101	54,002	BASELINE	23	33	42	48	55	62
LOW	3		20,099	19,399	24,247	28,713	36,231	44,389	LOW	23	19	24	27	31	35
HIGH	3		20,099	27,880	34,809	41,209	51,971	63,614	HIGH	23	48	61	70	79	89
TWDB Forecast	3		30,000	32,290	34,877	37,818	41,138	45,000	TWDB Forecast	36	40	45	51	57	64
BASELINE	4	ARANSAS	314	350	411	461	554	651	BASELINE	84	123	159	185	213	244
LOW	4		314	216	252	280	332	388	LOW	84	107	138	161	185	212
HIGH	4		314	483	571	643	775	915	HIGH	84	139	179	209	241	275
TWDB Forecast	4		352	430	497	572	684	810	TWDB Forecast	119	85	57	29	14	7
BASELINE	5	ARCHER	0	0	0	0	0	0	BASELINE	1	1	1	1	2	2
LOW	5		0	0	0	0	0	0	LOW	1	1	1	1	1	1
HIGH	5		0	0	0	0	0	0	HIGH	1	1	2	2	2	2
TWDB Forecast	5		0	0	0	0	0	0	TWDB Forecast	0	0	0	0	0	0
BASELINE	6	ARMSTRONG	0	0	0	0	0	0	BASELINE	19	26	32	34	37	40
LOW	6		0	0	0	0	0	0	LOW	19	13	16	17	19	20
HIGH	6		0	0	0	0	0	0	HIGH	19	40	48	52	56	60
TWDB Forecast	6		0	0	0	0	0	0	TWDB Forecast	25	24	25	26	26	26
BASELINE	7	ATASCOSA	0	0	0	0	0	0	BASELINE	1,028	1,393	1,710	1,891	2,080	2,277
LOW	7		0	0	0	0	0	0	LOW	1,028	1,154	1,416	1,566	1,722	1,886
HIGH	7		0	0	0	0	0	0	HIGH	1,028	1,632	2,004	2,216	2,437	2,668
TWDB Forecast	7		0	0	0	0	0	0	TWDB Forecast	1,558	1,583	1,693	1,804	1,918	2,048
BASELINE	8	AUSTIN	113	139	183	226	294	369	BASELINE	41	47	60	69	79	90
LOW	8		113	78	100	123	161	201	LOW	41	39	50	58	66	75
HIGH	8		113	202	266	328	428	537	HIGH	41	55	70	80	92	104
TWDB Forecast	8		120	147	176	207	249	296	TWDB Forecast	97	74	53	35	28	27
BASELINE	9	BAILEY	129	146	171	191	227	266	BASELINE	7	6	7	7	8	8
LOW	9		129	73	86	96	115	134	LOW	7	3	4	4	4	4
HIGH	9		129	218	256	286	340	398	HIGH	7	9	11	11	12	12
TWDB Forecast	9		172	199	224	247	281	315	TWDB Forecast	25	25	25	27	27	27
BASELINE	10	BANDERA	0	0	0	0	0	0	BASELINE	14	15	18	20	22	24
LOW	10		0	0	0	0	0	0	LOW	14	11	14	15	17	18
HIGH	10		0	0	0	0	0	0	HIGH	14	19	23	25	28	31
TWDB Forecast	10		11	13	15	16	19	22	TWDB Forecast	25	25	26	27	27	27
BASELINE	11	BASTROP	45	59	82	108	151	202	BASELINE	26	37	50	60	72	86
LOW	11		45	43	59	78	108	144	LOW	26	28	38	46	56	66
HIGH	11		45	75	104	139	195	260	HIGH	26	46	61	74	89	106
TWDB Forecast	11		33	40	48	57	67	78	TWDB Forecast	56	46	38	33	34	43
BASELINE	12	BAYLOR	0	0	0	0	0	0	BASELINE	32	37	45	48	51	55
LOW	12		0	0	0	0	0	0	LOW	32	27	33	35	38	40
HIGH	12		0	0	0	0	0	0	HIGH	32	47	57	61	65	69
TWDB Forecast	12		0	0	0	0	0	0	TWDB Forecast	32	21	10	5	0	0
BASELINE	13	BEE	1	1	2	2	2	3	BASELINE	26	34	44	52	59	68
LOW	13		1	1	1	1	1	2	LOW	26	29	38	44	50	58
HIGH	13		1	2	2	3	4	4	HIGH	26	40	51	59	68	78
TWDB Forecast	13		1	1	2	2	2	3	TWDB Forecast	24	14	8	3	0	0
BASELINE	14	BELL	746	897	1,142	1,384	1,782	2,224	BASELINE	136	206	293	377	478	598
LOW	14		746	578	726	869	1,106	1,372	LOW	136	114	162	208	263	330
HIGH	14		746	1,215	1,558	1,899	2,457	3,077	HIGH	136	298	425	546	692	866
TWDB Forecast	14		4,040	4,640	6,320	7,620	8,380	8,700	TWDB Forecast	155	157	162	166	171	176
BASELINE	15	BEXAR	20,879	22,342	25,906	28,754	31,222	32,741	BASELINE	3,292	4,783	6,131	7,095	8,140	9,280
LOW	15		20,879	16,650	18,922	20,595	21,999	22,788	LOW	3,292	4,063	5,209	6,027	6,915	7,883
HIGH	15		20,879	28,034	32,894	36,913	40,445	42,693	HIGH	3,292	5,503	7,054	8,162	9,365	10,676
TWDB Forecast	15		16,805	19,682	22,359	24,935	28,264	31,697	TWDB Forecast	4,963	4,936	5,201	5,406	5,645	5,962
BASELINE	16	BLANCO	0	0	0	0	0	0	BASELINE	6	8	10	11	12	14
LOW	16		0	0	0	0	0	0	LOW	6	5	6	7	8	9
HIGH	16		0	0	0	0	0	1	HIGH	6	11	13	15	17	19
TWDB Forecast	16		0	0	0	0	0	0	TWDB Forecast	13	9	5	1	0	0
BASELINE	17	BORDEN	0	0	0	0	0	0	BASELINE	694	822	987	1,064	1,141	1,220
LOW	17		0	0	0	0	0	0	LOW	694	470	564	608	652	697
HIGH	17		0	0	0	0	0	0	HIGH	694	1,174	1,411	1,520	1,630	1,743
TWDB Forecast	17		48	57	68	80	94	109	TWDB Forecast	934	776	701	677	665	672
BASELINE	18	BOSQUE	682	847	1,130	1,420	1,884	2,394	BASELINE	236	313	419	505	602	712
LOW	18		682	556	726	894	1,167	1,467	LOW	236	157	210	253	301	356
HIGH	18		682	1,137	1,534	1,947	2,601	3,320	HIGH	236	470	629	758	904	1,069

Water Demand Forecasts By County
In Acre-Feet/Year (continued)

			MANUFACTURING							MINING					
	CNTY	NAME	2000	2010	2020	2030	2040	2050		2000	2010	2020	2030	2040	2050
BASELINE	20	BRAZORIA	134,916	155,159	188,133	218,017	270,717	327,911	BASELINE	2,688	2,548	3,229	3,694	4,193	4,731
LOW	20		134,916	119,306	141,766	160,798	195,884	233,639	LOW	2,688	2,186	2,770	3,169	3,597	4,059
HIGH	20		134,916	191,012	234,500	275,236	345,549	422,184	HIGH	2,688	2,909	3,687	4,218	4,788	5,403
TWDB Forecast	20		228,424	257,569	274,057	288,204	316,451	344,404	TWDB Forecast	1,511	1,305	1,169	1,114	1,043	1,063
BASELINE	21	BRAZOS	282	359	488	632	864	1,131	BASELINE	24	36	49	60	72	86
LOW	21		282	228	307	393	531	689	LOW	24	26	35	43	52	62
HIGH	21		282	489	670	872	1,198	1,572	HIGH	24	47	63	77	93	111
TWDB Forecast	21		194	221	244	262	295	329	TWDB Forecast	27	27	28	30	32	34
BASELINE	22	BREWSTER	3	3	4	4	5	7	BASELINE	614	759	915	984	1,054	1,125
LOW	22		3	2	2	2	3	3	LOW	614	456	550	591	633	676
HIGH	22		3	4	5	6	8	10	HIGH	614	1,062	1,280	1,377	1,475	1,574
TWDB Forecast	22		4	4	5	5	6	7	TWDB Forecast	840	855	983	1,068	1,196	1,339
BASELINE	23	BRISCOE	0	0	0	0	0	0	BASELINE	0	0	0	0	0	0
LOW	23		0	0	0	0	0	0	LOW	0	0	0	0	0	0
HIGH	23		0	0	0	0	0	0	HIGH	0	0	0	0	0	0
TWDB Forecast	23		0	0	0	0	0	0	TWDB Forecast	0	0	0	0	0	0
BASELINE	24	BROOKS	0	0	0	0	0	0	BASELINE	82	91	118	137	157	180
LOW	24		0	0	0	0	0	0	LOW	82	73	95	110	127	145
HIGH	24		0	0	0	0	0	0	HIGH	82	109	140	163	188	215
TWDB Forecast	24		0	0	0	0	0	0	TWDB Forecast	129	108	92	78	65	55
BASELINE	25	BROWN	493	583	732	870	1,095	1,336	BASELINE	2,304	2,968	3,530	3,773	4,018	4,267
LOW	25		493	398	500	593	745	907	LOW	2,304	2,248	2,673	2,857	3,043	3,231
HIGH	25		493	767	965	1,148	1,446	1,765	HIGH	2,304	3,689	4,387	4,689	4,994	5,303
TWDB Forecast	25		485	524	567	608	660	714	TWDB Forecast	300	278	196	177	150	134
BASELINE	26	BURLESON	147	189	262	345	476	625	BASELINE	27	37	48	56	65	74
LOW	26		147	129	177	229	312	405	LOW	27	22	29	33	39	44
HIGH	26		147	248	348	462	640	844	HIGH	27	53	68	79	91	104
TWDB Forecast	26		131	145	158	171	182	194	TWDB Forecast	29	24	18	15	13	13
BASELINE	27	BURNET	1,363	1,734	2,381	3,094	4,211	5,463	BASELINE	1,140	1,548	1,944	2,194	2,458	2,738
LOW	27		1,363	1,040	1,410	1,812	2,445	3,157	LOW	1,140	1,228	1,542	1,741	1,950	2,172
HIGH	27		1,363	2,427	3,352	4,377	5,977	7,768	HIGH	1,140	1,868	2,346	2,648	2,966	3,304
TWDB Forecast	27		1,246	1,377	1,514	1,655	1,800	1,947	TWDB Forecast	1,013	987	1,006	1,028	1,058	1,091
BASELINE	28	CALDWELL	8	10	15	20	28	39	BASELINE	9	12	16	19	23	28
LOW	28		8	6	8	11	15	21	LOW	9	9	12	15	18	21
HIGH	28		8	15	21	29	41	56	HIGH	9	15	20	24	29	34
TWDB Forecast	28		62	67	71	77	82	87	TWDB Forecast	21	16	10	4	0	0
BASELINE	29	CALHOUN	38,643	44,502	53,963	62,340	76,905	92,621	BASELINE	26	31	43	54	67	82
LOW	29		38,643	34,957	42,134	48,332	59,223	70,928	LOW	26	23	32	40	49	61
HIGH	29		38,643	54,047	65,792	76,348	94,587	114,314	HIGH	26	39	54	68	85	104
TWDB Forecast	29		63,026	77,588	85,949	95,240	105,236	115,958	TWDB Forecast	28	21	12	6	3	3
BASELINE	30	CALLAHAN	0	0	0	0	0	0	BASELINE	85	115	137	147	156	166
LOW	30		0	0	0	0	0	0	LOW	85	97	115	123	131	139
HIGH	30		0	0	0	0	0	0	HIGH	85	134	159	170	181	192
TWDB Forecast	30		0	0	0	0	0	0	TWDB Forecast	193	174	135	119	106	104
BASELINE	31	CAMERON	1,162	1,381	1,758	2,135	2,757	3,441	BASELINE	8	10	13	14	15	16
LOW	31		1,162	894	1,123	1,345	1,718	2,126	LOW	8	5	6	7	8	8
HIGH	31		1,162	1,868	2,394	2,925	3,797	4,756	HIGH	8	15	19	21	22	24
TWDB Forecast	31		1,257	1,391	1,504	1,628	1,804	1,985	TWDB Forecast	12	8	4	1	0	0
BASELINE	32	CAMP	27	30	34	38	45	52	BASELINE	27	39	50	57	65	73
LOW	32		27	23	26	29	34	40	LOW	27	26	34	38	44	49
HIGH	32		27	37	43	47	55	64	HIGH	27	52	66	75	85	97
TWDB Forecast	32		10	2,242	2,242	2,242	2,242	2,242	TWDB Forecast	132	131	131	131	131	131
BASELINE	33	CARSON	455	537	683	813	1,019	1,234	BASELINE	1,669	2,258	2,723	2,947	3,174	3,406
LOW	33		455	419	532	632	792	958	LOW	1,669	1,404	1,693	1,832	1,973	2,118
HIGH	33		455	656	834	993	1,246	1,509	HIGH	1,669	3,112	3,754	4,062	4,375	4,695
TWDB Forecast	33		825	987	1,168	1,368	1,586	1,820	TWDB Forecast	2,183	1,698	1,491	1,404	1,365	1,358
BASELINE	34	CASS	85,527	87,397	94,690	97,975	99,692	99,388	BASELINE	737	1,200	1,493	1,675	1,866	2,068
LOW	34		85,527	62,487	67,674	69,954	71,089	70,771	LOW	737	974	1,213	1,360	1,516	1,680
HIGH	34		85,527	112,307	121,706	125,997	128,295	128,006	HIGH	737	1,425	1,773	1,989	2,216	2,457
TWDB Forecast	34		80,129	76,867	76,871	74,569	77,555	80,664	TWDB Forecast	1,254	990	942	902	872	496
BASELINE	35	CASTRO	1,745	2,011	2,417	2,762	3,363	4,005	BASELINE	0	0	0	0	0	0
LOW	35		1,745	1,460	1,750	1,996	2,427	2,888	LOW	0	0	0	0	0	0
HIGH	35		1,745	2,563	3,084	3,527	4,299	5,123	HIGH	0	0	0	0	0	0
TWDB Forecast	35		2,559	2,978	3,333	3,653	4,152	4,650	TWDB Forecast	0	0	0	0	0	0
BASELINE	36	CHAMBERS	6,186	7,342	9,130	10,829	13,707	16,918	BASELINE	8,391	14,443	18,572	21,560	24,811	28,365
LOW	36		6,186	4,922	6,044	7,071	8,835	10,786	LOW	8,391	11,951	15,368	17,841	20,530	23,471
HIGH	36		6,186	9,763	12,216	14,588	18,579	23,049	HIGH	8,391	16,935	21,777	25,280	29,091	33,259
TWDB Forecast	36		4,675	5,052	5,229	5,383	5,792	6,207	TWDB Forecast	13,233	9,379	8,155	7,707	7,388	7,344
BASELINE	37	CHEROKEE	631	733	909	1,065	1,328	1,605	BASELINE	83	120	152	174	198	224
LOW	37		631	483	581	661	807	960	LOW	83	93	118	135	154	174
HIGH	37		631	983	1,237	1,468	1,849	2,250	HIGH	83	147	186	213	242	274

Water Demand Forecasts By County
In Acre-Feet/Year (continued)

