SEMESTER/EXPLORATORY GRANT APPLICATION
Cover Sheet

Amount Requested: $168.39

Project Information

Stokes, Jessica	
Student Participant (Last, First)	
Concentration of Radon within Soil and Homes in the Ogden Area	
Project Title (10 words or less)	
Frantz, Carie	2507
Faculty Mentor Name (last, first)	Mail Code
College of Science	Earth and Environmental Science
College (Weber State is the University, NOT college)	Department

This project ___ DOES/_X__ DOES NOT require review by the WSU Institutional Review Board for Human Subjects or the WSU Animal Care and Use Committee.

Jessica Stokes — Student Signature — 1-23-19 — Date

Project Mentor Signature — 1/21/19 — Date Received by Mentor. Must be 10 business days before final deadline.

2507 — Campus Mail

x6181 — Phone Ext.

Tracy Covey — Undergraduate Research Committee Representative — 1-27-19 — Date Received by URC Rep. Must be 5 business days before final deadline.

Faculty Mentor Department Chair — 2/4/2019 — Date

Please check if attended Research Proposal Workshop:

X — Date Workshop attended **01/16/19**

(Please fill in the date of attendance)

Semester/Exploratory Grant Application
Budget Worksheet

BUDGET ITEM	Department or College Funds	Outside Agency Funds: Utah Dept. of Enviro. Quality	Personal Funds	Undergrad. Research Funds	GRAND TOTAL
Materials		Radon home test kits 40 x $11.95 ($478)		Radon in water test kit 3 x $24.50 ($73.50), other supplies detailed in Appendix A ($68.89)	$620.39
Mileage to gather Data (.38 per mile)	$50 towards travel			200 miles of travel = $76-$50 dept. contribution = $26	$76
GRAND TOTAL		$478		$168.39	$696.39

NOTES:

- Maximum request not to exceed $1000 and may not include a Research Scholarship.
- Equipment and left-over materials purchased with this grant will remain the property of WSU.
- You may not request money for gas purchases for travel. WSU reimburses travel expenses at a set mileage rate only.
- Grant money cannot be used retroactively on previously existing expenses. Requests for reimbursements will be denied. All purchases must be made after receiving funding and clearance from the OUR office.

Project Description

Radon is a naturally occurring, radioactive gas that causes cancer. It is responsible between 15,00 and 21,800 deaths in the U.S. as a result of lung cancer per year (Si-Heon Kim et al., 2016). Radon's half-life is only 3.82 days (Berger, 1990), but inhalation into the lungs leads to it remaining in the human body during that time while it damages DNA (Krewski et al., 2005). At only the recommended action level from the EPA, the risk of cancer from radon exposure is 5 times greater than the risk of dying in a car crash (EPA, 2018).

Radon comes from the natural decay of uranium. Uranium-rich rocks include granite, metamorphic rocks, black shales, and some volcanic rocks. Many of the basement rocks along the Wasatch front have high concentrations of uranium including the outcrop of the Precambrian Farmington Canyon Complex (FCC) near the Ogden area, which makes the Wasatch Front an area of particular concern for radon exposure.

Radon is found as a gas or dissolved in water, and moves readily through permeable rocks and soils, and ultimately into homes. Radon tends to accumulate in basements because that is the part of the house with the greatest surface area exposed to the surrounding soil, and because radon is denser than air. Radon can also get into homes through the water supply. The likelihood of high radon concentration levels in homes can depend on a couple of different factors, including the chemistry and permeability of underlying sediments, foundation condition, building ventilation and construction material.

The highest concentrations of radioactive uranium-238 are found in the benches along the Wasatch Front, and in coarse-grained Holocene alluvial fan and Bonneville Shoreline

deposits (Black and Solomon, 1996). High radon levels are also found along the Weber River in the Ogden valley. The lowest concentrations of radioactive uranium-238 are found in fine-grained deposits such as Bonneville lacustrine silts and shales in the valleys.

Although radon is a known risk in Ogden, household radon test results in the area are highly variable, and public awareness of the radon hazard is poor. In this project, we seek to produce and test a predictive model of radon risk levels in Ogden area homes based on location and home characteristics. We hope that this model can be used to inform Ogden area residents about radon risks and encourage home testing, which is inexpensive and easy for residents to do.

