



TECHNICAL ASSISTANCE AGREEMENT

This Technical Assistance Agreement is entered into by and between U.S. Geological Survey, a Bureau of the Department of the Interior, through the offices of its Western Ecological Research Center, Sacramento, CA, hereinafter referred to as the “USGS” and The City of Palo Alto, Palo Alto, CA, hereinafter referred to as “Collaborator.” USGS and Collaborator are sometimes herein referred to as a “Party” and collectively as the “Parties.”

Whereas, the USGS is authorized to perform technical assistance with other Federal agencies, units of State or local government, industrial organizations, private corporations, public and private foundations, and nonprofit organizations (including universities) under the Stevenson-nydler Act (15 U.S.C. § 3710a(b)(3)(A), as amended);

Whereas, the USGS has a mission in conducting scientific investigations on the Nation’s ecosystems and resources and has need of assessing the outcomes of novel restoration actions to support this mission;

Whereas, Collaborator has a restoration site, the Palo Alto Horizontal Levee Pilot Project and has need of USGS expertise in documenting the multiple ecosystem benefits of using horizontal levee as green infrastructure rather than manmade structures including: assessment of tidal marsh processes, salt marsh harvest mouse live-trapping and habitat use as well as monitoring of legacy contaminants, benthic community and bacterial pathogens;

Whereas, the project entitled “The Palo Alto Horizontal Levee Pilot Project: Post- Restoration Science and Monitoring” 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 attached Statement of Work (SOW) (Attachment A), incorporated by reference herein.
- 2. Principal Investigator.** The USGS principal investigators (PIs) for this Project are Susan De La Cruz, sdelacruz@usgs.gov, 707-562-2004; PO Box 158 Moffett Field, CA 94035; Karen Thorne, kthorne@usgs.gov, 916-502-2996, One Shields Ave. Davis, CA 95616; and Marie-Noële Croteau, mcroteau@usgs.gov, 650-329-4424, PO Box 158 Moffett Field, CA 94035. The PI for the Collaborator is Elise Sbarbori, Elise.Sbarbori@CityofPaloAlto.org, (650) 496-5958, and 1900 Embarcadero Road, Suite 205, Palo Alto, CA 94303. In the event that a PI is unable to continue in this project, the sponsoring agency will make every effort to substitute a replacement acceptable to the other Party.
- 3. Title to Equipment.** There will be no joint property purchased as a result of the work outlined in the SOW. Each Party will provide its own equipment necessary to support its participation in the technical evaluation.

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4. Term. The technical assistance 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) 5/1/2024 or (2) the date of the last signature by the Parties. The expiration date of this Agreement shall be 4/30/2029. The Agreement may be extended by mutual written agreement of the Parties.

5. Funding.

The total budget is \$924,745 and is intended to include work conducted by four different USGS Science Centers:

- USGS Western Ecological Research Center, San Francisco Bay Estuary Field Station (De La Cruz and Woo): \$324,216
- USGS Western Ecological Research Center, Davis Field Station (Thorne and Buffington): \$270,529
- USGS Geology Minerals Energy and Geophysics Science Center (Croteau): \$ 173,000
- Water Mission Area (Parchaso): \$82,000
- Upper Midwest Water Science Center (Givens): \$75,000

(a) The Collaborator will provide an estimated \$924,745.00 in funds-in to the project. The Collaborator is providing in-kind services valued at \$0.

(b) The USGS requires an advance of \$0.

(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 Section 9.d., on a quarterly basis. Invoices not paid within 60 days from date of bill for Local and State 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 valued at \$ 12,500 to the collaboration, including PI salary for science project direction and design.

6. Termination. This Agreement may be terminated by either Party on 30 days written notice to the other. In the event of an early termination, the 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 also supply a copy of the evaluations completed as of the Effective Date of Termination in the event of an early termination of the project.

7. Publications/Reports.

(a) Each Party is free to publish the non-proprietary or non-confidential information and data developed in the performance of this agreement. Before a Party submits the information and data for publication or otherwise intends to publicly release or disclose scientific information

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and data that is jointly developed, the Party shall have a review period of Fifteen (15) business days to ensure that the draft publication or presentation does not contain Confidential or Proprietary Business Information. Upon expiration of the review period with no comments received from the other Party, the first Party will proceed with submission of the publication and presentation. The review period is provided as a courtesy to review the publications or presentations to ensure confidential or proprietary information is not disclosed and ensure that there is not inadvertent release of such information that could be used for a patent or invention application. All comments provided within the review period will be forwarded to the contacts identified in Section 9. 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 this scientific information and data unless it contains 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 Practices: Review and Approval of Scientific Data for Release.

(b) Under the authority of 15 U.S.C. § 3710a (c)(7)(B), as amended, the Parties will have the opportunity, as part of the technical assistance, to identify protected research and development information, which is defined as information generated by the research which would have been proprietary information had it been obtained from a non-Federal entity. Each Party may designate as protected research and development information, any information generated by its own employees, and with the Agreement of the other Party, mark any information produced by the other Party's employees. Such protected research and development information shall be exempt from disclosure under 5 U.S.C. § 552(b)(4). After the protected research and development information period has expired, the USGS may publish the results of the research as part of open literature (journal and proceeding articles) or as USGS open file reports.

(c) Generated information and results which have been created and marked as protected research and development information may be protected from release or disclosure for a period of two (2) years, unless an earlier date is agreed upon by the Parties.

8. Proprietary Information/Intellectual Property/Background Intellectual Property.

No intellectual property is expected as a result of the research/technical effort.