	CNTY	NAME	MANUFACTURING 2000	2010	2020	2030	2040	2050		MINING 2000	2010	2020	2030	2040	2050
BASELINE	39	CLAY	0	0	0	0	0	0	BASELINE	195	212	254	273	292	312
LOW	39		0	0	0	0	0	0	LOW	195	142	170	183	196	209
HIGH	39		0	0	0	0	0	0	HIGH	195	282	338	363	388	414
TWDB Forecast	39		0	0	0	0	0	0	TWDB Forecast	308	222	198	184	180	180
BASELINE	40	COCHRAN	0	0	0	0	0	0	BASELINE	965	1,063	1,248	1,315	1,381	1,448
LOW	40		0	0	0	0	0	0	LOW	965	736	864	910	957	1,003
HIGH	40		0	0	0	0	0	0	HIGH	965	1,390	1,631	1,719	1,806	1,894
TWDB Forecast	40		0	0	0	0	0	0	TWDB Forecast	1,264	1,033	844	689	563	460
BASELINE	41	COKE	0	0	0	0	0	0	BASELINE	119	160	201	227	254	283
LOW	41		0	0	0	0	0	0	LOW	119	136	170	192	216	241
HIGH	41		0	0	0	0	0	0	HIGH	119	184	231	261	292	326
TWDB Forecast	41		0	0	0	0	0	0	TWDB Forecast	261	218	159	121	93	74
BASELINE	42	COLEMAN	2	2	3	3	4	5	BASELINE	14	17	20	22	23	24
LOW	42		2	1	2	2	2	3	LOW	14	14	17	18	19	21
HIGH	42		2	3	4	5	6	8	HIGH	14	20	23	25	26	28
TWDB Forecast	42		1	1	2	2	2	3	TWDB Forecast	15	16	16	17	17	17
BASELINE	43	COLLIN	2,236	2,742	3,685	4,740	5,890	6,988	BASELINE	298	396	521	619	728	850
LOW	43		2,236	1,408	1,885	2,416	2,994	3,546	LOW	298	273	360	428	503	587
HIGH	43		2,236	4,075	5,485	7,064	8,786	10,430	HIGH	298	518	682	810	953	1,112
TWDB Forecast	43		2,368	2,677	2,963	3,245	3,664	4,110	TWDB Forecast	182	183	175	171	163	172
BASELINE	44	COLLINGSWORTH	0	0	0	0	0	0	BASELINE	0	0	0	0	0	0
LOW	44		0	0	0	0	0	0	LOW	0	0	0	0	0	0
HIGH	44		0	0	0	0	0	0	HIGH	0	0	0	0	0	0
TWDB Forecast	44		0	0	0	0	0	0	TWDB Forecast	0	0	0	0	0	0
BASELINE	45	COLORADO	189	227	287	340	428	522	BASELINE	14,315	19,495	24,920	28,711	32,798	37,229
LOW	45		189	134	170	204	258	318	LOW	14,315	14,202	18,155	20,916	23,894	27,122
HIGH	45		189	321	403	476	597	727	HIGH	14,315	24,787	31,686	36,505	41,702	47,337
TWDB Forecast	45		1,150	1,224	1,297	1,369	1,438	1,508	TWDB Forecast	20,486	11,378	12,334	13,473	14,926	16,677
BASELINE	46	COMAL	9,109	10,990	14,209	17,456	22,718	28,493	BASELINE	3,656	5,312	6,808	7,879	9,039	10,305
LOW	46		9,109	6,647	8,457	10,245	13,190	16,422	LOW	3,656	4,401	5,642	6,528	7,490	8,539
HIGH	46		9,109	15,332	19,960	24,666	32,245	40,563	HIGH	3,656	6,222	7,975	9,229	10,589	12,071
TWDB Forecast	46		3,450	3,487	3,548	3,799	4,071	4,351	TWDB Forecast	5,570	5,464	5,628	5,796	3,590	2,224
BASELINE	47	COMANCHE	20	23	29	34	43	52	BASELINE	53	55	65	70	74	79
LOW	47		20	16	20	23	29	35	LOW	53	28	33	35	37	40
HIGH	47		20	31	38	45	56	68	HIGH	53	83	98	105	112	119
TWDB Forecast	47		28	32	38	43	50	58	TWDB Forecast	87	86	89	92	95	98
BASELINE	48	CONCHO	0	0	0	0	0	0	BASELINE	0	0	0	0	0	0
LOW	48		0	0	0	0	0	0	LOW	0	0	0	0	0	0
HIGH	48		0	0	0	0	0	0	HIGH	0	0	0	0	0	0
TWDB Forecast	48		0	0	0	0	0	0	TWDB Forecast	0	0	0	0	0	0
BASELINE	49	COOKE	184	223	289	354	460	575	BASELINE	270	433	556	642	735	837
LOW	49		184	150	194	238	309	387	LOW	270	331	424	490	562	639
HIGH	49		184	297	384	470	610	762	HIGH	270	536	687	794	909	1,035
TWDB Forecast	49		352	406	458	509	572	634	TWDB Forecast	595	433	385	341	328	330
BASELINE	50	CORYELL	4	4	6	7	9	12	BASELINE	109	177	252	323	409	513
LOW	50		4	3	3	4	6	7	LOW	109	118	168	216	274	343
HIGH	50		4	6	8	10	13	17	HIGH	109	235	335	430	545	683
TWDB Forecast	50		9	11	13	15	16	17	TWDB Forecast	104	108	112	116	120	124
BASELINE	51	COTTLE	0	0	0	0	0	0	BASELINE	12	11	13	14	15	16
LOW	51		0	0	0	0	0	0	LOW	12	7	8	9	9	10
HIGH	51		0	0	0	0	0	0	HIGH	12	15	18	20	21	22
TWDB Forecast	51		0	0	0	0	0	0	TWDB Forecast	25	25	27	28	30	30
BASELINE	52	CRANE	0	0	0	0	0	0	BASELINE	1,921	2,424	2,911	3,136	3,364	3,596
LOW	52		0	0	0	0	0	0	LOW	1,921	1,755	2,108	2,271	2,436	2,605
HIGH	52		0	0	0	0	0	0	HIGH	1,921	3,092	3,713	4,001	4,291	4,588
TWDB Forecast	52		0	0	0	0	0	0	TWDB Forecast	2,726	2,102	1,859	1,757	1,738	1,759
BASELINE	53	CROCKETT	0	0	0	0	0	0	BASELINE	336	468	586	661	741	826
LOW	53		0	0	0	0	0	0	LOW	336	373	467	527	591	659
HIGH	53		0	0	0	0	0	0	HIGH	336	563	704	795	892	994
TWDB Forecast	53		6	8	10	11	15	17	TWDB Forecast	402	280	226	202	185	190
BASELINE	54	CROSBY	2	3	3	4	4	5	BASELINE	363	670	787	829	871	913
LOW	54		2	2	2	2	3	3	LOW	363	521	612	644	677	710
HIGH	54		2	4	4	5	6	7	HIGH	363	820	962	1,014	1,065	1,117
TWDB Forecast	54		7	6	6	6	6	6	TWDB Forecast	855	863	889	916	943	970
BASELINE	55	CULBERSON	0	0	0	0	0	0	BASELINE	894	1,079	1,300	1,399	1,498	1,599
LOW	55		0	0	0	0	0	0	LOW	894	859	1,035	1,114	1,193	1,273
HIGH	55		0	0	0	0	0	0	HIGH	894	1,299	1,565	1,684	1,803	1,925
TWDB Forecast	55		1	1	2	2	2	3	TWDB Forecast	2,240	2,210	2,245	2,309	2,372	2,441
BASELINE	56	DALLAM	0	0	0	0	0	0	BASELINE	0	0	0	0	0	0
LOW	56		0	0	0	0	0	0	LOW	0	0	0	0	0	0
HIGH	56		0	0	0	0	0	0	HIGH	0	0	0	0	0	0

Water Demand Forecasts By County
In Acre-Feet/Year (continued)

	CNTY NAME	MANUFACTURING 2000	2010	2020	2030	2040	2050		MINING 2000	2010	2020	2030	2040	2050
BASELINE	77 FLOYD	9	10	12	14	17	20	BASELINE	34	33	38	40	42	44
LOW	77	9	7	8	10	12	14	LOW	34	16	19	20	21	22
HIGH	77	9	14	16	19	23	26	HIGH	34	49	57	61	64	67
TWDB Forecast	77	1	1	2	2	2	2	TWDB Forecast	66	50	47	46	45	45
BASELINE	78 FOARD	0	0	0	0	0	0	BASELINE	22	30	36	39	42	44
LOW	78	0	0	0	0	0	0	LOW	22	15	18	19	21	22
HIGH	78	0	0	0	0	0	0	HIGH	22	45	54	58	63	67
TWDB Forecast	78	0	0	0	0	0	0	TWDB Forecast	23	24	24	25	26	27
BASELINE	79 FORT BEND	19,697	21,303	25,227	28,581	31,313	32,810	BASELINE	205	298	384	445	513	586
LOW	79	19,697	12,336	14,344	15,993	17,304	17,970	LOW	205	217	279	324	373	426
HIGH	79	19,697	30,269	36,109	41,170	45,323	47,650	HIGH	205	380	488	567	653	746
TWDB Forecast	79	21,139	23,616	25,556	27,401	30,592	33,639	TWDB Forecast	258	250	235	219	220	228
BASELINE	80 FRANKLIN	0	0	0	0	0	0	BASELINE	1,128	1,502	1,869	2,097	2,337	2,590
LOW	80	0	0	0	0	0	0	LOW	1,128	863	1,074	1,205	1,342	1,488
HIGH	80	0	0	0	0	0	0	HIGH	1,128	2,141	2,665	2,990	3,331	3,692
TWDB Forecast	80	6	6	6	6	6	6	TWDB Forecast	1,479	1,384	1,338	1,278	1,297	1,359
BASELINE	81 FREESTONE	0	0	0	0	0	0	BASELINE	118	274	366	442	526	622
LOW	81	0	0	0	0	0	0	LOW	118	218	291	351	418	495
HIGH	81	0	0	0	0	0	0	HIGH	118	330	441	532	635	750
TWDB Forecast	81	0	0	0	0	0	0	TWDB Forecast	137	120	50	36	27	25
BASELINE	82 FRIO	0	0	0	0	0	0	BASELINE	87	96	117	130	143	156
LOW	82	0	0	0	0	0	0	LOW	87	54	66	73	80	88
HIGH	82	0	0	0	0	0	0	HIGH	87	138	169	187	205	225
TWDB Forecast	82	0	0	0	0	0	0	TWDB Forecast	150	63	32	16	7	3
BASELINE	83 GAINES	326	370	446	510	619	731	BASELINE	6,741	7,530	9,043	9,743	10,451	11,173
LOW	83	326	218	261	297	358	422	LOW	6,741	6,285	7,548	8,132	8,723	9,326
HIGH	83	326	523	632	723	880	1,040	HIGH	6,741	8,775	10,538	11,354	12,179	13,020
TWDB Forecast	83	331	358	205	381	412	442	TWDB Forecast	8,879	7,255	5,928	4,843	3,957	3,233
BASELINE	84 GALVESTON	41,747	47,452	56,449	63,914	77,446	91,788	BASELINE	409	437	535	592	652	714
LOW	84	41,747	35,680	42,040	47,191	56,788	66,953	LOW	409	362	443	491	540	591
HIGH	84	41,747	59,224	70,858	80,637	98,104	116,623	HIGH	409	512	627	694	764	837
TWDB Forecast	84	64,614	70,905	75,743	80,269	88,858	97,460	TWDB Forecast	84	63	55	44	42	44
BASELINE	85 GARZA	2	2	2	2	3	3	BASELINE	1,187	1,327	1,558	1,642	1,725	1,809
LOW	85	2	1	1	1	1	2	LOW	1,187	1,254	1,472	1,551	1,629	1,708
HIGH	85	2	3	3	4	4	5	HIGH	1,187	1,401	1,645	1,733	1,821	1,909
TWDB Forecast	85	2	3	3	4	5	5	TWDB Forecast	1,487	1,215	993	811	663	542
BASELINE	86 GILLESPIE	372	420	502	571	693	819	BASELINE	9	12	15	17	18	20
LOW	86	372	277	327	366	439	515	LOW	9	8	9	10	11	13
HIGH	86	372	563	678	775	946	1,123	HIGH	9	17	20	23	25	27
TWDB Forecast	86	502	556	608	657	727	795	TWDB Forecast	5	3	1	0	0	0
BASELINE	87 GLASSCOCK	0	0	0	0	0	0	BASELINE	7	10	12	13	14	15
LOW	87	0	0	0	0	0	0	LOW	7	5	6	6	7	7
HIGH	87	0	0	0	0	0	0	HIGH	7	15	18	19	21	22
TWDB Forecast	87	0	0	0	0	0	0	TWDB Forecast	5	3	1	1	0	0
BASELINE	88 GOLIAD	0	0	0	0	0	0	BASELINE	16	25	34	43	54	66
LOW	88	0	0	0	0	0	0	LOW	16	14	19	24	30	37
HIGH	88	0	0	0	0	0	0	HIGH	16	36	50	63	78	96
TWDB Forecast	88	0	0	0	0	0	0	TWDB Forecast	17	12	6	3	0	0
BASELINE	89 GONZALES	1,120	1,286	1,551	1,782	2,184	2,616	BASELINE	30	45	62	78	97	119
LOW	89	1,120	992	1,187	1,353	1,646	1,960	LOW	30	24	33	41	51	63
HIGH	89	1,120	1,579	1,914	2,211	2,722	3,272	HIGH	30	65	91	115	143	176
TWDB Forecast	89	929	992	1,043	1,083	1,160	1,231	TWDB Forecast	41	37	33	29	29	30
BASELINE	90 GRAY	4,014	4,586	5,575	6,466	7,354	8,161	BASELINE	976	1,268	1,530	1,655	1,783	1,913
LOW	90	4,014	4,007	4,853	5,606	6,350	7,022	LOW	976	1,026	1,238	1,340	1,443	1,548
HIGH	90	4,014	5,164	6,296	7,326	8,358	9,299	HIGH	976	1,510	1,821	1,971	2,123	2,278
TWDB Forecast	90	3,947	4,225	4,332	4,407	4,692	4,967	TWDB Forecast	1,524	1,112	996	920	948	1,029
BASELINE	91 GRAYSON	6,513	7,986	9,371	10,434	11,272	11,716	BASELINE	999	1,363	1,729	1,977	2,242	2,528
LOW	91	6,513	4,782	5,518	6,058	6,476	6,680	LOW	999	941	1,194	1,365	1,548	1,746
HIGH	91	6,513	11,191	13,224	14,809	16,068	16,751	HIGH	999	1,784	2,263	2,588	2,936	3,310
TWDB Forecast	91	6,214	6,735	7,095	7,559	8,175	9,025	TWDB Forecast	1,033	944	921	926	936	954
BASELINE	92 GREGG	1,385	1,684	2,199	2,715	3,538	4,430	BASELINE	51	116	151	177	206	237
LOW	92	1,385	1,178	1,521	1,859	2,404	2,992	LOW	51	110	143	168	195	224
HIGH	92	1,385	2,190	2,878	3,571	4,673	5,868	HIGH	51	123	159	187	217	250
TWDB Forecast	92	16,538	18,576	20,934	23,507	26,515	29,716	TWDB Forecast	96	67	46	37	29	27
BASELINE	93 GRIMES	205	262	365	480	663	875	BASELINE	156	248	320	372	428	490
LOW	93	205	156	215	281	385	506	LOW	156	178	229	267	307	352
HIGH	93	205	369	514	679	940	1,244	HIGH	156	318	410	477	549	628
TWDB Forecast	93	280	314	351	391	435	483	TWDB Forecast	273	255	236	219	213	212
BASELINE	94 GUADALUPE	1,698	2,094	2,789	3,517	4,667	5,941	BASELINE	230	292	375	434	498	567
LOW	94	1,698	1,193	1,565	1,945	2,554	3,227	LOW	230	228	293	339	388	443
HIGH	94	1,698	2,995	4,014	5,088	6,780	8,655	HIGH	230	357	457	529	607	692

Water Demand Forecasts By County In Acre-Feet/Year (continued)

			MANUFACTURING							MINING					
	CNTY	NAME	2000	2010	2020	2030	2040	2050		2000	2010	2020	2030	2040	2050
BASELINE	96	HALL	0	0	0	0	0	0	BASELINE	22	30	37	40	43	46
LOW	96		0	0	0	0	0	0	LOW	22	15	19	20	22	23
HIGH	96		0	0	0	0	0	0	HIGH	22	45	55	59	64	69
TWDB Forecast	96		0	0	0	0	0	0	TWDB Forecast	29	30	31	32	33	34
BASELINE	97	HAMILTON	2	3	3	4	6	8	BASELINE	0	0	0	0	0	0
LOW	97		2	2	2	3	3	4	LOW	0	0	0	0	0	0
HIGH	97		2	4	5	6	8	11	HIGH	0	0	0	0	0	0
TWDB Forecast	97		0	0	0	0	0	0	TWDB Forecast	0	0	0	0	0	0
BASELINE	98	HANSFORD	28	32	39	44	54	65	BASELINE	583	955	1,152	1,247	1,343	1,441
LOW	98		28	17	20	23	28	33	LOW	583	642	774	838	902	968
HIGH	98		28	48	58	66	81	97	HIGH	583	1,269	1,531	1,656	1,784	1,914
TWDB Forecast	98		46	50	51	51	55	58	TWDB Forecast	1,331	1,215	1,190	1,084	1,083	1,087
BASELINE	99	HARDEMAN	420	499	635	763	966	1,183	BASELINE	3	3	4	4	4	5
LOW	99		420	422	539	649	824	1,010	LOW	3	2	2	2	3	3
HIGH	99		420	576	732	876	1,108	1,355	HIGH	3	4	5	6	6	6
TWDB Forecast	99		347	374	398	424	452	480	TWDB Forecast	3	3	3	2	2	2
BASELINE	100	HARDIN	122	127	145	157	167	171	BASELINE	4,782	5,513	7,064	8,162	9,327	10,571
LOW	100		122	88	97	103	107	107	LOW	4,782	4,561	5,844	6,752	7,716	8,745
HIGH	100		122	167	192	211	227	235	HIGH	4,782	6,465	8,284	9,572	10,938	12,397
TWDB Forecast	100		111	116	123	129	138	147	TWDB Forecast	8,600	7,283	7,187	7,191	7,307	7,475
BASELINE	101	HARRIS	365,228	414,183	464,591	500,458	526,076	532,357	BASELINE	760	1,877	2,413	2,802	3,224	3,686
LOW	101		365,228	301,633	332,327	351,779	364,512	364,977	LOW	760	1,632	2,099	2,437	2,804	3,206
HIGH	101		365,228	526,732	596,856	649,137	687,639	699,738	HIGH	760	2,121	2,728	3,167	3,644	4,166
TWDB Forecast	101		386,430	419,816	446,155	468,909	515,487	561,743	TWDB Forecast	702	574	392	316	255	240
BASELINE	102	HARRISON	11,776	13,780	17,123	20,228	25,458	31,093	BASELINE	372	586	761	892	1,036	1,195
LOW	102		11,776	10,864	13,424	15,781	19,781	24,090	LOW	372	469	609	714	829	957
HIGH	102		11,776	16,696	20,822	24,674	31,135	38,096	HIGH	372	703	912	1,070	1,243	1,433
TWDB Forecast	102		110,588	135,166	141,913	147,949	161,370	176,471	TWDB Forecast	370	370	370	370	370	370
BASELINE	103	HARTLEY	0	0	0	0	0	0	BASELINE	0	0	0	0	0	0
LOW	103		0	0	0	0	0	0	LOW	0	0	0	0	0	0
HIGH	103		0	0	0	0	0	0	HIGH	0	0	0	0	0	0
TWDB Forecast	103		0	0	0	0	0	0	TWDB Forecast	0	0	0	0	0	0
BASELINE	104	HASKELL	0	0	0	0	0	0	BASELINE	75	82	97	104	110	117
LOW	104		0	0	0	0	0	0	LOW	75	55	66	70	75	80
HIGH	104		0	0	0	0	0	0	HIGH	75	108	128	137	146	155
TWDB Forecast	104		0	0	0	0	0	0	TWDB Forecast	95	47	23	12	3	1
BASELINE	105	HAYS	508	675	972	1,328	1,898	2,574	BASELINE	141	211	284	344	412	490
LOW	105		508	356	510	693	986	1,334	LOW	141	145	195	237	284	337
HIGH	105		508	994	1,434	1,963	2,809	3,813	HIGH	141	277	372	451	541	643
TWDB Forecast	105		381	445	507	564	620	677	TWDB Forecast	96	90	72	56	37	28
BASELINE	106	HEMPHILL	0	0	0	0	0	0	BASELINE	0	0	0	0	0	0
LOW	106		0	0	0	0	0	0	LOW	0	0	0	0	0	0
HIGH	106		0	0	0	0	1	1	HIGH	0	0	0	0	0	0
TWDB Forecast	106		4	5	6	7	8	9	TWDB Forecast	0	0	0	0	0	0
BASELINE	107	HENDERSON	64	83	116	155	218	295	BASELINE	236	474	624	742	872	1,018
LOW	107		64	54	75	99	139	187	LOW	236	410	540	642	755	882
HIGH	107		64	112	158	211	297	402	HIGH	236	537	708	841	989	1,154
TWDB Forecast	107		98	110	118	133	151	172	TWDB Forecast	197	173	152	136	121	108
BASELINE	108	HIDALGO	2,777	3,296	4,158	5,012	6,445	8,047	BASELINE	1,364	1,504	1,934	2,242	2,576	2,940
LOW	108		2,777	2,139	2,670	3,185	4,058	5,030	LOW	1,364	1,244	1,599	1,854	2,130	2,431
HIGH	108		2,777	4,452	5,646	6,839	8,833	11,064	HIGH	1,364	1,765	2,269	2,630	3,022	3,449
TWDB Forecast	108		3,718	4,115	4,374	4,541	4,927	5,307	TWDB Forecast	689	670	708	751	796	850
BASELINE	109	HILL	61	76	102	129	172	221	BASELINE	99	129	173	209	249	294
LOW	109		61	49	67	86	115	150	LOW	99	72	97	117	139	165
HIGH	109		61	102	137	172	229	293	HIGH	99	186	249	300	358	423
TWDB Forecast	109		72	83	93	102	116	130	TWDB Forecast	140	126	130	141	153	169
BASELINE	110	HOCKLEY	56	64	76	85	101	119	BASELINE	5,210	5,842	6,859	7,227	7,593	7,961
LOW	110		56	41	50	56	68	80	LOW	5,210	5,293	6,215	6,548	6,880	7,213
HIGH	110		56	86	101	113	135	158	HIGH	5,210	6,391	7,503	7,906	8,306	8,709
TWDB Forecast	110		82	98	117	138	161	188	TWDB Forecast	6,379	5,212	4,259	3,480	2,843	2,323
BASELINE	111	HOOD	12	14	19	23	30	39	BASELINE	147	200	267	322	383	453
LOW	111		12	8	10	12	16	21	LOW	147	129	172	207	246	291
HIGH	111		12	21	27	34	45	57	HIGH	147	271	362	437	520	614
TWDB Forecast	111		11	13	16	19	22	26	TWDB Forecast	135	114	106	102	102	104
BASELINE	112	HOPKINS	712	814	980	1,117	1,360	1,617	BASELINE	83	144	179	200	223	248
LOW	112		712	537	648	740	901	1,071	LOW	83	123	153	171	191	212
HIGH	112		712	1,090	1,312	1,495	1,819	2,164	HIGH	83	164	205	229	256	283
TWDB Forecast	112		2,654	2,853	3,016	3,148	3,410	3,669	TWDB Forecast	125	122	120	117	116	116
BASELINE	113	HOUSTON	135	161	206	248	317	391	BASELINE	118	129	164	187	213	240
LOW	113		135	119	152	182	232	286	LOW	118	83	105	120	137	154
HIGH	113		135	203	260	314	401	497	HIGH	118	175	222	254	288	325

