

Unofficial Title Page

Title: GP-UP: Undergraduate Preparation through Multidisciplinary Service Learning at Utah Lake (UP-Utah Lake)

Funding Program: National Science Foundation, Improving Undergraduate STEM Education: Geopaths (IUSE-Geopaths)

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Amount Requested: \$382,835

COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

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TITLE OF PROPOSED PROJECT GP-UP: Undergraduate Preparation through Multidisciplinary Service Learning at Utah Lake (UP-Utah Lake)					
REQUESTED AMOUNT \$ 382,835	PROPOSED DURATION (1-60 MONTHS) 36 months		REQUESTED STARTING DATE 01/01/21	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE	
THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW			<input type="checkbox"/> HUMAN SUBJECTS Human Subjects Assurance Number _____ <input type="checkbox"/> Exemption Subsection _____ or IRB App. Date _____ <input type="checkbox"/> FUNDING OF INT'L BRANCH CAMPUS OF U.S IHE <input type="checkbox"/> FUNDING OF FOREIGN ORG <input type="checkbox"/> INTERNATIONAL ACTIVITIES: COUNTRY/COUNTRIES INVOLVED _____ <input checked="" type="checkbox"/> COLLABORATIVE STATUS Not a collaborative proposal		
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PROJECT SUMMARY

Overview:

The IUSE GEOPAths UP program proposed by Utah Valley University (UVU) will facilitate undergraduate geoscience preparation and awareness through multidisciplinary service-learning project focused on Utah Lake. These projects will enhance students' professional skills, increase access to professional networks, and deepen knowledge of geoscience career pathways. Through the UP-Utah Lake project, students will conduct service learning, primarily in the form of community-based research, aimed at informing policy makers in efforts to rejuvenate the lake at the heart of this community. UP-Utah Lake participants will be drawn from the geoscience fields of hydrology, environmental science, biogeochemistry, and geography; from the social science fields of environmental communication and economics/business management; and from the related STEM fields of biology and chemistry. Major activities include: 1) implement the UP-Utah Lake service-learning project embedded in an 8-week summer ENVT 495R course for cohorts of 12 students annually; 2) create a learning environment within the summer course to meet the mentoring needs of participants, and to provide STEM workplace skill building and career-relevant experience; 3) develop a geoscience learning ecosystem (GLE) among stakeholders in the Utah Lake community to create enhanced learning opportunities for students; 4) integrate related UP-Utah Lake service learning in other courses during the academic year; and 5) deepen students' interest and knowledge of geoscience careers by activities with GLE such as career presentations, field trips, and job shadowing opportunities. Utah Lake, bordered by the Provo-Orem metropolitan area, is a valuable ecological and recreational resource, compromised by invasive species and degraded water quality. A multidisciplinary approach is required to address its complex issues.

Intellectual Merit:

Designed to maximize impact on student learning and career preparation, the proposed project leverages community-based research conducted by student-faculty teams over the past few years on Utah Lake and its watershed with funding from an NSF Utah EPSCoR project and in conjunction with local agency partners. To better address the complex issues that confront Utah Lake, a multidisciplinary team has been assembled including faculty with expertise in biogeochemistry, business management, environmental communication, geography, and environmental science, and a consulting hydrologist. The project will explore how this multi-disciplinary approach to an acute local issue creates interest and enthusiasm among student researchers and broadens participation to include more women in faculty-mentored research. The summer service-learning project is grounded in evidence-based practices such as mentoring from faculty and near-peers, and partnerships with area professionals from whom students will learn about geoscience careers. The Co-PI from UVU's Communication Department is an expert in assisting communication within diverse scientific teams. The Co-PI from UVU's Woodbury School of Business also directs UVU's Center for Social Impact, which oversees service-learning activities across campus. He will inform service-learning activities in the summer program and coordinate engaging service-learning activities during the academic year that will serve as a recruitment tool for the summer program.

Broader Impacts:

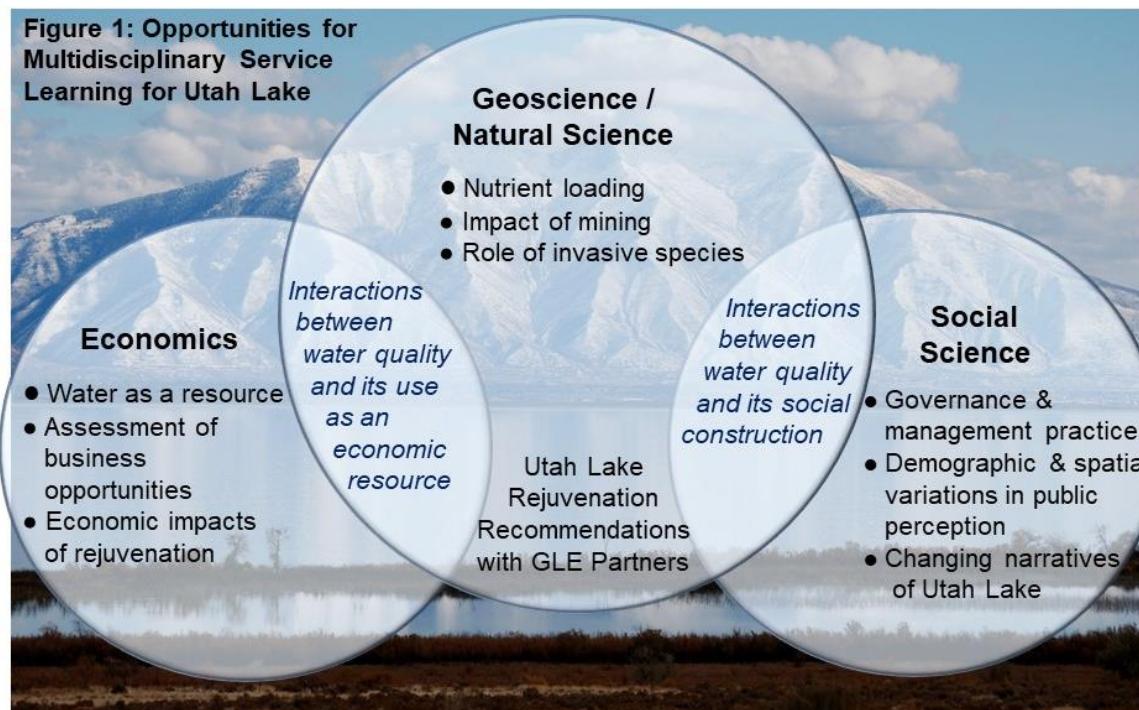
The proposed project will use and build evidence within the geoscience education community about multidisciplinary undergraduate research in the geosciences, particularly its potential to demonstrably deepen interest in, knowledge of, and preparation for geoscience career pathways. The inclusion of faculty and students from the fields of business and environmental communication will illuminate a more diverse range of careers and research interests and will increase knowledge about the geosciences for non-geoscience majors. The project will also boost enrollment and retention in UVU's Department of Earth Science, which has experienced declining enrollment and will address needs articulated by students for more career awareness and job skill development as an integral part of the curriculum. The participation of local agencies and organizations will provide students with opportunities to connect with professionals and to understand the potential usefulness of their geoscience studies. This research should assist policy makers in rejuvenating Utah Lake to the benefit of the community. Moreover, a service-learning and community-based research approach to this project will prepare students to be professionals who are better prepared think about problems in terms of practice; this approach will be of interest to other geoscience educators.

GP-UP: Undergraduate Preparation through Multidisciplinary Service Learning at Utah Lake (UP–Utah Lake)

1. OVERVIEW

A. Intellectual Focus

Utah Valley University (UVU) proposes a GEOPAths UP project that envisions a current need in this community as an opportunity to address specific needs of geoscience majors, namely, to apply their academic work to real-world problems, to learn about careers in their fields, and to better prepare for graduate programs and careers. The proposers plan a co-curricular service-learning project that also addresses the need of the UVU Department of Earth Science to attract more students, especially those from more diverse backgrounds, to geosciences majors by grappling with a complex problem from the perspective of various intersecting disciplines. UP–Utah Lake participants will be drawn from the geoscience fields of hydrology, environmental science, biogeochemistry, and geography; from the social science fields of environmental communication and economics/business management; and from the related STEM fields of biology and chemistry (Figure 1). By partnering with professionals in the community who are working to address this common problem, the proposers will organize the Utah Lake Geoscience Learning Ecosystem (UL-GLE) that will increase learning and preparation opportunities for students. Service learning will be directed toward research that informs policy makers in their efforts to rejuvenate Utah Lake, a major geological feature at the heart of the community. Students will collaborate with UL-GLE professionals and present their work to appropriate stakeholders. The opportunity to work on societally relevant issues while participating in a dynamic learning environment will excite interest in the geosciences for students from varied backgrounds including those who may be collaborators in their future professions.



"Geoscience has become more interdisciplinary, multidisciplinary and transdisciplinary, resulting in the need for students to have strength in their discipline as well as the ability to work across disciplinary boundaries." Future of Undergraduate Geoscience Education, 2014

B. Project Goals, Objectives, and General Activities

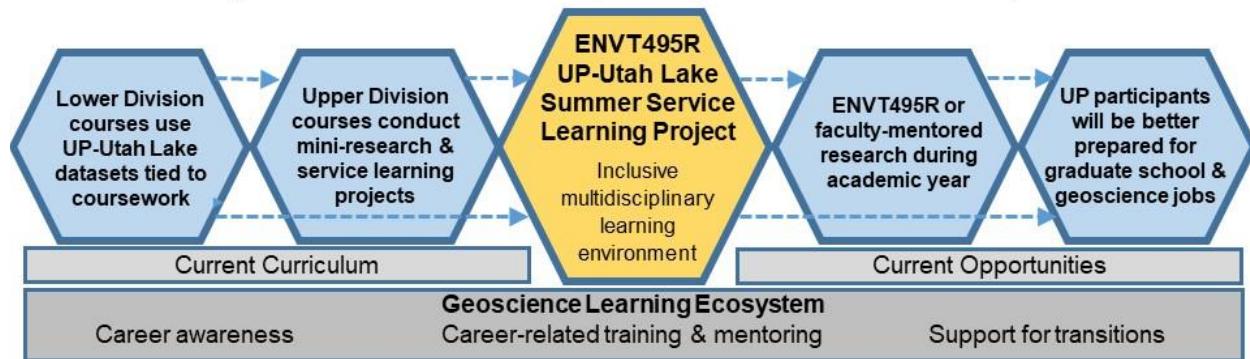
Goal: *Facilitate geoscience preparation of diverse undergraduate students at Utah Valley University through multidisciplinary service learning about Utah Lake (UP–Utah Lake) that will enhance professional skills, increase access to professional networks, and deepen knowledge of geoscience career pathways.*

Objective 1: Provide undergraduate students with a sustained service-learning experience in the geosciences and connected fields of study through an 8-week multidisciplinary summer project (UP-Utah Lake) focused on the environmental health of Utah Lake. Cohorts of 12 students each summer will be organized into teams of two students and a faculty expert in hydrology, environmental science, biogeochemistry, business management, environmental communication, or geography, based on their academic experience and interest. Students and their faculty mentors will collaborate with area professionals to address a particular research question or aspect of the greater problem each year. As characteristic of service learning in the geosciences (NASEM 2017), students will participate in applied, community-based research. The project will be conducted within a research course, ENVT 495R, and students will be paid for their work to ensure access for low-income students.

Objective 2: Create a learning environment to meet the needs of diverse participants in the UP-Utah Lake co-curricular project with mentoring, STEM workplace skill building, and career-relevant experience that includes presenting research findings to Utah Lake stakeholders.

A distinctive feature of this learning environment will be the inclusion of 4 students from the social science fields of communication and economics (along with 8 geoscience majors) because societally relevant issues in the geosciences, such as those at Utah Lake, frequently intersect with these disciplines. Diverse participants will also include students from groups underrepresented in the geosciences—namely, women, minorities, and first-generation students. The learning environment will incorporate evidence-based strategies for the success of individual students. Students will be trained in effective communication for diverse, interdisciplinary teams from a Co-PI with expertise in this area. Teams will report their progress and share information and perspectives in weekly project meetings. Faculty members will mentor the students in their teams and will have received training to facilitate their effectiveness. The learning environment will emphasize the processes of scientific investigation, creative problem solving, analysis, synthesis, reporting, and reflection.

Figure 2: Geoscience Pathway through the UP-Utah Lake Project



Objective 3: Develop a geoscience learning ecosystem (GLE) among stakeholders in the Utah Lake environment to create enhanced learning opportunities for students in the UP-Utah Lake project and for students in related curricular activities (below). Existing collaborations with the Utah Lake Commission, Utah Division of Water Quality, Utah Division of Wildlife, and others are being organized into the Utah Lake Geoscience Learning Ecosystem (UL-GLE). Additional members, including the Utah County Health Department, the Utah STEM Action Center, and Malach Consulting, will add breadth of perspective and networking opportunities. Students will learn about stakeholders' concerns for Utah Lake and will collaborate to apply their academic work to address complex, real-world issues. One of the concerns raised frequently by partnering agencies has been the lack of resources to conduct foundational research on specific topics concerning the lake. Students will undertake some of these applied research projects. They will report research findings to stakeholders and discuss potential solutions with them.

Objective 4: Scaffold the summer project to the academic curriculum by: 1) integrating UP-Utah Lake-related service learning and research into several lower- and upper-division classrooms for the purpose of recruiting and retaining diverse students; and 2) facilitating a faculty-mentored research option during the academic year for UP-Utah Lake participants. At least

120 students in existing geoscience and non-geoscience courses will participate annually in course-based service-learning or research experiences that engage them in activities related to the UP-Utah Lake project. Participating faculty in the disciplines cited above will employ evidence-based strategies to engage students and establish connections to the summer project. Students will have access to background materials and student presentations about Utah Lake on a website created for the project. About 40% of students will be in lower-division courses. The courses will provide opportunities for real-world application and skill development, as well as serve as a recruitment tool for the summer service-learning project. UP-Utah Lake summer participants will visit these classes to recruit for the next summer and act as role models for student participation, especially for women. UP-Utah Lake participants will also have the option of continuing their work through faculty-mentored research during the academic year (AY) in the ENVT 495R course. They will continue to work with members of the UL-GLE to present and discuss their research findings and to prepare for graduate work and/or careers.

Objective 5: Strengthen the geoscience pipeline by deepening students' interest in and knowledge of geoscience careers and by broadening awareness of and entry into the geosciences for students in the social sciences. In response to the expressed need of students in Department of Earth Science to have more opportunities to learn about careers in the geosciences, this program will utilize the UL-GLE to provide information to students in the department about geoscience careers and related opportunities. The project also aims to strengthen the geoscience pipeline at UVU in several significant ways: 1) to deepen students' knowledge and interest in the geosciences through service learning related to local problems; 2) to provide entry points to students from other STEM fields such as chemistry and biology and to students from the social sciences; 3) to increase awareness of the geosciences for students who will pursue other careers that intersect with the geosciences to increase future collaboration and problem solving oriented to the geosciences.

C. Target Population

The target populations for the proposed project are majors and prospective majors in the UVU Earth Science baccalaureate degree programs – Geology major, Environmental Science & Management major, Geography major, Earth Science Education major, and Environmental Studies emphasis. The program will specifically aim to increase participation of women in co-curricular research activities, as women in the UVU Earth Science program participate a lower rate than men (departmental survey).

Target for Objectives 1 & 2. The summer service-learning project will target juniors and seniors, and 2nd-semester sophomores. At least 35% of these students are non-traditional students, many with families: about 36% of seniors and 27% of juniors are parents. Institution wide, 42% of students are Pell eligible and a similar percentage work over 20 hours per week. Thus, we expect a high proportion of students to be low-income and in need of financial support for themselves and potentially their families. Most expect to work during the summer months. The critical juncture for these students is their immediate preparation for the geoscience workforce and for graduate school. In a recent departmental survey, a frequent comment concerned the need for more practical experiences related to careers in geoscience.

Target for Objective 4. The in-class service-learning and research interventions will target 360 students; at least 40% freshmen and sophomores (see *Recruitment* in SD#1). The 4 targeted groups are:

1) *Non-majors in general geoscience classes* will be students who have not selected a major but may be open to geoscience fields, including women and students from underrepresented groups. We hope to interest students in the geosciences as they explore real issues in their community and see how science is applied to informing policy that can affect them, such that more of them declare geoscience majors.

2) *Geosciences majors* who will benefit from the UP-Utah Lake enriched courses and will be encouraged to participate in the summer service-learning project or related research activities. The recent department survey showed that many students are not taking advantage of available research activities – faculty-mentored research, research courses, and capstone projects – and that a proportionally lower rate of women (30%) participate in mentored research activities than men (70%). These activities are considered High Impact Practices that can improve learning outcomes as well as persistence and completion rates (Kuh 2008). The classes will provide them with positive experiences to encourage future participation.

3) *STEM majors in fields related to geoscience such as biology and chemistry* who may enjoy cross-disciplinary work and/or find closer application to their interests in the geosciences.

4) Non-geoscience majors in communication and business management classes will develop knowledge about the geosciences, learn about how their field intersects with geoscience concerns, and develop awareness about career opportunities that intersect with the geosciences. Some participants may choose a degree in Integrated Studies with an emphasis in Environmental Studies. Their critical juncture may be in targeting a more specific career.

2. INSTITUTIONAL PROFILE

A. Utah Valley University is a comprehensive, open-enrollment university of over 41,000 students, charged with serving Utah's second most populous area. Formerly a state college, the institution became a university in 2008 and now has the largest population of students of any university in Utah. A primarily undergraduate institution, UVU seeks to engage students using real-world contexts to increase professional competence and confidence. Designated a Carnegie Community Engagement Institution for Curricular Engagement and Outreach, UVU sees student engagement as an integral component of academic excellence and student success, including retention and completion. Service learning and applied undergraduate research have become an integral part of undergraduate programs. To facilitate this effort, UVU supports the Center for Social Impact (supports service learning) and the Office of Undergraduate Research & Creative Activities, with resources to assist in these areas.

B. Status of Undergraduate Geoscience Education at UVU. The Department of Earth Science offers BS degrees in Geology, Geography, Environmental Science & Management, and Earth Sci. Education. The department includes 13 full-time faculty members with expertise in soil and water resources, earthquake and landslide hazards, behavior of earthquake faults, geographic information systems, hydrology, environmental policy, geochemistry, petrology, the growth of mountain ranges, the formation of rocks and minerals, and paleontology. Students appreciate the small class sizes and accessible professors.

Enrollment. While enrollment in Earth Science programs grew steadily until 2016, since that time, there has been a decline of 21% (from 234 majors in fall 2016 to 184 majors in 2019). During the same time period, institutional enrollment (excluding high school students) has increased by 12%, and enrollment in other science programs (Biology, Chemistry, and Physics) has increased by 7%. In Earth Science, however, gains were made in increasing enrollment of women from 28% to 40% of students. Minority participation has remained constant at about 17% of majors – slightly lower than the institutional percentage of 18% minority students. About 40% of majors are first-generation students. Graduation numbers have increased from 20 graduates in AY 2015–16 to 28 graduates in AY 2018–19.

Research & Training Opportunities. The Department of Earth Science offers curricular, co-curricular, and extracurricular research activities. Nearly all upper division classes require students to complete field assignments and about 8 faculty conduct extra-curricular research with undergraduates annually. Of the 48 students who graduated in the past two years, all have participated in significant curricular research and 14 have participated in extra-curricular faculty-mentored research, including 2 women. Student projects have included investigations of earthquake segmentation, active and pre-historic landslides, ancient marine mass-mortality sites, and water quality assessment in West Africa, Mexico, Nepal, and on Utah Lake. Much of the undergraduate research in this department can be considered service learning – projects in which students use knowledge and skills taught in the curriculum to address real needs in their communities (NASEM 2017). All student researchers are encouraged and assisted to present and publish their work. In a typical year, over 20 students present at professional conferences. Due in part to the educational enhancement these experiences provide, about 80% of Earth Science graduates are either working in their fields or enrolled in graduate programs.

Funding for student research has come from internal Grants for Engaged Learning and grants from the College of Science's Scholarly Activities Committee (1-yr) and from iUtah projects (12–18 months, funded by Utah's NSF EPSCOR grant); these short-term funding programs provide little opportunity for sustained research on one topic. The EPSCOR grant funded projects for all geoscience faculty on the project team and their student researchers, but this state-wide grant concluded in 2018 and is not renewable. Earth Science students have also been part of an NSF Scholarships in STEM (S-STEM) program. Participants receive a full-tuition scholarship and participate in faculty-mentored research. From 2012 to 2019, 15 Earth Science students participated in the S-STEM program, 9 men and 6 women. The PI, Dr. Cadet, currently mentors 2 scholarship recipients and Co-PI Wang mentors 1.

Needs Assessment. To help understand departmental enrollment trends the department requested that UVU's Office of Institutional Research to conduct a survey of Earth Science majors and former majors (juniors and seniors) to which 23 students responded. When asked in general about the strengths and weaknesses of the Earth Science programs, open-answer responses demonstrated the high value students place on engaged learning, including hands-on learning, field experiences, and research. Students noted that "Classes which integrate research into student curriculum are especially valuable." About 56% of respondents cited opportunities for engagement as a strength of the program, and about 26% expressed that these opportunities could be more plentiful and more meaningful. Other students indicated a desire for more research choices, including laboratory work and work with people, and more opportunity to acquire workforce-relevant skills. A frequent criticism of the Earth Science programs was a lack of job and career training for students not planning to attend graduate school and a general need to create awareness about careers in the geosciences.

Many students are not taking advantage of available research activities, which can provide invaluable benefits, including training in career skills. About 48% of students work more than 20 hours per week and can't afford time for co-curricular activities. Also, many students do not know the value of participating in research with a faculty member and may not plan for it until it is too late. Some have cited reasons of it not being important to them, not having enough time, not having enough information, and being nervous about working with faculty members. Some of these concerns may relate to women in the departmental survey who participated in a research course, capstone project, or faculty-mentored research project outside of class at a rate of 30% compared to 70% of men.

The Earth Science Education program currently enrolls 19 majors, several of whom participate in the NSF Robert Noyce Teacher Scholarship program. The program requires 58 hours in STEM courses and laboratories, in addition to high-caliber education courses. Full schedules often lead these students to overlook research opportunities, and they are sometimes overlooked in recruitment for these projects. Yet they have an intense need for hands-on experiences they can bring into the classroom, science application to local issues, and opportunities to become scientifically confident. Participation of Earth Science Ed. majors will be sought in proposed project and the program designed to address their needs.

3. PROJECT DESIGN

A. The Project's Approach to Service Learning in the Geosciences

Service learning is a High Impact Educational Practice demonstrated to have a positive impact on student engagement and success (Kuh 2008; Celio 2011). A 2019 workshop on Service Learning in Undergraduate Geosciences determined that "Service-learning fits well with the goals for undergraduate study in the geosciences." These goals include having students study geoscience issues and their effects on society, draw on the knowledge and skills learned in geosciences to address real-world issues of genuine importance to their community, collaborate with others to better understand and/or devise solutions to problems, and reflect on the successes and challenges they encountered and what they learned from the experience (NASEM 2017, pp. 1-2). Benefits of service learning in the geosciences include: "increasing depth of student content knowledge, increasing student capacity to retain content knowledge, increasing transferability and flexibility in using content knowledge, and increasing student understanding of the complexity of contexts where their content knowledge is needed" (Silka 2016; see also Lui 2004; Szymanski 2012).

