



INTERLOCAL COOPERATION CONTRACT NO. 20-041-AMS
BETWEEN THE
EDWARDS AQUIFER AUTHORITY
AND
THE UNIVERSITY OF TEXAS AT AUSTIN BUREAU OF ECONOMIC GEOLOGY
FOR
THE INSTALLATION, OPERATION AND ANALYSIS OF EDDY COVARIANCE FOR
QUANTIFYING EVAPOTRANSPIRATION

This INTERLOCAL COOPERATION CONTRACT (Contract) is made and entered into under the Texas Interlocal Cooperation Act (ICA), Chapter 791, Texas Government Code, by and between the EDWARDS AQUIFER AUTHORITY (EAA), a conservation and reclamation district and a political subdivision of the State of Texas, with its principal place of business located at 900 E. Quincy Street, San Antonio, Texas 78215, and THE UNIVERSITY OF TEXAS AT AUSTIN, an institution of higher education, on behalf of the BUREAU OF ECONOMIC GEOLOGY (Contractor), an agency of the State of Texas and an institution of higher learning in the University of Texas System, with its principal place of business located at 3925 W. Braker Lane, Suite 3.340 (Mail Code A9000), Austin, Texas 78759-5316. Each of these entities is, at times, referred to in this Contract individually as a “Party,” and both are referred to collectively as “Parties.”

RECITALS

WHEREAS, the EAA was created in 1993 by the Edwards Aquifer Authority Act, Act of May 30, 1993, 73rd Leg., R.S., ch. 626, 1993 Tex. Gen. Laws 2350, as amended (Act); and

WHEREAS, under Section 1.02 of the Act, the EAA is a conservation and reclamation district created by virtue of Article XVI, Section 59 of the Texas Constitution, and is a governmental agency and body politic and corporate vested with the full authority to exercise the powers and to perform the functions specified in the Act; and

WHEREAS, under Section 1.08(a) of the Act, the EAA has all the powers, rights and privileges necessary to manage, conserve, preserve, and protect the Edwards Aquifer (Aquifer) and to increase the recharge of, and prevent the waste or pollution of water in, the Aquifer; and

WHEREAS, under Section 1.27 of the Act, the EAA may conduct research; and

WHEREAS, under Section 1.11(d)(2) of the Act, and other applicable law, the EAA may enter into contracts; and

WHEREAS, under Section 49.211(a), Texas Water Code, the EAA has the functions, powers, authority, rights, and duties that will permit it to accomplish the purposes for which it was

created or the purposes authorized by the Constitution, the Texas Water Code, or any other law; and

WHEREAS, under Section 49.213(b), Texas Water Code, the EAA may enter into contracts with any person or any public or private entity in the performance of any purpose or function permitted by the EAA; and

WHEREAS, under Section 49.213(c)(7), Texas Water Code, the EAA may enter into contracts with persons or any public or private entities on the terms and conditions the Board of Directors of the EAA may consider desirable, fair, and advantageous for, among other things, the exercise of any rights, powers, and duties granted to the EAA; and

WHEREAS, this Contract is an interlocal contract entered into under the authority of the ICA, Chapter 791, Texas Government Code; and

WHEREAS, Section 791.011(b)(1) of the ICA authorizes a local government to contract with a state agency, including with a state institution of higher education or university system, to perform governmental functions and services; and

WHEREAS, under Section 791.003(4) and (5) of the ICA, the EAA is a local government; and

WHEREAS, under Section 771.002(1)(B) of the Interagency Cooperation Act, the Contractor is a state university, or any service or part of a state institution of higher education and, therefore, under 791.011(b)(1) of the ICA, is a “state agency”; and

WHEREAS, under Section 791.003(3) of the ICA, the activities that are the subject of this Contract are “governmental functions and services” because they involve the public health and welfare, and other governmental functions in which the Parties are mutually interested, and under Section 791.011(c)(2) of the ICA, involve activities that each Party is authorized to perform individually; and

WHEREAS, the EAA’s Board of Directors approved this Contract on December 8, 2020, and authorized the EAA’s General Manager to execute the Contract; and

WHEREAS, the EAA’s Board of Directors has elected to pursue the installation, operation and analysis of eddy covariance for quantifying evapotranspiration; and

WHEREAS, the Contractor is an institution of higher learning with research capabilities to perform environmental sciences and water resources services; and

WHEREAS, the EAA and Contractor have been authorized by their respective governing bodies to enter into this Contract; and

WHEREAS, it is in the public interest that the EAA enter into this Contract.