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:

(a) USGS Administrative Contact Information:

Helen Knepp
USGS Western Ecological Research Center

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hknepp@usgs.gov; 279-782-3589
3020 State University Drive. Modoc Hall, Suite 4004, Sacramento, CA 95819

(b) USGS Technical Contact Information:

Isa Woo
PO Box 158, Moffett Field, CA 94035-0158
iwoo@usgs.gov
707-562-2001
https://www.usgs.gov/centers/werc

(c) USGS Financial Contact Information:

Helen Knepp
3020 State University Drive, Modoc Hall Suite 4004 Sacramento, CA 95819
hknepp@usgs.gov
279-782-3589
USGS UEI: NJQMLNG5L8A5
USGS Tax ID: 53-0196958

(d) Collaborator Administrative Contact Information:

Elise Sbarbori
1900 Embarcadero Road, Suite 205, Palo Alto, CA 94303
Elise.Sbarbori@CityofPaloAlto.org
(650) 496-5958

(e) Collaborator Technical Contact Information:

Elise Sbarbori
1900 Embarcadero Road, Suite 205, Palo Alto, CA 94303
Elise.Sbarbori@CityofPaloAlto.org
(650) 496-5958
Click or tap here to enter text.

(f) Collaborator Financial Contact Information:

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94-6000389

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10. Independent Entity.

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 work. While in field locations, a Party's employees shall adhere to the safety and technical requirements imposed by the Party controlling the work site.

Neither Party shall have 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 may use the name of the other in advertising or other forms of publicity without the written permission of the other.

11. Governing Law/Liability.

(a) This Agreement is subject to interpretation under applicable State and Federal laws. Where there is inconsistency between the laws, Federal law is controlling. Each Party agrees to be responsible for the activities, including the negligence, of their employees. The USGS responsibility 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.

(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. These provisions shall survive the termination of the Agreement.

(c) The USGS shall not indemnify Collaborator or any third party against any liabilities, costs, attorney's fees, expenses, damages and losses (including any direct, indirect or consequential losses, loss of profit, loss of reputation and all interest, penalties, and legal costs and all other professional costs and expenses suffered or incurred by Collaborator or any third party arising from the work conducted under this technical assistance agreement.

12. Force Majeure.

Neither Party shall be 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 shall 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. This Agreement can be changed or amended only by a written instrument signed by the Parties. Due to the specialized nature of the 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 City of Palo Alto, Public Works Department of the Collaborator or his/her designee for resolution. If no resolution is reached, the Parties agree that the courts of the United States shall have jurisdiction over any claims arising out of work under this agreement.

15. Miscellaneous Provisions.

(a) Anti-Deficiency Act. Pursuant to the Anti-Deficiency Act, 31 U.S.C. §§ 1341 (a)(1)(A) and (B) and 31 USC § 1517(a), 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 or involving the Federal government in any obligation to pay money before funds have been appropriated for that purpose unless otherwise allowed by law.

(b) Import/Export. The use and dissemination of Information and materials exchanged under this Agreement will be in accordance with all U.S. laws and regulations, including those pertaining to national security and export control. Nothing in this Agreement shall be construed as a license to export Information or to permit any disclosure in violation of law, regulation, or Department of Interior policy. The exporting Collaborator is responsible for obtaining any export licenses that may be required by U.S. Federal law.

(c) Third Parties. The Parties acknowledge and agree to allow disclosure of Proprietary Information or Background Intellectual Property to third parties (such as, students, contractors, subcontractors and or consultants) or external collaborators for the purposes of carrying out this Agreement. If a Party engages a new third party to perform any portion of the SOW after the Effective Date of this Agreement, such Party will notify the other Party and provide information about the third-Party involvement within 7 days of engagement. No contractors shall be listed as ineligible in the System for Award Management (sam.gov), unless waived by the Department of the Interior. However, these participants are not Parties to the Agreement. The Parties agree that they will comply with and advise any third parties they have engaged to conduct the Agreement activities to comply with, all applicable Executive Orders, statutes, and regulations. The Parties agree that they will ensure that third party participants are under written obligation not to disclose Proprietary Information or Background Intellectual Property, except as required by law or court order, before the third parties have access to any Proprietary Information or Background Intellectual Property. No foreign personnel shall be engaged by the Collaborator as a contractor, consultant, grantee or third-party collaborator for the performance of any work under this TAA without first identifying the individual, his country of origin, and the work to be performed to USGS so that USGS may determine whether the agency requires advanced approval by an

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authorized agency official before working with the foreign contractor, consultant, grantee or third-party collaborator, and whether any data, technology or products shared with or used by a foreign contractor, consultant, grantee or third-party collaborator as part of the technical assistance under this agreement are in accordance with all U.S. laws and regulations, including national security export controls and U.S. Department of State regulations and policies.

16. Survivability.

The following provisions shall survive the termination of this Agreement: 7. Publications/Reports, 8. Proprietary Information/Intellectual Property/Background Intellectual Property and 14. Disputes.