At UVU, service learning is supported by the Social Impact Center, for which Co-PI Dr. Westover is the Director. Currently, about 350 course sections are taught annually that are officially designated as service-learning courses (students participate in at least 20 hours of service learning), and numerous other courses used engaged learning projects to a lesser extent. However, few courses in the Department of Earth Science have received the service-learning designation, although many courses do involve substantial community-based undergraduate research, which parallels service learning in many respects. Service learning, on the whole, however, places a greater emphasis on collaboration with community members, a more sustained focus on the benefit to the community, a clearer relationship to course curriculum, and a greater insistence on student reflection than traditional undergraduate research. Incorporating these characteristics into many of the community-based research projects in Department of Earth Science would likely benefit both students and the community. This project will explore the intersection between service learning and community-based undergraduate research and its

implementation in the geosciences at UVU. The PI, Dr. Cadet, has been at the forefront of service learning in geosciences courses and faculty-mentored undergraduate research.

Implementation. As service learning is by definition tied to curricular objectives, both in its generally accepted definition (NASEM 2017) and at UVU (UVU-CSI 2020), the proposers will conduct this project within a designated research course – ENVT 495R. This course is part of the current Earth Science curriculum and is defined as follows: *Instructor Permission and University Advanced Standing. Allows students to pursue undergraduate research projects. Includes instructor directed practical research. Students will prepare a report of their findings. May be repeated for a maximum of 6 credits toward graduation.* The requirement of University Advanced Standing will be waived for this course to allow students with sophomore class standing or above to participate.

Students may register for variable-credit course of up to 3 hours, depending on what is needed in their degree program, or they may participate in the project without enrolling in the course. The proposers have chosen this flexible approach to allow for broad participation of students with various programmatic and practical needs. Student considerations may include: 1) does the course count toward credit in their degree (of concern for non-Earth Science majors); only 6 hours of 495R courses may count toward the degree; 3) financial aid status; 4) financial restrictions for paying extra tuition; 5) greater need to earn money than to receive credit. Students must commit up to 20 hours to the project weekly, in the form of for-credit hours or work hours. Regardless of whether or not they choose to take the course for credit, they will be paid for 20 hours of work weekly. (This is similar to UVU's policy for internships.) Additionally, students may register for the ENVT 495R course during the academic year to continue sample processing and analysis, reporting to stakeholders, and manuscript preparation.

Course Learning Objectives. Upon completion of this course, students will be able to:

- 1) Conduct effective literature search and review of geoscience-related topics.
- 2) Connect with the local community through a service-learning project and work with others to apply knowledge to solve real world problems.
- 3) Recognize the interconnection between geoscience, environment, and people.
- 4) Apply effective communication strategies in multidisciplinary collaboration and teamwork.
- 5) Become increasingly independent in conducting effective laboratory and/or field work.
- 6) Interpret data, write reports, and give oral presentations.
- 7) Communicate scientific information to general public in a simple and accurate way.
- 8) Prepare to be competitive for the job market and graduate school studies.
- 9) Reflect on successes, challenges faced, and lessons learned in relation to course objectives.

Learning Environment. Interrelated components of the UP-Utah Lake learning environment, offered through the ENVT 495R course, are described in the *Rationale for Project Design* section, and include multidisciplinary community-based research, diverse student and faculty participation, communication skills training, research reports to inform policy makers, and conference. Another key component, faculty and near-peer mentoring, is described in the Mentoring Plan section of *Supplemental Document 1*. Teams will report their progress and share information and perspectives in weekly project meetings. Faculty will mentor the students in their teams and will have received training to facilitate their effectiveness. The learning environment will emphasize the processes of scientific investigation, creative problem solving, analysis, synthesis, reporting, and reflection.

B. UP-Utah Lake Summer Project Activities and Timeline

Table 1: Annual Summer Research Program Activities and Timeline			
Week	Summer Research Activities	Professional Dev	Group Rec Activities
1-2	Orientation to Utah Lake; Presentation of project proposals, goals, objectives, and methods; Introduction to working teams; Teams initiate problem solving & work with community partner; Literature reviews on focus areas; Development of sampling techniques, questions, plans, and procedures.	Research ethics and IRB workshop; Working agreements within teams; Collaboration with peers, faculty & professionals; Literature search; Research plan & design; Lab equipment training.	Hike or drive to the Wasatch Mountains to view Utah Lake in its entirety; Presentation by stakeholder agencies.

3-6	<u>Implement research described above;</u> students will be led to increased levels of research independence; Weekly meetings of all teams; Bi-weekly meetings with stakeholders or relevant agencies.	Training and practice in respective areas; Communication skills; Job & graduate school preparation activities. Stakeholder engagement	Recreational activities around Utah Lake: possibilities include tour lake by boat, canoe river delta regions, picnic, bird watch, paddle board, explore how others experience the lake, use creativity and senses to understand the landscape.
7	Prepare report on results; Create poster for presentation at symposium; Seminar on communicating research results with public & stakeholders.	Science & scholarly communication techniques; Synthesizing research projects and communicating results	
8	Create an action plan based on research results; Utah Lake Summit with research teams and stakeholders; Reflection successes, challenges, and lessons learned.	Meetings & presentations with Utah Lake Commission and other stakeholders.	Farewell picnic and boating; photo shoot.

C. UP-Utah Lake Geoscience Learning Ecosystem

The **UP-Utah Lake Geoscience Learning Ecosystem (UL-GLE)** will draw on strengths of established collaborative relationships that have assisted geoscience faculty in providing research and engagement opportunities for students and in providing pathways to employment. A new focus on creating a supportive, fertile educational environment for students is being applied to these relationships, and new partnerships are being included. UVU's initial GLE model will be to act as a hub for ecosystem partners, bring together resources as needed to support the critical transition points in student's preparatory pathways (NSTC 2018). As students, faculty, and partners collaborate with UL-GLE goals in focus, open new doors will be opened for building stronger connections and relationships among partners. The Utah STEM Action Center Through the collaborations fostered by this project, a sustainable ecosystem will be created. Goals of the UL-GLE are: 1) Assess training needs for employment; 2) Facilitate quality service learning through the UP–Utah Lake project; 3) Provide appropriate learning opportunities for UP students; and 4) Create viable pathways to employment. Partners are described in Table 2 and in *Facilities and Other Resources*; their commitment is documented in the *Letters of Collaboration*.

The Utah Lake Commission (ULC) will be a key participant in the UL-GLE. Utah Lake's overlapping web of interests, stakeholders, rights, and regulations are managed by the ULC, which acts primarily as facilitator and organizer of the disparate stakeholders across multiple geographic scales. The Commission brings nine stakeholder municipalities, state agencies, water conservancy districts, and water users together in governance and technical advisory roles to create the lake's master plan. The master plan guides development, recovery, conservation, and future uses of the lake, and includes feedback from the public, other relevant agencies, private landowners, and other stakeholders. UP-Utah Lake faculty will partner with the Commission as a whole, as well as with individual members, such as the Utah Division of Water Quality, Utah Division of Wildlife Resources, and the City of Orem (see Table 2 and *Facilities & Other Resources*.) The ULC Technical Steering Committee (and its Science Panel) will be a sounding board for students on research questions. Students will present their research findings to members of the Commission, who may in turn inform other stakeholders in the community or the public. Central Utah Water Conservancy District, a member of the ULC, annually hosts the Utah Lake Summit where presenters shared history and insight about the challenges, complexities and accomplishments in managing all aspects of Utah Lake. This symposium involves researchers from UVU, Utah State University, Brigham Young University, and Weber State University, as well as state agencies. Student researchers will present findings at this summit. These partnerships will provide many opportunities for career awareness, job shadowing, internships, mentorship, job networking, and employment for students.

An important new partnership is the USDA Utah Office of Natural Resources Conservation Service (NRCS). NRCS, with its connections agricultural land owners and expertise in agriculture, is interested in partnering on student projects within the Utah Lake ecosystem. They also have a number of on-going projects in watershed operations dam rehabilitation, as well as field office personnel and state specialists who would be interested in working with UVU students on career development and guidance.

Table 2: UP-Utah Lake Geoscience Learning Ecosystem

Partner	Role on this Project
Utah Lake Commission (ULC) *denotes a member of the ULC	THE ULC Technical Committee will be a sounding board for students on research questions; Students will present their research findings ULC members, who may inform other stakeholders. ULC will help facilitate career opportunities and presentations to students about career paths and jobs in local communities and agencies.
Utah Department of Water Quality (DWQ)*	DWQ will provide sampling support in the form of instrumentation, equipment, and staff (when available); assistance with E.coli and cyanobacteria analysis in water samples; sharing of DWQ datasets; UVU student access to DWQ sampling events for sample collection training; career speakers and mentors, and student volunteer opportunities.
Department of Natural Resources, Utah Division of Wildlife Resources (DWR)*	DWR will work with student research teams; Facilitate job shadowing activity; Give a tour of the DWR facility and a presentation about jobs at DWR; Provide the project with the use of some equipment, including the fish scale; Provide boat escort for fish sampling.
USDA Natural Resources Conservation Service (NRCS)	Agricultural – contacts w/ landowners, nutrient use and deliver, sediment delivery; Student connections – information about career tracks, internship and volunteer paths, and employment with USDA; Contacts with NRCS field office personnel and specialists from the State Office.
Utah STEM Action Center	The STEM Action Center will advise in connecting to partners in industry, business & government; the Center will provide a means for to disseminate lesson plans and resources about Utah Lake for K-12 Ed.
Utah County Health Department (UCHD)	DCHD will speak with students about career opportunities; Provide job shadowing and internship opportunities (in environmental sampling); Provide a career pathway for some students (many UVU Earth Science graduates have been employed by UCHD, some at a supervisory level).
Malach Consulting	Malach Consulting owner, Steven Emerman, will consult with the project in the field of hydrology and will serve as a faculty mentor. During semester, he will visit classes to talk about careers, consulting on environmental degradation, and resume review.
UVU College of Science (COS)	Visibility in college recruiting efforts; administrative oversight; partial sustainability & resources for research through grants from the Scholarly Activities Committee; career input and connections to community members from the COS Advisory Board.
UVU Center for Social Impact (CSI)	CSI will help implement and sustain the service-learning aspect of this project. CSI supports UVU faculty, students, and community partners with the development and implementation of service-learning courses and research projects.

D. Rationale for Project Design

Multidisciplinary Community-Based Research. A key element of service learning in current geoscience programs is interdisciplinary research and real-world problem solving (NASEM 2018). Solving the most critically important scientific challenges often requires teams of researchers from different backgrounds to work together, a necessity that introduces challenges and requires new skills (Lustig 2015). This is particularly true of the geosciences, which have an increasing “need for students to have strength in their discipline as well as the ability to work across disciplinary boundaries” (Mosher 2014; also NSTC 2018). The proposed project demonstrates an approach to undergraduate research that prepares students for the challenges of working with multidisciplinary teams. (See page 11 for Research Activities.) Scholarship indicates that this approach will be effective in helping undergraduates develop specific career-enabling skills (Walsh & Wicks 2014) and influencing career trajectories (Yaffe 2014). Anderson and colleagues (2015) report: “Our study shows that multi-disciplinary research projects can foster practical experience and encourage skill development in areas of communication and teamwork which directly impact how recent graduates approach their current careers.” Additionally, Linn et al. (2015) report that activities that could increase students’ benefit from research experiences include participating

in group meetings where current research is discussed, discussing research with mentors, and synthesizing their insights by creating research proposals, reports, or posters, (all planned for project).

Communication Design to Mitigate Potential Problems and Generate Interdisciplinary Knowledge.

The next generation of geoscientists must be able to engage in effective two-way communication with other scientists and the public (Mosher 2014). Interdisciplinary communication is a cornerstone of this project, but is difficult due to differing methodology, vocabulary, and epistemological assumptions associated with disciplines. Lead by Co-PI Blevins (Environmental Communication), the UP-Utah Lake summer project will employ a communication plan that includes: 1) starting each summer by establishing clear goals and objectives; 2) implementing initial orientation and teambuilding activities; 3) creating working agreements in which the student teams outline their individual responsibilities, group research norms, and deliverables of the group; 4) organized recreation activities to build comradery and trust; 5) weekly meetings to report on progress, evaluate the project, and share information; and, 6) workshops to build research skills, public speaking abilities, and critical thinking (Thompson 2009).

Broadening Recruitment and Retention in the Geosciences.

The UP-Utah Lake project addresses a high NSF priority to increase the number and diversity of students engaged and retained in geosciences education and career pathways. Evidence exists that elements of the project design such as service learning, undergraduate research experiences, community-based projects, and mentoring do assist in attracting and retaining students, especially those from underserved populations, to STEM fields (Lockeman 2013; Reed 2015; NRC 2011; Hurtado, et. al. 2010; Jones 2010). However, the geosciences present unique challenges (Egger & Klemperer 2011; NASEM 2017). O'Connell (2016) determined that four factors tend to deter some students, including women, from enrolling in the geosciences: 1) lack of exposure to the geosciences and career opportunities; 2) lack of interest in or exposure to outdoor activities (including field work); 3) interest in a career with greater perceived prestige; and 4) the perception that the geosciences are not relevant to their lives. In designing this project, we have included a variety of service learning and community-based research activities, that include archival research and interviews with people, as well as field and laboratory work. We have also planned socialization activities on Utah Lake so that students can have experiences around the lake they are researching. Working with professionals from government and business acquaints students with possible careers. The multi-disciplinary approach involving business and environmental communication may appeal to a more diverse group of students, as may the focus on informing and effecting policy (Szymanski 2012; Bouldin 2015).

Service Learning for Recruitment and Awareness in the Geosciences.

Service learning and community-based research related to the UP-Utah Lake project will be integrated into several courses taught during the academic year by participating faculty in their respective disciplines to facilitate geoscience learning as well as recruitment into the summer program (see Recruitment in SD#1). Research informing this activity is at the intersection of two related pedagogies – *undergraduate research* in STEM fields, and *service learning*, particularly community-based research. Both bodies of literature speak to the tremendous benefits of well-designed activities in applying coursework to real-world problems, engaging and retaining students in their disciplines, increasing completion rates, and teaching skills that are necessary for success in graduate education and/or careers (Russell 2007; Osborn and Karukstis 2009; NCUR & CUR 2005; NASEM 2017; Eyler & Giles 2001; Lockeman & Pelco 2013; Reed, et. al. 2015). Several researchers also report success in recruiting students into the Earth Sciences through research and service learning (Egger & Klemperer 2011; Lui, et.al. 2004); yet, some researchers indicate the need for more research on attracting students from underrepresented groups (O'Connell 2016; NAS 2016). All service-learning applications will have similar characteristics: 1) they will allow students to connect their coursework to a real-world problem; 2) they will be well-organized with phases of planning, implementation, summarization, reflection, and feedback; 3) they will require problem analysis, critical thinking, teamwork and leadership, data collection and analysis, and communication about their findings; and 4) they will require at least 20 hours of student participation (required for a UVU service-learning designated course).

Academic-year courses will be at all undergraduate levels; at least 40% of students will be in lower-division courses and will involve students who have generally not yet declared a major. Lower-division courses will include, but not be limited to Introduction to Physical Geography (GEOG 1000), Geography of Utah (GEOG1600), and Intro to Environmental Management (ENVT 1110). Students in will use data sets and reports from the summer project to examine relevant course questions. For example, in GEOG 1600, students will analyze anonymized interview or survey results; in ENVT 1110 students will

prepare reports on the UP-Utah Lake including the problem(s) and research findings. Courses will be visited by UP-Utah Lake summer participants who will give presentations, facilitate discussions, and make explicit the connection with the course material, research, and employment. Students in upper-division courses will also be engaged in the project, particularly through ongoing data analysis and interpretation, or in a service-learning research project. Upper-division courses include Environmental Toxicology (ENVT 3010); GIS (GEOG 3600); Wetland Studies (GEOG 3700); Communication Research Methods (COMM 3020); Organizational Development and Change (HR3550). Students in GEOG 3700, for example, will continue data analysis on samples collected and GEOG 3600 students will use summer research data in map analysis and geovisualization assignments. Students in GEOG3700 will conduct wetlands-related service-learning research. Students in COMM3020 and HR3550 will continue to design and conduct surveys in the community. Summer research students and agency partners will be invited to present in the Department Seminar Series (GEO 480R), which is a required course for all majors but open to all.

Research to Inform Policy Makers. Employers look for people who can think about problems in terms of practice, not just in terms of research or scholarship (Mascarelli, 2013; NSF Geoscience Education 1997). Thus, having students tackle real-world problems faced by local communities requires a specific deliverable in addition to the research, such as an action plan or compilation of data and analysis to inform policy makers (Szymanski 2016). The proposed research project at Utah Lake addresses the Utah State Legislature's Concurrent Resolution Urging Restoration of Utah Lake (Utah State 2017) passed in spring 2017 with the support of the Utah Lake Commission and Utah County. This resolution is an indicator to the state and public of the urgency to solve problems and improve the lake's water quality and role in public life. Thus, students participating in the UP-Utah Lake project will be required to present their findings annually to the Utah Lake Commission, and, as appropriate, make recommendations in the form of written reports and oral presentations to representatives of state agencies or others. They will also summarize findings for the UP-Utah Lake web site. This practical, impactful aspect of the project should illuminate the real value of geoscience education and careers and prepare students for the workforce.

Conference Presentations. Students in the summer research program will be required to give one academic presentation annually as well, such as at conferences on undergraduate research and at discipline-specific conferences (see *Dissemination*). Participation in conferences and seminars is an important way for students to prepare for graduate school and the professions because they gain a broader perspective of their disciplines, meet and network with other professionals and graduate students, and gain increased enthusiasm and commitment to careers in and related to the geosciences. Conference participation will be funded by this project and UVU grants to undergraduate researchers.

E. Research Questions and Activities

Research Case Study. Utah Lake is one of the largest freshwater bodies in the West, covering about 95,000 acres (380 km²). Between this large, shallow lake and the towering Wasatch Mountains, over half a million people live within the narrow strip of land that is home to the Provo-Orem metropolitan area – the seventh fastest growing population in the nation (Pugmire 2017). Unlike the briny Great Salt Lake to the north, Utah Lake once abounded with fish and wildlife. The lake and its surrounding wetlands remain critical for fish and wildlife resources, flood mitigation, and recreation. Historic and recent anthropogenic activities (mining; urban, industrial, and agricultural runoff; effluent from wastewater treatment plants, etc.) have introduced significant amounts of pollutants such as excessive nutrients, arsenic (As), trace metals, and polychlorinated biphenyl compounds (PCBs) into the lake (UT Department of Health 2006; Kreiger 2003; Wingert 2008). Although this deterioration is moderated to an unknown extent by natural cleansing processes or sinks (Lehnher 2012; Merritt 2014), on the whole, the lake struggles with pollution, loss of biodiversity, and harmful algal blooms, and thus a negative perception by the public.

In order to rejuvenate Utah Lake, several state agencies have been implementing projects to address the most urgent concerns (O'Donoghue 2017). A *Phragmites* control project aims to manage the spread of an invasive reed. A carp removal project is intended to reduce the invasive common carp population and facilitate the restoration of the June sucker (indigenous, endangered native fish species). A program of phased sewage plant changes attempts to remove 30 to 70% of phosphorus at a cost of several hundred million dollars (Merritt 2017). However, these projects have had limited success. One reason is that restoration attempts have been conducted in isolation, which may lead to unintended consequences, including disrupting natural sinks for trace metals (Kufel 1980; Brix et al. 2003.) Another reason for limited success has been the lack of thorough research of sources, impacts, and potential

solutions in context with other potential solutions and public perceptions (Utah Lake Commission Chair). Currently, Utah Lake does not play a vibrant role in community life. Anthropogenic impacts, water quality, and public perception have all contributed to the under-utilization of the lake. Research conducted through this service-learning project will help inform policy makers in their decisions about Utah Lake.

Service-Learning Topics and Research Questions. The service-learning topics and research questions presented here were created in response to concerns voiced by agency partners, community entities, and faculty expertise. The overall topics and specific questions will be refined and may be revised in the collaboration between students and agency partners: **Year 1** – What is the history and the real and perceived status of the inadequacy of Utah Lake as a natural resource? **Year 2** – What are the causes of the inadequacy of Utah Lake as a natural resource? **Year 3** – What countermeasures could rejuvenate Utah Lake as a natural resource? Each year's work will be initiated in the summer UP-Utah Lake course project and continued, for any students who chose to participate, throughout the academic year in a 495R course or in faculty-mentored research. All student researchers will have an opportunity to participate in the research process, including presentation of their findings.

[**Note to Readers:** Reviewers of the prior submission of this project questioned if this should be an REU project. We feel it is more suited to GEOPAths because it will involve undergraduate students from UVU who will remain at the institution to extend the project's impact on the community and the Department.]

Description of Research Projects by Discipline [faculty have prepared more detailed methodologies]

Biogeochemistry: Assessment of the Quantity of Phosphorus Loading from Different Sources to Utah Lake. This project will assess the quantity of phosphorus loading from different sources to Utah Lake using geochemical analysis and GIS spatial analysis and modeling. Findings can help state agencies prioritize remediation efforts and to establish specific regulations on phosphorus discharge.

Potential Research Questions and Student Activities:

Yr 1 – How much nutrient input to Utah Lake is from agricultural lands, residential lawns, and wastewater treatment plants? Yr 2 – What triggers the algal bloom in Utah Lake?

Yr 3 – What could be done to eliminate the algal blooms in Utah Lake?

Student Activities (as appropriate for each year): Students will: 1) conduct a literature review and build a conceptual model on phosphorus sources; 2) survey and map the locations of algal blooms; collect samples from sites around the lake and prepare them for analysis at UC Davis; 3) employ different GIS spatial analysis techniques to visualize the phosphorus concentrations; 4) synthesize findings to assess the factors and sources that contribute to algal blooms; and 5) present their findings to state agencies and propose solutions to help eliminate algal blooms in Utah Lake.

Faculty Mentor: Weihong Wang, Associate Professor, Department of Earth Science

Partnering Agencies: Utah Division of Water Quality; USDA Natural Resources Conservation Service

Business Management: Assessment of the Impact of Utah Lake Health on Local Business and Economic Prosperity. Many companies have relied and continue to rely on Utah Lake. Students will examine how various aspects of the local business environment have been impacted by changes to Utah Lake over time, from a social science literature-based and real-world business perspective.

Potential Research Questions:

Yr 1 – What is the history and current status of businesses that rely upon Utah Lake?

Yr 2 – What caused a change in the status of businesses that rely upon Utah Lake?