AGREEMENT

NOW THEREFORE, for and in consideration of the mutual promises and agreements set forth in this Contract, the EAA and Contractor agree as follows:

ARTICLE I – TERM; DESCRIPTION OF WORK

Section 1.1. Term. This Contract is effective and commences on January 1, 2021 (Effective Date) and terminates on December 31, 2023 (Expiration Date).

Section 1.2. Services. Subject to the terms and conditions of this Contract, the EAA engages the Contractor to perform, for the benefit of the EAA, the work set forth and described in this Contract and in the following documents (Services), which are attached hereto: (1) the Scope of Work, which is attached hereto as Exhibit A (Scope of Work); and (2) the Budget Estimate, which is attached hereto as Exhibit B (Budget Estimate). The Contractor accepts such engagement and agrees to devote its best efforts and abilities, and furnish all necessary labor, machinery, equipment, tools, and transportation necessary in furtherance thereof.

Section 1.3. Commencement and Completion of Services. The Participant will commence performing the Services immediately upon the date of receipt of the written notice to proceed issued by the EAA's General Manager. All Services will be completed and delivered to the EAA by the Expiration Date and shall be completed in compliance with the schedules, budgets, descriptions, and specifications contained herein and in the Exhibits attached hereto. It shall be the Contractor's responsibility to ensure that the completion times for the tasks required under this Contract are met. Time is of the essence in the performance of this Contract.

ARTICLE II – AMENDMENTS

Section 2.1. Amendments. The EAA may request changes or additions to the Scope of Work during the progress of the Services. Upon mutual agreement, the EAA and Contractor will make the necessary written revisions to the Scope of Work to reflect such changes or additions. Upon such request by the EAA, Contractor may propose the necessary revisions to specific tasks in the Scope of Work, associated schedules and costs. This Contract, including any changes to the Scope of Work, may be amended only by written agreement of the Parties.

Section 2.2. Delegation to the General Manager. The Board of Directors of the EAA delegates the authority to the General Manager to enter into amendments to this Contract without further authorization by the Board consistent with the General Manager's authority to enter into contracts under Section 4.01 of the EAA's Bylaws.

ARTICLE III – COMPENSATION

Section 3.1. Fees and Expenses. The EAA agrees to pay the Contractor for the Services rendered under this Contract in accordance with the Scope of Work and Budget Estimate, but in no event shall payments to the Contractor exceed \$199,939.71. The Contractor may not exceed this amount and will be responsible for the payment of all of its other additional costs and expenses. The Contractor is not authorized to expend any additional funds in excess of this amount without

the prior written approval from the EAA. The EAA will not be held accountable for any unauthorized work performed or funds expended by the Contractor in providing the Services under this Contract.

Section 3.2. Payment. All “invoice packets” from the Contractor to the EAA for the Services for each previous month’s activities shall be sent no later than the 15th day of each month beginning February 15, 2021, and shall provide an itemization of the Services rendered, and any costs and expenses incurred during the billing cycle. Documentation in the invoice packet must be sufficiently itemized and detailed and include invoices and/or receipts for all purchases and expenses (summary credit card charge receipts are not acceptable), which allows the EAA to clearly discern purchases made. Purchases and expenses documented with lost receipt forms are not eligible for reimbursement. Receipts without purchase details or that are not legible are not acceptable at any time. Alcohol purchases will NOT be reimbursed under any circumstances. Mileage will be reimbursed at the current IRS-approved rate, if submitted. The monthly invoice packet will be submitted electronically in Adobe Acrobat (pdf) format via email to the Director of Aquifer Science at pbertetti@edwardsaquifer.org. If the Contractor utilizes subcontractors (*see* Article V), the Contractor shall submit a Subcontractor Utilization Report with each invoice submitted to the EAA for payment. The terms of each invoice shall be net thirty (30) days upon EAA receipt and approval of that invoice.

ARTICLE IV – INDEPENDENT CONTRACTOR

Section 4.1. No Employment Relationship. The Parties understand and agree that this Contract does not create a fiduciary relationship between them, that they are separate entities, that the Contractor is an independent Contractor with respect to the performance of the Services and is not subject to the direct or continuous control and supervision of the EAA, and that nothing in this Contract is intended to make either Party a subsidiary, joint venturer, partner, employee, agent, servant or representative of the other Party for any purpose whatsoever. The Contractor shall provide any and all equipment and materials necessary for the performance of the Services. The EAA shall have no right of direction or control of the Contractor, or its employees and agents, except in the results to be obtained, and in a general right to order the performance of the Services to start or stop as agreed to herein, to inspect the progress of the Services, and to receive reports. The Contractor shall accommodate reasonable requests from the EAA to allow EAA employees, agents or representatives to accompany and observe Contractor personnel in carrying out the Services under this Contract.

