HERC/IGEM Project

Yr 3: Final Report

Project Title:	Sustaining the Competitiveness of the Food Industry in Southern Idaho: Integrated Water, Energy and Waste Management
Principal Investigator:	Dr. Karen Humes
Institution:	University of Idaho (lead) with subcontracts to Boise State University and Idaho State University
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Fiscal Period:	July 1, 2020 – June 30, 2021
Progress Report Submitted to SBOE:	July 8, 2021
Reporting Period:	July 1, 2020 – June 30, 2021

Table of Contents

1) Summary of project accomplishments for reporting period:

The accomplishments and plans for the four primary tasks identified in the original proposal are summarized here (Tasks A-D). A summary of accomplishments for the overall project management and coordinated stakeholder engagement activities are also summarized below, listed as Task E.

The team would like to stress that our partnerships with producers, processors, municipal treatment personnel and water management entities (private and public) are fundamental to all of our tasks and our project as a whole. Our Yr 3 activities have been influenced and enhanced by interactions with our Stakeholder Advisory Board (described in more detail under Task E below) and interactions with other stakeholders as well.

Task A) Recovery of energy, nutrients, water and bioproducts from waste streams: bench to place-based pilot projects

Team: Erik Coats (UI, environmental engineering/molecular biology; emphasis on resource recovery from waste streams); Armando McDonald (UI, biomass conversion and bioproducts); Kevin Feris (BSU, algae-based resource recovery and microbial ecology))

Team background and overall goals: This team collaborated for 10+ years and has the required multidisciplinary experience to integrate biological, chemical, physical and thermal approaches to the recovery of energy, bioproducts and nutrients from multiple waste streams. The team is leveraging investments made by the INL, CAES, HERC, and the IGEM incubation fund. Over the last 10 years our efforts have resulted in multiple extramurally funded awards, student training opportunities, scientific publications and a pending patent. We have worked across bench and pilot scales. Support from SBOE HERC allowed us to build a pilot scale system to convert dairy waste to value added products (biogas, bio-plastic, algal biomass); previous HERC funding supported construction of two pilot systems at UI by Dr. Coats–one located at the Moscow WWTP, designed for municipal wastewater and one mobile system (24 ft. trailer) designed for dairy manure resource recovery. We are engaged in testing, validating, and extending these systems to evaluate opportunities to recover high-value products (bioplastics, algae, biofuels) from industrial/municipal wastewater while achieving treatment. Research is focused on further understanding/optimizing our integrated system to maximize utility across input streams and demonstrate "real-world" applicability. Research objectives will further technology interrogations and advance wastewater as an economic resource. Ultimately, research will advance solutions that can be applied in Idaho agricultural and food processing sectors; producing economic value from waste will enhance Idaho-based industries by diversifying product portfolios.

Accomplishments this reporting period:

The following provides detail of progress in the first half of Year 3, building from Year 1-2 successes, towards the aims described in the original proposal.

i. Bench scale: Assess and evaluate nutrient recovery, energy reduction, bioplastics production, and algal production strategies to inform pilot scale operations.

a) Assessment of optimal process sequences (biological, chemical, physical, thermal) to recover energy, bioproducts (biofuels; bioplastics) and nutrients from mixed waste.

- (Coats) Phosphorus recovery from wastewater is most sustainably and reliably achieved through a process known as enhanced biological phosphorus removal, EBPR. Bench-scale EBPR operations are focused on ascertaining the effects of key process operational criteria on maximal P recovery. Building from past research efforts, current investigations are focused on two operational scenarios that integrate a new operational strategy. One operational scenario feeds all wastewater to the bioreactor at one time (beginning of the cycle), while the 2nd strategy feeds a more targeted, controlled wastewater (VFA-rich fermenter liquor) at the beginning of the cycle and then the raw wastewater stream at the end of the anaerobic period. The former operational strategy is identified as the A/O process, while the latter is known as the Westbank process. A central question relates to understanding the effect of adding VFAs outside of the anaerobic period. In Y2 research was expanded to incorporate a new operational strategy that controls the length of the anaerobic period, with concurrent measurement of the oxidation-reduction (redox) potential. Research suggests that "deep anaerobic" conditions (i.e., longer anerobic periods) can enhance and stabilize EBPR; we utilized real-time redox process monitoring to further evaluate this operational strategy and its impact on operational "success" vs. "failure." A Civil Engineering MS student completed all these assessments and completed her MS degree and thesis in early June 2021. Results also informed pilot (2021) operations. A publication is expected from this work.
- (Coats) Integrated with ongoing bench-scale EBPR bioreactor operations, another focus is analysis of a full-scale EBPR system to gain new insight into operation of secondary clarifiers related to achieved denitrification (reduction of nitrate to nitrogen gas). Excess nitrate recycled in an EBPR reactor can cause process failure. An MS graduate student defended his thesis June 25, 2021, focused on this topic. A publication is expected from this work.
- (Coats) Complementing EBPR investigations, we are investigating nitritation in an activated sludge wastewater treatment system achieving carbon, ammonia-N, nitrite-N, nitrate-N, and phosphorus removal. Nitritation is a biological process whereby ammonia-N is oxidized only to nitrite. Process success will result in significant energy savings in wastewater treatment. Process success was realized at both bench and pilot scale in late Y1 and in Y2/Y3; results are being reviewed to inform 2021 pilot operations, and also to generate a peer-reviewed publication.
- (Coats) Complementing the nitritation research are efforts to understand and better characterize denitritation, with the aim to further optimize the EBPR process for energy efficient nutrient recovery. Nitrate is a contaminant of concern in drinking water, and often must be removed from wastewater prior to discharge to the water environment. A primary concern with conventional EBPR processes that integrate nitrite/nitrate reduction is the potential production of nitrous oxide, which is a very potent greenhouse gas (300X CO_2). Bacteria exhibit variable metabolic pathways to reduce nitrate vs. nitrite; some bacteria cannot reduce nitrate to nitrite, which requires a more complex microbial culture to successfully eliminate nitrate from the wastewater. Ongoing efforts by one of Coats' PhD students is centered on better understanding the metabolic capabilities of bacteria and how

they reduce nitrate vs. nitrite. Preliminary research generated on this project will contribute to this student ultimately completing his dissertation in fall 2021.

- One of Coats' PhD students conducted intense evaluations of the dairy-based PHA pilot in Y1/Y2, with very successful results. Dr. Coats' student published a peer-reviewed journal manuscript that details the results from these investigations (Guho et al., 2020). The manuscript includes numerous team members, including McDonald's research team. Coats' PHA pilot also was operated spring/summer 2020 (Y2, Y3); a primary focus was to couple Coats' PHA pilot with his EBPR pilot to evaluate broader process integration for enhance waste resource recovery. Utilizing this data coupled with data generated from Coats' EBPR pilot, a peer-reviewed publication was generated (Coats et al., 2021) that focused on interrogating the "sustainability" of integrating the respective processes while also demonstrating proof of concept.
- (Coats) One of Dr. Coats' MS students in Environmental Science completed a comprehensive targeted metabolomics study of a mixed bacterial system synthesizing PHA bioplastics on fermented dairy manure. The MS student will defend her thesis July 1. Subsequent efforts will be made to i) publish the research, and ii) leverage results to further inform the manure-to-plastics process.
- (Feris) Algal cultivars were used throughout year 3 for routine experimental deployment. Experiments focused on cultivation at both bench and pilot scales employing wastewaters and waste nutrient from multiple sources (e.g. currently PHA effluent provided by the Coats lab and struvite provided by the City of Boise, respectively) to maximize nutrient capture and algal biomass production as well as production of high-value PUFA enriched algal biomass. Bench scale experiments have identified which strains produce optimal levels of biomass under various cultivation conditions and have been translated to pilot-scale operations of our greenhouse-based algal cultivation systems. Bench scale experiments have elucidated the effects of nutrient deprivation and temperature shock on biomass production when using struvite sourced nutrients (e.g. nitrogen (N) and phosphorus (P)) in the presence and absence of nutrient supplementation. On-going work is measuring effects of these treatments on PUFA production rates. We are continuing to work with three algal strains known to produce high concentrations of omega-3 fatty acids under the proper cultivation conditions (i.e. *Chlamydomonas reinhardtii*, *Nannochloropsis oculata*, and *Paeodactylum tricornutum*). Results from this work will be drafted into a manuscript as part of a MS thesis (by Mr. Alex Torres) during Fall and Winter of 2021, with a projected submission date in late 2021 or early 2022.

  (Feris and McDonald) We completed our greenhouse/pilot-scale cultivation experiments during Spring 2020 and Summer/Fall 2020 that utilized a mixed-culture approaches for the capture of nutrients from liquid wastewaters (i.e. PHA effluent from the Coats lab system). Produced algal biomass from these experiments have been (a) characterized for carbohydrate and lipid contents, (b) lipid fatty acid profiles, and (c) HTL processed by the McDonald lab in May-June 2021. The HTL aqueous fraction containing nutrients have been collected and analyzed for sugars and organic acids. During the summer of 2021 nutrients captured from the HTL processing of algal biomass will be tested as inputs to a struvite production system (either via modeling or bench scale struvite production). Struvite

produced in this way will then either be tested similar to the municipal struvite experiments described above or analyzed for mineral content to allow us to accurately estimate of the utility of the algae-capture nutrients purified by struvite production. Based on this suite of experiments we will determine the most appropriate mechanism for algal cultivation and nutrient source in our integrated system. A publication is expected from this work.

Greenhouse cultivation results indicate we can generate high and consistent/repeatable levels of algal biomass on PHA reactor effluents and that the growth rates, biomass yields, and nutrient capture rates are repeatable and reliable as well. Our data analysis suggests that our algal community and nutrient capture/biomass production system is resilient to a substantial temporal perturbation in cultivation/incubation. Therefore, providing additional evidence of the stability and reliability of this aspect of our system.

ii. Pilot scale assessments: Conduct pilot scale evaluations from mixed waste streams; implement/evaluate treatment resource recovery processes.