The model we propose will combine a geospatial model of rock and sediment types with data gathered from the literature and self-reported information about home construction. Radon risk calculations will be based on a radon flux model and with the variables and how we intend to define them in Table 1.

Once our model is constructed, we will test our model with measurements of home radon values from 30 home basements in Ogden, with tested homes selected to represent several areas of high radon concern (highly permeable soils that overlay U-bearing basement rocks or alluvial/lacustrine deposits containing basement rocks, e.g., near the mouth of Ogden Canyon; 10 homes), moderate radon concern (near and around Weber State University, locations in South Weber, and near Rainbow Gardens; 10 homes), and lower radon concern (lacustrine silts and shales, e.g., West Ogden near Fort Buenaventura; 10 homes); Figure 1.

Previous attempts to predict home radon levels in other locations have given mixed results (Sprinkel, 1990). We will plot measured home radon levels against radon levels predicted by the model. Any deviation from a 1:1 line will give us an assessment of our model's [in]accuracy.

If our model is able to predict home radon levels to some degree of confidence, we want to produce a public-facing website (with disclaimers) that provides information about radon and that will allow people to input information about their home footprint, construction, and location and predict their radon risk. We hope that this will inspire homeowners (and basement residents) to get their homes tested for radon.

This research will be done by the students in Geochemistry 4550. Dr. Carie Frantz will be providing guidance when needed, however, it is our own design and work and therefore primarily an independent project.

Project Methods & Timeline

Home radon levels will be tested using the $12 short-term home radon test kits that are recommended by the Utah Department of Environmental Quality and will be performed by volunteering home residents with our assistance. Soil radon levels will also be tested at 10 representative locations using the same kits and an inexpensive cup-based collection system (Appendix B, reference). Finally, we will test water radon levels at the three homes with the highest measured home radon values using water radon test kits. Potential soil test locations where radon is expected to be high are the Mouth of Ogden Canyon, Near and around Weber State University and Locations within South Weber.

Months in 2019	Model development	Buying radon test materials	Performing radon tests	Model accuracy assessment	Dissemination
January					
February					
March					
April					

Specifications of the budget:

- The Utah Department of Environmental Quality has donated 40 Short term Home radon test kits from Alpha Energy Laboratories that we will use to test home and soil radon levels in the Ogden, Utah area. Thirty test kits will be divided amongst 9 students to test home basements; ten test kits will be used to test three different types of bedrock soils including, alluvial soils and lacustrine soils from representative sites.
- The purchase of three at home water Radon test kits will then be used to test three separate water sources in homes with high tested radon levels.
- In order to test the soil, makeshift soil sampling devices will be made. These will be constructed using the ten test kits for soil, hefty plastic cups, Velcro to attach the test kits to the cups, and then small sections cut from the plywood to then cover the cups that have been filled with soil. The cups will then be marked with the date and location, using the Sharpie Markers, and will have their exact location in the ground marked by the purchased PVC marking flags. (Figure 2; Table 2)
- Assuming an average of 10 miles driven for 20 different trips to homes and other locations along the Wasatch front, mileage reimbursement at $0.38 per mile would cost $76.

SEMESTER/EXPLORATORY GRANT APPLICATION
Additional Questions

1. What funding have you received from OUR in the past, Where has your previous project been disseminated.

None of us have previously received OUR funding.

2. Is this project part of a required course? If so, please indicate the support (monetary and in-kind) provided for this project by the academic department.

This project is part of a Course-based Undergraduate Research Experience in our GEO 4550 (Geochemistry) course. We are not currently receiving funding from our department.

3. What additional sources of funding have been solicited? Is your department willing/able to fund any equipment they will be retaining?

The Utah Department of Environmental Quality has donated 40 short term Home Radon Test Kits, with a value of $478. The Department of Earth and Material Science will be providing $50 to go towards travel and mileage, as well as software licenses and other support required to complete our project.

4. Where do you plan to disseminate the results of this project?

We are hoping to present at the EPA Utah Radon Conference in April, as well as the OUR conference and a departmental seminar at the end of the semester. We also hope to be able to make a website to make the model and radon information available to the public.

5. If you are requesting a stipend, please list all significant time commitments (5+ hours per week) that you expect to maintain over the duration of your project including, for example, class and work schedules.

We are not requesting a stipend.

