STATE OF TEXAS TWDB Contract No.1600011921

COUNTY OF TRAVIS General Revenue

CDM SMITH, INC.

This Contract, (hereinafter "CONTRACT"), between the Texas Water Development Board (hereinafter "TWDB") and CDM Smith (hereinafter "CONTRACTOR"), is composed of two parts, SECTION I. SPECIFIC CONDITIONS AND EXCEPTIONS TO THE STANDARD AGREEMENT and SECTION II. STANDARD AGREEMENT. The terms and conditions set forth in SECTION I will take precedence over terms and conditions in SECTION II.

SECTION I. SPECIFIC CONDITIONS AND EXCEPTIONS TO STANDARD AGREEMENT

ARTICLE I. DEFINITIONS

For the purposes of this CONTRACT, the following terms or phrases shall have the meaning ascribed therewith:

1. TWDB – The Texas Water Development Board, or its designated representative

2. CONTRACTOR CDM Smith, Inc.

3. EXECUTIVE ADMINISTRATOR – The Executive Administrator of the TWDB or a designated representative

4. PARTICIPANT(S)- N/A

5. REQUIRED INTERLOCAL AGREEMENT(S) – N/A

6. RESEARCH PROJECT – Services to evaluate and propose methodologies to project three water demand categories, irrigation, steam electric and manufacturing.

7. DEADLINE FOR CONTRACT EXECUTION – January 31, 2016

8. CONTRACT INITIATION DATE – December 1, 2015

9. STUDY COMPLETION DATE – April 30, 2016

10. CONTRACT EXPIRATION DATE – August 30, 2016

11. TOTAL STUDY COSTS – $30,000.00

12. TWDB SHARE OF THE TOTAL STUDY COSTS – the lesser of $30,000.00 or 100 percent of the total study costs or individual payment submission

13. LOCAL SHARE OF THE TOTAL STUDY COSTS – $0.00 in cash or 0 percent of the total study costs or individual payment submission

14. PAYMENT SUBMISSION SCHEDULE – Monthly

15. OTHER SPECIAL CONDITIONS AND EXCEPTIONS TO STANDARD AGREEMENT OF THIS CONTRACT – N/A

SECTION II. STANDARD AGREEMENT

ARTICLE I. RECITALS

Whereas, the TWDB considered providing the CONTRACTOR a grant to conduct a RESEARCH PROJECT;

Whereas, the CONTRACTOR and PARTICIPANT will commit the LOCAL SHARE OF THE TOTAL STUDY COSTS, if applicable, in cash and/or in-kind services to pay for the LOCAL SHARE OF THE TOTAL STUDY COSTS of this RESEARCH PROJECT;

Whereas, the CONTRACTOR is the entity who will act as administrator of the TWDB's research grant and will be responsible for the execution of this contract;

Now, therefore, the TWDB and the CONTRACTOR, agree as follows:

ARTICLE II. PROJECT DESCRIPTION AND SERVICES TO BE PERFORMED

1. The TWDB enters into this CONTRACT pursuant to Water Code §§11.1491 and 16.058 as appropriate; Exhibit A, the original Statement of Qualifications, which is incorporated herein and made a permanent part of this CONTRACT; and this CONTRACT.

2. The CONTRACTOR will conduct a RESEARCH PROJECT, according to the Scope of Work contained in Exhibit B.

3. A progress report, including results to date, will be provided to the EXECUTIVE ADMINISTRATOR monthly throughout the project. Special interim reports on special topics and/or results will be provided as appropriate. Instructions for the progress report are shown in Exhibit E, TWDB Guidelines for a Progress Report.

ARTICLE III. CONTRACT TERM, SCHEDULE, REPORTS, AND OTHER PRODUCTS

1. The CONTRACTOR has until the DEADLINE FOR CONTRACT EXECUTION to execute this CONTRACT and to provide acceptable evidence of any REQUIRED INTERLOCAL AGREEMENT(S) and the Contractors' ability to provide the LOCAL SHARE OF THE TOTAL STUDY COSTS, if applicable, to the EXECUTIVE ADMINISTRATOR for approval or the TWDB's SHARE OF THE TOTAL STUDY COSTS will be rescinded.

2. The term of this CONTRACT shall begin and the CONTRACTOR shall begin performing its obligations hereunder on the CONTRACT INITIATION DATE and shall expire on the CONTRACT EXPIRATION DATE. Delivery of an acceptable

shall expire on the CONTRACT EXPIRATION DATE. Delivery of an acceptable final report prior to the CONTRACT EXPIRATION DATE shall constitute completion of the terms of this CONTRACT.

3. The CONTRACTOR will complete the Scope of Work and will deliver seven (7) double- sided copies of a draft final report to the EXECUTIVE ADMINISTRATOR no later than the STUDY COMPLETION DATE. The draft final report will include the scope of work; a description of the research performed; the methodology and materials used; any diagrams or graphics used to explain the procedures related to the study; any data collected; an electronic copy of any computer programs, maps, or models along with an operations manual and any sample data set(s) developed under the terms of this CONTRACT; analysis of the research results; conclusions and recommendations; a list of references, a Table of Contents, List of Figures, List of Tables, an Executive Summary, and any other pertinent information. All final reports should be prepared according to Exhibit D, Guidelines for Authors Submitting Contract Reports to the Texas Water Development Board. After a 30-day review period, the EXECUTIVE ADMINISTRATOR will return review comments to the CONTRACTOR.

4. The CONTRACTOR will consider incorporating comments from the EXECUTIVE ADMINISTRATOR and other commentors on the draft final report into a final report. The CONTRACTOR will include a copy of the EXECUTIVE ADMINISTRATOR's comments in the final report. The CONTRACTOR will submit one (1) electronic copy of the entire final report in Portable Document Format (PDF) and seven (7) bound double- sided copies of the final report to the EXECUTIVE ADMINISTRATOR no later than the sixty days (60) after the STUDY COMPLETION DATE.

   The CONTRACTOR will submit one (1) electronic copy of any computer programs or models and an operations manual developed under the terms of this CONTRACT. In compliance with Texas Administrative Code Chapters 206 and 213 (related to Accessibility and Usability of State Web Sites), the digital copy of the final report will comply with the requirements and standards specified in statute. After a 30-day review period, the EXECUTIVE ADMINISTRATOR will either accept or reject the final report. If the final report is rejected, the rejection letter sent to the CONTRACTOR shall state the reasons for rejection and the steps the CONTRACTOR need to take to have the final report accepted and the retainage released.

5. The CONTRACTOR will submit the most recent progress report with submittal of payments according to the PAYMENT SUBMISSION SCHEDULE. Progress reports shall be in written form and shall include a brief statement of the overall progress made since the last status report; a brief description of any problems that have been encountered during the previous reporting period that will affect the study, delay the timely completion of any portion of this CONTRACT, inhibit the completion of or cause a change in any of the study's products or objectives; and a description of any action the CONTRACTOR plans to take to correct any problems that have been encountered.

6. The EXECUTIVE ADMINISTRATOR can extend the STUDY COMPLETION DATE and the CONTRACT EXPIRATION DATE upon written approval. The CONTRACTOR should notify the EXECUTIVE ADMINISTRATOR in writing within ten (10) working days prior to the STUDY COMPLETION DATE or thirty (30) days prior to the CONTRACT EXPIRATION DATE that the CONTRACTOR is requesting an extension to the respective dates.

ARTICLE IV. COMPENSATION AND REIMBURSEMENT

1. The TWDB agrees to compensate and reimburse the CONTRACTOR in a total amount not to exceed the TWDB's SHARE OF THE TOTAL STUDY COSTS for costs incurred and paid by the CONTRACTOR pursuant to performance of this CONTRACT. The CONTRACTOR will contribute local matching funds, if applicable, in sources and amounts defined as the LOCAL SHARE OF THE TOTAL STUDY COSTS. The TWDB shall reimburse the CONTRACTOR for one hundred percent (100%) of the TWDB's share of each invoice pending the CONTRACTOR's performance up to ninety percent (90%) of the total funding costs. Upon completion of a Final Report, and written acceptance of said Final Report by the EXECUTIVE ADMINISTRATOR, the TWDB shall pay the remaining ten percent (10%) to the CONTRACTOR upon submission of a final invoice.

2. The CONTRACTOR shall submit payments and documentation for reimbursement billing according to the PAYMENT SUBMISSION SCHEDULE and in accordance with the approved task and expense budgets contained in Exhibit C to this CONTRACT. The CONTRACTOR has budget flexibility within task and expense budget categories to the extent that the resulting change in amount in any one task or expense category does not exceed 35% of the total authorized amount by this CONTRACT for the task or category. Larger deviations shall require approval by EXECUTIVE ADMINISTRATOR or designee which will be documented through an Approved Budget Memorandum to the TWDB contract file. The CONTRACTOR will be required to provide written explanation for the overage and reallocation of the task and expense amount.
   For all reimbursement billings including any subcontractor's expenses, the EXECUTIVE ADMINISTRATOR must have determined that the REQUIRED INTERLOCAL AGREEMENT(S) and contracts or agreements between the CONTRACTOR and the subcontractor are consistent with the terms of this CONTRACT. The CONTRACTOR is fully responsible for paying all charges by subcontractors prior to reimbursement by the TWDB.

3. The CONTRACTOR and its subcontractors shall maintain satisfactory financial accounting documents and records, including copies of invoices and receipts, and shall make them available for examination and audit by the EXECUTIVE ADMINISTRATOR. Accounting by the CONTRACTOR and its subcontractors shall be in a manner consistent with Generally Accepted Accounting Principles.

4. By executing this CONTRACT, the CONTRACTOR accepts the authority of the State Auditor's Office, under direction of the legislative audit committee, to conduct audits and investigations in connection with any and all state funds received pursuant to this contract. The CONTRACTOR shall comply with and cooperate in any such investigation or audit. The CONTRACTOR agrees to provide the State Auditor with access to any information the State Auditor considers relevant to the investigation or audit. The CONTRACTOR also agrees to include a provision in any subcontract related to this contract that requires the subcontractor to submit to audits and investigation by the State Auditor's Office in connection with any and all state funds received pursuant to the subcontract.

5. The CONTRACTOR shall submit a progress report as described in Article II, Item 3 and the following documentation which documents the TOTAL STUDY COSTS for the reporting period even if the TOTAL STUDY COSTS is zero for reimbursement by the TWDB to the CONTRACTOR for the TWDB's SHARE OF THE TOTAL STUDY COSTS shall be submitted by the CONTRACTOR to the EXECUTIVE ADMINISTRATOR for reimbursement billing:

   A. Completed and Signed Payment Request Checklist which includes the following:
      (1) TWDB CONTRACT Number;
      (2) Billing period; beginning (date) to ending date;
      (3) Total Expenses for this period;
      (4) Total In-kind services;
      (5) Less LOCAL SHARE OF THE TOTAL STUDY COSTS for the billing period;
      (6) Total TWDB's SHARE OF THE TOTAL STUDY COSTS for the billing period;
      (7) Amount of retainage to be withheld for the billing period;
      (8) Total costs to be reimbursed by the TWDB for the billing period; and
      (9) Certification, signed by the CONTRACTOR's authorized representative, that the expenses submitted for the billing period are a true and correct representation of amounts paid for work performed directly related to this contract.

   B. For direct expenses incurred by the CONTRACTOR other than subcontracted work:
      (1) A spreadsheet showing the tasks that were performed; the percent and cost of each task completed; a total cost figure for each direct expense category including labor, fringe, overhead, travel, and other expenses such as communication and postage, technical and computer services, expendable supplies, printing and reproduction; and
      (2) Copies of detailed, itemized invoices/receipts for other expenses (credit card summary receipts or statements are not acceptable)

C. For direct expenses incurred by the CONTRACTOR for subcontracted work:
   (1) Copies of invoices from the subcontractors to the CONTRACTOR;
   (2) A spreadsheet showing the tasks that were performed; the percent and cost of each task completed; a total cost figure for each direct expense category including labor, fringe, overhead, travel, and other expenses such as communication and postage, technical and computer services, expendable supplies, printing and reproduction; and the total dollar amount due to the consultant; and
   (3) Copies of detailed, itemized invoices/receipts for other expenses (credit card summary receipts or statements are not acceptable)

D. For travel expenses for the CONTRACTOR and/or subcontractor(s) –
   (1) Names, dates, work locations, time periods at work locations, itemization of subsistence expenses of each employee, limited, however, to travel expenses authorized for state employees by the General Appropriations Act, Tex. Leg. Regular Session, 2013, Article IX, Part 5, as amended or superceded. Receipts required for lodging;
   (2) Copies of invoices or tickets for transportation costs or, if not available, names, dates, and points of travel of individuals; and
   (3) All other reimbursable travel expenses -- invoices or purchase vouchers showing reason for expense with receipts to evidence the amount incurred.

6. Incomplete requests will be returned to the CONTRACTOR if deficiencies are not resolved within ten (10) business days.

7. If for some reason the reimbursement request cannot be processed due to the need for an amendment to the CONTRACT, the CONTRACTOR will be required to resubmit the Payment Request Checklist dated after the execution of the amendment.

8. The CONTRACTOR is responsible for any food or entertainment expenses incurred by its own organization or that of its subcontractors, outside that of the travel expenses authorized and approved by the State of Texas under this CONTRACT.

ARTICLE V. INTELLECTUAL PROPERTY: OWNERSHIP, PUBLICATION, AND ACKNOWLEDGMENT

1. "Use" of a work product, whether a CONTRACTOR Works, a Subcontractor Works or otherwise, shall mean and include, without limitation hereby, any lawful use, copying or dissemination of the work product, or any lawful development, use, copying or dissemination of derivative works of the work product, in any media or

forms, whether now known or later existing.

2. "No Compensation Obligation" shall mean there is no obligation on the part of one co- owner or licensee of a work, whether a CONTRACTOR Works, a Subcontractor Works or otherwise, to compensate other co-owners, licensees or licensors of the work for any use of the work by the using co-owner or licensee, including but not limited to compensation for or in the form of: royalties; co-owner or licensee accounting; sharing of revenues or profits among co-owners, licensees or licensors; or any other form of compensation to the other co-owners, licensees or licensors on account of any use of the work.

3. "Dissemination" shall include, without limitation hereby, any and all manner of: physical distribution; publication; broadcast; electronic transmission; internet streaming; posting on the Internet or world wide web; or any other form of communication, transmission, distribution, sending or providing, in any forms or formats, and in or using any media, whether now known or later existing.

4. The TWDB shall have an unlimited, unrestricted, perpetual, irrevocable, non-exclusive royalty-free right to access and receive in usable form and format, and to use all technical or other data or information developed by CONTRACTOR and Subcontractor in, or otherwise resulting from, the performance of services under this CONTRACT.

5. For purposes of this Article, "CONTRACTOR Works" are work products developed by CONTRACTOR and Subcontractor using funds provided under this CONTRACT or otherwise rendered in or related to the performance in whole or part of this CONTRACT, including but not limited to reports, drafts of reports, or other material, data, drawings, studies, analyses, notes, plans, computer programs and codes, or other work products, whether final or intermediate.

   a. It is agreed that all CONTRACTOR Works shall be the joint property of the TWDB and CONTRACTOR.

   b. The parties hereby agree that, if recognized as such by applicable law, the CONTRACTOR Works are intended to and shall be works-made-for-hire with joint ownership between the TWDB and CONTRACTOR as such works are created in whole or part.

   c. If the CONTRACTOR Works do not qualify as works-made-for-hire under applicable law, CONTRACTOR hereby conveys co-ownership of such works to the TWDB as they are created in whole or part. If present conveyance is ineffective under applicable law, CONTRACTOR agree to convey a co-ownership interest of the CONTRACTOR Works to the TWDB after creation in whole or part of such works, and to provide written documentation of such conveyance upon request by the TWDB.

d. The TWDB and CONTRACTOR acknowledge that the copyright in and to a copyrightable CONTRACTOR Work subsists upon creation of the CONTRACTOR Work and its fixing in any tangible medium. CONTRACTOR or the TWDB may register the copyrights to such Works jointly in the names of the CONTRACTOR and the TWDB.

e. The TWDB and CONTRACTOR each shall have full and unrestricted rights to use a CONTRACTOR Work with No Compensation Obligation.

6. For purposes of this Article, "Subcontractor Works" include all work product developed in whole or part by or on behalf of Subcontractors engaged by CONTRACTOR to perform work for or on behalf of any CONTRACTOR under this CONTRACT (or by the Subcontractors' Subcontractors hereunder, and so on). CONTRACTOR shall secure in writing from any Subcontractors so engaged:

a. unlimited, unrestricted, perpetual, irrevocable, royalty-free rights of the TWDB (and, if desired, of CONTRACTOR) to access and receive, and to use, any and all technical or other data or information developed in or resulting from the performance of services under such engagement, with No Compensation Obligation; and either

b. assignment by the Subcontractor to the TWDB (and, if desired by them, jointly to the CONTRACTOR) of ownership (or joint ownership with the Subcontractor) of all Subcontractor Works, with No Compensation Obligation; or

c. grant by Subcontractor of a non-exclusive, unrestricted, unlimited, perpetual, irrevocable, world-wide, royalty-free license to the TWDB (and, if desired by them, the CONTRACTOR) to use any and all Subcontractor Works, including the right to sublicense use to third parties, with No Compensation Obligation.

7. No unauthorized patents. CONTRACTOR Works and Subcontractor Works or other work product developed or created in the performance of this CONTRACT or otherwise using funds provided hereunder shall not be patented by CONTRACTOR or their Subcontractor unless the EXECUTIVE ADMINISTRATOR consents in writing to submission of an application for patent on such works; and provided that, unless otherwise agreed in writing, any application made for patent shall include and name the TWDB (and, as applicable and desired by them, CONTRACTOR) as co-owners of the patented work:

a. no patent granted shall in any way limit, or be used by CONTRACTOR or Subcontractor to limit or bar the TWDB's rights hereunder to access and receive in useable form and format, and right to use, any and all technical or

other data or information developed in or resulting from performance pursuant to this CONTRACT or the use of funds provided hereunder; and

b. the TWDB (and, if applicable, the CONTRACTOR) shall have No Compensation Obligation to any other co-owners or licensees of any such patented work, unless otherwise expressly agreed in writing.

8. CONTRACTOR shall include terms and conditions in all contracts or other engagement agreements with any Subcontractors as are necessary to secure these rights and protections for the TWDB; and shall require that their Subcontractors include similar such terms and conditions in any contracts or other engagements with their Subcontractors. For the purposes of this section, "Subcontractors" includes independent contractors (including consultants) and also employees working outside the course and scope of employment.

9. Any work products subject to a TWDB copyright or joint copyright and produced or developed by the CONTRACTOR or their Subcontractor pursuant to this CONTRACT or using any funding provided by the TWDB may be reproduced in any media, forms or formats by the TWDB or CONTRACTOR at their own cost, and be disseminated in any medium, format or form by any party at its sole cost and in its sole discretion. CONTRACTOR may utilize such work products as they may deem appropriate, including Dissemination of such work products or parts thereof under their own name, provided that any TWDB copyright is noted on the materials.

10. The CONTRACTOR agrees to acknowledge the TWDB in any news releases or other publications relating to the work performed under this CONTRACT.

ARTICLE VI. AMENDMENT, TERMINATION, AND STOP ORDERS

1. This CONTRACT may be altered or amended by mutual written consent or terminated by the EXECUTIVE ADMINISTRATOR at any time by written notice to the CONTRACTOR. Upon receipt of such termination notice, the CONTRACTOR shall, unless the notice directs otherwise, immediately discontinue all work in connection with the performance of this CONTRACT and shall proceed to cancel promptly all existing orders insofar as such orders are chargeable to this CONTRACT. The CONTRACTOR shall submit a statement showing in detail the work performed under this CONTRACT to the date of termination. The TWDB shall then pay the CONTRACTOR promptly that proportion of the prescribed fee, which applies to the work, actually performed under this CONTRACT, less all payments that have been previously made. Thereupon, copies of all work accomplished under this CONTRACT shall be delivered to the TWDB.

