COLLABORATIVE AGREEMENT

This Collaborative Agreement ("Agreement") is entered into by and between the U.S. Geological Survey (USGS), a bureau of the Department of the Interior, through the offices of its Laboratory and Analytical Services Division, Boulder, CO, hereinafter referred to as the "USGS" and Sonoma Water, Santa Rosa, CA, hereinafter referred to as "Collaborator." USGS and Collaborator are sometimes herein referred to as a "Party" and collectively as the "Parties." Any inconsistency between the standard terms of Articles 1 through 16 of this Agreement and any attachments to this Agreement shall be resolved by giving precedence to Articles 1 through 16.

Whereas, the USGS is authorized to perform collaborative work and prosecute projects in cooperation with other agencies, Federal, State or private, pursuant to 43 USC §36c; and

Whereas, the USGS is authorized to receive payments in arrears from any Tribe, State, Territory, Possession, or Political Subdivision by 43 USC §50b, and;

Whereas, the USGS has a mission in monitoring, analyzing, and predicting current and evolving Earth-system interactions and has need of delivering actionable data and/or materials to decision makers at relevant scales and timeframes to support this mission; and

Whereas, Collaborator has [hydrology and engineering data] and has need of USGS expertise in [Water Quality and Microbiology]; and

Whereas the Project entitled [Investigating Vulnerabilities to Riverbank Filtration under Hydrologic Extremes] is intended by the Parties to be mutually beneficial and to benefit the people of the United States;

Now, therefore, the Parties hereto agree as follows:

1. Statement of Work.
See the attached Statement of Work (SOW) (Attachment A), incorporated by reference herein.

2. Principal Investigator.
The USGS principal investigator (PI) for this Project is Jennifer Underwood, 303-541-3034, jcunder@usgs.gov, and 3215 Marine Street, E119, Boulder, CO 80303. The PI for the Collaborator is Stephen Maples, 707-526-5370, stephen.maples@scwa.ca.gov, and 404 Aviation Blvd, Santa Rosa, CA 95403. In the event that a PI is unable to continue in this Project, the sponsoring agency will make every effort to provide a replacement acceptable to the other Party.

3. Title to Equipment.
There will be no joint property purchased as a result of the collaborative effort outlined in the SOW. Each Party will provide its own equipment necessary to support its participation in the SOW.

4. Term.
The collaborative effort contemplated by this Agreement will commence on the effective date of this Agreement. The effective date of this Agreement shall be the later date of (1) 7/1/2026 or (2) the date of the last signature by the Parties. The expiration date of this Agreement shall be 6/1/2028.

5. Funding/Resource Share.

(a) The Collaborator will provide an estimated $187,500 in funds-in to the Project. The Collaborator is providing in-kind services and or resources with an estimated value of: $0.

(b) If the Collaborator is a non-governmental organization, the USGS requires an advance of $0.00. In the event that the advance payment is not received by USGS, USGS will submit an invoice. Invoices not paid within **60 days from date of bill** will bear Interest, and other fees required by Federal law, at the annual rate pursuant the Debt Collection Act of 1982, (codified at 31 U.S.C. § 3717) established by the U.S. Treasury.

(c) This agreement has been negotiated to be paid based on expenses incurred. The USGS will submit invoices to the Collaborator's administrative contact, identified in Article 9, on a quarterly basis. Invoices not paid within 60 days from date of bill for Tribal, State, and local government customers will bear Interest, and other fees required by Federal Law, at the annual rate pursuant the Debt Collection Act of 1982, (codified at 31 U.S.C. § 3717) established by the U.S. Treasury.

(d) The USGS is providing in-kind services and or resources with an estimated value of: $0.00 to the Project.

6. Amendments/Termination.
This Agreement can be changed or amended only by a written instrument signed by the Parties. This Agreement may be terminated by either Party on thirty (30) days written notice to the other Party. In the event of an early termination, USGS shall be reimbursed for any completed work or work in progress on the effective date of termination (i.e., when the Agreement actually terminates following the receipt of written notice from the other Party). Any unspent advanced funds will be returned to Collaborator. The USGS shall provide a copy of the outcomes completed as of the effective date of termination in the event of an early termination of the Agreement.

statement of work (SOW) and data management plan (DMP). Before a Party submits the information and data for publication or otherwise intends to publicly release or disclose scientific information and data that is jointly developed, the other Party will be provided thirty (30) days for review of the proposed release or disclosure, prior to submission for publication. The Parties acknowledge that scientific information and data developed as a result of the SOW are subject to applicable USGS Fundamental Science Practices (FSP) review, approval, and release

requirements, which are available in Survey Manual Chapter (SMC) 502.4, Fundamental Science Practices: Review, Approval, and Release of Information Products. The USGS is required to provide timely public access to the results of scientific information and data that does not contain sensitive protected information. Data and associated metadata will be open format and publicly accessible. The data and metadata will also be open access and machine readable in accordance with USGS FSP requirements available in SMC 502.7, Fundamental Science Practices: Metadata for USGS Scientific Information Products Including Data and SMC 502.8, Fundamental Science

