23 Student Research Grant Application

Green Fund Mission Statement: "The NAU Green Fund promotes student participation in and provides funding for projects that reduce NAU's negative impact on the environment and create a culture of sustainability."

In support of the Green Fund's Mission Statement and its ability to improve sustainability on campus, the Green Fund will be accepting proposals for research projects that help to understand and reduce NAU's environmental impact, with the goal that this research funding could act as seed funding for Green Fund project proposals.

Student Research Recognized Needs:

- **Waste Minimization:**
  - Conduction of a waste stream analysis
  - Evaluation of reduced availability of single-use plastics on campus
  - Impacts and tracking of waste during student move in/out
  - Construction of a student-friendly e-waste system
- **Emissions & Transportation:**
  - Carbon sequestration through campus landscaping practices
  - Contribution of campus green spaces to carbon sequestration
  - Feasibility of alternative transportation to campus
  - Carbon emissions of manufacturing construction materials used on campus
  - Analysis of carbon emissions of NAU
- **Intersectionality & Environmental Justice:**
  - Incorporating knowledge from Indigenous communities into NAU curriculum and campus culture
  - Evaluation of the impact of vegan/vegetarian diets on NAU dining services purchasing
  - Demographic of students experiencing food insecurity
- **Other:**
  - Audit of diverted energy from replacement of non renewable sources to green alternatives
  - Sustainability effective products as a replacement
  - Green roof feasibility on campus and cost-benefit analysis
  - Analyzing water capture and reduction on campus

- Understanding sustainability behavior/perspectives of NAU students

Grants will be awarded using rolling deadlines and the Committee will enforce a priority date with a soft close during week 12 of the semester. Due to limited time and a reduction in weekly meetings at the end of the semester, the Committee may not review applications submitted after.

Priority Deadline: November 17th, 2023

Submit completed application packages to: GreenFund@nau.edu

Application Details

All applications **must** meet the following requirements to be considered for funding:

1. Research must be primarily conducted by either an **undergraduate or graduate student** who is currently enrolled full-time at NAU.
2. Research must be conducted under the guidance and approval of a full-time NAU faculty member.
3. Research design and goals must focus on improving sustainability on NAU's campus.

Only a complete application package will be considered for funding. A complete application package includes:

- An abstract of the project's goals, expected results, and broader impacts to the NAU campus community; 200-300 words.

Stormwater management challenges caused by precipitation and subsequent flooding have been an issue for the Flagstaff following recent wildfires. To aid in stormwater retention, the city has released an incentive for the construction of Low Impact Detention Basins (LIDs) for stormwater capture fee reductions. Any landowner is eligible for bracketed reductions as long as the LID can retain 500 year storm. As a benefit, LID basins aid in the filtration runoff and recharge of groundwater - one of three water sources for the city. With the fee reduction incentive and the benefit of promoting groundwater recharge and reducing downstream effects, the continued installation of LID basins around NAU's mountain campus parking lots provide a sustainable solution for stormwater management issues.

The goal of the project is to determine the influence of LID basins on runoff filtration and groundwater recharge. This study is significant because of an anticipated 77% rise in stormwater capture fees over the next five years, which will cost NAU nearly $1,000,000/year for the current parking lot areas. Implementation of LID basins at NAU's largest parking lot - P62 - is eligible for $20,000/year in fee reductions when designed to the 500-year storm. Building a case for this implementation is aided by stating the current sustainable benefits the existing LID basins have. Continued development of these basins would further reduce the annual fees from the city.

The anticipated results of analysis will demonstrate improvements in water quality and enhanced groundwater replenishment made possible by the use of existing LID basins This research serves to build the case for sustainable stormwater management techniques on NAU's campus that align with both the Landscaping Master Plan and Sustainability initiatives.

- Detailed project proposal with specific information about current literature, research goals, methods, and how this research will improve sustainability at NAU; 1-2 pages.