Yr 3 – What changes in the real and perceived status of Utah Lake would result in a renaissance of businesses that rely upon Utah Lake?

Student Activities: Students will conduct a literature review, analyze available secondary and archival data, and create survey and interview questions for businesses based on the main research question and sub-questions. They will implement surveys and interviews with local businesses, quantitatively and qualitatively analyze survey and interview data, and utilize statistics to analyze survey data.

Faculty Mentor: Jonathan Westover, Associate Professor of Organizational Leadership & Ethics

Partnering Agencies: Utah Lake Commission

Environmental Science: Assessment of Anthropogenic Trace Metal Releases into Utah Lake, their Impact and Remediation. Contaminants, such as trace metal pollutants, introduced by anthropogenic activities into Utah Lake are sequestered in major sinks and may bio-accumulate in sport fish consumed by citizens, thereby posing a health risk. This research will assist state officials increase the utility of Utah Lake by lowering these risks through effective and holistic management practices.

Potential Research Questions and Student Activities:

- Yr 1 – What are the anthropogenic sources of heavy metal discharge into Utah Lake? Utah Lake will be divided into different sections based on anthropogenic activities and mapped using ArcGIS. Students will collect water and sediment core samples in triplicates at each location. Samples will be acid digested analyzed in the ICP-OES for trace metal content. Students will tabulate, interpret & present the data to regulatory agencies to help limit or reduce trace metal discharge.
- Yr 2 – What impact does the discharge of heavy metals have on fish species in Utah Lake? (samples of major sports fish collected, and their liver, muscles, skin and gills analyzed)
- Yr 3 – Could the invasive species, *Phragmites australis* (reeds), be used to rejuvenate Utah Lake via phytoremediation of heavy metal pollutants? (reed root sediment samples collected & analyzed)

Faculty Mentor: **Eddy Cadet**, Associate Professor of Environmental Science and Management

Partnering Agencies: Utah Division of Water Quality; Utah Division of Wildlife Resources

Environmental Communication: The Narratives Surrounding Utah Lake Health. This section of the study will investigate the narratives that people have regarding the lake that will allow researchers to understand the stories told about the lake and the way people communicate about the lake.

Potential Research Questions:

- Yr 1 – What are the narratives and memories that local residents have about Utah Lake?
- Yr 2 – What are the narratives surrounding the reasons Utah Lake is not a desirable natural resource?
- Yr 3 – What information would cause a change in the narratives that local residents have about Utah Lake? What would have to occur to make the lake seem like an attractive natural resource?

Student Activities: Students will: 1) conduct a content analysis of media for the last 100 yrs to identify the historical importance of the lake and see if media portrayal has changed; 2) create questions for surveys and interviews, conduct the surveys with local residents, and analyze the data; 3) connect the research findings to the data found by other research teams and communicate results of secondary and archival data, surveys and interviews to peers, partners, and others through written & oral works.

Faculty Mentor: **Maria Blevins**, Assistant Professor, Department of Communication

Partnering Agency: Utah Lake Commission

Geography: Governance, Perception, and the Future of Utah Lake

This project emphasizes spatial reasoning skills and connections through methods from human geography and social science to examine governance and society-natural resource relationships. Each year, students will create survey and interview questions based on the following research questions:

Potential Research Questions:

- Yr 1 – How do local politicians, residents, and other stakeholders think about and use Utah Lake, and how does this vary across demographics and space?
- Yr 2 – What caused a change in how local residents, politicians, and other stakeholders have thought about and used Utah Lake?
- Yr 3 – What would be the components of a plan for Utah Lake that residents, politicians, and other stakeholders would be most likely to support?

Student Activities: Each year, students will create new interview and/or survey questions to study the research questions. Surveys will be analyzed quantitatively, and responses mapped to investigate whether spatial relationships, such as distance to the lake or type of neighborhood, impacts results. Qualitative methods will be used to analyze in-depth interview data. Special emphasis will be placed on communicating results through maps, graphics, and other media.

Faculty Mentor: **Hilary Hungerford**, Associate Professor, Department of Earth Science

Partnering Agency: Utah Lake Commission; City of Orem

Hydrology: Assessment, Sources, and Remediation of As and Trace Metals in Utah Lake and its Watershed. Recent studies by UVU undergraduates have documented elevated concentrations of As and trace metals in Utah Lake and its watershed (Ferreira & Emerman 2012; Ferreira 2013; Hopkinson et al. 2014; Gherasim et al. 2016). This study will determine whether remediating abandoned mines in the Utah Lake watershed could have a significant impact on As and trace metals in Utah Lake.

Potential Research Questions and Student Activities

- Yr 1 – What is the distribution of As and trace metals in Utah Lake and its watershed? Students will: 1) determine the locations and histories of legacy mines in the watershed of Utah Lake through a compilation of information from state and federal agencies; and 2) determine the concentrations of As and trace metals in sediments in the tributaries of Utah Lake through collecting and analyzing sediment samples that are downstream from legacy mines.
- Yr 2 – What is the impact of the transport of mine tailings from unregulated mining on Utah Lake and its watershed? (numerical simulation; locations of dams, diversions, and legacy mines)
- Yr 3 – What would be the impact on Utah Lake of remediating abandoned mines in the Utah Lake watershed? (numerical simulation; multiple scenarios of mine remediation)

Faculty Mentor: **Steve Emerman**, Former Professor (UVU Department of Earth Science)

Partnering Organization: Malach Consulting; DNR Utah Division of Oil, Gas & Mining

F. Dissemination Plan

Research Component. Research results will be disseminated continually throughout the project. Research teams will give presentations to members of the Utah Lake Commission and to partnering agencies at the end of each summer. They will also present the project results annually at the Utah Lake Summit (see *Facilities*) in June and, at the end of the 3rd year, at the Symposium on Utah Lake in October. UP-Utah Lake students will present annually at UVU's Student Showcase and at an event hosted for high school students designed to inform and recruit other students. Once a year, UP-Utah Lake project will host an event on campus for high school students (including those in concurrent enrollment) and college students as a means of interesting them in the geosciences. Student researchers will also participate in conferences throughout the year, with funding coming from the project budget and from UVU resources (see *Facilities*). Each participant in the summer research will be expected to propose a presentation to conferences in their disciplines each year. Likely venues include the Utah State Spring Runoff Conference, Hydrology Days, Geological Society of America, Western States Communication Association, American Association of Geographers, Western Academy of Management. Faculty will include students in preparing papers for submission to peer-reviewed journals.

Educational Component. Institutions like UVU's with a mission that includes being Stewards of Place often pursue a research agenda with a focus on regional problems (AASCU 2015; Carnegie 2017). They may be interested in the UP-Utah Lake service-learning project and associated GLE and will be targeted at such conferences as American Association of State Colleges and Universities (AASCU) and Council on Undergraduate Research (CUR). In particular, we feel other educators will be interested in strategies for multidisciplinary research teams, partnerships with area agencies on geoscience issues, and community-based research as a vehicle for recruiting under-represented students into STEM fields. An article or articles will target *Research in Science Teaching*, *Science Education*, *Scientific Teaching*, *Higher Education Teaching and Learning*, *Michigan Journal of Community Service Learning*, or others.

4. PROJECT PERSONNEL (see *Biographical Sketches* for qualifications & *Facilities* for time commitment)

All faculty described below as members of the project team will serve as faculty mentors to students in the summer research program. They will also participate in the classroom implementation aimed at recruiting students into the research program at least once during the academic year. The diverse 6-member team includes 3 women, a Haitian American, an Asian, and a Hispanic.

Principal Investigator – Eddy Cadet, Ph.D., Associate Professor of Environmental Science & Management at UVU. Dr. Cadet will provide programmatic oversight and coordination; he will be responsible for the budget, reporting, and issues of compliance. He will lead the Summer Research Program; oversee the recruitment, selection, and orientation of research participants; hire peer-mentors;

and coordinate efforts among faculty. He will be responsible for submission of the annual and final reports. Dr. Cadet has mentored over 45 students just in the past three years, involving them in hands-on research activities using an iUtah Research Catalyst grant and a number of internal grants from UVU. Eleven students have been accepted to graduate schools or are in Environmental Health careers.

Co-PI – Weihong Wang, Ph.D., Associate Professor, Earth Science. Dr. Wang will coordinate recruitment of students to the summer research program, direct the initial training in the use of instrumentation and software, and supervise the near-peer lab assistant. She will serve as the liaison with the Utah Lake Commission and its constituents, organize job shadowing in geosciences, and coordinate dissemination of information about Utah Lake research to the Commission. Since coming to UVU in 2012, Dr. Wang has mentored 30+ students, mostly from underrepresented groups, and received three iUTAH Research Catalyst grants. She and her research students have published a chapter in a Geological Association Guidebook and in many presentations for regional and national conferences.

Co-PI – Maria Blevins, Ph.D., Assistant Professor, Department of Communication. Dr. Blevins will provide training for interdisciplinary team communication (see page 6) and facilitate the communication processes among members of the summer research group. She will organize guest speakers and co-organize group activities on Utah Lake. Her experience as a CLEAR Instructor for the University of Utah School of Engineering, where she collaborated to promote effective communication behaviors with engineering students and faculty, will benefit this project. She currently leads a team of 2 student researchers and serves as an advisor to 5 interdisciplinary studies students.

Co-PI – Jonathan Westover, Ph.D., Associate Professor of Organizational Leadership and Ethics, Woodbury School of Business. Dr. Westover will coordinate the service-learning component, the faculty-mentoring component, and faculty reporting of these efforts. He will organize job shadowing in the social sciences. He has served for five years as Academic Director of Center for Social Impact that trains faculty in service-learning pedagogy. He directs all academic community engagement efforts across UVU campus, involving nearly 200 faculty members, nearly 400 academic courses, and over 8,000 UVU students annually. He is dedicated to undergraduate research, mentoring at least three students annually in projects focused on organizational development, employee engagement, and pedagogy innovations.

Co-PI – Hilary Hungerford, Ph.D., Associate Professor, Department of Earth Science. Dr. Hungerford will train and supervise the near-peer graduate student (coordinator) and co-organize group activities on Utah Lake. Hungerford will coordinate data sharing in Hydroshare and dissemination activities beyond the Utah Lake Commission. She has been active in implementing research programs for undergraduates and integrating community-based research in the classroom. Since joining UVU in 2015, she has mentored 11 students on research projects. At South Dakota State Univ., she mentored 4 undergrads and was advisor to 3 graduate theses.

Consultant – Steven Emerman, Ph.D., former Professor, Department of Earth Science. Dr. Emerman, Professor Emeritus of Hydrology at UVU, will mentor students in the hydrology component of the summer project. He will provide links to professionals and job opportunities in geoscience fields, including environmental degradation. Since coming to UVU in 2008, Dr. Emerman has worked with students on many local and international research projects, including projects in Haiti, Nepal, Mexico, and Mali. He and his 168 undergraduate researchers have received 67 internal research grants. His undergraduate students have published 24 papers and delivered 225 presentations at professional meetings.

Training and Accountability for Faculty Mentors. Three members of the project team have participated in the UVU Mentoring Academy (see *Facilities*) that prepares faculty to be effective mentors on under-graduate research projects; the other three team members will participate before the program begins. Faculty mentors will meet annually in a workshop prior to the summer program to discuss readings relative to specific mentoring strategies including communicating about research and avoiding gender bias (led by Blevins), and using scaffolding to lead students to increased levels of research independence (Malachowski, et. al., 2018) (led by Hungerford). After the summer research period, faculty mentors will maintain a supportive, working relationship with their students, assisting them in setting and achieving academic and career goals, selecting and carrying out meaningful career-preparation activities, and/or planning graduate school applications, and utilizing campus resources to their advantage. Faculty mentors will report their activities with students quarterly to the faculty mentor coordinator (Dr. Westover).

5. MERIT REVIEW CRITERIA

A. Intellectual Merit. The proposed IUSE Geopaths project builds on prior community-based research conducted in recent years by student research teams directed by Drs. Cadet, Wang, Emerman and Hungerford on Utah Lake and its watershed. These NSF EPSCoR-funded projects (described in *Results of Prior NSF Support*) and the community partnerships they developed are being leveraged to design a deep learning environment for undergraduate research. Under this project, faculty and students from Business Management and Environmental Communication are being included in this geoscience service-learning project to better address the complex issues that confront Utah Lake. The project will explore how this multidisciplinary approach to a recognized local issue creates interest and enthusiasm among student researchers and broadens participation to include more women and minorities. The UP-Utah Lake project is grounded in evidence-based practices such as mentoring from faculty, near-peers, and association with professionals from whom students will learn about geoscience and related careers. The four geoscience faculty have expertise in their areas and in mentoring undergraduate research. Co-PI Blevins, an expert in assisting communication within scientific teams, will facilitate communication among this project's multidisciplinary teams. Co-PI Westover, who serves as Director of UVU's Center for Social Impact, will coordinate a robust community-based research component in the classroom that connects to the Utah Lake research and serves as a recruitment tool for the summer program. The formation of a Geoscience Learning Ecosystem that includes the Utah Lake Commission and other agencies has helped align the research focus and will facilitate student preparation and pathways in geoscience careers.

B. Broader Impacts. The proposed project will use and build evidence within the geoscience education community about service learning and multidisciplinary community-based research in the geosciences, particularly, its potential to demonstrably deepen interest in, knowledge of, and preparation for geoscience career pathways. The inclusion of faculty and students from the fields of business and environmental communication will illuminate a more diverse range of careers and research interests and will increase knowledge about the geosciences for non-geoscience majors. The project will also boost enrollment and retention in UVU's Department of Earth Science, which has experienced declining enrolment, and address needs articulated by students for more career awareness and job skill development. The participation of local agencies and organizations in the UL-GLE will provide students with opportunities to connect with professionals and to see the potential usefulness of their geoscience studies. This research should assist policy makers in rejuvenating Utah Lake to the benefit of the community. Moreover, service learning and community-based research approach to this project will prepare students to be professionals who are better prepared think about problems in terms of practice and will be of interest to other STEM educators.

6. RESULTS OF PRIOR NSF SUPPORT (Research products for each are in *References Cited – Products*)

A. Results of Prior NSF Support for Eddy Cadet

Title: Impact of *Phragmites australis* control on Utah Lake water quality **Award Number:** 1208732

Program: iUTAH (innovative Urban Transitions and Arid-region Hydro-sustainability) / EPSCoR

PI: Eddy Cadet **Co-PI:** Weihong Wang **Award Amount:** \$19,827 **Award Period:** 2016–2017

Summary of Results: **Intellectual Merit.** This project investigated the impacts of the control approach used to manage the invasive species *Phragmites australis* on Utah Lake ecosystem and its effect on water quality. **Broader Impacts.** This research advances understanding of geochemistry-ecological feedbacks in ecosystems, particularly involving exotic invasions. The results provide foundational data and insight into the invasive species' impacts at the study area that can be utilized in the broader iUTAH framework and will inform further basin-scale research directed at improving water management in the region.

B. Results of Prior NSF Support for Weihong Wang

Title: Investigating Temporal & Spatial Variations of Nutrient & Trace Metal Loading to Utah Lake

Program: iUTAH (innovative Urban Transitions and Arid-region Hydro-sustainability) / EPSCoR

PI: Weihong Wang **Award Amount:** \$20,000 **Award Period:** 2014–2016 **Award Number:** 1208732

Summary of Results: The project characterized ongoing impacts of population growth and climate change on water availability and quality. **Intellectual Merit.** Results indicate that Utah Lake is not well mixed horizontally but well mixed vertically. Elevated levels of arsenic and lead in water samples during the summer months were likely due to the application of manure as fertilizers from the surrounding agriculture lands and the runoff from mine tailings, respectively. **Broader Impacts.** The project provided research opportunities for 3 students; one was admitted to a graduate program at the University of Utah.

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* indicates UVU undergraduate co-authors

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Products Related to Prior NSF Support for Eddy Cadet and Weihong Wang
(* indicates UVU undergraduate co-authors)

- Peterson, Hannah*, Jeremy Andreini*, and Weihong Wang. 2016. Assessment of Historical Anthropogenic Impacts on the Utah Lake Ecosystem using GIS Spatial Analysis. Abstract and Poster Presentation. Conference on the Scholarship of Teaching and Engagement (SoTE), Utah Valley University.
- Peterson, Hannah,* Sheryce Henley*, Joshua W. Jackson*, Weihong Wang, and Eddy Cadet. 2014. Assessment of Anthropogenic Impacts on the Utah Lake (UT) Using Stable Isotope and Trace Metal Analysis. Abstract and Oral Presentation. Geological Society of America Annual Meeting.
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- Rakotoarisaona, Henintsoa,* Hannah Peterson*, Weihong Wang. 2016. Temporal and Spatial Variations of Trace Metal Loading to Utah Lake (UT). Abstract and Poster Presentation. Geological Society of America Annual Meeting.
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Wang, Weihong, 2017. Assessment of Anthropogenic Impacts on the Utah Lake Ecosystem - Integrating a Multi-Proxy Approach and GIS Spatial Analysis Technique. Abstract and Oral Presentation. Utah Lake Education Workshop.

Weihong Wang. 2016. Integrating Geochemistry with GIS Spatial Analysis in Utah Lake Studies. Abstract and Oral Presentation. 10th Annual Salt Lake County Watershed Symposium

Wang, Weihong, 2016. Temporal and Spatial Fluctuations of Nutrient and Trace Metal Loading to Utah Lake. Abstract and Poster Presentation. 22nd EPA National Nonpoint Source (NPS) Monitoring Workshop.

Zanazzi, Alessandro, Hannah Peterson*, David Sutterfield*, Henintsoa Rakotoarisaona*, Jeremy Andreini*, and Weihong Wang. 2017. A Stable Isotope Study of Utah Lake (Utah, USA). Abstract and Oral Presentation. Geological Society of America Annual Meeting.

Eddy L. Cadet
Principal Investigator – Environmental Science & Management

Professional Preparation

University of Illinois, Chicago Campus, IL	Biology	B.S.	1990
University of California, Davis	Hazardous Materials Mgmt	Cert.	1998
Tuskegee University, Tuskegee, Alabama	Environmental Science	M.S.	2002
Tuskegee University, Tuskegee, Alabama	Integrative Bioscience	Ph.D.	2013

Appointments

Associate Professor of Environmental Science and Management, Department of Earth Science, Utah Valley University, 1993 – present
Licensed Environmental Health Scientist, Utah County Health Depart., Provo, Utah, 2002–present
Assistant Professor, Environmental Technology, Utah Valley State College (now UVU), 2000–2001
Instructor, Environmental Technology, Utah Valley Community College (now UVU), 1993–2000
Registered Environmental Health Scientist, Lake County (Illinois) Department of Health, Chicago, Illinois, 1990 – 1992
Science Teacher, Science Department, Shiloh Academy, Chicago, Illinois, 1989 – 1990

Products

Products most Aligned with the Proposed Project

Weihong Wang, Suzanne Walther, **Eddy Cadet**, Greg Carling, Kevin Rey, Steve Nelson, David Tingly*, Paul Robertson*, and Buchanan Kersell*. 2017. The Historical Records of Stable Isotopes (¹³C and ¹⁵N) and Trace Metals along Utah Lake – Jordan River Transition Zone, Utah (US). In *2017 Utah Geological Association Guidebook: Geology and Resources of Wasatch – Back to Front*. 46, 171-185.

Ibrahim Alhassan*, Evensen, Arthur*, **Eddy Cadet**. 2016 Assessment of anthropogenic impact on trace metal concentrations in Utah Lake water and sediments. Abstract and Oral Presentation. Geological Society of America (GSA) Annual Meeting in Denver, Colorado, USA
<https://gsa.confex.com/gsa/2016AM/webprogram/Paper286623.html>

Hannah Peterson*, Sheryce Henley*, Joshua W. Jackson*, Weihong Wang, and **Eddy Cadet**. 2014. Assessment of Anthropogenic Impacts on the Utah Lake (UT) Using Stable Isotope and Trace Metal Analysis. Abstract and Oral Presentation. Geological Society of America Annual Meeting. https://gsa.confex.com/gsa/2014AM/finalprogram/abstract_245420.htm

Henintsoa Rakotoarisaona*, Kevin W. Jackman*, Sheryce Henley*, Joshua W. Jackson*, **Eddy Cadet**, Weihong Wang, and Suzanne Walther. 2014. Evaluation of the Distribution and Mobility of Selected Trace Metals in Sediments at the Jordan River Water Head of Utah Lake. Abstract and Oral Presentation. Geological Society of America Annual Meeting. https://gsa.confex.com/gsa/2014AM/finalprogram/abstract_250534.htm

Henintsoa Rakotoarisaona*, Jackman, Kevin W*. Henley, Sheryce*, Jackman, Joshua William*, **Cadet**, Eddy, Wang, Weihong, and Walther, Suzanne. 2014. Evaluation of the distribution and mobility of selected trace metals in sediments at the Jordan River Water head of Utah Lake. Abstract and Oral Presentation. Geological Society of America (GSA) Annual Meeting in Vancouver, British Columbia (19-22 October) https://gsa.confex.com/gsa/2014AM/finalprogram/abstract_250534.htm

Other Important Products

Emerman, Steve H., **Eddy Cadet**, Marcio Jose dos Santos, Caroline Gomide: 2019. The impact of the Tailings Storage Facilities of the Morro do Ouro Mine on Downstream Water Quality, Minas Gerais, Brazil. Oral Presentation: Geological Society of America (GSA) Annual Meeting in Phoenix Arizona, USA.

Hungerford, Hilary, Sarah Smiley*, Taylor Blair*, Samantha Beutler*, Noel Bowers*, and **Eddy Cadet**, 2019. Coping with Floods in Piking, Senegal: An Exploration of Household Impacts and Prevention Efforts. *Urban Science*: 3, 54.

Cadet, E., 2005. Water quality in Utah Lake. In D. Horn (ed.), *Utah Lake Comprehensive Management Plan Resource Document*. Department of Earth Science, Utah Valley University.

Cadet, E., 2005. Water related planning efforts in the Utah Lake Basin. In D. Horn (ed.), *Utah Lake Comprehensive Management Plan Resource Document*. Department of Earth Science, Utah Valley University.

Ghera Sim, Janelle*, Oliverson, Cobly, McNeff*, Joshua, Nichols, Jarrett*, Tulley, Skyler*, Roberts, Sterling*, Christensen, Brennan*, Emerman, Steven, Simon, Alexander, **Cadet, Eddy**. 2015. Geochemical and Sociological Study of Backyard Wells and Gardens in Utah Valley, Utah. GSA Annual Meeting in Baltimore, Maryland, USA (1-4November). <https://gsa.confex.com/gsa/2015AM/webprogram/Paper262927.html>

Synergistic Activities

Internship Coordinator, Department of Earth Science, Utah Valley University (since 1993). I worked with industry and governmental agencies to place student in positions related to their fields in preparation for the work force. For example, during the past 10 years at least 20 students have had opportunity to complete internships at the Utah County Health Department and or water reclamation plants in Utah. At least 10 of these student have been hired by Health departments throughout the Western United States; several are in supervisory positions for Orem City Water Reclamation Facility.