Water Demand Forecasts By County
In Acre-Feet/Year (continued)

			MANUFACTURING							MINING					
	CNTY	NAME	2000	2010	2020	2030	2040	2050		2000	2010	2020	2030	2040	2050
BASELINE	115	HUDSPETH	1	2	2	3	3	4	BASELINE	0	0	0	0	0	0
LOW	115		1	1	2	2	2	3	LOW	0	0	0	0	0	0
HIGH	115		1	2	3	3	4	5	HIGH	0	0	0	0	0	0
TWDB Forecast	115		2	3	4	4	5	6	TWDB Forecast	0	0	0	0	0	0
BASELINE	116	HUNT	597	775	1,087	1,450	2,036	2,735	BASELINE	79	118	155	184	217	253
LOW	116		597	585	817	1,084	1,513	2,021	LOW	79	67	88	104	123	143
HIGH	116		597	965	1,356	1,815	2,559	3,449	HIGH	79	169	223	264	311	363
TWDB Forecast	116		740	818	903	998	1,129	1,276	TWDB Forecast	70	71	73	75	77	79
BASELINE	117	HUTCHINSON	15,742	18,134	21,768	24,848	30,275	36,090	BASELINE	282	382	460	498	537	576
LOW	117		15,742	12,681	15,198	17,326	21,089	25,122	LOW	282	281	339	367	395	424
HIGH	117		15,742	23,586	28,338	32,370	39,461	47,058	HIGH	282	483	582	630	678	728
TWDB Forecast	117		19,871	21,975	23,374	24,545	26,895	29,203	TWDB Forecast	551	510	373	210	132	95
BASELINE	118	IRION	0	0	0	0	0	0	BASELINE	98	103	128	145	163	181
LOW	118		0	0	0	0	0	0	LOW	98	72	90	101	113	127
HIGH	118		0	0	0	0	0	0	HIGH	98	134	167	189	212	236
TWDB Forecast	118		0	0	0	0	0	0	TWDB Forecast	6	5	3	2	2	2
BASELINE	119	JACK	0	0	0	0	0	0	BASELINE	400	536	642	690	738	788
LOW	119		0	0	0	0	0	0	LOW	400	464	555	596	638	681
HIGH	119		0	0	0	0	0	0	HIGH	400	609	729	783	838	895
TWDB Forecast	119		0	0	0	0	0	0	TWDB Forecast	544	479	460	450	453	462
BASELINE	120	JACKSON	657	740	866	965	1,149	1,344	BASELINE	81	104	146	183	228	280
LOW	120		657	370	433	483	575	672	LOW	81	75	105	132	164	202
HIGH	120		657	1,110	1,299	1,447	1,723	2,016	HIGH	81	133	186	234	291	358
TWDB Forecast	120		1,002	1,803	1,899	2,164	2,435	2,712	TWDB Forecast	94	50	38	27	21	21
BASELINE	121	JASPER	57,821	62,059	71,041	77,754	83,685	87,903	BASELINE	5	7	9	10	11	13
LOW	121		57,821	50,281	56,896	61,483	65,357	67,943	LOW	5	4	6	6	7	8
HIGH	121		57,821	73,837	85,185	94,025	102,013	107,863	HIGH	5	9	12	13	15	17
TWDB Forecast	121		56,531	54,338	54,408	52,880	55,011	57,224	TWDB Forecast	4	4	4	4	4	4
BASELINE	122	JEFF DAVIS	0	0	0	0	0	0	BASELINE	0	0	0	0	0	0
LOW	122		0	0	0	0	0	0	LOW	0	0	0	0	0	0
HIGH	122		0	0	0	0	0	0	HIGH	0	0	0	0	0	0
TWDB Forecast	122		0	0	0	0	0	0	TWDB Forecast	0	0	0	0	0	0
BASELINE	123	JEFFERSON	111,335	128,022	154,296	176,977	217,199	260,193	BASELINE	224	317	423	509	605	714
LOW	123		111,335	110,431	132,695	151,748	185,759	222,099	LOW	224	230	307	369	439	518
HIGH	123		111,335	145,613	175,897	202,206	248,639	298,286	HIGH	224	404	539	648	771	910
TWDB Forecast	123		158,590	176,248	187,896	197,739	217,235	236,435	TWDB Forecast	216	100	63	50	38	34
BASELINE	124	JIM HOGG	0	0	0	0	0	0	BASELINE	27	38	47	52	58	63
LOW	124		0	0	0	0	0	0	LOW	27	33	40	45	49	54
HIGH	124		0	0	0	0	0	0	HIGH	27	44	54	60	66	73
TWDB Forecast	124		0	0	0	0	0	0	TWDB Forecast	19	9	5	3	1	0
BASELINE	125	JIM WELLS	0	0	0	0	0	0	BASELINE	160	298	384	446	515	589
LOW	125		0	0	0	0	0	0	LOW	160	248	320	372	429	490
HIGH	125		0	0	0	0	0	0	HIGH	160	347	448	521	601	687
TWDB Forecast	125		0	0	0	0	0	0	TWDB Forecast	327	212	148	102	59	22
BASELINE	126	JOHNSON	1,851	2,022	2,416	2,763	3,072	3,266	BASELINE	309	447	596	718	856	1,011
LOW	126		1,851	1,242	1,467	1,658	1,825	1,928	LOW	309	337	450	541	645	762
HIGH	126		1,851	2,801	3,365	3,869	4,319	4,604	HIGH	309	557	743	895	1,066	1,260
TWDB Forecast	126		1,134	1,338	1,563	1,803	2,064	2,333	TWDB Forecast	335	208	154	130	114	118
BASELINE	127	JONES	260	304	371	430	532	643	BASELINE	189	195	231	247	263	280
LOW	127		260	204	247	284	350	422	LOW	189	149	177	189	201	214
HIGH	127		260	404	494	575	714	865	HIGH	189	240	286	305	325	345
TWDB Forecast	127		331	353	369	380	409	436	TWDB Forecast	289	237	217	208	205	208
BASELINE	128	KARNES	72	78	88	94	108	122	BASELINE	114	158	194	215	236	258
LOW	128		72	54	61	65	74	83	LOW	114	101	124	138	151	166
HIGH	128		72	103	116	124	143	162	HIGH	114	215	264	292	321	351
TWDB Forecast	128		296	320	331	340	356	383	TWDB Forecast	166	73	31	19	10	4
BASELINE	129	KAUFMAN	719	932	1,304	1,735	2,429	3,241	BASELINE	83	124	163	194	228	266
LOW	129		719	616	853	1,122	1,556	2,062	LOW	83	87	115	137	161	188
HIGH	129		719	1,248	1,755	2,348	3,302	4,419	HIGH	83	161	212	251	296	345
TWDB Forecast	129		343	364	387	406	433	463	TWDB Forecast	96	106	121	136	151	168
BASELINE	130	KENDALL	2	2	2	2	3	4	BASELINE	6	9	11	12	13	14
LOW	130		2	1	1	1	2	2	LOW	6	6	8	9	10	11
HIGH	130		2	3	3	4	4	5	HIGH	6	11	13	15	16	17
TWDB Forecast	130		2	3	4	4	5	6	TWDB Forecast	13	9	5	1	0	0
BASELINE	131	KENEDY	0	0	0	0	0	0	BASELINE	1	2	2	2	3	3
LOW	131		0	0	0	0	0	0	LOW	1	1	1	2	2	2
HIGH	131		0	0	0	0	0	0	HIGH	1	2	3	3	4	4
TWDB Forecast	131		0	0	0	0	0	0	TWDB Forecast	3	1	1	0	0	0
BASELINE	132	KENT	0	0	0	0	0	0	BASELINE	242	211	251	269	286	304
LOW	132		0	0	0	0	0	0	LOW	242	106	126	134	143	152
HIGH	132		0	0	0	0	0	0	HIGH	242	317	377	403	429	455

Water Demand Forecasts By County In Acre-Feet/Year (continued)

		MANUFACTURING							MINING					
	CNTY NAME	2000	2010	2020	2030	2040	2050		2000	2010	2020	2030	2040	2050
BASELINE	134 KIMBLE	431	510	647	779	1,004	1,262	BASELINE	99	141	177	199	224	249
LOW	134	431	302	377	447	568	706	LOW	99	78	97	110	123	137
HIGH	134	431	718	917	1,112	1,440	1,818	HIGH	99	205	256	289	324	362
TWDB Forecast	134	1,637	1,777	1,849	1,909	2,067	2,229	TWDB Forecast	105	100	99	98	100	103
BASELINE	135 KING	0	0	0	0	0	0	BASELINE	0	0	0	0	0	0
LOW	135	0	0	0	0	0	0	LOW	0	0	0	0	0	0
HIGH	135	0	0	0	0	0	0	HIGH	0	0	0	0	0	0
TWDB Forecast	135	0	0	0	0	0	0	TWDB Forecast	0	0	0	0	0	0
BASELINE	136 KINNEY	0	0	0	0	0	0	BASELINE	0	0	0	0	0	0
LOW	136	0	0	0	0	0	0	LOW	0	0	0	0	0	0
HIGH	136	0	0	0	0	0	0	HIGH	0	0	0	0	0	0
TWDB Forecast	136	0	0	0	0	0	0	TWDB Forecast	0	0	0	0	0	0
BASELINE	137 KLEBERG	7	7	8	9	11	12	BASELINE	1,599	1,863	2,403	2,795	3,220	3,686
LOW	137	7	4	5	5	6	7	LOW	1,599	1,303	1,682	1,956	2,254	2,579
HIGH	137	7	10	12	13	15	17	HIGH	1,599	2,422	3,125	3,634	4,187	4,793
TWDB Forecast	137	0	0	0	0	0	0	TWDB Forecast	1,055	844	739	633	542	0
BASELINE	138 KNOX	0	0	0	0	0	0	BASELINE	22	26	31	33	35	38
LOW	138	0	0	0	0	0	0	LOW	22	20	23	25	27	28
HIGH	138	0	0	0	0	0	0	HIGH	22	33	39	41	44	47
TWDB Forecast	138	0	0	0	0	0	0	TWDB Forecast	20	17	15	14	13	13
BASELINE	139 LAMAR	4,815	5,486	6,548	7,412	8,968	10,628	BASELINE	20	26	32	36	40	44
LOW	139	4,815	3,600	4,262	4,787	5,749	6,763	LOW	20	13	16	18	21	23
HIGH	139	4,815	7,373	8,834	10,037	12,187	14,493	HIGH	20	38	47	53	59	65
TWDB Forecast	139	5,422	6,213	6,932	7,575	8,590	9,608	TWDB Forecast	25	24	24	25	25	25
BASELINE	140 LAMB	432	487	575	644	771	904	BASELINE	119	155	182	192	202	211
LOW	140	432	319	375	419	500	585	LOW	119	87	102	107	113	118
HIGH	140	432	656	776	870	1,041	1,223	HIGH	119	224	263	277	291	305
TWDB Forecast	140	711	655	593	593	593	593	TWDB Forecast	138	107	97	94	92	95
BASELINE	141 LAMPASAS	93	109	135	160	202	248	BASELINE	189	276	364	431	506	588
LOW	141	93	76	93	109	136	165	LOW	189	146	192	227	267	310
HIGH	141	93	142	177	212	269	332	HIGH	189	407	536	636	745	867
TWDB Forecast	141	114	121	127	131	141	151	TWDB Forecast	188	175	176	179	183	189
BASELINE	142 LA SALLE	0	0	0	0	0	0	BASELINE	0	0	0	0	0	0
LOW	142	0	0	0	0	0	0	LOW	0	0	0	0	0	0
HIGH	142	0	0	0	0	0	0	HIGH	0	0	0	0	0	0
TWDB Forecast	142	0	0	0	0	0	0	TWDB Forecast	0	0	0	0	0	0
BASELINE	143 LAVACA	248	294	373	450	576	712	BASELINE	36	82	115	144	179	220
LOW	143	248	196	246	294	372	457	LOW	36	60	83	105	130	160
HIGH	143	248	392	500	606	779	967	HIGH	36	105	146	184	229	281
TWDB Forecast	143	318	343	365	383	415	447	TWDB Forecast	57	40	27	13	8	0
BASELINE	144 LEE	8	10	12	15	19	24	BASELINE	15	20	25	28	31	35
LOW	144	8	6	7	9	11	14	LOW	15	12	15	17	19	21
HIGH	144	8	14	17	21	27	33	HIGH	15	28	35	40	44	49
TWDB Forecast	144	6	7	8	9	11	12	TWDB Forecast	30	20,021	25,013	25,005	25,001	25,000
BASELINE	145 LEON	482	619	862	1,137	1,568	2,067	BASELINE	2,123	3,111	4,014	4,666	5,376	6,151
LOW	145	482	412	574	756	1,042	1,373	LOW	2,123	1,851	2,388	2,776	3,198	3,659
HIGH	145	482	825	1,150	1,517	2,094	2,761	HIGH	2,123	4,371	5,640	6,556	7,553	8,643
TWDB Forecast	145	178	191	192	193	194	195	TWDB Forecast	1,459	1,045	508	384	327	335
BASELINE	146 LIBERTY	228	297	419	561	789	1,058	BASELINE	7,207	9,076	11,671	13,548	15,591	17,825
LOW	146	228	186	258	339	470	623	LOW	7,207	6,280	8,075	9,374	10,788	12,333
HIGH	146	228	408	581	783	1,109	1,493	HIGH	7,207	11,872	15,267	17,723	20,395	23,316
TWDB Forecast	146	486	551	615	681	753	826	TWDB Forecast	15,430	16,852	19,021	21,193	23,389	25,827
BASELINE	147 LIMESTONE	9	11	14	17	22	27	BASELINE	399	803	1,074	1,294	1,543	1,825
LOW	147	9	7	9	11	14	18	LOW	399	558	747	900	1,074	1,269
HIGH	147	9	14	18	23	29	36	HIGH	399	1,047	1,400	1,689	2,013	2,381
TWDB Forecast	147	453	549	657	779	913	1,061	TWDB Forecast	941	872	913	976	1,080	1,214
BASELINE	148 LIPSCOMB	93	108	129	148	180	215	BASELINE	6	8	10	11	12	13
LOW	148	93	64	76	87	106	127	LOW	6	7	8	9	9	10
HIGH	148	93	152	182	209	254	303	HIGH	6	10	12	13	14	15
TWDB Forecast	148	156	166	172	176	188	200	TWDB Forecast	8	8	8	8	9	18
BASELINE	149 LIVE OAK	1,339	1,446	1,621	1,726	1,972	2,219	BASELINE	2,652	3,485	4,034	4,208	4,350	4,467
LOW	149	1,339	825	925	985	1,124	1,265	LOW	2,652	2,983	3,453	3,602	3,724	3,824
HIGH	149	1,339	2,066	2,318	2,468	2,819	3,173	HIGH	2,652	3,987	4,614	4,814	4,976	5,110
TWDB Forecast	149	1,021	1,088	1,137	1,171	1,261	1,345	TWDB Forecast	4,888	5,228	1,395	1,980	2,833	2,915
BASELINE	150 LLANO	2	3	4	5	6	8	BASELINE	178	254	319	360	403	449
LOW	150	2	2	2	3	4	5	LOW	178	174	218	246	276	307
HIGH	150	2	4	5	6	9	11	HIGH	178	334	419	473	530	591
TWDB Forecast	150	0	0	0	0	0	0	TWDB Forecast	143	112	99	95	92	95
BASELINE	151 LOVING	0	0	0	0	0	0	BASELINE	4	5	6	6	7	7
LOW	151	0	0	0	0	0	0	LOW	4	2	3	3	3	4
HIGH	151	0	0	0	0	0	0	HIGH	4	7	9	10	10	11