- Both Coats' pilot systems (PHA system located at the UI dairy; EBPR system located at the Moscow, Idaho treatment facility) were operational in Y1-Y3. Coats' research team was fully trained on systems operation.
- Completed 2020 operations of Coats' pilot operations. Former efforts continued to focus on collecting data to facilitate ultimate transition to a full scale system; data was used to prepare a journal manuscript (Guho et al., 2020). PHA pilot data greatly informed potential future scale-up to commercial operations, and the team is evaluating potential new funding opportunities to make the transition to commercialization. Latter efforts focused on preliminary assessment of integrated EBPR-nitritation, with an emphasis on integrating ammonia-based aeration control (ABAC) to enhance nitritation over nitrification. Successful nitritation was achieved for the entire operational period in summer 2020 (end of Y2; beginning of Y3); data evaluation is ongoing, with the aim to inform 2021 pilot operations that will continue post-grant.
- Coats' pilot scale system at the Moscow treatment facility is operational for May-October 2021. This grant supported efforts to continue operations.
- Pilot scale greenhouse systems were constructed at the Boise State research greenhouse and have been validated for suitability for cultivation of multiple algal strains. In 2019 we purchased, installed and tested a new 20L flow through centrifuge for rapid collection and concentration of the algal biomass produced in our pilot-scale greenhouse cultivation experiments. In 2020 we used this centrifuge routinely for the collection of algal biomass associated with our greenhouse cultivation experiments. These experiments have produced significant quantities of algal biomass for testing in our HTL process development (McDonald lab) as described in section (i). Data collection and analysis from the greenhouse/pilot scale experiments have been completed during the second half of year 3. These results will be used to inform decisions about which types of algal cultivation systems to couple with the AD/PHA aspects of our integrated system. We will continue to operate the pilot scale algal cultivation systems through 2021 in collaboration with the Coats and McDonald labs at UI and as described above for our struvite-based experiments.

iii. Produce prototype products (bioplastic mulch film, biochar, biofuel) for evaluation.

- One PhD student in McDonald's lab has been working on exploring "green" extraction and isolation procedures for producing pure PHA bioplastic generated from pilot plant operations in years 1 and 2. We have trialed the following solvents dimethyl carbonate (DMC), cyclohexanone (CYC), and ethanol in comparison with the standard solvent chloroform. We have also modified an extraction system to accommodate (0.5 kg) batches of biomass for hot extraction. It was shown the DMC was a suitable solvent to extract PHA and can be purified in 1-step rather than a 2-3 step process using chloroform. The new DMC extraction protocols have not had a major influence on PHA properties. We have written a draft manuscript and plan to submit it in July 2021.
- One M.S. student in McDonald's lab has completed her M.S. degree May 2021 and had worked on cross-linking pilot plant extracted and commercial PHA to improve its melt flow properties (rheology) for producing film products. The work shows that cross-linking has improved its melt strength (viscosity) and toughness of the modified PHA. A publication is expected from this work.
- Blends of polylactic acid (PLA) and PHBV (67/33) have been successfully blown into films (Figure 1) and this is a suitable strategy to utilize PHBV in film-based materials. Current and ongoing work will focus on increasing PHBV content by varying process parameters and/or cross-linking PLA-PHBV. This work has been done by McDonald's Ph.D. student. A publication is expected from this work.
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ii. Figure 1. Photo of blown-film being produced of polylactic acid-PHBV blend
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- Greenhouse scale experiments in the Feris lab have been completed and produced suitable quantities of algal biomass. Protein, carbohydrate and lipid content of the algae was determined prior to HTL experiments by the McDonald lab. And on-going analyses are comparing protein extracted/non-extracted algae for HTL. Primary outputs of HTL processing of algal biomass will include biofuel (i.e. biooil), biochar, and aqueous phase nutrients. The aqueous phase nutrients will be used for struvite production and secondary

algal cultivation (as described above).

iv. Partnerships with producers, processors and municipal treatment personnel are fundamental to all of these tasks. Team will build on existing relationships with Twin Falls wastewater treatment facility, Food Northwest, Chobani, Amalgamated Sugar, J.R. Simplot, Idaho Dairymen's Association, and Glanbia, and expand to new partners throughout this project

a. A third SAB meeting was convened virtually on December 15, 2020. This meeting focused on providing research updates to our SAB committee members and inquiring with them on where they felt we should focus our efforts over the remainder of year 3. Importantly, a significant component of this conversation was focused on strategies and pathways to commercialization of the technologies we have studied and developed during this project. More work is needed in this area and will likely continue beyond the scope of this project. However, the relationships and advice developed and received by our SAB will be essential to our successful translation from the laboratory to "real-world" deployment.

b. A second SAB meeting was held virtually on December 17th, 2019. This meeting focused on providing research updates to our SAB committee members and inquiring with them on where they felt we should focus our efforts over the remainder of year 2. SAB members were supportive of the direction of the research but provided feedback that the team should continue to focus on potential routes towards commercialization of the technologies under investigation. SAB members renewed their commitments to help the team pursue potential routes for commercialization as opportunities arise. Additionally, the SAB provided additional detail on how to best help move portions of our work towards commercialization. These included suggestions to focus interpretation and analyses of experimental outcomes in the context of typical or example real world systems. Specifically, to look into how our technology would translate to implementation at a 1500 head dairy (the typical dairy size in ID). The SAB also suggested we look into how implementation of our technology would help Idaho Dairies reach a net zero status. One means by which the team could achieve these goals would be to engage students and faculty from the Business schools in our respective universities.

c. Additionally, our SAB engagement resulted in leadership from the Idaho Dairymen's Association inviting two members of our team (Feris, Coats) to the joint Idaho/Utah Dairymen's association meeting in Salt Lake City, UT in July 2019. This meeting provided an opportunity to further develop relationships with regional dairy producers and to introduce them to the potential outcomes of our project. Additionally, the Idaho Dairymen's Association networked Coats/Feris with Newtrient LLC (Steve Rowe, CEO). Newtrient is advancing an integrated set of technologies focused on achieving 'net zero' emissions from dairies. Discussions will continue with Newtrient to i) potentially ascertain how the PHA technology might be integrated, and ii) potentially collaborate on future commercialization funding.

d. <u>Research plan adjustments in response to our Stakeholder Advisory Board (SAB):</u> SAB feedback from the mid-year meeting in December 2020 continued to support our focus on the utilization of struvite as a nutrient source for algal cultivation for production of high value biomass. Further, current algal cultivation experiments are being planned within the context of potential future application at a typically sized ID dairy and in the context of net

economic return. The Task A team also intends to build upon the SAB recommendations by contacting our university and regional support networks for business development. One of the Task A team's goals is commercialization of our integrated technology and during the 2nd half of year 3 we will work towards making appropriate contacts to forward this goal.

e. Another recommendation from our December 2019 SAB meeting was to evaluate i) the greenhouse gas footprint of Coats' PHA process, and ii) evaluate the potential of Coats' PHA process to remove phosphorus. These evaluations are ongoing.
f. One of our goals for year 3 of this project was to continue to build on our budding Stakeholder relationship with the hopes that they will blossom into partnerships for seeking pre-commercialization funding beyond the scope of this project. We continue to work towards this goal and during year 3, and beyond, we will focus our data collection efforts on system development and scale up as well as communication of research findings with our stakeholder group.
g. Research plan adjustments in response to the COVID-19 pandemic: Research facilities at the University of Idaho and Boise State University were shut down for a significant component of the second half of year 2 of this project. During the facility shut down research activities were focused on data analysis, literature reviews, and planning for experiments once facilities were reopened. Although some delays in data collection were experienced due to the COVID-19 pandemic, as of early June 2020, research facilities at both institutions are re-opening and since that time we have made significant progress towards our year 2 and year 3 research goals. Travel to and attendance at conferences/meetings that were planned were halted during this period and delivery of presentations impeded.

Goals/Plans for the remainder of Summer 2021 and follow-on research to be completed (Task A):

i: Bench scale

- Due to time limitations we have not completed our proposed experiments where the nutrients captured via HTL processing of algal biomass were to be tested in a secondary stage algae production system for high value commodity production either directly as aqueous nutrients or via production of struvite. However, we will strive to complete this work during the summer/fall of 2021 and use these data to evaluate the highest value use of the algal biomass and captured nutrients. This evaluation will be based on the algae's growth rates, yields, biomass characteristics, and economic potential when grown in the different wastewater nutrient sources.

ii: Pilot scale:

- We will continue to operate and analyze performance of Dr. Coats' bioplastics pilot system at the UI dairy.
  - Refine and evaluate operational criteria based on successes from Y2 operations.
  - Have produced 300 g quantities of bioplastic material from Coats' pilot scale system for McDonald's ongoing polymer characterization work.
  - Have undertaken blown film trials using commercial and pilot scale produced PHA bioplastics by blending with PLA (Figure 1).

- Operate and analyze performance of Dr. Coats' municipal enhanced biological phosphorus removal system located at the city of Moscow wastewater treatment system. Focus on translating/assessing operational criteria from Coats' bench scale reactors to his pilot scale systems. Specific focus will be:
  - Achieve and assess shortcut nitrogen removal
  - Evaluate the impacts of the return activated sludge flow rate on process stability and performance
  - Evaluate the impacts of integrating effluent from Dr. Coats' bioplastics pilot on overall wastewater treatment and resource recovery
- We will continue to operate the pilot scale algal cultivation systems through 2020-2021 in collaboration with the Coats and McDonald labs at UI.

iii: Producing prototype products:

- The Feris lab has produced suitable quantities of algal biomass in year 2 and 3 for HTL experiments in the McDonald lab. Primary outputs of HTL processing of algal biomass will include biofuel (i.e. biooil), biochar, and aqueous phase nutrients. The aqueous phase will be recycled to the algal cultivation system to enhance algal biomass production.
- Produce bioplastic blown films of PHA/PLA blends for assessment.

iv: Training:

- Conducting training for the city of Moscow, Idaho wastewater treatment staff, focused on the basics of biological wastewater treatment and integrating knowledge on the operation of their enhanced biological phosphorus removal system.