Supervise Student Research. Have lead a number of student field studies and supervised many student research projects and senior theses. For example, I have worked with at least 39 students in investigating anthropogenic impact on Utah Lake. Under my mentorship students have collected and analyzed environmental samples and have been trained in state of the art instrumentation (such as the inductively coupled plasma optical emission spectroscopy or ICP-OES) in my lab resulting in at least 7 presentations in state and national conferenced in the past three years. Some of these students have continued to graduate studies and most are employed in environmental fields.

Laboratory Development. I received funding through the College of Science in 2019 for the purchase of a laser technology particle size analyzer (the Mastesizer) at a cost of \$50,000 and for the purchase of a Microwave Accelerated Digestion System at a cost of \$40,000. This equipment will be used in the environmental science laboratory for the proposed UP-Utah Lake project.

Invited Speaker. I was an invited speaker for the Annual Conference of the Utah Environmental Health Association to speak on my research activities regarding Utah Lake Water Quality. The title of my talk was Impact of Phragmites Control on Utah Lake Water Quality. (Spring 2018).

Training Workshops. I chaperoned my students to the United Nations 62nd Session of the Commission on the Status of Women in New York City to speak on their research work on Water Quality in Senegal, Africa in 2018.

Maria Blevins
Co-PI – Environmental Communication

Professional Preparation

University of Maine at Machias, ME	Outdoor Recreation Management	BS	1998
University of Montana, Missoula, MT	Communication	MA	2007
University of Utah, Salt Lake City, UT	Communication	PhD	2015

Appointments

Utah Valley University

Assistant Professor, Department of Communication, 2014-Present
Lecturer, Department of Communication, 2013-2014

Products

Products Most Related to the Current Project

Lindley, B., Blevins, M., Williams, S. (2018) Cultural meanings and management challenges: High use in Urban proximate wildernesses. *International Journal of Wilderness Management*, 24(3), Dec. 2018. Online at <https://ijw.org/cultural-meanings-and-management-challenges/>.

Canary, H. E., Blevins, M., & Ghorbani, S. S. (2015). Organizational Policy Communication Research: Challenges, Discoveries, and Future Directions. *Communication Reports*, 28(1), 48–64. <http://doi.org/10.1080/08934215.2013.865063>

Burian, S. J., Barbanell, E. M., & Blevins, M. D. (2011). Avoiding Another Tower of Babel: Bridging Communication Barriers Among Students and Instructors from Civil Engineering, Humanities, and Other Disciplines in a Multidisciplinary Course. Presented at the American Society of Engineering Education annual meeting, Vancouver, British Columbia.

Other Products

Blevins, M. (2018) Negotiating gender in the outdoor recreation industry. Competitively selected paper presented at the National Communication Association annual convention, Salt Lake City, UT.

Blevins, M.D. (2017) Participant observation in SAGE encyclopedia of communication research methods. Thousand Oaks, CA: Sage.

Blevins, M. (2016). Calling on action for climate change: Utilizing structuration theory to enact change in organizational practices. Competitively selected paper presented at the National Communication Association annual convention, Philadelphia, PA.

Blevins, M.D. & Burien, S. (2012). Analysis of the Sustainability Culture in Civil and Environmental Engineering and Mechanical Engineering Programs. Presented at the American Society of Engineering Education annual meeting, San Antonio, TX.

Synergistic Activities

CLEAR Instructor, School of Engineering, University of Utah. Furthering the goals of the Communication, Leadership, Ethics, and Research program, she collaborated with engineering professors to design and implement innovative communication curriculum to assist engineers with communication. She provided students with personalized feedback regarding writing, public speaking, and working in teams to conduct research regarding communication in engineering department.

Communication Consultant at Engineering Firms. Working in conjunction with engineering firms, she has designed communication trainings that help with community engagement, environmental conflict, public speaking, and small group communication.

Curriculum Development. As an Assistant Professor in the Department of Communication at Utah Valley University, she has developed curriculum in Environmental, Organizational, and Conflict Communication.

Reviewer for competitive papers. Dr. Blevins serves as a reviewer for competitive papers at the National Communication Association (NCA) and the Western States Communication Association (WSCA).

SIMLab Fellow. Dr. Blevins is a faculty fellow in the SIMLab, supported by the Center for Social Impact. She works with student fellows who to carry out faculty-mentored evaluations of the social and economic impact of programs conducted by local, domestic and international community organizations, with first preference given to non-profits.

Hilary Hungerford
Co-PI – Geography

Professional Preparation

University of Northern Colorado, Greeley, Colorado	Geography	B.A.	2001
The University of Kansas, Lawrence, Kansas	Geography	M.A.	2007
The University of Kansas, Lawrence, Kansas	Geography	Ph.D.	2012

Appointments

Associate Professor, Department of Earth Science, *Utah Valley University*, 2018 to present
Assistant Professor, Department of Earth Science, *Utah Valley University*, 2015 to present
Assistant Professor, Department of Geography, *South Dakota State University*, 2012 – 2015
United States Peace Corps Volunteer, Benin, 2002 to 2004

Products – Peer-review publications

Hungerford, H., Smiley, S., Blair, T., Beutler, S., Cadet, E. (2019). Coping with floods in Pikine, Senegal. An exploration of household impact and prevention efforts. *Urban Science*.

Kuehl, B., & **Hungerford, H.** (2017). Global Citizenship in Intercultural Communication: Spatial Awareness of Globalization through Map Your Consumption. *Communication Teacher*.

Hungerford, H., & Yaye, M. (2016). Seeing the (urban) forest through the trees: governance and household trees in Niamey, Niger. *African Geographical Review*.

Hungerford, H., & Smiley, S. L. (2016). Comparing colonial water provision in British and French Africa. *Journal of Historical Geography*, 52, 74-83.

Bontianti, A., **Hungerford, H.**, Harouna, H., Noma, A. (2014). Fluid experiences: Comparing local adaptations to water inaccessibility in two disadvantaged neighborhoods in Niamey, Niger. *Habitat International*, Volume 43, July 2014, pages 283–292 (corresponding author).

Products – Presentations with undergraduate collaborators (* indicates undergrad student)

Beutler, S.*, Blair, T.* , **Hungerford, H.**. Household mediation of floods in Senegal. Paper presented at American Association of Geographers, April 2018.

Bejar, C.* , Larsen, I.* , Jensen, J.* , Hungerford, H., Cadet, E. Flooding and water quality in Pikine, Senegal. Poster presented American Association of Geographers, April 2018.

Abbott, M.* , Nofchissey, S.* , Bushman, P.* , Joe, D.* , Gherasim, J*., Campbell, S.* , Tulley, S.* , Emerman, S., **Hungerford, H.**, Santon, L. The history of water in Bears Ears National Monument, Southeastern Utah: Towards a synthesis of geochronology, Native American oral history, and rock art. Paper presented at the Geological Society of America, October 2017.

Keck, M.*, Todd, M.* , and **Hungerford, H.** Mobile water: changing water rights in Utah County. Paper to be presented at the International Society Landscape, Place, and Material Culture, October 2017.

Delora, M.* , Toke, N., **Hungerford, H.** Assessment of Environmental Injustices Associated with TRI Sites in Utah's Wasatch Front Communities Using Dasymetric Mapping and Geographically Weighted Regression. Paper presented at the Association of American Geographers annual conference, April 2017.

Synergistic Activities

Invited Lecture. Blevins, M., Hungerford, H., Holt, A. Invited workshop on Community/Academic Collaborations for Water Management and Climate Change. 68th NGO/DPI conference of the United Nations, August 26th, 2019.

Curriculum Development. I serve as the chair of the Curriculum Committee for the College of Science at UVU and as the College of Science representative to the University Curriculum Committee.

Undergraduate Research. Since joining UVU in 2015, I have mentored 15 students on research projects. During my previous three years at South Dakota State University, I was advisor on three graduate theses and mentored four undergraduates. These researchers work with me to prepare conference presentations and publications.

Grant Management. I served as the lead at UVU for the large, NSF-EPSCOR funded grant entitled *Science for Utah's Water Future: Innovative Urban Transitions and Aridregion Hydro-sustainability (iUtah)*. The main grant was awarded to Utah State University; UVU faculty received eight of the twenty sub-awards funded through this grant. At UVU, I tracked research awards to other faculty and facilitated reporting of faculty participants, and also conducted my own smaller projects.

Service-Learning / Community-based Research in the Classroom. I participated in the service-learning fellowship program at UVU in Spring 2017. During this fellowship, I received mentoring on setting up service-learning and integrating into classroom activities. I have since developed community-based research in my Geography of Utah class, which has 30 students per semester.

WEIHONG WANG
Co-PI – Biogeochemistry, Wetland Studies, GIS Mapping

Professional Preparation

Jianghan Petroleum University, Jingzhou, China	Geophysics	B.Sc. 1997
Jianghan Petroleum University, Jingzhou, China	Environmental Geology	M.Sc. 2000
Iowa State University, Ames, IA	Geology	M.Sc. 2004
University of South Carolina, Columbia, SC	Marine Science	Ph.D., 2008
Yale University, New Haven, CT	Biogeochemistry	2009-2010

Appointments

Utah Valley University

- Associate Professor, Department of Earth Science, 2018-present
- Acting Chair, Department of Earth Science, 2018-2019
- Assistant Professor, Department of Earth Science, 2012-2018

Brookdale Community College

- Instructor with Tenure Track, Department of Environmental Science, 2010-2012

Yale University

- Postdoctoral Associate, Department of Ecology and Evolutionary Biology, 2009-2010

University of South Carolina

- Research Assistant (Dr. J.T. Morris advisor), 2006-2008
- Teaching Assistant, 2005-2006

Iowa State University

- Research Assistant (Dr. G. Mora advisor), 2003-2004

Products

Five Products most related to the Proposed Project (*denotes student author)

- Derek McGovern*, Erin Call*, **Weihong Wang**, and Justin White. 2019 Annual American Association of Geographers. Assessing the Impact of ~75 years of Land Use and Land Cover Change on the Utah Lake Watershed with Remote Sensing and Spatial Modeling.
- Erin Call*, Derek McGovern*, **Weihong Wang**, and Justin White. 2019 Spring Runoff Conference. Calculating the Impact of ~65 years of Anthropogenic Activity on the Utah Lake Watershed using Remote Sensing and Spatial Modeling
- **Weihong Wang**, Suzanne Walther, Eddy Cadet, Greg Carling, Kevin Rey, Steve Nelson, David Tingey, Paul Robertson*, and Buchanan Kerswell*. The Historical Records of Stable Isotopes ($\delta^{13}\text{C}$ and $\delta^{15}\text{N}$) and Trace Metals along Utah Lake – Jordan River Transition Zone, Utah (USA). 2017 Utah Geological Association Guidebook: Wasatch Front to Back, 46: 171-185.
- **Weihong Wang**, Henintsoa Rakotoarisaona*, and Hannah Peterson*. 2017. Investigating Temporal and Spatial Variations of Trace Metal Loading To Utah Lake, UT (USA). Abstract and Oral Presentation. 2017 iUTAH Annual Symposium & Summer All-Hands Meeting.
- Alessandro Zanazzi, Hannah Peterson*, David Sutterfield*, Henintsoa Rakotoarisaona*, Jeremy Andreini*, and **Weihong Wang**. 2017. A Stable Isotope Study of Utah Lake (Utah, USA). Abstract and Oral Presentation. Geological Society of America Annual Meeting.

Five Other Products (*denotes student author)

- **Weihong Wang**, Eric Call*, Derek McGovern*. 2018. 12th Annual Salt Lake County Watershed Symposium. Assessment of Land Use and Land Cover Change in Utah Lake-Jordan River Watershed.

- Serena Smith*, Sydney Hoopes*, Sydney Houghton*, Daniel Ormond*, and **Weihong Wang**. 2018. 29th Annual David Keller Environmental Ethics Symposium. Nitrate and Phosphate Loading from Orem Wastewater Treatment Plant to Utah Lake.
- Henintsoa Rakotoarisaona*, Hannah Peterson*, and **Weihong Wang**. 2017. Using GIS Spatial Analysis Techniques to Assess Trace Metal Loading to Utah Lake (Utah, USA). Abstract and Oral Presentation. Geological Society of America Annual Meeting.
- Henintsoa Rakotoarisaona*, Hannah Peterson*, **Weihong Wang**, and Jeremy Andreini*. 2017. Investigating Temporal and Spatial Variations of Trace Metal Loading to Utah Lake. 31st National Conference on Undergraduate Research (NCUR).
- Kenneth Larson*, Janelle Gherasim*, Brock Howell*, and **Weihong Wang**. 2016. Investigating the Environmental Impact of the Gold King Mine Spill (CO) on the San Juan River (UT). Abstract and Poster Presentation. Geological Society of America Annual Meeting.

Synergistic Activities

Project-Based Learning. In my upper division courses [Energy on Earth, Geographic Information System (GIS), Advanced GIS, Wetland Studies, and Wetland Studies Laboratory], I use project-based learning extensively. Students are able to apply what they learn in class to scientific projects and solve real-world problems. This practice has facilitated student learning and built their confidence to succeed in school and life.

Student research and mentorship. In the past 7 years, I have mentored over 32 students in my research. Six of them were admitted to prestigious graduate programs in the nation. Two of them became Earth Science teachers in Jr High schools. Under my mentorship, my research students have submitted 18 abstracts to renowned meetings in my field, including GSA (Geological Society of America), NCUR (National Conference for Undergraduate Research), AAG (American Association of Geographers), and 18 of them attended national/regional meetings to give oral/poster presentations.

UVU Re-envisioning Undergraduate Experience Committee (RUEC). I served on the RUEC as a representative for the College of Science. The committee's charge is on how to improve student learning and college experience at UVU. The committee validated UVU Student Learning Outcomes (SLOs), explored high impact practices (HIPs), reassessed GE requirements, and proposed first year seminars for freshmen.

Annual GIS Day organizer. I organize the annual GIS Day event at UVU. We invite more than 500 local K-12 students on UVU campus and help them understand the importance of technology and GIS application in our daily life using different engaging activities. This event facilitates young students' interest in technology and recruits future STEM majors to UVU.

Women in STEM and STEM Recruitment. I have been part of "Women in STEM Open House" annual event at UVU. The open house is intended for women who are pursuing, or considering, degrees in STEM fields.

Jonathan H. Westover, Ph.D.
Co-PI – Business Management

Professional Preparation

Brigham Young University (Provo, UT)	B.S.	Sociology	2003
Brigham Young University (Provo, UT)	M.P.A.	Public Administration	2005
University of Utah (Salt Lake City, UT)	Ph.D.	Sociology	2011

Appointments

Utah Valley University

Associate/Assistant Professor of Organizational Leadership and Ethics, Utah Valley University,
Woodbury School of Business, 2009-Present
Center for the Study of Ethics Faculty Fellow, Utah Valley University, 2017-Present
Associate Director, Center for the Study of Ethics, Utah Valley University, 2015-2017
Academic Director, Center for Social Impact, Utah Valley University, 2012-2015; 2017-Present
Melisa Nellesen Center for Autism Faculty Fellow, Utah Valley University, 2016-2017
Community Engagement Fellow in Residence, Utah Valley University, 2016

Other Universities and Centers

Senior Fellow, The Higher Education Academy (Heslington, UK), 2018-present
Academic Fellow, Chartered Institute of Personnel and Development (London, UK), 2018-present
Visiting Academic at Harris Manchester College, University of Oxford (Oxford, UK), 2019
Fulbright/AMINEF Senior Scholar, Atma Jaya Catholic University of Indonesia (Jakarta,
Indonesia), 2018
Visiting Fellow, Institute of Teaching and Learning Innovation (ITaLI), University of Queensland
(Brisbane Australia), 2017
POSCO Fellow, East-West Center (Center for Cultural and Technical Interchange Between East
and West, Honolulu, Hawaii), 2016-2017
Community-based Research Scholar in Residence, Marymount California University, 2015
(while on UVU sabbatical)
Visiting Scholar, Kennan Institute, Woodrow Wilson International Center for Scholars
(Washington D.C.), 2015, 2017
Visiting/Affiliate Research Professor/Dissertation Chair, Indiana Institute of Technology (Ph.D.
in Global Leadership program; Fort Wayne, Indiana), 2015-Present
Visiting Professor, L'ISEG Business & Finance School/International School of Management
(MBA program; Paris, France), 2013-2015
Visiting/Affiliate Professor, Polish Academy of Sciences, Institute of Economics and Institute of
Computer Sciences (DBA and MBA programs; Warsaw, Poland), 2012-Present
Fulbright Professor/Scholar, Belarusian State University, School of Business and Management of
Technology (MBA program; Minsk, Belarus), 2012
Visiting/Affiliate Professor, University of Science and Technology of China, School of
Management Science (MBA program, Hefei, China), 2011-Present

Products

Products most related to the proposed project

- Goodman, E., Westover, J.H., Workman, L., and Andrade, M. 2018. “A Model of Student Learning: A Cross-Disciplinary Examination of Student Reflections of Service-Learning Experiences.” *Experiential Learning and Teaching in Higher Education*, Vol. 2, Issue 1, p. 26-36.
- Stephenson, R., Rothlisberger, C., and Westover, Jonathan H. 2018. “Extracurricular Engagement and Person-Organization Fit through Internalizing Organizational Mission Statements and Values.” *Organizational Cultures: An International Journal*, Vol. 17, p. 3-19.

- Westover, Jonathan H. 2018. "Utilizing Community-Engaged Experiential Learning and Service-Learning Pedagogy to Foster Increased Engaged Educational Experiences at Utah Valley University: A Research Proposal." *Journal of the Utah Academy of Sciences, Arts, and Letters*, Vol. 94, p. 229-246.
- Andrade, Maureen, Westover, Jonathan H. 2019. "Job Satisfaction and Gender." *Journal of Business Diversity*, Vol. 19, Issue 3, 22-40.
- Andrade, Maureen, and Westover, Jonathan H. 2018. "Generational Differences in Work Quality Characteristics and Job Satisfaction." *Evidence-Based Human Resource Management*, Vol. 6, Issue 3, p. 287-304.

Other significant products

- Andrade, Maureen, Westover, Jonathan H., and Kupka, Bernd, 2019. "The Role of Work-Life Balance and Worker Scheduling Flexibility in Predicting Global Comparative Job Satisfaction." *International Journal of Human Resource Studies*, Vol. 9, Issue 2, p. 80-115.
- Andrade, Maureen, and Westover, Jonathan H. 2018. "Revisiting the Impact of Age on Job Satisfaction: A Global Comparative Examination." *Global Studies Journal*, Vol. 11, Issue 4, p. 1-24.
- Westover, Jonathan H. 2018. "Shifting Workplace Orientations and Conditions in Eurasian Nations, 1981–2016." *The Global Studies Journal*, Vol. 11, Issue 3, p. 27-49.
- Hughes, Kathryn, Westover, Jonathan H., and Cardon, Teresa. 2018. "Autism in the Workplace Today: A Literature Review and Examination of Five Autism Programs." *The International Journal of Interdisciplinary Organizational Studies*, Vol. 13, Issue 2, p. 1-13.
- Westover, Jonathan H. 2017. "The Evolving International Political Economy of the Northeast Asia Region: A Focus on Shifting Workplace Orientations and Conditions, 1981–2014." *International Journal of Interdisciplinary Global Studies*, Vol. 12:2, p. 1-26.

Synergistic Activities

Undergraduate Research: For the past 9 years I have been committed to undergraduate research, mentoring dozens of undergraduate and graduate students on more than a dozen research projects, ultimately culminating in academic conference presentations and journal publications. Topics have generally focused on organizational development, employee engagement, and pedagogy innovations.

Curriculum Development: For the past 10 years I have been director/co-director of the UVU Human Resource Management Program, including the development of new major/minor and integrated studies emphasis, the development of new courses, and updating existing courses with teaching and learning innovations to enhance student experiences and outcomes.

Faculty Development: I am currently the Academic Director of the Center for Social Impact and oversee the Academic Service Learning initiative at UVU, a position I have held for a total of seven years. I train faculty across the University in service-learning pedagogy and successful community project implementation. Usually 20 or more faculty members are involved in training each year.

Community Engagement: I direct all academic community engagement efforts across UVU campus, involving nearly 250 faculty, over 350 academic courses, and over 8,000 UVU students each year that enroll in service-learning designated courses and complete community engagement projects.

Assessment: In my role as Academic Director of the Center for Social Impact and my responsibilities for the Academic Service Learning initiative, I am very focused on outcomes-based assessment for all for-credit community engagement activities on campus, including a range of pre-post-test student attitudinal and professional skills assessment and community partner assessments of student projects.