8. (Reserved)

9. Notices.

Any notice required to be given or which shall be given under this Agreement shall be in writing and delivered by first-class mail to the Parties as follows:

USGS Technical:

Jennifer Underwood
U.S. Geological Survey, 3215 Marine Street, E119, Boulder, CO, 80303
jcunder@usgs.gov
303-541-3034
https://www.usgs.gov/staff-profiles/jennifer-underwood

USGS Administrative:

J.D. Zeigler
U.S. Geological Survey, 12201 Sunrise Valley Dr., MS 436, Reston, VA 20192
jzeigler@usgs.gov
703-648-5708

Collaborator Technical:

Stephen Maples
404 Aviation Blvd, Santa Rosa, CA 95403
stephen.maples@scwa.ca.gov
707-526-5370
https://www.sonomawater.org/

Collaborator Administrative:

Grant Davis
Sonoma Water, 404 Aviation Blvd, Santa Rosa, CA 95403
Grant.Davis@scwa.ca.gov
707-521-6210

Collaborator Financial Information:

Jake Spaulding
Sonoma Water, 404 Aviation Blvd, Santa Rosa, CA 95403
Jake.Spaulding@scwa.ca.gov

707-524-8373
Collaborator Finance UEI: VHH1S8T4VFQ9

10. Independent Organization.
For purposes of this Agreement and all research and services to be provided hereunder, each Party shall be, and shall be deemed to be, an independent Party and not an agent or employee of the other Party. Each Party shall have exclusive control over its employees in the performance of the SOW. While in field locations, a Party's employees must adhere to the safety and technical requirements imposed by the Party controlling the work site.

Neither Party has authority to make any statements, representations, or commitments of any kind, or take any action, which shall be binding on the other Party, except as may be explicitly provided for herein or authorized in writing. Neither Party has authority to use the name of the other in advertising or in other forms of publicity without the written permission of the other.

11. Governing Law.
(a) This Agreement is subject to interpretation under State and Federal law. If there is inconsistency between the laws, then Federal law is controlling. Each Party agrees to be responsible for the activities, including the negligence, of their employees. Responsibility of the USGS for the payment of claims for loss of property, personal injury, or death caused by the negligence or wrongful act or omission of a USGS employee, while acting within the scope of their employment, is limited to provisions of the Federal Tort Claims Act, 28 USC §§ 2671-80. USGS warrants that it is self-insured for the purposes of Worker's Compensation.

(b) The USGS and the Collaborator make no express or implied warranty as to the conditions of the research, merchantability or fitness for a particular purpose of the research, data, or resulting product incorporating data developed and exchanged under the SOW.

12. Force Majeure. Neither Party shall be held liable for any unforeseeable event beyond its control, not caused by the fault or negligence of such Party, which causes such Party to be unable to perform its obligations under this Agreement, and which it is unable to overcome by the exercise of due diligence including, but not limited to, flood, drought, earthquake, storm, fire, pestilence, lightning, and other natural catastrophes; epidemic, war, riot, civil disturbance, or disobedience; strikes, labor disputes, or failure, threat of failure, or sabotage; or any order or injunction made by a court or public agency. In the event of the occurrence of such a force majeure event, the Party unable to perform must promptly notify the other Party. It shall further use its best efforts to resume performance as quickly as possible and shall suspend performance only for such period of time as is necessary as a result of the force majeure event.

13. Entire Agreement.
This Agreement contains all of the terms of the Parties and supersedes all prior Agreements and understandings related thereto. Due to the specialized nature of the collaborative work, this Agreement is non-assignable by both Parties.

14. Disputes.

The signatories to this Agreement shall expend their best efforts to amicably resolve any dispute that may arise under this Agreement. Any dispute that the signatories are unable to resolve shall be submitted to the Director of the USGS or his/her designee and the Sonoma Water of the Collaborator or his/her designee for resolution.

15. Miscellaneous Provisions.
Pursuant to the Anti-Deficiency Act, 31 U.S.C. §1341 (a)(1), nothing herein contained shall be construed as binding the USGS to expend in any one fiscal year any sum in excess of its appropriations or funding in excess or what it has received for the collaborative work outlined in the SOW.

16. Survivability.
The following provisions shall survive the termination of this Agreement: 7. Publications/Reports/Data, and 14. Disputes.

IN WITNESS WHEREOF, the Parties have caused this Agreement to be executed on the last date listed below.