Task B) Decision-support tools for industry and community leaders to quantify and visualize trade-offs among water, energy, land use and municipal growth

Team: Jae Ryu, UI, systems dynamics modeling, water resources; Karen Humes (UI, water/energy nexus, geospatial analysis

Overall Goals:

The goal of this task is to integrate energy components into an updated version of a pre-existing system dynamics model for water supply, use and flows in the region of the Eastern Snake Plain Aquifer. The model which will serve as a decision-support tool for stakeholders (including the food producers, food processors, irrigation districts, water and energy providers and municipal communities/citizens). The tool will quantify and provide users with visuals on the linkages between water, energy, land use and municipal growth, to be used for planning and decision-making by producers, water users, businesses, utilities, state agencies and communities.

Accomplishments in Yr 3:

i) Improvements to the water portion of system dynamics model, including updates to correspond to most recent IDWR EPSAM output, and improved user interface to provide decision-support tool for stakeholders

- Evaluated the existing system dynamics model to determine how to implement water management options (e.g., managed aquifer recharge) given the existing data types available
- Interacted with IDWR on their newest ESPAM (Eastern Snake Plain Aquifer Model) model version and updated data to be released by IDWR in 2021
- Evaluated the feedback from IDWR and Surface Water User's Association at the stakeholder meetings in May 2019, Dec 2019, and Oct 2020 and how the ESPAM output could be more useful for stakeholders by incorporating ESPAM-derived behavior into the system dynamics model and creating a user-friendly interface that to allow stakeholders to adjust/understand the impacts of key system variables, thus serving as a decision-support tool for stakeholders
- Incorporated new features that are available in Stella Architect into the system dynamics model and user interface
- Performed an-in-depth review of the theoretical and technical background of each variable applied to the water balance, including the way it was produced by or for the IDWR ESPAM, how the data was accessed in 2008, and how it may change under new versions of ESPAM.
- Developed adaptable and individualized R coding to organize recent versions of the ESPAM data to work with the existing System Dynamics framework. All of this data may change along with changes to ESPAM, including units, size/number of entities, how calculations are performed, and format of the data. Thus, it was necessary for our R coding to be flexible in order to evolve with frequent changes.
- In order to formalize the process for reviewing and adapting the data in the future, R "markdown" files were used to begin development of a "bookdown", which can be used as an instructional guide and reference for future users working with the ESPAM data and system dynamics model.
- The ESPA System Dynamics model was streamlined to increase ease of updating data.
- Verified all units and calculations in the system dynamics model to ensure that they continue to match any formatting changes with the updated ESPAM data.
- Three separate model files were created for additional ease of use, depending on if the user wants to primarily focus on climate issues, is interested in varying the different types of groundwater pumping and recharge, or wants to work as deeply as the surface/groundwater entity scale.
- The newest version of the R bookdown file was completed and published in such a way that it is widely accessible, including researchers and water stakeholders.
- The models now represent the most recent data available from IDWR (Sept. 2018) and the new data in the system dynamics model are now available for stakeholder engagement and scenario planning.
- Improved graphical user interface by making the decision support tool available in the public domain over the internet so that all water interest groups can evaluate various scenarios by incorporating their interest and needs, ultimately enhancing water management decisions in ESPA.
- Updated available water data for Stella Architect using the outcomes from the latest version of ESPAM model
- Incorporated management options into the model, such as water conservation, managed recharge, etc.
- Developed system evaluation criteria associated with new data inputs and potential uses for the expanded and update model, such as system reliability, vulnerability, resilience, etc.

- Notes have been added to the models to reflect changes and improve ease of understanding.
- A manual was written to discuss the functioning of the model files, sources of data, and procedures for update.

ii) Further improvement of systems dynamics model to include linkages between water and energy use in irrigation

- Explored available data on energy use in irrigation, including interactions with IDWR and collaboration with experts on energy use in irrigation at Idaho Power.
- Further evaluation of spatial patterns in energy use for irrigation in the ESPA and controlling factors in order to identify key variables to relate water and energy use in irrigation (i.e., crop type, irrigation system characteristics, water source, etc.). Data analysis nearly complete, with publication to be submitted and relationships coded into systems dynamics model in August 2021

Follow-on tasks post grant period:

- The team will continue to work with stakeholders to disseminate the decision support tool to water users and food production/processing entities, as well as seeking external funds to continue to improve it and disseminate it.

Task C) Technical innovations/sensing systems to reduce water/energy/nutrient use in targeted production systems:

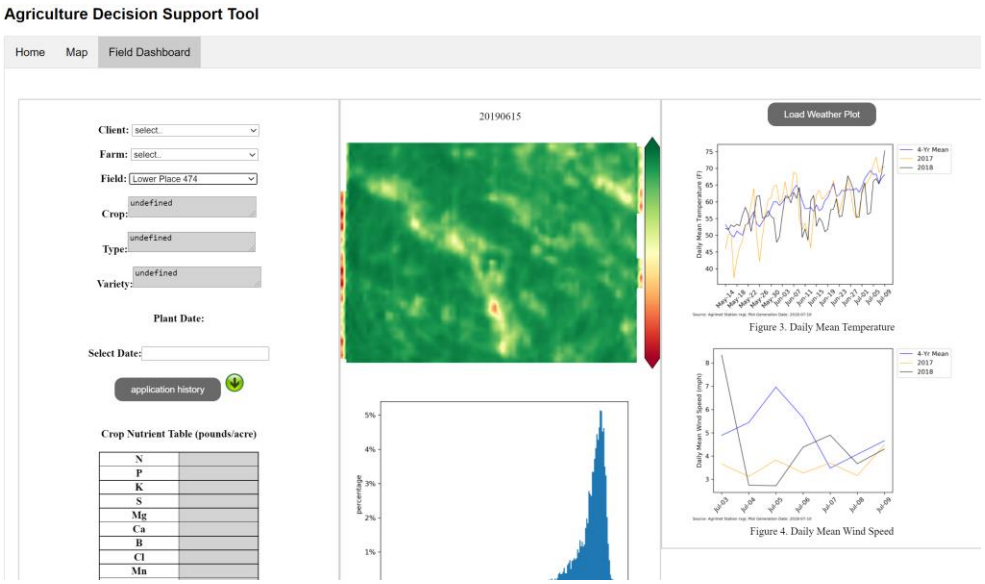
Primary team members: Donna Delparte, (ISU, drone and satellite-based sensing systems) and partners among growers and crop consultants.

Accomplishments this period:

Progress in the following task area has been made through the subcontract award to Idaho State University and included:

- **Goal 1 – Decision Support Systems**
    - With our stakeholder input and feedback, our programmer (Di Wu) implemented a decision support online prototype tool for sustainable agriculture decision making: http://avalanche.geology.isu.edu/i2i/progro_hist2.html
    - This decision support tool was developed by working with stakeholders and our Advisory Board member (Brandon Vining, ProGro) to provide remote sensing data/tools to aid decision making that is relevant to business decision making and operations
    - A key component of the decision support system is to use a historical record of vegetation health over growing seasons going back to 2016 to develop a field prescription map for variable rate nutrient application
    - Stakeholders can browse satellite imagery taken over growing seasons 2016-2020 showing field variation within individual fields online and review prescription recommendations for the coming year

- Stakeholders are utilizing the outputs of the tool to improve ROI, reduce fertilizer inputs and improve precision farming techniques for sustainable agriculture
- Python code to automate nutrient prescription generation is now integrated in to the online tool and producers are adopting new fertilizer prescriptions.
- We have improved the interface to provide a dashboard (see image below) that is useful to growers.



- **Goal 2 - Pilot projects to use drone-based, other field-based and satellite sensors to reduce water/nutrient/energy use in production of targeted crops**
  - Hyperspectral camera data collection during the 2019 and 2020 growing seasons supplied a foundation to develop a model for detection of Potato Virus Y (PVY) in potato fields. This spring, our team collected new data from 2021's potato crop and used our model to identify infected plants in the field.
  - PhD student Mike Griffel developed Python code to apply a detection method to identify individual unhealthy plants in a grower's field. This approach leverages machine learning of hyperspectral imagery – thus offering the opportunity to reduce inputs for control and mitigation of disease. We are working with an outside venture capital company to market this technology in partnership with our spin-off company.
  - By individually detecting these plants we can provide coordinate locations for plant removal to existing spraying equipment to target and destroy these plants. By removing these plants, less nutrients are required to mitigate the impact of the virus.
  - Co-I Delparte launched a new Idaho based spin-off company (I2IGeo) to provide growers with technological innovations and decision support to aid their operations, leveraging the research outcomes from this grant.
  - To increase business market potential and kick start I2IGeo LLC, Delparte attended the Idaho I-Corps Ignite Faculty Summer Workshop offered by UI, BSU, ISU and the Center for Advanced Energy Studies.

Plans for the remainder of Summer 2021:

Our team will focus on the final testing and validation of UAS platform and sensor combinations for summer 2021 data collection. The emphasis will be on in-situ PVY detection, nutrient management decision support systems. Dr. Delparte will also continue to work actively toward commercialization of the most promising technologies from this research through her new Idaho company (I2IGeo) based on knowledge and skills developed in the I-Corps Ignite program.

- Additional training/testing with growers on the effectiveness of the satellite-based decision support tool for nutrient application prescriptions
- Commercialization of early season in-situ detection of PVY in potato crops
- Final stakeholder input on preferred delivery methods of time critical data and information related to yield forecasting and best practices for the treatment and removal of infected plants.

Task D) Engaging the present and future workforce in the adoption of new technologies

Team members for training (primary): Karen Humes, Erik Coats, Kevin Feris, and partners at CSI, UI Idaho Falls and professional organizations such as Food Northwest, *Primary team member for drone outreach activities:* Jae Ryu (Idaho Drone League (I-Drone), Founder).

Overall goals:

The overall goals in this task are two-fold: 1) to provide direct support to our stakeholders in the near-term by identifying workforce development needs that universities could plan and implement, together with partners at community colleges and professional organizations (resourced primarily in Yrs 2 and 3) and 2) contribute to longer-term workforce needs by holding outreach events designed to engage the future workforce in STEM activities that will serve the food industry in Idaho in the future, such as drone operations and the analysis of data from sensors onboard drones.