Steven H. Emerman
Consultant – Hydrology

Professional Preparation

The Ohio State University, Columbus, Ohio	Mathematics	B.S.	1978
Princeton University, Princeton, New Jersey	Geophysics	M.A.	1980
Cornell University, Ithaca, New York	Geophysics	Ph.D.	1984
Minors: Seismology, Theoretical and Applied Mechanics			
Cornell University, Ithaca, New York	Polymer Engineering		1984-1986
Cornell University, Ithaca, New York	Soil Hydrology & Soil Physics		1993-1994
Cornell University, Ithaca, New York	Plant Physiological Ecology		1994-1995

Appointments

Owner, **Malach Consulting: Specializing in Groundwater and Mining**, 2018-present
Fulbright Professor (2018), Visiting Professor (2016), Department of Geology and Petroleum,
Escuela Politécnica Nacional, Quito, Ecuador, 2016, 2018
Associate Professor, Department of Earth Science, **Utah Valley University**, 2008-2018
Visiting Professor at **Iowa State University** (Ames, Iowa) and **Tribhuvan University** (Kathmandu, Nepal), 2007-2008
Associate Professor, Department of Biology and Environmental Science, **Simpson College**, Indianola, Iowa, 2004-2007 (Assistant Professor, 1998-2004)
Fulbright Professor, **Tribhuvan University**, Kathmandu, Nepal, 2003
Assistant Professor, Department of Chemistry, Geology and Physics, **Ashland University**, Ashland, Ohio, 1995-1998
Mechanical Engineer, **Transonic Systems**, Ithaca, New York, 1989-1992
Lecturer, Department of Physics, **University of Botswana**, Gaborone, Botswana, 1987-1989
Short-Term Appointments at **Nicaraguan Institute for Terrestrial Studies**, **University of Zimbabwe**, **Zimbabwe Geological Survey**, **Eduardo Mondlane University** (Mozambique), **Lomonosov Moscow State University** (USSR), 1986-1994

Products Closely Related to the Proposed Project (*indicates undergraduate co-authors)

1. **Emerman, S.H.**, 2019. Impact on regional water quality of the Rio Tinto QMM ilmenite mine, southeastern Madagascar: Report to Andrew Lees Trust, 43 p.
2. **Emerman, S.H.**, 2019. Risk analysis of the tailings dams at the Riotinto mine, Andalusia, Spain: Report to London Mining Network, 62 p.
3. **Emerman, S.H.**, *M.S. Abbott, *S.K. Tulley, *S.I. Nofchissey, *P.G. Bushman, *D. Joe, *J.E. Gherasim, *S.R. Campbell, *E.C. Matheson, *K.L. Larsen, *B.O. Howell, and *D.J. Zacharias, 2018. The history of water in Bears Ears National Monument, southeastern Utah: In Emerman, S.H., B. Bowen, S. Schamel, and S. Simmons (eds.), Geofluids of Utah: 2018 Utah Geological Association Publication 47, pp. 1-21.
4. *Colledge, P. and **S.H. Emerman**, 2017. The use of detrital zircon geochronology in the Wasatch Conglomerate (Eocene) to determine river directions before the rise of the Wasatch Range, Utah: In Lund, W., **S.H. Emerman**, W. Wang, and A. Zanazzi (eds.), Geology and Resources of the Wasatch: Back to Front: 2017 Utah Geological Association Publication 46, pp. 319-417.
5. *Allen, S.M., **S.H. Emerman**, *T.H. Murdock, and *S.K. Tulley, 2016. A conceptual framework for the use of machine learning for the synthesis of stream discharge – gage height rating curves: In Ramirez, J.A. (ed.), Proceedings of the 36th Annual American Geophysical Union Hydrology Days, Hydrology Days Publications, Fort Collins, CO, pp. 1-12

Other Significant Products

1. **Emerman, S.H.**, 2017. The use of lichenometry for assessment of the destruction and reconstruction of Buddhist sacred walls in Langtang Valley, Nepal Himalaya, following the 2015 Gorka earthquake: Arctic, Antarctic and Alpine Research, v. 49, pp. 61-79.
2. **Emerman, S.H.**, *S. Adhikari, *S. Panday, T.N. Bhattacharai, *T. Gautam, S.A. Fellows, *R.B. Anderson, *N. Adhikari, *K. Karki, and *M.A. Palmer, 2016. The integration of the direct and indirect methods in lichenometry for dating Buddhist sacred walls in Langtang Valley, Nepal Himalaya: Arctic, Antarctic and Alpine Research, v. 48, pp. 9-31.
3. **Emerman, S.H.**, *J.R. Nelson, *J.K. Carlson, *T.K. Anderson, *A. Sharma, and B.R. Adhikari, 2014. The effect of surface lithology on arsenic and other heavy metals in surface water and ground-water in Mustang Valley, Nepal Himalaya: Journal of Nepal Geological Society, v. 47, pp. 57-77.
4. *Ivie, H.A., **S.H. Emerman**, *D.B. Dastrup, *A.W. Simister, *J. Selck, *D.R. Howard, and *A.W. Fletcher, 2014. An improved method for calculating the Manning roughness coefficient for estimation of stream discharge through slot canyons in southern Utah: In MacLean, J.S., R.F. Biek, and J.E. Huntoon (eds.), Geology of Utah's Far South: Utah Geological Association Publication 43, pp. 1-10.
5. **Emerman, S.H.**, M. Bjørnerud, J.S. Schneiderman, and S.A. Levy (eds.), 2012. Liberation Science: Putting Science to Work for Social and Environmental Justice. Lulu Press, Raleigh, NC.

Synergistic Activities

1. Dr. Emerman was co-facilitator of the UVU College of Science & Health's Teaching Academy, 2012-13, Fall 2013, 2014-15. From 2008-2018, Dr. Emerman also gave 25 presentations and served on nine panels at professional meetings on various aspects of service-learning and team-based learning.
2. From 2008-2018, Dr. Emerman and his undergraduate research students published 27 papers including 75 student co-authors, and 15 papers on which a student was first author. In addition, 183 research students delivered 230 presentations at professional meetings. Dr. Emerman's students received 69 internal research grants.
3. Dr. Emerman received the Utah Campus Compact Presidential Award for Community Engaged Faculty in 2017 and received five awards from Utah Valley University for service-learning from 2015-2018 (Community Engaged Scholar of the Year, Community-Based Research Fellowship (three times), Community Engaged Fellow in Residence – Academic Service-Learning). Dr. Emerman also served as a member of the UVU Service-Learning Committee (2009-2018), as a liaison for a Service-Learning Designated Department (2010-2018), and as a Service-Learning Fellowship Mentor (2011-2018).
4. Chair of Faculty Advisory Board, ICON: Inquiry Connection (Utah Valley University Journal of Undergraduate Research), 2016-2018.
5. Prior NSF Support: *Program:* iUTAH (innovative Urban Transitions and Arid-region Hydro-sustainability) / EPSCoR. *Title:* A Geochemical and Sociological Study of Backyard Wells and Gardens in Utah Valley: Implications for the Future of Water Sustainability in Utah. *Award #:* 1208732. *Amount:* \$20,000. *Period:* July 31, 2014 – July 31, 2016. *PI:* Steven Emerman (in collaboration with Drs. Eddy Cadet and Alex Simon, UVU). *Summary of Results:* Intellectual Merit. In Utah Valley, it is common for urban residents to dig shallow wells in their backyards. Analysis of 179 backyard wells showed that EPA drinking water standards were not met for Mn, As, Cd, Fe, Cu, Pb, and nitrate in 18.7%, 15.9%, 6.5%, 6.5%, 0.9%, 0.9%, and 0.9% of wells. Broader Impacts. These data are a significant part of the documentation of elevated As and trace metals in the Utah Lake watershed. Ten undergraduate researchers participated; 13 conference presentations were given by these students.

Rasha Mohsen Qudisat
External Evaluator

Professional Preparation

Jordan University of Science & Technology, Jordan	Agricultural Engineering & Technology	Bsc. 2003
Jordan University of Science & Technology, Jordan	Civil Engineering	Msc. 2005
Brigham Young University, Provo, UT	Education, Inquiry, Measurement and Evaluation	PhD. 2015

Appointments

- Director of Engaged Undergraduate Research and Creative Work, Utah Valley University (UVU), Orem, Utah (Jul. 2017 – Dec. 2018)
- Program Director of Engaged Learning, Assessment and Planning, Office of Engaged Learning, UVU (Jan. 2016 – Jul. 2017)
- Senior Research Analyst, Office of Engaged Learning and Institutional Research, UVU (Apr. 2015 – Jan. 2016)
- Research Assistant, McKay School of Education, Brigham Young University (BYU) (Aug. 2012 – Aug. 2015)
- Gender Equity Policy Evaluator, for Aya for Consultancy and Development, funded by USAID Jordan. (U.S. based, contractual) (Apr. 2015 – Aug. 2015).
- Qualitative and Quantitative Evaluator, for Aya for Consultancy and Development, funded by ILO Jordan (U.S. based, contractual) (Apr. 2014 – Aug. 2014) - “Rapid Assessment on Child Labor Agricultural Sector in Jordan in Jordan Valley (Ghor) for Jordanians and Syrians.”
- European Union Consultant, Ministry of Municipalities Affairs (MOMA) (Nov. 2011-Apr. 2012).
- World Bank Consultant (Dec. 2010 – Feb. 2012) – Economic Social Rapid Assessment in Al-Aghwar area, Jordan.
- Advisor of the Jordanian Minister of Social Development (Sep. 2008 – Apr. 2012) – Performance management specialist/monitoring and evaluation.
- Head of Monitoring Division, Ministry of Planning and International Cooperation, Jordan (Mar. 2006 - Aug. 2008)
- Teacher Assistant, Jordan University for Science and Technology, Jordan (Jul. 2003 – Jun. 2005).
- Project Manager, Jordan (Aug. 2003 – Aug. 2004) – On-site project manager for water and sanitary project.

Products

- Randall S. Davies & Rasha M. Qudisat (2015) “Benefits of the Michiana Daily Mathtracks Programme for students living in poverty,” Educational Research and Evaluation.
- Qudisat, Rasha Mohsen, "Effect of Gender, Guilt, and Shame on BYU Business School Students' Innovation: Structural Equation Modeling Approach" (2015). All Theses and Dissertations. Paper 5790.
- “Monitoring and Evaluation within New Environment in Developing Countries”, in “Development Evaluation in Times of Turbulence: Dealing with Crises That Endanger Our Future.” The World Bank 2013, Washington, D.C.

Synergistic Activities

Evaluation of Engaged Learning in Higher Education. As Director of Engaged Undergraduate Research and Creative Work at UVU, I was responsible for assessing engaged learning initiatives, including planning, instrument validation, reporting, monitoring, and evaluation.

Co-Invented the In-class Engagement Measurement Tool. During my work at UVU as Director of Engaged Learning, I co-invented an instrument that measures the level and type of academic and community engagement of courses. The tool consists of a survey, administered to the students in all sections of a course, and a dashboard that aggregates engagement activities on the course level (not the section level). The instrument utilizes confirmatory factor analysis for the academic engagement factors, and structural equation models for the institution and each college. The instrument is now being prepared for use in all classes at across campus to assess the level of engagement of courses at the institution level, college level, and department level.

Title III Director. I managed a Title III project from the U.S. Department of Education entitled "Strengthening Engagement and Completion at Utah Valley University," which was awarded in 2014 for the amount of \$2,225,000. I was responsible to develop and supervise the implementation plan, evaluation plan, data collection and analysis.

External Evaluator for one of the NSF Scholarships in STEM programs in the College of Science at UVU. Evaluation for that project is similar to the evaluation proposed for this one, utilizing a mix of qualitative and quantitative measures.

Education Research Assistant. I was the lead researcher in assessing collaborative problem-based learning for Electrical and Computer Engineering students at Brigham Young University. For this project, I conducted qualitative analysis using ethnography and content analysis, and factor analysis and structural modeling to estimate the effect of engaged learning, group dynamics, students-faculty interaction, and students' motivation on students' performance in terms of course retention and success. The study was replicated over two years to triangulate and validate the predictive model of engaged learning on students' retention and success.

**SUMMARY
PROPOSAL BUDGET**

YEAR 1

		FOR NSF USE ONLY			
ORGANIZATION		PROPOSAL NO.		DURATION (months)	
Utah Valley University				Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR		AWARD NO.			
Eddy Cadet					
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)		NSF Funded Person-months			Funds Requested By proposer
		CAL	ACAD	SUMR	Funds granted by NSF (if different)
1. Eddy Cadet - PI		0.00	0.00	2.00	7,056
2. Maria Blevins - Co-Pi		0.00	0.00	2.00	5,021
3. Hilary Hungerford - Co-PI		0.00	0.00	2.00	5,008
4. Weihong Wang - Co-PI		0.00	0.00	2.00	5,009
5. Jon Westover - Co-PI		0.00	0.00	2.00	5,021
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)		0.00	0.00	0.00	0
7. (5) TOTAL SENIOR PERSONNEL (1 - 6)		0.00	0.00	10.00	27,115
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL SCHOLARS		0.00	0.00	0.00	0
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)		0.00	0.00	0.00	0
3. (1) GRADUATE STUDENTS					2,400
4. (13) UNDERGRADUATE STUDENTS					27,360
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)					0
6. (0) OTHER					0
TOTAL SALARIES AND WAGES (A + B)					56,875
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)					8,590
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)					65,465
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)					
TOTAL EQUIPMENT					0
E. TRAVEL 1. DOMESTIC (INCL. U.S. POSSESSIONS)					6,000
2. INTERNATIONAL					0
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS \$ 0					
2. TRAVEL 0					
3. SUBSISTENCE 0					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0)					0
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES					13,403
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION					1,000
3. CONSULTANT SERVICES					14,998
4. COMPUTER SERVICES					1,250
5. SUBAWARDS					0
6. OTHER					4,025
TOTAL OTHER DIRECT COSTS					34,676
H. TOTAL DIRECT COSTS (A THROUGH G)					106,141
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) Salaries, Wages, Fringe Benefits (Rate: 38.0000, Base: 65465)					
TOTAL INDIRECT COSTS (F&A)					24,877
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)					131,018
K. FEE					0
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)					131,018
M. COST SHARING PROPOSED LEVEL \$ 0		AGREED LEVEL IF DIFFERENT \$			
PI/PD NAME Eddy Cadet		FOR NSF USE ONLY			
ORG. REP. NAME*		INDIRECT COST RATE VERIFICATION			
		Date Checked	Date Of Rate Sheet	Initials - ORG	

1 *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

**SUMMARY
PROPOSAL BUDGET**

YEAR 2

		FOR NSF USE ONLY			
ORGANIZATION		PROPOSAL NO.		DURATION (months)	
Utah Valley University				Proposed	Granted
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR		AWARD NO.			
Eddy Cadet					
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)		NSF Funded Person-months			Funds Requested By proposer
		CAL	ACAD	SUMR	Funds granted by NSF (if different)
1. Eddy Cadet - PI		0.00	0.00	2.00	6,840
2. Maria Blevins - Co-Pi		0.00	0.00	2.00	5,152
3. Hilary Hungerford - Co-PI		0.00	0.00	2.00	4,997
4. Weihong Wang - Co-PI		0.00	0.00	2.00	5,507
5. Jon Westover - Co-PI		0.00	0.00	2.00	5,179
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)		0.00	0.00	0.00	0
7. (5) TOTAL SENIOR PERSONNEL (1 - 6)		0.00	0.00	10.00	27,675
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL SCHOLARS		0.00	0.00	0.00	0
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)		0.00	0.00	0.00	0
3. (1) GRADUATE STUDENTS					2,472
4. (13) UNDERGRADUATE STUDENTS					27,360
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)					0
6. (0) OTHER					0
TOTAL SALARIES AND WAGES (A + B)					57,507
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)					8,724
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)					66,231
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)					
TOTAL EQUIPMENT					0
E. TRAVEL 1. DOMESTIC (INCL. U.S. POSSESSIONS)					6,000
2. INTERNATIONAL					0
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS \$ 0					
2. TRAVEL 0					
3. SUBSISTENCE 0					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0)					0
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES					8,414
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION					1,000
3. CONSULTANT SERVICES					14,998
4. COMPUTER SERVICES					1,000
5. SUBAWARDS					0
6. OTHER					4,025
TOTAL OTHER DIRECT COSTS					29,437
H. TOTAL DIRECT COSTS (A THROUGH G)					101,668
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) Salaries, Wages, Fringe Benefits (Rate: 38.0000, Base: 66232)					
TOTAL INDIRECT COSTS (F&A)					25,168
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)					126,836
K. FEE					0
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)					126,836
M. COST SHARING PROPOSED LEVEL \$ 0		AGREED LEVEL IF DIFFERENT \$			
PI/PD NAME Eddy Cadet		FOR NSF USE ONLY			
ORG. REP. NAME*		INDIRECT COST RATE VERIFICATION			
		Date Checked	Date Of Rate Sheet	Initials - ORG	

**SUMMARY
PROPOSAL BUDGET**

YEAR 3

		FOR NSF USE ONLY			
		PROPOSAL NO.		DURATION (months)	
		Proposed		Granted	
ORGANIZATION Utah Valley University					
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR Eddy Cadet				AWARD NO.	
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)		NSF Funded Person-months			Funds Requested By proposer
		CAL	ACAD	SUMR	Funds granted by NSF (if different)
1. Eddy Cadet - PI		0.00	0.00	2.00	7,046
2. Maria Blevins - Co-Pi		0.00	0.00	2.00	5,306
3. Hilary Hungerford - Co-PI		0.00	0.00	2.00	5,147
4. Weihong Wang - Co-PI		0.00	0.00	2.00	5,673
5. Jon Westover - Co-PI		0.00	0.00	2.00	5,335
6. (0) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)		0.00	0.00	0.00	0
7. (5) TOTAL SENIOR PERSONNEL (1 - 6)		0.00	0.00	10.00	28,507
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL SCHOLARS		0.00	0.00	0.00	0
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)		0.00	0.00	0.00	0
3. (1) GRADUATE STUDENTS					2,546
4. (13) UNDERGRADUATE STUDENTS					27,360
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)					0
6. (0) OTHER					0
TOTAL SALARIES AND WAGES (A + B)					58,413
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)					8,920
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)					67,333
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)					
TOTAL EQUIPMENT					0
E. TRAVEL 1. DOMESTIC (INCL. U.S. POSSESSIONS)					6,000
2. INTERNATIONAL					0
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS \$ 0					
2. TRAVEL 0					
3. SUBSISTENCE 0					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0)					0
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES					7,814
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION					1,000
3. CONSULTANT SERVICES					14,998
4. COMPUTER SERVICES					1,000
5. SUBAWARDS					0
6. OTHER					1,250
TOTAL OTHER DIRECT COSTS					26,062
H. TOTAL DIRECT COSTS (A THROUGH G)					99,395
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) Salaries, Wages, Fringe Benefits (Rate: 38.0000, Base: 67332)					
TOTAL INDIRECT COSTS (F&A)					25,586
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)					124,981
K. FEE					0
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)					124,981
M. COST SHARING PROPOSED LEVEL \$ 0		AGREED LEVEL IF DIFFERENT \$			
PI/PD NAME Eddy Cadet		FOR NSF USE ONLY			
ORG. REP. NAME*		Date Checked		Date Of Rate Sheet	Initials - ORG

**SUMMARY
PROPOSAL BUDGET**

Cumulative

ORGANIZATION Utah Valley University		FOR NSF USE ONLY			
		PROPOSAL NO.		DURATION (months)	
PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR Eddy Cadet		AWARD NO.			
A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)		NSF Funded Person-months		Funds Requested By proposer	Funds granted by NSF (if different)
		CAL	ACAD		
1. Eddy Cadet - PI		0.00	0.00	6.00	20,942
2. Maria Blevins - Co-Pi		0.00	0.00	6.00	15,479
3. Hilary Hungerford - Co-PI		0.00	0.00	6.00	15,152
4. Weihong Wang - Co-PI		0.00	0.00	6.00	16,189
5. Jon Westover - Co-PI		0.00	0.00	6.00	15,535
6. () OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)		0.00	0.00	0.00	0
7. (5) TOTAL SENIOR PERSONNEL (1 - 6)		0.00	0.00	30.00	83,297
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (0) POST DOCTORAL SCHOLARS		0.00	0.00	0.00	0
2. (0) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)		0.00	0.00	0.00	0
3. (3) GRADUATE STUDENTS					7,418
4. (39) UNDERGRADUATE STUDENTS					82,080
5. (0) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)					0
6. (0) OTHER					0
TOTAL SALARIES AND WAGES (A + B)					172,795
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)					26,234
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)					199,029
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$5,000.)					
TOTAL EQUIPMENT					0
E. TRAVEL 1. DOMESTIC (INCL. U.S. POSSESSIONS)					18,000
2. INTERNATIONAL					0
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS \$ 0					
2. TRAVEL 0					
3. SUBSISTENCE 0					
4. OTHER 0					
TOTAL NUMBER OF PARTICIPANTS (0)					0
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES					29,631
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION					3,000
3. CONSULTANT SERVICES					44,994
4. COMPUTER SERVICES					3,250
5. SUBAWARDS					0
6. OTHER					9,300
TOTAL OTHER DIRECT COSTS					90,175
H. TOTAL DIRECT COSTS (A THROUGH G)					307,204
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)					75,631
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)					382,835
K. FEE					0
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)					382,835
M. COST SHARING PROPOSED LEVEL \$ 0		AGREED LEVEL IF DIFFERENT \$			
PI/PD NAME Eddy Cadet		FOR NSF USE ONLY			
		INDIRECT COST RATE VERIFICATION			
ORG. REP. NAME*		Date Checked	Date Of Rate Sheet	Initials - ORG	

C *ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET

Budget Justification

This project will be conducted over three years. The budget primarily funds a high-quality summer research experience for 12 undergraduate students annually. The costs for the research work that will be conducted during the academic year is not included in the budget (see *Facilities*); however, costs for the External Evaluator extend through the whole year. The total amount of the request is \$382,835.

Personnel

Table A-C: Personnel	Year 1 4/1/19 – 3/31/20	Year 2 4/1/20 – 3/31/21	Year 3 4/1/21 – 3/31/22	Total
A. Senior Personnel (2 summer, part-time)				
Faculty – Eddy Cadet	7,056	6,840	7,046	20,942
Hilary Hungerford	5,008	4,997	5,147	15,151
Weihong Wang	5,009	5,507	5,673	16,189
Jonathan Westover	5,021	5,179	5,335	15,534
Maria Blevins	5,021	5,152	5,306	15,480
Total Senior Personnel	27,115	27,675	28,506	83,296
B. Other Personnel				
Undergraduate Student Researchers	24,960	24,960	24,960	74,880
Undergraduate Near-Peer Mentors	2,400	2,400	2,400	7,200
Graduate Near-Peer Mentor	2,400	2,472	2,546	7,418
Total Other Personnel	29,760	29,832	29,906	89,498
C. Fringe Benefits				
– faculty fringe benefits – 22.9%	6,209	6,338	6,528	19,075
– student fringe benefits – 8%	2,381	2,381	2,381	7,142
Total Fringe Benefits	8,590	8,718	8,920	26,235
Total Salaries, Wages & Fringe Benefits	65,465	66,232	67,332	199,029

A. Senior Personnel

This program is a collaboration between faculty of three Utah Valley University departments in three colleges, namely Earth Science (College of Science), Communication (College of Humanities and Social Sciences) and Business Management (Woodbury School of Business). This number of departments and faculty are necessary to address the complexities of the concerns involving Utah Lake. Five UVU faculty will be involved and one retired faculty member is included as a consultant (see Other Direct Costs). Faculty will be remunerated during the summer months only. The base salary, percent of effort, and total salary for year one is shown below. The second and third years each include a 3% increase of salary.

Senior Personnel – Year 1	Role on Project	# Summer Months	% of Effort	Base Salary	Salary Requested
Person					
Faculty – Eddy Cadet	PI	2	42.50%	\$74,712	\$7,056
Hilary Hungerford	Co-PI	2	30.70%	\$73,403	\$5,008
Weihong Wang	Co-PI	2	30.40%	\$74,150	\$5,009
Jonathan Westover	Co-PI	2	19.40%	\$116,456	\$5,021
Maria Blevins	Co-PI	2	36.00%	\$62,767	\$5,021
Total					\$27,115

B. Other Personnel

Undergraduate Students Researchers. Twelve (12) paid student researchers will be enrolled annually in the summer research program for a total of 36 students over 3 years. Each student will be paid at a rate of \$13/hour x 20 hours for 8 weeks to equal \$2,080 per summer for the summer research they will be conducting with their faculty mentor.

Undergraduate Students – Near-Peer Mentors. Two near-peer mentors will be hired. Both students will be paid at a rate of \$15/hour x 20 hours for 8 weeks to equal \$2,400 each per summer.

The near-peer laboratory assistant will be an advanced undergraduate student in the geosciences with experience using the laboratory instrumentation required for this project. This person will assist in training research participants in the use of the equipment, supervise the lab, answer questions, and ascertain whether or not the student's projects are moving toward completion in a timely manner.

The near-peer student coordinator will be a graduate student enrolled in a graduate program in one of the local universities in Utah. This person will assist in coordinating research activities and assist student researchers in preparing for graduate school or job application, including how to apply for graduate programs, writing a successful résumé, and other issues related to transitioning.