2. The EXECUTIVE ADMINISTRATOR may issue a Stop Work Order to the CONTRACTOR at any time. Upon receipt of such order, the CONTRACTOR shall discontinue all work under this CONTRACT and cancel all orders pursuant to

this CONTRACT, unless the order directs otherwise. If the EXECUTIVE ADMINISTRATOR does not issue a Restart Order within 60 days after receipt by the CONTRACTOR of the Stop Work Order, the CONTRACTOR shall regard this CONTRACT terminated in accordance with the foregoing provisions.

ARTICLE VII. SUBCONTRACTS

Each Subcontract entered into to perform required work under this CONTRACT shall contain the following provisions:

a. a detailed budget estimate with specific cost details for each task or specific item of work to be performed by the Subcontractor and for each category of reimbursable expenses;

b. a clause stating that the Subcontract is subject to audit by the Texas State Auditor's Office and requiring the Subcontractor to cooperate with any request for information from the Texas State Auditor, as further described in Article X, Section 1, Paragraph D hereof;

c. a clause stating that payments under the Subcontract are contingent upon the appropriation of funds by the Texas Legislature, as further described in Article X, Section 1, Paragraph A hereof;

d. a clause stating that ownership of data, materials and work papers, in any media, that is gathered, compiled, adapted for use, or generated by the Subcontractor or the CONTRACTOR shall become data, materials and work owned by the TWDB and that Subcontractor shall have no proprietary rights in such data, materials and work papers, except as further described in Article V hereof;

e. a clause stating that Subcontractor shall keep timely and accurate books and records of accounts according to generally acceptable accounting principles as further described in Article X, Section 2, Paragraph G;

f. a clause stating that Subcontractor is solely responsible for securing all required licenses and permits from local, state and federal governmental entities and that Subcontractor is solely responsible for obtaining sufficient insurance in accordance with the general standards and practices of the industry or governmental entity; and

g. a clause stating that Subcontractor is an independent contractor and that the TWDB shall have no liability resulting from any failure of Subcontractor that results in breach of CONTRACT, property damage, personal injury or death.

ARTICLE VIII. LICENSES, PERMIT, AND INSURANCE

1. For the purpose of this CONTRACT, the CONTRACTOR will be considered an independent contractor and therefore solely responsible for liability resulting from negligent acts or omissions. The CONTRACTOR shall obtain all necessary insurance, in the judgment of the CONTRACTOR, to protect themselves, the TWDB, and employees and officials of the TWDB from liability arising out of this CONTRACT.

2. The CONTRACTOR shall be solely and entirely responsible for procuring all appropriate licenses and permits, which may be required by any competent authority for the CONTRACTOR to perform the subject work.

3. Indemnification. The CONTRACTOR shall indemnify and hold the TWDB and the State of Texas harmless, to the extent the CONTRACTOR may do so in accordance with state law, from any and all losses, damages, liability, or claims therefore, on account of personal injury, death, or property damage of any nature whatsoever caused by the CONTRACTOR, caused by or resulting from the negligent acts, errors, or omissions of the CONTRACTOR in its performance of the activities and work conducted pursuant to this CONTRACT. The CONTRACTOR is solely responsible for liability arising out of its negligent acts or omissions during the performance of this CONTRACT.

ARTICLE IX. SEVERANCE PROVISIONS

Should any one or more provisions of this CONTRACT be held to be null, void, voidable, or for any reason whatsoever, of no force and effect, such provision(s) shall be construed as severable from the remainder of this CONTRACT and shall not affect the validity of all other provisions of this CONTRACT which shall remain of full force and effect.

ARTICLE X. GENERAL TERMS AND CONDITIONS

1. GENERAL TERMS.

   a. No Debt Against the State. This CONTRACT does not create any debt by or on behalf of the State of Texas and the TWDB. The TWDB's obligations under this CONTRACT are contingent upon the availability of appropriated funds and the continued legal authority of the TWDB to enter into this CONTRACT.

   b. Independent Contractor. Both parties hereto, in the performance of this contract, shall act in an individual capacity and not as agents, employees, partners, joint ventures or associates of one another. The employees or agents of one party shall not be deemed or construed to be the employees or agents of the other party for any purposes whatsoever.

   c. Procurement Laws. The CONTRACTOR shall comply with applicable State

of Texas procurement laws, rules and policies, including but not limited to competitive bidding and the Professional Services Procurement Act, Government Code, Chapter 2254, relating to contracting with persons whose services are within the scope of practice of: accountants, architects, landscape architects, land surveyors, medical doctors, optometrists, professional engineers, real estate appraisers, professional nurses, and certified public accountants.

d. Right to Audit. The CONTRACTOR and its Subcontractors shall maintain all financial accounting documents and records, including copies of all invoices and receipts for expenditures, relating to the work under this CONTRACT. CONTRACTOR shall make such documents and records available for examination and audit by the EXECUTIVE ADMINISTRATOR or any other authorized entity of the State of Texas. CONTRACTOR'S financial accounting documents and records shall be kept and maintained in accordance with generally accepted accounting principles. By executing this CONTRACT, the CONTRACTOR accepts the authority of the Texas State Auditor's Office to conduct audits and investigations in connection with all state funds received pursuant to this CONTRACT. The CONTRACTOR shall comply with directives from the Texas State Auditor and shall cooperate in any such investigation or audit. The CONTRACTOR agrees to provide the Texas State Auditor with access to any information the Texas State Auditor considers relevant to the investigation or audit. The CONTRACTOR also agrees to include a provision in any Subcontract related to this CONTRACT that requires the Subcontractor to submit to audits and investigation by the State Auditor's Office in connection with all state funds received pursuant to the Subcontract.

e. Force Majeure. Unless otherwise provided, neither CONTRACTOR nor the TWDB nor any agency of the State of Texas, shall be liable to the other for any delay in, or failure of performance, of a requirement contained in this CONTRACT caused by force majeure. The existence of such causes of delay or failure shall extend the period of performance until after the causes of delay or failure have been removed provided the non-performing party exercises all reasonable due diligence to perform. Force majeure is defined as acts of God, war, strike, fires, explosions, or other causes that are beyond the reasonable control of either party and that by exercise of due foresight such party could not reasonably have been expected to avoid, and which, by the exercise of all reasonable due diligence, such party is unable to overcome. Each party must inform the other in writing with proof of receipt within two (2) business days of the existence of such force majeure or otherwise waive this right as a defense.

2. STANDARDS OF PERFORMANCE.

a. Personnel. CONTRACTOR shall assign only qualified personnel to perform the services required under this CONTRACT. CONTRACTOR shall be responsible for ensuring that any Subcontractor utilized shall also assign only qualified personnel. Qualified personnel are persons who are properly licensed to perform the work and who have sufficient knowledge, skills and ability to perform the tasks and services required herein according to the standards of performance and care for their trade or profession.

b. Professional Standards. CONTRACTOR shall provide the services and deliverables in accordance with applicable professional standards. CONTRACTOR represents and warrants that he is authorized to acquire Subcontractors with the requisite qualifications, experience, personnel and other resources to perform in the manner required by this CONTRACT.

c. Antitrust. CONTRACTOR represents and warrants that neither CONTRACTOR nor any firm, corporation, partnership, or institution represented by CONTRACTOR, or anyone acting for such firm, corporation, partnership, or institution has (1) violated the antitrust laws of the State of Texas under the Texas Business & Commerce Code, Chapter 15, of the federal antitrust laws; or (2) communicated directly or indirectly the proposal resulting in this CONTRACT to any competitor or other person engaged in such line of business during the procurement process for this CONTRACT.

d. Conflict of Interest. CONTRACTOR represents and warrants that CONTRACTOR has no actual or potential conflicts of interest in providing the deliverables required by this CONTRACT to the State of Texas and the TWDB. CONTRACTOR represents that the provision of services under this CONTRACT will not create an appearance of impropriety. CONTRACTOR also represents and warrants that, during the term of this CONTRACT, CONTRACTOR will immediately notify the TWDB, in writing, of any potential conflict of interest that could adversely affect the TWDB by creating the appearance of a conflict of interest.

CONTRACTOR represents and warrants that neither CONTRACTOR nor any person or entity that will participate financially in this CONTRACT has received compensation from the TWDB or any agency of the State of Texas for participation in the preparation of specifications for this CONTRACT. CONTRACTOR represents and warrants that he has not given, offered to give, and does not intend to give at any time hereafter, any economic opportunity, future employment, gift, loan, gratuity, special discount, trip, favor or service to any public servant in connection with this CONTRACT.

e. Proprietary and Confidential Information. CONTRACTOR warrants and represents that any information that is proprietary or confidential, and is received by CONTRACTOR from the TWDB or any governmental entity, shall not be disclosed to third parties without the written consent of the TWDB or applicable governmental entity, whose consent shall not be unreasonably withheld.

f. Public Information Act. CONTRACTOR acknowledges and agrees that all documents, in any media, generated in the performance of work conducted under this CONTRACT are subject to public disclosure under the Public Information Act, Government Code, Chapter 552. CONTRACTOR shall produce all documents upon request of the TWDB within two (2) business days when the documents are required to comply with a request for information under the Public Information Act.

g. Accurate and Timely Record Keeping. CONTRACTOR warrants and represents that he will keep timely, accurate and honest books and records relating to the work performed and the payments received under this CONTRACT according to generally accepted accounting standards. Further, CONTRACTOR agrees that he will create such books and records at or about the time the transaction reflected in the books and records occurs.

h. Dispute Resolution. The CONTRACTOR and the TWDB agree to make a good faith effort to resolve any dispute relating to the work required under this CONTRACT through negotiation and mediation as provided by Government Code, Chapter 2260 relating to resolution of certain contract claims against the state. The CONTRACTOR and the TWDB further agree that they shall attempt to use any method of alternative dispute resolution mutually agreed upon to resolve any dispute arising under this CONTRACT if this CONTRACT is not subject to Chapter 2260.

i. Contract Administration. The TWDB shall designate a project manager for this CONTRACT. The project manager will serve as the point of contact between the TWDB and CONTRACTOR. The TWDB's project manager shall supervise the TWDB's review of CONTRACTOR's technical work, deliverables, draft reports, the final report, payment requests, schedules, financial and budget administration, and similar matters. The project manager does not have any express or implied authority to vary the terms of the CONTRACT, amend the CONTRACT in any way or waive strict performance of the terms or conditions of the CONTRACT.

ARTICLE XI. CORRESPONDENCE

All correspondence between the parties shall be made to the following addresses:

For the **TWDB**:

Contract Issues:
Texas Water Development Board
Attention: Contract Administration
P.O. Box 13231
Austin, Texas 78711-3231
Email: contracts@twdb.texas.gov

Payment Request Submission:
Texas Water Development Board
Attention: Accounts Payable
P.O. Box 13231
Austin, Texas 78711-3231
Email: invoice@twdb.texas.gov

Physical Address:
Stephen F. Austin State Office Building
1700 N. Congress Avenue
Austin, Texas 78701

For the **CONTRACTOR:**

Contract Issues:
Tina Petersen, Ph.D., P.E.
CDM Smith, Inc.
11490 Westheimer Road
Houston, Texas 77077
Email: petersencm@cdmsmith.com

Payment Request Submission:
Juliet Wingenbach
CDM Smith, Inc.
11490 Westheimer Road
Houston, Texas 77077
Email: wingenbachjr@cdmsmith.com

Physical Address:
1490 Westheimer Road
Houston, Texas 77077

IN WITNESS WHEREOF, the parties have caused this CONTRACT to be duly executed in multiple originals.

TEXAS WATER DEVELOPMENT BOARD

Kevin Patteson
Executive Administrator

Date: 2/10/16

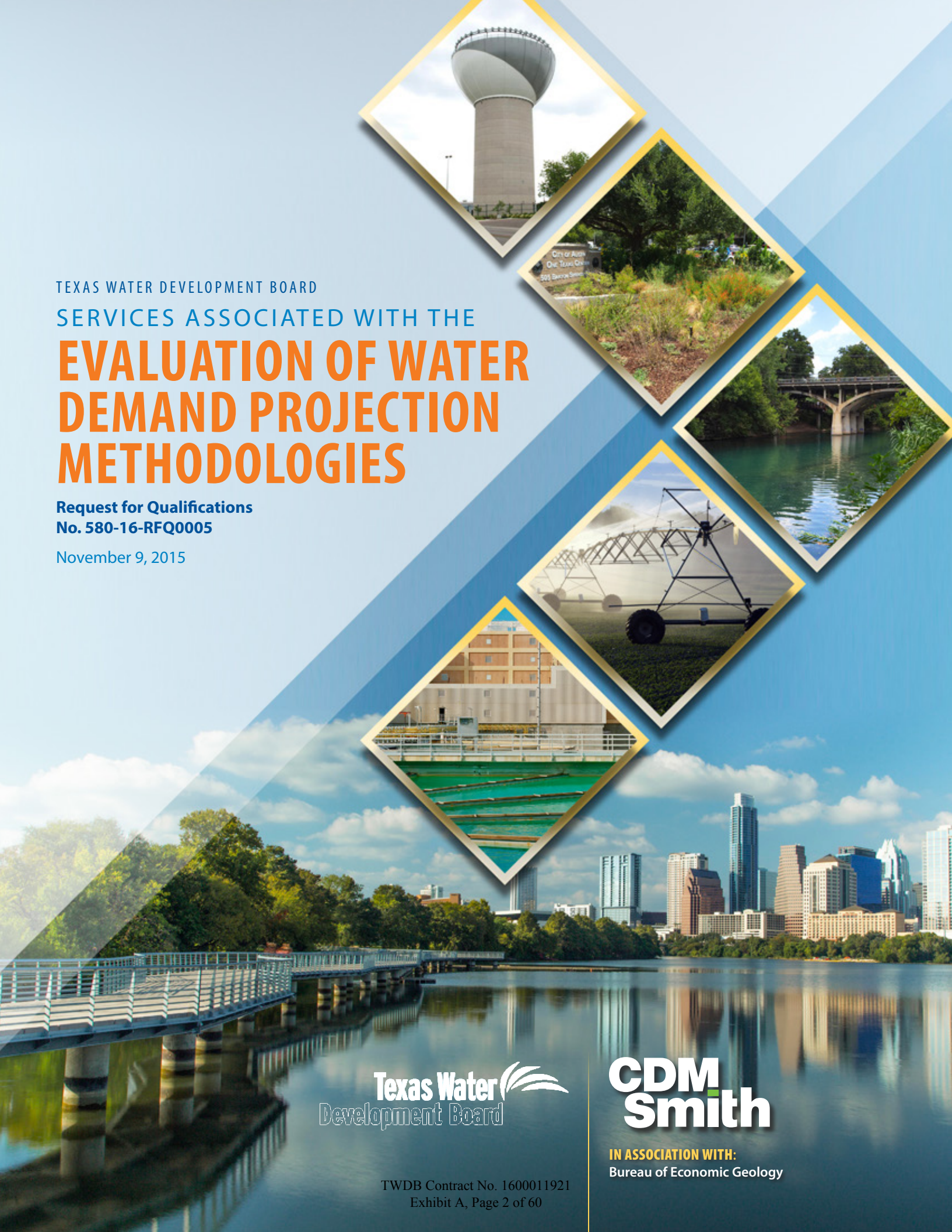
CDM SMITH, INC.

Christopher Canonico, P.E.
Vice President

Date: 1/26/16

EXHIBIT A

ORIGINAL STATEMENT OF QUALIFICATIONS



TEXAS WATER DEVELOPMENT BOARD

SERVICES ASSOCIATED WITH THE

EVALUATION OF WATER DEMAND PROJECTION METHODOLOGIES

Request for Qualifications
No. 580-16-RFQ0005

November 9, 2015

Texas Water Development Board

CDM Smith

IN ASSOCIATION WITH:
Bureau of Economic Geology

CDM Smith
11490 Westheimer, Suite 700
Houston, TX 77077
tel: 713-423-7300

November 5, 2015

Texas Water Development Board
Contracting & Purchasing
1701 North Congress Avenue, 6th Floor Reception Desk
Austin, TX 78701

Subject: Services Associated with the Evaluation of Water Demand Projection Methodologies
RFQ No. 580-16-RFQ0005

To Whom it May Concern:

CDM Smith, in conjunction with the Bureau of Economic Geology (BEG), is pleased to submit this Statement of Qualifications (SOQ) to the Texas Water Development Board (TWDB) for evaluation of three categories of water demands: (1) irrigation; (2) manufacturing; (3) steam-electric power. We are proposing to study all three water demand categories as part of this SOQ submittal.

The CDM Smith Team is proud to offer the TWDB **our proven expertise in developing water demand projections using a wide variety of technical approaches for regional and state water planning throughout the U.S. along with a clear understanding of current Texas water demand methodologies for the three water use sectors to be reviewed:**

- CDM Smith is a national leader in water supply planning and brings experience in the development of water demand projections for each of the subject sectors based on the following state plans completed by CDM Smith: Oklahoma, Arkansas, California, Colorado, Georgia, and Pennsylvania. Through our work on these state plans, we have demonstrated strong capability in evaluating water demand methodologies and developing long-term demand projections for irrigation, manufacturing and steam-electric power and also has extensive experience in the development of water demand projects for the Texas regional water planning process.

- Our major partner, the BEG, is a leading expert in water demand projections for the steam-electric power sector and has previously developed projections for the TWDB. The BEG is also leading state-of-the-science research for the TWDB to determine irrigation water demands based on remote sensing.

On behalf of the entire CDM Smith Team, please do not hesitate to contact me at (713) 423-7300 or petersencm@cdmsmith.com should you have any questions regarding the enclosed proposal.

Very truly yours,

Tina Petersen

Tina Petersen, PhD, PE
Project Manager and Associate Water Resources Engineer
CDM Smith Inc.

WATER + ENVIRONMENT + TRANSPORTATION + ENERGY + FACILITIES

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Section 1

Signed/Dated Execution of Proposal Attachment A

ATTACHMENT A

EXECUTION OF PROPOSAL
to the
REQUEST FOR QUALIFICATIONS

Company Name:	CDM Smith
Address:	11490 Westheimer Road
	Suite 700
	Houston, TX 77077
Phone Number:	713-423-7300

I, Tina Petersen, am the above-referenced company's representative and I am authorized to submit this proposal and sign future Contract documents.

Tina Petersen

Authorized Signature

November 5, 2015
Date

Section 2

Company Profile Summary and History

SECTION 2 – COMPANY PROFILE SUMMARY AND HISTORY

Company name and address:	CDM Smith 11490 Westheimer Road, Suite 700 Houston, TX 77077
Contact person:	Tina Petersen, Ph.D., P.E. 713-423-7300
Authorized person to contractually bind the firm:	Tina Petersen, Ph.D., P.E. 713-423-7300
Company details:	Number of years in business: 68 Type of business: Corporation Scope of operation: International firm with 6 offices in Texas

Overview of CDM Smith Team: For more than 60 years, CDM Smith has provided innovative solutions combined with responsive, professional service to our clients. With annual revenues of more than $1.2 billion, and more than 5,000 professionals in over 125 offices worldwide, CDM Smith maintains the size, stability, and resources to take on a wide range of projects successfully. To offer the TWDB the most qualified team, we have partnered with the Bureau of Economic Geology (the Bureau) who offers state-of-the-science research programs into relevant topics for the subject study. The Bureau, established in 1909, is the oldest and second largest research unit at the University of Texas at Austin, conducting high quality research focused on the intersection of energy, environment and economy.