ARTICLE V – CONTRACTOR PERSONNEL AND SUBCONTRACTORS

Section 5.1. Personnel. The Contractor will provide any and all personnel necessary for its performance of the Services. The Contractor will be responsible for its employees and agents in all respects, including, without limitation, their compliance with applicable laws and their safety, including without limitation, all Occupational Safety and Health Administration (OSHA) standards, requirements, and regulations. To the extent authorized by law, each Party indemnifies and holds harmless the other Party, as well as the other Party’s officers, employees, and directors, from and against any claims brought by any employee, subcontractor, or other agent of the indemnifying Party relating in any way to the Services performed under this Contract.

Section 5.2. Subcontractors. In performing the Services under this Contract, the Contractor may retain and utilize as its subcontractors, to the extent that they are not already employees of the Contractor, those individuals identified to and approved in writing by the EAA, in advance. The EAA, in consultation with the Contractor, shall have the right to terminate, limit, or alter, at any time, the participation of any subcontractor utilized by the Contractor. No additional subcontractors may be retained by the Contractor to perform any Services under this Contract without the prior written consent of the EAA, provided that no such consent shall be necessary for the retention of any subcontractor previously approved by the EAA and identified by the Contractor on the Effective Date of this Contract. The Contractor will be responsible for its subcontractors in all respects, including their compliance with applicable laws and their safety, including without limitation, all OSHA standards, requirements, and regulations.

ARTICLE VI – TERMINATION

Section 6.1. Termination for Convenience. The EAA may terminate this Contract at any time, including at the expiration of each budget or payment period during the term of this Contract, with or without cause, upon ten (10) days' prior written notice to Contractor.

Section 6.2. Termination for Cause. If the Services are not being carried out in a manner satisfactory to the EAA, the EAA may terminate this Contract upon the failure of Contractor to cure the unsatisfactory condition within ten (10) days after receipt of written notice from the EAA. The word "satisfactory" or "unsatisfactory" in this Section 6.2 means that the Contractor has either reasonably complied, or not complied, with all performance requirements and obligations as set forth in Exhibit A of this Agreement and other applicable provisions of this Agreement.

Section 6.3. Actions in the Event of Early Termination. Upon receipt of a notice of termination under this Article, Contractor shall immediately stop all work in progress, including all work performed by its employees, agents, or subcontractors. Insofar as possible, all work in progress will be brought to a logical termination point. Within 30 days of the final invoice following termination, the EAA shall pay Contractor all moneys then due and owing for the Services rendered, and costs and expenses reasonably incurred up to the time of termination. Contractor will deliver to the EAA copies of all finished and unfinished documents, data, studies, surveys, drawings, maps, reports, photographs, and other materials prepared by Contractor, and each Party shall be free to utilize such documents, data, studies, surveys, drawings, maps, reports, photographs, and other materials as it sees fit.

ARTICLE VII – OWNERSHIP OF MATERIALS

Section 7.1. Ownership. All information, documents, property, or materials produced, created, or supplied under this Contract by the Contractor, its employees, agents or subcontractors or anyone else, and whether finished or unfinished or in draft or final form, will be the jointly owned property of EAA and the Contractor. Each Party shall have unlimited rights to technical and other data resulting directly from the performance of the Contractor's Services under this Contract.

Section 7.2. Delivery of Documents upon Termination. Upon termination of this Contract under Sections 1.3 or 6.1, all such information, documents, property and materials not already in the possession of the EAA will be delivered to the EAA within 30 days of termination.

Section 7.3. Nondisclosure of Documents. Both Parties recognize that each Party is subject to the provisions of Chapter 552, Texas Government Code. If a request for public information is filed with one of the Parties under Chapter 552, any information, property, or materials produced, created, or supplied under this Contract that is subject to disclosure under Chapter 552 may be disclosed by the Party to any third party without the prior written consent of the other Party. If such a request is filed, the Party receiving the request shall promptly give notice to the other Party of the request and provide a schedule of the documents provided.

Section 7.4. Record Copies. The Contractor shall retain a record copy of all information, documents, property, or materials developed in the course of performing the Services for a minimum of three (3) years. Upon request of the EAA, such information, documents, property, or materials will be promptly supplied to the EAA, including after the Expiration Date or the termination of this Contract under Section 6.1. The EAA will reimburse the Contractor for actual cost of time and expenses of reproduction of such materials requested.