Urbanization of land to create NAU's campus has caused significant changes to the ability for substantial amounts of water to infiltrate into the ground. Impervious surfaces, like parking lots, decrease the amount of water retention in soil and increase the amount of water quality pollution. According to the article *Low-Impact Parking Lot Design Reduces Runoff and Pollutant* impervious surfaces in watersheds are the main contributor to pollutant loads and created from vehicle operation and settled airborne pollutants to stormwater runoff than any other form of land use [1]. Also, if not contained, water in watersheds with 10% or more of impervious surfaces can have negative impacts on downstream flow and cause damage to ecosystems and cause floods. This creates an increased urgency to create solutions to the potential damage of flooding and water pollution from precipitation events. The City of Flagstaff relies on three sources of water: Upper Lake Mary, deep aquifers, and reclaimed water [2]. Water availability is becoming more variable as climate change poses increased strain on precipitation regularity, which increases the probability of intense flooding events. As the city continues developing to accommodate regional migration, runoff water quality issues may arise from the increase of impervious surfaces like parking lots. Parking lots retain pollutants that are carried off by runoff and are transported into the groundwater or downstream areas. The Environmental Protection Agency (EPA) has identified Low Impact Development (LID) detention basins as a method to filter runoff; using onsite, sustainable, and green infrastructure these basins work to increase water quality and reduce downstream flow by promoting water capture and groundwater recharge in the article *Protecting Water Quality from Urban Runoff* [3]. The long-term goal of this project is to identify the effectiveness of LID basins through research, create a proposed design for an NAU parking lot during Senior Capstone and develop a plan to expand LID use across NAU's mountain campus.

The team has been tasked with answering the following questions for Dr. Adam Bringhurst: What are the water quality issues associated with parking lot runoff? And what effects do LID basins have on water quality and groundwater recharge on NAU's campus? Over the next 5 years, the city is imposing a 77% increase in impervious surface stormwater runoff fees, which will cost NAU nearly $1,000,000 per year for parking lots alone. However, effective LID basins qualify for large fee reductions because of lower downstream impacts of impervious runoff. In the Landscape Master plan, the university expresses the desire to use stormwater detention to improve water quality, reduce downstream flooding, and increase groundwater recharge - a goal to increase sustainability. Parking lots prevent water from direct infiltration into groundwater. LID basins are designed to collect this imperious runoff for filtration and infiltration.

The two first flush devices will be placed at the inlets of existing LID basins next to the parking lots P63 and P47A on NAU's campus. Here, the team will collect initial parking lot runoff samples and perform water quality analyses per EPA Industrial Stormwater Monitoring and Sampling Guide. Using the Environmental Engineering Lab, the samples

will be tested for\Chemical Oxygen Demand (COD), pH, Total Suspended Solids, and Turbidity. Total Kjeldahl and Dissolved Oxygen will also be measured. The National Service Center for Environmental Publications describes that excess amount of Nitrogen affects the level for dissolved oxygen in stormwater runoff and negatively affects plant life and ecosystems [4]. In conjunction with the water quality analysis will be the collection of precipitation data via rain gauges and hydrologic analyses to determine the volume of rainwater that flows off of parking lots and into the LID basins. For quality assurance, we will collect water quality samples for as many runoff events that occur during our data collection period to increase the quality of our analysis through a larger sampling size. Additional funding will allow for expansion of first flush devices to the outlets of the existing basins - now the effectiveness of the basin can be measured - and at P62. Devices at P62 inlets will provide an idea, with the measured effectiveness of the existing basins, on expected pollutant removal. Increased devices will increase the number of duplicate samples per event - ensuring quality assurance. The goal is to gather as much data as possible to be used in analysis.

We anticipate observing water quality levels from parking lot runoff that do not meet the National Pollutant Discharge Elimination System's standards due to high pollutant concentrations [4]. We anticipate an improvement in water quality and increased groundwater recharge demonstrated by the LID Detention Basins.

Through support of this research - and hopeful implementation of proposed design - NAU is acknowledging not only the benefits of sustainable landscaping for the community and environment, but also the negative footprint of the large parking areas currently experienced. As climate change increasingly affects the region, the use of traditional methods of stormwater capture lacks the aesthetic and environmental benefits of LID basins. LIDs offer islands of riparian habitat and promote filtration of runoff before infiltration to the groundwater. These basins are a catch all solution to the growing need for green solutions and align with NAU's commitment to sustainability efforts [5]. This design will present NAU a sustainable reduction in parking lot footprint that is a commitment from the college to better relationships and influences on the surrounding area.

- Questionnaire (filled out from template provided below).
    - Project budget (filled out from template provided below).
    - Project timeline (filled out from template provided below).
- Letter of recommendation from the faculty supervisor of the project which specifically addresses the student's ability to conduct and complete the research (may be submitted separately from the rest of the application package, but must be received by the deadline).