CDM Smith Profile: CDM Smith has been a leader in the field of water demand forecasting for decades - and are familiar with the TWDB water demand projection methodology through our work nationally as well as within the State of Texas. Whether developing long-range forecasts for municipal providers with detailed customer classes and diverse geographic service areas, or state and regional forecasts for a wide range of water users, our forecasting philosophy is to develop the right methodologies to match the informational needs of decision makers with the available data and resources. We have experience with analyzing methodologies, understanding water use and the contributing factors of water use for irrigation, manufacturing and steam electric power categories – and have demonstrated this expertise through development of statewide forecasting methodologies for the States of Arkansas California, Colorado, Georgia, Missouri, Oklahoma, and Pennsylvania. Our work is documented in reports and/or published for each of these plans.

CDM Smith Team Offers Proven Water Demand Projection Expertise

- We have developed demand projections for irrigation, manufacturing and/or power generation sectors for multiple state water planning processes – including State of Texas
- For previous TWDB efforts, members of our team developed the steam electric power generation demand projections and provided recent updates
- Members of our team maintain a cutting edge research program in use of remote sensing to improve irrigation demand projections, including projects funded by TWDB
- Our team has developed water use forecasting tools (IWR-MAIN Water Management Suite, site specific models, spreadsheet tools) that can easily scale to local, regional, state-wide needs

SECTION 2 – COMPANY PROFILE SUMMARY AND HISTORY

Our plans often include long-term demand projections; for example, the state water plans for Oklahoma and Arkansas included 50 year projections of water requirements for municipalities, large industries, thermoelectric power, livestock and crop irrigation. In addition to developing three of the Georgia State Regional Plans, CDM Smith also developed the statewide projected water demands for thermoelectric power generation based upon US Department of Energy projections of power production by fuel type by power pool. Additionally, CDM Smith has worked with industries in the manufacturing and steam electric power sectors to evaluate water demands and has developed tools to evaluate water conservation and water reuse strategies.

Bureau of Economic Geology Profile: The Bureau also has a long history with water demand forecasting and is very familiar with the TWDB's water demand projection methodology as demonstrated by their long history of collaboration with the TWDB. The Bureau has extensive experience with understanding water use and the contributing factors of water use for the irrigation and steam electric power, as evidenced by their state-of-the-science research programs.

For example, the Bureau currently maintains a research program into water use by power generators, demonstrating their understanding of the factors affecting water withdrawal and consumption. This research program has involved updating the data on water withdrawal and consumption for electricity generation in Texas for 2010 using data from Energy Information Administration, Texas Water Development Board, and Texas Commission on Environmental Quality. In addition to quantifying water withdrawal and demand for 2010, they also evaluated spatial variability in water use for thermoelectric power plants and updated the TWDB database on water use for steam electric power generation in Texas for 2010, 2011, and 2012. Example publications from this program include the following:

King CW, Duncan I, Webber M (2008) Water demand projections for power generation in Texas. Contract Report prepared for the Texas Water Development Board, variably paginated

Scanlon BR, Reedy RC, Duncan I, Mullican WF, III, Young MY (2013a) Controls on Water Use for Thermoelectric Generation: Case Study Texas, U.S. Env Sci & Tech, 47, 11326-11334 47

Scanlon BR, Duncan I, Reedy RC (2013b) Drought and the water energy nexus in Texas. Environ Res Lett, 8(4), 045033, doi:101088/1748-9326/8/4/045033 DOI 045033

King CW, Duncan I, Webber M (2008) Water demand projections for power generation in Texas. Contract Report prepared for the Texas Water Development Board, variably paginated

Additionally, the Bureau also maintains a research program that is investigating the use of remote sensing to improve irrigation demand projections. One study, funded by TWDB, seeks to assess the feasibility of the current state-of-the-science remote sensing approaches to quantify crop ET across the climatically and agriculturally diverse landscape of Texas. Example publications from this program include the following:

Caldwell TG, Huntington J, Joros A, Howard T, Scanlon BR (2014). Improving irrigation water use estimates with remote sensing technologies: an initial feasibility study for Texas. Contract Report prepared for the Texas Water Development Board, 52 Pp.

Caldwell TG (2015), Soil Characterization at Camp Bullis, TX. Contract report prepared for the Edwards Aquifer Authority, 22 Pp.

Section 3

Company References

- State Water Supply Initiative – Colorado Water Conservation Board
- Arkansas State Plan – Arkansas Natural Resources Commission
- Oklahoma State Plan – Oklahoma Water Resources Board
- Georgia State Plan – Georgia Department of Natural Resources
- Panhandle Groundwater Conservation District
- Soil Characterization and Diffuse Recharge at Camp Bullis, Texas - Edwards Aquifer Authority

SECTION 3 – COMPANY REFERENCES

REFERENCE #1

Name of Organization:	Colorado Water Conservation Board		
Business Address:	1313 Sherman Street		
	Suite 718		
Business City:	Denver		
Business State:	CO	**Zip:**	80203
Contact Person Name:	Eric Hecox		
Contact Person Title:	Formerly Section Chief (now with South Metro Water Supply Agency)		
Phone Number:	303-409-7747	**Fax:**	303-409-7748
Client Comments:			

CDM Smith performed demand projections for the Colorado State Water Supply Initiative and the Colorado State Water Plan. CDM Smith developed water demand methodologies for irrigation, manufacturing and steam-electric power categories (among others), which were refined and approved through a rigorous stakeholder process. I can recommend CDM Smith for the review and revision of the water demand methodologies used by the State of Texas.

Sincerely,

Eric Hecox

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Statewide Water Supply Initiative

Colorado Water Conservation Board

The Colorado Water Conservation Board (CWCB) commissioned the Statewide Water Supply Initiative (SWSI) to help Colorado maintain an adequate water supply for its citizens, agricultural and the environment through a mix of solutions, all of which should be pursued concurrently. As part of this effort, CDM Smith was selected to conduct a basin-by-basin and statewide water supply investigation for use in identifying solutions to growing water use conflicts in times of both drought and significant growth. CDM Smith estimated demands and investigated supply options in eight river basins across the state and developed a comprehensive report that was delivered to the Colorado Legislature in November 2004. In 2010, CDM Smith updated the original SWSI report with data and analyses completed over the past several years as part of finalizing the SWSI 2010 report. The update of the SWSI 2010 report included information from the SWSI Phase 2 report that was completed in 2007.

For SWSI and SWSI 2010, CDM Smith calculated statewide water demands for municipal, industrial and agriculture for the eight major river basins across the state. The goals of this evaluation were to:

- Update population projections and extend them to 2050
- Update municipal and industrial (M&I) per capita estimates including passive conservation
- Extend the SWSI 1 consumptive water use projections to 2050 for the M&I sector
- Update the self-supplied industrial (SSI) sector forecast to 2050
- Update the current tally of irrigated acres throughout Colorado and forecast irrigated acres in 2050
- Update current agricultural demands and shortages
- Update the consumptive demand forecast to 2050 for the agricultural sector

To accomplish these goals, CDM Smith estimated these water demands for the year 2000 and the year 2030 at a county level (M&I) and water district level (agricultural). CDM Smith also generated a water provider database and statewide demographic information to estimate M&I demands. CDM Smith further develop this database and projected M&I and agricultural demands to 2050 at a county level and water district level.

The State Water Plan also included an evaluation of water demand associated with the following self-supplied industrial subsectors:

- Large industries, including mining, manufacturing, brewing, and food processing
- Thermoelectric power generation at coal- and natural gas-fired facilities
- Water needed for snowmaking

Client:
Colorado Water Conservation Board

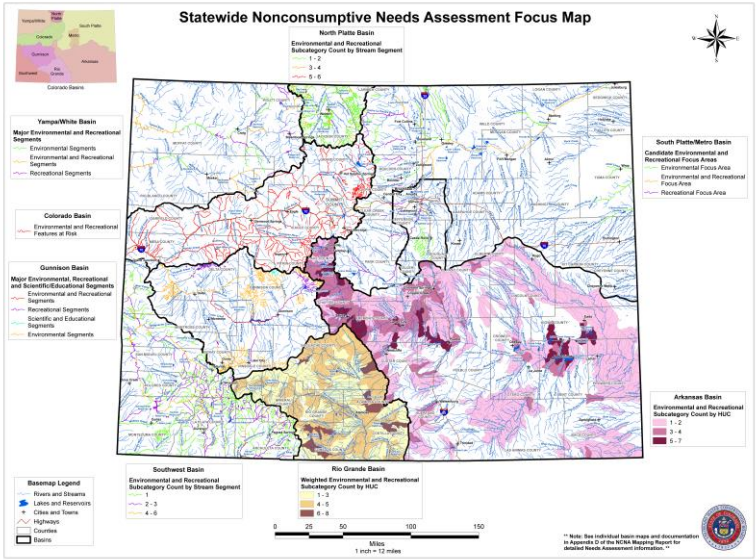
Project Dates:
June 2003 - June 2011; 2015 - current

- Energy development, including the extraction and production of natural gas, coal, uranium, and oil shale

These demands were estimated through a combination of surveys of water users and then forecast based on factors affecting water use, such as facility type, location, and known expansions.

Through SWSI Phase 1 and SWSI 2010, water needs of all users throughout the state were analyzed using a consistent methodology. CDM Smith found that municipal and industrial demands are expected to nearly double by 2050. Agricultural demands are expected to continue to comprise the majority of overall water use statewide –but at the same time, irrigated agricultural land will be taken out of production due to water transfers and urban growth, potentially impacting economies and open space in many rural areas. To address irrigated agricultural issues, CDM Smith investigated alternative transfer methods to permanent transfer of irrigated lands to M&I uses. Concurrently, SWSI took the unprecedented steps of directly recognizing and incorporating the economic and non-economic importance of recreational and environmental water uses into statewide water planning.

Through this process, stakeholders hailed the accomplishments of SWSI, noting that "You have helped change how people view the CWCB and how people view Colorado's water future" and "Great strides were made in defining the water supply challenges within the State of Colorado." Through the ongoing dialogues and efforts associated with this landmark initiative, CDM Smith directly supported the goals of providing safe and adequate water for Colorado's citizens, agriculture, and the environment.



CDM provided technical assistance in developing focus area mapping for environmental and recreational needs.

REFERENCE #2

Name of Organization:	Arkansas Natural Resources Commission		
Business Address:	101 East Capitol Avenue		
	Suite 350		
Business City:	Little Rock		
Business State:	AR	**Zip:**	72201
Contact Person Name:	Mr. Edward Swaim		
Contact Person Title:	Water Resources Division Manager		
Phone Number:	501-682-3979	501-682-3991 **Fax:**	
Client Comments:			

CDM Smith was the lead contractor for the Arkansas Water Plan update that concluded in November of 2014 with more than 2,600 pages of planning and public engagement documents. Demand and supply projections to 2050 were the basis of the update.

CDM Smith developed water demand methodologies for irrigation, manufacturing, and steam-electric power categories (among others), which were refined and approved through a rigorous stakeholder process. Please see the planning documents at: arkansaswaterplan.org.

I recommend CDM Smith for the review and revision of the water demand methodologies used by the State of Texas.

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Arkansas Water Plan

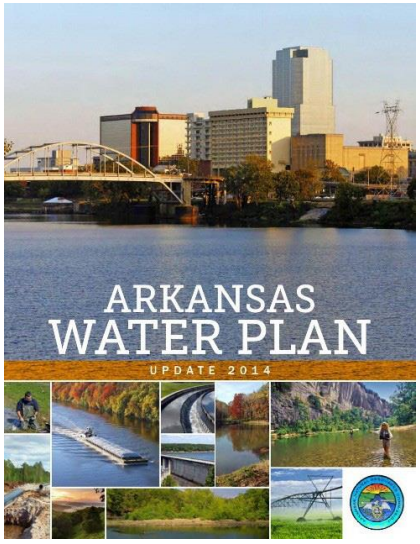
Arkansas Natural Resources Department

The Arkansas Natural Resources Commission (ANRC), the state agency delegated responsibility for the AWP engaged CDM Smith to develop the Arkansas Water Plan (AW_ 2014 Update, providing long-term water supply planning for the state. The major building blocks of the AWP are the projections of demands, water supply availability, and gap analysis. The information from these building blocks was used to develop the priority issues and recommendations that are the focus of the AWP 2014 Update. All of the work on the AWP 2014 Update was completed with unprecedented outreach and stakeholder involvement.

Demands were forecast separately for 12 sectors of water use within the state:

- Municipal
- Self-supplied Domestic
- Commercial
- Industrial/Manufacturing
  - Aquaculture
- Thermoelectric Power
- Mining
- Agriculture
  - Crop irrigation
  - Livestock
- Shale Gas
- Duck (Hunting) Clubs and Habitat Maintenance
- Navigational Considerations

Sector forecasts are necessary because each sector has unique factors that influence its water demand. The data, forecast methods, and summaries of estimated future water demand in the State of Arkansas through 2050. The water demands for all sectors, except navigation, are developed for each of the 72 Arkansas counties. The water demands of each county were quantified at the individual withdrawal point level with a specific coordinate and source. The water demands were then re-aggregated by planning region, aquifer, and surface water basin. A technical work group composed of representatives of the demand sectors reviewed the approach to demand projection and the resulting demand data.



Client:
Arkansas Natural Resources Department

Project Dates:
2012 - 2014

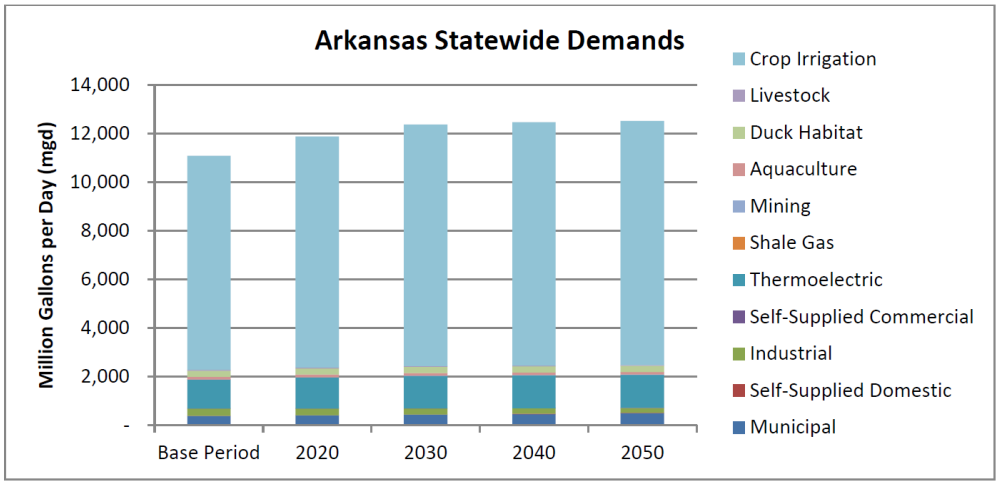


Figure 2.1 Statewide Water Demand, with Thermoelectric Withdrawals and Crop Irrigation

Water supply availability was projected for surface water and groundwater. Surface water availability was estimated using Arkansas's definition of excess water and is based on gaged stream flow in eight major stream basins. Groundwater availability was assessed using a groundwater model developed by the U.S. Geological Survey with the projected demands. Water quality and fish and wildlife flows were considered in the quantification of water availability. A technical work group of knowledgeable stakeholders provided review of the water availability approach and results.

The gap analysis quantified the difference between project supply and demand for both groundwater and surface water. The gaps were estimated on the planning region and river basin basis.

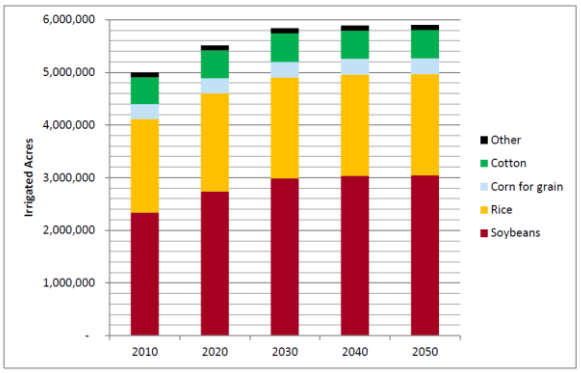


Figure 11.1 Total Projected Irrigated Acres by Crop

The priority issues and recommendations for the AWP 2014 Update were developed by stakeholder groups from each of the five planning regions. The groups used the demand, supply and gap information to inform their prioritization of the issues and recommendations. In addition to the technical work groups for demand, supply, and issues, there was extensive general public outreach, intended to provide an opportunity for sharing information to and obtaining feedback from the general public. Thirty-six public meetings were held at the locations around the state. The public meetings were held at important milestones in the AWP process

SECTION 3 – COMPANY REFERENCES

REFERENCE #1

Name of Organization:	Oklahoma Water Resources Board		
Business Address:	3800 N. Classen		
Business City:	Oklahoma City		
Business State:	OK	**Zip:**	73118
Contact Person Name:	Mr. J. D. Strong		
Contact Person Title:	OWRB Executive Director		
Phone Number:	405-530-8800	**Fax:**	405-530-8900
Client Comments:			

CDM Smith performed demand projections for the 2012 Update of the Oklahoma Comprehensive Water Plan. CDM Smith developed water demand methodologies for irrigation, manufacturing and steam-electric power categories (among others), which were refined through a stakeholder process. I can recommend CDM Smith for the review and revision of the water demand methodologies for these sectors used by the State of Texas. While the methodology used to forecast future irrigation demands was a relatively simple procedure similar to that used for our 1995 and unpublished 2005 OCWP updates, it served our purposes and provided consistency, although we may want to revisit that procedure in future updates.

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Oklahoma Comprehensive Water Plan

Oklahoma Water Resources Board

To address future water needs statewide, the Oklahoma Water Resources Board (OWRB) developed the Oklahoma Comprehensive Water Plan (Water Plan). In accordance with the Oklahoma Legislature's directive, the OWRB undertook an unprecedented effort to characterize and develop a plan for the state's water needs and water resources through 2060. By proactively planning its water future, Oklahoma will be able to predict and mitigate potential conflicts between competing water uses and water users.

Through a unique water planning partnership with the U.S. Army Corps of Engineers (USACE), the OWRB engaged CDM Smith to develop a Programmatic Work Plan that provides a roadmap for the detailed technical work to be conducted through 2011 in developing the Water Plan. While building on past water planning efforts, the Oklahoma Comprehensive Water Plan is designed to meet growing and changing needs of the state's water users and water-related environment. The Water Plan will identify sources of public water supply for the vast majority of Oklahomans, integrating existing plans and helping communities identify long-term solutions to their water needs. In addition, the Water Plan is thoroughly assessing the water needs and supplies for agricultural uses, industrial uses, and in-stream environmental flow considerations.

The Programmatic Work Plan developed by CDM Smith:

- Clearly defines and documents key goals and objectives for the Water Plan
- Establishes appropriate, sound, and accepted methods for developing technical aspects of the Water Plan
- Defines priorities for the Water Plan process and define a prioritized "roadmap" for phased completion of the Water Plan

First among CDM Smith's work on the OCWP will be forecasting water uses and supplies through 2060, which will in turn be used to

Client:

Oklahoma Water Resource Board

Project Dates:

2007 –2012

identify areas of potential future water supply shortages and conflicts.

Water demand projections for all major water users throughout the state were developed for the base year, or starting point of the forecast (generally 2007) and then at 10-year intervals from 2010 to 2060. Water users are grouped into four major categories—publically supplied M&I; self-supplied residential; self-supplied nonresidential, and agriculture.

The demand forecast is estimated by sub-categories as follows:

- Publically-supplied M&I
  - Residential
  - Nonresidential
- Self-supplied residential
- Self-supplied nonresidential
  - Thermoelectric power
  - Oil and gas
  - Other large industries
- Agriculture
  - Livestock
  - Crop irrigation

CDM Smith also developed alternatives that analyze impacts from potential conservation and climate change in the municipal, industrial and agriculture sectors. These efforts included detailed seasonal analysis of potential water savings and associated costs for a comprehensive array of municipal water conservation and drought management activities.