Section 7.5 Publications. For publications, the publishing Party shall provide the other Party a thirty-day (30) period in which to review proposed publications, identify proprietary or confidential information, and submit comments. The publishing Party will give full consideration to all comments before publication. All publications created by Contractor pertaining to this Contract shall acknowledge that research performed by Contractor was funded in part by the EAA.

ARTICLE VIII –PERFORMANCE

Section 8.1. Performance of Services. The Contractor agrees that it will perform all Services in a good and workmanlike manner, strictly in accordance with the standards of the Contractor's profession, the Scope of Work, and as otherwise provided in this Contract and the Exhibits hereto. To the extent permitted by law, the Contractor's failure to timely perform the Services as agreed shall constitute a breach of this Contract and shall be subject to all applicable remedies at law or equity. Judgment of nonperformance shall rest solely with the EAA.

ARTICLE IX – RESERVED

THIS ARTICLE INTENTIONALLY LEFT BLANK

ARTICLE X – RESERVED

THIS ARTICLE INTENTIONALLY LEFT BLANK

ARTICLE XI – INSURANCE

Section 11.1. Insurance Coverages. EAA acknowledges that, because Contractor is an agency of the State of Texas, liability for the tortious conduct of the agents and employees of

Contractor is governed by Chapters 101 and 104, Texas Civil Practice and Remedies Code and Chapter 2259, Texas Government Code, and that Workers' Compensation Insurance coverage for employees of Contractor is provided by Contractor as mandated by the provisions of Chapter 503, Texas Labor Code. The liability of Contractor and its members for personal injury and property damage is controlled by the Texas Tort Claims Act, Texas Civil Practice and Remedies Code, Chapter 101, Section 101.021. The limits of liability are \$250,000 for each person, \$500,000 for each single occurrence for bodily injury or death and \$100,000 for each single occurrence for injury to or destruction of property.

Section 11.2. No limitations. Contractor's obligation to obtain and maintain the foregoing policy or policies in the amounts specified shall not be limited in any way by reason of any insurance which may be maintained by the EAA, nor shall Contractor's performance of this obligation relieve it of liability under the indemnity provisions set forth in Section 12.2.

ARTICLE XII – ASSUMPTION OF RISK AND INDEMNIFICATION

Section 12.1. Risk. To the extent authorized by law, each Party shall assume all risks associated with its or its subcontractors' performance under this Contract and shall waive any claim against the other Party for damages arising out of the performance of the Services under this Contract.

Section 12.2. Indemnification. To the extent authorized by law, each Party shall defend, indemnify, and hold harmless the other Party, its directors, officers, employees, and agents from any and all damages, loss, or liability arising from (a) other contracts or arrangements between the indemnifying Party and any third parties that are entered into to perform the Services of this Contract, (b) any claims brought by any person relating to this Contract or the Services, or (c) the quality or the performance of the Services. The foregoing indemnification is limited to the extent that such liability, loss, or damage was caused by the negligent act, error, or omission of the indemnifying Party or any person or entity for whom the indemnifying Party is legally liable.

Section 12.3. Sovereign Immunity. Nothing herein shall constitute a waiver of the State's right or either Party's right to assert sovereign immunity.

ARTICLE XIII – NOTICES

Section 13.1. Notices to the EAA. All notices or communications under this Contract to be mailed or delivered to the EAA shall be in writing and shall be sent to the EAA's principal place of business as follows, unless and until the Contractor is otherwise notified:

EDWARDS AQUIFER AUTHORITY
Attention: Latifah Jackson, Contract and Business Development Lead
900 E. Quincy Street
San Antonio, Texas 78215

Section 13.2. Notices to the Contractor. All notices or communications under this Contract to be mailed or delivered to the Contractor shall be in writing and shall be sent to the address of the Contractor as follows, unless and until the EAA is otherwise notified:

The Bureau of Economic Geology
THE UNIVERSITY OF TEXAS AT AUSTIN
Attention: Assistant Director, Office of Sponsored Projects
3925 W. Braker Lane, Suite 3.340 (Mail Code A9000)
Austin, Texas 78759-5316

Section 13.3. Effective Date of Notice. Any notices or communications required to be given in writing by one Party to the other shall be considered as having been given to the addressee on the date the notice of communication is posted by the sending Party. Electronic notices shall be deemed delivered as of the stamp date generated by the receiving Party's system.

ARTICLE XIV – MISCELLANEOUS

Section 14.1. Entire Agreement. This Contract and the attached Exhibits constitute the entire agreement between the Parties regarding the Services to be performed by the Contractor and there are no representations, warranties, agreements or commitments between the Parties except as set forth herein. Unless otherwise authorized herein, no amendments or additions to this Contract shall be binding on the Parties unless in writing and signed by the Parties.