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

U.S. GEOLOGICAL SURVEY

COLLABORATOR

By: _____

By: _____

Name: A. Keith Miles

Name: Ed Shikada

Title: WERC Center Director

Title: City Manager

Date: _____

Date: _____

Attest:

By: _____

Name: Brad Eggleston

Title: Public Works Director

Date: _____

APPROVED AS TO FORM:

By: _____

Name: Caio Arellano

Title: Chief Assistant City Attorney

Date: _____

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Attachment A: Statement of Work

The Palo Alto Horizontal Levee Pilot Project: Post- Restoration Science and Monitoring

May 1, 2024 - April 30, 2029

Research Team:

- Susan De La Cruz and Isa Woo: USGS Western Ecological Research Center, San Francisco Bay Estuary Field Station
- Karen Thorne and Kevin Buffington: USGS Western Ecological Research Center, Davis Field Station
- Marie-Noële Croteau: USGS Geology Minerals Energy and Geophysics Science Center
- Francis Parchaso: USGS Water Mission Area
- Carrie Givens: USGS Upper Midwest Water Science Center

I. BACKGROUND/INTRODUCTION:

The City of Palo Alto is leading a Palo Alto Horizontal Levee Pilot Project (PAHLPP) at the Palo Alto Baylands Nature Preserve. This innovative pilot project is intended to use green infrastructure rather than hard grey structures to promote multiple ecosystem benefits including wind/wave attenuation, flood protection, and use of treated wastewater for plant irrigation in addition to enhancing marsh-upland transition zone habitat and high tide refugia for tidal marsh inhabitants. The horizontal levee may include freshwater marsh, wet meadows, and riparian/scrub ecosystems. This restoration will transition into a brackish marsh zone that transitions into the salt marsh of the adjacent Harbor Marsh. This project will restore a rare habitat type in the San Francisco Bay estuary and also provide flood protection and human recreation opportunities. Furthermore, a gentle sloping transition zone will also enhance the ability to enhance marsh resiliency to sea level rise.

Additionally, USGS scientists will monitor metals, bacterial pathogens, and the benthic macroinvertebrate community at an intertidal site near the PAHLPP and near the outfall of the Palo Alto Regional Water Quality Control Plant (RWQCP). The latter site has been monitored for the last 30 years. Initially, exceptionally high concentrations of copper and silver were found in mud-dwelling animals, and the RWQCP was identified as a point source for these metals. The

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elevated metal concentrations also coincided with reduced reproductive activity in resident clams (*Limecola petalum*, formerly *Macoma balthica* and *Macoma petalum*), and the benthic community showed signs of environmental stress. Metal concentrations in both sediments and clams have declined significantly in the 1980s as the Palo Alto RWQCP implemented more advanced wastewater treatment and source control programs. Since the 1990s, metal concentrations have continued to slowly decrease and even stabilize, except for silver, which continues to be 2-3 times higher than the regional background. Overall metrics suggest improved environmental conditions at the site. Continued efforts to document changes in pollutant concentrations, forms, and types over time is critical to assess ecosystem health.

II. PURPOSE:

The overall purpose of this agreement is to provide technical assistance to the City of Palo Alto to quantify the effectiveness of the PAHLPP restoration in comparison to appropriate reference sites. These assessments are focused on assessing the habitat for endangered species such as the salt marsh harvest mouse (SMHM; *Reithrodontomys raviventris*) presence and habitat functions; monitoring of benthic community for bacterial pathogens and contaminants; and understanding tidal marsh processes in terms of elevation, channel morphology, and vegetation. The science and monitoring will be conducted by four USGS Science Centers with the following 3 objectives.

III. OBJECTIVES:

Our objectives are divided into three components: 1) Determining Salt Marsh Harvest Mouse presence and assessing habitat function for seed resources and high tide refugia; 2) Monitoring of contaminants and pathogens; 3) Understanding wetland processes (elevation, vegetation). These objectives will be addressed in the following three studies.

Study 1: Determine Salt Marsh Harvest Mouse presence and assess habitat function for seed resources and high tide refugia (Woo and De La Cruz)

The SMHM is an endangered species that is endemic to the San Francisco Estuary. Many Federal, state, and regional management, recovery, or restoration plans have emphasized the importance of habitat restoration and enhancement for SMHM recovery; yet few studies have addressed the direct benefits of these management actions for SMHM. Most studies on SMHM focus on SMHM presence either by live trapping or via fecal pellets with subsequent genetic analyses to identify species (Aylward et al. 2023). Yet, species presence alone provides limited information on how individuals use or benefit from specific restoration actions. Here, we propose a step-wise and methodical approach in assessing critical habitat functions in terms of food and habitat resources for SMHM. This study dovetails with UC Davis proposed work on fecal pellets for SMHM detection. We propose a tiered approach to assess the effectiveness of the PAHLPP at augmenting food resources and providing high tide refugia for SMHM using the Opportunity, Capacity, and Realized Function framework set forth by Simenstad and Cordell (2000) and used by USGS to characterize restoration effectiveness at the Nisqually River Delta (Ellings et al. 2016, Davis et al. 2018, Woo et al. 2018). Opportunity is defined by habitat suitability which will be measured by SMHM live trapping for presence. Capacity is defined by

the restoration’s production of food resources (i.e., seed quantity, diversity, and biomass per unit area during fall). Realized Function is the integration of Opportunity and Capacity in terms of evidence that SMHM is consuming the additional food resources provided by the restoration. Evidence that SMHM is consuming food from the PAHLPP will be measured by reconstructing diet from droppings (saved from live trapped individuals). Habitat functions in terms of high tide refugia will also be quantified via focal observations of predation during king tide events.

Task 1.1 Opportunity: SMHM Presence

Opportunity is defined by habitat suitability which will be measured by SMHM live trapping for presence.

Task 1.1a. Does the PAHLPP provide habitat for Salt Marsh Harvest Mouse measured by live-trapping?

A single pre-restoration small mammal trapping session occurred in Fall 2023 and will be repeated annually for post-restoration comparisons. Our study sites will be focused on the PAHLPP site and adjacent marshes and a reference site north of PAHLPP (Figure 1). Droppings will be collected and archived for later analyses of diet (via dietary DNA). Salt marsh harvest mouse surveys will be led by permitted biologist (State permit: Woo SC-183120006. Federal Permit USGS: TE020548-15). All SMHM protocols will be followed.



Figure 1. The Palo Alto Horizontal Levee Pilot Project and reference site to compare Salt Marsh Harvest Mouse presence and food resources.