Project Advisor: Adam Bringhurst, PhD Civil and Environmental Engineering

Stormwater runoff from parking lots contributes to increased downstream flooding and decreased water quality in natural channels. With a focus on parking lots on NAU campus, this project aims to answer two relevant stormwater runoff questions. The first question is based on water quality. We will collect and analyze stormwater runoff for several water quality constituents. We will classify parking lot runoff and determine the improvements made to water quality by low impact development detention basins. Second, we will perform a high-resolution topographic survey of parking lot 62. We will delineate the subbasins of this parking lot and perform multiple hydrologic analyses to determine the volume of detention required to attenuate a 500-year recurrence interval storm. These are critical first steps in the design process for stormwater management. Looking forward, we would like to design and build a low impact development detention basin for Parking lot 62, we would increase NAU's sustainability by improving water quality, reducing the risk of downstream flooding, and add water to the local aquifers through groundwater recharge. Beyond the goals of this sustainable design is the hope to work with the City of Flagstaff to save NAU upwards of $20,000/year on their stormwater management fees.

These students are supported by the Civil and Environmental Engineering department with the use of lab space, lab and field-testing equipment, advising and technical support. I am providing technical support to the team on their experimental design and analysis of data.

The students are required to submit to me a professional report supporting the data which they collect. They will present their findings at the following conferences: UGRADS (NAU), The Student Water Symposium (NAU), and one of the following statewide conferences: the Arizona Floodplain Management Association annual conference (Chandler, AZ), or the Arizona Hydrological Society annual symposium (TBD). Additionally, three of these students are going to take this initial work and apply it to their senior capstone design project, where they will move forward with the design of an extensive network of Low Impact Development stormwater detention basins for parking lot 62.

I, Adam Bringhurst, the project advisor, understand that funding provided by the Green Fund may be used to fund student wages. I understand that the coordination of student wages must be done through the department of the project advisor/within the department that the research is being conducted. I understand that upon approval, funding will be dispersed to the department of the project advisor for all associated costs.

- Signed commitment from the student to present a status update of their research in the form of both an oral presentation to the Green Fund Committee and a poster/exhibit presentation at the Undergraduate or Graduate Symposium, no more than 1 year after receiving notification of funding.

Additional Requirements and Rules:

- Funding provided by the Green Fund may not be used in any way for faculty salary.
- Funding may allow for use as student wages depending on the specifics of the project and explicit approval from the Green Fund. The Green Fund recognizes that some projects require minimal physical materials, but rather a significant amount of time.
- If funding is being utilized to pay student wages, the applicant must coordinate these payments through the department of the project advisor (unless otherwise specified). The Green Fund does not coordinate student positions.
- Funding is limited to one proposal per student per year, but applicants may apply across multiple years. A student who has previously received a Green Fund Student Research Grant is no more or less likely to receive a second year of funding.
- Recipients of the Student Research Grant will be determined at the sole discretion of the Green Fund Committee. Funding is dependent on merit and goals-based review of all complete applications.
- As of Spring 2023, the Student Research Grant application portal and associated documents will remain available throughout the calendar year; however, funds will be encumbered at the beginning of each semester to cover the expected costs. Grants will be awarded using rolling deadlines to increase student participation and the Committee will enforce a priority date with a soft close during week 12 of the semester. Due to limited time and a reduction in weekly meetings at the end of the semester, the Committee may not review applications submitted after.
- Other university entities may need to be contacted for the utilization of space or alteration of existing infrastructure; this must be coordinated by the applicant.
- Upon approval, funding will be dispersed to the department of the project advisor
- Undergraduate students may budget $15.00/hour for 200 hours maximum
- Graduate students may budget $15.50/hour for 200 hours maximum
- **Any increase/decrease in these values is up to the discretion of the committee.**

Contact Information

Project Leader Name: Gabrial A Harju E-mail: gah229@nau.edu

Expected Graduation Date: Spring 2025

Project Advisor Name: Adam Bringhurst, PhD

Project Advisor Department: Department of Civil Engineering, Construction Management and Environmental Engineering

E-mail: adam.bringhurst@nau.edu

Position: Faculty Mentor / Instructor and Lab Manager for CECMEE Laboratory Facilities

Project Name: Identifying Impervious Surface Runoff Quality and the Roles of Low Impact Development Basins in Filtration and Groundwater Recharge

Date of Application Submission: Project Proposal 11/8/23; Revised Research Proposal 11/30/23

Questionnaire

Please select the focus of your research project, then address the following questions.