Section 14.2. Non-Waiver. No delay or failure by either Party to exercise any right under this Contract, nor any partial or single exercise of that right, shall constitute a waiver of that or any other right, unless otherwise expressly provided herein.

Section 14.3. Headings. Headings in this Contract are for convenience only and shall not be used to interpret or construe its provisions.

Section 14.4. Governing Law. This Contract shall be deemed to have been executed and performed in the State of Texas and shall be construed in accordance with and governed by the laws of the State of Texas. Venue for any disputes or claims arising from this Contract shall be exclusively in the proper courts in Bexar County, Texas. The dispute resolution process provided for in Section 2009.053(c) of the Texas Government Code shall be used to resolve a dispute arising under this Contract.

Section 14.5. Counterparts. This Contract may be executed in two or more counterparts, each of which shall be deemed an original but all of which together shall constitute one and the same instrument.

Section 14.6. Binding Effect. The provisions of this Contract shall be binding upon and inure to the benefit of the Parties and their respective successors and assigns; provided, however, that the Contractor may not assign any of its rights nor delegate any of its duties hereunder without the EAA's prior written consent.

Section 14.7. Validity. The invalidity of any provision or provisions of this Contract shall not affect any other provision of this Contract, which shall remain in full force and effect, nor shall the invalidity of a portion of any provision of this Contract affect the balance of such provision.

Section 14.8 Reserved. Intentionally left blank.

Section 14.9. Survival. Termination of this Contract for breach shall not constitute a waiver of any rights or remedies available at law or in equity to a Party to redress such breach. All remedies, either under this Contract or at law or in equity or otherwise available to a Party, are cumulative and not alternative and may be exercised or pursued separately or collectively in any order, sequence or combination. In addition, to these provisions, applicable provisions of this Contract shall survive any termination of this Contract.

Section 14.10. Attachments. The Exhibits, schedules and/or other documents attached or referred to, are incorporated in and made a part of this Contract for all purposes. As used herein, the expression "Contract" means the body of this Contract and such attachments, Exhibits, schedules and/or other documents, and the expressions "herein," "hereof," and "hereunder" and other words of similar import refer to this Contract and such attachments, exhibits, schedules and/or other documents as a whole and not to any particular part or subdivision thereof.

Section 14.11. Costs. If any legal action, arbitration, or other proceeding is brought by a Party for the enforcement of this Contract or because of an alleged breach or default of this Contract, the prevailing Party shall be entitled to recover reasonable costs incurred, including but not limited to attorney's fees, in such action or proceeding in addition to any other relief to which it or they may be entitled.

Section 14.12. Authority to Contract. Each Party represents and warrants for the benefit of the other Party that: (1) it has the legal authority to enter into this Contract; (2) this Contract has been duly approved and executed; (3) no other authorizations or approvals are or will be necessary in order to approve this Contract and to enable that Party to enter into and comply with the terms and conditions of this Contract; (4) the person executing this Contract on behalf of each Party has the authority to bind that Party; and (5) the Party is empowered by law to execute any other agreement or documents and to give such other approvals, in writing or otherwise, as are or may hereafter be required to implement and comply with this Contract.

Section 14.13. Officers or Agents. No officer or agent of the Parties is authorized to waive or modify any provision of this Contract. No amendment to or rescission of this Contract may be made except by a written document signed by the Parties' authorized representatives.

IN WITNESS WHEREOF, this Contract is executed as of the day and date first stated above, in Section 1.1.

EDWARDS AQUIFER AUTHORITY

THE UNIVERSITY OF TEXAS AT AUSTIN

By: _____
Roland Ruiz
General Manager

By: _____
Mark Featherston
Assistant Director, Office of Sponsored Projects

ATTEST:

ATTEST

By: _____
Jennifer Wong-Esparza
Assistant to the Board Secretary

By: _____
Michael Young
Bureau of Economic Geology

APPROVED AS TO FORM:

Darcy Alan Frownfelter
Darcy Alan Frownfelter (Dec 3, 2020 08:56 CST)

Darcy Alan Frownfelter
General Counsel
Edwards Aquifer Authority

EXHIBIT A SCOPE OF WORK

BACKGROUND

Climate, vegetation, and soils each exert controls on groundwater recharge. Mean annual precipitation explains 80% of the variation in recharge across Texas [Keese *et al.*, 2005], but the incredible diversity of vegetation and climate in Texas makes local recharge estimates very difficult to assess. In karst terrain, for example, the majority of recharge originates from focused direct recharge from losing streams while a smaller, less temporally dynamic proportion originates as diffuse recharge through the soil between the stream channels [Marclay, 1995; Wong *et al.*, 2012]. This means that the scale of measurement and the measurements themselves become important considerations. The need to understand recharge and other water balance components are intense given future climate variability and increased population, which will further stress the supply and demand of regional water resources (Sharp *et al.*, 2020; Loáiciga and Schofield, 2020).