Task 1.2: Habitat Capacity

Task 1.2a. Does PAHLPP produce food resources for SMHM?

We will quantify the availability of seed resources in the PAHLPP compared to nearby reference site as a metric of the restoration’s structural capacity to provide food resources. This survey will be conducted after the SMHM trapping session, annually in the Fall, so that any diet information gathered during live-trapping can be related to the on-site production of seed resources, and later analyses of consumption (via dietary DNA analyses on droppings, currently not funded).

Task 1.2b. Does PAHLPP provide plant cover compared to reference?

We will assess the pre- and post- restoration habitat of the PAHLPP to provide plant cover during king tide events compared to the reference marsh. To do this we will integrate water levels (via a water level logger), with vegetation height surveys supplemented by Objective 3 surveys of elevation and vegetation (see Objective 3) to model pre- and post- restoration to assess the amount of vegetative cover at varying high tide levels.

Task 1.3: Habitat Functions

Task 1.3a. Do SMHM consume seeds from PAHLPP

In order to facilitate analyses of dietary DNA (via droppings), we will establish a localized DNA library or supplement existing DNA libraries to include the full suite of onsite plant species, common tidal marsh vegetation, and common invertebrates. This would allow for more accurate dietary reconstruction from small mammal droppings.

Task 1.3b. Does PAHLPP provide high tide refugia compared to reference?

King tide events are extreme high tides that occur in winter and flood the marsh to the extent where very little vegetative cover remains. Small mammals that live within marshes with abrupt upland transition zones may be exposed to greater predation risk because of the lack of vegetated cover during king tides. To quantify this, we will conduct focal observations on avian predators during king tide events at the PAHLPP and reference site, for pre- and post- restoration.

Task 1.3c. Optional Subtask: DNA analyses: Dietary reconstruction from collected and archived fecal pellets (additional \$46,000 required)

This optional task is not currently funded, and would require an additional \$46,000 to conduct DNA analyses on collected and archived fecal pellets of the small mammal community. These pellets have been collected and preserved in molecular grade ethanol to facilitate analyses until an additional funding source is identified.

Task 1.4: Project Management and Reporting

Task 1.4a. Project/Data Management; endangered species permits; Data analyses; Reporting

Results from this work will be included in the final report as described in section VII of this Agreement. Project update reporting in the form of email will be provided annually by April 30, to cover activities conducted during the previous calendar year.

Project communication will occur with periodic email updates to coordinate research activities. An email update of the work activities completed will be provided annually. Basic summary information will be provided in a form of an email, presentation slides, or teams meeting. Project management also includes permitting reports for endangered species reporting, data entry and basic data analyses.

Study 1 Budget Subtotal

Total post-restoration budget for Study Objective 1: Salt Marsh Harvest Mouse Trapping and functional assessment of habitat is \$ 324,216.

Study 2: Monitoring of benthic community and bacterial pathogens, as well as legacy and emerging contaminants (Croteau, Parchaso, Givens)

The goal of this study is to assess aquatic ecosystem responses (including long-term responses) to contaminants, in particular metals and bacterial pathogens, as well document recovery after contaminant assault and physical disturbances at two sites in South San Francisco Bay, i.e., 1) legacy monitoring site, and 2) new site located within the horizontal levee perimeter. Specific goals include:

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- 1) Continue monitoring metals in sediments and in resident clam species, as well as benthic invertebrate community composition at the legacy site.
- 2) Continue DNA analyses initiated in 2021 to assess the influence of wastewater effluent on the microbial communities at the legacy site.

After the construction of the horizontal levee, the study will also characterize metal exposures and colonization by benthic invertebrates at a (new) site located within the horizontal levee perimeter.

Study objectives- Objectives are mostly a continuation of previous agreements with the City of Palo Alto, except the addition of a new site nearby the horizontal levee. They include the following tasks with details provided below:

Task 2.1: Measure metals of regulatory interest in sediment and in tissues of a local sentinel species

Task 2.1a. Sample for metals

Contaminants will include toxic metals monitored since the mid-1970s (e.g., Cu and Ag), metals used in clean energy technology (e.g., Cr, Co, Ni, Co, Mn and Zn), selenium, and mercury, although mercury analyses will be done at a lower frequency. Samples will be collected 6-times per year. Methods used will be similar to previous agreements (Cain et al. 2023).

Sediments will be collected at low tide from the exposed mudflat. Samples will be scraped from the visibly oxidized surface layer of the mud, which represents recently deposited sediment and detritus, or sediment affected by recent chemical reactions with the water column. The sediment also supports microflora and fauna, a nutritional source ingested by *M. petalum*. Sediment will be obtained to conduct all proposed analyses (Table 1) and to archive approximately 10 grams for any unforeseen future needs. Clams (approximately 60-100 individuals) will be collected by hand from the same areas.

Table 1. Chemical and physical data, and analytical methodology for monitoring the near-field discharge of the Palo Alto RWQCP

Constituent	Matrix	Method
Ag, Al, Cr, Cu, Fe, Ni, Ti, Zn	Sediment/tissue	ICP-OES
Nb	Sediment	ICP-MS
Hg	Sediment/tissue	Atomic fluorescence spectrometry
Se	Sediment/tissue	ICP-MS coupled to hydride generation
Particle size	Sediment	Physical separation
Total organic carbon (TOC)	Sediment	IRMS*
Microbial load	Water/Sediment	Cultivation on R2A media
Microbial community (microbiome)	Tissue	16S rRNA sequencing
Antimicrobial gene markers	Water/Sediment	Polymerase chain reaction (PCR)

*Continuous Flow Isotope ratio Mass Spectrophotometry (IRMS)

Sample preparation- Sediments will be sieved through 100 µm mesh in ultra-clean (18 Mohm-cm) deionized water immediately upon return to the laboratory. Both the fraction of sediment passing through the sieve (silt/clay fraction) and the fraction retained on the sieve will be dried and weighed. Particle size distribution will be defined as the proportion of the total sediment mass divided between these two fractions.