Accomplishments this period:

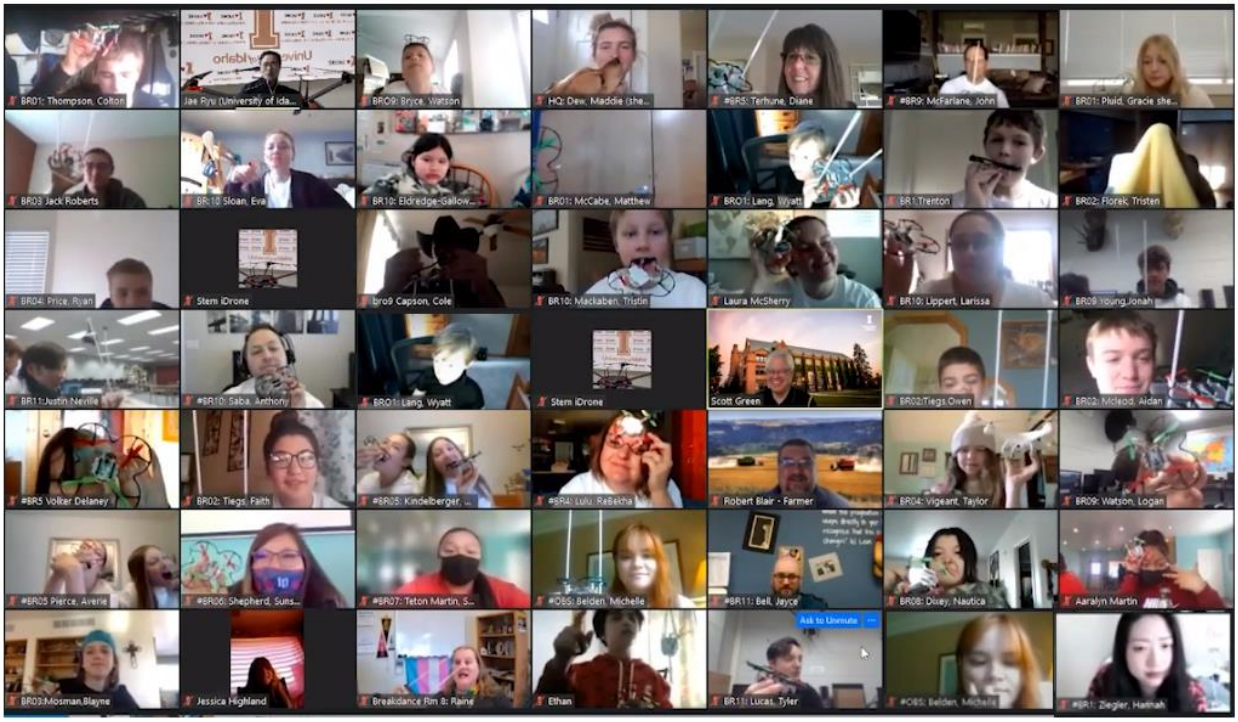
- *Goal 1: Current/near-term workforce development needs*
  - Due to Covid-19 and the cancellation of the meetings for the rural water treatment association, some of the outreach planned for the end of Yr 2 and during Yr 3 for outreach to these professionals via these meetings was difficult to accomplish. However, the team is continuing to engage with our Stakeholder Advisory Board and professional organizations such as Food Northwest and stakeholders such as the IDEQ on needs and opportunities in professional development on pollution control and management. We will continue to identify and implement professional development needs in food, water, energy and waste and interact with stakeholder to identify ways in which the universities can catalyze and facilitate these.
  - In order to better prepare university graduates for careers in integrated management of food production/processing, water and waste streams, as well as maintaining the tri-

institution collaboration in this IGEM grant, the universities plan to develop and maintain an ongoing seminar series in Food-Energy-Water-Waste for faculty, undergrads and undergraduates. The seminar will be joint among the three universities and include coordination with the CAES (Center for Advanced Energy Studies) organization.

- *Goal 2: Longer-term workforce needs*

An important component of meeting longer-term workforce needs throughout all years of our project has been hosting a virtual education program known as "Idaho Drone League(iDrone)" in the Treasure Valley and elsewhere throughout the state. The purpose of these events is to promote STEM pipelines and skills important to the Idaho food industry in the future.

Two Idaho Drone League events took place on October 10, 2020 and April 2-3, 2021 in Year 3. But due to the global pandemic, these events were offered online. Despite the virtual format, the event was very well attended.



For the April 2-3, 2021 event, more than 80 people joined this meeting online, including UI President Green, 12 Zoom breakout session coordinators, 65 registrants, and 10 observers.

Task E) Project Management/Stakeholder Engagement

Background: An important element of our project management was to put together and meet regularly with an advisory board comprised of stakeholders in the food production and processing industries, water user groups and state agencies. In Year 1 we formed this advisory and had a very successful 1st meeting in person in Boise in early May 2019. As noted in the technical progress reports (earlier sections of this report), the board feedback influenced our research plans in Year 2, as planned. The board agreed to meet in its entirety once/yr in person (May/June), once/yr via videoconference (Nov/Dec) and have specialized meetings between specific sub-groups of team and advisory board members in between.

Accomplishments this period:

- We held a 3rd meeting of our full Stakeholder Advisory Board (SAB) on Dec 15, 2020. Due to travel restrictions because of the ongoing pandemic, the meeting was held by video conference. The following SAB members attended and those listed with a (*) were invited and had hoped to attend but were not able to do so:
    - Jeff Bohlscheid, Senior Principal Scientist, J.R. Simplot Company*
    - Shawn Moffitt, Regional Business Manager, Jacobs Engineering (contractor for City of Twin Falls and Chobani water treatment plants)
    - Megan Satterwhite, Operations Manager, Idaho Dairyman's Association
    - Ben Nydegger, Biosolids Program Manager, City of Boise
    - Sean Vincent, Hydrology Section Manager, Idaho Dept of Water Resources*
    - Ben Jarvis, Pollution Prevention Projects Coordinator, Idaho Department of Environmental Quality
    - Brian Olmstead*, President, Surface Water Appropriators and General Manager, Twin Falls Canal Company
    - Brandon Vining, ProGro Consulting

- As noted on early sections of this report, the Task A team has been engaged in discussions with the Idaho Dairyman's association and the Newtrient LLC on technology transfer, the Task B team is interacting with water users for dissemination of the decision support tool for water/energy planning, and the Task C team was highly engaged with stakeholders in the food production arena on decision support tools.

Plans for follow-on:

- We will hold a SAB meeting in August 2021 to discuss final project accomplishments from Summer 2021 field and research season and discuss plans for follow-on with stakeholders
- Develop a task force that will continue to meet beyond end date of the grant to discuss mechanisms for transfer of applied research from the grant into the private sector. The task force will consist of personnel from the research team, tech transfer and economic development officers from the Office of Research and Economic Development from UI, BSU and ISU, plus stakeholder advisory board members as available.

- Continue to build on existing relationships with Twin Falls wastewater treatment facility, Food Northwest, Chobani, Amalgamated Sugar, J.R. Simplot, Idaho Dairymen's Association, and Glanbia to engage in follow-on applied research and mechanism for technology transfer.

2. Summary of budget expenditures to date for Yr 3

A detailed expenditure report for estimated expenses incurred at the UI is provided in Appendix A. Please note that this does not constitute a final report, as some expenses incurred before June 30 are still clearing the system, but this is what we anticipate to be as close to our final numbers as we are able to estimate at this time. The table below summarizes the spending in the major budget categories, relative to the budgeted amounts for Year 3. Please note that the line below for Operating Expenses (OE) includes the amounts originally budgeted for both OE and Participant Costs. This is because the expenses placed under participant costs in the original 2018 budget were judged by the UI accounting personnel to be more appropriately placed under the category of Operating Expenses.

Per grant guidelines, the UI and both subawardees, prior to June 20, the UI and both subawardees carefully projected all spending that would occur by June 30 and returned to SBOE funds that would not be spent by 6/30. The UI and ISU projected that all funds would be expended by June 30, but subawardee Boise State University projected that $6623.60 would not be spent by June 30. The UI sent a check to SBOE in that amount just prior to June 20, 2021. A final and full financial report will be sent to SBOE within the typical timeframe for final grant closeout.

Estimate of Funds Expended (not final)

Category	Budget	Funds Expended	Difference
Salaries/Hourly/Fringe	297756	297378	378
Travel	3337	2520	817
OE	83998	85151	-1153
Participant Support	0	0	0
<$5K Capital	85	85	0
Trustee/Benefits	63410	63452	-42
Sub Contracts	247414	240790	6624
Total	696000	689376	6624

Note: $6623.63 returned to SBOE on 6/20/21

3. Demonstration of economic development/impact

- Patents, copyrights, Plant Variety Protection Certificates received or pending

Co-I Dr. Donna Delparte has formed a private company in Idaho called ***I2IGeo*** and is working to develop a commercialization pathway for her research on this grant related to the use of satellite and drone technology to assist growers in the application of nutrients, herbicides, pesticides and water.

- Private sector engagement

Because every aspect of our work involves considerable private sector engagement, we have noted those engagements in each of our five tasks described in Section 1, particularly under *Task E: Project Management/Stakeholder Engagement.*

- Jobs created

Several of the research assistant and all of student research assistantship positions described in the next section were newly created in Year 1 of this grant.

4. Numbers of faculty and student participation

In Yr 3, the numbers of faculty, students and other researchers participating are as follows:

Faculty: 6 (4 UI, 1 BSU, 1 ISU)
Graduate Students: 11 (7 UI (3 whom are from groups underrepresented in STEM), 2 ISU; 2 BSU (both of whom are from groups underrepresented in STEM fields)
Undergrad Students: 7 (5 at UI, 2 at BSU)
Research Scientists: 1 (1 ISU, both partially supported by this grant)

More details on staffing, by Task:

Task A: Recovery of energy, nutrients, water and bioproducts from waste streams

Coats staffing: 2 PhD students in Environmental Engineering (one PT, one FT); 3 MS student in Environmental Engineering; 4 undergraduate students in Environmental Engineering. 4 women, 5 men.