This project focuses on the ET data needed to understand the hydrology of complex landscapes underlain by epikarst material, where the presence of woody vegetation points to substantial water loss pathways through ET. The challenge is that data needed to resolve differing research results are lacking. For example, some findings suggest water is sourced from epikarst [Wilcox *et al.*, 2005; Wilcox and Huang, 2010; Wong and Banner, 2010], even though plant-available water appears to be disconnected from deeper waters [Kukowski *et al.*, 2013; Schwartz *et al.*, 2013] and other research shows vegetation without deep rooting [Schwinning, 2008; Heilman *et al.*, 2009].

SCOPE OF WORK

The three (3) components of the Scope of Work (SOW) related to the installation, operation and analysis of eddy covariance for quantifying evapotranspiration (Project) are:

1. To deploy, maintain and operate a minimum of two (2) eddy covariance systems for a three (3) year period.
2. To QA/QC and distribute final data streams for subsequent analyses by the EAA and Contactor research teams.
3. To use the data to assess water balance components in the vicinity of the systems and submit the compiled data stream in a final report.

Task 1. Deploy and Maintain Eddy Covariance (EC) Systems

In the initial phase of this Project, the Contractor will focus on installing and operating two (2) eddy covariance towers at locations to be jointly determined by Contractor and EAA, but likely one tower in the eastern and a second in the western portion of the EAA region (e.g., Bexar and Uvalde Counties, respectively). Once installed, the Contractor will continue to maintain and operate the eddy covariance systems for the term of the Contract. Figure 1 below provides an example of the eddy covariance system to be deployed.



Figure 1. Images of eddy covariance towers installed at Camp Bullis site.

Task 2. QA/QC and Distribute Final Data Streams

Data will be quality controlled and then used for subsequent research into local and upscaled water balance.

Task 2.1 Field EC Data Collection

Field data collection will focus primarily on EC as a direct measurement of ET upwind of the instrument (known as the fetch) over an area with a radius approximately 100 times the instrument height above the canopy (known as the footprint). This footprint also depends on surface roughness, and thermal stability. EC towers consist of a three-dimensional anemometer to measure temperature and wind speed and direction, and an open-path infrared gas analyzer (IRGA) to measure gas concentration (i.e., humidity and carbon dioxide). The 3D anemometer samples rotating eddies of air to determine the total concentration of vertical flux, which is represented as the covariance of the vertical component of the velocity (measured with the anemometer) and the concentration of water (or carbon) molecules (measured with the IRGA). Instruments will be installed approximately 1.2 m above the height of the vegetation.

The Contractor should anticipate re-deploying the same instrument suite used at the previous Camp Bullis study conducted by the Contractor. As then, the Contractor will use an open-path analyzer and 3D sonic anemometer (IRGASON, Campbell Scientific, Logan, UT) with an electronics module (EC100, Campbell Scientific) to measure high-frequency (10 Hz) water vapor and CO₂ fluxes, and the three-dimensional wind vector. Depending on availability, the Contractor may use an LI-7500a (LI-COR, Lincoln, NE) to measure

water vapor and CO₂ concentrations, and a CSAT3 3D-sonic anemometer (Campbell Scientific) to determine wind vectors. Regardless, measurements will be collected every 0.1 seconds (i.e., 10 Hz) and averaged over 30 minutes to obtain 48 ET flux estimates per day. Calibration of the EC systems will occur biannually, for example during November and May of each season, using a dew point generator (LI-610, LI-COR), a zero-gas reference, and a 500-ppm CO₂ standard.

Additional meteorological and soil moisture measurements will be collected at each site every 30 minutes. These include measurements of precipitation using a tipping-bucket rain gage (TE525, Texas Electronics, Dallas, TX) and net radiation (NR-LITE or CNR4, Kipp & Zonen, Delft, Netherlands). Soil water content and temperature will be recorded using water content reflectometers (CS655, Campbell Scientific) at two locations, both at a depth of 5 cm, one under a canopy and a second sensor installed in the interspace. Additional soil depths will be monitored if possible. Soil heat flux will be measured using soil heat flux plates (HFP01, Hukseflux Delft, Netherlands) installed at a depth of 8 cm and two averaging thermocouples (TCAV, Campbell Scientific) installed above and below the heat flux plate.

