GPSA Funding Application: Explanation of Activities

Concise Project Summary:
I am researching the uranium contamination of groundwater below a defunct uranium mine, Orphan Lode Mine, in Grand Canyon National Park for my M.S. thesis. I’m asking for $1,656.74 to fund the collection and chemical analysis of 15 groundwater samples below this mine. Each sample’s chemistry will be analyzed for trace metals, major ions, and stable isotopes. The data will allow for robust statistical and hydrogeochemical modeling applications that will provide critical insight into uranium’s behavior in groundwater at this site. Additionally, in understanding the influences on the uranium’s behavior below this mine, future impacts of mining on groundwater in the Grand Canyon will be further understood.

Significance of Project:
The Grand Canyon is located in Northern Arizona and is known around the world for its stunning views, unique geology, and spectacular wildlife. The lifeblood of the canyon is the water that flows from above and below, sometimes traveling hundreds of miles before it emerges from the walls of the Grand Canyon or surges through the Colorado river. In addition to its profound ecological importance, springs in the Grand Canyon hold strong cultural significance and is a critical resource for Native American people who live within the Grand Canyon. Many communities such as the Havasupai and Hualapai do not have access to water rights from the Colorado river, and consequently are heavily reliant on groundwater resources.

However, groundwater is not the only valuable resource situated in the region; some of the highest-grade uranium ores in the United States are found in and around the Grand Canyon. In 2009, the U.S. Secretary of the Interior, Ken Salazar, put into place a 20-year moratorium on new uranium mining within the Grand Canyon, for the purpose of allowing time for further research to be conducted on the impacts of uranium mining on groundwater resources. One major site of interest in conjunction with this moratorium is the now defunct Orphan Mine. Groundwater containing the highest concentrations of dissolved uranium on record in the Grand Canyon are found below this mine, with concentrations soaring to ten times the maximum contaminant level set by the United States Environmental Protection Agency. Understanding the factors influencing uranium in this groundwater is the focus of my research.

Broader Impacts of Project:
This project will provide further insight into uranium mining regulation for policy makers within the National Park Service, Arizona state government, and environmental regulatory agencies at the federal level. My research builds off of nearly two decades of previous work from UNLV students and my work will likely be built on by future students, continuing the legacy of spring sustainability and groundwater quality research in the Grand Canyon at UNLV. Furthermore, as part of this project I am inviting a handful of undergraduate students in the geoscience department to accompany me into the field and gain hands on field experience. This will provide invaluable opportunities for students hoping to pursue their own hydrogeology research one day.

My research and my ambition to publish using the data funded by this proposal will also contribute towards UNLV’s status as an R1 institution. Additionally, in funding my research, the GPSA will directly play a role in advancing the scientific understanding of uranium contamination in one of the world’s most spectacular natural wonders. Uranium mining is an issue in which many stakeholders are involved, such as mining companies, who often have significant resources and a vested interest in obtaining favorable outcomes. This project seeks to better understand the uranium contamination from a balanced, scientific perspective. This is a
critically relevant issue for the future of the water resources in the Grand Canyon, and the communities that rely on its groundwater for the survival of their way of life.

**Timeline:**

The sampling will likely occur over two 3-day weekends due to the remote nature of the sampling sites. The first sampling is anticipated to occur on November 4th-6th, and a second sampling on November 18th-20th. Grand Canyon National Park has already approved this research, with the permit lasting through December 31st of 2022. Chemical analysis will likely occur within 2-3 weeks of the time of sampling, which means that all data should be available for interpretation by mid-December.
### Itemized Budget