Replicate aliquots of sediment (< 100 µm fraction) will be digested with concentrated nitric acid in heat blocks. This method provides a “near-total” extraction of metals from the sediment and is comparable to the recommended procedures of the U.S. Environmental Protection Agency (USEPA) for leachable metals and to the procedures employed in the Regional Monitoring Program. Another set of replicate subsamples from < 100 µm fraction will be directly extracted with dilute (0.6 N) hydrochloric acid (HCl) for 2 hours at room temperature. This method extracts metals bound to sediment surfaces and is operationally designed to obtain the leachable, anthropogenic contribution to the sediment concentration (Luoma and Bryan 1982).

Clams will be depurated for 48 h at 15° C in clean ocean water diluted to the salinity on the mudflat at the time of collection. Following depuration, the length of each clam will be determined, and shell and soft tissue will be separated. Soft tissues will be composited into 8 samples, each containing animals of similar shell length. Samples will be dried and digested by nitric acid in heat blocks. Samples for mercury and selenium analysis will be composited as above into 3 samples, homogenized and stored at -80° C. Metal content of a standard sized clam will be calculated for each collection to facilitate comparisons of metal exposure over time.

Analytical methods- Digested tissue and sediment samples will be evaporated to dryness and reconstituted in either 1% nitric acid or 5% hydrochloric acid. Elements, except Hg and Se, will be analyzed by inductively coupled plasma optical emission spectrophotometry (ICPOES) (Table 1). Tissue and sediment samples for total mercury will be digested in nitric acid, followed by BrCl oxidation, purge and trap, and cold vapor atomic fluorescence spectrometry according to the EPA Method 1631. Similarly, tissue and sediment samples for selenium analysis will be digested in nitric acid, followed by hydrogen peroxide oxidation, hydride generation inductively coupled plasma mass spectrometry (HG-ICP-MS) according to existing methods. Total organic carbon (TOC) concentrations will be determined using a continuous flow isotope ratio mass spectrophotometer (IRMS) at UC Davis. Before the analysis, sediment samples will be acidified with 12 N HCl vapor to remove inorganic carbon.

Quality control will be assessed by frequent analysis of blanks, certified reference materials with each analytical run, and internal comparisons with prepared quality control standards. Method detection limits (MDL) and reporting levels (MRL) will be determined using existing procedures.

Task 2.2: Characterize the benthic community composition

Task 2.2a. Collect, sort and identify benthic invertebrates

The benthic community structure will be characterized to support assessments of benthic community dynamics in relation to contaminant exposures. Data will allow evaluating relationships between metal exposures and biological metrics (benthic community structure, condition index).

Three replicate samples will be collected using 8.5 cm diameter x 20 cm deep cores for the benthic community monitoring study. Benthic samples will be washed on a 0.5 mm screen, preserved in 10% formalin for two weeks and then transferred to 70% ethyl alcohol with Rose Bengal stain. A minimum of 10 individual *M. petalum* of varying sizes (minimum of 5mm) will be collected for the analysis of reproductive activity (if additional funds are available).

Benthic samples will be sorted and individuals identified to the lowest taxonomic level possible, and individuals for each species will be enumerated. Note that as a cost-saving measure, taxonomy of some phylum (for example, annelids) will be coarser.

Task 2.2b. Collect, preserve, dissect and assess reproductive status of clams (additional funding source required)

Clams collected for reproductive analysis will be immediately preserved in 10% formalin at the time of collection, to stabilize samples for archiving, until additional funds becomes available. If additional funding becomes available, in the laboratory, the visceral mass of each clam will be removed, stored in 70% ethyl alcohol, and then prepared using standard histological techniques. Thin sections of clam reproductive tissue will be examined with a light microscope to characterize sex, developmental stage, and condition of gonads.

Task 2.3: Characterize the microbial community in water, sediment and clams.

Task 2.3a. Measure microbial load in sediment, water and in clams

Measures of microbial load in water, sediment and clams will allow assessing the influence of wastewater effluent on the microbial community (microbiome) as well as provide insights on microbial-mediated processes. Triplicate sediment samples will be scraped from the visibly oxidized surface layer of the mud using a sterile spatula and added into sterile Falcon tubes. Triplicate water samples will be collected from pools at the mudflat surface using sterile Falcon tubes. Clams (20-25) will be collected by hand, as described in task 2.1.a. In the laboratory, clams will be rinsed with sterile MilliQ water, transferred into a sterile jar filled with DNA-RNA shield solution. Samples will be shipped on ice overnight to the Michigan Bacteriological Research Laboratory. Altogether, data for this project will increase the understanding of aquatic ecosystem responses to anthropogenic contaminants, in particular metals and bacterial pathogens.

Task 2.3b. Characterize the microbial community and assess presence of bacterial pathogens and antimicrobial gene markers

Using next-generation amplicon sequencing targeting a universal Bacteria 16S rRNA gene, we will characterize and compare the microbial community composition, or microbiome, of the surface water, sediment, and clams. Microbiome variation will be evaluated temporally and spatially and in regard to other measured environmental variables, metal analysis, and benthic community metrics. This collective analysis should provide details on how metal concentration and exposure influence the microbiome of these separate environmental compartments with the potential of influencing clam health and physiology. Note that if funds from other tasks can be leveraged, the presence of bacterial pathogen and antimicrobial gene markers will also be evaluated.