At each location, the Contractor will characterize the soil hydraulic properties, so that water fluxes can be evaluated in the context of site and soil conditions. This will include soil sampling at each location into which sensors are installed. Soil will be analyzed for textural components and bulk density, at a minimum, and then used to estimate soil hydraulic properties using any of a number of pedotransfer function approaches (e.g., Van Looy et al., 2017). Soil and ET measurements can be used in a 1D vadose zone model (benchmarked to available in-situ soil moisture data) and then compared to remotely sensed vegetation indices and ET estimates from, for example, the MODIS satellite platform.

Task 2.2 EC Data Processing

Specific hardware configurations may dictate processing software. For example, data collected using IRGASONS will be processed using Campbell Scientific's EasyFlux program, and data collected using LI-COR equipment will be processed similarly using LI-COR's EddyPro software. Section 2 of the Appendix in Sun et al. (2020) describes the EC processing steps and the corrections needed, including frequency corrections and air density, fluctuations in sonic temperature and humidity, and axis and tilt rotation. Further processing such as gap filling will also be done, as described in the same Appendix Section 2. Due to factors still being studied in the scientific community, the surface energy fluxes are often underestimated by 10–30% relative to the available energy (Wilson et al., 2002; Foken et al., 2012; Alfieri et al., 2012; Moorehead et al., 2019). Latent heat flux (*LE*) and sensible heat flux (*H*) will be adjusted to force closure, while maintaining a constant Bowen ratio (β), which is the ratio between *H* and *LE* as shown in Equations 2.2-1 and 2.2-2 (Blanken et al., 1997; Lee, 1998; Twine et al., 2000).

$$LE_{corr} = \frac{(R_n - G)}{1 + \beta} \quad \text{Eq. 0-1}$$

$$H_{corr} = LE_{corr} \times \beta \quad \text{Eq. 0-2}$$

Energy balance states the difference between R_n and G (the available energy) should equal the sum of the sensible heat flux (H) and latent heat flux (LE) (the surface energy flux). Thus, ET has a direct relationship with the latent heat flux described in Equation 2.2-3

$$ET = \frac{LE}{\lambda \rho_w} \quad \text{Eq. 0-3}$$

where λ is the latent heat of vaporization of water, and ρ_w is the density of the water.

Task 3. Site Water Budget and Final Report

In the final report submitted on the Camp Bullis project (Sun et al., 2020), one of the conclusions in the Executive Summary is related to the difficulty in constraining the local water budget given uncertainty and temporal dynamics in soil water storage, and variations in monthly soil water storage can account for more than 40% of measured ET collected from the EC systems. This becomes important because of the difficulty in determining the water source (e.g., shallow soil versus deep epikarst versus perched shallow groundwater) for larger trees. The models tested by Sun et al. (2020), including Noah, Mosaic, and VIC (part of NLDAS) showed that changes in soil water storage ranged from between 16 and 50 mm/month, which translates to differences in volumetric water content between 0.04 and 0.125 cm³/cm³, assuming a soil thickness of 40 cm.

Here, the Contractor will conduct a similar water budget analysis for the sites being considered for EC system installation, thereby increasing the number and geographic diversity of sites that EAA can use for calibration of models, or remote sensing products. The approach will be similar to that done before, in which we assume that diffuse recharge (R_{df}) is the difference between precipitation (P) and actual evapotranspiration (ET), plus or minus change in soil water balance (dS), all of which are measured by the EC system, or:

$$R_{df} = P - ET - dS \quad \text{Eq. 2.3-1}$$

Here, the Contractor will assume that surface runoff (onto and off the site) and subsurface groundwater flow (into and out of the site) are negligible. By using these components in a water balance equation now, we can, *at some future time*, more easily import the data into a numerical model (e.g., HYDRUS as used in Sun et al., 2020) or compare the results to satellite products (e.g., NASA's SMAP or CYGNSS) or other land surface representations (e.g., NLDAS or SPoRT LIS). The Contractor will submit the final datasets that will constitute a final report to be delivered by the end of the contract term.

DELIVERABLES AND TIMELINE

The Project timeline will be January 2021 – December 2023 (approximately thirty six (36) months from the notice to proceed). The three (3) tasks outlined by this SOW shall have deliverables as follows:

Task 1 – Within the first six (6) months from receipt of notice to proceed, the Contractor, in conjunction with EAA staff, shall have selected appropriate sites for, and installed, two (2) EC towers.