Research Travel, Sampling Supplies, and Laboratory Analysis for Thesis

<table>
<thead>
<tr>
<th>Item #</th>
<th>Description of Item</th>
<th>Source (Company)</th>
<th>Quantity</th>
<th>Individual Cost</th>
<th>Total Cost (Quantity x Ind. Cost)</th>
<th>Amount Requested</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Travel from LV to Grand Canyon South Rim Visitor Center and back</td>
<td>Gas</td>
<td>2</td>
<td>$105.92 (560 mile roundtrip(^3) at 27mpg for a 2018 Subaru Cross Trek and an assumed price of $5.107/gallon in Las Vegas(^3))</td>
<td><strong>$211.84</strong></td>
<td>$211.84</td>
</tr>
<tr>
<td>1a</td>
<td>Mileage on personal vehicle (~1,120 miles – no reimbursement requested)</td>
<td>Personal Vehicle</td>
<td>2</td>
<td>$0</td>
<td><strong>$0</strong></td>
<td>$0</td>
</tr>
<tr>
<td>1b</td>
<td>Geoscience Dept. Vehicle</td>
<td>$313.60 (^2) ($.56 per mile vehicle use fee at 560 miles roundtrip)</td>
<td>2</td>
<td><strong>$627.20</strong></td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Lodging</td>
<td>Grand Canyon National Park</td>
<td>4 nights</td>
<td>Backcountry campsite - $12 per person, per night + $10 backcountry permit(^4)</td>
<td><strong>$154</strong></td>
<td>$0</td>
</tr>
<tr>
<td>3</td>
<td>Sample Collection: Polypropylene Bottles</td>
<td>UNLV Department of Geoscience</td>
<td>25</td>
<td>$37.54 for pkg. of 12 polypropylene bottles(^5) – UNLV ICP-MS lab has agreed to supply bottles for free.</td>
<td><strong>$46.93</strong></td>
<td>$0</td>
</tr>
<tr>
<td>4</td>
<td>Sample Collection: Ultra-Pure Nitric Acid</td>
<td>Avantor</td>
<td>0.5L</td>
<td>$161.20 for 0.5L(^6). Another UNLV student has agreed to buy nitric acid in bulk and allow me to use needed quantities at no cost.</td>
<td><strong>$161.20</strong></td>
<td>$0</td>
</tr>
<tr>
<td>5</td>
<td>Sample Collection: Hydro-Cloric Acid</td>
<td></td>
<td>1L</td>
<td>Another UNLV student has agreed to buy HCl in bulk and allow me to use needed quantities at no cost.</td>
<td><strong>$26.99(^7)</strong></td>
<td>$0</td>
</tr>
<tr>
<td>6</td>
<td>Sample Collection: Shipping</td>
<td>USPS</td>
<td>2</td>
<td>Large Flat Rate Box @ $22.45(^8)</td>
<td><strong>$44.90</strong></td>
<td><strong>$44.90</strong></td>
</tr>
<tr>
<td>6a</td>
<td>FedEx</td>
<td>2</td>
<td>$27 per shipment(^10)</td>
<td><strong>$54.00</strong></td>
<td><strong>$54.00</strong></td>
<td></td>
</tr>
<tr>
<td>Item #</td>
<td>Description of Item</td>
<td>Source (Company)</td>
<td>Quantity</td>
<td>Individual Cost</td>
<td>Total Cost (Quantity x Ind. Cost)</td>
<td>Amount Requested</td>
</tr>
<tr>
<td>-------</td>
<td>----------------------</td>
<td>------------------</td>
<td>----------</td>
<td>-----------------</td>
<td>----------------------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>6b</td>
<td>UPS</td>
<td></td>
<td>2</td>
<td>$38.80 per shipment&lt;sup&gt;9&lt;/sup&gt;</td>
<td>$77.60</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Sample Analysis: ICP-MS, Ion Chromatography, Shimadzu TOC/TN</td>
<td>Core Analytical Lab (University of Nevada, Reno)</td>
<td>16</td>
<td>$65 (special NSHE rate at $20 for ICP-MS, $20 for Ion Chromatography, $25 for Shimadzu TOC/TN)&lt;sup&gt;11&lt;/sup&gt;</td>
<td>$1,040</td>
<td>$1,040</td>
</tr>
<tr>
<td>7a</td>
<td>ICP-MS Lab at Michigan State</td>
<td></td>
<td>16</td>
<td>$111.50 (XRF + LA-ICP-MS $100, Sample prep $11.50)&lt;sup&gt;12&lt;/sup&gt;</td>
<td>$1,784</td>
<td></td>
</tr>
<tr>
<td>7b</td>
<td>ICP-MS Scan at Huffman Hazen Labs</td>
<td></td>
<td>16</td>
<td>$410 per sample&lt;sup&gt;13&lt;/sup&gt;</td>
<td>$6,560</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Sample Analysis: Stable Isotopes of Deuterium and Oxygen-18</td>
<td>UNM Stable Isotopes Lab</td>
<td>15</td>
<td>$24 ($12 for Deuterium and $12 for Oxygen-18)&lt;sup&gt;14&lt;/sup&gt;</td>
<td>$360</td>
<td>$360</td>
</tr>
<tr>
<td>8a</td>
<td>University of Arizona Environmental Isotope Lab</td>
<td></td>
<td>15</td>
<td>$34 (deuterium and oxygen-18 coupled together for pricing)&lt;sup&gt;16&lt;/sup&gt;</td>
<td>$525</td>
<td></td>
</tr>
<tr>
<td>8b</td>
<td>UNR Stable Isotopes Lab</td>
<td></td>
<td>15</td>
<td>$58 ($29 for Deuterium and $29 for Oxygen-18)&lt;sup&gt;15&lt;/sup&gt;</td>
<td>$870</td>
<td></td>
</tr>
</tbody>
</table>