☐ Renewable energy/Energy efficiency
☐ Emissions reduction
☐ Environmental justice/Intersectionality
☐ Waste Minimization
☐ Understanding sustainability behavior/perspectives of NAU students
☐ Transportation
☒ Other: Water Resources and Sustainable Landscaping

1. How will your research promote the purpose of the Green Fund and further sustainability on NAU's campus?

   This research aims to build the case for sustainable stormwater management practices. Through the anticipated results, LID basins will be presented as an optimal solution for fee reductions, downstream impact, water filtration and groundwater recharge. Implementation of these basins is a commitment from NAU to the environment and the community. Reducing the footprint from large impervious surfaces demonstrates NAU's acknowledgement and action to lower its negative impacts. This research is the first step in achieving this goal as the results of analysis will be the basis for the proposed design of LID basins for P62, and the start of a vision to expand this technique throughout the campus, for all parking areas.

2. Will your research require the utilization of any spaces or infrastructure on campus? If so, identify the specific locations and/or infrastructure, how much of the space you require, and what each space will be used for. Please refer to the Space Committee Approval Process document to know if your research will require approval through the space committee.

   No. At this time, this project is focused on the research of feasibility for a Low Impact Development basin for P62. Space for construction is not needed at this time.

3. Will other departments on campus be needed to assist in this project (i.e. Facility Services, Campus Transit)? If so, identify department partnerships.

   No. At this time, the project's research step does not require partnerships for campus departments outside of CEIAS.

4. How will you monitor the impact of your research after completion? What do you plan to do with the results of your research?

   As mentioned, the collected data will be used to support the feasibility of a LID basin installation near P62. The collected data will be used to defend the effectiveness of LID basins in treating runoff water quality and groundwater recharge by sampling existing basins around campus. The results will be used in the justification for installation of an LID basin. Later impacts of this research will be visible in the design of a 500-year LID basin for P62 and possible installation of the proposed design pending later construction grants.

Project Budget

Please respond to the following funding question, and complete a thorough breakdown of all project costs in the provided Line Item Budget below. **Include a 5% line item for contingency of the overall costs**.

1. Does this project have any other sources of funding, and/or have you applied for other sources of funding? If so, list all additional sources of funding, both confirmed and potential, outside of the funds being requested from the Green Fund.

   The team is a Fall 2023 Recipient of the Jean Shuler Research Mino-Grant ($500). In addition to the Green Fund, the team will be applying for funding from the Hooper Undergraduate Research Award (HURA) and professional association scholarships as available. Additional funding will promote greater data collection opportunities.

Line Item Budget:

Non - Consumables (Researcher Pay)				
Item	**Item Justification**	**Quantity***	**Price per Unit**	**Price + 10% Tax****
Rain Gauge Installation	**Required Device for Precipitation Analysis**	**8 Hours**	**$15.00 / Hour**	**N / A**
First Flush Device Construction and Installation	**Required Device for Runoff Capture and Analysis**	**8 Hours**	**$15.00 / Hour**	**N / A**
P62 Site Survey***	**Required Step for Precipitation and Volume Analysis**	**40 Hours**	**$15.00 / Hour**	**N / A**
Survey Data Processing and Map Creation***	**Required Data for Precipitation and Volume Analysis**	**8 Hours**	**$15.00 / Hour**	**N / A**
Watershed Delineation***	**Required Data for Precipitation and Volume Analysis**	**8 Hours**	**$15.00 / Hour**	**N / A**
Hydrological Analysis***	**Required Data for Precipitation and Volume Analysis**	**8 Hours**	**$15.00 / Hour**	**N / A**
Runoff Sampling***	**Required Device for Runoff Analysis**	**8 Hours, 1 Hour per Storm for 8 Expected Storms**	**$15.00 / Hour**	**N / A**
Laboratory Analysis	**Required Device for Runoff Analysis**	**48 Hours, 6 Hours per Storm for 8 Expected Storms**	**$15.00 / Hour**	**N / A**

Consumables (Test Kits + Materials)				
Item	**Item Justification**	**Quantity**	**Price per Unit**	**Price + 10% Tax****
Total Kjeldahl Nitrogen (TKN) testing kits	**Required Test Kit for Runoff Analysis**	**1 kit order of 25 tests**	**$250**	**$275**
Chemical Oxygen Demand (COD) test kits	**Required Test Kit for Runoff Analysis**	**2 kit orders of 25 tests**	**2 x $55, $110**	**$121**
Total Suspended Solids (TSS) test kits		**2 kit orders of 25 tests**	**2 x $17.50, $35**	**$38.5**
First Flush Device (Constructed)	**Required Device for Runoff Capture and Analysis**	**2 devices**	**2 x $60, $120**	**$132**

* Non - consumable quantities reflect the shared total hours for completion amount researchers, not the quantity per researcher per item.