Note that if funds from other tasks can be leveraged, the presence of bacterial pathogen and antimicrobial gene markers will also be evaluated.

Task 2.4: Project Management and Reporting

Task 2.4a. Project/data management, reporting

Project update reporting in the form of email and/or meeting will be provided annually by the end of spring to cover activities conducted during the previous calendar year. Data will also be summarized in the form of a USGS ScienceBase data release.

Study 2 Budget Subtotal

The annual budget for Study 2 is \$330,000. It includes salary for project management and reporting, as well as field work, sample processing, analytical and taxonomical analyses. Note that specimens will be collected and preserved for task 2.2, but additional funding will be required to pay for external analyses.

Study 3: Understanding wetland processes for Palo Alto Horizontal Levee Pilot Project: long-term monitoring (Thorne)

The city of Palo Alto is constructing a horizontal levee and irrigated ecotone to create a transitional freshwater wetland slope with a variety of habitat types proposed. The horizontal levee may include freshwater marsh, wet meadows, and riparian/scrub ecosystems. This restoration will transition into a brackish marsh zone that transitions into the salt marsh of the adjacent Harbor Marsh. This project will restore a rare habitat type in the San Francisco Bay estuary and also provide flood protection and human recreation opportunities.

Objectives: Assess the physical and biological conditions pre and post construction for the Palo Alto Horizontal Levee Pilot Project and the adjacent Harbor Marsh. Here we propose to monitor the Palo Alto Horizontal Levee Pilot Project restoration and the adjacent Harbor Marsh to understand the ecological outcomes following the restoration efforts. We also propose monitoring a control site (e.g., Laumeister marsh) to compare desired restoration outcomes to an existing non-restored marsh ecosystem. The following monitoring activities meet the

recommendations from the Palo Alto Horizontal Levee Pilot Project: Monitoring and Adaptive Management Plan (ESA, 2023; Table 2 *Summary of Monitoring Schedule*). Pre-construction monitoring (Q1 and Q2 of 2024) has been funded under a separate agreement, so the work below will focus on Post-restoration monitoring.

Study questions:

1. How does habitat elevation and accretion processes respond to restoration?
2. What is the vegetation composition (native and invasive species) pre and post restoration? Does vegetation cover and species diversity change following restoration?
3. How do soil properties, such as bulk density and percent organic matter, evolve post-restoration?
4. What is the pore water (soil) salinity pre and post restoration and how does this compare to an area without freshwater inflow?
5. How do these measurements compare to a marsh site without restoration efforts?

Study site: Will include the Project boundary (3.56 acres) and the adjacent Harbor Marsh. All tasks below will include sampling in both locations.

Task 3.1. Elevation monitoring and soils development

Task 3.1a. Install and monitor SETs, sample soils for nutrient analysis

Accretion and Elevation: Surface elevation tables with marker horizons (SET-MH) will be installed immediately following construction (Q4 2024) in the restoration site and salt marsh to monitor surface deposition (accretion) and total changes in elevation (Figure 2). SET-MH quantify the relative contributions of surface and subsurface processes to elevation change (i.e., root growth, decomposition, compaction, water flux), shallow subsidence (accretion – elevation), and shallow subsidence between shallow (root zone) and deeper (to >10 m) portions of the soil profile. Two SET-MH will be deployed in the upland restoration and two SET-MH in the salt marsh. We will deploy each SET with three feldspar marker horizon (MH) plots. This information will be paired with existing SET-MH deployed in Laumeister Marsh in 2022. These will be measured biannually (Q1 and Q3, 2025-2028). All SET-MH locations will be surveyed using a Real Time Kinematic GPS (RTK GPS) with horizontal and vertical accuracy of ~ 2 cm.



Figure 2. Proposed locations for Surface Elevation Table-Marker Horizon installation.

Soil development: Along a transect perpendicular to Harbor Road we will measure soil properties within all habitat types (freshwater marsh, wet meadow, riparian/upland scrub, and salt marsh) to the SF Bay edge. Three shallow (10 cm) soil cores will be collected each year at each habitat type. We will measure soil properties, including soil salinity, bulk density, percent organic matter, and macronutrients (nitrogen, phosphorous). All soil core locations will be surveyed using a RTK GPS. Core data was already collected at Laumeister Marsh in 2022 for comparison.

Analysis: Accretion and elevation change rates (mm/yr) will be calculated for each data collection period and over the project timeline. These rates of change will be compared to Laumeister Marsh to assess if accretion rates are the same, greater, or less than a non-restored salt marsh. Soil core data will be summarized by year and overall trajectory of change for the site. Comparison to Laumeister Marsh and other existing data will be done.

Task 3.2. Vegetation establishment and change

Task 3.2a. Monitor vegetation development with annual surveys, invasive species surveys (x2), habitat analysis

Vegetation cover: Three transects will be established that span from the top of the horizontal levee through Harbor Marsh to the SF Bay. Twelve points will be selected along the transect, three each in the upland grassland, wet meadow, brackish marsh and salt marsh habitat classes within the project area. A PVC pipe will mark the north corner of each 0.5 x 0.5 m plot to ensure data are comparable through time. Quadrat vegetation surveys will document all plant taxa present, percent cover by species, percent cover by native, non-native, and invasive species, and height (avg. and maximum by species). Also a visual assessment of vegetation health and vigor will be done. This will be conducted each year during peak growing season (Q3).