Total Costs Avoided: $1,016.32
Total: 1,656.74
Explanation of Costs

**Item #1: Travel**
The roundtrip from UNLV to Grand Canyon National Park is 560 miles\(^1\) and to avoid fees for using a department vehicle for field work, I will use my personal vehicle (avoiding $627.20 in cost\(^2\)). My personal vehicle gets roughly 27 mpg, and with the average price of gas in Las Vegas being $5.107\(^3\), the total cost of traveling between campus and the Grand Canyon twice will be $211.04.

**Item #2: Lodging**
For 6 days (four nights) in the backcountry of Grand Canyon National Park, it would typically cost $12 per person per night\(^3\) plus an additional one-time backpacking permit fee of $10\(^4\). Our sampling team will include three people (myself and two other students). However, I have worked with the park Hydrologist before and the park has agreed to waive camping fees for the research party (avoiding $154 in cost).

**Item #3: Polypropylene Bottles**
For 15 bottles (required for field collection), the cost would usually be $46.93\(^5\). However, I spoke with the supervisor of the currently out of service ICP-MS lab and he agreed to supply sampling bottles at no cost (avoiding $46.93 in cost).

**Item #4: Ultra-pure Nitric Acid**
Ultra-pure Nitric Acid is ($161.20 for 0.5L\(^6\)) necessary for preserving trace metals in samples in remote field locations. I spoke with another geoscience student who has significant external funding and they have agreed to allow me to use their Nitric Acid in exchange for helping them with their field work (avoiding $161.20 in cost).

**Item #5: Hydro-chloric Acid**
Hydro-chloric acid is used to wash reusable sampling equipment to avoid cross-contamination. The same geoscience student has also agreed to let me use their HCl solution as necessary at no cost in exchange for helping them with their field work (avoiding $26.99 in cost\(^7\)).

**Item #6: Shipping**
USPS using a large flat rate box is the cheapest option between the USPS\(^8\), UPS\(^9\), and FedEx\(^10\). None of the websites would allow for projection far enough into the future to project pricing in November. Please disregard specific shipping dates in the quotes listed. Express/overnight shipping is not required due to in the field preservation methods. Total cost for two shipments (one shipment per field weekend) will be $44.90.
Item #7: ICP-MS, Ion Chromatography, Shimadzu TOC/TN
These three methods combined will characterize the major ions, trace elements, and total carbon and nitrogen within each groundwater sample. Due to uranium’s complex mobility, all of these tracers are required to fully understand factors that may be influencing its movement. **Due to special NSHE pricing,** the UNR Lab can run all three analyses for a total of $65 per sample\(^\text{11}\) (an incredibly low cost for the complexity and detail this analysis provides).
Comparatively, just an ICP-MS analysis alone from Michigan State\(^\text{12}\) or Huffman Hazen laboratories\(^\text{13}\) dwarf the cost of the entire suite of analyses offered by UNR. As such, further comparisons for the specific cost of Ion Chromatography and Shimadzu were not taken at these labs as the ICP-MS had already exceeded UNR (it is common practice to use only one laboratory for all analyses to streamline shipping, minimize risk of samples being lost, and consistent analysis times). The total cost for analyzing 16 samples (the 16\(^{\text{th}}\) sample is an extra “blank” sample required to analyze for accuracy of laboratory methods) in the field is $1,040.

Item #8: Stable Isotopes of Deuterium and Oxygen-18
These two stable isotopes in conjunction with one another are great environmental tracers to track the source of groundwater, and were selected for this project because they are very inexpensive relative to many other environmental tracers. The total cost for both deuterium and oxygen-18 at the University of New Mexico’s stable isotope lab is $24 per sample\(^\text{14}\), cheaper than UNR’s stable isotope lab\(^\text{15}\) and the University of Arizona’s Environmental Isotope Laboratory\(^\text{16}\).
Proof of Cost