ACCEPTED AND AGREED

The USGS signatory certifies that:

- The USGS signatory is consistent with the delegations of authority to sign agreements, SM 205.13.
- The Collaborator is a U.S. owned organization.
- The COI form has been coordinated with the Ethics Office, as applicable.
- This Collaborative Agreement contains standard terms only or, if it contains non-standard terms, it was sent to OPA for review.

U.S. GEOLOGICAL SURVEY	COLLABORATOR
By: _____	By: _____
Name: _____	Name: _____
Title: _____	Title: _____
Date: _____	Date: _____
	Reviewed as to funds:
	By: _____ Sonoma County Water Agency

Division Manager - Administrative Services

Approved as to form:

By: _____

Cory Wurtzel O'Donnell
Chief Deputy County Counsel

Attachment A: Statement of Work between USGS and Sonoma County

Investigating Vulnerabilities to Riverbank Filtration under Hydrologic Extremes: Implications for Hydraulic Connectivity and Drinking Water Reliability

PI: Jennifer Underwood and Ramon Naranjo, **Team members:** Morgan Schachterle and Anna Schroeder, Donald Rosenberry

Motivation: Riverbank Filtration (RBF) systems rely on natural streambed and alluvial aquifer processes beneath and adjacent to the river to provide water availability and quality benefits and can therefore be operationally sensitive to hydrologic extremes. Extreme hydrologic events have been shown to alter hydraulic connectivity between surface water and groundwater and potentially impact operational reliability of Sonoma Water's RBF system. For example, elevated river turbidity levels observed during high flow conditions are known to impact water quality standards for produced water from Collector 5. Additionally, water levels in Collector 6 temporarily dropped below operational thresholds during summer and fall of 2022 following the 2020-2022 drought, highlighting risks related to drought-induced declines in streambed hydraulic connectivity, which are thought to be related to (1) reductions in the magnitude and frequency of wet-season, high-flow scour events and (2) prolonged inflation of an inflatable dam, which creates a back water pool and fosters bioclogging conditions near Collectors 1, 2, and 6 . Such interruptions present potential risks to the overall operational reliability of Sonoma Water's RBF system, and climate projections suggest increasing intensity of both droughts and floods in the future. To ensure ongoing RBF resilience, it is critical to identify threshold conditions (i.e., hydrologic or water quality outliers) that signal when system performance may become compromised.

Goal: This project will leverage Sonoma Water's extensive monitoring datasets to determine the primary drivers influencing RBF operational vulnerabilities under hydrologic extremes. Data sources include:

- Long-term continuous records: Surface water discharge and water quality metrics (DO, pH, temperature, and turbidity) from nearby USGS streamgages (e.g., Russian River Hacienda: 11467000, 2007–present). Historical Russian River streamflow reconstructions using the Basin Characterization Model (BCM; 1910–2024). Collector well water level, pumping rate, temperature, pH, and turbidity. Wohler Pool water surface elevation. Groundwater monitoring well water levels and temperatures (~2008–present).
- Mid-range discrete datasets (2017–2024): Discrete surface-water chemistry and microbiology metrics collected year-round, with higher-frequency sampling during summer. Discrete river-bottom chemistry and microbiology metrics. Temperature profiler, ERT, and cryocore data.

- Recent fine-scale spatial observations (2023–2024): Temperature profiler array, streambed piezometer water levels, ERT, infiltrometer, bathymetry, streambed pore water chemistry/microbiology, Monitoring well chemistry/microbiology

An integrated analysis across these temporal scales will improve understanding of streambed connectivity, surface water-groundwater interactions, RBF filtration capacity during hydrologic extremes, identify key indicators of system vulnerability, and develop predictive thresholds to inform operational decision-making.

Integrated Hydrological, Water Quality, and Microbial Processes Questions and Approach:

1. Long-term continuous data: Characterize periods of hydrological extremes and corresponding responses in the RBF system.
    a. Questions: Do hydrologic extremes (e.g., elevated turbidity during high flow events, reduced magnitude and frequency of high flow events and extended periods of dam-up conditions during droughts) and associated changes in surface water quality (e.g. temperature, turbidity, pH, DO) relate to changes in collector well water production efficiency or collector well water quality?
    b. Approach: We will evaluate how Russian River flow volumes, duration of 'dam up' conditions at Wohler Pool, and surface water quality metrics evolve over summer seasons under contrasting hydrologic conditions (e.g., with preceding wet/high-flow years vs. preceding dry/low-flow years). The analysis will include both: 1) a whole-season comparison across observed hydrologic water-year types, and 2) longitudinal, within-season assessments of how conditions change from early to late summer during 'dam up' conditions.