SECTION 3 – COMPANY REFERENCES

REFERENCE #3

Name of Organization:	Georgia Department of Natural Resources – Environmental Protection Division		
Business Address:	2 Martin Luther King, Jr. Drive, SE		
	Suite 1152 East		
Business City:	Atlanta		
Business State:	GA	**Zip:**	30334-9000
Contact Person Name:	Mr. Nap Caldwell		
Contact Person Title:	Watershed Protection Branch – Water Supply Program Manager		
Phone Number:	404-463-1511	**Fax:**	404-656-2453
Client Comments:			
Project Description Attached			

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Statewide Water Development & Conservation Plan

Georgia Department of Natural Resources Environmental Protection Division

CDM Smith assisted the Georgia EPD in developing Regional Water Development and Conservation Plans (Regional Plans) in support of Georgia's Statewide Water Management Plan. CDM Smith assisted EPD by developing Regional Plans for three Regional Water Planning Councils: Coastal Georgia, Suwannee-Satilla, and Altamaha. This high-profile, $2.5 million project involved developing comprehensive and sustainable water supply, waste water, and stormwater plans and management strategies for the regional councils. The planning process emphasized local decision-making with CDM Smith providing technical, facilitation, coordination, and decision making expertise to the regional councils. CDM Smith led each of the three councils through the identification of water resource goals and objectives, developing a common understanding of the regions resource needs, and identification of feasible water management strategies to meet those needs.

The development of sustainable and implementable regional water plans involved: quantifying and forecasting current and future (thorough the year 2050) municipal, commercial, and industrial water needs; assessing current resources within the regions; identification of "gaps" between available water resources and future water resource needs; and the development and evaluation of diverse water supply and demand management strategies that can be implemented to meet future needs while protecting water quality and natural systems.

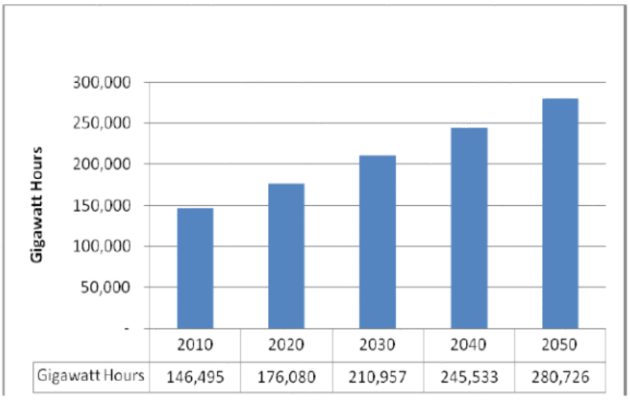
We have completed planning efforts involving statewide/regional demand analysis and growth projections that have included interviews with individual water providers in Georgia, Oklahoma, Colorado, Arkansas, and throughout the U.S. to gain an understanding of their respective needs and supplies as well as open public discussions at strategic locations (such as County levels) to allow for input from varying perspectives.

"EPD is happy with all our planning contractors, but CDM Smith is the gold standard by which we judge all others." ~ Georgia EPD State Water Plan Project Manager

Energy / Thermoelectric Power Generation

CDM Smith was the lead contractor selected to complete the statewide energy forecasts which involve engaging major energy producers in Georgia, documenting forecasting methodology, training other planning contractors to present forecasts, and presented forecasts for other planning regions when requested by the region specific planning contractor.

Figure 3 Projected Statewide Power Generation Needs in Georgia 2010-2050, Baseline Scenario



The process included using the population projections developed by the Governor's Office of Planning and Budget (OPB) and information on the historical relationship between population growth and energy

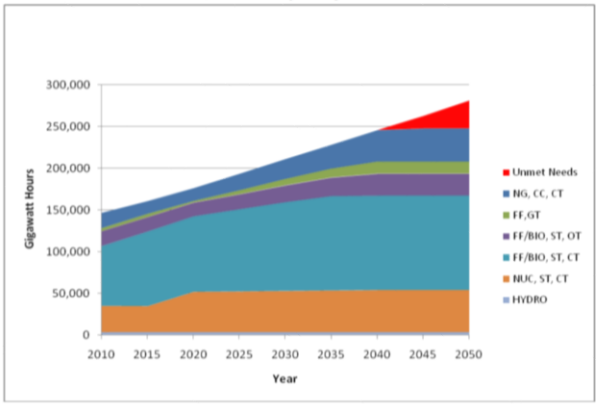
Client:
Georgia Department of Natural Resources Environmental Protection Division

Project Dates:
2009 - 2011; 2015 – current

consumption in Georgia to project future energy needs. Then, to forecast the water needed to meet the future energy needs in Georgia, relationships between the types of power production processes use d and water withdrawal and consumption were developed. Using this relationship, the water needs for existing and known planned facilities were forecasted. A power ad hoc group provided input to EPD during the process.

The results of the forecasts provide region-specific forecasts of water needs for power generation including existing and known planned facilities through 2020.

Figure 6 State of Georgia Projected Power Needs by Combination, Baseline Power Needs, 2017 Capacity Forecast Scenario



Stakeholder Involvement

During development of the 2011 Georgia water plan, the CDM Smith planning team recognized a potential significant level of opposition to the municipal and industrial forecast. Working within the overall planning guidance the team formed a subgroup of Council members to explore development of a standard and alternate forecast. The alternate forecast examined changes in gallons per capita per day based on potential changes in the mix of commercial and residential water use and changes in industrial water use growth assumptions. To garner Council support and address uncertainties in industrial growth the CDM Smith planning team examined factors that would potentially drive growth including: surface transportation opportunities, potential deepening of the Savannah Harbor, and location of industrial development sites. These factors were then combined with source of supply data to complete the forecast and gap analysis for the region.

SECTION 3 – COMPANY REFERENCES

Reference #1:

Name of Organization:	Panhandle Groundwater Conservation District		
Business Address:	201 West 3rd Avenue		
	P.O. **Box 637**		
Business City:	White Deer		
Business State:	TX	Zip Code:79097	
Contact Person:	C.E. Williams		Email: cew@pgcd.us
Contact Person Title:	General Manager		
Phone Number:	806-883-2501	Fax: 806-883-2162	
Client Comments:			

I have worked with Dr. Scanlon on numerous occasions both professionally and personally and found her to be the leading expert in groundwater recharge in the country. She has led several BEG teams on work in the Ogallala aquifer thought the Panhandle area. She in my opinion will make an excellent addition to the evaluation team for water demands projections for TWDB.

Sincerely,

C. E. Williams
General Manager

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Please see the following publications for this reference:

Caldwell TG, Huntington J, Joros A, Howard T, Scanlon BR (2014). Improving irrigation water use estimates with remote sensing technologies: an initial feasibility study for Texas. Contract Report prepared for the Texas Water Development Board, 52 Pp.

Caldwell TG (2015), Soil Characterization at Camp Bullis, TX. Contract report prepared for the Edwards Aquifer Authority, 22 Pp.

Scanlon BR, Faunt CC, Longuevergne L, Reedy RC, Alley WM, McGuire VL, McMahon PB (2012) Groundwater depletion and sustainability of irrigation in the US High Plains and Central Valley. Proceedings of the National Academy of Sciences of the United States of America 109: 9320-9325 DOI 10.1073/pnas.1200311109

Scanlon BR, Reedy RC, Gates JB (2010) Effects of irrigated agroecosystems: (1) Quantity of soil water and groundwater in the Southern High Plains, Texas. Water Resour. Res., 46, W09537, doi:101029/2009WR008427

Scanlon BR, Gates JB, Reedy RC, Jackson A, Bordovsky J (2010) Effects of irrigated agroecosystems: (2). Quality of soil water and groundwater in the Southern High Plains, Texas. Water Resou. Res. , 46, W09538, doi:101029/2009WR008428

Scanlon BR, Reedy RC, Gates JB, Gowda PH (2010) Impact of agroecosystems on groundwater resources in the Central High Plains, USA. Agriculture, Ecosystems, & Environment 139: 700-713.

Scanlon BR, Reedy RC, Gates JB, Gowda PH (2010) Impact of agroecosystems on groundwater resources in the Central High Plains, USA. Agriculture, Ecosystems, & Environment 139: 700-713.

Section 4

Resumes

- Mr. Bill Davis
- Dr. Bridget Scanlon
- Mr. Bill Mullican
- Dr. Todd Caldwell
- Dr. Tina Petersen

William Y. Davis

Principal Planner, Senior Economist

Mr. Davis specializes in conducting water demand analyses, developing water use forecasts, evaluating water conservation programs, and incorporating these analytical components into Integrated Resource Planning. His has direct experience in developing water demand forecasts for industrial, steam electric and irrigation water demands for Colorado, Arkansas, Oklahoma, Georgia, Pennsylvania, Wisconsin, and has done similar, more focused studies for a wide range of regional water suppliers and cities across the United States. Mr. Davis was a member of the Development Team responsible for the IWR-MAIN Water Demand Management Suite, and conducted more than 30 training workshops on application of the IWR-MAIN software. Mr. Davis served four years as a chair of the Water Resources Planning and Management committee of the water resources sustainability division of the American Water Works Association, and is currently a Trustee and Vice-Chair of the AWWA Water Resources Sustainability Division.

Water Demand Projections for Manufacturing, Irrigation, Steam-Electric - State Water Plans

Municipal and Industrial Water Demand Forecasts, Statewide Water Supply Initiative, Colorado. For the Colorado Water Conservation Board, Mr. Davis was responsible for developing the municipal and industrial water demand forecast for all counties within the state of Colorado. Future water demands were reduced for both hypothetical (alternative) conservation levels and approximated current levels of water conservation effort for each county.

Comprehensive Water Demand Forecasts, 2014 Arkansas State Water Plan. Mr. Davis provided technical direction, oversight and review of water demand forecasting methodologies and deliverables for county level water demand forecasts for the Arkansas State Water Plan. Water demands for each county include public-supply residential and non-residential use, self-supplied residential use, large industrial uses, oil and gas, irrigation (subdivided into livestock, aquaculture and crop irrigation). Reductions in future water demands due to improvements in water use efficiency were evaluated as alternative supply options.

Municipal, Industrial and Agricultural Water Demand Forecasts, Statewide Water Demand Forecast, Oklahoma. For the Oklahoma Water Resources Board and the U.S. Army Corps of Engineers (USACE), Tulsa District, Mr. Davis lead the CDM Smith team that provides the municipal, industrial and agricultural water demand forecasts by county, basin, and water provider for the Statewide Water Plan. In addition, Mr. Davis led the analysis of potential statewide savings from water conservation among public supply and agricultural water users.

Statewide Power Generation Water Need Assessment and Regional Water Demand Forecasts Regional Plans for the Georgia Department of Environmental Protection. CDM Smith was responsible for developing regional water plans for three planning regions of the State of Georgia as components of the Statewide Comprehensive Water Plan. Mr. Davis was instrumental in the design of the water demand and wastewater flow forecast

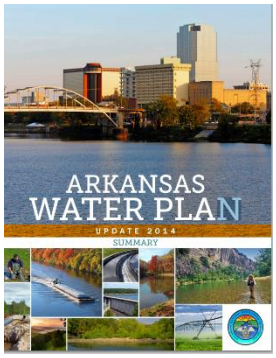
Education

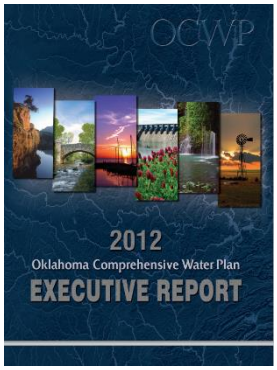
M.S. – Agribusiness Economics
Southern Illinois University, 1986

Peace Corps – Swaziland, Africa, 1978-1980

Technical Training, Renewable Energy Technology, 1978

B.S.W. – Social Work/ Psychology, University of Kansas, 1973





methodology used by all contractors in all planning regions of the state. He was task leader in the implementation of the water demand and wastewater flow estimations for the three regions assigned to CDM Smith. In addition, Mr. Davis was separately contracted by the Georgia EPD to develop a statewide assessment and forecast of water needs for power generation throughout the state.

Municipal, Industrial, Mining, Agricultural, Power Generation Sector Demand Forecasts, Development of a Water Demand Forecast Methodology, Pennsylvania. For the Delaware River Basin Commission and Pennsylvania Department of Environmental Protection**,** Mr. Davis served as task manager in the review of available information, and development of statewide applicable forecasting methodologies for the municipal, industrial, mining, thermoelectric power, hydroelectric power and agricultural sectors of the state of Pennsylvania.

Water Demand Forecast Update, Puerto Rico. For the Office of the Water Plan, Puerto Rico Department of Natural and Environmental Resources, Mr. Davis was project manager for updating the projections of municipal water demand for the 78 counties of Puerto Rico using the IWR-MAIN Water Demand Management software.

Water Demand Projections for Manufacturing, Irrigation, Steam-Electric – City and Regional Plans

Project Manager, Update of Long-term Water Demand Forecast, San Diego, California. For the City of San Diego, Mr. Davis led the effort to revise the water demand forecast to the year 2030 for 135 hydraulic pressure zones within the city's service area. The forecast included water savings estimated from planned conservation programs allocated to each pressure zone. The forecast was used to assess the impact of two potential climate change scenarios on future water demand. Mr. Davis has provided updates to the city's water demand forecast in 1998, 2002, 2005, 2008, 2010 and 2015.

Task Manager, Water Conservation Potential Study, Los Angeles Department of Water and Power (LADWP). Mr. Davis is responsible for the design and development of the LADWP Water End Use Tool for estimating baseline and future water demand by sectors and end uses of water. The End Use Tool is populated with user-level data obtained through surveys of customers by sector conducted under this study. The Water End Use Tool is used to evaluate potential efficiency measures in terms of technically feasibility, economic feasibility and maximum achievable potential.

Task Manager, The Central Puget Sound Water Suppliers' Forum Demand Forecast and Water Supply Assessment, Washington. For the Central Puget Sound Supplier's Forum, Mr. Davis led the development of the water demand forecast to the year 2060 for the three-county area, and development of custom water demand forecasting software for integration with the assessment of future regional water supplies. The model was used to assess alternative growth, economic and climatic scenarios, including potential climate change scenarios.

Water Footprint for Airports, Water Efficiency Management Program Guidebook and Toolbox, National Academy of Sciences, Airport Cooperative Research Program (ACRP). Mr. Davis is responsible for the design and development of the ACRP Water End Use Tool for estimating the water footprint of airports in the US. In addition, Mr. Davis co-

authored the companion Guidebook for the development of water efficiency programs at airports by airport managers.

Economist, Work Plan and Model Review for Water Demand Methodology, California. For the Cal-Fed Bay Delta Program, Mr. Davis provided a review of methodological approaches to developing a water demand forecast, and recommendations for developing a state-wide water demand forecast for the state of California based on a review of data availability and resources available to the state.

Project Advisor, Southwest Missouri Regional Planning. Mr. Davis assisted with an initial project workshop by presenting water demand forecasting concepts and methodologies. He assisted with the review of available data and development of an appropriate water demand methodology to meet the planning needs for southwest Missouri by the Missouri Department of Natural Resources and the Corps of Engineers. Mr. Davis provided oversight in the data analysis and forecast model development as well as quality control and review of deliverables and documentation.

Project Manager, Analysis of Water Use, California. For the Directorate of Public Works, Presidio of Monterey, California, and the U. S. Army Corps of Engineers, Institute for Water Resources, the quantification of water savings from installation of waterless urinals, and other water efficiency measures was crucial for the permitting of water use in new buildings at the Presidio. Mr. Davis conducted an empirical analysis of water savings at the Presidio for presentation to the Monterey Peninsula Water Management District Board of Directors.

Project Manager, Water Demand Forecast Model for Spokane County, Washington. Mr. Davis provided sub-contracting services to develop a water demand forecast model in Microsoft Excel for Spokane County, Washington. The water demand forecast incorporated water use data from the 144 water providers within the county to estimate water demand among public supply systems according to location within the county, water source, housing density and other unique characteristics of service areas. The water demand model also included forecasts for the self-supplied residential, self-supplied industrial and agricultural sectors of the county. The forecast model was developed within a six-month project schedule and a limited budget. Subsequently, County staff engaged in the development of the model were able to implement recommended refinements to the model based upon additional data collection and analysis.

Task Manager, Evaluation of Future Demands Reflecting Reduction in Unaccounted-For Water and Conservation, Florida. For the Miami-Dade Water and Sewer Department, Mr. Davis led the development of a water demand forecast to the year 2030 for the retail and wholesale service areas. Retail service water demand was estimated for 1469 sub-areas from geo-coded account-level billing data for integration of water demands with distribution models. A unique algorithm was developed in the demand model to separate conservation effects from real and apparent water losses.

Project Manager, Regional Water Supply Plan Update, Portland, Oregon. For the Regional Water Providers Consortium of Portland, Oregon**,** Mr. Davis led the identification and economic analysis of current and potential water conservation programs to be included in the update of the regional water supply plan. Implementation costs and estimated savings were evaluated for an array of water conservation programs. Those programs that met the selection criteria were recommended for inclusion in the analysis

of supply and demand management alternatives. Two public involvement workshops were conducted to obtain stakeholder input into the evaluation process.

Project Manager, Update of Long-term Water Demand Forecast, San Diego, California. Mr. Davis used updated demographic projections and more recent (i.e., year 2000) demographic and water use data to recalibrate existing water demand models and revise the water demand projections for the 23 major pressure zones of the City of San Diego, California. The water demand forecast utilized water demand models previously estimated for the San Diego County Water Authority. Updated inputs and assumptions were used to revise the water conservation savings estimates resulting from continued implementation of the best management practices by the city. The conservation savings were estimated with the IWR-MAIN end-use model. City staff members were trained in the use of the IWR-MAIN databases established for the water demand and water conservation components of the water demand forecast for the city.

Additional water demand and water conservation planning

Project Manager, Wisconsin Public Service Commission Water Efficiency water conservation programs for potential water savings, cost effectiveness and customer satisfaction. A benefit-cost analysis was conducted of potential efficiency and water loss control programs. Statewide costs and savings were estimated and programs were ranked by technical achievable savings, cost-effective savings, and realistically achievable savings.

Project Manager, Analysis of Commercial Water Use Conservation Potential for the Metropolitan Water District of Southern California. Mr. Davis led the effort to conduct random surveys of high water using business types within the MWDSC service area, estimate the potential for improved water efficiency and estimate total service area commercial water use and potential savings.

Task Manager, Detailed Water Resources Study in All Al-Harrat, Saudi Arabia. Mr. Davis was responsible for the developing the water use inventory and water demand components water resource study of the Al-Harrat study area. The study area included eight of the western regions of the Kingdom of Saudi Arabia.

Task Manager, Riyadh Water and Wastewater Master Plans, Saudi Arabia. Mr. Davis is responsible for the land use, population and water demand components of the water and wastewater master plan under development by CDM Smith for the Riyadh City Business Unit of the National Water Company of Saudi Arabia. The spatially disaggregate water demand forecast and estimated wastewater flows are being developed as GIS layers for use in designing water and wastewater services for the City service area to the year 2035.

Economist, Cost-Benefit Analysis for Implementing the West Coast Sewerage Project under a Public Private Partnership Arrangement, Barbados. For the Barbados Water Authority, Mr. Davis provided the quantitative and qualitative benefit-cost analysis of six project options including ocean discharge, wastewater reuse and aquifer recharge for the proposed sewerage service to the West Coast of Barbados. As part of this effort, Mr. Davis led a stakeholder workshop to score and rank the economic, social and environmental elements of each project option.

Technical Advisor, Long-term Plan for Desalinated Water in the Kingdom of Saudi Arabia. For King Saud University and the Saudi Ministry of Water and Electricity, Mr. Davis provided technical training and guidance to the project team in the development of a long-range water demand forecast for the Kingdom of Saudi Arabia for use in planning future potable water needs.