1 Google maps of anticipated route to and from Grand Canyon National Park

2 Cost of Department Vehicle

B. Costs for Vehicle Use.
   Use of the Department vehicles will be charged $56.5 cents/mile. Costs will be reviewed at the end of each fiscal year, and modified as needed.
   For vehicle use related to classes, the Department will pay for gas. Gas can not be purchased using a P-Card.
   Gas may be purchased using a gas card that can be checked out from department office or personal funds. No P-card use for gas. Vehicles must be returned with a full fuel tank.
3 Average cost of gas in Las Vegas, NV as of 9/27/2022 per AAA

4 Cost of backcountry camping and permit at Grand Canyon National Park

9/28/22, 6:53 PM  Grand Canyon National Park announces backcountry camping fee increase - Grand Canyon National Park (U.S. National Park Service)

The cost recovery charge for overnight backcountry permits will increase for all permits that begin or end on or after July 1, 2022. The charge of $10 per backcountry permit remains the same; the nightly per person fee will be increased from $8 per person to $12 per person or stock animal camping below the rim in designated backcountry camping areas. This increase does not affect camping fees at Mather, Desert View, or the North Rim campgrounds.
Cost of Polypropylene Bottles

Technical Specs

Cost of Ultra-Pure Nitric Acid
Cost of Hydrochloric Acid
United States Postal Service Shipping

Mail Services
Flat Rate Box, mailed on October 27
from LAS VEGAS NV 89119 to SUN VALLEY NV 89433

Priority Mail® Large Flat Rate Box
USPS-Produced Box: 23-11/16" x 11-3/4" x 3" or 12" x 12" x 5-1/2"

<table>
<thead>
<tr>
<th>Select a Delivery Option</th>
<th>Expected Delivery Day</th>
<th>Retail</th>
<th>Click-N-Ship®</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Delivery Time</td>
<td>Sat, Oct 29</td>
<td>$22.45</td>
<td>$22.45</td>
</tr>
<tr>
<td>Hold For Pickup</td>
<td>Mon, Oct 31</td>
<td>Not available</td>
<td>$22.45</td>
</tr>
</tbody>
</table>
9 UPS Shipping

Estimate Shipping Cost

Visit The UPS Store® today and ask our certified packing experts about our Pack & Ship Guarantee.

Estimate Shipping Cost

Please provide information about your shipment to estimate the shipping cost. If you're looking to ship larger items, please contact your neighborhood location to inquire about the UPS Store® services.

UPS Next Day Air® Early A.M.
UPS 2nd Day Air®
UPS Next Day Air®
UPS 3 Day Select®
UPS 2nd Day Air® A.M.
UPS Ground*

*Note: The actual rate for UPS Ground may be different than the rate reflected in this online calculator. Visit your local UPS Store® to determine whether your rate is different than what is reflected here.

Ship From
United States
LAS VEGAS
89119

Ship To
United States
RENO
62086

Number of Packages: 1
Total Shipment Weight: 15 lbs
Packaging Type: Your Packaging
Currency: USD
FedEx Shipping

10

https://www.fedex.com/en-

FedEx

Ship, manage, track, deliver

Calculate FedEx shipping rates.

Shipping LTL Freight? (https://www.fedex.com/ltl-rates/?locale=en-

us)

FROM
Las Vegas, 89147, United States
TO
Reno, Nevada, 89501, United States

DELIVERED BY
4:30 PM
FedEx 2Day®

$27.00

https://www.fedex.com/en-us/home.html"
Water Chemistry Analysis Inquiry

Core Analytical Lab <cal@unr.edu>  
To: [Redacted]  
Tue, Sep 27, 2022 at 4:54 PM

Hi,

It looks like we will have the following analyses. The sample preparation and volume requirements for each are detailed below.

- **ICP-MS ($20/sample)**: Quantification of Al, Sb, As, Ba, Be, B, Cd, Ca, Cr, Co, Cu, Fe, Pb, Li, Mg, Mn, Mo, Ni, K, Se, Si, Ag, Na, Sr, Ti, W, U, V, and Zn. This will require at least 20 mL for each sample. The submitted sample must be filtered through 0.45 um (or smaller pore size) inert filter (consider submitting a method blank, as many syringe filter membranes contribute some metals to the filtrate), and must be acidified to pH < 1 (our default is 2% trace metal grade nitric acid, but as long as your pH is < 1, your samples should be stable).

- **Ion Chromatography ($25/sample)**: Quantification of fluoride, bromide, chloride, nitrate, nitrite, sulfate, and phosphate. Analysis requires 10 mL of sample, filtered through 0.45 um (or smaller) filter. DO NOT acidify or preserve in any way.