SEMESTER/EXPLORATORY GRANT APPLICATION
Faculty Recommendation Form

Student Name (last, first): Jessica Stokes and students of the GEO 4550 Geochemistry Course

Project Title: Concentration of Radon within Soils and Homes in the Ogden Area

Mentor Directions: After carefully reviewing the proposal and assessing both the viability of this project and the qualifications of the student requesting funding, answer the questions found below. Please expand the sections as necessary (**do not attach separate letter**). If the project involves the use of human subjects or protected animals, be sure the student secures IRB or ACUC approval. If the project receives funding, it is your responsibility to work closely with the student, monitor the ongoing progress of the project and budget, and evaluate the project's results. Failure to do so will jeopardize funding for this project and any future projects.

1. How long and in what capacity have you known this student?

I am the instructor of the students' Geochemistry course and have known them since January 2019.

2. Briefly describe the proposed project. Is this part of a larger research project? Is this part of a course? If so, how is the project apart from the nature and scope of activities normally taken for the course (Please attach a copy of your course syllabus)?

As a required part of my Geochemistry course (syllabus attached), students are asked to work together to (1) identify a local environmental issue of interest, (2) articulate a geochemistry-related research question related to the issue, (3) produce a geochemical numerical/mass-balance model to investigate the research question. This year, the students have chosen to focus on radon hazards in local homes, with the aim of using the model they develop to help predict radon levels in homes built on different soil types in the Ogden area. Although I have provided general guidance, the project is wholly their idea, and the research is their own.

3. Give an assessment of the project's significance to the student's discipline and of the project's educational and/or professional benefit to the student.

As an educator, I am very excited about this research project because it will reinforce several learning objectives, including giving students hands-on experience with geochemical modeling, applying geospatial data to investigating environmental problems, and analytical techniques and data analysis. In addition, the proposed research project has the potential to provide a real public health benefit to the residents of Ogden.

4. Comment on the qualifications of the student to successfully complete this project, both in terms of the project's scope and its time frame.

Between the nine of them, the students have the requisite background in geospatial techniques and modeling, analytical chemistry, and statistics to complete this project. Project themes will be woven through course content, and I will provide guidance where needed. The proposal is realistic in scope and I am confident that they will be able to complete this project in the anticipated time frame.

5. Comment on the justification and appropriateness of the project budget, including the necessity of a stipend (if requesting one).

The bulk of the requested budget will fund radon test kits, which will be used to test the radon model they are developing. The number of kits requested will provide multiple

test sites for each of three major soil types, providing a robust pilot test of their model. The budget also asks for basic materials for performing the radon tests, and mileage reimbursement for students traveling to the selected test sites.

6. Describe your role in the project.

I will provide general project guidance, including help with finding and interpreting background information, teach students how to build a mass balance model, and include accountability checkpoints as course assignments in order to keep the project on track.

7. Include anything else that you think will be helpful to the committee in evaluating this application.

This project is a Course-based Undergraduate Research Experience (CURE), a high-impact practice that gives a large number of students the opportunity to conduct a mentored research project.

This project _____ DOES _X_ DOES NOT require review by the WSU Institutional Review Board for Human Subjects or the WSU Animal Care and Use Committee.

Project Mentor Signature

1/30/19
Date

Appendix A

Item	Vendor	Quantity	Individual Price	Total cost (tax + shipping + item)
RevolutionPly 5mm Poplar Plywood, Application as 4 X 8	Lowes	1	$16.98	$18.13
Hefty Easy Grip Cups, 18 Oz, 50 Ct	Walmart	1	$3.81	$4.08
VELCRO® Brand Sticky Back 5ft x 3/4in Roll, White	Walmart	1	$5.84	$6.28
PVC Marking flag	Lowes	2	$9.76	$10.42
Sharpie Twin-Tip Markers 3pk	Walmart	2	$29.98	$29.98

Appendix B:

- Part 1: Soil Testing

  Building of instruments: Apply two connecting pieces of Velcro to the radon detector and inside of the plastic cup. The radon monitor will connect at the bottom of the plastic cup. The cups' function is to trap the gas from the soil, a 6"x6" piece of plywood will be used to cover the cup while it is buried. This wood will prevent any atmospheric gases from interfering.