Water Demand Forecasts By County In Acre-Feet/Year (continued)

		MANUFACTURING							MINING					
	CNTY NAME	2000	2010	2020	2030	2040	2050		2000	2010	2020	2030	2040	2050
BASELINE	153 LYNN	0	0	0	0	0	0	BASELINE	229	306	359	378	397	417
LOW	153	0	0	0	0	0	0	LOW	229	171	201	212	222	233
HIGH	153	0	0	0	0	0	0	HIGH	229	440	517	545	572	600
TWDB Forecast	153	0	0	0	0	0	0	TWDB Forecast	60	49	40	32	27	22
BASELINE	154 MCCULLOCH	349	425	557	689	901	1,136	BASELINE	130	173	216	244	274	305
LOW	154	349	222	288	354	461	579	LOW	130	134	168	189	212	237
HIGH	154	349	628	825	1,024	1,341	1,692	HIGH	130	211	264	299	335	373
TWDB Forecast	154	844	903	963	1,027	1,090	1,153	TWDB Forecast	146	152	158	164	170	176
BASELINE	155 MCLENNAN	2,962	3,654	4,802	5,977	7,888	10,029	BASELINE	756	1,178	1,616	2,000	2,443	2,956
LOW	155	2,962	2,665	3,464	4,260	5,565	7,025	LOW	756	653	897	1,109	1,355	1,640
HIGH	155	2,962	4,643	6,140	7,693	10,210	13,033	HIGH	756	1,702	2,335	2,890	3,530	4,272
TWDB Forecast	155	3,106	3,553	3,985	4,419	4,967	5,652	TWDB Forecast	750	833	952	1,071	1,190	1,322
BASELINE	156 MCMULLEN	0	0	0	0	0	0	BASELINE	267	297	383	446	514	588
LOW	156	0	0	0	0	0	0	LOW	267	225	291	338	389	446
HIGH	156	0	0	0	0	0	0	HIGH	267	369	476	554	638	731
TWDB Forecast	156	0	0	0	0	0	0	TWDB Forecast	165	66	34	23	12	8
BASELINE	157 MADISON	140	174	234	298	402	522	BASELINE	18	22	29	33	38	44
LOW	157	140	88	118	150	202	263	LOW	18	16	20	23	27	31
HIGH	157	140	260	349	446	602	781	HIGH	18	29	37	43	50	57
TWDB Forecast	157	78	82	85	87	94	99	TWDB Forecast	42	36	33	28	27	28
BASELINE	158 MARION	33	37	46	52	64	77	BASELINE	63	66	84	96	109	123
LOW	158	33	28	34	39	48	57	LOW	63	51	65	75	85	96
HIGH	158	33	47	57	66	81	98	HIGH	63	81	103	118	134	151
TWDB Forecast	158	20	20	20	20	20	20	TWDB Forecast	71	43	30	24	20	34
BASELINE	159 MARTIN	20	23	27	30	35	41	BASELINE	257	231	278	299	321	343
LOW	159	20	11	13	15	18	20	LOW	257	135	162	174	187	200
HIGH	159	20	34	40	44	53	61	HIGH	257	328	393	424	455	486
TWDB Forecast	159	32	35	36	36	38	40	TWDB Forecast	1,228	1,015	990	987	978	1,006
BASELINE	160 MASON	0	0	0	0	0	0	BASELINE	6	9	11	12	14	15
LOW	160	0	0	0	0	0	0	LOW	6	6	7	8	9	10
HIGH	160	0	0	0	0	0	0	HIGH	6	12	15	16	18	20
TWDB Forecast	160	0	0	0	0	0	0	TWDB Forecast	12	8	4	1	0	0
BASELINE	161 MATAGORDA	6,796	7,840	9,263	10,193	11,982	13,797	BASELINE	159	218	279	322	368	417
LOW	161	6,796	6,148	7,239	7,937	9,298	10,675	LOW	159	136	174	200	228	259
HIGH	161	6,796	9,533	11,287	12,449	14,665	16,918	HIGH	159	301	385	444	507	575
TWDB Forecast	161	13,022	32,532	32,715	32,835	33,352	33,849	TWDB Forecast	5,299	6,956	6,945	6,942	6,942	6,949
BASELINE	162 MAVERICK	68	76	90	101	121	143	BASELINE	126	172	226	265	306	351
LOW	162	68	57	66	73	87	101	LOW	126	127	167	196	226	260
HIGH	162	68	96	114	129	156	184	HIGH	126	217	285	334	386	443
TWDB Forecast	162	76	91	108	127	148	171	TWDB Forecast	116	59	29	15	6	4
BASELINE	163 MEDINA	50	59	74	88	111	135	BASELINE	102	126	155	171	188	206
LOW	163	50	45	56	67	85	104	LOW	102	100	123	136	149	163
HIGH	163	50	72	91	108	136	166	HIGH	102	152	187	207	227	249
TWDB Forecast	163	302	319	339	361	384	411	TWDB Forecast	143	128	128	129	132	136
BASELINE	164 MENARD	0	0	0	0	0	0	BASELINE	0	0	0	0	0	0
LOW	164	0	0	0	0	0	0	LOW	0	0	0	0	0	0
HIGH	164	0	0	0	0	0	0	HIGH	0	0	0	0	0	0
TWDB Forecast	164	0	0	0	0	0	0	TWDB Forecast	0	0	0	0	0	0
BASELINE	165 MIDLAND	162	173	203	225	243	252	BASELINE	501	784	1,023	1,205	1,406	1,629
LOW	165	162	115	134	148	158	164	LOW	501	697	910	1,072	1,250	1,448
HIGH	165	162	232	272	302	327	340	HIGH	501	871	1,137	1,339	1,562	1,809
TWDB Forecast	165	148	161	174	188	201	216	TWDB Forecast	669	318	159	80	26	0
BASELINE	166 MILAM	39,880	50,311	68,833	89,146	121,036	157,550	BASELINE	8	12	16	19	22	26
LOW	166	39,880	44,365	60,807	78,835	107,109	139,471	LOW	8	10	13	16	18	22
HIGH	166	39,880	56,258	76,860	99,457	134,964	175,629	HIGH	8	14	18	22	25	30
TWDB Forecast	166	6,820	6,820	8,250	8,250	8,250	9,800	TWDB Forecast	30,008	20,008	20,009	20,009	20,009	20,009
BASELINE	167 MILLS	1	1	1	2	2	3	BASELINE	0	0	0	0	0	0
LOW	167	1	1	1	1	1	2	LOW	0	0	0	0	0	0
HIGH	167	1	1	2	2	3	4	HIGH	0	0	0	0	0	0
TWDB Forecast	167	0	0	0	0	0	0	TWDB Forecast	0	0	0	0	0	0
BASELINE	168 MITCHELL	0	0	0	0	0	0	BASELINE	106	127	151	161	172	182
LOW	168	0	0	0	0	0	0	LOW	106	76	91	97	103	110
HIGH	168	0	0	0	0	0	0	HIGH	106	177	211	225	240	255
TWDB Forecast	168	0	0	0	0	0	0	TWDB Forecast	223	106	53	26	9	0
BASELINE	169 MONTAGUE	2	3	3	4	4	5	BASELINE	617	828	991	1,066	1,141	1,218
LOW	169	2	2	2	3	3	4	LOW	617	649	777	835	894	954
HIGH	169	2	3	4	5	6	7	HIGH	617	1,008	1,206	1,297	1,388	1,481
TWDB Forecast	169	7	9	12	15	19	24	TWDB Forecast	627	505	481	473	477	490
BASELINE	170 MONTGOMERY	1,676	2,118	2,880	3,729	5,086	6,645	BASELINE	292	425	546	634	730	835
LOW	170	1,676	1,221	1,629	2,074	2,793	3,616	LOW	292	338	435	505	581	664
HIGH	170	1,676	3,015	4,131	5,384	7,382	9,674	HIGH	292	512	658	764	879	1,005

Water Demand Forecasts By County In Acre-Feet/Year (continued)

			MANUFACTURING							MINING					
	CNTY	NAME	2000	2010	2020	2030	2040	2050		2000	2010	2020	2030	2040	2050
BASELINE	172	MORRIS	148,983	163,498	194,903	219,832	241,699	257,471	BASELINE	35	44	55	61	68	76
LOW	172		148,983	113,243	135,086	152,385	167,539	178,449	LOW	35	28	34	39	43	48
HIGH	172		148,983	213,753	254,719	287,279	315,860	336,493	HIGH	35	60	75	84	94	104
TWDB Forecast	172		132,451	135,264	129,869	124,443	119,127	113,929	TWDB Forecast	31	16	12	10	10	11
BASELINE	173	MOTLEY	2	2	2	2	3	3	BASELINE	24	32	37	39	41	43
LOW	173		2	1	1	1	1	2	LOW	24	18	21	22	23	24
HIGH	173		2	3	3	4	4	5	HIGH	24	46	53	56	59	62
TWDB Forecast	173		4	4	5	6	7	8	TWDB Forecast	26	26	27	28	28	28
BASELINE	174	NACOGDOCHES	960	1,134	1,429	1,704	2,163	2,658	BASELINE	174	208	263	301	341	385
LOW	174		960	811	997	1,161	1,444	1,747	LOW	174	141	179	204	232	261
HIGH	174		960	1,458	1,861	2,247	2,883	3,569	HIGH	174	274	347	397	451	509
TWDB Forecast	174		2,040	2,375	2,690	3,097	3,504	4,042	TWDB Forecast	261	280	312	345	378	415
BASELINE	175	NAVARRO	909	1,101	1,421	1,737	2,247	2,810	BASELINE	80	107	138	159	182	208
LOW	175		909	798	1,029	1,256	1,626	2,034	LOW	80	85	109	126	144	164
HIGH	175		909	1,403	1,814	2,217	2,869	3,586	HIGH	80	129	167	193	221	251
TWDB Forecast	175		868	968	1,043	1,118	1,215	1,312	TWDB Forecast	104	110	121	132	143	155
BASELINE	176	NEWTON	443	535	698	858	1,112	1,391	BASELINE	37	53	67	77	87	98
LOW	176		443	432	561	684	879	1,090	LOW	37	35	45	51	58	65
HIGH	176		443	638	836	1,032	1,346	1,693	HIGH	37	71	90	103	116	131
TWDB Forecast	176		122	131	139	146	154	162	TWDB Forecast	37	38	39	40	41	42
BASELINE	177	NOLAN	587	697	891	1,074	1,364	1,674	BASELINE	264	367	437	467	497	528
LOW	177		587	601	768	926	1,176	1,444	LOW	264	272	323	346	368	391
HIGH	177		587	793	1,014	1,222	1,552	1,904	HIGH	264	462	550	588	626	665
TWDB Forecast	177		558	619	682	747	815	885	TWDB Forecast	482	407	390	356	350	354
BASELINE	178	NUECES	37,269	42,753	51,505	59,108	72,564	86,977	BASELINE	1,028	1,089	1,354	1,519	1,691	1,874
LOW	178		37,269	30,042	35,616	40,282	48,877	58,068	LOW	1,028	891	1,108	1,243	1,384	1,534
HIGH	178		37,269	55,463	67,394	77,934	96,252	115,886	HIGH	1,028	1,287	1,601	1,794	1,998	2,215
TWDB Forecast	178		46,247	50,338	55,686	60,899	66,005	70,801	TWDB Forecast	144	93	57	28	16	12
BASELINE	179	OCHILTREE	0	1	1	1	1	1	BASELINE	182	226	273	295	318	341
LOW	179		0	0	0	0	1	1	LOW	182	198	239	258	278	299
HIGH	179		0	1	1	1	1	2	HIGH	182	254	306	331	357	383
TWDB Forecast	179		0	0	0	0	0	0	TWDB Forecast	228	202	186	170	151	155
BASELINE	180	OLDHAM	0	0	0	0	0	0	BASELINE	448	501	604	653	704	755
LOW	180		0	0	0	0	0	0	LOW	448	409	494	534	575	617
HIGH	180		0	0	0	0	0	0	HIGH	448	592	714	773	832	893
TWDB Forecast	180		0	0	0	0	0	0	TWDB Forecast	502	517	532	548	565	582
BASELINE	181	ORANGE	46,182	53,523	65,288	75,764	93,806	113,319	BASELINE	7	11	15	18	21	25
LOW	181		46,182	43,687	52,756	60,586	74,318	89,158	LOW	7	9	11	14	16	19
HIGH	181		46,182	63,359	77,821	90,943	113,295	137,479	HIGH	7	13	18	22	26	30
TWDB Forecast	181		54,349	58,286	61,862	64,872	71,425	78,309	TWDB Forecast	8	8	9	9	9	9
BASELINE	182	PALO PINTO	28	34	44	54	70	88	BASELINE	2	2	3	4	4	5
LOW	182		28	24	31	38	50	63	LOW	2	2	2	3	3	4
HIGH	182		28	44	57	69	90	112	HIGH	2	3	4	5	5	6
TWDB Forecast	182		65	74	83	93	108	125	TWDB Forecast	2	2	2	3	3	3
BASELINE	183	PANOLA	603	677	800	897	1,079	1,271	BASELINE	3,361	4,112	5,223	5,984	6,801	7,683
LOW	183		603	449	529	589	702	821	LOW	3,361	3,701	4,701	5,385	6,121	6,914
HIGH	183		603	905	1,071	1,206	1,456	1,722	HIGH	3,361	4,524	5,745	6,582	7,481	8,451
TWDB Forecast	183		685	730	762	785	844	897	TWDB Forecast	3,245	2,645	8,697	16,912	17,179	16,912
BASELINE	184	PARKER	968	1,218	1,649	2,126	2,888	3,755	BASELINE	76	124	165	199	237	280
LOW	184		968	665	893	1,143	1,544	2,001	LOW	76	106	142	171	204	240
HIGH	184		968	1,771	2,404	3,108	4,231	5,509	HIGH	76	141	188	227	270	319
TWDB Forecast	184		303	342	380	416	462	497	TWDB Forecast	1,866	2,065	2,352	2,640	2,963	3,326
BASELINE	185	PARMER	1,539	1,770	2,117	2,409	2,926	3,481	BASELINE	0	0	0	0	0	0
LOW	185		1,539	1,273	1,523	1,733	2,105	2,504	LOW	0	0	0	0	0	0
HIGH	185		1,539	2,267	2,711	3,085	3,746	4,457	HIGH	0	0	0	0	0	0
TWDB Forecast	185		1,599	1,694	1,758	1,800	1,925	2,042	TWDB Forecast	0	0	0	0	0	0
BASELINE	186	PECOS	6	7	8	8	10	11	BASELINE	82	154	185	199	214	228
LOW	186		6	4	5	5	6	7	LOW	82	110	132	142	153	163
HIGH	186		6	9	10	11	13	16	HIGH	82	198	238	256	275	293
TWDB Forecast	186		7	8	10	11	13	15	TWDB Forecast	322	267	263	266	270	277
BASELINE	187	POLK	595	718	934	1,144	1,490	1,876	BASELINE	24	34	44	50	57	64
LOW	187		595	580	742	889	1,130	1,392	LOW	24	29	36	41	47	53
HIGH	187		595	856	1,125	1,399	1,850	2,359	HIGH	24	40	51	58	66	75
TWDB Forecast	187		825	879	933	986	1,039	1,090	TWDB Forecast	26	26	27	27	28	29
BASELINE	188	POTTER	6,004	6,945	8,456	9,778	12,050	14,470	BASELINE	507	1,118	1,474	1,752	2,062	2,407
LOW	188		6,004	5,336	6,470	7,447	9,138	10,934	LOW	507	944	1,244	1,479	1,740	2,031
HIGH	188		6,004	8,554	10,442	12,109	14,963	18,007	HIGH	507	1,293	1,704	2,025	2,383	2,782
TWDB Forecast	188		4,614	5,038	5,365	5,643	6,131	6,606	TWDB Forecast	430	381	387	393	399	410
BASELINE	189	PRESIDIO	0	0	0	0	0	0	BASELINE	9	12	15	16	17	18
LOW	189		0	0	0	0	0	0	LOW	9	6	7	8	8	9
HIGH	189		0	0	0	0	0	0	HIGH	9	18	22	24	25	27

Water Demand Forecasts By County In Acre-Feet/Year (continued)