C. Fringe Benefits

UVU's fringe benefit amounts are based on a percent of direct-labor dollars. For full-time employees the rate is 22.9% and 8% for student employees. Costs for the health insurance premium are also included for full-time employees by months worked and family-type policy chosen.

D. Equipment

No equipment is requested for this project.

E. Travel

E-1 Domestic Travel. All travel funds requested are for domestic travel.

Senior Personnel. We request \$5,000 per year for faculty travel to attend conferences for the purposes of disseminating information about the research and/or the project, and of escorting student researchers who will also present (student travel will be paid by internal funds). A summary of the travel expenses for PI and co-PI's is shown in the table below. Travel funds are included for the PI to attend the NSF IUSE: Geopaths PI Conference in Washington, D.C. in the first year, and approximately two senior personnel per year will be funded for major trips. Costs per major trip are estimated at about \$2,000 each for a total of \$4,000 per year. Airfare is estimated high because locations of conferences are not yet known. Additional funds each year (\$400 in year 1 and \$1,000 in years 2 and 3) will be allocated for participation in in-state and close regional conferences or use to supplement internal funds for any appropriate conference.

We request that NSF fund the full cost of travel requested. While it is difficult to predict the full cost of trips, not knowing yet the locations of conferences or where papers will be accepted, any funds not spent for the allocated trips would be used for dissemination activities at other conferences, supplemented by funds from the College of Science's Scholarly Activities Committee, the UVU Office of Undergraduate Research, dean's offices, and departmental funds. The project team would work to ensure that funding is spent to maximize impact and would leverage institutional resources for project dissemination as much as possible.

Undergraduate Student Researchers. A total of \$3,000 (\$1,000 per year) has been allocated for local travel, for example, sampling trips to Utah Lake, surveying businesses and citizens in Utah County as well as travels associated with recreational activities near and around the Lake. Travel each year will be reimbursed at the current NSF approved rate per mile. Please note that travel for student participation and presentation at conferences, which is of high importance to this project, will be funded from internal UVU sources, cited above and in the *Facilities and Other Resources* document.

E-1. Domestic Travel	Explanation	Year 1	Year 2	Year 3
Senior Personnel				
PI – Cadet	IUSE: Geopaths PI Conference Airfare – \$350 Ground Transport – \$100 Per-Diem – \$75 x2 days = \$150	\$600		
PI – Cadet Co-PI – Blevins Co-PI – Hungerford Co-PI – Wang Co-PI – Westover Consult. – Emerman	Approx. one trip each at \$2,000: Conference Registration – \$325 Lodging – \$250 x3 days = \$750 Airfare – \$600 Ground Transport – \$100 Per-Diem – \$75 x3 days = \$225	2 faculty at 2 major conferences at about \$2,000 ea = \$4,000	2 faculty at 2 major conferences at about \$2,000 ea = \$4,000	2 faculty at 2 major conferences at about \$2,000 ea = \$4,000
<u>Likely Conferences and Potential Locations</u> Geological Society of America, Indianapolis, IN (Cadet, Wang) American Association of Geographers, New Orleans, LA (Wang, Hungerford) Western States Communication Association, Seattle, WA (Blevins) Western Academy of Management, Rohnert Park, California (Westover) National Conference on Undergraduate Research (any senior personnel)				
All Senior Personnel	In-state and close regional conferences – travel, registration, and food	\$400	\$1,000	\$1,000
<u>Likely Local Conferences and Locations</u> Utah Conference on Undergraduate Research, Salt Lake City, Utah Utah State Spring Runoff Conference, Logan, Utah Geological Society of America Rocky Mountain Section Meeting, Moscow, Idaho				
Undergraduate Student Researchers				
All students	Local travel to conduct research (sampling at Utah Lake & surveys) team building activities	\$1,000	\$1,000	\$1,000
Total		\$6,000	\$6,000	\$6,000

F. Participant Support Costs

No participant support costs are requested for this project. As per university policy, the participants will be paid as undergraduate student researchers.

G. Other Direct Costs

Table G. Other Direct Costs	Year 1	Year 2	Year 3	Total
G-1 Materials & Supplies <i>Itemized in Table G-1 below</i>	\$13,403	\$8,414	\$7,814	29,931
G-2 Publication	\$1,000	\$1,000	\$1,000	\$3,000
G-3 Consultant Services Consultant, Hydrology – Steve Emerman External Evaluator – Rasha Qudisat	\$5,000 \$9,998	\$5,000 \$9,998	\$5,000 \$9,998	\$15,000 \$29,994
G-4 Computer Services Web site creation and maintenance	\$1,250	\$1,000	\$1,000	\$3,250

G-6 Other Video of research – recruitment tool for lower division students Analysis cost for $\delta^{18}\text{O}$ in Phosphate at UC Davis -- \$18.50 x 300	\$1,250 \$2,775	\$1,250 \$2,775	\$1,250 \$0	\$3,750 \$5,550
Total	\$34,976	\$29,437	\$26,062	\$90,475

G-1 Materials and Supplies. Funds will be used to purchase all materials and supplies needed in this project (Table 2). The cost of materials and supplies is higher in year 1 than in years 2 and 3. The majority of the “Materials and Supplies” budget will be used to purchase needed articles for the processing and analysis of samples in the Microwave Accelerated Reaction System and the inductively coupled plasma-optical emission spectroscopy, respectively. Some samples (isotopes of oxygen and phosphate) will not be analyzed at UVU environmental laboratory, but will be shipped to the University of California–Davis (UC–Davis) for analysis. An amount of \$4,580 will be used to purchase supplies (voice recorders, camera, participant gifts, and survey copies) to facilitate conducting of surveys to assess the attitude of the residents and businesses business communities near and around Utah Lake. The total cost for materials and supplies is \$35,481 for all three years.

Table G-1. Materials and Supplies for Scientific Research	Year 1	Year 2	Year 3	Total
Con. Nitric Acid	\$500	\$500	\$500	\$1,500
CHEMetrics Kits for nutrients concentration	\$289	\$289	\$289	\$867
Research grade O	\$347	\$347	\$347	\$1,041
Research grade H	\$220	\$220	\$220	\$660
Research grade Air	\$112	\$112	\$112	\$336
Tin capsules for $\delta^{18}\text{O}$ in Phosphate	\$160	\$160	\$160	\$480
Standards for ICP	\$800	\$800	\$800	\$2,400
Nebulizers (ICP)	\$800	\$400	\$400	\$1,600
Grinder for sediment & fish tissue processing	\$300			\$300
Membrane filters	\$500	\$400	\$400	\$1,300
Grinder replacement blade		\$221		\$221
ICP Torch	\$850	\$350	\$350	\$1,550
Standard tubes (50mL)	\$600	\$600	\$221	\$14,21
Sampling tubes (15mL)	\$200	\$200	\$200	\$600
Sample containers (250 mL)	\$290	\$290	\$290	\$870
Filter cups	\$925	\$925	\$925	\$2,775
Argon Gas for ICP	\$800	\$800	\$800	\$2,400
Participant gifts (for survey participants)	\$1,100	\$1,100	\$1,100	\$3,300
Voice recorders (for surveys) (x6)	\$300			\$300
Copies of the surveys	\$160	\$160	\$160	\$480
Digital Camera	\$500			\$500
Lab coats (12)	\$750			\$750
Lab Notebooks (36)	\$360			\$360
Gloves	\$540	\$540	\$540	\$1,620
Tablets computers w/ software (x4)	\$2,000			\$2,000
Total	\$13,403	\$8,414	\$7,814	29,631

G-2 Publication. It is the intention of the faculty involved to present the findings of the research conducted under this project to collaborating agencies and organizations, in forums such as the Utah

Lake Summit and the Symposium on Utah Lake, and at conferences as described in the Project Description. Publication costs are primarily for poster presentations and reports. And, at least, one peer-reviewed article will be published after completion of the research project, which will likely require a publication fee. Annually, \$1,000 is budgeted for publication costs.

G-3 Consultant Services.

Consultant in Hydrology, Dr. Steven Emerman from Utah Valley Earth Forum. Dr. Emerman, former Professor of Earth Science at UVU, will mentor students in the hydrology component of the summer project. He will coordinate with Utah Valley Earth Forum to provide links to professionals and job opportunities in geoscience fields. He will be paid \$5,000 for his work each summer.

External Evaluator, Dr. Rasha Qudisat. The external evaluator will be retained to assist in evaluating the effectiveness of the program as to how successful it is in reaching its goal and facilitate dissemination. The evaluator will be working with the team all three years throughout the life of the project. She will be paid \$9,998 for evaluation services annually.

G-4 Computer Services. Construction and maintenance of website for the Utah Lake Research Project, which will be a means to disseminate information among members of the interdisciplinary team, students (including students in introductory courses), high schools, and the general public. The cost is \$1,250 in Year 1 and \$1,000 in Years 2 & 3 for a total of \$3,250.

G-6 Other.

A video of the Utah Lake Research Project for will be produced that introduces the Utah Lake Research Project and talks about the progress results obtained each year. Talks by area professionals about career opportunities in the geosciences will be taped as well. A copy of these videos will be posted on the website, used for in-class participants on Canvas (UVU's LMS), and for departmental and recruiting purposes.

Analysis cost for $\delta^{18}\text{O}$ in phosphate at UC Davis. The cost is \$18.50 per sample x 300 samples: 100 samples will be collected from agricultural areas around Utah Lake, 100 samples from residential areas around the lake, and 100 samples from 6 waste water treatment plants. All samples will be collected in year 1, refrigerated, and prepared for analysis in years 1 and 2. Samples will be analyzed by the UC-Davis Stable Isotope Facility. Dr. Wang has worked with this facility previously and finds it to be reliable and to communicate well with researchers.

H. Total Direct Costs

Table H: Total Direct Costs	Year 1	Year 2	Year 3	Total
Total of A-G	\$106,141	\$101,669	\$99,394	\$307,204

I. Indirect Costs

Table I: Total Indirect Costs	Year 1	Year 2	Year 3	Total
UVU's negotiated indirect cost rate is 38% of salaries, wages, and fringe benefits.	\$24,877	\$25,168	\$25,586	\$75,631

J. Total Direct and Indirect Costs

Table H: Total Direct & Indirect Costs	Year 1	Year 2	Year 3	Total
	\$131,018	\$126,837	\$124,980	\$382,835

L. Amount of this Request

Utah Valley University requests \$382,835 for this project.

Facilities, Equipment and Other Resources

Utah Valley University (UVU) in Orem, Utah is accredited by the Northwest Commission on Colleges and Universities. The proposed project includes the College of Science (Department of Earth Science), Woodbury School of Business (Department of Organizational Leadership), and College of Humanities and Social Studies (Department of Communication). The university and colleges have adequate classroom, laboratory, office, and conferencing space to support this program. The university also has outstanding institutional support for undergraduate research and faculty professional development that will support the proposed project.

1. FACILITIES & EQUIPMENT

Laboratory Facilities

- Two environmental/geochemical laboratories equipped with chemical fume hoods and storage cabinets.
- Teaching GIS laboratory that contains 24 dual-monitor workstations equipped with a suite of software including ArcGIS, Global Mapper, Trimble Business Center, Trimble Pathfinder, Agisoft Photoscan, Adobe Creative Cloud, Aquifer Test, Visual ModFlow, and Microsoft Office. This laboratory is available for independent student use approximately 20 hours per week.
- Earthquake and surficial processes laboratory equipped with three high powered workstations (64 GB RAM, dual-GPU, six and eight – core processors; designed for SfM processing) outfitted with a suite of software similar to the GIS lab.
- 2600 ft² greenhouse with three climate-controlled sections (temperate, tropical, and arid); operated by UVU Botany program.
- Dedicated student research room equipped with four workstations outfitted with a suite of software similar to a GIS lab.

Equipment

Geochemical Analytical Instrumentation and Related Equipment

- Perkin-Elmer Optima 8000 inductively coupled plasma – optical emission spectrometer (ICP-OES) with auto sampler
- CEM MARS 6 Microwave accelerated reaction system (digester)
- Los Gatos Research liquid water isotope analyzer
- Two Hach portable spectrophotometers
- Bruker portable X-ray fluorescence instrument
- Thermo Scientific Sorval St 16 centrifuge
- Rock saw and thin section preparation equipment
- Buehler Isomet low speed saw and other stable isotope preparation equipment
- Ro-Tap sieve shaker with sieves
- Soil Moisture Equipment Filter Extraction System (three)
- Two drying ovens
- Laboratory furnace
- Refrigerated storage
- Mastersizer 3000 (Laser particle size analyzer)

Field Support Equipment

- Five GPS-enabled iPad Minis for digital field data collection
- Four Garmin 64s handheld GPS units for digital field collection
- Bucket augers, hand auger, tile probe, and other soil / shallow sediment sample collection tools
- Handheld field radios
- Two field cameras (one DSLR, one ultra-compact)
- 18 Brunton compasses

Other Equipment

- Geometrics GEOFDE 24 geophone seismometer
- Isis Junior Electrical Resistivity system
- Bartington Instruments Magnetic Susceptibility Meter
- SM-20 Hand-held Magnetic Susceptibility Meter
- Geometrics Proton Precession Magnetometer
- Guelph Permeameter
- Two water level indicators
- Ten Olympus CX-31 petrographic microscopes

2. OTHER RESOURCES

Partnering State Agencies and Organizations

All of the agencies and organizations listed below will be included in the UP Utah Lake Geoscience Learning Ecosystem. They have agreed, in various ways to help: 1) assess training needs for employment; 2) facilitate quality service learning through the UP–Utah Lake project; 3) provide appropriate learning opportunities for UP students; and 4) create viable pathways to employment.

Utah Lake Commission. Utah Lake encompasses in an overlapping web of interests, stakeholders, rights, and regulations. Nine municipalities lay claim to water in the lake, both as upstream and downstream users. Utah Lake is managed by the Utah Lake Commission, who acts primarily as facilitator and organizer of the disparate stakeholders across multiple geographic scales. The executive Director, Eric Ellis, has met with the proposal planning committee several times to talk about a shared agenda and the Commission's support for the project. The Commission will continue to collaborate with members of the project team and facilitate connections with members of the Commission. Students will present their research findings to members of the Commission. In the third year of the project, students will present at the Utah Lake Annual Symposium, hosted by the Commission every October to share results among researchers and provide scientific information to state agencies and local communities.

The Utah Lake Commission is comprised of the following local and state agencies:

State Legislature	Lindon City
Utah County	Mapleton City
Central Utah Water Conservancy District	Orem City
Utah Department of Environmental Quality	Payson City
Utah Department of Natural Resources	Provo City
Utah Division of Forestry, Fire, and State Lands	Salem City
Alpine City	Saratoga Springs City
American Fork City	Spanish Fork City
Elk Ridge City	Springville City
Highland City	Vineyard Town
Lehi City	Woodland Hills

Division of Water Quality (DWQ) in the Utah Department of Environmental Quality. DWQ will collaborate with the project in some, if not all, of following ways: sampling support in the form of equipment, instrumentation, and DWQ staff (when available); assistance with E.coli and cyanobacteria analysis in water samples taken by the UVU research group; sharing of DWQ datasets; UVU student access to DWQ sampling events for sample collection training (when available); and student volunteer opportunities. They will also give a presentation about water quality issues at Utah Lake, facilitate a job shadowing activity, give a tour of the DWQ facility with a presentation about jobs at DWQ.

Division of Wildlife Resources (DWR) in the Utah Department of Natural Resources. DWR will work with student research teams. They will provide resources to assist in determining whether AquaNeat herbicide application (sprayed for the purpose of invasive *Phragmites* eradication) has any detrimental impact on the development and proliferation of the June sucker in Utah Lake. DWR will provide the project with use of some equipment, including the fish scale; provide boat escort for fish sampling; facilitate a job shadowing activity; and give a tour of the DWR facility and a presentation about jobs at DWR.

USDA Natural Resources Conservation Service (NRCS) will provide agency connections, information, and expertise for the students and faculty in the UP-Utah Lake project to include the following. 1) Agricultural information for research projects: contacts with landowners (farmers, producers, ranchers) in the area; information about nutrient use and delivery; water needs and uses; sediment delivery; geomorphological implications and effects. 2) Potential participation in large scale community protection projects: emergency watershed protection programs; Utah Lake watershed operations projects; dam rehabilitation projects. 3) Access to specific agency personnel at the local field office (near Utah Lake) and to specialists from the State Office. NRCS is particularly interested in providing assistance with career development and guidance for students.

Utah County Health Department (UCHD) has been a consistent source of internships and jobs for UVU Earth Science Students. Many UVU alumni are now employed by UCHD, some at the supervisory level. Its Environmental Health Department supports a Bureau of Water Quality and a Bureau of Air Quality and Hazardous Wastes. For the proposed project, UCHD employees will speak with students about career opportunities; provide job shadowing and internship opportunities (in environmental sampling); and potentially provide a career pathway for interested students.

Utah STEM Action Center, prioritizes STEM through best practices in education to ensure connection with industry and the development of Utah's workforce of the future. The program drives research and implementation of STEM education best practices across Utah by coordinating STEM-related activities, creating and supporting STEM education, facilitating educator access to education tools, and aligning public STEM education with higher-education STEM activities. For this project, the Utah STEM Action Center will facilitate networking with business and industry and provide a resource for Earth Science Education majors to disseminate lesson plans they create about Utah Lake.

Malach Consulting. Malach Consulting specializes in evaluating the environmental impacts of mining for mining companies, as well as governmental agencies and non-governmental organizations. Owner Steven Emerman, will serve on the project team in the field of hydrology as a faculty mentor. Though he will be compensated for his summer work on the UP-Utah Lake project, he will volunteer his time during the fall and spring semester. He will visit classes to talk about careers and about consulting in environmental degradation, and will review student resumes.

UVU Grants for Undergraduate Research and Service Learning

The University supports several mechanisms for funding undergraduate research and service learning. In the proposed project, these funds may be used to provide additional faculty-mentored research opportunities during the academic year and to fund student and faculty research to present at conferences. They may also be used to help sustain the program after the 3-year project concludes.

The College of Science (COS) Scholarly Activities Committee (SAC). The COS-SAC program awards about \$160,000 to students and faculty projects distributed to the 6 departments in the college annually. The SAC committee has one representative from each college department and is overseen by an associate dean. Last year, Earth Science received 23 awards totaling \$60,541 involving 7 faculty and 28 students. In the proposed IUSE GEOPATHS program, SAC awards will be used to support conference participation for the summer researchers and faculty-mentored student research during the academic year, as well as to supplement conference participation for the faculty to accompany students and to disseminate research and project findings.

The Office of Undergraduate Research (UR) provides a resource for undergraduate students to engage in meaningful scholarly and creative activities with faculty mentors. UR supports several grants for students that could benefit students in the PRO-STEM program: 1) URSCA" grants (Undergraduate Research, Scholarly and Creative Activities); 2) TEEL grants (Turner Endowment for Engaged Learning), and 3) GEL grants (Grants for Engaged Learning). Last year, these programs awarded about \$.5M to student scholarly activities and to faculty projects involving students university wide. Many recipients were Earth Science students and faculty. This office is overseen by the Associate Vice President for Engaged Learning. In the proposed program, these awards will be used to support conference participation for the summer researchers and faculty-mentored student research during the academic year. UR gives funding priority to students in projects funded by NSF.

The Center for Social Impact (CSI). CSI supports curricular, co-curricular, and extra-curricular

student experiences in diverse pathways of social impact including, community-engaged learning and research. In partnership with Academic Service Learning, CSI offers project mini-grants of up to \$500 per course section to assist in implementing community-engaged learning projects in SL-designated courses. CSI supports faculty development of service-learning courses and research projects through training and resources. CSI also sponsors the Social Impact Metrics Lab (SIMLab) in which three project Co-PIs participate. CSI will help implement and sustain the service-learning aspect of this project.

UVU Faculty Professional Development

UVU Faculty Mentoring Academy, supported by the Office of Academic Affairs and the Scholarly & Creative Undergraduate Learning Partnership Team, helps faculty formulate a detailed plan for improving and enhancing their mentoring of undergraduate students in their scholarship. This includes 6 1-hour training sessions, as well as the development of a personal mentoring philosophy and mentoring plan, which should align with and be seen as an extension of the faculty members' ideas and goals they have as a mentor. Three members of the faculty team have completed mentorship training in this academy and the other three will complete training before or during the first year of the proposed project.

Service-Learning Faculty Fellowship, sponsored by the Office of Academic Affairs and the Center for Social Impact, trains and supports faculty in designing or modifying courses that integrate service-learning into the course curriculum. (Service-Learning encompasses the community-based research described in this proposal.) The Fellowship is facilitated by the Center for Social Impact Director (Co-PI on the proposed project). As part of the fellowship, faculty will receive readings and resources, assistance forming community partnerships, and a stipend of \$500. Four members of the faculty team have completed this program and the other two will complete before or during the first year of the proposed project.

Other NSF DUE Programs in the UVU College of Science

The other NSF DUE programs in UVU's College of Science share the same aim of supporting an increase in diversity, size, and quality of the next generation of STEM professionals who enter the workforce with four-year degrees or who continue their studies in graduate and professional schools. These programs are coordinating efforts to recruit students – including women, minorities, and others underrepresented in STEM professions -- into the sciences. They will also collaborate in the following ways:

Scholarships in STEM, physical science program. Award #1742504; \$999,826; 12/1/2017 to 1/30/2022; PI – Phil Matheson. This project team will collaborate with the proposed IUSE Geopaths project to host two STEM career seminars annually.

Scholarship in STEM, biological science program. Award #1833880; \$972,287; 3/1/2019 to 2/29/2024; PI – Geoff Zahn. The PI will collaborate to teach faculty in the IUSE Geopaths project about strategies for effectively communicating their research work to others, which should assist in their mentoring and recruitment of undergraduate students to faculty-mentored research.

Robert Noyce Teacher Scholarship Program, Award #1557305; \$1,050,000; 5/1/2016 to 4/30/2021; PI – Richard Tolman. This project team will collaborate by using their network of science educators in the local schools and districts to find career speakers and mentors for Earth Science Education students. Some students from this scholarship program may participate in the proposed research at Utah Lake and share lesson plans for hands-on projects related to the Utah Lake Research with pre-service science educators.

Diversity Outreach Organizations at UVU

Multicultural Center. UVU has a vibrant Multicultural Center that facilitates student success by fostering and sustaining an inclusive campus community, where the dignity, worth, identities, and cultures of every individual are validated and respected. The Multicultural Center coordinates UVU's Latino Initiative, Native American Initiative, and Pacific Islander Initiative. It also has ties to a number of affiliated clubs and organizations, including the African Club, Black Student Union, Filipino Club, Native Wolverine Association, Oceana Pasifika Club, and Unidamos Saldremos Adelante. The Utah Lake Research Project will partner with the Multicultural Student Council, a group of 10 to 15 student leaders, to strategize ways to work with all clubs to promote the summer research program and will work together to host one STEM career awareness seminar annually for students from minority cultures.