McDonald staffing: 1 PhD student in Environmental Science. 1 woman.

Feris staffing: Current staffing includes 2 male graduate students (both from underrepresented groups in STEM). Both graduate students were previously employed as research technicians on this project, however, by Jan 2020 both transitioned to the MS graduate program in the Biological Sciences with a Spring 2020 start date. Both students will participate in experimental development, data collection, and data analysis. We have recruited 2 undergraduate students (1 or 2) for the second half of year 2 and year 3 to assist with laboratory and greenhouse scale experiments.

Task B: Quantifying Water/Energy Linkages

- 1.5 PhD students (1 in Geography, 0.5 in Water Resources) were supported throughout Yr 3. In the last quarter of Yr 3, we sought and received permission to redirect travel funds to support two undergraduates and one additional graduate student as research assistants for this task.

Task C: Technical innovations/sensing systems for reducing water/nutrient use in targeted production systems

- 1 PhD students in Geosciences
- 3 summer Masters students in Geoscience
- 1 research/programming technician

5. Description of future plans for project continuation or expansion

- PI Karen Humes is a Co-Lead on the CAES Focus Area group in the Energy-Water Nexus arena. Being a CAES Focus Area lead provides some access to CAES resources, including program development funds, to build a team of CAES researchers in pursuit of establishing CAES as a global leader in research, education, and innovation related to the energy-water nexus. Team members of this project are looking forward to leveraging our current work to pursue future opportunities. The coupling of food, water and energy is exceptionally strong in southern Idaho, from both a national and international standpoint, making a compelling case for other funding sources. Our integrated approach to water, energy and waste is also unique among teams studying the food-energy-water nexus. She and Co-I Erik Coats organized and attended a workshop at CAES in Idaho Falls on Nov 25, 2019 and are now involved in developing proposals.

- Team members are also actively writing grants to other agencies for related work, such as the NSF, USDA and NASA. This includes a current effort led by PI Karen Humes and involving Co-I Erik Coats and 6 other UI faculty) for a graduate student training grant to NSF (the NSF Research Training Grant progam, or NRT) related to water quality and public health, with emphasis on Idaho (proposal was submitted to NSF in Feb 2021 and is currently pending). This effort includes also stakeholder partners such as IDWR, IDEQ, and the City of Boise Dept of Public Works. The NSF-NRT program is highly competitive and it would be very unusual for the proposal to be funded on the first attempt; however, if not funded, the team is dedicated to strengthening the proposal (particularly the partnerships with stakeholders) and resubmit in Sept 2021.

- Co-I Erik Coats (and team leader for Task A of this grant) is a Co-I on the recently awarded 5-yr $20M grant funded by USDA, led by the College of Agriculture and Life Science, that has among its goals the recovery of byproducts from dairy waste. Dr. Coats will ensure that progress made in the IGEM grant will be brought to bear on the USDA grant and vice-versa.

- Delparte (Lead Task C) received funding to further the PVY testing for the upcoming growing season from the Idaho Specialty Crop Block Grant (Idaho State Department of Agriculture/US Department of Agriculture). Awarded. Field Trials for an Automated Early Season Potato Virus Y (PVY) Detection System. PI- Delparte. Oct 2020 to Oct 2022. $97,803.16

- Delparte (Lead Task C) is working towards commercialization of research supported by this initiative to aid growers in sustainable fertilizer applications and towards a targeted treatment approach for potato virus y.

- All 6 members of the Co-I team are active grant writers and continue to look for new opportunities to “bridge the gap” between academic research and state needs in this arena. One such opportunity we will be evaluating in the future is a new proposed program within the National Science Foundation (NSF) specifically designed to create stronger partnerships between academic institutions and technological needs. The current administration budget proposal for for FY22, the NSF budget includes $865 million for the new program called Technology, Innovation, and Partnerships. We will also aggressively pursue other opportunities within USDA, NSF, EPA, NASA, and other federal agencies.

6. Expenditure reports

The expenditure reports presented in Appendix A details the expenditures at the University of Idaho, as of July 7. As noted above, this is not a final report, as some personnel charges are still clearing the system and a small amount of operational expenses incurred are in the process of being removed.

7. Commercialization Revenue

None to report yet, but the company I2IGeo (Co-I Delparte as Founder) has been formed. Delparte attended the Idaho I-Corps Ignite program in Summer 2021 to learn more about business development and commercializing research.

Publications:

Guho, N.M., D. Pokhrel, M. Abbasi, A.G. McDonald, M. Alfaro, C.K. Brinkman, and E.R. Coats, Pilot-scale production of poly-3-hydroxybutyrate-co-3-hydroxyvalerate from fermented dairy manure: Process performance, polymer characterization, and scale-up implications. Bioresource Technology Reports, 2020. 12: p. 100588.

Bryant, C. and E.R. Coats, Integrating Dairy Manure for Enhanced Resource Recovery at a WRRF: Environmental Life Cycle and Pilot-scale Analyses. Water Environ. Res., 2021.

Coats, E.R., *B. Deyo, *N. Brower, and C.K. Brinkman, Effects of Anaerobic HRT and VFA Loading on the Kinetics and Stoichiometry of Enhanced Biological Phosphorus Removal. Water Environ. Res., 2021.

Appendix A

Detailed Expense Report

Detailed UI Expenditures as of July 7, 2021 and Final Invoices from Subawardees

Please note: This is not a final financial report, because not all expenses have cleared the reporting system. Final financial report will be forthcoming upon grant close-out, including detailed reports from subawardees

FWRITEM University of Idaho
Itemized Expenditures by Grant Code
From 01-JUL-2020 To 08-JUL-2021

Grant: SG4609 - ISBOE IGEM FY21 Sustain Food Ind-KH 08-Jul-2021 12:11 PM

Salaries		
E4106 Staff		
Brinkman, Cynthia		8979.78
495.02 hours		
E4108 Summer Salary		
Coats, Erik		2350.32
33.60 hours		
Humes, Karen		21228.48
288.00 hours		
McDonald, Armando		11225.76
156.00 hours		
Ryu, Jae		19585.32
334.46 hours		
E4109 IA/GA Salary		
Abbasi, Maryam		19869.76
992.00 hours		
Brower, Nicole		17100.00
912.00 hours		
Deyo, Brent		22800.00
912.00 hours		
Mellin, Jason		9903.52
272.00 hours		
Pokhrel, Dikshya		7547.40
420.00 hours		
Smoot, Lindsey		18700.00
992.00 hours		
Thompson, Emily		17245.80
780.00 hours		
E4175 Overtime - Covered by FLSA		
Brinkman, Cynthia		45.59
5.02 hours		
		$ 176581.73
Temporary/Irregular Help		
E4110 Temporary Employee		
Holownia, Sam		2250.00
125.00 hours		
E4135 Temporary Student		
Alfaro Salmeron, Glenda		1500.00
80.00 hours		

Black, Edward	5810.75
539.00 hours	
Brower, Nicole	1125.00
60.00 hours	
Buonarati, Nickolas	459.25
41.75 hours	
Crites, Willow	6301.65
576.00 hours	
Cutler, Kylie	270.88
25.00 hours	
Deyo, Brent	2000.00
80.00 hours	
Emerick, Austin	1245.75
116.50 hours	
Guho, Nicholas	8972.98
323.00 hours	
Hurdman, Julie	688.50
38.25 hours	
Neupane, Saurav	10657.64
992.00 hours	
Thompson, Emily	6440.00
280.00 hours	
Walters, Riveraine	10448.00
434.00 hours	
Woodruff, Craig	3625.00
145.00 hours	

	$ 61795.40

Fringe Benefits

E4280 Faculty CFR Benefit Expense	16697.67
E4281 Staff CFR Benefit Expense	3772.59
E4282 Student CFR Fringe Expense	3627.07
E4283 Temporary CFR Benefit Expense	177.75

	$ 24275.08

Travel

E5360 Personal Vehicle - In-State

28-SEP-20	I2149392	Ryu, Jae H.	147.53
20-OCT-20	I2152672	Ryu, Jae H.	190.53
20-OCT-20	I2152672	Ryu, Jae H.	251.98
20-OCT-20	I2152672	Ryu, Jae H.	250.36
20-OCT-20	I2152672	Ryu, Jae H.	251.98
20-OCT-20	I2152672	Ryu, Jae H.	190.53
19-NOV-20	I2156564	Ryu, Jae H.	112.70
20-NOV-20	I2156758	Ryu, Jae H.	150.35
23-JUN-21	I2184245	Ryu, Jae H.	175.19
23-JUN-21	I2184245	Ryu, Jae H.	143.68

E5367 Rental Vehicles - In-State			
13-OCT-20	Z1010112	Car Rental Fuel 09142020	26.52
13-OCT-20	Z1010112	Car Rental Fuel 09152020	16.27
13-OCT-20	I2151573	Ryu, Jae H.	87.55
E5396 Lodging & Per Diem ? In State			
28-SEP-20	I2149392	Ryu, Jae H.	49.00
13-OCT-20	I2151573	Ryu, Jae H.	26.00
13-OCT-20	I2151573	Ryu, Jae H.	23.00
20-OCT-20	I2152672	Ryu, Jae H.	42.00
20-OCT-20	I2152672	Ryu, Jae H.	49.00
20-OCT-20	I2152672	Ryu, Jae H.	49.00
20-OCT-20	I2152672	Ryu, Jae H.	42.00
20-OCT-20	I2152672	Ryu, Jae H.	49.00
19-NOV-20	I2156564	Ryu, Jae H.	49.00
20-NOV-20	I2156758	Ryu, Jae H.	49.00
23-JUN-21	I2184245	Ryu, Jae H.	49.00
23-JUN-21	I2184245	Ryu, Jae H.	49.00