Task Manager, Dependability Study, New York. For the New York City Department of Environmental Protection**,** Mr. Davis was task manager for the demand reduction and water reuse work group. He was responsible for developing and managing the budget and approach for evaluation of potential water conservation programs applicable to the New York City service area. A full array of conservation measures were evaluated for technical applicability, social acceptability and economic effectiveness.

Economist, Phase I Water Demand Study, Arizona. For the Coconino Plateau Water Advisory Council in North Central Arizona**,** Mr. Davis collaborated with Mr. Richard Pinkham of the Rocky Mountain Institute to conduct an examination of water use, water conservation, and alternative supply potential in non-reservation communities on the Coconino Plateau. Field interviews were conducted with utilities, system operators, and resource planners within Coconino County. An inventory of current water use and conservation efforts was developed, along with an assessment of data availability and the potential for further water use efficiency. Recommendations were made for a Phase II water demand analysis based on the data available with the region.

Professional Activities

American Water Works Association, member since 1996

- Member, Climate Change Committee, 2008-present
- Chair, Water Resources Division Planning and Management Committee, 2005-2009
- Trustee, Water Resources Sustainability Division, 2010-2016
- Co-chair, Sustainable Water Management Conference planning committee, 2013

Reviewer for the Journal of Water Resources Planning and Management

Reviewer for the Journal of the American Water Works Association

Reviewer for the Journal of Water Supply: Research and Technology

Book reviewer for American Water Works Association

Contributing author to AWWA M50 Water Resource Planning, Version 3

Publications and Presentations

Davis, W.Y. and T. J. Schaadt. "Finding the Next Tier of CII Water Efficiency." Presented at the AWWA Annual Conference, Denver, CO, June 2013.

Davis, W. Y. "Demand Side Management's Role in IWRM." AWRA Water Resources IMPACT. Volume 15, Number 3. May 2013.

Davis, W.Y. "Are There Added Costs to the Utility for Sustainability." Presented at the AWWA Sustainable Water Management Conference, Nashville, TN, April 2013.

Panelist: "Understanding the Impact of Climate Change on Water Resources Sustainability." WaterSmart Innovations Conference. Las Vegas NV. October 2012.

Davis, W.Y. "Demand Forecasting with Climate Change: What We Know and What We Don't Know." Presented at the AWWA Sustainable Water Management Conference, Portland, Oregon, March 2012.

Davis, W.Y. (contributing author). "Sustainability of Future Water Resources will be Dependent on Climate Variability." Committee report from the AWWA Climate Change Committee, Journal of American Water Works Association, June 2011.

Davis, W.Y., J. R. Fritsche, and B. M. Goldenberg. "Eliminating or Delaying $1.3 Billion of Capital Improvements with Water Conservation: Miami-Dade Water Facilities Master Plan" Presented at the Florida Water Resources Conference, Orlando, Florida, May 2011.

Davis, W.Y. "The Magnitude of Non-Revenue Water in Water Demand Forecasting." Presented at The Arab Water Week, the Arab Countries Water Utilities' Association (ACWUA) first international conference, Amman, Jordan, December 2010.

Davis, W.Y. "Estimating Future Water Conservation Savings in Statewide Planning: What is Potential?" Presented at the AWWA Sustainable Water Management Conference, Albuquerque, New Mexico, April 2010.

Davis, W.Y. "Case Studies in Integrated Water Resource Planning." Presented at the Illinois AWWA annual meeting, Springfield, Illinois, March 2010.

Davis, W.Y. "Case Studies in Integrated Water Resource Planning." Presented at the Indiana AWWA Annual Meeting, Indianapolis, Indiana, February 2010.

Davis, W.Y. (contributing author). "Sustainable Water Resources, a Compendium of Issues and Trends." American Water Works Association, 2010.

Davis, W.Y. "Forecasting Water Demand: M50 Chapter 3." Presented at American Water Works Association Sustainable Water Sources Conference, Reno, Nevada, February 2008.

Davis, W.Y., and J. Kiefer. "Incorporating Uncertainty in Long-range Forecasts of Water Demand: The Role of Uncertainty Analysis." Presented at American Water Works Association Water Sources Conference, Albuquerque, New Mexico, February 2006.

Davis, W.Y. "Demanding a Better Way: The Benefits of Water Demand Forecasting." *Public Works*. October 2005.

Davis, W.Y. "Developing a Water Demand Forecast for Puerto Rico: Challenges and Achievements." Presented at the 14th Annual Caribbean Water and Wastewater Association, Barbados, October 2005.

Davis, W.Y. "Case Studies in Effective Water Conservation Implementation." Invited presentation at the Florida Section American Water Works Association Pre-conference Workshop, Orlando, Florida, 2004.

Davis, W.Y., and D. Baird. "Waterless Urinals, Garbage Disposal Systems: Examples of Institutional Water Efficiency at Presidio of Monterey." *Public Works Digest*. Vol. XVI, No. 5. (September-October 2004).

Davis, W.Y., and D. Baird. "Waterless Urinals and Garbage Disposal Systems: Two Examples of Institutional Water Efficiency." Presented at American Water Works Association Water Sources Conference, Austin, Texas, 2004.

Davis, W.Y., and D. Baird. "Waterless Urinals and Garbage Disposal Systems: Two Examples of Institutional Water Efficiency." Presented at National Defense Industry Association Environmental and Energy Symposium, San Diego, California. 2004.

Davis, W.Y., and R. Pinkham. "A Regional Assessment of Water Demand in North Central Arizona." Presented at American Water Works Association Water Sources Conference, Austin, Texas, 2004.

Davis, W.Y. and R. Geisen. "Cost-Effective Water Conservation Planning for the Portland Metropolitan Area." Presented at American Water Works Association Annual Conference, Anaheim, California, 2003.

Davis, W.Y. "Preparing a Baseline Water Use Forecast for Conservation Planning." Presented at Water Conservation Program Planning Workshop for the Northwest Pennsylvania Department of Environmental Protection, Grove City College, Pennsylvania, 2002.

Davis, W.Y., E.A. Holland, and R. E. DuBose. "Analysis of Institutional Water Demand: A Standardized Approach." Presented at American Water Works Association Water Sources Conference, Las Vegas, Nevada, 2002.

Davis, W.Y. "Estimating the Value to Utilities of Plumbing Codes and Standards." Presented at American Water Works Association Water Sources Conference, Las Vegas, Nevada, 2002.

Davis, W.Y. "Preparing a Baseline Water Use Forecast for Conservation Planning." Presented at Quickstart to Water Conservation Program Planning Workshop at American Water Works Association Water Sources Conference, Las Vegas, Nevada, 2002.

Davis, W.Y. and J. C. Kiefer. "Estimating Water Savings from Water Conservation Programs: Finding the Right Evaluation Procedures." Presented at the Florida Section American Water Works Association Conference, Kissimmee, Florida, 2001.

Davis, W.Y., J. C. Kiefer, and B. Dziegielewski. "Long-term Water Demand Forecasting with Conservation: The End-Use Approach." Presented at Water Resources Conference of American Water Works Association, Norfolk, Virginia, 1999.

Davis, W.Y., J. C. Kiefer, and G.A. Porter. "Development of Residential Water Use Models from Household Level Data." Presented at *American Water Works Association 1999 Annual Conference*. Chicago, Illinois. 1999.

Davis, W.Y., B. Dziegielewski, and P.W. Mayer. "Existing Efficiencies in Residential Indoor Water Use." Presented at *CONSERV99, M*onterey, California, 1999.

Davis, W.Y. and C.M. Rogers. "Demonstration of IWR-MAIN Water Demand Management Suite for Windows." Presented at CONSERV99, Monterey, California, 1999.

Davis, W.Y. and B. Dziegielewski. "A Comparison of Water Demand Forecasting Methods." Presented at American Water Resources Association Annual Conference, Point Clear, Alabama, 1998.

Davis, W.Y. "Development of Municipal and Industrial Water Demand Forecasts for the ACT-ACF Comprehensive Study." Presented at Alabama-Coosa-Tallapoosa and Apalachicola-Chattahoochee-Flint (ACT-ACF) Water Allocation Workshop sponsored by the World Wildlife Fund, Jacksonville, Alabama, 1998.

Davis, W.Y. and B. Dziegielewski. "Advantages of Advanced Water Demand Forecasting Method." Presented at Water Resources Management Conference of American Water Works Association, Seattle, Washington, 1997.

Davis, W.Y. "Municipal and Industrial Water Use Forecasting for the Alabama-Coosa-Tallapoosa and Apalachicola-Chattahoochee-Flint (ACT-ACF) Comprehensive Study." Presented at Florida Chapter Meeting of American Water Resources Association, Apalachicola, Florida, 1996.

Davis, W.Y. and B. Dziegielewski. "Estimating the Benefits and Costs of Implementing Water Conservation Measure." Presented at CONSERV90: The National Conference and Exposition Offering Water Supply Solutions for the 1990s, Phoenix, Arizona, August 12-16, 1990.

Davis, W.Y. "Forecasting Municipal Water Demand and Conservation Evaluation: The IWR-MAIN System, Version 5.1." Presented at the Symposium on Water-Use Data for Water Resources Management, American Water Resources Association, Tucson, Arizona, 1988.

Davis, W.Y., J.D. Esseks, and S. E. Kraft. "Soil Conservation by Farmers: Results of Discriminant Analysis." Presented at the Annual Meeting of the American Agricultural Economics Association, Reno, Nevada, 1986.

Davis, W.Y., J.D. Esseks, and S.E. Kraft. "Adoption of Soil Conservation Practices in Jackson County, Illinois." Presented at the 79th Annual Meeting of Illinois State Academy of Science, Edwardsville, Illinois, 1985.

Davis, W.Y., and S. E. Kraft. "Economics of Soil Heterogeneity and Implications for Soil Conservation." Selected paper for meeting of Southern Agricultural Economics Association, Biloxi, Mississippi, 1985.

Course Instructor

Instructor for "IWR-MAIN, Water Demand Management Suite–Training Course." Sponsored by Kentucky Infrastructure Authority, Frankfort, Kentucky, September 2001.

Instructor for "IWR-MAIN, Water Demand Management Suite–Training Course." Sponsored by City of Albuquerque Public Works Department, Albuquerque, New Mexico, July 2001.

Instructor for "Forecasting Tomorrow's Municipal Water Demand." ASCE-EWRI Congress Short Course, Orlando, Florida, May 2001.

Instructor for "IWR-MAIN, Water Demand Management Suite–Training Course." San Antonio, Texas, May 2000; Anaheim, California, July 2000; November 2000, Seattle, Washington; September 2000, Orlando, Florida.

Instructor for "IWR-MAIN, Water Demand Management Suite–Training Course." St. Louis, Missouri, 1999.

Instructor for "IWR-MAIN, Version 6.1, Water Demand Analysis Software–Training Course." Sponsored by the Georgia Department of Natural Resources, Atlanta, Georgia, 1997.

Instructor for "IWR-MAIN, Version 6.1, Water Demand Analysis Software–Training Course." Sponsored by the U.S. Geological Survey, St. Louis, Missouri, 1997.

Instructor for "IWR-MAIN, Version 6.1, Water Demand Analysis Software–Training Course." Sponsored by the U.S. Army Corps of Engineers—Antilles, San Juan, Puerto Rico, 1997.

Instructor for "IWR-MAIN, Version 6.1, Water Demand Analysis Software–Training Course." Fort Lauderdale, Florida, 1996.

Instructor for "IWR-MAIN, Version 6.1, Water Demand Analysis Software–Training Course." St. Louis, Missouri, 1995.

Instructor for "IWR-MAIN Water Demand Analysis Software, Version 6.1–Training Workshop." Training Course conducted for the Alabama-Coosa-Tallapoosa and Apalachicola-Chattahoochee-Flint (ACT-ACF) Comprehensive Study, Tallahassee, Florida, 1995.

Instructor for "IWR-MAIN, Version 6.1, Water Demand Analysis Software–Training Course." St. Louis, Missouri, 1995.

Instructor for "IWR-MAIN Water Demand Analysis Software, Version 6.0–Training Workshop." Training Course conducted for the U. S. Army Corps of Engineers, Los Angeles District, Los Angeles, California, 1995.

Instructor for "IWR-MAIN Water Demand Analysis Software, Version 6.0–Training Workshop." Training Course conducted for the Alabama-Coosa-Tallapoosa

and Apalachicola-Chattahoochee-Flint (ACT-ACF) Comprehensive Study, Montgomery, Alabama, 1994.

Instructor for "IWR-MAIN Water Demand Analysis Software, Version 6.0–Training Workshop." Training Course conducted for the Alabama-Coosa-Tallapoosa and Apalachicola-Chattahoochee-Flint (ACT-ACF) Comprehensive Study, Atlanta, Georgia, 1994.

Instructor for "IWR-MAIN Water Demand Analysis Software, Version 6.0–Training Workshop." Training Course conducted for the U. S. Army Corps of Engineers, Mobile District, Mobile, Alabama, 1994.

Instructor for SWF-MAIN Water Use Forecasting System, Version 5.1–Training Workshop." Conducted for Southwest Florida Water Management District, Brooksville, Florida, December 1990.

Instructor for "IWR-MAIN Water Use Forecasting System, Version 5.1–Training Workshop." Training Course conducted for the U. S. Army Corps of Engineers, Louisville District, Louisville, Kentucky and subsequent series of IWR-technical workshops in Frankfort, Covington and Bowling Green for State of Kentucky, Division of Water, 1989.

Instructor for "IWR-MAIN Water Use Forecasting System, Version 5.1–Training Workshop." Training Course conducted for the U. S. Army Corps of Engineers, Louisville District, Louisville, Kentucky and subsequent series of IWR-MAIN technical workshops in Frankfort, Covington and Bowling Green for State of Kentucky, Division of Water, 1989.

Facilitator of group workshop at the Strategic Planning Workshop on Future Engineering Challenges and OCE/USACE Long-Range Planning, Fort Belvoir, Virginia, 1988.

Bridget R. Scanlon, Ph.D.

Research Associate

Education

Ph.D. – Geology, University of Kentucky, Lexington, 1985

M.Sc. – Geology, University of Alabama, Tuscaloosa, 1983

B.Sc. – Geology, Trinity College, Dublin, 1980

Bridget Scanlon is a Senior Research Scientist at the Bureau with 30 years of experience in the fields of hydrogeology, unsaturated zone hydrology, and groundwater quality. She has ~100 peer reviewed journal publications and has given presentations at state, national, and international conferences. Dr. Scanlon also is also very interested in the linkages between water resources and energy production and assessing a variety of water sources, including brackish resources. This includes presentations to industry to encourage them to share the data they are currently collecting that is relevant to brackish resources. She has conducted several studies related to irrigated agriculture, related to water quantity and quality issues, mostly in the High Plains with comparisons with the California Central Valley. Her recent research has focused on the interdependence of water and energy, including water consumption for power generation and water use for energy extraction.

Principal Investigator, State of Texas Advanced Research, 2012 –2013. Controls on Water Use for Power Generation in Texas. This study involved updating the data on water withdrawal and consumption for electricity generation in Texas for 2010 using data from Energy Information Administration, Texas Water Development Board, and Texas Commission on Environmental Quality. In addition to quantifying water withdrawal and demand for 2010, we also evaluated spatial variability in water use for thermoelectric power plants. We identified the primary controls on water demand, including fuel type (nuclear, coal and natural gas), generator technology (combustion turbine [no water], steam turbine, and combined cycle [combustion and steam turbines]; and cooling system [once-through and cooling towers]. Changes in water withdrawal and consumption over time varied with increasing numbers of natural gas combined cycle plants replacing coal steam turbine plants and reducing water use since the late 1990s. We worked with power plant operators and river authorities to validate our results. This study provided extensive experience with using EIA data on water withdrawal and consumption for power generation. We also interacted with ERCOT to determine projections on water demand with power plant retirements and replacements with new plants.

Principal Investigator, State of Texas Advanced Research, 2012 –2013. Water Demand versus Supplies for Thermoelectric Generation. This study examined water demand for thermoelectricity, particularly during the extreme drought in 2011 and comparing it with water supplies for power generation. While 2011 represented the most extreme one year drought on record in Texas with heat waves in the summer, water demand for electricity generation only increased a few percent. The drought was expected to cause brownouts or blackouts; however, analyses of the data showed that power plant operators adapted to the extreme conditions by switching cooling systems or generator technology to reduce water demand. In this analysis, we compared water demand for electricity generation with that in other sectors, including irrigation and municipal and industrial use. Water demand in 2011 (drought) was compared with that in 2010, a considered a normal year. The study provided an in depth evaluation of water demand for electricity generation and the various water supplies, including surface water and recycled

municipal waste water. We conducted several meetings with power plant operators to better understand their water demand and ability to adapt to extreme drought conditions.

Principal Investigator, Shell Univ. of Texas Unconventional Resource, 2012 - 2014. Water Demand for Hydraulic Fracturing in the Eagle Ford Shale Play. Dr. Scanlon and team quantified water demand for hydraulic fracturing in the Eagle Ford play from 2005 – 2013 using data from the IHS and FracFocus databases. Controls on water demand were determined, including length of horizontal wells, number of frac stages per well, type of frac fluid (slickwater, gel, or hybrid) etc. Trends in water demand were determined and variations in water use for oil versus gas wells were examined. We compared water demand for oil and gas extraction in the Eagle Ford shale with that in the Bakken in N. Dakota. Water demand for hydraulic fracturing was compared with water supplies in the Eagle Ford, with the dominant source being fresh groundwater from the Carrizo-Wilcox aquifer. We estimated future water demand over the life of the play (~ 20 years) and compared it with fresh and brackish water resources estimated from water quality data and the Groundwater Availability Models at a square mile grid scale. We showed that water demand for hydraulic fracturing represents ~ 6% of the water consumed at power plants that use that gas.

Principal Investigator, Texas Commission on Environmental Quality, 2010 – 2011: Comparison of Water Demand relative to Supplies in the High Plains and California Central Valley. Dr. Scanlon led efforts examining water demand for irrigation in the U.S. High Plains and the Central Valley of California and compared those with water supplies and groundwater pumpage to determine aquifer depletion. The results of this study were very interesting, showing variations in groundwater depletion in the High Plains results from differences in groundwater recharge between Nebraska and Texas: higher recharge in Nebraska supporting irrigation attributed to coarser textured soils relative to lower recharge in Kansas and Texas, resulting in intensive depletion. We examined spatial and temporal variability in water demand for irrigation over decades. Maps of irrigated areas were obtained from remote sensing. Various approaches for quantifying irrigation water demand in the different states were compared. The comparison provided valuable insights into water demand estimation in the different regions.

Principal Investigator; Bureau of Reclamation, 2009 – 2010: Impacts of irrigation on groundwater quantity and quality in the Texas High Plains. Dr. Scanlon and her team evaluated the impacts of irrigated agriculture on groundwater resources in the Texas High Plains. This study provided strong evidence for deficit irrigation in the High Plains as evidenced by the salt buildup in the soils under irrigated areas. Soil profiling provided strong evidence for deficit irrigation and indicated that soil salinization may become an issue in the future if sufficient irrigation is not applied to flush salts through the soil profile. Such data can constrain water demand estimates for irrigated agriculture.

Principal Investigator; Panhandle Groundwater Conservation District, 2009 – 2010: Irrigated Agriculture in the Central High Plains. This study involved detailed soil profiling to assess the water use and recharge rates beneath irrigated agriculture relative to dryland agriculture and rangeland areas in the Central High Plains in Texas. Results of the analyses showed the dominant control of soil texture on water movement through the soil profile. Therefore, previous groundwater models that suggested large volumes of irrigation return flow from irrigated agriculture are not supported by the soil profile data.

This study provides constraints on water use for irrigation in the Central High Plains and indicates that most of the water remains in the shallow subsurface to be used by crops. The latest revision of the groundwater model for the High Plains incorporates these findings into the model and greatly reduces irrigation application in these regions.