Women's Success Center. The Women's Success Center provides support, leadership, coaching, and advocacy for women students. They are currently partnering with the two S-STEM programs in the College of Science to recruit women into STEM programs through social media and career seminars. Members of the project team for proposed IUSE Geopaths would join these efforts.

Personnel Resources

Principal Investigator – Eddy Cadet, Associate Professor of Environmental Science & Management at UVU. Dr. Cadet received his Ph.D. in Integrative Biosciences at Tuskegee University. He teaches both upper and lower division courses including Introduction to Environmental Science and Management, Environmental Health, Hazardous Materials Regulations, Environmental Toxicology, Resource Conservation and Recovery, Environmental Compliance, and Land Use Planning. Cadet will devote 0.15 of his nine-month position to the project, in addition to the summer salary funded by NSF. The summer salary will support 0.85 month of work in administering the project. He will also be paid by the College of Science for teaching the ENVT495R course (one month). This teaching responsibility may shift to Dr. Wang or Dr. Hungerford after year one.

Co-PI – Weihong Wang, Assistant Professor in Wetland Studies at UVU. Dr. Wang received her M.Sc. in Environmental Geology from Jianghan Petroleum University in China and her Ph.D. from University of South Carolina in Marine Science. She teaches both upper and lower division courses, involving her students in field trips, hands-on-learning, and research projects. Dr. Wang will devote 0.05 of her nine-month position to the project, in addition to the summer salary funded by NSF.

Co-PI – Maria Blevins, Assistant Professor, Department of Communication. Dr. Blevins holds a Ph.D. in Communication from the University of Utah. She has taught at UVU since 2013, developing curriculum and teaching for the communication department including theory, research methods and environmental communication, among other courses. She will devote 0.05 of her nine-month position to the project, in addition to the summer salary funded by NSF.

Co-PI – Jonathan Westover, Associate Professor of Organizational Leadership and Ethics. Dr. Westover holds a Ph.D. in Sociology from University of Utah and a Masters of Public Administration. He has been a member of the UVU Woodbury School of Business faculty since 2009. Dr. Westover will devote 0.05 of his nine-month position to the project, in addition to the summer salary funded by NSF.

Co-PI – Hilary Hungerford, Ph.D., Assistant Professor, Department of Earth Science. Dr. Hungerford received her Ph.D. in Geography from the University of Kansas. She joined the Earth Science Department at UVU in 2015 after serving for three years as an Assistant Professor of Geography at South Dakota State University. She will devote 0.05 of her nine-month position to the project, in addition to the summer salary funded by NSF.

DATA MANAGEMENT PLAN

1. The types of data, samples, physical collections, software, curriculum materials, and other materials to be produced in the course of the project.

There are two broad categories of data collections: student impact and research projects.

The following student impact data will be collected during the project:

Development and formative evaluation period

- Number of students in summer research program each year
- Number of students registered for target recruitment courses each year
- Student retention rates
- Students' persistence rates (program and project levels)
- Demographics of all students (ethnicity, gender, age, socio-economic status, etc.)
- Students research fellows' career and goals aspirations
- Pre-post-tests measurement of Interpersonal Communication (STEM ICSAB).
- Mentorship Competency assessment (faculty and students' perspective).
- Pre- and post-assessment of knowledge and awareness of geoscience careers and opportunities.
- Post measurement of student's self-assessment of community engagement experience.
- Level and type of academic engagement of the upper and lower participating classes (i.e. In-class engagement).
- Level of students' engagement in classes, with focus on underrepresented groups.
- Number of professionals and partners involved in the project.
- Students' participation in presentations and conferences

Summative evaluation period

- Students' retention rates
- Structured interviews and focus groups
- In-class engagement of the geoscience classes.
 - Students' course grades
 - Students' GPA
- Post assessment of students' interest, knowledge and awareness of geoscience careers and opportunities.

The data will be collected each semester.

The following research product data will be collected during the project:

Data collected by research areas fall into two broad categories: physical and social sciences.

- Physical science data collected will include trace metals, phosphorus loading, invasive plant and fish species, and biogeochemistry. Physical sample collections will be stored in the locked laboratories in the Earth Science department at UVU.
- Social science data collected include survey data, transcribed interviews, newspaper and historical document analysis, and business evaluations.

2. The standards to be used for data and metadata format and content (where existing standards are absent or deemed inadequate, this should be documented along with any proposed solutions or remedies).

Safeguarding the interests of students, partners, professionals, and faculty, will be adhered to at all times. Any personal information obtained during the course of the implementation, interviews, focus groups will be kept confidential. Consent forms will be signed by students and faculty, and confidentiality will be guaranteed, by coding and storing the data in electronic forms. Data will be coded, prepared, and stored (e.g. survey data—SPSS/SAS; spreadsheet – .xlsx; document formats, .docx, .pdf, and relational database – .MDF and .LDF) and analyzed to be later aggregated for program operations, presentations or annual reports. Data storage will follow the standard protocol, in

a password protected- UVU server, which will be accessed by the PI and the External Evaluator. Any products of research of this grant will be material for conference presentations and/or publications.

3. Policies for access and sharing including provisions for appropriate protection of privacy, confidentiality, security, intellectual property, or other rights or requirements.

Student retention and persistence data will be shared internally with UVU's Institutional Research and the Office of Engaged Learning. Student data will be made anonymous before internal sharing to protect the confidentiality of students. All student data stored are indexed by pseudonym and stored on a secure file server, secured by SSL encryption and only made available to members of the specific research team, as specified by Utah Valley University guidelines and the University's handbook of operating procedures. In compliance with University Handbook of Operating Procedures (HOP), all participants in the study will provide written consent prior to any data collection. To protect their privacy, pseudonyms are used, storage of the data is secured, and access to the data is restricted. The availability of the data sets will be communicated to research peers and at conferences, and referenced in publications.

All data from the physical science-focused research projects will be published on Hydroshare, an online collaborative website designed to share hydrologic data (<https://www.hydroshare.org/>). As part of the research design, each team must submit a data sharing plan to Hilary Hungerford, who will oversee data management. A UVU-GEOPATHS group will be created within Hydroshare to share initial results among team members, and final results will be shared with the public through publication and indexing of datasets on Hydroshare. When possible, social science or qualitative data will be shared through Hydroshare, but first this data will be anonymized, then reviewed for suitability for publication. If Hydroshare is not appropriate for social science data, the Inter-University Consortium for Political and Social Research (ICPSR) will be used to share data. Both Hydroshare and ICPSR are secure and protect intellectual property rights through their designation of permanent DOI's for data sets.

4. Policies and provisions for re-use, re-distribution, and the production of derivatives.

The HOP does not generally allow identifiable data to be made public. To protect privacy, pseudonyms will be used, storage of the data will be secured, and access to the data will be restricted. To ensure that participants and their resulting data are treated ethically, all staff will complete the CT0927 FERPA compliance training. Data generated under this project will be disseminated in accordance with University and NSF policies. Data related to program evaluation, which is not publishable, will not be shared with the public and will be used internally for lessons learned and development of best practices at UVU.

5. Plans for archiving data, samples, and other research products, and for preservation of/ access to them.

Hydroshare and ICPSR enable publication and archiving of data sets to enable preservation and access of data. Hydroshare will be used for publication of all physical science data sets, and when possible social science data sets will also be published and archived here.

In addition, all data generated by the UVU GEOPATHS programs will reside on encrypted computers and servers that are redundantly backed up. Data will be retained for a minimum of five years after conclusion of the award or five years after public release (publication), whichever is later. Data that support intellectual property, such as copyrights, patents, or trademarks, will be retained for the entire term of the issued rights.

SUPPLEMENTAL DOCUMENT 1: PARTICIPANT RECRUITMENT, SELECTION, AND MENTORING**A. Recruitment in Geoscience and Non-Geoscience Courses (including underrepresented)**

As demonstrated in previous discussions (see *Objective 4*, p. 2; *Target Population*, pp. 3-4; and *Rationale for Project Design*, pp. 8-9), recruitment is woven into the fabric of the project design both the UP-Utah Lake summer program and for Earth Science programs in general.

Recruitment to the Summer Research Program. The academic year courses that tie service-learning and research to the UP-Utah Lake project will be the major recruiting ground for the summer program (see page 9). Faculty will help students see the larger context of the Utah Lake research and its relationship to their course material. A video will depict the ongoing project. Students will generate questions, and participants from the UP-Utah Lake project will visit classes to talk about their work and act as role models to other students. Women in the classes will see women students and faculty engaged in the research. They will gain confidence in classroom service-learning and research activities and receive encouragement to participate in the faculty-mentored research program.

The UVU academic advisors are being asked by campus administration to encourage students to enter plans to participate in High Impact Practices (i.e., service-learning and faculty-mentored research) into their academic plans on Wolverine Track, UVU's degree audit system. The Earth Science academic advisor and advisors in Business and Communication will be given information about the UP-Utah Lake program, including a project website that provides students with an idea of what their summer research experience will be and what they will do. The site will include photos and videos field and lab work, photos and contact information of faculty, applications and program materials. The website will describe the benefits of participating in the summer program and insights by previous participants. Links to the website will be provided on the Center for Social Impact and Undergraduate Research Office websites' listings of student opportunities. Also, at the annual Dean's Day forum for the College of Science, a block of time will be reserved for UP-Utah Lake presentations to other students and faculty. UP-Utah Lake students will also present at UVU's Student Showcase to inform the campus community about the work and to recruit other students. Each year, UP-Utah Lake will host an event on campus for high school students (including concurrent enrollment) and college students as a means of interesting them in the geosciences.

Leveraging other NSF undergraduate programs at UVU. The UP-Utah Lake program will collaborate with the project management teams of other NSF programs in the College of Science to recruit students from underrepresented backgrounds into STEM programs and NSF-funded opportunities. UVU's College of Science has two NSF Scholarships in STEM programs – one for students in the physical sciences and one for those in the biological sciences, as well as a Robert Noyce Teacher Scholarship program, with some joint efforts for recruiting broad participation. Joint efforts include outreach through the Women's Success Center, the Multicultural Center, and the I Am First program for First-generation students. Students in the NSF-sponsored programs would also be eligible to participate in the summer UP-Utah Lake or in the academic year courses. The S-STEM MORE-BIO program will share their training for faculty about a strategy for effectively communicating research work to others called "3-minute thesis" (Cooke et al. 2017), which will be useful in some outreach activities.

Increasing Career Awareness. The lack of awareness of careers related to Geoscience majors may be one of the biggest inhibitors for recruitment and retention in the geosciences. It was one of the chief concerns expressed by students in the departmental survey and has been cited as a contributor nationally as well (Mosher 2014). Thus, the project team will help spearhead efforts to make students aware of career opportunities and their societal relevance. Students will also be shown how the skills they learn in their earth science majors can be applicable to many careers (NSF Geoscience Education 1997). The project team will join with the Department in hosting career speaker events from among the partnering agencies and professionals. The Earth Science Academic Advisor will be invited to attend. Guest speakers will be recorded and included in a video tape accessible on Canvas (UVU's LMS) for classroom or recruitment use. Career speakers' messages will also be included in the department newsletter.

B. Selection of Summer Research Participants.

Applications for participation in the summer research program will be due by Feb 15th each year and recipients announced by March 1st. All members of the Project Team will participate on the Selection Committee. Table 3 describes required application materials and evaluation criteria.

Table 3: Research Student Selection Criteria		
Criterion	Relevant Application Materials	Max Pts.
Academic performance	Course transcripts (grades and number of math & science courses taken), GPA	20
Cover Letter	Essay on educational and professional aspirations, interest in doing research, and commitment to the project	20
Recommendation letter	A letter of recommendation from a faculty member at UVU	20
Interview	Interview with committee will help to see the student holistically and leave room for potentially great students.	20
Underrepresented group	Application, interview (women, minorities, first-generation students, and students with disabilities that can be accommodated for this project).	10

C. Mentoring Plan

Mentoring for Summer Research Program. The goal of the mentoring program will be to provide the student with the knowledge, skills and experience to persist in their geoscience program and to successfully transition from undergraduate education to career paths or further academic work. The plan's level of success will be evaluated by the student's ability to advance in their education and career path. During the application process, the student will perform a self-assessment to identify career and professional goals that will guide the direction of the remainder of the mentoring plan. Three levels of mentoring will be included in the program:

1) Faculty Mentors. Students will work with a faculty mentor (member of the project team) from their discipline and interact with other faculty in the project. Mentoring activities include:

1. Orient participants to the project with clear expectations: of hours, productivity, reporting; of the UP-Utah Lake project; of the service-learning and research; and of mentoring expectations.
2. Train participants in the responsible conduct of research, including both human subjects and laboratory safety. As students work with geoscience professionals to determine problems and refine research questions, faculty mentors will help develop sound methodology for the research question.
3. Provide opportunities for scientific exchange, working with team members, frequent contact with mentors, joint weekly meeting of the research teams, and interactions with geoscience professionals.
4. Train participants in communication skills and provide opportunities to collaborate with others from diverse backgrounds and disciplinary areas.
5. Mentor participants in analyzing data and communicating research results to peers, professionals, and lay audiences in various settings, as well as in written reports.
6. High potential for the participants to obtain travel support from internal sources to attend regional and national scientific conferences or meetings.

For each skill set, students will become more independent as their competence increases. The above practices are described by Kuh (2013) and by Osborn & Karukstis (2009) as those that help make student-faculty research highly effective. (See Key Personnel for faculty mentor training & accountability.)

2) Near-Peer Mentors. The project will hire two near-peer mentors to assist students. An experienced undergraduate will be hired as a laboratory assistant to train students on instrumentation and safety (trained and supervised by Dr. Wang). In addition, a graduate student from a near-by university will be hired to assist with project coordination and mentor student researchers in preparation for graduate school (trained and supervised by Dr. Hungerford). Training of near-peer mentors will take place in the week prior to the summer program and will include participation in all or part of the faculty-training workshop (see page 11).

3) Association with Geoscience Professionals. Participants will have opportunities to associate with geosciences professionals through the UL-GLE. Each team of two students will be associated with at least one professional. These professionals will guide service-learning activities, particularly as it concerns their agency's or organization's involvement with the problem. While these associations may not rise to the level of formal mentoring, they will provide students with opportunities to observe professionals in geoscience careers in work settings and to network with professionals, which could lead to internship and career possibilities.

SUPPLEMENTAL DOCUMENT 2: PROJECT EVALUATION AND REPORTING**A. Evaluation Plan**

External Evaluator (EE). Project evaluation will be conducted by Rasha Qudisat, who has served as the Director of Engaged Undergraduate Research and Creative Work at UVU. Dr. Qudisat has extensive experience evaluating education programs and student engagement activities (see *Supplemental Documents* for her Biographical Sketch). She has assisted in designing the evaluation plan below and will also assist the Project Management Team (PMT) in refining the evaluation plan during the first months of the project. The evaluation plan consists of three phases of evaluation – developmental (Patton 2010), formative, and summative. The timeline of the evaluation is presented in Table 4. Table 5 outlines the framework for evaluating student and project outcomes within this 3-phase work flow.

Developmental Evaluation (DE) is best used for complex, dynamic situations, like education, aiming at making a change (Patton 2010). In the context of IUSE-Geopaths, DE coincides with the initial planning period and extends into the implementation period. This phase focuses on asking questions and learning as the evaluation progresses. The main strategic question to be asked is: "What needs to happen?" The EE will have a significant role in this phase in helping the PMT ask questions and implement the activities with a focus on differentiating activities. The measurement system, key performance indicators (KPIs), and the tracking system will be designed in the planning phase, to address the objectives of the project. During the planning phase, team members, in collaboration with the evaluator, will work together to develop student surveys and create or refine assessments.

Formative Evaluation begins when student participation begins and is designed to answer the question: "How well is it working?" Formative measures are described Table 5 and include: an evaluation of methods of recruitment to the summer program, pre- and post- tests to assess students' awareness of the geosciences & careers, knowledge and communication skills; structured interviews and focus groups to understand strengths and weaknesses of the program; and students' reflections to ascertain the learning experience of individual students and lessons to be learned for the program. The EE will report findings to the PMT who will meet periodically adjust the program recruitment and implementation.

Summative Evaluation, designed to answer the question: "What difference did it make?", will be planned to evaluate UP-Utah Lake near the end of the project. Summative measures for medium-term outcomes are described in Table 5 and include: persistence rates, interest in geoscience, and preparation for graduate school and careers. Anticipated long-term outcomes for the project (not included in Table 5) are graduate school acceptance in geoscience programs or job placement in geoscience-related careers of students who participated in the summer program. These will be tracked at the conclusion of each project year and for a period of one year following the 3-year period of the grant as a follow-up activity.

B. Assessment Questions tied to Project Objectives

Objective 1: Provide undergraduate students with sustained service-learning experience in the geosciences and connected fields of study . . . through a multidisciplinary summer program.

Question: To what extent did the service-learning component of the project benefit students' understanding of real-world geoscience problems and potential solutions?

Qualitative Evaluation: Community engagement self-assessment (exit survey). Content analysis and/or ethnographic analysis. The survey is open-ended questions that address reciprocity, reflection, reality, responsibility, and rewards of synergy. Focus groups will be conducted to support the qualitative survey and assess the students' perspectives and reflections.

Method of Analysis: thematic analysis using Nvivo software.

Quantitative Evaluation: The project will use the available data at OEL to assess the level of engagement in the geoscience classes, whether they are SL or research classes. The UVU Office of Engaged Learning administers an In-class Engagement Measurement Survey (developed and tested at UVU over the last five years under ED Title III funding) every semester to assess the level and type of engagement of UVU classes. Engagement data will assist in: 1) assess the level of engagement in participating SL and research courses, 2) create time series of engaged learning of the geoscience classes to improve, as needed, the engaged learning experience.

Method of Analysis: Confirmatory Factor analysis and Structural Equation Modeling using Mplus.

Objective 2: Create a learning environment to meet the needs of diverse participants in UP–UL project...

Question: To what extent was communication among student and faculty team members, and with community professionals effective in creating an productive learning environment?

Quantitative Evaluation: Pre- and post-measurement of the participants' communication skills, using the Science, Technology, Engineering, and Math Interpersonal Communication Skills Assessment Battery (STEM ICSAB) tool. Mentorship will be evaluated every semester using the Mentoring Competency Assessment (MCA) tool to assess the consistency, or gap, between the mentors and mentees, also, time series for the mentors to explain the change over time in their mentorship skills.

Method of Analysis: Descriptive statistics and group comparisons using SPSS.

Objective 3: Develop a *geoscience learning ecosystem* (GLE) among stakeholders in the Utah Lake environment to create enhanced learning opportunities for students . . .

Question: To what extent did the collaboration with the GLE create enhanced learning opportunities?

Quantitative Evaluation: Focused on descriptive KPIs; the number of professional partners in this project, the number of presentations by the participants to the stakeholders and partners, number of professionals and guest speakers. **Method of Analysis:** descriptive measurement and time series.

Qualitative Evaluation: Assessing students' reflections on their research and SL experience (*community engagement self-assessment*), and structured interviews with partners and professionals.

Method of Analysis: a thematic analysis using Nvivo.

Objective 4: Integrate UP–Utah Lake-related service-learning into several lower- and upper-division classrooms for the purpose of recruiting and retaining diverse students . . .

Question: To what extent did participation in an undergraduate class with an UP-Utah Lake service-learning component influence a student's decision to participate in the summer project?

Quantitative Evaluation: Descriptive KPIs 1) Number of students enrolled in upper and lower divisions, 2) number of students applied for the summer program, 3) % of students applied for the program *through* the recruiting activity. Application (entry survey – developed in planning phase) data will include how they heard about the program, why they are applying for the program, and their future plans, their awareness, and knowledge of geoscience careers and opportunities.

Method of Analysis: Descriptive statistics, group/time comparison, using SPSS.

Objective 5: Strengthen the *geoscience pipeline* by deepening students' interest in and knowledge of geoscience careers and by broadening awareness . . .

Question: To what extent did the curricular & co-curricular service-learning projects and activities with community professionals increase student awareness of the geosciences and geoscience careers?

Quantitative Evaluation: Pre (Application) and post (community engagement self-assessment) surveys will assess the change in students' awareness and knowledge of the geoscience careers and opportunities. **Method of Analysis:** descriptive and group/time comparison using SPSS.

C. Evaluation Timeline and Outcomes Assessment Framework

Table 4: Evaluation Timeline

	Activity	Persons	Assessment
Spring, Year 1 – Project Planning			
Planning	PMT Meeting – Project review & set-up	PMT*	Notes & plan of action
	Refine Evaluation Plan	PMT & EE**	Written plan
	Develop the Evaluation Surveys & IRB approval	PMT & EE	Written surveys & IRB
	Develop Communication Plan	Blevins	Written plan
Spring, Years 1, 2 & 3 – UP-Utah Lake Summer Course Participation Recruitment/Selection			
Implementation	Announce/recruit for the program; Applications submission & interviews; Select & announce participants; Participation orientation & instructions	PMT	Written report on the effectiveness of recruitment/selection
	Summer, Years 1, 2 & 3 – UP-Utah Lake Summer Program		
	UP-Utah Lake summer program implemented	PMT	MCA for mentorship
	Pre-, post-surveys – week 1 & week 8	PMT	STEM IS CAB
	Interviews & focus groups – week 4 & 8	EE	SL assessment survey

	Student reflections – week 8	PMT & EE	Evaluator report
	PMT Meeting – review report, lessons learned	PMT & EE	Formative assessment
Fall & Spring, Years 1, 2, 3 – Additional Courses			
	ENVT495R course	PMT & EE	In-class Engagement Measurement Tool SL assessment survey
	6+ Courses in GEOG, ENVT, COMM & HR	PMT & EE	
	- Use Up-Utah Lake data in some courses	PMT & EE	
	- Service-learning project in some courses	PMT & EE	
	Annual report to NSF	PI	
Fall, Year 3 – Summative Evaluation & Close-out			
	Final project evaluation including student persistence / graduation / placement data	PMT & EE	Evaluator's report
	Dissemination of project results	PMT	Conferences & pubs.
	Final Report to NSF	PI	PI's report

*PMT = Project Management Team; **EE = External Evaluator

Table 5: Student and Program Outcomes Framework

Developmental Evaluation: What needs to be done? (Planning Period)		Formative Evaluation: How well is it working? (Implementation Period)	Summative Evaluation: What Difference Did It Make? (Evaluation Period)
	Planning & Implementation	Short-term Outcomes	Medium-term Outcomes
Theory of Change	<ul style="list-style-type: none"> Program set up, recruit students, research applications and awards, summer program, and academic year classes. Develop a methodology to evaluate the quality of the project outcomes. 	<ul style="list-style-type: none"> Students deepen knowledge and awareness of geoscience careers and opportunities. Students experience a high level of engagement in SL & research. Students experience development in geoscience and related fields. 	<ul style="list-style-type: none"> A positive effect of UP-UL on student preparation for careers in geosciences. Positive effect of UP-UL participation in the geosciences. Faculty improvement in mentorship skills.
Student Outcomes Summer Program	KPI's of action plan and recruitment plan, such as: <ul style="list-style-type: none"> Pre-questionnaire (plans - career aspiration, graduate school; demographics). # students recruited from upper and lower courses as a result of Up-Utah Lake related activities. 	<ul style="list-style-type: none"> <u>Students' persistence rates:</u> (program level, project level). <u>Pre- and Post-surveys of STEM ICSAB, MCA</u> (mentors and mentees). <u>Structured interviews of the participants and partners.</u> 	<ul style="list-style-type: none"> <u>Descriptive KPIs of Students' enrollment & persistence</u> with a focus on women and minorities. <u>Community engagement self-assessment, focus groups;</u> <u>MCA Mentorship time series</u> (over project)
St. Outcomes AY Courses	Descriptive KPI's of action plan and recruitment plan, students' enrollment and course success and engagend learning.	<ul style="list-style-type: none"> <u>In-class Engagement Measurement Tool:</u> the level of academic & community engagement of the participating. <u>Application survey & community engagement self-assessment.</u> 	<ul style="list-style-type: none"> <u>Structural Equation Modeling (SEM):</u> Effect of academic engagement on students' course success,
Project Outcomes	<ul style="list-style-type: none"> Instruments review development for formative and summative evaluation. Guidelines and criteria to assess project products. Rubrics for applications and interviews. 	<ul style="list-style-type: none"> <u>Pre-post measurement</u> of students' skills, knowledge and awareness, learning experiences and motivation related to STEM. 	<ul style="list-style-type: none"> <u>Persistence rates</u>, focus on underrepresented; effect of UP-UL project. <u>Increased interested</u> in the geoscience field & preparation for graduate school & careers.