Task 2 – Once installed, the Contractor will collect and QA/QC the data stream for distribution. At the onset of the data collection phase and throughout the remainder of the project, the Contractor will issue quarterly updates and routine data stream deliveries to EAA staff.

Task 3 – By December 31, 2023, the Contractor will submit the final quality controlled and quality assessed data stream that will constitute a final report.

EXPECTED RESULTS AND BENEFITS

The majority of the output from this project will be a QA/QC'd ET dataset and a local water budget, especially diffuse recharge. The Contractor can anticipate close communication with EAA scientists to ensure that the output from this Project fits the input needs for hydrologic models. A significant benefit of this research is that actual ET measurements have been collected at Camp Bullis. Adding additional sites will augment the information needed for comprehensive analyses of water resources in the Edwards and Trinity aquifer area, furthering the potential that the data can be scaled across the Edwards Recharge Zone.

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**EXHIBIT B
BUDGET ESTIMATE**

The EAA will compensate the Contractor an amount not to exceed \$199,939.71 over the Contract term for work related to Tasks 1–3 as described in Exhibit A, as follows:

Calendar Year	Associated Tasks	Total
2021	Tasks 1-2	\$64,134.16
2022	Tasks 1-2	\$66,610.54
2023	Tasks 1-3	\$69,195.00
2021-2023 Total		\$199,939.71

PERSONNEL CHART AND OTHER COSTS

	YEAR 1	YEAR 2	YEAR 3
Personnel/Work Category/Description	EST SALARY		
Michael Young, Principal Investigator	\$ 14,323.00	\$ 14,895.92	\$ 15,491.76
Project coordination, data analysis, and technical reporting			
Tara Bongiovanni, Co-Principal Investigator	14,873.51	15,468.45	16,087.19
Field deployment, data QA/QC and technical reporting			
Ken Wisian, Associate Director	183.53	190.87	198.51
Management advising			
Graphic Illustrator-TBD	50.80	52.83	54.94
Reporting and preparation of the technical printed material			
Editor-TBD	42.01	43.69	45.44
Reporting and preparation of the technical printed material			
Total - Personnel Monthly Effort	3.78	3.78	3.78
Fringe Benefits - Salaries - Projected Rate	30.1%	30.6%	31.1%
Administrative Costs - Rate	16.5%	16.5%	16.5%
Indirect Costs - Rate	26.0%	26.0%	26.0%
Other Direct Costs			
Computer Expenses - Monthly	Actual Personnel Monthly Effort * \$300		
Materials, Supplies, Services	At Cost; Receipts Required		
Travel – Food/Lodging/Airfare/Car Rental	At Cost; Receipts Required		
Mileage	At Current IRS Rates		

COST EXPLANATIONS

1. Salary: Contractor personnel salary rates are based on the Contractor's currently approved salaries for FY20-FY21 and are derived from Contractor's approved pay plans for the job categories.
2. Fringe benefits, vacation and sick leave benefits: The Contractor's fringe rates are negotiated with its cognizant agency (Department of Health and Human Services, or DHHS) and are part of the Contractor's F&A Cost Rate Agreement found at <https://research.utexas.edu/osp/resources/fa-memo/>. Fringe benefit rate information may also be found at <https://payroll.utexas.edu/payroll-info/fringe-benefits>. The projected fringe rates for fiscal year 2021 are included in the above table. Fringe will be charged at the applicable rate at the time the cost is incurred.
3. Administrative Costs: The administrative cost rate is applied to the total direct costs on projects with a reduced indirect cost rate.
4. Indirect Costs: The indirect cost rate is based on the Contractor's mandatory set rate with DHHS.
5. Computer Expenses: The Contractor utilizes existing computer systems that include a variety of Windows NT and LINUX workstations, UNIX workstations, mass storage devices, printers and plotters. Billable usage is based on fixed monthly rate of \$300/month multiplied by the total funded personnel effort months plus personnel effort contributed.
6. Materials, supplies and services: This category includes all expendable supplies for research activities as well as photocopying, report preparation expenses, long distance and cell telephone charges, batteries and all costs, and other standard project expenses related to this Project's report.
7. Travel: Domestic travel will reimbursed for fieldwork to Uvalde and Bexar Counties in Texas. Travel costs include food, lodging, airfare and car rental.






20-041-AMS UT Austin BEG Eddy Covariance Install Operation and Analysis Exp 12-2023 - To Committee

Final Audit Report

2020-12-03

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