References

Reedy RC, Scanlon BR, Nicot JP, Uhlman K (2014) Drought Resilience of Water Supplies for Shale Gas Extraction and Related Power Generation in Texas AGU Fall Meeting GC13b-0630

Reedy RC, Scanlon BR (2013) Temporal Evolution of Water Use for Thermoelectric Generation. Abstract H11J-1275 presented at 2013 Fall Meeting, AGU, San Francisco, Calif, 9-13 Dec

Scanlon BR, Duncan I, Reedy RC (2013) Drought and the water energy nexus in Texas. Environ Res Lett, 8(4), 045033, doi:101088/1748-9326/8/4/045033.

Scanlon BR, Reedy RC, Duncan I, Mullican WF, III, Young MY (2013) Controls on Water Use for Thermoelectric Generation: Case Study Texas, U.S. Env Sci & Tech, 47, 11326-11334 47

Scanlon BR, Faunt CC, Longuevergne L, Reedy RC, Alley WM, McGuire VL, McMahon PB (2012) Groundwater depletion and sustainability of irrigation in the US High Plains and Central Valley. Proceedings of the National Academy of Sciences of the United States of America 109: 9320-9325 DOI 10.1073/pnas.1200311109

Scanlon BR, Reedy RC, Gates JB (2010) Effects of irrigated agroecosystems: (1) Quantity of soil water and groundwater in the Southern High Plains, Texas. Water Resour. Res., 46, W09537, doi:101029/2009WR008427

Scanlon BR, Gates JB, Reedy RC, Jackson A, Bordovsky J (2010) Effects of irrigated agroecosystems: (2). Quality of soil water and groundwater in the Southern High Plains, Texas. Water Resou. Res. , 46, W09538, doi:101029/2009WR008428

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Scanlon BR, Reedy RC, Gates JB, Gowda PH (2010) Impact of agroecosystems on groundwater resources in the Central High Plains, USA. Agriculture, Ecosystems, & Environment 139: 700-713.

William F. Mullican, III, P.G.
Water Resources Specialist

In his over 30-year career, Mr. Mullican has specialized in the field of water planning. He is experienced in the creation, design, development and management of complex, multi-disciplinary projects. His integrated approach includes oversight, development, and implementation of water policy, technical aspects of surface water and groundwater availability, and population and water demand projections for a wide variety of water user sectors. Mr. Mullican also has extensive interaction with the technical community, governmental entities at the local, state, and federal levels, stakeholders, and general public and provided invited testimony to the United States Congress on four occasions, over 25 occasions to the Texas Legislature, and authored and coauthored over 135 scientific books, articles, and reports, and two Texas State Water Plans. Since his retirement from the TWDB, Mr. Mullican has continued to expand his water planning experiences with CMD Smith in their state water planning efforts in Georgia, Colorado, and most recently in Arkansas. There efforts have provided a better understanding of the tools necessary to support regional and state water planning. Most recently, he served as Co-Chairman of the Texas Water Conservation Association's Groundwater Panel, Aquifer Storage and Recovery Committee which was successful in developing consensus legislation for consideration by the 84th Texas Legislature.

Experience Highlights

- Development of 2002 and 2007 Texas State Water Plans
- Creation, design, and oversight of Groundwater Availability Modeling Program at TWDB
- Responsible for strategic direction of brackish groundwater and sea water desalination programs at TWDB
- Developed concept and design for Brackish Resources Aquifer Characterization System approved by Texas Legislature in 2009

Texas Water Development Board. From 1997 to 2009, Mr. Mullican worked for the Texas Water Development Board. His responsibilities included developing methodologies for projecting water demands in the six major water use sectors on which water planning in Texas is based. Utilizing these new water demand projections and population projections, Mr. Mullican was responsible for development and adoption of the first Texas State Water Plan (2002) based on the Senate Bill 1 regional water planning process.

Deputy Executive Administrator for Water Science and Conservation. In this position, Mr. Mullican served in two critical overarching capacities. First, to provide leadership and direction to the agency's ever expanding scientific and conservation programs as mandated by Senate Bill 2 (2001), House Bill 1763 (2005), Senate Bill 3 (2007), and House Bills 3 and 4 (2007). Second, primary responsibilities include overall direction, management, coordination, and allocation of resources. Programmatic responsibilities included:

- Development of the State Water Plan
- Technical assistance for groundwater conservation districts

Education

M.S. – Geology, Texas Tech University (1978)

B.S. – Broadfield Science-Education, Texas Tech University, 1978

Registrations, Licenses, Certification

Professional Geoscientist, Texas

Certified Ground Water Profession, National Ground Water Association

CDM Smith

- Water Research Program
- Environmental, including Bay and Estuary, and Instream Flow Program
- Conservation Technical Assistance
- Agricultural Water Conservation Program

Deputy Executive Administrator for Planning. In this position, Mr. Mullican functioned as the Chief State Water Planner. Primary responsibilities included overall direction, management, coordination, and allocation of resources for the Office of Planning. Programmatic responsibilities included:

- Development of foundational information to be utilized in the regional water planning process, including water demand projections, water supply projections, and socioeconomic impact analysis.
- Development of the State Water Plan
- Groundwater Availability Modeling
- Coordination, management, and technical assistance for regional water planning
- Texas Water Bank and Texas Water Trust
- Research and Planning Fund Grant Management
- Conservation Technical Assistance
- Agricultural Water Conservation Program
- Water Use Survey Program
- Texas Flood Control Planning Program
- FEMA Flood Mitigation Assistance Program (
- Streamgaging Program
- Hydrographic Survey Program

Division Director, Water Resources Planning. Mr. Mullican's primary responsibilities included direction, management, coordination, and allocation of resources for the development of the Texas State Water Plan. Responsibilities also involved the direction of technical, planning, and policy initiatives related to the planning for long term water resource needs for the State of Texas.

Professional Activities

Member, National Advisory Council for Environmental Policy and Technology, appointed by the U.S. Environmental Protection Agency Administrator Stephen Johnson, April 23, 2007 (term expires April 23, 2009).

Member, Rehabilitation Council of Texas, appointed by Governor Rick Perry, November 17, 2005 (term expires October 29, 2009).

Co-Chairman, Texas Water Conservation Association Groundwater Panel, Aquifer Storage and Recovery Committee.

Todd G. Caldwell, Ph.D.

Research Associate

Education

Ph.D. – Hydrogeology, University of Nevada, Reno, 2011

M.S. – Hydrogeology, University of Nevada, Reno, 1999

B.S. – Earth and Planetary Sciences, University of New Mexico, 1997

Dr. Todd Caldwell is a hydrologist and geoscientist at the Bureau of Economic Geology in the Jackson School of Geosciences at the University of Texas at Austin. He specializes in field investigations and numerical modeling associated with soil and vadose zone processes and its application to the remote sensing of water resources. His current research focuses on drought, soil moisture monitoring, modeling and scaling, as well as soil-plant interactions, near-surface geophysics and regional evapotranspiration. Dr. Caldwell has published over 20 papers in peer review literature.

Principal Investigator, Texas Water Development Board, 2013 –2016. Improving Irrigation Water Use Estimates with Remote Sensing Technologies: An initial feasibility study for Texas. Accurate estimates of crop evapotranspiration (ET) are needed annually to determine irrigated water use per county and to feed into irrigation demand estimates state-wide. Remote sensing has the potential to improve the accuracy of crop ET (water out) and precipitation (water in) by increasing the spatial and temporal resolution state-wide. As PI, Dr. Caldwell is to assessing the feasibility of the current state-of-the-science remote sensing approaches to quantify crop ET across the climatically and agriculturally diverse landscape of Texas.

Principal Investigator, Edwards Aquifer Authority, 2015 – 2018. Quantifying Diffuse Recharge at Camp Bullis, TX: Integrating soil water, evapotranspiration, and remote sensing. Dr. Caldwell is leading the effort to develop, evaluate, and quantify water balance estimates of inter-stream (or diffuse) recharge into the Trinity Aquifer and the Edwards Aquifer at Camp Bullis, Bexar County, Texas. This study employs a multi-scale modeling/remote sensing approach and characterizes multiple components of water flux through the vadose zone of the Aquifers. In so doing, this study is integrating measurements of evapotranspiration annually from selected field locations with soil water content derived from in-situ sensors, and eddy covariance weather tower measurements combined with field-based geophysics repeated at other selected sites. A one-dimensional vadose zone model and remote sensing data will then be utilized to scale up the evapotranspiration estimates to a regional scale over the entire approximately 28,000 acre area of Camp Bullis.

Principal Investigator, NASA Jet Propulsion Laboratory, 2015-2016. Texas Soil Observation Network (TxSON). Dr. Caldwell and team have designed, calibrated and build an intensively-monitored soil moisture research area (1300 km^2) in support of NASA's Soil Moisture Active/Passive (SMAP) Cal/Val Program. TxSON is located near Fredericksburg, Texas along the Pedernales River. The network consists of over 40 monitoring stations that measure in situ soil moisture and precipitation in real-time. TxSON produces regional scale soil moisture at 3, 9 and 36 km pixels, serving as one of 9 core sites in the SMAP Cal/Val mission.

Principal Investigator, Edwards Aquifer Authority, 2013 – 2015. Soil Characterization and Diffuse Recharge at Camp Bullis, Texas. Dr. Caldwell led efforts to characterize the physical properties of soil at 23 existing monitoring locations, develop a 1-D vadose zone model for each location and benchmark the results to available time

series data of in situ soil moisture at Camp Bullis. The results will help inform a recharge map that can guide further efforts for larger-scale ET mapping over the Edwards Aquifer Zone. This approach will focus on the controls of deep vadose zone recharge, namely soil water storage and percolation of precipitation below the root zone.

References

Caldwell TG, Huntington J, Joros A, Howard T, Scanlon BR (2014). Improving irrigation water use estimates with remote sensing technologies: an initial feasibility study for Texas. Contract Report prepared for the Texas Water Development Board, 52 Pp.

Caldwell TG (2015), Soil Characterization at Camp Bullis, TX. Contract report prepared for the Edwards Aquifer Authority, 22 Pp.

Christina (Tina) M. Petersen, Ph.D., P.E.

Associate Water Resources Engineer

Dr. Petersen is an experienced water resources project manager and team leader with over 14 years of experience, supporting her c lients on a wide range of water resources project needs, including water supply (industrial, power generation and municipal), water quality, and water reuse challenges. She has worked closely with numerous power generation and industrial facilities to evaluate their water use and identify conservation strategies for better managing their water supply. She has applied or overseen application of a number of water quality, hydrologic and hydraulic modeling tools in her work including HSPF, SWMM, WASP, WinSLAMM, CORMIX, SWAM, SLAMM, EFDC, SWAT, HEC-HMS, HEC-RAS, and StormCAD. Dr. Petersen has published over 30 papers in conference proceedings and peer review literature.

Water Supply

Project Manager, Water Conservation Planning, Confidential Power Generation clients (8/2011 – 5/2013). Dr. Petersen is leading several water conservation studies for natural gas combined cycle power plants throughout Texas. The projects involves several phases: drought support services to evaluate water supply risk and potential for water competition, development of a water conservation study to identify best management practices and a water conservation plan to document the planned improvements using TCEQ industrial water conservation plan guidance. To develop the water conservation study, Dr. Petersen applied a CDM Smith-developed tool to assess initial BMP options. These BMPs were reviewed by the project team and customized to develop facility specific recommendations. Subsequently, the water conservation plan was prepared using information from the water study.

Project Manager, Water Conservation Tool for Power Generators, CDM Smith Internal Research Project (10/2011 – 12/2011). Dr. Petersen lead a n internal CDM Smith research project to develop a tool to assist clients with understanding water conservation opportunities at natural gas combined cycle power plants. The tool uses a combination of operational and water balance data to develop metrics that are compared with industry standard benchmarks to identify water conservation opportunities. The tool then provides an array of best management practices that can be evaluated through an on-site facility audit. The tool was developed in Microsoft Access and is readily scalable to incorporate new benchmarks and/or BMPs.

Project Manager, Eagle Ford Water Management Study, Marathon Oil Company, Texas (9/2011 – current). As project manager, Dr. Petersen has led a team of water experts to prepare a comprehensive water management plan for Marathon's Eagle Ford asset management team. This work started with a fundamental evaluation of Texas water rights and water law to understand the full regulatory requirements associated with acquiring water for O&G operations and more specifically the hydraulic fracturing process. The evaluation went on to include detailed aspects of water supply and availability, permitting requirements for the Railroad Commission and Groundwater Conservation Districts, as well as various requirements and recommendations for the construction of both freshwater and brackish water supply wells in the Carrizo-Wilcox aquifer.

Education

Ph.D. – Environmental Engineering, University of Houston, 2006

M.S. – Environmental Engineering, University of Houston, 2003

B.S. – Biology and Environmental Studies, Baylor University, 1997

Registration

Professional Engineer: Texas, 2009

CDM Smith

Project Manager, Dallas Long Range Water Supply Plan, City of Dallas Water Utilities (Subconsultant to HDR), Texas (11/2012 – 4/2015). For this project, Dr. Petersen is leading a team of engineers and planners to provide an update to the Dallas Long Range Water Supply Plan. Tasks included as part of this project include providing guidance on groundwater regulatory environment and developing options to incorporate the Integrated Pipeline into the Dallas Water Utilities System through their existing water treatment plants or a new Southwest Water Treatment Plant as well as providing reuse and new intra-state water supply options. The team is also working to support regional coordination, identification of emergency supplies.

Project Manager, Technically Based Local Limit Development (TBLL) Development and Pretreatment Program Assistance, City of Bryan, Texas (4/2012 – current). Dr. Petersen is assisting the City of Georgetown to develop a new industrial pretreatment program. As part of this project, she is leading the project team in the development of standard operating procedures, enforcement response guides/procedures and will assist the client with TCEQ negotiations and responding to comments on the program.

Project Manager, Water Reuse Permitting and Water Quality Evaluation, City of Wichita Falls, Texas (5/2013 – 10/2014). Dr. Petersen is Project Manager for this indirect potable reuse permitting project to supplement the City of Wichita Falls' Lake Arrowhead water supply with up to 16 mgd of reclaim water from the city's River Road wastewater treatment plant. Her innovative work demonstrated that indirect potable reuse was a viable water supply strategy for the drought-stricken City. Specific tasks on the project related to water quality modeling of nutrients and TDS for the permit application, as well as creative problem solving to surmount regulatory and institutional challenges.

Project Engineer, Water Reuse Feasibility Study, City of Wichita Falls, Texas (10/2012 – 4/2013). Dr. Petersen is a Project Engineer for both indirect and direct potable reuse for Wichita Falls. The indirect potable reuse alternatives evaluated sending approximately 10 mgd of reclaim water to either Lake Arrowhead, a current water supply source, or Lake Wichita which was a previous water supply source for the city. The direct potable reuse options evaluated modifications to either of the city's two water treatment plants for advanced treatment of up to 10 mgd of reclaim water. Based on both economic and non-economic factors, indirect potable reuse to Lake Arrowhead was the recommended alternative for long term implementation.

Project Manager, Port of Houston General Water Quality Consulting (Excluding Stormwater), Houston, Texas (5/2009- 6/2012). Dr. Petersen was the project manager for this Port of Houston contract. Task orders executed under this contract included the development of Flushing Plans for Barbours Cut and Bayport Terminals, evaluation of impact to the PHA by proposed Ballast Water Regulations, preparation of a Vessel General Permit Compliance Logbook and support for regulatory questions that arise and preparation of a water accounting study, which lays the groundwork for future water conservation activities.

Project Manager, Ellis and Johnson Counties Regional Supply Study, Tarrant County, Texas (10/2010 – 3/2012). Dr. Petersen managed this project to evaluate regional water supply alternatives for Ellis and Johnson Counties using the STELLA model developed for the Integrated Pipeline Study. Alternatives being evaluated include terminal storage

options and water integration plans for several water supply reservoirs in Central Texas to prioritize use of local supply and improve the reliability of the regional water supplies for the counties. The project also includes coordination with water user groups and regional wholesale water providers for the Upper Trinity basin.

Project Engineer, Raw Water Transmission Integration Study, Tarrant Regional Water District/City of Dallas, Texas (10/2010 – 6/2011). Dr. Petersen was part of a project team developing a system operations model using STELLA to represent the infrastructure operations of the integrated transmission system for TRWD and Dallas Water Utilities. Tasks associated with this project included evaluation of different operational scenarios and associated costs. The operations model was the one and only model that represented the TRWD, Dallas, and the Integrated Pipeline (TRWD and Dallas) operations.

Task Leader, Source Water Protection, Texas Commission on Environmental Quality (TCEQ), Texas (9/2007 – 8/2010). As task leader for the Source Water Protection project for the Texas Commission on Environmental Quality, Dr. Petersen directed field and office work to identify potential sources of contamination for a number of public water supply systems in Texas. As part of this work, she developed a best management practice (BMP) evaluation and selection database supplemented with funding options. She also provides oversight to subcontractors in preparation of a project website, media toolkit and various educational brochures. Dr. Petersen represents the project at public stakeholder meetings and outreach events.

Project Manager, Technically Based Local Limit Development (TBLL) Development and Pretreatment Program Assistance, Galveston, Texas (3/2010 – 7/2010). Dr. Petersen assisted the City of Galveston with the update of its industrial pretreatment program. As part of this project, she lead the project team in providing industrial user survey assistance, development and implementation of a wastewater treatment plant and collection system sampling program, development of TBLLs and preparation of a summary report for TCEQ. The program development required significant and close coordination with the TCEQ staff to meet critical deadlines throughout this fast-paced project.

Technical Lead, Groundwater Reduction Plan, Texas (1/2010 – 11/2010). In support of groundwater reduction planning, Dr. Petersen is assisting with evaluating alternatives for Frito Lay, a local industrial client. The plan focuses on novel approaches to meeting the required reductions by the Fort Bend Subsidence District, including water reuse. As part of the evaluation, a hayfield water balance was developed to account for runoff, soil moisture, and evapotranspiration. The results of this analysis will be presented to the Fort Bend Subsidence District.

Hydrology / Stormwater

Project Engineer, Containment Assessment, Texas (3/2007 – 5/2007). Dr. Petersen assisted an industrial client with evaluating alternatives to satisfy the containment requirements for oil specified in the Spill Prevention, Control, and Countermeasure Plan (SPCC) regulations. Findings from this evaluation demonstrated that the client was meeting SPCC containment requirements.

Project Engineer, Watershed Master Plan, Texas (10/2006 – 4/2007). As a project engineer for the watershed master plan, Dr. Petersen conducted HEC-RAS and HEC-HMS

modeling to estimate ultimate conditions for various levels of service. The analysis included determination of channel size, channel geometry, channel profile, and required right-of-way for ultimate conditions.

Project Engineer, Stormwater Modeling, Texas (11/2006- 3/2007). Dr. Petersen was responsible for the development of a StormCAD model simulating a ½ acre industrial site from existing plant information and survey data. The work included supervision of survey crews. The steady state assessment evaluated peak flows entering a treatment basin. Recommendations were provided to size treatment basins and pumps.

Project Engineer, Hydrologic Modeling, Texas (10/2006 – 1/2007). Dr. Petersen assisted in the analysis of current drainage conditions for Team Express. Hydrologic modeling for this work used the HouStorm model, a Houston-specific version of the WinStorm hydrologic modeling software.

Additional Experience

Task Manager, Hydrodynamic and Water Quality Model for Fort Worth Central City, Fort Worth, Texas (5/2013 – current). CDM Smith is supporting Tarrant Regional Water District on the Central City project, which will construct a bypass channel on the Trinity River to allow flood waters to bypass downtown fort worth, allowing for revitalization and development of a new "isolated" waterfront area. Dr. Petersen is leading the development of the watershed model to determine watershed and operational strategies necessary to ensure suitable water quality as part of a significant redevelopment. In Phase 1 of the project, she lead the development of a SWMM5 water quality model that is linked to a CE-QUAL-W2 receiving water model. Modeled constituents include nutrients, sediment, and bacteria. As part of Phase 2, she is leading the project team in evaluation of best management practices - in particular green infrastructure – that can be applied to mitigate water quality concerns.