Supplemental Document 3: Sustainability Plan

The summer research program will require the creation of a section of ENVT 495R dedicated to the UP-Utah Lake project to be delivered each summer of the program (see page 6). From two to four additional sections of ENVT 495R dedicated for the Utah Lake research that will be offered during the academic year to continue the momentum of the summer project. However, once funding ends in 2023, an important part of the sustainability plan is to continue the offering of ENVT 495R to students who will be engaged in research in the Earth Science Department and other disciplines at UVU. This NSF funded project will have facilitated an improved course curriculum including service-learning component that will be used in future years (Lui 2014). Environmental concerns of Utah Lake are, in themselves a sustainable topic for geoscience research. The research projects that will be maintained through the UP-Utah Lake project are closely tied to the UVU Earth Sciences program. Some closely related courses include: Wetland Studies (GEOG 3700), Environmental Toxicology (ENVT 3010); Introduction to Environmental Science and Management (ENVT 1110). The ENVT 495R course will continue to focus on service learning through community-based research and will seek to collaborate in multidisciplinary work. We hope that this multidisciplinary, service-learning approach in geoscience education will be replicated by others in the Department of Earth Science.

Funding for student research projects is available from various sources internal to UVU. UVU provides strong institutional support for undergraduate research through the Office of Engaged Learning and other programs. As a part of the sustainability plan, faculty involved in student-mentored research will tap into these resources, not only to acquire needed materials and supplies, but for student salaries as well. Grant opportunities that are available for research through competitive application include: Community Matching Projects (up to \$5000); Seed Carrot Grant (up to \$15,000 per year, for 2 years); Grants for Engaged Learning (\$10,000 for one year); the Green Grant (up to \$30,000 - up to one year); and the Scholarly and Creative Activities grant (SAC) from the College of Science.

The UP-Utah Lake project will also be sustained via opportunities provided by the Center for Social Impact which houses the Service-Learning program at UVU. Service Learning is a way of connecting the classroom to community partners, where students identify, research and provide plausible solutions to a challenge encountered by the community partner. Several classes in the Earth Science Department have been designated as Service-Learning courses (ENVT 1110; ENVT 2560; Hydrology (ENVT4790). Service-Learning designated courses require students to invest at least 20 hours outside of class to interact with community partners as they address the issues at hand. The benefit of this program is to keep the course work relevant to students while completing their education. Additionally, annually, The Center for Social Impact provide up to \$5000 matching grant opportunities for research that connects to a community partner. Dr. Jon Westover, a Co-PI of this proposal, is the Director of the Center for Social Impact and will support research activities that will emerge as a result of the UP-Utah Lake Project.

A very important component of the sustainability plan is to maintain the geoscience learning ecosystem (GLE) or partnerships developed during the implementation of the UP-Utah Lake Project. The GLE include organizations: Department of Water Quality (DWQ), Utah Lake Commission (ULC), Utah Division of Wildlife Resources (DWR), Utah County Health Department (UCHD), USDA Natural Resources Conservation Service (NRCS), and the Utah Action STEM Center. Each partner has professionals in STEM fields who will connect students to potential career paths, according to their individual needs. Some of the partners have committed to provide job shadowing, and internship opportunities for students in Earth Science. Maintaining a relationship with the various professionals of the GLE will help address an important challenge faced by students in the program. According to a survey conducted for the purpose of this proposal, students voiced the concern that they are uncertain about careers they could pursue when they graduate. Addressing this concern will make students more confident about their degree, attract students to Earth Science and, therefore, strengthen the program. The USDA NRCS representative, Cianna E. Wyshnytzky, was excited about the focus on career development and guidance. She said this was the kind of help she didn't get, but very much needed. The proposers view this focus as a sustainable improvement.

To ensure that the UP-Utah Lake summer project is sustained, the College of Science has fully equipped the environmental laboratory where students will be working, and samples collected from Utah Lake will be stored, prepared and analyzed. The lab, which is the meeting place for the ENVT 495R research class, is equipped with an Inductively Coupled Plasma, Optical Emission Spectroscopy (ICP-OES) which will be used to perform metal analysis, a Microwave Digestor Accelerated System (MARS) for acid digestion of soil, plant and fish tissues, and a recently purchased laser Particle Size Analyzer to conduct soil analysis. The College of Science is committed to maintain the equipment by purchasing service contracts costing over \$10,000 each year to ensure the functionality of the equipment during and after the NSF funding of the UP-Utah Lake project ends in 2024 (see *Facilities* document).

Please see the first Letter of Collaboration from Dr. Daniel Horns, Dean of the College of Science in support of the sustainability plan.

Current and Pending Support

(See PAPPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.	
Investigator: Eddy Cadet	Other agencies (including NSF) to which this proposal has been/will be submitted.
<p>Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support</p> <p>Project/Proposal Title: GP-UP: Undergraduate Preparation through Multidisciplinary Service Learning at Utah Lake (UP?Utah Lake)</p> <p>Source of Support: NSF IUSE GEOPATHS</p> <p>Total Award Amount: \$ 382,835 Total Award Period Covered: 01/01/21 - 12/31/23</p> <p>Location of Project: Utah Valley University</p> <p>Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 1.35 Sumr: 1.80</p>	
<p>Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support</p> <p>Project/Proposal Title: Determination and quantification of non-point sources of nitrogen and phosphorus loading into Utah Lake: Implication for management of a hypereutrophic lake.</p> <p>Source of Support: Utah Valley University</p> <p>Total Award Amount: \$ 14,698 Total Award Period Covered: 08/01/19 - 06/30/20</p> <p>Location of Project: Utah Valley University</p> <p>Person-Months Per Year Committed to the Project. Cal:0.00 Acad: 2.00 Sumr: 0.00</p>	
<p>Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support</p> <p>Project/Proposal Title:</p> <p>Source of Support:</p> <p>Total Award Amount: \$ Total Award Period Covered:</p> <p>Location of Project:</p> <p>Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:</p>	
<p>Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support</p> <p>Project/Proposal Title:</p> <p>Source of Support:</p> <p>Total Award Amount: \$ Total Award Period Covered:</p> <p>Location of Project:</p> <p>Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:</p>	
<p>Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support</p> <p>Project/Proposal Title:</p> <p>Source of Support:</p> <p>Total Award Amount: \$ Total Award Period Covered:</p> <p>Location of Project:</p> <p>Person-Months Per Year Committed to the Project. Cal: Acad: Summ:</p>	

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See PAPPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.	
Investigator: Maria Blevins	Other agencies (including NSF) to which this proposal has been/will be submitted.
<p>Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support</p> <p>Project/Proposal Title: GP-UP: Undergraduate Preparation through Multidisciplinary Service Learning at Utah Lake (UP?Utah Lake)</p> <p>Source of Support: NSF IUSE GEOPATHS</p> <p>Total Award Amount: \$ 382,835 Total Award Period Covered: 01/01/21 - 01/01/23</p> <p>Location of Project: Utah Valley University</p> <p>Person-Months Per Year Committed to the Project. Cal:0.00 Acad:0.45 Sumr: 0.70</p>	
<p>Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support</p> <p>Project/Proposal Title:</p> <p>Source of Support:</p> <p>Total Award Amount: \$ Total Award Period Covered:</p> <p>Location of Project:</p> <p>Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:</p>	
<p>Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support</p> <p>Project/Proposal Title:</p> <p>Source of Support:</p> <p>Total Award Amount: \$ Total Award Period Covered:</p> <p>Location of Project:</p> <p>Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:</p>	
<p>Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support</p> <p>Project/Proposal Title:</p> <p>Source of Support:</p> <p>Total Award Amount: \$ Total Award Period Covered:</p> <p>Location of Project:</p> <p>Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:</p>	
<p>Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support</p> <p>Project/Proposal Title:</p> <p>Source of Support:</p> <p>Total Award Amount: \$ Total Award Period Covered:</p> <p>Location of Project:</p> <p>Person-Months Per Year Committed to the Project. Cal: Acad: Summ:</p>	

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See PAPPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.	
Investigator: Hilary Hungerford	Other agencies (including NSF) to which this proposal has been/will be submitted.
<p>Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support</p> <p>Project/Proposal Title: GP-UP: Undergraduate Preparation through Multidisciplinary Service Learning at Utah Lake (UP?Utah Lake)</p> <p>Source of Support: NSF IUSE GEOPATHS</p> <p>Total Award Amount: \$ 382,835 Total Award Period Covered: 01/01/21 - 12/31/23</p> <p>Location of Project: Utah Valley University</p> <p>Person-Months Per Year Committed to the Project. Cal:0.00 Acad:0.90 Sumr: 0.60</p>	
<p>Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support</p> <p>Project/Proposal Title:</p> <p>Source of Support:</p> <p>Total Award Amount: \$ Total Award Period Covered:</p> <p>Location of Project:</p> <p>Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:</p>	
<p>Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support</p> <p>Project/Proposal Title:</p> <p>Source of Support:</p> <p>Total Award Amount: \$ Total Award Period Covered:</p> <p>Location of Project:</p> <p>Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:</p>	
<p>Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support</p> <p>Project/Proposal Title:</p> <p>Source of Support:</p> <p>Total Award Amount: \$ Total Award Period Covered:</p> <p>Location of Project:</p> <p>Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:</p>	
<p>Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support</p> <p>Project/Proposal Title:</p> <p>Source of Support:</p> <p>Total Award Amount: \$ Total Award Period Covered:</p> <p>Location of Project:</p> <p>Person-Months Per Year Committed to the Project. Cal: Acad: Summ:</p>	

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See PAPPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.	
Investigator: Weihong Wang	Other agencies (including NSF) to which this proposal has been/will be submitted.
<p>Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support</p> <p>Project/Proposal Title: GP-UP: Undergraduate Preparation through Multidisciplinary Service Learning at Utah Lake (UP?Utah Lake)</p> <p>Source of Support: NSF IUSE GEOPATHS</p> <p>Total Award Amount: \$ 382,835 Total Award Period Covered: 01/01/21 - 12/31/23</p> <p>Location of Project: Utah Valley University</p> <p>Person-Months Per Year Committed to the Project. Cal:0.00 Acad:0.45 Sumr: 0.60</p>	
<p>Support: <input checked="" type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support</p> <p>Project/Proposal Title: Watershed analysis in an arid area: Changes in Utah Lake shoreline (1953-2019) and land use within the Lake?s watershed (1985-2019)</p> <p>Source of Support: Utah Valley University</p> <p>Total Award Amount: \$ 3,405 Total Award Period Covered: 07/01/19 - 06/30/20</p> <p>Location of Project: Utah Valley University</p> <p>Person-Months Per Year Committed to the Project. Cal:0.00 Acad:2.00 Sumr: 0.00</p>	
<p>Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support</p> <p>Project/Proposal Title:</p> <p>Source of Support:</p> <p>Total Award Amount: \$ Total Award Period Covered:</p> <p>Location of Project:</p> <p>Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:</p>	
<p>Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support</p> <p>Project/Proposal Title:</p> <p>Source of Support:</p> <p>Total Award Amount: \$ Total Award Period Covered:</p> <p>Location of Project:</p> <p>Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:</p>	
<p>Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support</p> <p>Project/Proposal Title:</p> <p>Source of Support:</p> <p>Total Award Amount: \$ Total Award Period Covered:</p> <p>Location of Project:</p> <p>Person-Months Per Year Committed to the Project. Cal: Acad: Summ:</p>	

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See PAPPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.	
Investigator: Jon Westover	Other agencies (including NSF) to which this proposal has been/will be submitted.
Support: <input type="checkbox"/> Current <input checked="" type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title: GP-UP: Undergraduate Preparation through Multidisciplinary Service Learning at Utah Lake (UP?Utah Lake)	
Source of Support: NSF IUSE GEOPATHS Total Award Amount: \$ 382,835 Total Award Period Covered: 01/01/21 - 12/31/23 Location of Project: Utah Valley University Person-Months Per Year Committed to the Project. Cal:0.00 Acad:0.45 Sumr: 0.60	
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title:	
Source of Support: Total Award Amount: \$ Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:	
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title:	
Source of Support: Total Award Amount: \$ Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:	
Support: <input type="checkbox"/> Current <input type="checkbox"/> Pending <input type="checkbox"/> Submission Planned in Near Future <input type="checkbox"/> *Transfer of Support Project/Proposal Title:	
Source of Support: Total Award Amount: \$ Total Award Period Covered: Location of Project: Person-Months Per Year Committed to the Project. Cal: Acad: Summ:	

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.



Tuesday, February 11, 2020

Letter to support Sustainability

Dr. M. Brandon Jones
GEO/OAD, telephone: (703) 292-4713
Directorate for Geosciences
Directorate for Education and Human Resources
National Science Foundation

Dear Dr. Jones,

If the proposal submitted by Dr. Eddy Cadet entitled *GP-UP: Undergraduate Preparation through Multidisciplinary Service Learning at Utah Lake (UP-Utah Lake)* is selected for funding by NSF, it is the intent of College of Science at Utah Valley University to collaborate and commit resources as detailed in the *Facilities, Equipment and Other Resources* section of the proposal.

Additionally, recognizing the benefits the proposed program will afford the Earth Science program, the College of Science, will support sustainable elements of the project after the project funding concludes. These sustainable elements include: 1) a section of the ENVT 495R course dedicated to the UP-Utah Lake project; 2) potential funding for UP-Utah Lake students for research and/or conference travel through competitively funded grants from the Scholarly Activities Committee; 3) maintenance equipment in the Environmental Laboratory, including service contracts as necessary to insure equipment functionality; 4) support for faculty to participate in the project as part of their research and scholarly activities; and 5) administrative support, oversight, and visibility within the College of Science. This project will strengthen the College's ongoing efforts to provide high-quality learning opportunities to our students and practical career and workforce preparation.

Sincerely,

A handwritten signature in black ink, appearing to read 'Daniel M. Horns'.

Daniel M. Horns
Interim Dean, College of Science



UTAH VALLEY UNIVERSITY

WOODBURY SCHOOL OF BUSINESS

February 11, 2020

Dr. M. Brandon Jones
GEO/OAD, telephone: (703) 292-4713
Directorate for Geosciences
Directorate for Education and Human Resources
National Science Foundation

Dear Dr. Jones,

If the proposal submitted by Dr. Eddy Cadet entitled *GP-UP: Undergraduate Preparation through Multidisciplinary Service Learning at Utah Lake (UP-Utah Lake)* is selected for funding by NSF, it is the intent of Woodbury School of Business at Utah Valley University to collaborate and commit resources as detailed in the *Facilities, Equipment and Other Resources* section of the proposal.

Sincerely,

Norman S. Wright
Dean, Woodbury School of Business



2/11/2020

Dr. M. Brandon Jones
GEO/OAD, telephone: (703) 292-4713
Directorate for Geosciences
Directorate for Education and Human Resources
National Science Foundation

Dear Dr. Jones,

If the proposal submitted by Dr. Eddy Cadet entitled *GP-UP: Undergraduate Preparation through Multidisciplinary Service Learning at Utah Lake (UP-Utah Lake)* is selected for funding by NSF, it is the intent of the College of Humanities and Social Sciences at Utah Valley University to collaborate and commit resources as detailed in the *Facilities, Equipment and Other Resources* section of the proposal.

Sincerely,

Steven Clark, Ph.D.
Dean, College of Humanities and Social Sciences



February 11, 2020

Dr. M. Brandon Jones
GEO/OAD, telephone: (703) 292-4713
Directorate for Geosciences
Directorate for Education and Human Resources
National Science Foundation

Dear Dr. Jones,

If the proposal submitted by Dr. Eddy Cadet entitled *GP-UP: Undergraduate Preparation through Multidisciplinary Service Learning at Utah Lake (UP-Utah Lake)* is selected for funding by NSF, it is the intent of the Center for Social Impact at Utah Valley University to collaborate and commit resources as detailed in the *Facilities, Equipment and Other Resources* section of the proposal.

Sincerely,

A handwritten signature in blue ink that reads "Summer Valente".

Summer Valente
Director, Center for Social Impact



2/5/2020

To: NSF IUSE-Geopaths Program

If the proposal submitted by Dr. Eddy Cadet entitled *GP-UP: Undergraduate Preparation through Multidisciplinary Service Learning at Utah Lake (UP-Utah Lake)* is selected for funding by NSF, it is the intent of the Utah Lake Commission to collaborate and commit resources as detailed in the *Facilities, Equipment and Other Resources* section of the proposal.

Sincerely,

Eric J. Ellis

Executive Director
UTAH LAKE COMMISSION
801-851-2901 o
801-836-1963 c
eric@utahlakecommission.org
[www.utahlakecommission.org](http://utahlakecommission.org)

Utah Lake Commission
Historic Utah County Courthouse
51 South University Ave.
Suite 109
Provo, Utah
84601

ph. (801) 851-2900
fx. (801) 851-2903

<http://utahlake.gov>



UTAH DEPARTMENT OF
ENVIRONMENTAL QUALITY
**WATER
QUALITY**

2/10/2020

To: NSF IUSE-Geopaths Program

If the proposal submitted by Dr. Eddy Cadet entitled GP-UP: Undergraduate Preparation through Multidisciplinary Service Learning at Utah Lake (UP-Utah Lake) is selected for funding by NSF, the Utah Division of Water Quality may collaborate and provide in-kind support when research activities inform the ongoing Utah Lake Water Quality Study (utahlake.deq.utah.gov).

DWQ provides this letter of support with the understanding that the Utah Lake Science Panel endorses the study. DWQ welcomes this opportunity to collaborate and to integrate University research with the Utah Lake Water Quality Study.

Please feel free to contact me with any questions.

Sincerely,

A handwritten signature in blue ink that reads "Scott Daly".

Scott Daly
Utah Lake Watershed Coordinator
Utah Department of Environmental Quality
Division of Water Quality
Phone: 801.536.4333
sdaly@utah.gov
195 N 1950 W Salt Lake City, UT 84116



GARY R. HERBERT
Governor

SPENCER J. COX
Lieutenant Governor

State of Utah

DEPARTMENT OF NATURAL RESOURCES

MICHAEL R. STYLER
Executive Director

Division of Wildlife Resources

GREGORY J. SHEEHAN
Division Director

17/2020

To: NSF IUSE-GEOPATHS Program

If the proposal submitted by Eddy Cadet entitled *GP-UP: Undergraduate Preparation through Multidisciplinary Service Learning at Utah Lake (UP-Utah Lake)* is selected for funding by NSF, it is the intent of the Utah Division of Wildlife Resources (DWR) to collaborate with the project team to assist with research on the water quality of Utah Lake. DWR will work with student research teams; facilitate job shadowing activity; give a tour of the DWR facility and a presentation about jobs at DWR; provide the project with the use of some equipment, including the fish scale; provide boat escort for fish sampling.

Sincerely,

Dale Fonken

Dale Fonken
June Sucker Biologist
Utah Division of Wildlife Resources
dfonken@utah.gov
1115 North Main Street
Springville, UT 84663
[\(503\) 730-9424](tel:(503)730-9424)



United States Department of Agriculture

4 February 2020

Natural Resources
Conservation Service

Utah State Office
125 South State Street
Room 4010
Salt Lake City, UT 84138
Ph: 801-524-4550
Fax: 844-715-4928
www.ut.nrcs.usda.gov

To: NSF IUSE-Geopaths Program

If the proposal submitted by Dr. Eddy Cadet entitled *GP-UP: Undergraduate Preparation through Multidisciplinary Service Learning at Utah Lake (UP-Utah Lake)* is selected for funding by NSF, it is the intent of the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Utah team to collaborate and commit resources as detailed in the *Facilities, Equipment, and Other Resources* section of the proposal.

Sincerely,

A handwritten signature in black ink, appearing to read "Cianna E. Wyshnytzky".

Cianna E. Wyshnytzky, PhD

Geologist
USDA-NRCS
125 South State Street, Room 4010
Salt Lake City, Utah 84138
801-524-4253



UTAH COUNTY HEALTH DEPARTMENT

Ralph L. Clegg, E.H.S., M.P.A.

Executive Director

Eric S. Edwards, M.C.H.E.S., M.P.A.

Deputy Director

January 29, 2020

To: NSF IUSE-Geopaths Program

If the proposal submitted by Dr. Eddy Cadet entitled *GP-UP: Undergraduate Preparation through Multidisciplinary Service Learning at Utah Lake (UP-Utah Lake)* is selected for funding by NSF, it is the intent of Utah County Health Department to collaborate and commit resources as detailed in the *Facilities, Equipment and Other Resources* section of the proposal.

Sincerely,

Bryce C. Larsen, MPA, LEHS
Environmental Health Director

Board of Health

Clyde Nielsen, RPh, Chair

Henry M. Yeates, M.D.
Commissioner Larry Ellertson

Diane Lohner
Superintendent Keith C. Rittel

Dianne C. Carr, RD
Mayor Jeff Acerson

Gaye L Ray, RN
Teresa Tavares



Steven H. Emerman, Ph.D.
Specializing in Groundwater and Mining

shemerman@gmail.com • (801) 921-1228
785 N 200 W, Spanish Fork, Utah 84660, USA

January 26, 2020

To: NSF IUSE-Geophaths Program

If the proposal submitted by Dr. Eddy Cadet entitled *GP-UP: Undergraduate Preparation through Multidisciplinary Service Learning at Utah Lake (UP-Utah Lake)* is selected for funding by NSF, it is the intent of Malach Consulting to collaborate and commit resources as detailed in the *Facilities, Equipment and Other Resources* section of the proposal.

Sincerely,

Steven H. Emerman

Steven H. Emerman
Owner, Malach Consulting