		MANUFACTURING							MINING					
	CNTY NAME	2000	2010	2020	2030	2040	2050		2000	2010	2020	2030	2040	2050
BASELINE	191 RANDALL	251	304	395	483	622	768	BASELINE	15	25	33	39	46	53
LOW	191	251	178	229	278	356	438	LOW	15	19	26	30	36	42
HIGH	191	251	429	560	688	887	1,098	HIGH	15	30	40	47	56	65
TWDB Forecast	191	557	517	472	475	478	482	TWDB Forecast	8	6	5	5	5	7
BASELINE	192 REAGAN	0	0	0	0	0	0	BASELINE	1,419	1,710	2,139	2,415	2,707	3,019
LOW	192	0	0	0	0	0	0	LOW	1,419	1,407	1,761	1,988	2,229	2,485
HIGH	192	0	0	0	0	0	0	HIGH	1,419	2,012	2,517	2,842	3,186	3,552
TWDB Forecast	192	0	0	0	0	0	0	TWDB Forecast	1,589	1,524	1,474	1,427	1,439	1,481
BASELINE	193 REAL	0	0	0	0	0	0	BASELINE	7	10	13	16	18	21
LOW	193	0	0	0	0	0	0	LOW	7	5	7	8	9	10
HIGH	193	0	0	0	0	0	0	HIGH	7	15	20	24	27	31
TWDB Forecast	193	0	0	0	0	0	0	TWDB Forecast	13	9	5	2	0	0
BASELINE	194 RED RIVER	5	6	7	8	10	12	BASELINE	0	0	0	0	0	0
LOW	194	5	4	5	6	7	9	LOW	0	0	0	0	0	0
HIGH	194	5	7	9	11	13	16	HIGH	0	0	0	0	0	0
TWDB Forecast	194	11	15	17	19	21	25	TWDB Forecast	0	0	0	0	0	0
BASELINE	195 REEVES	1,028	1,127	1,283	1,387	1,607	1,832	BASELINE	112	206	247	266	286	305
LOW	195	1,028	570	648	700	810	922	LOW	112	134	162	174	187	200
HIGH	195	1,028	1,685	1,919	2,075	2,404	2,741	HIGH	112	277	333	359	385	411
TWDB Forecast	195	12	13	13	13	14	15	TWDB Forecast	175	136	116	113	112	115
BASELINE	196 REFUGIO	0	0	0	0	0	0	BASELINE	19	63	81	94	109	124
LOW	196	0	0	0	0	0	0	LOW	19	52	67	78	90	103
HIGH	196	0	0	0	0	0	0	HIGH	19	74	95	110	127	146
TWDB Forecast	196	0	0	0	0	0	0	TWDB Forecast	44	26	19	11	4	4
BASELINE	197 ROBERTS	0	0	0	0	0	0	BASELINE	8	11	14	15	16	17
LOW	197	0	0	0	0	0	0	LOW	8	6	7	7	8	9
HIGH	197	0	0	0	0	0	0	HIGH	8	17	21	22	24	26
TWDB Forecast	197	0	0	0	0	0	0	TWDB Forecast	11	11	9	8	8	8
BASELINE	198 ROBERTSON	52	67	93	122	168	222	BASELINE	101	147	190	221	255	291
LOW	198	52	47	65	83	113	148	LOW	101	91	117	136	157	179
HIGH	198	52	86	121	160	223	296	HIGH	101	204	263	306	353	403
TWDB Forecast	198	42	51	61	72	84	98	TWDB Forecast	45	45	45	45	45	45
BASELINE	199 ROCKWALL	17	23	32	42	59	79	BASELINE	38	57	75	89	104	122
LOW	199	17	11	16	21	30	40	LOW	38	38	50	59	70	82
HIGH	199	17	34	47	63	89	118	HIGH	38	75	99	118	139	162
TWDB Forecast	199	5	6	6	6	6	6	TWDB Forecast	0	0	0	0	0	0
BASELINE	200 RUNNELS	43	51	64	76	96	118	BASELINE	26	26	31	33	35	37
LOW	200	43	36	45	54	68	84	LOW	26	21	25	26	28	30
HIGH	200	43	66	83	99	124	152	HIGH	26	31	37	40	42	45
TWDB Forecast	200	47	56	68	80	95	112	TWDB Forecast	35	28	26	25	25	25
BASELINE	201 RUSK	86	100	125	147	183	223	BASELINE	1,253	1,728	2,195	2,515	2,858	3,229
LOW	201	86	69	85	99	123	149	LOW	1,253	1,465	1,860	2,131	2,422	2,736
HIGH	201	86	131	164	194	244	296	HIGH	1,253	1,992	2,530	2,899	3,294	3,722
TWDB Forecast	201	344	382	425	469	512	559	TWDB Forecast	1,498	901	399	238	137	14
BASELINE	202 SABINE	331	397	511	621	796	984	BASELINE	0	0	0	0	0	0
LOW	202	331	349	452	552	709	879	LOW	0	0	0	0	0	0
HIGH	202	331	444	570	690	882	1,089	HIGH	0	0	0	0	0	0
TWDB Forecast	202	1,837	1,958	2,078	2,196	2,313	2,427	TWDB Forecast	0	0	0	0	0	0
BASELINE	203 SAN AUGUSTINE	4	4	6	7	9	11	BASELINE	0	0	0	0	0	0
LOW	203	4	4	5	6	7	9	LOW	0	0	0	0	0	0
HIGH	203	4	5	7	8	11	14	HIGH	0	0	0	0	0	0
TWDB Forecast	203	0	0	0	0	0	0	TWDB Forecast	0	0	0	0	0	0
BASELINE	204 SAN JACINTO	30	36	47	57	75	95	BASELINE	36	50	64	73	83	94
LOW	204	30	18	23	29	38	47	LOW	36	30	38	43	49	55
HIGH	204	30	54	70	86	113	142	HIGH	36	71	90	103	117	132
TWDB Forecast	204	24	27	31	34	38	41	TWDB Forecast	76	52	30	10	2	0
BASELINE	205 SAN PATRICIO	11,291	13,146	16,204	19,028	23,813	29,020	BASELINE	73	92	114	128	143	158
LOW	205	11,291	9,819	11,914	13,775	17,002	20,494	LOW	73	76	94	106	118	131
HIGH	205	11,291	16,474	20,494	24,280	30,624	37,546	HIGH	73	108	134	150	167	185
TWDB Forecast	205	20,164	24,645	28,330	32,414	38,535	45,682	TWDB Forecast	103	97	96	96	97	100
BASELINE	206 SAN SABA	13	15	18	21	26	32	BASELINE	138	181	238	282	330	384
LOW	206	13	8	10	11	14	16	LOW	138	120	158	188	220	256
HIGH	206	13	22	27	31	39	47	HIGH	138	241	317	376	441	513
TWDB Forecast	206	0	0	0	0	0	0	TWDB Forecast	172	133	124	123	122	126
BASELINE	207 SCHLEICHER	0	0	0	0	0	0	BASELINE	87	119	149	168	188	210
LOW	207	0	0	0	0	0	0	LOW	87	100	125	141	158	176
HIGH	207	0	0	0	0	0	0	HIGH	87	138	173	195	219	244
TWDB Forecast	207	0	0	0	0	0	0	TWDB Forecast	147	125	107	104	102	105
BASELINE	208 SCURRY	0	0	0	0	0	0	BASELINE	2,071	2,500	2,973	3,178	3,384	3,594
LOW	208	0	0	0	0	0	0	LOW	2,071	2,202	2,619	2,800	2,982	3,166
HIGH	208	0	0	0	0	0	0	HIGH	2,071	2,797	3,326	3,556	3,787	4,021

Water Demand Forecasts By County
In Acre-Feet/Year (continued)

	MANUFACTURING									MINING					
	CNTY	NAME	2000	2010	2020	2030	2040	2050		2000	2010	2020	2030	2040	2050
BASELINE	210	SHELBY	1,438	1,675	2,057	2,399	2,987	3,625	BASELINE	0	0	0	0	0	0
LOW	210		1,438	1,282	1,555	1,786	2,193	2,630	LOW	0	0	0	0	0	0
HIGH	210		1,438	2,068	2,559	3,011	3,781	4,620	HIGH	0	0	0	0	0	0
TWDB Forecast	210		1,535	1,892	2,249	2,605	2,962	3,319	TWDB Forecast	0	0	0	0	0	0
BASELINE	211	SHERMAN	0	0	0	0	0	0	BASELINE	7	6	7	8	8	9
LOW	211		0	0	0	0	0	0	LOW	7	4	4	5	5	6
HIGH	211		0	0	0	0	0	0	HIGH	7	8	10	11	12	13
TWDB Forecast	211		0	0	0	0	0	0	TWDB Forecast	26	26	27	28	29	31
BASELINE	212	SMITH	2,908	3,475	4,444	5,379	6,885	8,502	BASELINE	345	643	846	1,005	1,182	1,380
LOW	212		2,908	2,392	3,017	3,604	4,568	5,601	LOW	345	600	790	939	1,104	1,289
HIGH	212		2,908	4,559	5,872	7,153	9,202	11,403	HIGH	345	685	902	1,071	1,260	1,471
TWDB Forecast	212		4,618	5,020	5,297	5,557	5,822	6,082	TWDB Forecast	690	448	367	313	305	299
BASELINE	213	SOMERVELL	1	1	2	2	3	3	BASELINE	475	695	893	1,033	1,184	1,348
LOW	213		1	1	1	1	1	2	LOW	475	369	474	549	629	716
HIGH	213		1	2	2	3	4	5	HIGH	475	1,020	1,312	1,518	1,740	1,981
TWDB Forecast	213		0	0	0	0	0	0	TWDB Forecast	326	289	275	273	274	282
BASELINE	214	STARR	0	0	0	0	0	0	BASELINE	863	1,095	1,360	1,510	1,664	1,825
LOW	214		0	0	0	0	0	0	LOW	863	842	1,046	1,161	1,279	1,403
HIGH	214		0	0	0	0	0	0	HIGH	863	1,348	1,675	1,859	2,049	2,247
TWDB Forecast	214		0	0	0	0	0	0	TWDB Forecast	1,284	1,085	1,046	1,009	999	1,027
BASELINE	215	STEPHENS	7	9	11	14	18	22	BASELINE	6,840	7,459	8,870	9,482	10,098	10,724
LOW	215		7	5	7	8	10	13	LOW	6,840	6,567	7,810	8,349	8,891	9,442
HIGH	215		7	12	16	20	25	32	HIGH	6,840	8,351	9,931	10,616	11,305	12,005
TWDB Forecast	215		7	7	7	8	8	8	TWDB Forecast	448	256	171	131	104	107
BASELINE	216	STERLING	0	0	0	0	0	0	BASELINE	506	658	823	929	1,041	1,161
LOW	216		0	0	0	0	0	0	LOW	506	488	611	690	773	862
HIGH	216		0	0	0	0	0	0	HIGH	506	827	1,035	1,168	1,309	1,460
TWDB Forecast	216		0	0	0	0	0	0	TWDB Forecast	570	422	405	397	393	396
BASELINE	217	STONEWALL	0	0	0	0	0	0	BASELINE	9	13	15	16	17	18
LOW	217		0	0	0	0	0	0	LOW	9	10	12	12	13	14
HIGH	217		0	0	0	0	0	0	HIGH	9	16	19	20	21	22
TWDB Forecast	217		0	0	0	0	0	0	TWDB Forecast	219	181	92	53	23	17
BASELINE	218	SUTTON	0	0	0	0	0	0	BASELINE	67	87	108	122	137	153
LOW	218		0	0	0	0	0	0	LOW	67	65	81	92	103	115
HIGH	218		0	0	0	0	0	0	HIGH	67	108	135	153	171	191
TWDB Forecast	218		0	0	0	0	0	0	TWDB Forecast	81	81	81	83	84	86
BASELINE	219	SWISHER	0	0	0	0	0	0	BASELINE	4	5	6	6	7	7
LOW	219		0	0	0	0	0	0	LOW	4	2	3	3	3	4
HIGH	219		0	0	0	0	0	0	HIGH	4	7	9	10	10	11
TWDB Forecast	219		0	0	0	0	0	0	TWDB Forecast	4	2	1	1	0	0
BASELINE	220	TARRANT	24,481	30,907	42,011	54,363	74,238	97,033	BASELINE	92	140	186	224	267	316
LOW	220		24,481	22,307	29,555	37,323	49,960	64,358	LOW	92	117	156	188	224	265
HIGH	220		24,481	39,506	54,466	71,404	98,516	129,709	HIGH	92	162	217	261	311	367
TWDB Forecast	220		62,951	72,991	80,336	88,560	97,997	110,131	TWDB Forecast	96	94	96	99	102	105
BASELINE	221	TAYLOR	925	1,118	1,442	1,758	2,266	2,813	BASELINE	201	250	305	334	365	397
LOW	221		925	715	916	1,110	1,425	1,765	LOW	201	212	259	284	310	337
HIGH	221		925	1,520	1,967	2,405	3,106	3,862	HIGH	201	287	351	385	420	456
TWDB Forecast	221		1,775	1,921	2,062	2,201	2,387	2,575	TWDB Forecast	245	192	180	178	181	198
BASELINE	222	TERRELL	0	0	0	0	0	0	BASELINE	8	8	9	10	11	12
LOW	222		0	0	0	0	0	0	LOW	8	4	5	5	5	6
HIGH	222		0	0	0	0	0	0	HIGH	8	12	14	15	16	17
TWDB Forecast	222		0	0	0	0	0	0	TWDB Forecast	27	21	19	18	17	17
BASELINE	223	TERRY	1	1	1	2	2	2	BASELINE	194	260	305	322	338	354
LOW	223		1	1	1	1	1	1	LOW	194	206	242	255	268	281
HIGH	223		1	2	2	2	3	3	HIGH	194	314	368	388	407	427
TWDB Forecast	223		0	0	0	0	0	0	TWDB Forecast	1,237	1,011	826	675	551	451
BASELINE	224	THROCKMORTON	0	0	0	0	0	0	BASELINE	36	44	52	56	59	63
LOW	224		0	0	0	0	0	0	LOW	36	39	47	50	53	57
HIGH	224		0	0	0	0	0	0	HIGH	36	48	57	61	65	69
TWDB Forecast	224		0	0	0	0	0	0	TWDB Forecast	34	28	26	25	25	26
BASELINE	225	TITUS	971	1,105	1,315	1,485	1,790	2,110	BASELINE	2,550	3,566	4,438	4,979	5,547	6,149
LOW	225		971	556	661	746	898	1,058	LOW	2,550	3,234	4,024	4,514	5,030	5,576
HIGH	225		971	1,654	1,969	2,224	2,682	3,162	HIGH	2,550	3,898	4,852	5,443	6,064	6,722
TWDB Forecast	225		3,734	3,997	4,199	4,357	4,722	5,079	TWDB Forecast	2,772	1,991	1,796	1,722	1,705	1,744
BASELINE	226	TOM GREEN	508	596	747	888	1,121	1,372	BASELINE	73	126	163	189	218	250
LOW	226		508	461	576	681	857	1,046	LOW	73	107	138	161	185	212
HIGH	226		508	730	919	1,095	1,385	1,697	HIGH	73	145	187	218	252	288
TWDB Forecast	226		718	777	832	889	976	1,064	TWDB Forecast	79	81	84	87	90	93
BASELINE	227	TRAVIS	19,371	25,971	37,745	51,980	74,660	102,056	BASELINE	1,714	2,612	3,509	4,253	5,097	6,055
LOW	227		19,371	13,585	19,592	26,815	38,346	52,261	LOW	1,714	2,042	2,744	3,325	3,985	4,734
HIGH	227		19,371	38,356	55,898	77,144	110,975	151,852	HIGH	1,714	3,182	4,275	5,182	6,209	7,376

Water Demand Forecasts By County
In Acre-Feet/Year (continued)

			MANUFACTURING							MINING					
	CNTY	NAME	2000	2010	2020	2030	2040	2050		2000	2010	2020	2030	2040	2050
BASELINE	229	TYLER	61	73	95	117	152	191	BASELINE	0	0	0	0	0	0
LOW	229		61	61	79	96	124	155	LOW	0	0	0	0	0	0
HIGH	229		61	85	111	137	180	228	HIGH	0	0	0	0	0	0
TWDB Forecast	229		36	40	44	48	53	57	TWDB Forecast	0	0	0	0	0	0
BASELINE	230	UPSHUR	152	180	227	272	349	436	BASELINE	1	2	2	3	3	3
LOW	230		152	110	140	167	215	268	LOW	1	1	2	2	2	2
HIGH	230		152	249	314	377	484	604	HIGH	1	2	3	3	4	4
TWDB Forecast	230		215	232	241	243	277	314	TWDB Forecast	1	1	1	1	1	0
BASELINE	231	UPTON	0	0	0	0	0	0	BASELINE	2,311	2,955	3,548	3,823	4,101	4,384
LOW	231		0	0	0	0	0	0	LOW	2,311	2,211	2,655	2,861	3,069	3,281
HIGH	231		0	0	0	0	0	0	HIGH	2,311	3,698	4,441	4,785	5,133	5,487
TWDB Forecast	231		0	0	0	0	0	0	TWDB Forecast	2,405	1,887	1,792	1,757	1,762	1,813
BASELINE	232	UVALDE	242	271	320	360	432	509	BASELINE	281	425	558	653	755	866
LOW	232		242	168	197	220	262	307	LOW	281	352	462	541	626	718
HIGH	232		242	375	444	500	602	710	HIGH	281	497	653	764	884	1,015
TWDB Forecast	232		600	643	675	700	759	817	TWDB Forecast	444	428	499	576	666	777
BASELINE	233	VAL VERDE	0	0	0	0	0	0	BASELINE	163	180	236	277	320	367
LOW	233		0	0	0	0	0	0	LOW	163	90	118	138	160	184
HIGH	233		0	0	0	0	0	0	HIGH	163	270	355	415	480	551
TWDB Forecast	233		0	0	0	0	0	0	TWDB Forecast	114	121	138	155	172	191
BASELINE	234	VAN ZANDT	298	349	438	518	649	787	BASELINE	894	1,310	1,664	1,906	2,166	2,447
LOW	234		298	206	256	301	376	454	LOW	894	1,199	1,522	1,744	1,982	2,239
HIGH	234		298	493	620	734	922	1,121	HIGH	894	1,421	1,805	2,068	2,350	2,655
TWDB Forecast	234		280	344	396	451	508	566	TWDB Forecast	1,359	1,167	1,099	1,077	1,084	1,115
BASELINE	235	VICTORIA	31,646	36,655	44,622	51,691	63,868	77,032	BASELINE	2,751	3,367	4,482	5,386	6,402	7,549
LOW	235		31,646	29,919	36,056	41,335	50,575	60,472	LOW	2,751	2,919	3,885	4,669	5,550	6,544
HIGH	235		31,646	43,391	53,188	62,046	77,161	93,593	HIGH	2,751	3,815	5,078	6,102	7,254	8,554
TWDB Forecast	235		24,115	28,446	31,157	33,670	37,900	42,201	TWDB Forecast	2,578	2,028	1,732	1,714	1,720	1,862
BASELINE	236	WALKER	663	828	1,108	1,390	1,852	2,364	BASELINE	6	6	7	9	10	11
LOW	236		663	558	718	864	1,112	1,386	LOW	6	4	5	6	7	8
HIGH	236		663	1,098	1,498	1,917	2,591	3,343	HIGH	6	7	9	11	12	14
TWDB Forecast	236		228	245	260	276	290	306	TWDB Forecast	15	16	18	19	21	23
BASELINE	237	WALLER	78	100	139	182	251	331	BASELINE	278	406	521	605	697	796
LOW	237		78	50	70	92	126	166	LOW	278	278	358	415	478	546
HIGH	237		78	150	207	273	376	496	HIGH	278	533	685	796	915	1,047
TWDB Forecast	237		44	49	56	62	68	75	TWDB Forecast	687	351	192	106	53	30
BASELINE	238	WARD	3	4	4	5	6	7	BASELINE	120	195	234	252	271	289
LOW	238		3	2	3	3	4	5	LOW	120	148	178	191	205	219
HIGH	238		3	5	6	7	8	10	HIGH	120	242	291	313	336	359
TWDB Forecast	238		4	4	5	6	6	7	TWDB Forecast	635	495	318	231	190	194
BASELINE	239	WASHINGTON	586	638	754	855	948	1,014	BASELINE	144	173	223	259	299	342
LOW	239		586	384	445	496	542	573	LOW	144	139	179	208	240	275
HIGH	239		586	892	1,063	1,215	1,355	1,454	HIGH	144	207	267	311	358	409
TWDB Forecast	239		495	519	538	569	616	663	TWDB Forecast	131	125	121	119	120	124
BASELINE	240	WEBB	4	5	6	8	10	13	BASELINE	306	458	526	543	560	576
LOW	240		4	3	4	5	6	8	LOW	306	333	383	395	407	419
HIGH	240		4	7	9	11	15	18	HIGH	306	582	670	691	712	733
TWDB Forecast	240		33	38	43	49	57	65	TWDB Forecast	489	390	312	268	248	255
BASELINE	241	WHARTON	217	261	329	390	492	602	BASELINE	596	941	1,203	1,386	1,584	1,797
LOW	241		217	157	199	235	296	362	LOW	596	747	955	1,100	1,257	1,427
HIGH	241		217	365	460	544	687	842	HIGH	596	1,135	1,451	1,672	1,910	2,168
TWDB Forecast	241		442	486	521	554	596	637	TWDB Forecast	2,374	2,431	2,502	2,568	2,641	2,720
BASELINE	242	WHEELER	0	0	0	0	0	0	BASELINE	110	147	178	192	207	222
LOW	242		0	0	0	0	0	0	LOW	110	85	102	111	119	128
HIGH	242		0	0	0	0	0	0	HIGH	110	210	253	274	295	317
TWDB Forecast	242		0	0	0	0	0	0	TWDB Forecast	102	43	23	11	5	2
BASELINE	243	WICHITA	2,463	2,658	3,123	3,485	3,770	3,911	BASELINE	131	234	290	323	358	394
LOW	243		2,463	1,768	2,059	2,280	2,451	2,531	LOW	131	208	258	288	319	351
HIGH	243		2,463	3,547	4,186	4,690	5,090	5,291	HIGH	131	259	322	358	397	437
TWDB Forecast	243		2,172	2,315	2,441	2,558	2,702	2,814	TWDB Forecast	134	86	78	70	46	39
BASELINE	244	WILBARGER	745	859	1,031	1,178	1,435	1,712	BASELINE	24	32	38	41	44	47
LOW	244		745	576	690	788	959	1,143	LOW	24	20	24	26	28	30
HIGH	244		745	1,142	1,372	1,568	1,912	2,281	HIGH	24	44	53	57	61	65
TWDB Forecast	244		740	849	904	971	1,087	1,206	TWDB Forecast	24	23	24	24	24	24
BASELINE	245	WILLACY	0	0	0	0	0	0	BASELINE	6	8	9	9	9	9
LOW	245		0	0	0	0	0	0	LOW	6	6	7	7	7	7
HIGH	245		0	0	0	0	0	0	HIGH	6	10	11	11	11	11
TWDB Forecast	245		0	0	0	0	0	0	TWDB Forecast	12	8	5	2	0	0
BASELINE	246	WILLIAMSON	1,397	1,610	2,035	2,457	2,857	3,157	BASELINE	2,031	2,712	3,192	3,388	3,556	3,701
LOW	246		1,397	829	1,042	1,252	1,451	1,601	LOW	2,031	2,228	2,623	2,784	2,922	3,041
HIGH	246		1,397	2,390	3,028	3,663	4,263	4,714	HIGH	2,031	3,196	3,761	3,992	4,190	4,360