Invasive plant surveys. Locations of perennial pepperweed (*Lepidium latifolium*), stinkwort (*Dittrichia graveolens*), and other highly invasive plants will be surveyed and recorded in monitoring years 2 and 5. Surveys will occur twice in each monitoring year (e.g., late spring, Q2;

and late summer, Q3) to capture species with different seasonal growth periods. Stands of target invasive plants will be mapped to estimate total coverage with the project limits and track invasive plant colonization and establishment for comparison between monitoring years. Surveys will include documenting percent cover and location.

Habitat type extent: Delineation of habitat types by area will occur both in the field and with remote imagery in monitoring years 3 and 5 (monitoring year 1 is the first growing season following construction completion and plant installation). Habitat types include freshwater marsh, wet meadow, riparian/upland scrub, brackish salt marsh, and invasive species and will be summarized by percent cover. We will estimate this using field surveys and paired satellite imagery to develop a change analysis over the course of the monitoring period.

Analysis: Plant species richness and dominance will be compared through time, including vegetation percent cover by habitat type. This will be done at the quadrat scale (Task 3.1) and project scale (Task 3.3). Also, the change in extent and composition of invasive species through time will be done. This will be compared with study site characteristics (e.g., elevation, soil properties) to understand change and success. A map of photopoint locations will be provided and photos will be summarized and presented.

Task 3.3. Tidal channel and soil water quality.

Task 3.3a. Record surface and pore water levels and salinity

Marsh channel water quality: Effluent volumes are important to monitor, but to correlate to vegetation establishment and evolution measurements of marsh channel water quality is needed. We will install two sensors (Solinst Edge loggers) to measure water level and salinity near the restoration and in Harbor Marsh. Biannually (Q1 and Q3), a handheld water quality meter (e.g., YSI Water Quality Meter) will measure pH, ammonium, nitrate, and temperature in the channels.

Marsh pore water quality: The water quality in the root zone influences vegetation health and vigor. We will establish two pore water wells near the restoration site and in Harbor Marsh and download data biannually. Wells will include Solinst Edge loggers to measure water level and salinity. A handheld water quality meter (e.g., YSI Water Quality Meter) will measure pH, ammonium, nitrate, and temperature.

Analysis: Water quality parameters will be correlated to vegetation distribution and species composition. This will also be related to health and vigor of the vegetation. Water level data will be used to calculate percent time flooded for the restoration and Harbor Marsh to correlate with accretion and elevation change measurements. Also, using water level data and RTK GPS data (from above) we will calculate the local tidal datums for the project and Harbor Marsh sites.

Task 3.4. Project Management and Reporting

Task 3.4a. Project/data management, synthesis, analysis, reporting

Administrative tasks: Manage the contract, budget, and allow the development of any billing or invoices as needed. Acquisition of necessary permits and trainings will be done. Data analyses will be ongoing throughout the year. All data will follow DOI data quality guidelines, with

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appropriate data quality measures implemented. All data will be reviewed and inspected to ensure it is complete, correct, accurate, structured correctly, and formatted correctly per the scope of work.

Reporting: will be done annually. A summary report as outlined in the Palo Alto Horizontal Levee Pilot Project: Monitoring and Adaptive Management Plan (ESA, 2023; Section 4 *Reporting*) will be provided to the Collaborator by January 15 after monitoring years 1-5 covering the previous year's work. Peer-reviewed scientific journals will be submitted. Presentations to funder, stakeholders, and other interested parties will be provided both virtual and in-person, when requested. Final project reporting will be provided by April 30, 2029.

Study 3 Budget Subtotal

Total post-restoration budget for Study 3, Understanding wetland processes for Palo Alto Horizontal Levee Pilot Project long-term monitoring is \$ 270,529.

IV. TERM AND PROPOSED PROJECT SCHEDULE/MILESTONES

This agreement is to cover post-construction monitoring activities from May 1, 2024 to April 30, 2029. As funding becomes available, this agreement may be modified and expanded to incorporate an expanded scope for post-restoration research and activities.

V. COLLABORATOR ROLE AND EXPERTISE

The Collaborator's role is to conduct the pilot project using a horizontal levee concept to function as green infrastructure, providing levee protection as well as enhancing wildlife habitat.

Specific Collaborator Tasks: The Collaborator will facilitate access to the PAHLPP site, provide updates on construction timelines and activities that may influence research and monitoring activities, and facilitate coordination amongst other research groups at the PAHLPP.

VI. USGS ROLE AND EXPERTISE

This interdisciplinary team of USGS scientists from four USGS Science Centers possesses the depth and breadth of expertise to assess the PAHLPP for endangered species benefits, marsh processes, metal contaminants, and pathogens. The Western Ecological Research Center (De La Cruz, Woo, Thorne) has expertise in wetland ecology, restoration, and monitoring to assess wetland structure and function as well as expertise and permitting for handling the salt marsh harvest mouse (SMHM, *Reithrodontomys raviventris*). The Geology Minerals Energy and Geophysics Science Center (Croteau) has metal contaminant expertise and has led the interdisciplinary team including Water Mission Area (Parchaso, expertise in benthic invertebrate ecology) and Upper Midwest Water Science Center (Givens, expertise in environmental microbiology) for the long-term monitoring of metals and the benthic macroinvertebrate community.



VII. ANTICIPATED OUTCOMES/EXPECTED RESULTS

USGS will work with Collaborator to identify the information needed for their reporting requirements, so that we can provide timely and management-relevant information throughout the project including annual project summary updates. Annual summary reports will be completed by April 30, summarizing the activities and results of the previous calendar year. Any other interim updates can be provided upon request in the form of email update, presentation slides, or teams meeting.