- **Shimadzu TOC/TN ($20/sample)**: Quantification of total organic carbon, total dissolved carbon, total inorganic carbon, and total dissolved nitrogen. Samples must be filtered through 0.45 um (or smaller) filter. DO NOT acidify or preserve in any way. Ensure there is no headspace in the collection container. Ideally the collection container is glass, or another gas-tight container; plastic is not ideal.

Let me know if you have any questions.

Best,

[Director, Core Analytical Laboratory]  
[University of Nevada, Reno]  
[1654 N. Virginia Street, MS 186]  
[Reno, Nevada 89557]
### Major and trace element packages (per sample)

<table>
<thead>
<tr>
<th>Elements</th>
<th>Academic or research</th>
<th>Commercial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major elements + 30 trace elements** (XRF + LA-ICP-MS)</td>
<td>$100</td>
<td>$200</td>
</tr>
</tbody>
</table>

### Sample preparation fees for any type of elemental analysis

<table>
<thead>
<tr>
<th>Sample type</th>
<th>Cost per sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trimming/powdering of bulk samples*</td>
<td>$5/sample</td>
</tr>
<tr>
<td>Li$_2$B$_4$O$_7$ fusion (of powdered samples**)</td>
<td>$6.50/sample</td>
</tr>
</tbody>
</table>
ICP-MS Analysis

Inductively-Coupled Plasma Mass Spectrometry

Most elements from atomic mass 6 to mass 238 can be determined by this technique. In clean matrices such as deionized water, detection limits are sub parts per billion (ppb) for the majority of elements. Quantifiable elements and actual detection limits vary with sample matrix and required sample decompositions. Our ICP-MS capabilities include both reaction and collision cell technology. This allows for the elimination of isobaric ICP-MS interferences for a variety of elements, providing lower detection limits and improved precision and accuracy.

Pricing

Prices shown are “per sample”, and may be subject to MINIMUM CHARGES and/or DISCOUNT PRICING. See the GETTING STARTED page for more information.

- 5 samples per test minimum charge

<table>
<thead>
<tr>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICP-MS sample setup</td>
<td>$80.00</td>
</tr>
<tr>
<td>Each element (in the same solution)</td>
<td>$10.00</td>
</tr>
<tr>
<td>ICP-MS Scan* for approximately 60 elements (in a single solution)</td>
<td>$410.00</td>
</tr>
</tbody>
</table>

*Prices may vary depending on sample matrix and required decompositions.
14 University of New Mexico Stable Isotope Analysis ($12 refers to a single stable isotope – total of $24 for analyzing both isotopes in a sample)

Stable Isotope Groundwater Analysis

Hi [Name]

Thanks for your inquiry! We can assist with these measurements, our current rate is $12 per sample. Turnaround time depends on the samples backlog and instruments used at the time of submission, so I cannot guarantee a turnaround time now, however, I don't expect it to be very long as you don't have many samples.

I hope this helps, please let me know if any questions!

All best,

[Name]
Senior Research Scientist and CSI Manager
Center for Stable Isotopes; Interdisciplinary Science Cooperative
PAIS Building
MSC 04 2553
1 University of New Mexico
Albuquerque NM 87131
That said, yes we can run dD and d18O on waters here at UNR, but we cannot run tritium analyses. The cost is:

- Water-dD $29 each
- Water-d18O $29 each
- i.e. $58 for both water-dD and water-d18O analyses

I hope this helps, and please let me know if you have any additional Qs.

Sincerely,

[Name]

Research Professor
COST and additional information:
Tritium content in Water Samples:
  - $190 per sample.
  - Detection limit 0.5 TU, or 1.3 pCi/L for 9X enrichment

Stable Isotope Measurement
University of Arizona researchers receive discounted rates for some analyses. Please contact David Dettman (mailto:%20dettman@email.arizona.edu) for our internal UA rate sheet.

Academic Rates (Industrial Rates and Payment Details are below)

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>MEASUREMENT</th>
<th>RATE</th>
<th>PRECISION (1σ)</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>WATER</td>
<td>dD and d$^{18}$O</td>
<td>$35.00</td>
<td>1.0%, 0.1%</td>
<td>A</td>
</tr>
<tr>
<td>WATER</td>
<td>dD or d$^{18}$O</td>
<td>$25.00</td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Water (&gt;200g/l salt)</td>
<td>dD and d$^{18}$O (activity)</td>
<td>$50.00</td>
<td>1.0%, 0.1%</td>
<td></td>
</tr>
</tbody>
</table>