** Expected 10% tax to cover state tax and shipping + handling costs.

*** Opportunity to reduce budget impact by "in kind" outsourcing services such as: site survey, data processing, lab testing etc., to CEIAS courses will be utilized when available. This will promote field experiences to the course for non-team students.

Total Funding Requested: $

2040 (Non - consumables) + $566.50 (Consumables) = $2606.50 (Requested),

$2606.50 + 5% (Required contingency) **= $2736.83 (Total)**

Project Timeline

Please provide an expected timeline for your research in the template below. The Green Fund recognizes that complex projects of this nature should have flexible, adaptable schedules, and the timeline provided will be treated as such. However, it is expected that you strive to adhere to this schedule as much as possible.

Expected Timeline:

Action	**Parties Involved**	**Completion Month & Year**
First round of ordering test kits, rain gauges and first flush device materials	OURCA - Jean Shuler Mini Grant	11/2023
Installation of measuring devices and first flush test capture	CEIAS - Environmental Engineering Lab	11/2023
Environmental Lab testing and procedures practice, safety briefing	CEIAS - Environmental Engineering Lab	11-12/2023
Continued measurement and capture of runoff events. Followed by sampling and testing	CEIAS - Environmental Engineering Lab	12/2023 - 4/2024
Assembly of Fall 2023 and Spring 2024 research results for upcoming disseminations. Applications to present at events. Application to HURA.	OURCA, Arizona Floodplain Managers Association (AZFMA), Arizona Hydrological Society (AHS)	4/2024
Present at NAU Student Water Symposium	NAUSWS	4/2024
Present at NAY Undergraduate Research Symposium	OURCA, Jean Shuler, Green Fund	4/24/2024
P62 Site Survey and Data Processing	CEMEE / CEIAS - CM 499, CENE 286L	4 - 5/2024
Present at Arizona Floodplain Managers Association Conference	AZFMA	5/1/2024 - 5/3/2024
Present at Arizona Hydrological Society Symposium	AHS	TBD
Continued measurement and capture of runoff events. Followed by sampling and testing	CEIAS - Environmental Engineering Lab	5 - 8/2024
Begin Senior Capstone Design stage of multi - year project using collected data and results of analysis for 500-year storm capture. This marks the end of requested funding from the Green Fund as the team will be transitioning from research to design project.	CEIAS - 460C	9/2024 - 5/2025

Expected Project Completion Date: Runoff Data Collection 8/2024 (Research and Green Fund Funding), Design of Proposed LID basin 5/2025 (Senior Design Project).

Commitment to Present Research

Please read and sign the statement below, acknowledging your commitment to present the findings of your research.

If selected as a recipient of the Green Fund Student Research Grant, regardless of the outcome of my research project, I *Gabrial A Harju – as the student representative and applicant of the team -* commit to presenting the status of the research as described in this application in the form of an oral presentation to the Green Fund Committee or a poster exhibit presentation at the Undergraduate or Graduate Research Symposium, no more than 1 year after receiving notification of funding.

The oral presentation to the Green Fund Committee will consist of an approximately 10 minute long PowerPoint that includes the following aspects of your project:

- Original goal and purpose of research
- Conflicts or changes to the original purpose
- Results/Conclusion
- All relevant graphical displays of data

Student Signature: 

Thank you for your submission. We deeply appreciate your commitment to sustainability at NAU, and we look forward to reviewing your application. Please direct any further questions to ***GreenFund@nau.edu***.

Works Cited

[1] B. T. Rushton, "LOW-IMPACT PARKING LOT DESIGN REDUCES RUNOFF AND," 2001.

[2] S. M. City of Flagstaff. [Online]. Available: https://www.flagstaff.az.gov/4781/Stormwater-Rate-Adjustment.

[3] E. P. Agency, "Protecting Water Quality from Urban Runoff," 2003.

[4] E. P. Agency, "Guidance on Systematic Planning Using the Data Quality Objectives Process," 2006.

[5] N. P. D. E. System. [Online]. Available: https://www.epa.gov/npdes. [Accessed November 2023].

[6] N. O. o. Sustainability, "Green NAU," [Online]. Available: https://in.nau.edu/green-nau/office-of-sustainability/#:~:text=Our%20mission%20is%20to%20create,continuous%20improvement%20and%20sustainable%20practices.. [Accessed November 2023].