To support these comparisons, we will: 1. analyze collector well production efficiency (e.g., production volume vs. collector drawdown) in relation to streamflow conditions (e.g., inflow volumes, dam-up duration, water quality metrics) to identify how hydrologic variability influences collector well performance. 2. Compare collector well water-quality metrics with corresponding surface-water measurements to evaluate connectivity and travel times. 3. Identify streamflow and water-quality percentile-based thresholds associated with shifts in collector-well chemistry or operational behavior and determine when well conditions diverge significantly from long-term wet-season, dry-season, and annual means.

2. Mid-range discrete datasets:
    a. Questions: How do variations in surface-water flow magnitude, temperature, nutrient inputs, and microbial community structure relate to microbial abundance, biofilm development, and geochemical conditions in the streambed? How do streambed microbial communities respond to hydrologic extremes (preceding wet/high-flow years vs. preceding

dry/low-flow years), and do shifts in functional gene composition reflect changes in microbial processes that may intensify or reduce clogging within the streambed? How do the patterns observed in these discrete datasets align with long-term continuous surface-water quality trends and collector-well water-quality and efficiency metrics?

b. Approach: We will evaluate discrete surface-water quality, collector-well quality and riverbed sediment conditions by percentile-based hydrologic and water-quality thresholds identified from the long-term continuous dataset. Analysis will include both whole-season (preceding wet/high-flow years vs. preceding dry/low-flow years) comparisons and, where possible, within-season evaluations of how conditions evolve through the duration of the dry season.

To support these comparisons, we will: 1. Compare discrete surface-water and streambed measurements to flow- and water-quality thresholds previously identified from the long-term analysis to determine the conditions associated with shifts in river chemistry. 2. Determine key environmental drivers that influence the structure and abundance of microbial communities within riverbed sediments. 3. Relate changes in functional gene composition to concurrent changes in discrete collector-well chemistry, assessing whether shifts in microbial functional potential correspond with processes that may influence water quality or streambed clogging.

3. Recent fine-scale spatial observations datasets:
   a. Questions: How do spatiotemporal variations in infiltration rates relate to pumping activity and collector-well production efficiency? How do seasonal changes in surface-water quality, combined with spatial variations in infiltration rates, influence pore-water and shallow aquifer chemistry, including mixing patterns between river water and ambient groundwater? What environmental factors most strongly control redox conditions in pore water (e.g., nitrate reduction, iron reduction, sulfate reduction, methanogenesis) and the abundance/composition of microbial communities?
   b. Approach: Hydrologic percentile thresholds from the long-term dataset will be used to categorize each sampling year into defined flow conditions (e.g., <25th percentile dry years, 25–75th percentile average years, >75th percentile wet years). These categories allow us to evaluate how infiltration behavior differs under contrasting hydrologic regimes and to make consistent year-to-year comparisons. If the study years (2023 and 2024) fall within similar streamflow percentile categories, observed differences in infiltration behavior can then be attributed to other factors—such as changes in streambed bathymetry or sediment structure—rather than hydrologic regime alone. Within-season analyses will examine how

infiltration rates evolve across the dry season along the transects and relate those spatial patterns to pore-water chemistry and microbiology.

To support these comparisons, we will: 1. Develop estimates of infiltration using models (VS2DH) at select locations using streambed temperature-profile data, streambed piezometer gradients, and infiltrometer measurements. Results will help identify spatial and temporal patterns of infiltration and in response to collector well operation.2. Relate both year-to-year and within-season changes in infiltration to pore-water chemistry and microbiology. 3. Compare these infiltration-driven biogeochemical patterns with monitoring-well chemistry and water-exchange indicators—including redox-sensitive constituents, stable isotopes (^{2}H, ^{18}O), and dissolved noble gases such as argon—to evaluate the degree and timing of surface-water recharge into the shallow aquifer and its influence on collector-well water quality.

Deliverables:

This project will produce four primary deliverables. (1) A publicly accessible data release of the fine-scale spatial observations dataset, including temperature-profile arrays, streambed piezometer data, infiltrometer measurements, bathymetry, pore-water chemistry, and related metadata. (2) A second data release containing microbial community sequences from the mid-range discrete sampling and the fine-scale transect datasets. (3) A calibrated VS2DH numerical model, delivered with all input files, parameter sets, and documentation necessary for reproducing infiltration and heat-transport simulations across transects and vertical profiles. (4) A peer-reviewed journal article synthesizing the hydrologic, geochemical, and microbial findings and evaluating their implications for riverbank filtration performance during hydrologic extremes.

Schedule:

Approach ID	Estimated Start Date	Estimated End Date
1	7/1/2026	12/30/2026
2	10/1/2026	4/14/2028
3	10/1/2026	4/14/2028

Budget:

Fiscal Year	Gross Funds
2026	$93, 750
2027	$93, 750