Project Manager, City of Beaumont MS4 Permitting Support, Beaumont, Texas (10/2012 – current). As project manager, Dr. Petersen is managing the Municipal Separate Storm Sewer System (MS4) Permit for the City of Beaumont. Services provided include conducting representative monitoring, and conduct required dry and wet weather screenings. Dr. Petersen also oversees preparation and submittal of the Annual Report to the TCEQ and will represent the City on permit renewal modifications as well as conduct employee training at City departments and provide Storm Water Management Program (SWMP) implementation activities for best management practices (BMPs). When requested, Dr. Petersen also oversees assistance to the City on Industrial facility inspections and construction site audits as well as other activities as required by the MS4 Permit.

Professional Activities

Member, Water Environment Federation

Water Environment Association of Texas Watershed Management Committee

Member, American Society of Civil Engineers

Environmental and Water Resources Systems Committee

Publications and Presentations

Invited Presentations

Petersen, T.M., H.S. Rifai, and P. LaWare. "Modeling Fecal Coliform Contamination in the Rio Grande." Presented at the Technical Advisory Work Group of the Lower Rio Grande Water Quality Initiative, Harlingen, Texas, October 16, 2008,.

Petersen, T.M., and C. Sowells. "Implementing Source Water Protection Programs in a Voluntary Environment in Texas." Presented at Texas Commission on Environmental Quality Public Drinking Water Conference, 2009.

Petersen, T.M. " Obtaining Individual Permits for Phase I (Large & Medium-Size) Systems." Halfmoon Stormwater Management for Municipal Separate Storm Sewer Systems (MS4s) Workshop. January 27, 2015.

Journal Publications

Petersen, T.M., R. Sobel and H.S. Rifai. 2015 - In Review. "Linking HSPF with a Tidal Prism Model for Simulating Indicator Bacteria in a Coastal Watershed." *Journal of American Water Resources Association.*

Desai, A.M, H. S. Rifai, T. M. Petersen, and R. Stein. "Mass Balance and Water Quality Modeling for Load Allocation of *E. coli* in an Urban Watershed." *Journal of Water Resources Planning & Management*, Vol. 135, Issue 5, (September 2011): 412-427.

Petersen, T.M., H.S. Rifai, G.C. Villarreal, and R. Stein. "Modeling *Escherichia coli* and its Sources in an Urban Bayou with HSPF." *Journal of Environmental Engineering*, Vol. 137, Issue 6, (June 2011): 487-503.

Petersen, T.M., H.S. Rifai, and R. Stein.. "Bacteria Load Estimator Spreadsheet Tool (BLEST) For Modeling Spatial *Escherichia coli* Loads to an Urban Bayou." *Journal of Environmental Engineering*, Vol. 135, Issue 4, (April 2009): 203-217. **Received CDM award for Best Peer Review Paper in 2009.**

Petersen, T.M., M.P. Suarez, H.S. Rifai, P. Jensen, Y.C. Su, and R. Stein. "Status and Trends of Fecal Indicator Bacteria in Two Urban Watersheds." Water Environment Research. Vol. 78, No. 12, (2006): 2340-2355.

Petersen, T., M.P. Suarez, H.S. Rifai, and R. Stein. "Bacteria Loads from Point and Nonpoint Sources in an Urban Watershed." *Journal of Environmental Engineering*. Vol. 131, Issue 10, (October 2005): 1414-1425.

Conference Presentations/Papers

Titus, T., Tina Petersen, Austin Haynes, Jason Mills, Stew Magenheimer. 2015. "The Use of Brackish Groundwater for Hydraulic Fracturing Activities in South Texas." 2015 NGWA Groundwater Summit. March 8, 2015.

Haynes, A; Tom Titus, Tina Petersen. 2015. "Water Management and Reuse Considerations for Hydraulic Fracturing." 2015 Industrial and Commercial Water Reuse Conference, Austin, TX. February 2, 2015.

Petersen, T.M., Susan Crawford, Richard Wagner. 2014. "Water quality considerations for indirect potable reuse permitting." 4th Annual Texas Water Reuse Conference; Houston, TX. July 18, 2014.

Petersen, T.M., Bob Brashear, Tim Osting. 2014. "Case Study: Linking Watershed and Receiving Models to Protect and Enhance Water Quality in the Trinity River." USEPA Region 6 MS4 Stormwater Conference; Fort Worth, TX. July 30, 2014

Petersen, T.M, Rose Sobel, Hanadi S. Rifai. "Novel Case Study of Indicator Bacteria Modeling in Tidal Water Bodies Along the Texas Gulf Coast." WEFTEC Stormwater Congress; New Orleans, LA. October 1, 2014.

Petersen, T.M., T. Beck. "Water Management Sourcing, Treatment and Disposal." U.S. China Oil and Gas Industry Forum, San Antonio, Texas, 2012.

Petersen, T.M., T. Beck. "Water Management Sourcing, Treatment and Disposal." U.S. China Oil and Gas Industry Forum, San Antonio, Texas, 2012.

Petersen, T.M., R. Kim, G. Cooley. "Development of a Water Conservation Tool for Power Generators." International Water Conservation Conference, San Antonio, Texas, 2012.

Petersen, T.M. Randi Kim. "Development of a Water Conservation Tool for Power Generators." Energy Utility and Environmental Conference, Phoenix, Arizona, 2012.

Petersen, T.M., C. Sowells, E. Johnson, and S. Ables. "Implementing Voluntary Source Water Protection in the State of Texas." Selected for Platform Presentation and Paper at the World Water and Environmental Resources Congress, Providence, Rhode Island, 2010.

Petersen, T.M., H. Rifai, R. Wagner, R. Miranda. "Evaluation and Modeling of Bacteria Water Quality in an Urbanizing Stream." Selected for Platform Presentation and Paper at the World Water and Environmental Resources Congress, Providence, Rhode Island, 2010.

Lu, Silong and Christina Petersen. "Hydrodynamic, Sediment, and Water Quality Modeling Evaluations of the Maurepas Swamp for the Blind River Freshwater Diversion." Selected for Platform Presentation and Paper at the 2010 Restore America's Estuaries 5th National Conference on Coastal and Estuarine Habitat Restoration - Preparing for Climate Change: Science, Practice, and Policy.

Lea, C.K., T. Petersen, C. Sowells, S. Ables. "Clean Water Everywhere: A Look at Source Water Assessment and Protection across the United States." Selected for Platform Presentation and Paper at the Texas Water, Corpus Christi, Texas, 2010.

Petersen, T.M., C. Sowells, E. Johnson, and S. Ables. "Implementing Voluntary Source Water Protection in the State of Texas." Selected for Platform Presentation and Paper at the Association of State Drinking Water Administrators, Portland, Oregon, 2009.

Petersen, T., H.S. Rifai, L. Grecho, and R. Miranda. "Bacteria Water Quality in Dickinson Bayou." Selected as an Alternate for Platform Presentation and Paper at Water Environment Federation TMDL Conference, Minneapolis, Minnesota, 2009.

Petersen, T.M., C. Sowells, G. McCurry, A. Doody, and S. Ables. "Selection and Prioritization of Best Management Practices for Potential Sources of Contamination in a Wellhead Protection Area." Selected for Platform Presentation and Paper at the World Water and Environmental Resources Congress, Kansas City, Kansas, 2009.

Sowells, C., T. Petersen, and S. Ables. "Implementing Source Water Protection in a Voluntary Environment." Selected for Platform Presentation and Paper at the World Water and Environmental Resources Congress, Kansas City, Kansas, 2009.

Petersen, T., C. Sowells, G. McCurry, A. Doody, and C. Krug. "A Tale of Two Cities - Source Water Protection Case Studies for Systems in Rural Settings." Selected for Platform Presentation and Paper at the World Water and Environmental Resources Congress, Kansas City, Kansas, 2009.

Petersen, T., H.S. Rifai, L. Grecho, C. Sowells, and R. Miranda. "Bacteria Water Quality in Dickinson Bayou." Selected for Platform Presentation at the World Water and Environmental Resource Congress, Galveston, Texas, 2009.

Petersen, T., C. Sowells, G. McCurry, A. Doody, and C. Krug. "A Tale of Two Cities - Source Water Protection Case Studies for Systems in Rural Settings." Selected for Platform Presentation at the World Water and Environmental Resource Congress, Galveston, Texas, 2009.

Petersen, T., H.S. Rifai, R. Stein, and C. Sowells. "Comparisons of Methods to Calculate TMDLs for *E. coli*: Load Duration Curves, Mass Balance and HSPF." Selected for Platform Presentation and Paper at the World Water and Environmental Resources Congress, Honolulu, Hawaii, 2008.

Sowells, C., T. Petersen, C. White, and C. Elliott. "Is Your Representative Outfall Really Representative?" Selected for Platform Presentation and Paper at the World Water and Environmental Resources Congress, Honolulu, Hawaii, 2008.

Desai, A.M., T. Petersen, H. S. Rifai, and R. Stein. "Indicator Bacteria in Houston Metropolitan Bayous." Selected for Platform Presentation at the Texas Association of Environmental Professional Conference, Houston, Texas, 2008.

Desai, A.M., H.S. Rifai, T. Petersen, and R. Stein. "Load Allocation of Indicator Bacteria Sources in Houston Metropolitan Region, Houston, Texas." Selected for Platform Presentation at WEFTEC, Chicago, Illinois, 2008.

Petersen, T., H.S. Rifai, G. Villarreal, and R. Stein. "Load Estimates, Modeling, and Allocations for Bacteria TMDL Development." Selected for Platform Presentation and Paper at Water Environment Federation TMDL Conference, Bellevue, Washington, 2007.

Rifai, H.S., A. Desai, T. Petersen, R. Palachek, and R. Stein. "Characterizing *E. coli* Loads into Houston Bayous." Selected for platform presentation at State of the Bay, Galveston, Texas, 2007.

Petersen, T., and H.S. Rifai. "Levels of Indicator Bacteria in an Urban Bayou." Selected for student paper competition at Texas Water Conference, Galveston, Texas, 2003.

Petersen, T., M.P. Suarez, H.S. Rifai, P. Jensen, Y. Su, and R. Stein. "Modeling and Allocation Development for an Urban Indicator Bacteria TMDL." Platform Presentation and Paper at American Water Resources Association Conference, San Diego, California, 2003.

Petersen, T., M.P. Suarez, H.S. Rifai, P. Jensen, Yu-Chun Su, R. Stein. "Development of an Urban Indicator Bacteria TMDL: Modeling and Allocations." Platform Presentation and Paper at Water Environment Federation TMDL Conference, Chicago, Illinois, 2003.

Petersen, T., M.P. Suarez, H.S. Rifai, P. Jensen, Yu-Chun Su, and R. Stein. "Indicator Bacteria TMDL Development in Urban Environments." State of the Bay Symposium, League City, Texas, 2003.

Petersen, T. and H.S. Rifai. "Assessing and Modeling of Pathogens in Whiteoak Bayou." Selected for student paper competition at Texas Water Conference, Corpus Christi, Texas, 2003.

Petersen, T., M.P. Suarez, H.S. Rifai, P. Jensen, Yu-Chun Su, R. Stein. "Sources of Indicator Bacteria to Two Urban Bayous." Platform Presentation and Paper at Water Environment Federation TMDL Conference, Phoenix, Arizona, 2002.

Section 5

Historically Underutilized Business Subcontracting Plan

Historically underutilized business (HUB) plan is not required for contracts valued at less than $100,000.

Section 6

Individuals with at least 25 percent ownership

There are no individuals with 25 percent or more ownership in CDM Smith.

Section 7

Proposal

The CDM Smith team proposes to evaluate and propose a methodology to project all three water demand categories: irrigation, steam electric and manufacturing.

Our proposed approach will closely follow the Scope of Work, which is outlined in the Request for Qualifications. Our tasks are described in more detail below. The scope of work for each category would follow the same general process.

Task 1: Kick Off Meeting

The CDM Smith team will conduct an initial meeting and discussion of the scope with the TWDB. The meeting will review projection studies previously funded by the TWDB, as appropriate.

Task 2: Water Demand Methodology Review

The CDM Smith team will then review the agency's water demand forecasting/projection methodologies for the water demand categories of interest: irrigation, steam electric and manufacturing.

We will develop proposed changes to the projection methodologies based on our review of several documents, which include but are not limited to the following:

- Methodologies applied in other state water plans
- Methodologies applied by the USGS (including new methodologies developed for steam electric demands)
- Methodologies that may be improved by implementing improvements suggested by on-going research studies

The CDM Smith team will have interim meetings/conference calls with agency coordinator/contract manager as necessary during this task.

Task 3: Technical Memorandum

A draft technical memorandum will be developed to include the following:

- Evaluation of the current methods of forecasting/projection methodologies for each water demand category, including how a base year and subsequent projections are developed and extended
- Draft recommendations for options regarding changes to projection methodologies that might be used for TWDB staff to strengthen and improve future projections based on available data and agency resources
- Descriptions of most beneficial use of funds, when available, for future external study, data collection and/or projections development

After meeting with the TWDB as described in Task 4, a final technical memorandum will be prepared with recommendations.

Task 4: Final project meeting

A final project meeting will be held with TWDB to review findings and recommendations from the project. Comments from TWDB will be captured and addressed as part of developing the final technical memorandum in Task 3.

Section 8

Addendum

Texas Water Development Board

Addendum No. 1

RFQ NO:	580-16-RFQ0005	**ADDENDUM NO. :**	1
Deadline for Submission for RFQ:	3:00 PM, Monday, November 9, 2015		
Contact: Angela Wallace	Phone: 512-463-7979 Email: Angela.Wallace@twdb.texas.gov		

PURPOSE OF ADDENDUM

1. On Page 6 of 15 under section 2.3 REQUIRMENTS - remove the words "and budgets" stated in the last sentence. No budgets shall be submitted.

*****End of Addendum No. 1*****

IN THE SUBMISSION OF RQP, RESPONDENT SHOULD ACKNOWLEDGE RECEIPT OF THIS ADDENDUM; OTHERWISE THE SUBMISSION MAY NOT BE GIVEN CONSIDERATION. RESPONDENT MAY ACKNOWLEDGE RECEIPT BY RETURNING A SIGNED COPY WITH THEIR SUBMISSION.

Tina Petersen

RESPONDENT NAME

Tina Petersen

AUTHORIZED SIGNATURE

CDM Smith®

cdmsmith.com

EXHIBIT B

SCOPE OF WORK

The CDM Smith team proposes to evaluate and propose a methodology to project all three water demand categories: irrigation, steam electric and manufacturing.

Our proposed approach will closely follow the Scope of Work, which is outlined in the Request for Qualifications. Our tasks are described in more detail below. The scope of work for each category would follow the same general process.

Task 1: Kick Off Meeting

The CDM Smith team will conduct an initial meeting and discussion of the scope with the TWDB. The meeting will review projection studies previously funded by the TWDB, as appropriate.

Task 2: Water Demand Methodology Review

The CDM Smith team will then review the agency's water demand forecasting/projection methodologies for the water demand categories of interest: irrigation, steam electric and manufacturing.

We will develop proposed changes to the projection methodologies based on our review of several documents, which include but are not limited to the following:

- Methodologies applied in other state water plans
- Methodologies applied by the USGS (including new methodologies developed for steam electric demands)
- Methodologies that may be improved by implementing improvements suggested by on-going research studies

The CDM Smith team will have interim meetings/conference calls with agency coordinator/contract manager as necessary during this task.

Task 3: Technical Memorandum

A draft technical memorandum will be developed to include the following:

- Evaluation of the current methods of forecasting/projection methodologies for each water demand category, including how a base year and subsequent projections are developed and extended
- Draft recommendations for options regarding changes to projection methodologies that might be used for TWDB staff to strengthen and improve future projections based on available data and agency resources

- Descriptions of most beneficial use of funds, when available, for future external study, data collection and/or projections development

After meeting with the TWDB as described in Task 4, a final technical memorandum will be prepared with recommendations.

Task 4: Final project meeting

A final project meeting will be held with TWDB to review findings and recommendations from the project. Comments from TWDB will be captured and addressed as part of developing the final technical memorandum in Task 3.

Task 5: Documentation

EXHIBIT C

TASK AND EXPENSE BUDGETS

TASK BUDGET

TASK	DESCRIPTION	TWDB AMOUNT
Task 1.0	Kickoff Meeting	$3,215.00
Task 2.0	Water Demand Methodology Review	$20,455.00
Task 3.0	Technical Memorandum	$3,115.00
Task 4.0	Final Project Meeting	$3,215.00
Total		**$30,000.00**

WATER DEMAND SECTOR SPECIFIC BUDGETS

DESCRIPTION	TWDB AMOUNT
Steam Electric	$8,045.00
Irrigation	$11,825.00
Manufacturing	$10,130.00
Total	**$30,000.00**

EXPENSE BUDGET

CATEGORY	TWDB AMOUNT
Salaries, Wages[1] /Fringe[2] /Overhead[5] /Profit	$17,185.00
Other Expenses[3]	$815.00
Travel[4]	$0.00
Subcontract Services	$12,000.00
TOTAL	**$30,000.00**

[1] Salaries and Wages is defined as the cost of salaries of engineers, draftsmen, stenographers, surveymen, clerks, laborers, etc., for time directly chargeable to this contract.
[2] Fringe is defined as the cost of social security contributions, unemployment, excise, and payroll taxes, workers' compensation insurance, retirement benefits, medical and insurance benefits, sick leave, vacation, and holiday pay applicable thereto.
[3] Travel is limited to the maximum amounts authorized for state employees by the General Appropriations Act, Tex. Leg. Regular Session, 2015, Article IX, Part 5, as amended or superseded
[4] Other Expenses is defined to include expendable supplies, communications, reproduction, postage, and costs of public meetings directly chargeable to this CONTRACT.
[5] Overhead is defined as the costs incurred in maintaining a place of business and performing professional services similar to those specified in this contract.

EXHIBIT D

GUIDELINES FOR AUTHORS SUBMITTING CONTRACT REPORTS TO THE TEXAS WATER DEVELOPMENT BOARD

1.0 Introduction

The purpose of this document is to describe the required format of contract reports submitted to the Texas Water Development Board (TWDB). Our reason for standardizing the format of contract reports is to provide our customers a consistent, and therefore familiar, format for contract reports (which we post online for public access). Another reason for standardizing the format is so that we can more easily turn a contract report into a TWDB numbered report if we so choose. Remember that your report will not only be seen by TWDB staff, but also by any person interested in the results of your study. A professional and high quality report will reflect well on you, your employer, and the TWDB.

Available upon request, we will provide a Microsoft Word template (used to write these instructions) that gives the fonts, spacing, and other specifications for the headings and text of the report. Please follow this template as closely as possible.

2.0 Formatting your report

The TWDB format is designed for simplicity. For example, we use Times New Roman for all text. We use 12 point, single-spaced text, left justification for paragraph text, 18 point bold for first-level headings, and 14 point bold for second-level headings. Page numbers are centered at the bottom of the page. Other than page numbers, please refrain from adding content to the document header or footer. Page setup should use one-inch margins on all four sides.

2.1 Text

The best way to format your document is to use the styles described and embedded in the template document (Authors_Template.dot) that is available on request from the TWDB. To use the Authors_Template.dot file, open it in Word (make sure *.dot is listed under Files of type) and save it as a .doc file. Advanced users can add the .dot file to their computers as a template. Make sure the formatting bar is on the desktop (to open, go to View→Toolbars→Formatting) or, to view all of the formatting at once, go to Format→Styles and Formatting and select Available Styles from the dropdown box at the bottom of the window. The formatting in the template document provides styles (such as font type, spacing, and indents) for each piece of your report. Each style is named to describe what it should be used for (for example, style names include Chapter Title, Body Text, Heading 1, References, and Figure or Table Caption). As you add to your report, use the dropdown list on the Formatting Toolbar or the list in the Styles and Formatting window to adjust the text to the correct style. The Authors_Template.dot file shows and lists the specifications for each style.