Water Demand Forecasts By County In Acre-Feet/Year (continued)

MANUFACTURING

	CNTY	NAME	2000	2010	2020	2030	2040	2050
BASELINE	248	WINKLER	0	0	0	0	0	0
LOW	248		0	0	0	0	0	0
HIGH	248		0	0	0	0	0	0
TWDB Forecast	248		8	10	11	12	14	17
BASELINE	249	WISE	2,208	2,795	3,807	4,862	6,503	8,287
LOW	249		2,208	1,667	2,240	2,827	3,748	4,751
HIGH	249		2,208	3,924	5,375	6,897	9,258	11,824
TWDB Forecast	249		5,420	5,921	6,435	6,957	7,496	8,038
BASELINE	250	WOOD	117	135	164	190	233	279
LOW	250		117	81	98	112	136	161
HIGH	250		117	188	231	268	331	396
TWDB Forecast	250		244	290	341	391	468	544
BASELINE	251	YOAKUM	0	0	0	0	0	0
LOW	251		0	0	0	0	0	0
HIGH	251		0	0	0	0	0	0
TWDB Forecast	251		0	0	0	0	0	0
BASELINE	252	YOUNG	16	19	25	30	39	47
LOW	252		16	11	14	17	21	26
HIGH	252		16	28	36	44	56	69
TWDB Forecast	252		158	182	203	223	258	299
BASELINE	253	ZAPATA	0	0	0	0	0	0
LOW	253		0	0	0	0	0	0
HIGH	253		0	0	0	0	0	0
TWDB Forecast	253		0	0	0	0	0	0
BASELINE	254	ZAVALA	704	782	907	1,002	1,184	1,373
LOW	254		704	578	668	734	863	997
HIGH	254		704	985	1,147	1,270	1,506	1,750
TWDB Forecast	254		1,407	1,507	1,582	1,642	1,780	1,914

MINING

	2000	2010	2020	2030	2040	2050
BASELINE	1,013	1,459	1,753	1,888	2,026	2,166
LOW	1,013	896	1,077	1,160	1,244	1,330
HIGH	1,013	2,023	2,429	2,617	2,807	3,001
TWDB Forecast	2,040	1,779	1,605	1,436	1,360	1,398
BASELINE	14,288	17,818	22,913	26,501	30,377	34,585
LOW	14,288	16,500	21,218	24,541	28,130	32,026
HIGH	14,288	19,136	24,608	28,462	32,624	37,143
TWDB Forecast	4,086	3,902	3,966	4,057	4,172	4,297
BASELINE	274	778	988	1,132	1,286	1,453
LOW	274	578	734	841	956	1,080
HIGH	274	977	1,241	1,422	1,616	1,825
TWDB Forecast	2,102	17,584	17,344	17,107	16,107	4,641
BASELINE	4,913	5,247	6,161	6,491	6,820	7,150
LOW	4,913	4,340	5,095	5,368	5,640	5,914
HIGH	4,913	6,155	7,226	7,614	8,000	8,387
TWDB Forecast	7,298	5,963	4,872	3,981	3,253	2,658
BASELINE	147	212	253	272	292	311
LOW	147	195	234	251	269	287
HIGH	147	228	273	294	314	336
TWDB Forecast	255	179	148	134	125	129
BASELINE	30	42	53	58	64	70
LOW	30	27	33	37	41	45
HIGH	30	58	72	80	88	96
TWDB Forecast	20	6	3	1	0	0
BASELINE	33	31	41	48	55	63
LOW	33	22	29	34	39	45
HIGH	33	40	53	62	71	82
TWDB Forecast	97	42	25	8	2	0

COMMENTS FROM THE TWDB

December 5, 2002

Ms. Carla Johnson, President
Waterstone Environmental
Hydrology & Engineering, Inc.
1650 38th St. Suite 201E
Boulder, CO 80301

Re: Research Grant Contract Between Waterstone Environmental Hydrology and Engineering, Inc. (WEHEI), and the Texas Water Development Board (Board), Draft Report Entitled "Water Demand Methodology and Projections for Mining and Manufacturing," Contract No. 2001-483-397

Dear Ms. Johnson:

Staff members of the Texas Water Development Board have completed a review of the draft report under TWDB Contract No. 2001-483-397. Comments are presented in Attachment 1. Due to the content of the Board comments, please submit two (2) copies of a revised draft final report for review.

Please contact Dr. Dan Hardin at (512) 936-0880 if you have any questions about the Board's comments.

Sincerely,

William F. Mullican, III
Deputy Executive Administrator
Office of Planning

cc: Dan Hardin, TWDB

ATTACHMENT 1

Review Comments on Research Grant Contract for
" Water Demand Methodology and Projections for Mining and Manufacturing"
Contract No. 2001-483-397

This Waterstone draft is disappointing. Very few of the proposed objectives/deliverables are completely fulfilled, the projections are not defendable, and the final report is eight months late. This creates a hardship to TWDB staff that shouldn't have occurred and could have been prevented.

The results of this study are significantly different from the previous 2002 state projections for the manufacturing and mining water demand, as indicated below. Unfortunately, this study did not provide any explanation for these differences. Please provide sufficient justification for these drastic differences or make significant adjustments to the projections.

	Water Demand Growth for Manufacturing (2000-2050)	Water Demand Growth for Mining (2000-2050)
Low (Study)	121%	102%
Base (Study)	184%	154%
High (Study)	306%	202%
SWP 2002	47%	-3%

The table shown below lists the objectives and deliverables identified in Waterstone's proposal.

An analysis of previous TWDB projections or research into more recent water-use efficiency estimates was located. In addition, no evidence of Waterstone's consultation with experts in the areas of mining or manufacturing water use was found. The most insightful statements regarding manufacturing water use in Texas came from the TWDB's own State Water Plan.

The Perryman Group did provide manufacturing and mining demand forecasts, however the forecast at the 2-digit Standard Industrial Classification (SIC) codes were not included in the report and would be crucial for continuing work in manufacturing and mining water demand projections.

Though the final report was clear and concise, it failed to provide and document in-depth information on Texas manufacturing or mining water use.

OBJECTIVE STATED IN THE WATERSTONE PROPOSAL	**STATUS**
Task 1: Uncertainty Analysis of Previous TWDB Water Use Efficiency Estimates	
1) "...we will also determine the accuracy of the TWDB predictions made by Mr. Butch Bloodworth using data from the last survey by Pequod Associates." (A-18)	Can't Find
2) "We will calculate the differences between the predicted water use efficiency estimates and compare them to the actual data obtained from an updated survey (if necessary)." (A-18)	Can't Find

3) "...we will only survey the manufacturing industry to update the water use efficiency estimates expected to be attained over the 2000-2050 period." (A-18)	Can't Find

It appears that this study did not conduct an extensive analysis of the previous TWDB water use efficiency estimates. Instead, this study shows the differences in water demand projections but does not identify the causes of the differences. It simply states, "It is unclear why this discrepancy arises" (pp. 4). The causes must be identified with supporting documentation.

Task 2: Industry Expert Anaysis and Input-Output Analysis

1) "Waterstone will provide expertise on technological advance in the mining industry." (A-18)	Can't Find
2) "While not yet identified, an expert on high-tech manufacturing technologies and an expert on traditional Texas manufacturing will be interviewed to support TPG in developing manufacturing water-use estimates." (A-18)	Can't Find
3) "...industry experts will investigate the developing technologies that have resulted in significant changes in how water is use to produce output in Texas. ... This analysis will provide our research time and the TWDB with accurate information on how industries alter their operations to maintain output in response to both short and long-term water shortages." (A-19)	Can't Find
4) "As requested in the RFQ, we will also identify specific types of firms for which water use is not directly related to production of output." (A-19)	Can't Find

No documentation of any consultation with experts regarding technological changes or industry-specific water use patterns that could affect the water demand projections directly is provided.

Due to the lack of information on how TPG conducted the Input-Output analysis, it is difficult to determine how the first item under Task 2 was accomplished.

Task 3: Water Demand Forecast by Industry

1) "...provide a 'best guess' or mean (average) demand forecast along with maximum and minimum ranges of demand [on a county by county basis]." (A-19)	YES

However, rationale is provided for the three different scenarios (base, low and high) of water demand projections.

Task 4 Reporting

1) "Our findings will be written in a clear, concise, yet comprehensive report." (A-19)	Yes

2) "We will meet with the TWDB several times during the research... Once completed, a final presentation on the results of this research will be given." (A-19)	Not to our knowledge

This report needs more detail in order that TWDB staff can understand the approaches and procedures taken to develop the final draft report.

No TPG study was provided separately; only the resulting data was submitted.

No meetings or presentations were held for the appropriate TWDB staff.

Comments Regarding Portions of the Report

1) The water-use coefficients should be calculated at the county level and at the 2-digit SIC code specification. In the manufacturing industries, one type of industry may make up 100% of the water use, but only 60% of the gross output. Of greater concern, the intensive water-using industries may be forecast at different rates than those industries that use less water.

A similar problem may exist with the mining industries, particularly in the oil and gas extraction industry. Though oil & gas extraction would produce a large amount of economic output, fresh water use in large volume is utilized only in enhanced recovery extraction efforts.

Due to SB2, TWDB was not able to release water-use data below the county level, but some compensation should have been possible due to Waterstone's expertise in mining and with consultations with Texas manufacturing experts.

2) At the end of page 2, the text mentions that "The mean manufacturing water use efficiency values used in the model are shown in Table 1" and lists the source as the 1996 Plan. What type of mean is this? When the same information was looked up in the 1996 Plan, it lists efficiency schedules for five manufacturing industries. The 'mean efficiency values' listed in the report match the efficiency values for three of the five industries exactly. The efficiency levels for the unmatched industries were significantly higher, so how is what is listed in Table 1 a mean?

Comments Regarding the Water Demand Projections

In a number of counties, the manufacturing water demand projections are so different from the historical usage, that it's not certain that the projections could be presented to the regions as draft projections without significant amount of adjustment. This is the same for the mining water demand projections, though for fewer counties.

Methodology

Following is a brief discussion of some of the problems inherent in the Waterstone methodology:

According to the 2002 TWDB state plan, there are five kinds of manufacturing products (2 digit SIC code), which account for about 90 percent of the total manufacturing water use in Texas. The plan also indicates that each of the SIC code has a different water use pattern. Therefore, it is critical to understand the relationship between output and water use by SIC code, as well as the different dynamics of economy within individual county, in order to obtain more accurate water demand projections for a long time period.

However, the Waterstone study simply calculates the average water use coefficient of all the manufacturing output by county and applies it to all the manufacturing categories. As a result, this analysis could not take into account the different water use patterns affected by the combination of various industry-specific growth rate and water use coefficient within a county. This may account for the trend in the gap (between the projection numbers of this study and the 2002 plan), compounding as we move further from the year 2000.

Since there is no detailed document about the Input-Output study conducted by TPG, the county gross output analysis cannot be reviewed adequately. This must be included in this report, along with the detailed output data by SIC code.

The report does not discuss the factors such as technological changes that might affect water use efficiency in the future. Instead, this study adopted the water use efficiency analysis conducted in 1993 by Pequod. Although the Waterstone study reported on the average number of water use efficiency estimates, it does not indicate how the number was arrived at and why the average value is used instead of the actual numbers varied by SIC code as shown in the Pequod study.

Pequod Study

Category	SIC	2000	2010	2020	2030	2040	2050
Chemical and Allied	28	0.96	0.92	0.88	0.83	0.83	0.83
Pulp and Paper	26	0.93	0.86	0.78	0.70	0.70	0.70
Semiconductor	36	0.91	0.82	0.71	0.40	0.40	0.40
Petroleum Refining	29	0.96	0.92	0.88	0.83	0.83	0.83

Waterstone Study

Manufacturing	Average	0.96	0.92	0.88	0.83	0.83	0.83

This approach probably does not capture the differences created by industry compositions, which vary by county. For instance, Harris County has SIC code 26, which takes about 55% of the total manufacturing water use. Due to the high share of the total water use by this manufacturing category in Harris County, if we use SIC code-specific water use efficiency estimates shown in the Pequod study, the total water use estimates would be less than those obtained from using the average water use efficiency estimate.

Regarding the water demand projections for mining, the Waterstone report doesn't currently reflect information on the Texas mining industry and its water use pattern or its technological advances that could lead to improvement of water use efficiencies in mining.

One of the tasks for the Waterstone study was to identify the water use efficiency factors. However, the report only states, "Water use efficiency factors for mining do not exist and were not used. If such values can be determined, mining water demand values can be reduced." This sort of observation does not reflect good faith effort by Waterstone.

When the total county gross product for mining is compared with that of the Texas comptroller's state gross product forecast, between the years 2000 and 2020, the TPG's projections for mining appear to be over-estimated.

	State Gross Product Growth for Mining (2000-2020)
Low (Study)	61%
Base (Study)	91%
High (Study)	119%
Texas Comptroller's Forecast	36%

Additional Comments:

- In the tables at the back of the report, there are no labels on the manufacturing numbers (low, high, etc.), and on the mining numbers, there are no associated county names.

Manufacturing Projections:

- La Salle County has #Div/0! Error in the manufacturing projections data table. (Loving, McMullen, and Kenedy Counties also have that error in the electronic data).
- Harrison County was one of the Top 10 manufacturing water use counties in the 2002 plan. No information was presented on what accounts for such a significant drop in the water use in that county.
- What accounts for the significant increase in manufacturing water demand in Comal County?
- What accounts for the significant increase in manufacturing water demand in Jasper County?
- Harris County skyrockets after the 2030 projection (projection was done through 2030 by Perryman). What causes this significant increase after 2030? Dallas, Bexar, Cass, Gray, Grayson, Jefferson, McLennan, Nueces, Orange and Fort Bend Counties exhibit this same divergence after 2030 as well.
- Milam, Morris, Victoria, Travis, Potter, Williamson and Wichita counties in this set of projections have a significant increase in water demand over the 2002 Plan numbers.

Mining Projections:

- When comparing numbers to the 2002 Plan, the following counties now show a significant decrease in mining water demand: Lee, Matagorda, Milam.
- What accounts for the significant increase in mining water use is Anderson, Kleberg, Hockley, Gaines, Leon, Lubbock, Rusk, Stephens and Titus counties when in the 2002 Plan, these number overall 50 year trend was a decrease in water demand?

- The following mining demand numbers are significantly higher than the 2002 Plan numbers without much evidence presented in the report: Bell, Bexar, Brazoria, Brown, Comal, Chambers, Colorado, Ector, Live Oak, Nueces, Victoria, Wise, and Yoakum.

Overall the 2050 projection in the 2002 TWDB plan is half of what is projected in this set of data. This seems like a siginifant increase without much supporting information provided.

RESPONSE TO COMMENTS

WATERSTONE
Environmental Hydrology and Engineering, Inc.