			$ 2520.17

Operating Expenses			
E5020 Postage & Mailing			
13-JAN-21	Z1012991	Shipping materials to graduate stud	28.99
E5023 Express Mail			
05-JAN-21	Z1012750	RyuJa 893235 USPS Stamps and mailin	15.40
14-JUN-21	Z1018542	Shipping Charges for the Spectromet	112.80
29-JUN-21	Z1019772	McDonald, A: FedEx shipping costs t	508.27
30-JUN-21	I2185662	Ryu, Jae H.	17.99
30-JUN-21	I2185662	Ryu, Jae H.	17.99
30-JUN-21	I2185662	Ryu, Jae H.	350.00
30-JUN-21	I2185662	Ryu, Jae H.	17.99
E5025 Printing & Binding			
09-SEP-20	J1275946	Tckt#555840827 iDrone flyr-CALS;bc	150.00
E5070 Conference/Registration Fees			
14-DEC-20	Z1012231	RyuJa 701172 Facebook Event registr	10.00
16-DEC-20	Z1012307	AGU Full meeting, advance, non-memb	350.00
16-DEC-20	Z1012307	Student (graduate): Full meeting, A	125.00
17-DEC-20	I2159740	Thompson, Emily	40.00
15-MAR-21	I2169914	Humes, Karen S..	150.00
20-MAY-21	I2178710	Abbasi, Maryam	495.00
E5152 All Other Services			
12-AUG-20	I2143936	Idaho STEM Action Center	1250.00
E5177 Program Fees			
05-JAN-21	Z1012750	RyuJa 893235 Register@FAA iDrone re	5.00
E5199 Other Professional Service			
20-AUG-20	I2144864	Built by Thrive LLC	1450.00
21-SEP-20	I2148357	Built by Thrive LLC	1450.00
E5320 Software/Applications - Individual			
14-APR-21	Z1016016	Stella Architect software license	849.00

E5330 Software/Applications - College/Dep			
14-DEC-20	Z1012231	RyuJa 701172 Screencastify Software	29.00
18-DEC-20	Z1012417	RyuJa 622558 Amazon Web Services SB	30.87
E5560 Technology - Supplies			
25-FEB-21	Z1014270	Printer cartridge for lab. Sales ta	121.58
25-FEB-21	Z1014270	Refund for sales tax. Index 820907	-6.88
E5640 R&M Sup - Technology Infrastructure			
23-JUN-21	TC062321	TDX 164787 Switch for Boise Lab 224	327.96
E5710 Tools			
01-MAR-21	Z1014435	A McDonald: laser cutter for resear	389.99
10-MAR-21	Z1014808	A McDonald: Bench circular saw for	126.39
E5720 Educational Supplies			
07-AUG-20	J1274219	JKD/ Phys Mchn Shp Wrk: A.McDonald	373.78
21-SEP-20	J1276372	JKD/ Phys Mchn Shp Wrk: A. McDonald	243.31
E5724 Research Supplies			
09-JUL-20	Z1007362	McDonald- purchased this micromanip	62.00
09-JUL-20	Z1007362	McDonald-purchased some lab supplie	21.71
09-JUL-20	Z1007362	McDonald-purchased these sample hol	160.00
09-JUL-20	Z1007362	McDonald-purchased this replacement	73.32
14-JUL-20	Z1007430	Charge for bulk fasteners for tank	4.19
14-JUL-20	Z1007430	Charge for cylinders, specialty gas	49.50
14-JUL-20	Z1007430	Charge for misc. parts and fittings	221.47
14-JUL-20	Z1007430	Charge for pipette tips, research s	277.84
29-JUL-20	Z1007739	Book: Water in Plain Sight: Hope	15.25
29-JUL-20	Z1007739	Books purchased from Amazon: The C	118.97
29-JUL-20	Z1007739	Books: The Fate of Food: What We'l	33.18
04-AUG-20	Z1007879	McDonald- purchased these glass ext	147.47
04-AUG-20	Z1007879	McDonald- supplies for research	369.58
04-AUG-20	Z1007879	McDonald-purchased 2 replacement pr	196.52
04-AUG-20	Z1007879	McDonald-purchased a small wet/dry	53.97
04-AUG-20	Z1007879	McDonald-purchased these DMA access	116.60
05-AUG-20	Z1007927	Charge for 1000 round bottom test t	373.70
05-AUG-20	Z1007927	Charge for 2 ml vials and caps, 10	360.48
05-AUG-20	Z1007927	Charge for lab tape, research suppl	43.23
05-AUG-20	Z1007927	Charge for nitrogen test kits, rese	109.83
05-AUG-20	Z1007927	Charge for premeasured unit dose re	37.54
05-AUG-20	Z1007927	Charge for reagent, research suppli	738.20
05-AUG-20	Z1007927	Charge for standards for pH testing	59.34
05-AUG-20	Z1007927	Charge for sterile pipettes, resear	61.65
05-AUG-20	Z1007927	Charge for wipes, pipettes for lab	308.47
18-AUG-20	Z1008276	Charge for enzymes to test for glyc	145.55
18-AUG-20	Z1008276	Charge for massive re-stocking of t	3274.96
18-AUG-20	Z1008276	Charge for test kits for nitrogen a	456.42
18-AUG-20	Z1008276	Charge for two new pH probes, resea	541.95
20-AUG-20	I2144934	Ryu, Jae H.	1382.48
01-SEP-20	I2146251	Ryu, Jae H.	534.97
04-SEP-20	Z1008779	Charge for cable for new VFD contro	63.75
04-SEP-20	Z1008779	Charge for cylinders, specialty gas	195.63
04-SEP-20	Z1008779	Charge for medium and large nitrile	342.63

04-SEP-20	Z1008779	Charge for new key pad for Erik Coa	154.50
04-SEP-20	Z1008779	Charge for new sensor caps for diss	442.75
04-SEP-20	Z1008779	Charge for nitrite reagent powder,	149.07
04-SEP-20	Z1008779	Charge for universal pipette tips,	84.63
08-SEP-20	Z1008846	McDonald- item was not as described	-42.40
08-SEP-20	Z1008846	McDonald- purchased disposable glov	92.37
08-SEP-20	Z1008846	McDonald- purchased some gas fittin	26.50
08-SEP-20	Z1008846	McDonald- purchased some high tempe	12.98
08-SEP-20	Z1008846	McDonald- purchased these quick con	41.87
08-SEP-20	Z1008846	McDonald-disposable gloves for rese	104.00
08-SEP-20	Z1008846	McDonald-purchased some gas fitting	42.40
08-SEP-20	Z1008846	McDonald-purchased these hole-saws	8.19
08-SEP-20	Z1008846	McDonald-purchased this glass grind	110.00
22-SEP-20	Z1009345	RyuJa 305625 Amazon Camera mount an	35.98
22-SEP-20	Z1009345	RyuJa 305625 Amazon Monitor mount a	35.39
22-SEP-20	Z1009345	RyuJa 305625 Amazon Power outlet, t	201.73
22-SEP-20	Z1009345	RyuJa 305625 Amazon Printer pick up	12.50
22-SEP-20	Z1009345	RyuJa 305625 Amazon Table mat neede	58.03
22-SEP-20	Z1009345	RyuJa 305625 Amazon UAS development	127.07
22-SEP-20	Z1009345	RyuJa 305625 Amazon Webcam, network	205.32
22-SEP-20	Z1009345	RyuJa 305625 Costco A small monitor	169.59
22-SEP-20	Z1009345	RyuJa 305625 Costco CAMP office sup	83.72
22-SEP-20	Z1009345	RyuJa 305625 Staples Storage boxes	91.12
22-SEP-20	Z1009354	RyuJa 221612 Amazon Data storage an	31.71
22-SEP-20	Z1009354	RyuJa 221612 Amazon SBOE research p	9.53
22-SEP-20	Z1009354	RyuJa 221612 Amazon SBOE research p	12.77
22-SEP-20	Z1009354	RyuJa 221612 Amazon SBOE research p	22.44
22-SEP-20	Z1009354	RyuJa 221612 Amazon SBOE research p	8.99
22-SEP-20	Z1009354	RyuJa 221612 Amazon SBOE research p	7.99
22-SEP-20	Z1009354	RyuJa 221612 Amazon SBOE research p	-80.55
22-SEP-20	Z1009354	RyuJa 221612 Amazon SBOE research p	203.66
22-SEP-20	Z1009354	RyuJa 221612 Amazon SBOE research p	19.99
22-SEP-20	Z1009354	RyuJa 221612 Amazon SBOE research p	73.17
22-SEP-20	Z1009354	RyuJa 221612 Amazon SBOE research p	65.52
22-SEP-20	Z1009354	RyuJa 221612 Amazon SBOE research p	35.23
22-SEP-20	Z1009354	RyuJa 221612 Amazon SBOE research p	122.14
22-SEP-20	Z1009354	RyuJa 221612 Amazon SBOE research p	10.96
22-SEP-20	Z1009354	RyuJa 221612 Amazon SBOE research p	244.92
22-SEP-20	Z1009354	RyuJa 221612 Amazon SBOE research p	219.94
22-SEP-20	Z1009354	RyuJa 221612 Tower Hobbies SBOE res	13.76
22-SEP-20	Z1009354	RyuJa 221612 Verizon SBOE research	182.82
24-SEP-20	Z1009447	Charge for cylinders, specialty gas	195.63
24-SEP-20	Z1009447	Charge for liners for Erik Coats' G	174.53
24-SEP-20	Z1009447	Charge for new septa for Erik Coats	78.40
29-SEP-20	I2149458	Oxarc Inc.	80.75
29-SEP-20	I2149453	Oxarc Inc.	68.36
01-OCT-20	J1276792	cfc: ct from 691709 to 691680	8.49
02-OCT-20	I2150083	Oxarc Inc.	80.75
08-OCT-20	I2151006	Ryu, Jae H.	8077.76