2.1.1 Title

Give your report a title that gives the reader an idea of the topic of your report but is not terribly long. In addition to the general subject (for example, “Droughts”), you may include a few additional words to describe a place, methodology, or other detail focused on throughout the paper (for example, “Droughts in the High Plains of Texas” or “Evaluating the effects of drought using groundwater flow modeling”). Please capitalize only the first letter of each word except ‘minor’ words such as ‘and’ and ‘of’. Never use all caps.

Use headings to help the reader follow you through the main sections of your report and to make it easier for readers to skim through your report to find sections that might be the most interesting or useful to them. The text of the report should include an executive summary and sections outlined in 4.4 of Attachment 1. Headings for up to five levels of subdivision are provided in the template; however, we suggest not using more than three or four levels of subdivision except where absolutely necessary. Please avoid stacked headings (for example, a Heading 1 followed immediately by a Heading 2), and capitalize only the first letter of headings or words where appropriate—never use all caps.

2.2 Figures and photographs

To publish professional-looking graphics, **we need all originals to be saved at 300 dots-per-inch** (dpi) and in grayscale, if possible, or in the CMYK color format if color is necessary. Excessive use of color, especially color graphics that do not also work in grayscale, will prevent us from publishing your report as a TWDB numbered report (color reproduction costs can be prohibitive). Preferred file formats for your original graphics are Adobe Illustrator (.ai), Photoshop (.psd), EPS with .tiff preview, .jpg, .png, or .tiff files. Refrain from using low resolution .jpg or .gif files. Internet images at 72 dpi are unacceptable for use in reports.

All graphics shall be submitted in two forms:

1. Inserted into the Microsoft Word document before you submit your report. Ideally, inserted graphics should be centered on the page. Format the picture to downsize to 6 inches wide if necessary. Please do not upsize a graphic in Word.
2. Saved in one of the formats listed above.

2.2.1 Other graphics specifications

It is easiest to design your figures separately and add them in after the text of your report is more or less complete. Graphics should remain within the 1-inch page margins of the template (6.5 inches maximum graphic width). Be sure that the graphics (as well as tables) are numbered in the same order that they are mentioned in the text. Figures should appear embedded in the report after being called out in the text. Also, remember to include a caption for each graphic in Word, not as part of the graphic. We are not able to edit or format figure captions that are part of the figure. For figures and photographs, the caption should appear below the graphic. For tables, the caption should appear above.

2.2.2 Creating publication-quality graphics

When designing a graphic, make sure that the graphic (1) emphasizes the important information and does not show unnecessary data, lines, or labels; (2) includes the needed support material for the reader to understand what you are showing; and (3) is readable (see Figures 1 and 2 for examples). Edward R. Tufte's books on presenting information (Tufte, 1983; 1990; 1997) are great references on good graphic design. Figures 1 through 3 are examples of properly formatted, easy to understand graphics. Do not include fonts that are less than 6 points.

For good-looking graphics, the resolution needs to be high enough to provide a clear image at the size you make them within the report. In general, 300 dpi will make a clear image—200 dpi is a minimum. Try to create your figures at the same size they will be in the report, as resizing them in Word greatly reduces image quality. Photographs taken with at least a two-megapixel camera (if using digital) and with good contrast will make the best images. Save the original, and then adjust color levels and size in a renamed image copy. Print a draft copy of your report to double-check that your figures and photographs have clear lines and show all the features that you want them to have.

Figures and photographs should be in grayscale. Color greatly adds to the cost of printing, so we are trying to keep it to a minimum. Also remember that your report may be photocopied, scanned, or downloaded and printed in black and white. For this reason, you should use symbols or patterns, or make sure that colors print as different shades in black and white. All interval or ratio data (data measuring continuous phenomena, with each color representing an equal interval) need to be displayed in a graded scale of a single color (Figure 3). This way your figures will be useful even as a photocopy.

If you need help with your graphics or have questions, please contact the TWDB graphics department at (512) 936-0129.

2.2.3 Using other people's graphics

Figures and photographs (and tables) need to be your own unless you have written permission from the publisher that allows us to reprint them (we will need a copy of this permission for our records). Avoid using any figures or photographs taken off the Internet or from newspapers or magazines—these sources are difficult to cite, and it is often time-consuming and expensive to gain permission to reproduce them.

2.3 Tables

Tables should be created in Microsoft Word (see Table 1). Tables should include a minimal amount of outlining or bold font to emphasize headings, totals, or other important points. Tables should be numbered separately from figures, and captions should appear above the text of the table.

Table 1: A sample table. Note caption above table.

			Table text heading*					
Table text	1940	1950	1960	1970	1980	1990	2000	%GW
Table text	15	441	340	926	196	522	83	97.4
Table text	64	944	626	173	356	171	516	99.9
Total	79	1385	966	1099	552	693	599	

* A footnote should look like this using 10 point Times New Roman.
%GW = percent groundwater
Be sure to describe any abbreviations or symbols, and, unlike in this table, be sure to note the units!

3.0 Units

Measurements should be in English units. Metric units may be included in parentheses after the English units.

All units of geologic time should conform to the most recent geologic timescale (Gradstein and others, 2004). A summary of this timescale is available from the International Commission on Stratigraphy's website at http://stratigraphy.org/chus.pdf.

4.0 Citations and references

It is important to give credit where credit is due. Therefore, be sure to use the appropriate citations and include references in your paper.

4.1 In-text citations

Each piece of information you use in your report that comes from an outside source must be cited within

the text using the author's last name and the year of publication. If there are two authors, list the last name of each followed by the year, and if there are more than two authors, list the last name of the first author followed by "and others" and the year. For example: the end of the Jurassic Period occurred approximately 145.5 million years ago (Gradstein and others, 2004).

4.2 References

All sources that are cited within the report should be listed at the end of the paper under the heading References. The references should follow the guidelines in "Suggestions to Authors of the Reports of the United States Geological Survey" (Hansen, 1991). These are available online at http://www.nwrc.usgs.gov/lib/lib_sta.html (a link to the chapter "Preparing references for Survey reports," p. 234-241, is found here). Several examples of complete reference citations are listed at the end of these guidelines. Be sure that any citations that appear in tables or figures are included in the reference list. Also, before submitting the report, please check that all the citations in the report are included in the reference list and all references in the reference list are cited in the report. If at all possible, avoid web-based citations. These materials are often transient and therefore useless to future readers.

5.0 Submitting your report

Before you submit your report, proofread it. Look for spelling and grammatical errors. Also, check to see that you have structured the headings, paragraphs, and sentences in your paper so that it is easy to follow and understand (imagine you are a reader who does not already know the information you are presenting!).

6.0 Conclusions

Following the instructions above and providing accurate and readable text, tables, figures, and citations will help to make your report useful to readers. Scientists may read your report, as well as water planners, utility providers, and interested citizens. If your report successfully conveys accurate scientific information and explanations to these readers, we can help to create more informed decisions about the use, development, and management of water in the state.

7.0 Acknowledgments

Be sure to acknowledge the people and entities that assisted you in your study and report. For example: We would like to thank the Keck Geology Consortium, the American Society of Civil Engineers, and the Texas Bar CLE for providing examples to use in developing these guidelines. In addition, we appreciate Mike Parcher for providing information on how to create publication-quality graphics, Shirley Wade for creating the data used in sample Figure 1, and Ian Jones for providing sample Figure 3.

8.0 References

Gradstein, F.M., J.G. Ogg, and A.G. Smith, eds., 2005, A geologic time scale 2004: Cambridge, Cambridge University Press, 610 p.

Hansen, W.R., ed., 1991, Suggestions to authors of the reports of the United States Geological Survey (7th ed.): Washington, D.C., U.S. Government Printing Office, 289 p.

Tufte, E. R., 1983, The visual display of quantitative information: Cheshire, C.T., Graphics Press, 197 p. Tufte, E. R., 1990, Envisioning information: Cheshire, C.T., Graphics Press, 126 p.

Tufte, E. R., 1997, Visual explanations: Cheshire, C.T., Graphics Press, 156 p.

9.0 Examples of references

Arroyo, J. A., and Mullican, III, W. F., 2004, Desalination: *in* Mace, R. E., Angle, E. S., and Mullican, W. F., III, editors, Aquifers of the Edwards Plateau: Texas Water Development Board Report 360, p. 293-302.

Bates, R. L., and Jackson, J. A., 1984, Dictionary of geological terms: Anchor Press/Doubleday, Garden City, New York, 571 p.

Blandford, T. N., Blazer, D. J., Calhoun, K. C., Dutton, A. R., Naing, T., Reedy, R. C., and Scanlon, B. R., 2003, Groundwater availability of the southern Ogallala aquifer in Texas and New Mexico–Numerical simulations through 2050: contract report by Daniel B. Stephens and Associates, Inc., and the Bureau of Economic Geology, The University of Texas at Austin to the Texas Water Development Board, variably paginated.

Fenneman, N. M., 1931, Physiography of Western United States (1st edition): New York, McGraw-Hill, 534 p.

Hubert, M., 1999, Senate Bill 1–The first big bold step toward meeting Texas's future water needs: Texas Tech Law Review, v. 30, no. 1, p. 53-70.

Kunianski, E. L., 1989, Precipitation, streamflow, and baseflow in West-Central Texas, December 1974 through March 1977: U. S. Geological Survey Water-Resources Investigations Report 89-4208, 2 sheets.

Mace, R. E., Chowdhury, A. H., Anaya, R., and Way, S.-C., 2000, A numerical groundwater flow model of the Upper and Middle Trinity aquifer, Hill Country area: Texas Water Development Board Open File Report 00-02, 62 p.

Maclay, R. W., and Land, L. F., 1988, Simulation of flow in the Edwards aquifer, San Antonio Region, Texas, and refinements of storage and flow concepts: U. S. Geological Survey Water-Supply Paper 2336, 48 p.

For more examples of references, see p. 239-241 of “Suggestions to Authors of the Reports of the United States Geological Survey” at http://www.nwrc.usgs.gov/lib/lib_sta.htmhttp://www.nwrc.usgs.gov/lib/lib_sta.html.

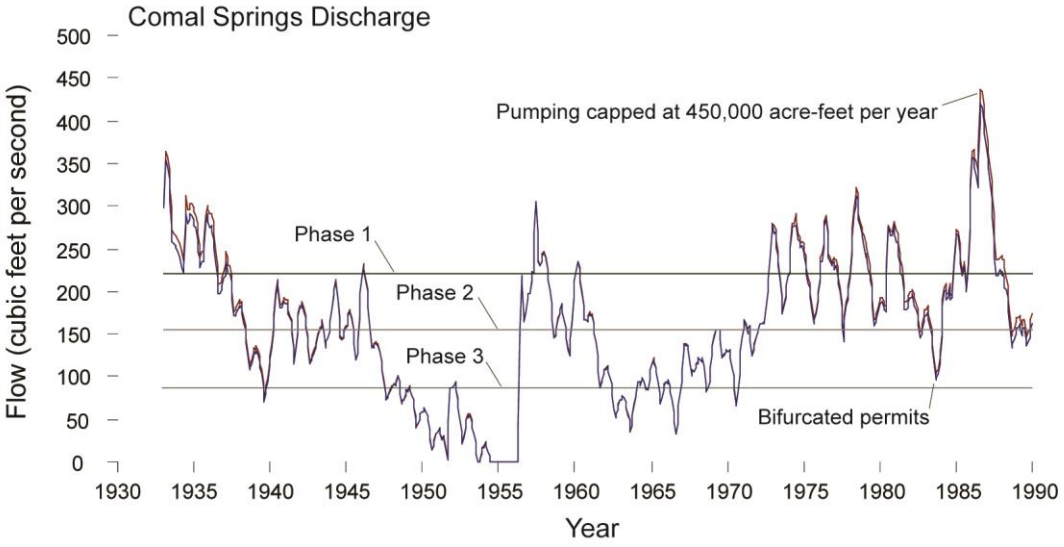

Figure 1. A sample figure showing only the information needed to help the reader understand the data. Font size for figure callouts or labels should never be less than 6 point.

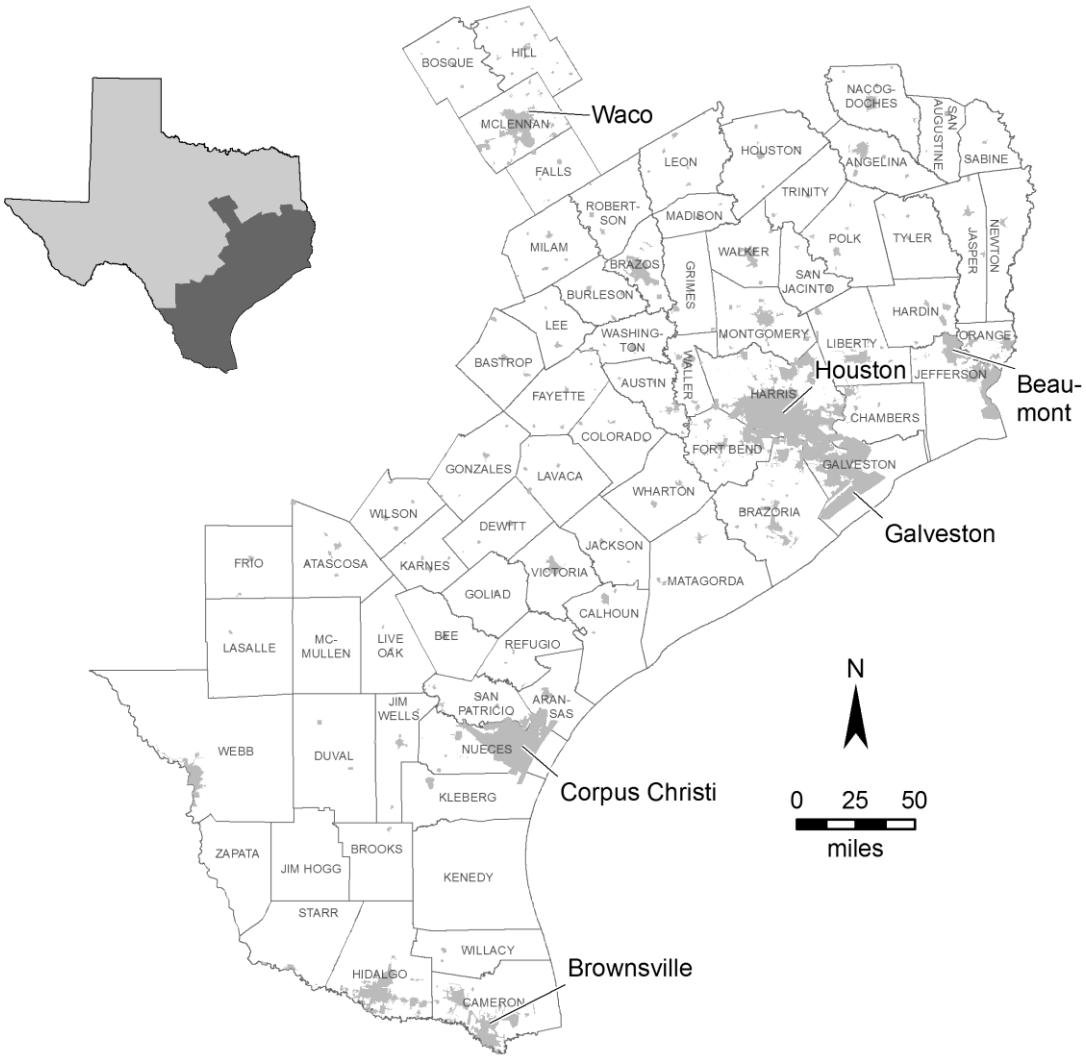

Figure 2. A sample subject area map, giving the reader enough information to understand the location being discussed in this conference. For map figures, be sure to include a north arrow to orient the reader, a scale, and, if needed, a submap that places the figure in greater geographic context. Be sure that text is readable and that any citations listed on the figure or in the figure caption are included in the reference list. Font size should never be less than 6 pt.

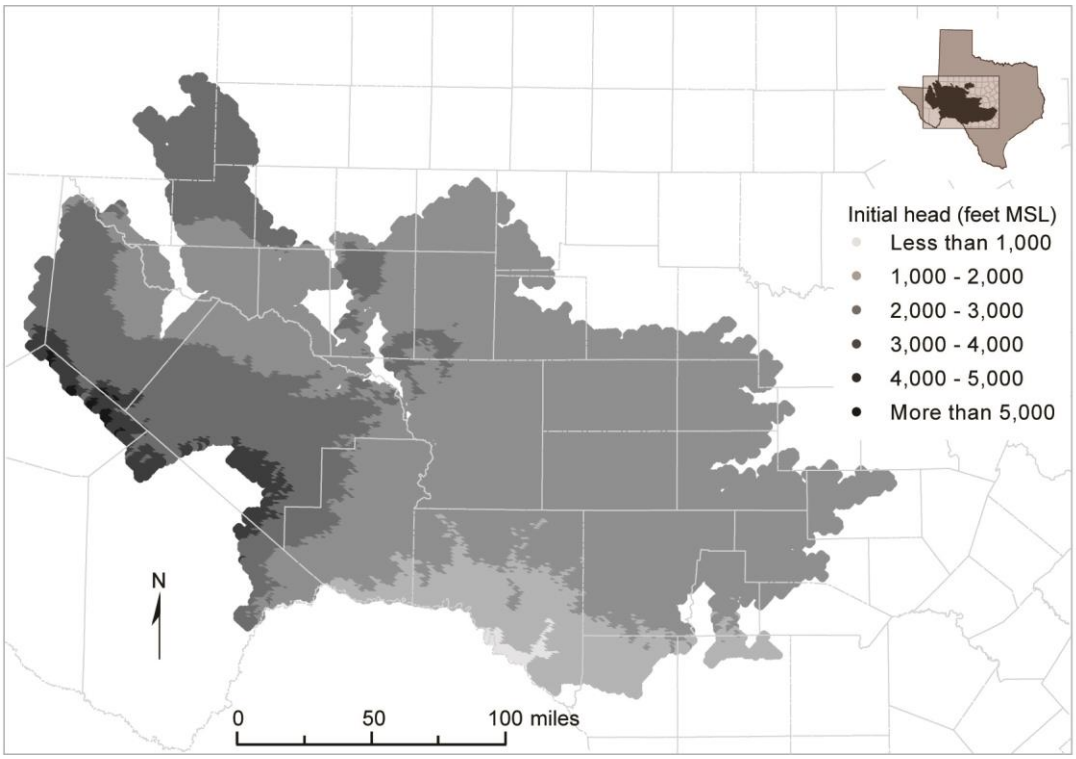

Figure 3. Initial hydraulic heads used in model simulations for layer 1. Note the use of grayscale shading to show differences.

EXHIBIT E
TWDB Guidelines for a Progress Report

Texas Water Development Board Contractors are required by their contracts to provide Progress Reports usually with the submission of an invoice/payment request.

The progress report should contain the following standard elements:

- Date: Date the memo is sent
- To: Name and position of the reader
- From: Name and position of the writer
- Subject: TWDB Contract Number and a clear phrase that focuses the reader's attention on the subject of the memo

Work Completed: *(The next section of a progress report explains what work has been done during the reporting period. Specify the dates of the reporting period and use active voice verbs to give the impression that you or you and your team have been busy) For Example:*

Task 1: Completed 3 draft chapters and all appendices. Met with sub consultants on their chapters.
Task 2: Completed sample collection throughout river reach.
Task 3: No work completed in reporting period.

Problems:
If the reader is likely to be interested in the glitches you have encountered along the way, mention the problems you have encountered and explain how you have solved them. If there are problems you have not yet been able to solve, explain your strategy for solving them and give tell the reader when you think you will have them solved.