- Part 2: Homes - How to test radon in homes:

  Thirty different households with basements along the Wasatch Front, in the Ogden area, will be tested. Avoid any room that might be damp, like a kitchen, bathroom, or laundry room. Also avoid any spot that is indirect contact with any sort of central or flowing air throughout the house, or any high traffic entrance or exit.

Place the test kit on the kit on a table or chair, not the floor, in a place that is out of the way and can be left undisturbed. The test must remain there for 2-5 days. Once the test period is complete, test kits will be sent to an external laboratory for analysis.

- Part 3: Water Testing

Water will be tested at sites that have the highest measured concentration of radon.

Figure 1: Map

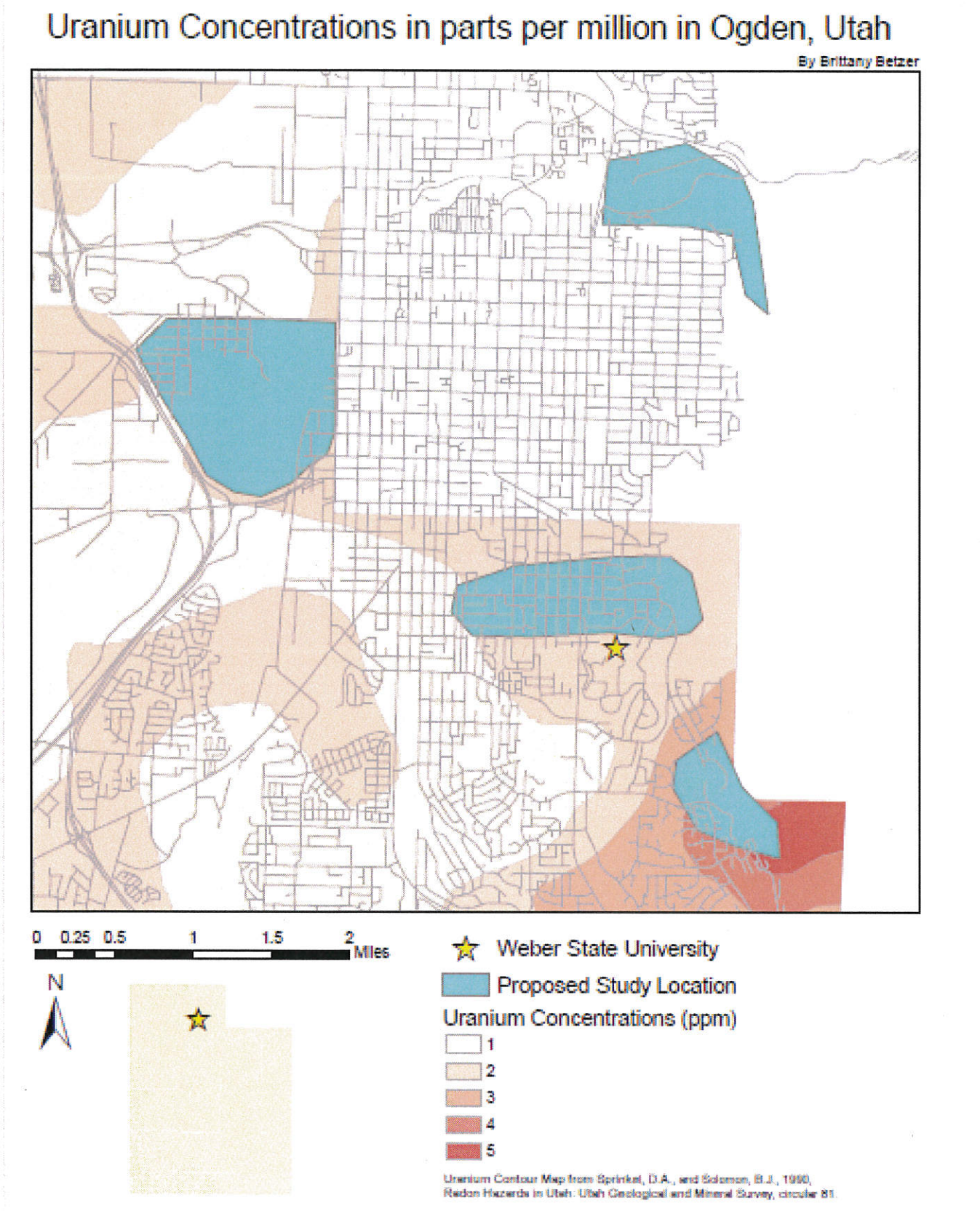
Uranium Concentrations in parts per million in Ogden, Utah
By Brittany Betzer
0 0.25 0.5 1 1.5 2 Miles
N
Weber State University
Proposed Study Location
Uranium Concentrations (ppm)
1
2
3
4
5
Uranium Contour Map from Sprinkel, D.A., and Solomon, B.J., 1990,
Radon Hazards in Utah: Utah Geological and Mineral Survey, circular 81