A final project report will be completed by April 30, 2029 for all tasks covered by this agreement and accompanied by a USGS Data Release, in which all data will be publicly available at sciencebase.gov. Data releases may occur separately by each objective. USGS will work with Collaborator to identify final reporting requirements and reporting structure, which may include separate reports by objective. In some instances, the final report may be structured as draft manuscripts to be submitted to peer-reviewed journals, a USGS Scientific Investigation Report, or a USGS Open File Report.



Budget

Total budget for the post-restoration research and monitoring is \$924,745.00.

USGS 5 Year Agreement: May 1, 2024 to April 30, 2029

Gross Estimate of Costs		2024- construction	2025	2026	2027	2028	2029	5 year average	Total
		May-Dec	Jan-Dec	Jan-Dec	Jan-Dec	Jan-Dec	Jan-Apr		
STUDY OBJECTIVE 1	Task 1.1: Does the PAHLPP provide habitat for Salt Marsh Harvest Mouse measured by live-trapping?								
	1.1a Small mammal live trapping, PAHLPP and 1-2 reference sites	\$ -	\$28,921	\$28,921	\$28,921	\$28,921	\$ -	\$19,281	\$115,684
	Task 1.2: Habitat Capacity. Does PAHLPP produce food resources for SMHM. Does PAHLPP provide plant cover compared to reference?								
	1.2a Quantify food resources for SMHM and the small mammal community	\$17,986	\$5,613	\$5,613	\$17,986	\$5,613	\$ -	\$8,802	\$52,811
	1.2b Assess functional plant cover at varying high tide	\$ -	\$8,376	\$8,376	\$8,376	\$8,376	\$ -	\$5,384	\$35,904
	Task 1.3: Habitat Functions. Do SMHM consume seeds from PAHLPP. Does PAHLPP provide high tide refugia compared to reference?								
	1.3a Collect, clean, ID, preserve plants for DNA library of food resources and preserve pellets for analyses in Task 1.3c	\$ -	\$11,147	\$11,147	\$11,147	\$11,147	\$ -	\$7,431	\$44,588
	1.3b King tide predation surveys	\$ -	\$12,637	\$12,637	\$12,637	\$12,637	\$ -	\$8,425	\$50,548
	1.3c Optional Subtask: DNA analyses: Dietary reconstruction from collected and archived fecal pellets (additional \$46,000 required)	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$46,000
	Task 1.4: Project Management and Reporting								
1.4a Project/Data Management; endangered spp permits; Data analyses; Reporting	\$ -	\$5,613	\$5,613	\$5,613	\$7,842	\$ -	\$4,114	\$24,681	
SMHM and Functional Habitat Subtotal	\$17,986	\$72,907	\$72,907	\$85,280	\$75,136	\$ -	\$54,036	\$324,216	
STUDY OBJECTIVE 2	Task 2.1: Monitoring of metals of regulatory interest in sediments and in the tissues of a local sentinel species							5 year avera	Total
2.1a samples for metals	\$ 26,000	\$33,000	\$33,000	\$33,000	\$33,000	\$ -	\$ 31,600	\$ 158,000	
Task 2.2: Characterization of the benthic community and reproductive status of clams									
2.2a Collect, sort and identify benthic invertebrates	\$ 14,000	\$17,000	\$17,000	\$17,000	\$17,000	\$ -	\$ 16,400	\$ 82,000	
2.2b Collect, preserve, dissect and assess reproductive status of clams (additional funding source required)	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
Task 2.3: Characterization of the microbial community									
2.3a Measure microbial load in sediment, water and in clams	\$ 5,000	\$ 5,000	\$ 5,000	\$ 5,000	\$ 5,000	\$ -	\$ 5,000	\$ 25,000	
2.3b Characterize the microbial community and assess presence of bacterial pathogens and antimicrobial gene markers	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ 10,000	\$ -	\$ 10,000	\$ 50,000	
Task 2.4: Project Management and Reporting									
2.4a Project/data management, reporting	\$ 3,000	\$ 3,000	\$ 3,000	\$ 3,000	\$ 3,000	\$ -	\$ 3,000	\$ 15,000	
	\$ 58,000	\$ 68,000	\$ 68,000	\$ 68,000	\$ 68,000	\$ -	\$ 66,000	\$330,000	
STUDY OBJECTIVE 3	Task 3.1. Elevation monitoring and soils development							5 year avera	Total
3.1a Install and monitor SETs, sample soils for nutrient analysis	\$ 7,115	\$ 19,541	\$ 10,781	\$ 11,123	\$ 11,486	\$ -	\$ 12,009	\$ 60,046	
Task 3.2. Vegetation surveys									
3.2a surveys, invasive species surveys (x2), habitat analysis	\$ -	\$27,702	\$38,187	\$26,097	\$41,746	\$ -	\$ 26,746	\$ 133,732	
Task 3.3. Water level and salinity									
3.3a Record surface and pore water levels and salinity	\$3,392	\$3,595	\$3,811	\$4,040	\$4,282	\$ -	\$ 3,824	\$ 19,120	
Task 3.4. Project management and reporting									
3.4a Project/data management, synthesis, analysis, reporting	\$7,542	\$11,450	\$12,137	\$12,865	\$13,637	\$ -	\$ 11,526	\$ 57,631	
	\$ 18,049	\$ 62,288	\$ 64,916	\$ 54,125	\$ 71,151	\$ -	\$ 54,106	\$ 270,529	
	\$94,035	\$203,195	\$205,823	\$207,405	\$214,287	\$0	Grand total	\$924,745	

¹ Supplies include: live traps, sterilized bait, sanitation supplies for traps, molecular grade ethanol for DNA preservation, jars, vials, labels; hydrology instruments, Surface Elevation Table supplies

² Please note that your budget exhibits may be modified annually to offset uncontrollable changes in USGS Bureau overhead rates.