09-OCT-20	Z1009984	McDonald- PTFE sheets for research	40.99
09-OCT-20	Z1009984	McDonald- Return of amazon research	-22.60
09-OCT-20	Z1009984	McDonald- items for research	38.34
09-OCT-20	Z1009984	McDonald- purchased this item for r	59.19
09-OCT-20	Z1009984	McDonald- purchased this replacemen	94.34
09-OCT-20	Z1009984	McDonald- sharpening stones for res	22.60
09-OCT-20	Z1009984	McDonald- supplies for research	183.08
09-OCT-20	Z1009984	McDonald-purchased replacement UPS	29.90
09-OCT-20	Z1009984	McDonald-replacement temperature co	20.00
13-OCT-20	I2151582	Ryu, Jae H.	132.32
28-OCT-20	Z1010668	Charge for cylinders, specialty gas	483.22
28-OCT-20	Z1010668	Charge for enzymes for glycogen tes	162.62
28-OCT-20	Z1010668	Charge for metabolites, research su	304.87
28-OCT-20	Z1010668	Charge for metabolites, research su	301.45
28-OCT-20	Z1010668	Charge for metabolites, research su	86.40
28-OCT-20	Z1010668	Charge for vials with screw top cap	360.48
09-NOV-20	Z1011044	McDonald- book for research	13.98
09-NOV-20	Z1011044	McDonald- items purchased for resea	243.61
09-NOV-20	Z1011044	McDonald- items purchased for resea	13.00
09-NOV-20	Z1011044	McDonald- purchased book for resear	7.98
09-NOV-20	Z1011044	McDonald- temperature controller fo	19.74
11-NOV-20	I2155421	Oxarc Inc.	68.36
12-NOV-20	I2155674	Oxarc Inc.	80.75
20-NOV-20	Z1011508	Charge for cylinders, specialty gas	57.00
20-NOV-20	Z1011508	Charge for enzymes for glycogen ana	145.55
20-NOV-20	Z1011508	Charge for metabolites for analysis	453.09
20-NOV-20	Z1011508	Charge for metabolites for analysis	139.41
20-NOV-20	Z1011508	Charge for metabolites for analysis	250.28
20-NOV-20	Z1011508	Charge for new caps for ammonia pro	2634.54
20-NOV-20	Z1011508	Charge for new column for LC/MS to	654.93
03-DEC-20	Z1011818	McDonald- hot blade for research	19.99
03-DEC-20	Z1011818	McDonald- lab supplies for research	38.34
03-DEC-20	Z1011818	McDonald- lab supplies for research	16.00
03-DEC-20	Z1011818	McDonald- lab supplies for research	10.88
03-DEC-20	Z1011818	McDonald- research supplies	194.67
03-DEC-20	Z1011818	McDonald- research supplies	152.87
03-DEC-20	Z1011818	McDonald- steel rulers for the lab	7.98
03-DEC-20	Z1011818	McDonald- supplies for research	321.42
04-DEC-20	I2158036	Oxarc Inc.	80.75
14-DEC-20	Z1012231	RyuJa 701172 Amazon Rubber bands ne	5.18
14-DEC-20	Z1012231	RyuJa 701172 Amazon Weight scale ne	25.02
14-DEC-20	Z1012231	RyuJa 701172 Amazon Wood chips need	27.95
15-DEC-20	Z1012248	Charge for cylinders, specialty gas	195.63
15-DEC-20	Z1012248	Charge for new jugs for wastewater,	39.82
18-DEC-20	Z1012417	RyuJa 622558 Staples Box storage fo	90.91
18-DEC-20	Z1012417	RyuJa 622558 VistaPrint Refund of I	-5.08
18-DEC-20	Z1012417	RyuJa 622558 VistaPrint Refund of I	-3.30
18-DEC-20	Z1012417	RyuJa 622558 VistaPrint Refund of I	-12.46
18-DEC-20	Z1012417	RyuJa 622558 VistaPrint SBOE Stem C	58.30

18-DEC-20	Z1012417	RyuJa 622558 VistaPrint STEM Camp i	89.75
18-DEC-20	Z1012417	RyuJa 622558 Vistaprint Idaho sales	219.64
05-JAN-21	Z1012750	RyuJa 893235 Amazon Certificate cov	7.11
05-JAN-21	Z1012750	RyuJa 893235 Amazon Certificate pap	41.93
06-JAN-21	I2161260	Oxarc Inc.	80.75
13-JAN-21	Z1012991	Chemicals for research purposes.	183.08
13-JAN-21	Z1012991	Chisel for research purposes.	7.99
13-JAN-21	Z1012991	DSC Sample Pan and Pan Style Lid Ki	475.07
13-JAN-21	Z1012991	Electronic balance for research.	293.22
13-JAN-21	Z1012991	Fastener for research purposes	2.60
13-JAN-21	Z1012991	Filters for research purposes	170.95
13-JAN-21	Z1012991	GCMS septa for research purposes	295.02
13-JAN-21	Z1012991	PurpleAir air monitor for research	288.33
13-JAN-21	Z1012991	Switches and outlets for research.	16.85
04-FEB-21	I2165000	Oxarc Inc.	426.22
04-FEB-21	I2165028	Oxarc Inc.	88.80
19-FEB-21	B1847480	Oxarc Inc.	-80.75
19-FEB-21	I2166735	Oxarc Inc.	80.75
25-FEB-21	Z1014270	Oxarc cylinder rental on index 8209	57.00
25-FEB-21	Z1014270	PGO enzyme kit for research. Index	145.55
26-FEB-21	Z1014361	Bearings for pumps. Index 820907 su	76.40
26-FEB-21	Z1014361	Brush to clean glassware. Index 820	7.19
26-FEB-21	Z1014361	Diffuser stones for bioreactors. In	17.97
26-FEB-21	Z1014361	Gasses for my GC/FID. Index 820907	57.00
26-FEB-21	Z1014361	Gene fragment for conducting RT-qPC	100.91
26-FEB-21	Z1014361	Jugs for wastewater. Index 820907 s	60.93
26-FEB-21	Z1014361	Mechanical seals for pumps. Index 8	58.98
26-FEB-21	Z1014361	New pump for lab bioreactors. Index	450.50
26-FEB-21	Z1014361	New pump for lab reactors. Index 82	413.03
26-FEB-21	Z1014361	Test tubes and caps for research. I	547.40
26-FEB-21	Z1014361	Tubing for lab reactors. Index 8209	9.09
26-FEB-21	Z1014361	pH probes for research. Index 82090	673.95
01-MAR-21	Z1014435	A McDonald: Quartz slides for resea	19.28
01-MAR-21	Z1014435	A McDonald: replacement battery for	4.49
09-MAR-21	I2169187	Oxarc Inc.	80.75
10-MAR-21	Z1014808	A McDonald: label maker, USB hub, r	50.24
10-MAR-21	Z1014808	A McDonald: storage containers for	27.98
07-APR-21	I2172827	Humes, Karen S..	31.79
14-APR-21	Z1016039	Caps for DO probes. Index 820907 su	483.95
14-APR-21	Z1016039	Chemicals to inhibit nitrification.	249.21
14-APR-21	Z1016039	DNA fragments for ongoing molecular	110.04
14-APR-21	Z1016039	GC vials and caps for Coats' resear	714.58
14-APR-21	Z1016039	Gas for instruments. Index 820907 s	64.50
14-APR-21	Z1016039	Pump parts for my scale model syste	2628.59
14-APR-21	Z1016039	Wastewater jugs. Index 820907 sueb	40.62
14-APR-21	Z1016039	gene fragments for transcriptomics.	126.63
14-APR-21	I2173614	Oxarc Inc.	80.75
22-APR-21	J1286681	CTMA from 826717 to 820907	369.11
22-APR-21	I2174805	Oxarc Inc.	446.78

29-APR-21	Z1016653	A McDonald: bolts for research proj	6.24
04-MAY-21	J1287367	JKD/ Phys Shp Wrk: AMcDonald	45.00
10-MAY-21	Z1017010	A McDonald: DSC pans for research	708.89
10-MAY-21	Z1017010	A McDonald: Visitorspc Unctd Ansi f	69.95
10-MAY-21	Z1017010	A McDonald: assorted rubber o-rings	7.19
10-MAY-21	Z1017010	A McDonald: lab supplies: wire whee	12.99
10-MAY-21	Z1017010	A McDonald: lab/woodshop supplies f	34.79
10-MAY-21	Z1017010	A McDonald: lab/woodshop supplies f	37.68
10-MAY-21	Z1017010	A McDonald: microscope slides for l	11.95
10-MAY-21	Z1017010	A McDonald: pellet die set for rese	92.05
10-MAY-21	Z1017010	A McDonald: pipe fittings for rese	58.44
10-MAY-21	Z1017010	A McDonald: plug for research equip	3.49
10-MAY-21	Z1017010	A McDonald: quick disconnect compre	34.04
10-MAY-21	Z1017010	A McDonald: replacement v-belt for	6.59
10-MAY-21	I2177451	Oxarc Inc.	71.02
10-MAY-21	I2177459	Oxarc Inc.	88.80
24-MAY-21	J1288566	JKD/ Phys Mchn Shp Wrk: McDonald	105.00
24-MAY-21	J1288569	JKD/ Phys Mchn Shp Wrk: McDonald	138.95
28-MAY-21	Z1017886	Electromagnetic flow meters for my	1619.44
28-MAY-21	Z1017886	New redox probe for research. Index	502.95
28-MAY-21	Z1017886	Nitrate test kits and syringes for	1001.90
28-MAY-21	Z1017886	Nitrate test kits. Index 820907 sue	119.25
28-MAY-21	Z1017886	Phosphorus, ammonia, nitrate test k	2018.55
28-MAY-21	Z1017886	Receipt for Oxarc invoice. Index 82	49.50
02-JUN-21	I2180685	Oxarc Inc.	88.80
14-JUN-21	I2182710	Oxarc Inc.	15.00
22-JUN-21	I2183987	Ryu, Jae H.	1799.00
22-JUN-21	I2183987	Ryu, Jae H.	5000.00
22-JUN-21	I2183987	Ryu, Jae H.	380.22
22-JUN-21	I2183987	Ryu, Jae H.	977.07
24-JUN-21	Z1019058	McDonald, A: Ceramic terminal cover	68.45
28-JUN-21	Z1019296	Gasses for GC/FID. Index 820907 bba	49.50
28-JUN-21	Z1019296	pH buffer solutions for probe calib	139.37
29-JUN-21	Z1019577	Book to be used in completing the g	29.95
29-JUN-21	Z1019577	Book: A systems approach to modelin	49.95
29-JUN-21	Z1019577	Book: System approach to Modeling V	49.95
29-JUN-21	Z1019577	Books and computer accessories to b	124.98
29-JUN-21	Z1019577	Calibration and new optical attachm	2599.00
29-JUN-21	Z1019577	Energy Use in Global food productio	121.88
29-JUN-21	Z1019772	McDonald, A: TA sample holder for r	418.70
29-JUN-21	Z1019772	McDonald, A: TMA standard accessory	371.00
29-JUN-21	Z1019772	McDonald, A: polylactic acid pellet	112.05
29-JUN-21	Z1019772	McDonald, A: replacement PTFE react	84.80
29-JUN-21	Z1019772	McDonald, A: replacement gaskets fr	121.80
29-JUN-21	Z1019772	McDonald, A: small fridge needed fo	139.00
30-JUN-21	F0210814	GRT237742- CALS SOIL/H20	-585.00
30-JUN-21	Z1019899	RyuJa 166416 Amazon Research and ed	159.99
30-JUN-21	Z1019899	RyuJa 166416 Amazon Research and ed	125.16
30-JUN-21	Z1019988	Nitrogen test kits. 768.10 on 82090	768.10