March 7, 2003

William F. Mullican, III
Deputy Executive Administrator
Office of Planning
Texas Water Development Board
1700 N. Congress Ave.
Austin, TX 78711-3231

Subject: **Response to Comments on the Draft Report, "Water Demand Methodology and Projections for Mining and Manufacturing", Contract No. 2001-483-397**

Dear Mr. Mullican,

As requested in your letter dated December 5th, 2002, Waterstone has incorporated and responded to the comments that were provided in Attachment 1 of your letter. Waterstone has expended considerable efforts to address the concerns expressed by the reviewers. The results of these efforts are summarized as Attachment 1 to this letter. The four attachments included with this letter, as well as the final report and The Perryman Group's economic forecasts, will demonstrate to you the level of conviction that Waterstone has regarding your satisfaction with the final product.

Several comments were requests for results that Waterstone is unable to produce, either because the full extent of the request is beyond a reasonable interpretation of the contract, or because the requested results were not promised in the contract. For example, considering the monetary size of the contract, it is unreasonable to expect that any organization would be able to perform a complete manufacturing survey. Generating such information, with a sufficient level of certainty, is clearly outside the scope of the contract. Attachment 2 provides a more detailed discussion of this point. A second example, providing water demand projections at the SIC level, is not stipulated in the contract.

1650 38th St. Suite 201E ■ Boulder, CO 80301 ■ www.waterstoneinc.com ■ (303) 444-3500 fax ■ (303) 444-1000

This letter, the TWDB comments, and Waterstone's responses have all been incorporated into an extensively revised final report. Waterstone is interested in resolving any outstanding issues at your earliest convenience. Please contact us if you have any questions.

Sincerely,
Waterstone Environmental Hydrology and Engineering, Inc.

Carla Johnson
CEO

The Perryman Group

Ray Perryman
President

Attachment 1

ATTACHMENT 1 - RESPONSE TO TWDB COMMENTS ON THE DRAFT REPORT: "WATER DEMAND METHODOLOGY AND PROJECTIONS FOR MINING AND MANUFACTURING", CONTRACT NO. 2001-483-397

The following pages provide details of any revisions Waterstone has made to the Draft report in response to TWDB comments. Revisions range from correcting simple formatting errors to modifying the analysis so that it accounts for counties exhibiting insensitivity to water demand.

The following provides the details of Waterstone's responses to the TWDB comments included in the letter dated December, 5th 2002. Except for the introductory set of paragraphs, the comments from the TWDB reviewers were provided with numbering or headings. The introductory paragraphs have been placed under the heading "General Comments" and are addressed first. The remainder of the document has been prepared to reflect the headings and numbering used by the TWDB.

General Comments Received From the TWDB

Paragraph One. Waterstone acknowledges that the draft form of the report may have made interpretation more difficult. At the same time, it is appropriate to point out the following facts:

- The projections are defensible. Waterstone has engaged in conversations and correspondence with the TWDB project manager (Dan Hardin) to explain the results that were included in the draft report.
- The eight-month delay of the final report included a period of approximately three months during which the TWDB did not supply any feedback on the draft report, despite requests for feedback (at the time the draft report was submitted, 9/2002, and one month thereafter).
- At the time that the TWDB did request clarification of certain numbers, Waterstone analyzed, updated numbers and provided a detailed response to the TWDB within three working days.

Paragraph Two and Table. The source of the data in the table provided by the reviewer is unclear. There were 254 counties examined in the model, the table appears to have targeted one individual county. In the initial draft, section 3.3 does provide justification for some of the differences between the TWDB (SWP 2002) and Waterstone forecasts. The differences between these two projections reflect some of the changes in trends that have occurred during the intervening years. Some projections from the SWP 2002 study are considerably different, and are unreasonable for the near future. Specific examples and more detailed justifications are discussed in later sections of this attachment.

Paragraph Three. Response to the individual items in the referenced table are organized in the same manner as the table produced by the TWDB reviewers.

Paragraph Four. Waterstone has revised the report to indicate when industry experts were consulted. In general, experts were consulted as part of the economic forecast process: the Perryman Group has developed a sophisticated forecasting methodology using expert input which is frequently updated/revised based on continuing expert input and as new data becomes available.

Paragraph Five. Waterstone will provide the manufacturing and mining economic forecasts at the 2 digit SIC code level that were produced by the Perryman Group.

Paragraph Six. Waterstone appreciates the acknowledgement of providing a "clear and concise" report. Unfortunately, the failures cited are vague. In the interest of serving the TWDB, Waterstone will address each of the specific comments below in the hope that this addresses the reviewers' broad concerns expressed in this paragraph.

TASK 1: UNCERTAINTY ANALYSIS OF PREVIOUS TWDB WATER USE EFFICIENCY ESTIMATES

Response to comment numbers 1,2 and 3 The accuracy of the predictions from previous studies by the TWDB and Pequod cannot be ascertained since there has been no updated survey in the interim. A survey to update the data and evaluate prediction uncertainty would require a level of effort considerably beyond the scope of the current contract: an updated survey would require not only soliciting data, collecting it and analyzing it, but would also require some form of review. In addition, there would still be relatively large uncertainty in such updated values. Put simply, the range in uncertainty of any updates would probably encompass both the original values, as well as the revised values. As a result, it would probably not be possible to consider the revised values significantly different than the original values. A final note to put these issues in perspective: it is unlikely that any update in water use efficiency fact has changed by more than 10%. Given the magnitude of other changes over the course of the forecasting period, the impact of updates in water use efficiency factors would be minor compared to other changes.

Waterstone has modified the text, providing explanations for differences between the water demand surveys. The causes are identified and the supporting documentation cited. It should also be added that the comment "It is unclear why this discrepancy arises" (pp. 4 in the draft) should have been further developed. The intention of the statement was to convey the fact that Waterstone was not familiar with every detail of the methodology behind the TWDB model. This precluded an exact analysis of the source of differences in the results. The sentence has been modified to correctly reflect the reasons why an exact interpretation of differences between surveys was not possible.

TASK 2: INDUSTRY EXPERT ANALYSIS AND INPUT-OUTPUT ANALYSIS

1) To provide the water demand forecast, Waterstone sought the assistance of the Perryman Group to provide economic output forecasts for the years 2000-2050. Inherent in their studies, TPG has consulted many experts in the manufacturing and mining industries. Please see further discussion provided by TPG in attachment 3.
2) Please see the response to previous bullet.
3) Please see the response to the first bullet of this section.
4) The data to identify industries where production is not directly related to water use is not readily available (Personal communication with: Jan Gersten, EDF; Bill Hoffman City of Austin; Irwin Margiloff, Chemical Engineer; 2003). From a qualitative standpoint, one can say that the manufacturing industry as a whole has very few examples of production that is not heavily correlated with water use. One of the best examples of an industry that may have minimal correlation is the garment industry (Bill Hoffman, personal communication, 2003). However, there are several caveats to this statement. First of all, it would be the assembly side of the garment industry that is not heavily dependent on water consumption for production. This aspect of the industry has been relatively mobile, with considerable changes in its presence over recent decades. A second point is that there are segments of the industry that rely on water for production. An example is dying; the process of coloring fabrics requires large amounts of water. In summary, most of the manufacturing industry relies on water for production, but for examples where the correlation is not that strong, it probably only applies to a portion of that industry's segment.

TASK 3: WATER DEMAND FORECAST BY INDUSTRY

1) The TWDB comment acknowledges completion of this task. No response is necessary.

The intent of the final comment in this section is unclear. However, in an effort to provide clarification Waterstone has supplied a detailed explanation of The Perryman Group's methodology in Attachment 3.

TASK 4: REPORTING

1) The TWDB comment acknowledges completion of this task. No response is necessary.
2) Waterstone has engaged the TWDB contract manager in multiple conference calls. A Waterstone representative, Carla Johnson (CEO), has traveled to meet with Dan on two separate occasions, to discuss status and timing of the project. A final presentation has not been performed since the results have yet to be accepted. However, considering the level of effort incorporated into responses to the TWDB's requests and comments, a final meeting is not anticipated at this time.

The first comment following the numbered items in this section seems to contradict the feedback expressed in comment number one. However, in an effort to address the concerns expressed, Waterstone has made considerable revisions to the report, providing additional details regarding the approaches and procedures used to develop the report.

The Perryman Group Study is included as an appendix in the final report.

Please see the response to comment number two of this section, explaining the circumstances leading to a decision to focus efforts on analysis rather than travel.

COMMENTS REGARDING PORTIONS OF THE REPORT

1) This section focuses primarily on the reviewer's desire to obtain water-use coefficients at the 2-digit SIC code level. This analysis was not supplied to the TWDB for two reasons:
   - Neither the contract nor proposal specified performing such analysis,
   - The TWDB is unable to release the water-use data at this level of detail.

   If the data had been available, Waterstone probably would have performed this analysis simply to provide more insight. Without this information, Waterstone would face the unreasonable task of performing a survey for each of the 254 counties, to study the amount of water that each industry in each county consumes, since water usage within each industry also varies by county and locality. It is acknowledged that certain industries use water in a disproportionate amount to their economic output. However, the economic output data provided by TPG show that, for the most part, there is little fluctuation in the percentage of the economic contribution by industry (typically the maximum change from year 2010 to 2050 is approximately 10%). Therefore, despite the fact that a particular industry will use more water than another, a county's characteristics of the water-use trend will remain the same since their proportion of the economic output is proportionately constant. It is unreasonable to suggest that Waterstone provide such analysis considering the size of the contract, the uncertainty involved with producing such a data set as part of a small research grant, and the fact that the analysis was not proposed.

2) Conflicts between the text and analysis have been corrected so that the text now correctly reflects the analysis indicated.

COMMENTS REGARDING THE WATER DEMAND PROJECTIONS

Waterstone has analyzed the cause for the discrepancies between the TWDB 2002 plan and the Waterstone forecasts. Without knowing the exact details of how the TWDB 2002 water demand forecast was determined, the source of discrepancies between the two forecasts cannot be explicitly identified. However, the following discusses three of the primary factors contributing to these discrepancies.

1) The values from the 2002 SWP do not appear to reflect recent water use patterns. Four such manufacturing examples brought into question by TWDB are Harrison, Comal, Milam, and Williamson.

HARRISON	1990	1996	1997	1998	1999	2000	2010	2020	2030	2040	2050
TWDB (actual)	75,039	49,692	46,461	6,323	6,223	--	--	--	--	--	--
TWDB (forecast)	--	--	--	--	--	110,588	135,166	141,913	147,949	161,370	176,471
Waterstone	--	--	--	--	--	11,776	13,780	17,123	20,228	25,458	31,093

COMAL	1990	1996	1997	1998	1999	2000	2010	2020	2030	2040	2050
TWDB (actual)	3,248	11,964	8,171	8,650	7,883	--	--	--	--	--	--
TWDB (forecast)	--	--	--	--	--	3,450	3,487	3,548	3,799	4,071	4,351
Waterstone	--	--	--	--	--	9,109	10,990	14,209	17,456	22,718	28,493

MILAM	1990	1996	1997	1998	1999	2000	2010	2020	2030	2040	2050
TWDB (actual)	22,047	45,124	42,224	41,325	39,816	--	--	--	--	--	--
TWDB (forecast)	--	--	--	--	--	6,820	6,820	8,250	8,250	8,250	9,800
Waterstone	--	--	--	--	--	39,880	50,311	68,833	89,146	121,036	157,550

WILLIAMSON	1990	1996	1997	1998	1999	2000	2010	2020	2030	2040	2050
TWDB (actual)	326	1225	1328	1268	1182	--	--	--	--	--	--
TWDB (forecast)	--	--	--	--	--	368	398	409	405	443	481
Waterstone	--	--	--	--	--	1397	1609.5	2035	2457	2857	3157

In each of these cases the historic water use trend exhibited for the years 1996 through 1999 is not reflected in the TWDB forecast for the year 2000. The TWDB water forecast for the year 2000 appears to have overestimated or underestimated the water demand by a considerable amount. In most of these cases, the water demand projections from the 2002 State Water Plan do not reflect trends occurring during the late 1990s. For example, in Harrison county the water-use has been dropping since 1996 and is an order of magnitude smaller in 1999 than 1990. The TWDB forecast for 2000 shows water-use rate that are in line with the 1990 water-use levels while the Waterstone forecast reflects the recent reduction in water use. Other counties exhibiting this situation for manufacturing include Bell, Brazoria, and Kimble.

2) The greatest discrepancies between the TWDB and Waterstone forecasts appear in later years, after 2030. The water demand forecasts are strongly dependent on the economic output variable. For some counties there exists a high incremental economic output after 2030 resulting in higher water demands. Just a few examples of such counties are Travis, Jefferson, Bosque, McLenna, and Orange for manufacturing.

3) There were some counties where the water use trend appeared to be insensitive to the economic output. There are about a 20 counties, about 10% of all counties, that fall under this category. For these counties a secondary model has been put into place and the water demand forecast has been modified. Some of the counties that use the secondary algorithm include Dallas, Harris, and Bexar.

Lastly, as a point of discussion, it is worth noting that it would be unreasonable for the values of both models to be identical considering some of the changes that have occurred in the interim. It is reasonable to expect that projections 5 decades into the future would differ markedly considering the differences in the trends and data available at the time of the respective studies.

METHODOLOGY

Response to 1st paragraph of the section: The first paragraph simply serves as an introduction. No response is necessary.

Response to 2nd and 3rd paragraphs of the section:
Waterstone was unable to obtain water use data at the 2-digit SIC level. As a result, the available five, water-use efficiency factors by SIC code were not uniquely applied and instead, an average was used. Furthermore, a 2-digit SIC level analysis is beyond the scope of the contract.

Response to 4th paragraph of the section:
In Attachment 3, a detailed description of the econometric model used to provide county 2-digit SIC gross output data is provided.

Response to 5th paragraph of the section:
Without water-use at the 2-digit SIC and not knowing the percent of water-use used by each manufacturing for each individual county, it is not possible to apply water-use efficiency factors at the 2-digit SIC level.

Response to 6th paragraph of the section:
The model incorporates historic trends with emphasis on the water use trends in the recent past. This inherently accounts for the variations in the manufacturing use assuming the proportion of the manufacturing use does not vary a great deal. The economic output data provided by TPG show for the most part there is very little fluctuation in the percentage of the economic output contributed by each industry (approximately a maximum of 10% change from year 2010 to 2050).

Response to 7th paragraph of the section:
The model inherently reflects current water use trends. Technological advances are studied as a necessary condition to the TPG econometric model.

Response to 8th paragraph of the section:
There has been no historic use of water use efficiency factors for mining. Limited resources may require significant changes in recovery methods, e.g. switching to secondary recovery. Such recovery method changes could dramatically modify any estimated potential efficiency changes. Assessing recovery methods would require evaluating on a site-by-site, and resource-by-resource basis, an effort well outside the scope of this project.

Response to 9th paragraph of the section:
TPG responds directly to this concern in Attachment 3 and Attachment 4.

ADDITIONAL COMMENTS

- As a result of formatting errors in the draft report, data in these tables were not presented correctly. This has been resolved.

MANUFACTURING PROJECTIONS

The following bullets address each of the TWDB's bulleted comments for this section.

- This has been rectified. The "#Div/0!" errors were indications of a zero water demand. Zero water demand is now indicated.
- Based on recent historic water demand use, the TWDB forecast appears to overestimate the water demand for Harrison. See table above in the section, "Comments Regarding The Water Demand Projections" for Harrison County.
- Based on recent historic water demand use, the TWDB forecast appears to overestimate the water demand for Comal. See table above in the section, "Comments Regarding The Water Demand Projections" for Comal County.
- Jasper is one of a dozen counties which exhibit insensitivity to economic output. The second algorithm has been applied this county.
- See above in "Comments Regarding The Water Demand Projections".
- See above in "Comments Regarding The Water Demand Projections".

MINING PROJECTIONS

The following bullets address each of the TWDB's bulleted comments for this section.

- Based on the historic use pattern for these three counties, the TWDB appears to greatly overestimate the water use.

Lee	1995	1996	1997	1998	1999	2000	2010	2020	2030	2040	2050
TWDB actual	16	16	16	16	16	---	---	---	---	---	---
Waterstone	---	---	---	---	---	14.86	19.84	24.91	28.12	31.49	35.08
TWDB forecast	---	---	---	---	---	30	20021	25013	25005	25001	25000

Matagorda	1995	1996	1997	1998	1999	2000	2010	2020	2030	2040	2050
TWDB actual	277	277	251	196	196	---	---	---	---	---	---
Waterstone	---	---	---	---	---	158.58	218.48	279.28	321.76	367.56	417.23
TWDB forecast	---	---	---	---	---	5299	6956	6945	6942	6942	6949

Milam	1995	1996	1997	1998	1999	2000	2010	2020	2030	2040	2050
TWDB actual	8	8	8	8	8	---	---	---	---	---	---
Waterstone	---	---	---	---	---	8.01	12.00	15.80	18.72	21.95	25.53
TWDB forecast	---	---	---	---	---	30008	20008	20009	20009	20009	20009

- The explanatory variable (predictor) for the water demand is based on the economic output forecasted into the future provided by TPG. In all these counties, the economic output shows an increase that will result in an increase in water demand, in contrast to the decrease in the TWDB forecast.
- The explanations provided in the section, "Comments Regarding The Water Demand Projections", are also applicable here. In most of these cases, the higher water demand is a reflection of the economic output forecast.

At the time that TPG conducted their economic output study, the gross state product data released from the US Department of Commerce was only available through 1999 (with preliminary estimates for 2000). The subsequent release (after the projections were submitted) showed values of $37.6 billion and $29.9 billion for 1999 and 2000, respectively. These rather sizable revisions in the historical series (which mostly reflect the way price indices are constructed for this series), in turn affects the economic output values (Attachment 4, Dr. Perryman's response to this issue, provides additional details).

A calibration adjustment was made on the mining economic output to account for the updated 2000 values by applying a constant factor to the existing forecast. The ratio of the "new" to the "old" values for each decade is given below:

Year	New/Old
2000	0.6626
2010	0.6458
2020	0.6557
2030	0.6655
2040	0.6754
2050	0.6854

Final paragraph of the section:
The sections above provide explanations for the differences between the Waterstone and TWDB water demand forecasts for the counties mentioned in the TWDB comments.

Attachment 2

ATTACHMENT 2: DISSCUSSION REGARDING AN UPDATED WATER USE SURVEY.

One of the comments Waterstone received as a result of the TWDB's review of Waterstone's Draft Report identified the lack of an updated survey. This attachment discusses the reasons why such a request is unreasonable considering the scope and focus of the current research. The discussion below focuses on two areas:

1. The level of effort required to perform a survey, as demonstrated by a previous survey.
2. The level of confidence associated with the water use survey information.