Table 1. Variables in the radon model

Equation 1. Model of our system

$((((m_U)*(2.53.x10\text{^}(21))+(\lambda_F*\text{Age of Rock (s)})) - ((m_U)*(2.53.x10\text{^}(21)))*(K_{basement} - K_{sediment}))/(A_{surface})$ = Number of Radon atoms present in basement

Variable (symbol)	**Variable description**	**What we will use**	**Reference**
m_U	uranium content of underlying rock or sediment	Measured uranium concentrations in representative samples from Geologic Map of the 7.5' Quadrangle, Weber and Davis Counties, Utah 1:24,00	(Yonkee and Lowe, 2004)
λ_F	Uranium decay rate (radon production rate)	$\lambda F=(7.03\pm0.11)\times10-17\ yr-1$	(Roberts, Gold & Armani, 1968)
$K_{sediment}$	Permeability of underlying sediment	Measured permeability values from representative samples of the major rock types in the area as defined by the Geologic Map of the 7.5' Quadrangle, Weber and Davis Counties, Utah 1:24,000	(Yonkee and Lowe, 2004)
$K_{basement}$	Basement permeability	Values will be derived from a student conducted survey of the foundation quality and basement ventilation	
$A_{surface}$	Basement surface area	Entered values from building footprint	

Table 2. Supplies for constructing soil test devices

Item	Vendor	Quantity	Individual Price	Total cost (tax + shipping + item)
RevolutionPly 5mm Poplar Plywood, Application as 4 X 8	Lowes	1	$16.98	$18.13
Hefty Easy Grip Cups, 18 Oz, 50 Ct	Walmart	1	$3.81	$4.08
VELCRO® Brand Sticky Back 5ft x 3/4in Roll, White	Walmart	1	$5.84	$6.28
PVC Marking flag	Lowes	2	$9.76	$10.42
Sharpie Twin-Tip Markers 3pk	Walmart	2	$29.98	$29.98

References

Berger, R.S., 1990, The Carcinogenicity of Radon: Environmental Science & Technology, v. 24, p. 30–31, doi: 10.1021/es00071a003.

Health Risk of Radon, 2018, EPA, https://www.epa.gov/radon/health-risk-radon (accessed January 2019).

Krewski, D., Lubin, J.H., Zielinksi, J.M., Alavanja, M., Catalan, V.S., Field, R.W., Klotz, J.B., Letourneau, E.G., Lynch, C.F., Lyon, J.I., Sandler, D.P., Schoenberg, J.B., Steck, D.J., Stolwijk, J.A., et al., 2005, Residential Radon and Risk of Lung Cancer: A Combined Analysis of 7 North American Case-Control Studies: Epidemiology, v. 16, p. 137–145, doi: 10.1097/01.ede.0000152522.80261.e3.

Roberts, J.H., Gold, R., and Armani, R.J., 1968, Spontaneous-Fission Decay Constant of 238-U: Physical Review E, https://journals.aps.org/pr/abstract/10.1103/PhysRev.174.1482 (accessed February 2019).

E, https://journals.aps.org/pr/abstract/10.1103/PhysRev.174.1482 (accessed February 2019).

Si-Heon Kim, Ju Hwang, J.-S.C., and Dae Ryong Kang, 2016, Attributable risk of lung cancer deaths due to indoor radon exposure: Annals of Occupational and Environmental Medicine, https://aoemj.biomedcentral.com/articles/10.1186/s40557-016-0093-4 (accessed February 2019).

Sprinkel, D.A., and Solomon, B.J., 1990, Radon Hazards in Utah: Utah Geological and Mineral Survey, circular 81.

Yonkee, A., and Lowe, M., 2004, Geologic Map of the Ogden 7.5-Minute Quadrangle, Weber and Davis Counties, Utah, Utah Geological Survey.