In 1993 Pequod Associates performed a water use survey for the TWDB. The TWDB retained Pequod Associates specifically to "perform research on the industrial water usage of several groups of manufacturers in Texas"[1]. The research was intended to "establish linkages between conservation and the specifics of plant history, technology, costs, products, production levels, and other aspects of industrial operations". Pequod Associates mailed 365 questionnaires. The Pequod report points out (Methodology, page three, second paragraph) that both the TWDB and many of the firms targeted may have had issues regarding the proprietary nature of responses to many of the questions. Addressing these concerns required specific procedures to ensure that the certain aspects of the information collected would not be made available. The Pequod report describes an involved process of designing a survey, distributing it, expending "considerable" effort to achieve a 25% response rate, expert screening of submitted data to ascertain if the responses were reasonable or if the questionnaire had been misinterpreted, and a variety of procedures to protect proprietary information.

In an effort to understand some of the uncertainty associated with updating a water use survey, Waterstone contacted a variety of professionals in the water conservation field. These included:

- Jan Gersten, with the Environmental Defense Fund and Texas A&M
- Irwin Margiloff, Chemical Engineer, Efficiency Consultant
- Bill Hoffman, City of Austin, Industrial Water Conservation Expert

The discussion with these professionals focused on trying to understand the complexity of completing an accurate water use survey. Points of discussion included

1. Variability below the 2-digit SIC level.
2. Variability and uncertainty in trends at 2-digit SIC level.
3. Limitations as a result of uncertainty at the 2-digit SIC level.

The general consensus was that a survey would inevitably include considerable uncertainty, which would require careful analysis to determine reasonable applications of the data.

Based on the level of effort involved with the Pequod's original survey, and the inherent uncertainty, it is unreasonable to expect Waterstone to provide an updated survey as part of the report for TWDB contract number 2001-483-397.

[1] Pequod Associates Inc., Texas Industrial Water Use Efficiency Report, prepared for the Texas Water Development Board, October, 1993.

Attachment 3

ATTACHMENT 3: THE PERRYMAN GROUP'S RESPONSE TO COMMENTS FROM THE TWDB

January 20, 2003

TO: Wendy Cheung

FROM: Ray Perryman

SUBJECT: TWDB

As requested, I have examined the material that you provided. To assist you in the final report, I will offer a few observations. I will address the issues in the order they appeared in you memo.

As to the documentation, I provided a brief description of the modeling process (which is really more econometric than input-output in nature). I am attaching an Appendix which we include in our subscription forecast which provides more detail on the overall process.

With regard to the technological changes, no one knows with certainty that advances will be made over a period of five decades. We model the interaction of employment and output simultaneously with explicit technological factors in the system (a basic neo-classical growth function). This approach captures historical patterns in productivity (including changes in the rate of increase) in technological progress. Beyond that, the adjustment factors include input from significant participants in every major sector of the economy. This type of input is obtained by The Perryman Group on a regular basis as part of our standard forecasting practice (as has been the case for more than 20 years) and all information is provided on a confidential basis. Although we don't retain any work papers on these matters once a forecast cycle is completed, I feel very comfortable in saying that dozens of knowledgeable industry experts were consulted.

The scenarios were described to some extent earlier, but I will endeavor to be more descriptive. The high and low values used input variables from "high growth" and "low growth" national economic scenarios prepared by major national forecasting models. These exogenous variables were simulated to develop alternative forecasts by industry on a short-term basis. These results were tested for reasonableness and modified as necessary. The results were then extrapolated into the future, subject to constraints which limited their degree of variation to reasonable levels. Even modest variations, when expanded over 50 years, can produce widespread patterns in some sectors.

Finally, I'm not sure what I can add to my prior remarks about mining. I can only say that both the historical patterns and the current status of the mineral (oil and gas) sector would argue against extrapolating 50 years of history from two years of data. I would also again emphasize that, while mineral output in the form of barrels of oil extracted will decline due to geological factors, the gross product measure (and the implications for water use) will not decline proportionately. As activity occurs to replace depleted resources, it will require more resources per barrel than in earlier years (and the corresponding need for more water per barrel). I dare say that the large drops in gross product in the past two years (as measured on a constant dollar basis) did not bring a proportional drop in water requirements. As to the disagreement of our forecast with the Comptroller's, I am not certain of the approach used in those projections. We are normally, but not always, reasonably close. I can do no more than point to 25 years of experience, as well as the fact that I live in the Permian Basin, publish a quarterly newsletter directed exclusively to oil and gas, have most of the major oil companies as long-term clients, am an advisor to the US Department of Energy, and am extremely familiar with the oil and gas sector. Having said that, I would also add that there are certainly no guarantees associated with economic forecasts, particularly those spanning a half century in a highly volatile sector.

I hope that the information in this memo helps you to finalize the report.

TECHNICAL EXPLANATION

The models used in developing the Perryman Economic Forecast are formulated in an internally consistent manner and are designed to permit the integration of relevant global, national, state, and local factors into the projection process. They are the result of more than 20 years of continuing research in econometrics, economic theory, statistical methods, and key policy issues and behavioral patterns, as well as intensive, ongoing study of all aspects of the global, US, and Texas economies.

The remainder of this Technical Appendix describes the forecasting process in a comprehensive manner, focusing on both the modeling and the supplemental analysis. The overall methodology, while certainly not ensuring perfect foresight, permits an enormous body of relevant information to impact the economic outlook in a systematic manner.

Model Logic and Structure

The expanded version of the Texas Econometric Model, developed and maintained by The Perryman Group, revolves around a core system which projects output, income, and employment by industry in a simultaneous manner. For purposes of illustration, it is useful to initially consider the employment functions. Essentially, employment within the system is a derived demand relationship obtained from a neo-Classical production function. The expressions are augmented to include dynamic temporal adjustments to changes in relative factor input costs, output and (implicitly) productivity, and technological progress over time. Thus, the typical equation includes output, the relative real cost of labor and capital, dynamic lag structures, and a technological adjustment parameter. The functional form is logarithmic, thus preserving the theoretical consistency with the neo-Classical formulation.

The income segment of the model is divided into wage and non-wage components. The wage equations, like their employment counterparts, are individually estimated at the two-digit Standard Industrial Classification (SIC) level of aggregation. Hence, income by place of work is measured for approximately 70 distinct production categories. The wage equations measure real compensation, with the form of the variable structure differing between "basic" and "non-basic."

The basic industries, comprised primarily of the various components of Mining, Agriculture, and Manufacturing, are export-oriented, i.e., they bring external dollars into the area and form the core of the economy. The production of these sectors typically flows into national and international markets; hence, the labor markets are influenced by conditions in areas beyond the borders of the particular region. Thus, real (inflation-adjusted) wages in the basic industry are expressed as a function of the corresponding national rates, as well as measures of local labor market conditions (the reciprocal of the unemployment rate), dynamic adjustment parameters, and ongoing trends.

The "non-basic" sectors are somewhat different in nature, as the strength of their labor markets is linked to the health of the local export sectors. Consequently, wages in these industries are related to those in the basic segment of the economy. The relationship also includes the local labor market measures contained in the basic wage equations.

Note that compensation rates in the export or "basic" sectors provide a key element of the interaction of the regional economies with national and international market phenomena, while the "non-basic" or local industries are strongly impacted by area production levels. Given the wage and employment equations, multiplicative identities in each industry provide expressions for total compensation; these totals may then be aggregated to determine aggregate wage and salary income. Simple linkage equations are then estimated for the calculation of personal income by place of work.

The non-labor aspects of personal income are modeled at the regional level using straightforward empirical expressions relating to national performance, dynamic responses, and evolving temporal patterns. In some instances (such as dividends, rents, and others) national variables (for example, interest rates) directly enter the forecasting system. These factors have numerous other implicit linkages into the system resulting from their simultaneous interaction with other phenomena in national and international markets which are explicitly included in various expressions.

The output or gross area product expressions are also developed at the two-digit SIC level. Regional output for basic industries is linked to national performance in the relevant industries, local and national production in key related sectors, relative area and national labor costs in the industry, dynamic adjustment parameters, and ongoing changes in industrial interrelationships (driven by technological changes in production processes).

Output in the non-basic sectors is modeled as a function of basic production levels, output in related local support industries (if applicable), dynamic temporal adjustments, and ongoing patterns. The interindustry linkages are obtained from the input-output (impact assessment) system which is part of the overall integrated modeling structure maintained by The Perryman

Group. Note that the dominant component of the econometric system involves the simultaneous estimation and projection of output, income, and employment at a disaggregated industrial level.

Several other components of the model are critical to the multi-regional forecasting process. The demographic module includes (1) a linkage equation between wage and salary (establishment) employment and household employment, (2) a labor force participation rate function, and (3) a complete age-cohort-survival population system with endogenous migration. Given household employment, labor force participation (which is a function of economic conditions and evolving patterns of worker preferences), and the working age population (from the age-cohort-survival model), the unemployment rate and level become identities.

The population system uses Census information, fertility rates, and life tables to determine the "natural" changes in population by age group. Migration, the most difficult segment of population dynamics to track, is estimated in relation to relative regional and extra-regional economic conditions over time. Because evolving economic conditions determine migration in the system, population changes are allowed to interact simultaneously with overall economic conditions.

Retail sales is related to income, interest rates, dynamic adjustments, and patterns in consumer behavior on a store group basis. Inflation at the state level relates to national patterns, indicators of relative economic conditions, and ongoing trends.

A final significant segment of the forecasting system relates to real estate absorption and activity. The short-term demand for various types of property is determined by underlying economic and demographic factors, with short-term adjustments to reflect the current status of the pertinent building cycle. In some instances, this portion of the forecast requires integration with the Multi-Regional Industry-Occupation System which is maintained by The Perryman Group.

The overall Texas Econometric Model contains numerous additional specifications, and individual expressions are modified to reflect alternative lag structures, empirical properties of the estimates, simulation requirements, and similar phenomena. Nonetheless, the above synopsis offers a basic understanding of the overall structure and underlying logic of the system.

Model Simulation and Multi-Regional Structure

The initial phase of the simulation process is the execution of a standard non-linear algorithm for the state system and that of each of the individual sub-areas. The external assumptions are derived from scenarios developed through national and international models and extensive analysis by The Perryman Group.

Once the initial simulations are completed, they are merged into a single system with additive constraints and interregional flows. Using information on minimum regional requirements, import needs, export potential, and locations, it becomes possible to balance the various forecasts into a mathematically consistent set of results. This process is, in effect, a disciplining exercise with regard to the individual regional (including metropolitan and rural) systems. By compelling equilibrium across all regions and sectors, the algorithm ensures that the patterns in state activity are reasonable in light of smaller area dynamics and, conversely, that the regional outlooks are within plausible performance levels for the state as a whole.

The iterative simulation process has the additional property of imposing a global convergence criterion across the entire multi-regional system, with balance being achieved simultaneously on both a sectoral and a geographic basis. This approach is particularly critical on non-linear dynamic systems, as independent simulations of individual systems often yield unstable, non-convergent outcomes.

It should be noted that the underlying data for the modeling and simulation process are frequently updated and revised by the various public and private entities compiling them. Whenever those modifications to the database occur, they bring corresponding changes to the structural parameter estimates of the various systems and the solutions to the simulation and forecasting system. The multi-regional version of the Texas Econometric Model is automatically re-estimated and simulated with each such data release, thus providing a constantly evolving and current assessment of state and local business activity.

The Final Forecast

The process described above is followed to produce the preliminary forecast. Through the comprehensive multi-regional modeling and simulation process, a systematic analysis is generated which accounts for both historical patterns in economic performance and inter-relationships and best available information on the future course of pertinent external factors. While the best available techniques and data are employed in this effort, they are not capable of directly capturing "street sense," i.e., the contemporaneous and often non-quantifiable information that can materially affect economic outcomes. In order to provide a comprehensive approach to the prediction of business conditions, it is necessary to compile and assimilate extensive material regarding "what's happenin'" both across the state of Texas and elsewhere.

This critical aspect of the forecasting methodology includes activities such as (1) daily review of hundreds of financial and business publications and electronic information sites; (2) review of all major newspapers in the state on a daily basis; (3) dozens of hours of direct telephone interviews with key business and political leaders in all parts of the state; (4) face-to-face discussions with representatives of major industry groups; and (5) frequent site visits to the various regions of the state. The insights arising from this "fact finding" are analyzed and evaluated for their effects on the likely course of the future activity.

Another vital information resource stems from the firm's ongoing interaction with key players in the international, domestic, and state economic scenes. Such activities include visiting with corporate groups on a regular basis and being regularly involved in the policy process at all levels. The firm is also an active participant in many major corporate relocations, economic development initiatives, and regulatory proceedings.

Once organized, this information is carefully assessed and, when appropriate, independently verified. The impact on specific communities and sectors that is distinct from what is captured by the econometric system is then factored into the forecast analysis. For example, the opening or closing of a major facility, particularly in a relatively small area, can cause a sudden change in business performance that will not be accounted for by either a modeling system based on historical relationships or expected (primarily national and international) factors.

The final step in the forecasting process is the integration of this material into the results in a logical and mathematically consistent manner. In some instances, this task is accomplished through "constant adjustment factors" which augment relevant equations. In other cases, anticipated changes in industrial structure or regulatory parameters are initially simulated within the context of the Texas Multi-Regional Impact Assessment System to estimate their ultimate effects by sector. Those findings are then factored into the simulation as constant adjustments on a distributed temporal basis. Once this scenario is formulated, the extended system is again balanced across regions and sectors through an iterative simulation algorithm analogous to that described in the preceding section.

There are those who maintain that the best forecasts are generated by complex models that capture the interactive forces that drive economic activity. There are others who claim that the optimal approach is to rely on the informed judgment of those who are involved in the process. On this issue, I stand firmly in the middle. I have long held that well-developed models are invaluable tools. They impose logic and consistency on millions of interrelated phenomena and, when properly structured, provide key insights into the ways in which changes in part of the economy work through the entire system. On the other hand, I realize that the knowledge on the streets (both Main and Wall) is equally essential to reliable forecasting. I view my mission for my clients and subscribers as providing the best information I possibly can. I can only do that by combining the two approaches.

As much as some of my colleagues in the quantitative world hate to admit it, there is an irrefutable rationale in statistical theory for using judgmental, non-quantitative information in the preparation of forecasts. Specifically, the desirable property of statistical efficiency (minimum variance) can only be achieved if a prior condition, known as statistical sufficiency, is satisfied. Statistical sufficiency, in turn, requires that all relevant information be used, be it an economic time series published by a government agency or the thoughts and insights of a local building contractor. It's really pretty simple: the more relevant the information, the better the forecast.

Synopsis

No forecasting technique is perfect. There are no guarantees. Wars, assassinations, natural disasters, technological breakthroughs, and countless other factors can alter the course of the economy in a heartbeat. Subtle changes in the underlying structure of the economy may not be perceptible in the data for decades, and the future policy environment is anything but certain. Consumer and business expectations can shift with the wind, responding to things far removed from local conditions. At The Perryman Group, we don't promise perfect forecasts. To do so would be patently foolish. We do pledge, however, to use the best information and systems available to provide a reasonable, rational picture of the future course of economic activity. Our expanded modeling systems reflect this commitment which has been consistent and unyielding over the course of the past two decades.

Attachment 4

ATTACHMENT 4: THE PERRYMAN GROUP'S RESPONSE TO DISCREPANCIES REPORTED BY THE TWDB TO WATERSTONE DURING DECEMBER 2002.

December 9, 2002
Via email: barth@waterstoneinc.com
TO: Gil Barth, Waterstone, Inc.
FROM: Ray Perryman
SUBJECT: Mining Forecast

As requested, I have prepared this memo to discuss the mining forecast prepared as part of the project for the Texas Water Development Board (TWDB). At the time we prepared this forecast in accordance with the project schedule, the gross state product data release from the US Department of Commerce was only available through 1999 (with preliminary estimates for 2000). This release showed a 1999 value of $43.1 billion and at 2000 estimate of 45.1 billion for real gross product in mining. The subsequent release (after the projections were submitted) showed values of $37.6 billion and $29.9 billion for 1999 and 2000, respectively. These rather sizable revisions in the historical series (which mostly reflect the way price indices are constructed for this series) has evidently led to some confusion regarding the forecast.

Let me begin by saying that the estimates are in constant 1996 dollars. Any confusion in that point evidently stems from two sources. First, the 1990 values for real ($39.7 billion) and nominal ($39.6 billion) gross product in mining are very similar. This fact reflects nothing more the fact that 1990 prices were very close to 1996 prices (the deflator for 1990 was close to 1). Second, new nominal (current dollar) gross product value of $46.2 billion in 2000 is actually closer in magnitude to the prior estimate of real gross product for 2000 ($45.1 billion) than is the new 2000 value for real output ($29.9 billion). In reality, all measures in the forecast are in real (1996 dollars) terms.

Second, you raised a concern that, because real output has fallen for the past two years, you evidently feel that it should decline for the next five decades. All I can do is respectfully disagree and perhaps provide some perspective. First, it is true that mining production (primarily oil and gas in Texas) has decline for the past 30 years <u>as measured in terms of barrels-of-oil equivalents</u>. This pattern is indeed likely to persist, more as a matter if geology than anything else. That is <u>not</u> the same thing, however, as saying that gross product as measured on a national income accounting basis is declining. Gross product is essentially value-added (output value less costs of purchased goods and services inputs). As oilfields age, it takes more effort (such as labor inputs) to extract minerals. Thus, the same number of barrels will often be associated with more gross product. Because secondary recovery methods often result in higher levels of water use per barrel of extraction, gross product would seem to be a superior measure for water planning analysis.

Second, it is quite inappropriate to extrapolate 50 years into the future based on 2 years of history. Over the past 30 years of declines in barrels of production, real gross product in mining has gone up 17 years and down 13 years. The vast majority of the changes in direction occurred after one or two years, with a five-year positive trend being the longest. Moreover, preliminary values for 2001 and 2002 indicate that the negative pattern in 1999 and 2000 has already been reversed.

If you wish to make a calibration adjustment to reflect the 2000 revision, I would suggest that you do so using ratios of our state baseline forecast based on the most recent data release. The ratio of the "new" to the "old" values for each decade is given below:

2000	0.6626
2010	0.6458
2020	0.6557
2030	0.6655
2040	0.6754
2050	0.6854

If you have additional questions, please let me know.