30-JUN-21	I2185662	Ryu, Jae H.	8.99
30-JUN-21	I2185662	Ryu, Jae H.	650.00
30-JUN-21	I2185662	Ryu, Jae H.	864.78
30-JUN-21	I2185662	Ryu, Jae H.	190.94
30-JUN-21	I2185662	Ryu, Jae H.	79.95
30-JUN-21	I2185662	Ryu, Jae H.	1088.00
30-JUN-21	I2185662	Ryu, Jae H.	1218.99
30-JUN-21	I2185662	Ryu, Jae H.	4.99
30-JUN-21	I2185663	Ryu, Jae H.	356.49
30-JUN-21	I2185663	Ryu, Jae H.	309.99
30-JUN-21	I2185663	Ryu, Jae H.	1347.99
30-JUN-21	I2185663	Ryu, Jae H.	90.00
30-JUN-21	I2185663	Ryu, Jae H.	699.95
30-JUN-21	I2185663	Ryu, Jae H.	309.99
06-JUL-21	J1291836	CT/MA from 826703 to 826699	-1347.99
06-JUL-21	J1291836	CT/MA from 826703 to 826699	-309.99
06-JUL-21	Z1020186	Gasses for GC/FID. Index 820907 bba	49.50
06-JUL-21	Z1020186	Gloves for laboratory research work	1543.66
06-JUL-21	Z1020186	New controller for lab operations.	1474.11
06-JUL-21	Z1020186	Nutrients test kits for IGEM resear	1435.65
06-JUL-21	Z1020186	Parts for pumps at my scale model w	1450.03
06-JUL-21	Z1020186	qPCR reagents for ongoing transcrip	2000.54
E5741 Med Lab & Tech Supplies			
13-JUL-20	U0135598	Chemstores/Smoot	73.92
23-JUL-20	U0135673	Chemstores/Crites	2.70
04-AUG-20	I2142886	Oxarc Inc.	80.75
10-AUG-20	U0135767	Chemstores/Abbisa	62.99
10-AUG-20	U0135768	Chemstores/Abbisa	16.95
10-AUG-20	U0135769	Chemstores/Crites	16.95
01-SEP-20	U0135958	Chemstores/Abbasi	13.37
23-SEP-20	U0136136	Chemstores/Abbissa	75.29
23-SEP-20	U0136144	Chemstores/Abbissa	60.52
25-SEP-20	U0136171	Chemstores/Abbissa	58.35
01-OCT-20	J1276988	cfc: ct from 691709 to 691680	19.45
02-OCT-20	U0136231	Chemstores/Abbissa	62.99
06-OCT-20	U0136264	Chemstores/Crites	69.74
15-OCT-20	U0136349	Chemstores/Guho	36.09
20-OCT-20	U0136368	Chemstores/Abbissi	33.91
22-OCT-20	U0120730	Chemstores/Brower	60.90
23-OCT-20	U0121249	Abbasi	50.86
26-OCT-20	U0136387	Chemstores/McDonald	19.21
09-NOV-20	U0136505	Chemstores/Neubane	21.76
24-NOV-20	I2148563	Fisher Scientific Co.	110.72
24-NOV-20	I2148546	Fisher Scientific Co.	88.82
15-JAN-21	U0136853	Chemstores/Smoot	39.87
29-JAN-21	U0137007	Chemstores/Abissa	11.19
29-JAN-21	U0137017	Chemstores/Smoot	29.32
12-FEB-21	U0137139	Chemstoes/McDonald	37.04
22-FEB-21	U0137189	Biostore/Brinkman	195.86

24-MAR-21	U0137411	Chemstores/Peters	87.74
17-MAY-21	U0137815	Chemstores/Abbasi	13.06
07-JUN-21	U0137944	Chemstores/Peters	22.98
10-JUN-21	U0137986	Chemstores/Black	93.39
E5747 Safety Supplies			
10-MAR-21	Z1014808	A McDonald: galvanized safety can f	30.00
E5910 Rent - Machinery & Equip			
01-JUN-21	I2180550	Culligan Water Conditioning	29.95
01-JUL-21	I2185873	Culligan Water Conditioning	29.95
			86662.06

Subawards

ES001 Subaward 1 Expenses			
06-NOV-20	I2154863	Boise State University	24016.80
21-DEC-20	I2160003	Boise State University	5033.24
21-DEC-20	I2160004	Boise State University	7119.96
09-FEB-21	I2165725	Boise State University	5682.39
26-FEB-21	I2167676	Boise State University	4981.14
19-MAR-21	I2170575	Boise State University	14500.61
14-MAY-21	I2178317	Boise State University	11071.18
14-MAY-21	I2178320	Boise State University	15468.67
11-JUN-21	I2182512	Boise State University	28847.79
ES002 Subaward 2 Expenses			
19-MAR-21	I2170470	Idaho State University	59513.70
28-JUN-21	I2184831	Idaho State University	64554.89
			$ 240790.37

Small Equipment (<$5K)

E7951 <5K Office Furniture			
05-AUG-20	Z1007927	Charge for 2 adjustable swivel bar	84.79
			$ 84.79

Tuition Remission and Training

E7140 Tuition and Fees - Grad Assistants			
14-AUG-20	J1274562	G1GB for 171-55579	786.00
14-AUG-20	J1274562	SHI1 for 171-55579	951.00
14-AUG-20	J1274562	T1GB for 171-55579	4152.00
21-AUG-20	J1274874	G1GB for V00664521	786.00
21-AUG-20	J1274874	SHI1 for V00664521	951.00
21-AUG-20	J1274874	T1GB for V00664521	4152.00
21-AUG-20	J1274874	VVSF for V00664521	100.00
02-SEP-20	J1275593	G1HD for 142-24168	43.50
02-SEP-20	J1275593	N1HD for 142-24168	534.50
02-SEP-20	J1275593	SHI1 for 142-24168	475.50
02-SEP-20	J1275593	T1HD for 142-24168	231.00
08-SEP-20	J1275909	G1GA for 151-29182	786.00

08-SEP-20	J1275909	G1GB for 051-04535	786.00
08-SEP-20	J1275909	G1GB for 151-22411	786.00
08-SEP-20	J1275909	T1GA for 151-29182	4152.00
08-SEP-20	J1275909	T1GB for 051-04535	4152.00
08-SEP-20	J1275909	T1GB for 151-22411	4152.00
28-OCT-20	J1278784	G1GB for V00665494	786.00
28-OCT-20	J1278784	SHI1 for V00665494	951.00
28-OCT-20	J1278784	T1GB for V00665494	4152.00
28-OCT-20	J1278784	VVSF for V00665494	100.00
06-JAN-21	J1281486	G2GB for 171-55579	786.00
06-JAN-21	J1281486	SHI2 for 171-55579	951.00
06-JAN-21	J1281486	T2GB for 171-55579	4152.00
08-JAN-21	J1281710	G2GA for 151-29182	786.00
08-JAN-21	J1281710	G2GB for 051-04535	786.00
08-JAN-21	J1281710	G2GB for 151-22411	786.00
08-JAN-21	J1281710	T2GA for 151-29182	4152.00
08-JAN-21	J1281710	T2GB for 051-04535	4152.00
08-JAN-21	J1281710	T2GB for 151-22411	4152.00
14-JAN-21	J1281351	G2GB for V00665494	786.00
14-JAN-21	J1281351	SHI2 for V00665494	951.00
14-JAN-21	J1281351	T2GB for V00665494	4152.00
14-JAN-21	J1281351	VVSF for V00665494	100.00
01-FEB-21	J1282802	G2HD for 142-24168	43.50
01-FEB-21	J1282802	N2HD for 142-24168	534.50
01-FEB-21	J1282802	SHI2 for 142-24168	475.50
01-FEB-21	J1282802	T2HD for 142-24168	231.00
20-MAY-21	J1288392	RSN3 for 151-22411	137.25
20-MAY-21	J1288396	RSN3 for 051-04535	137.25
20-MAY-21	J1288398	G3HA for 151-29182	87.00
20-MAY-21	J1288398	T3HA for 151-29182	462.00
21-MAY-21	J1287827	G3HB for V00665494	87.00
21-MAY-21	J1287827	T3HB for V00665494	462.00
01-JUN-21	J1288997	cfc: ct from 820928 to 820907	137.25
			63451.75

Total Expenses	$ 656161.35

FWRITEM University of Idaho
Itemized Expenditures by Grant Code
From 01-JUL-2020 To 08-JUL-2021

Grant: SG4609 - ISBOE IGEM FY21 Sustain Food Ind-KH 08-Jul-2021 12:11 PM

Salaries
E4106 Staff
Brinkman, Cynthia 8979.78
495.02 hours
E4108 Summer Salary

	Coats, Erik	2350.32
	33.60 hours	
	Humes, Karen	21228.48
	288.00 hours	
	McDonald, Armando	11225.76
	156.00 hours	
	Ryu, Jae	19585.32
	334.46 hours	
E4109	IA/GA Salary	
	Abbasi, Maryam	19869.76
	992.00 hours	
	Brower, Nicole	17100.00
	912.00 hours	
	Deyo, Brent	22800.00
	912.00 hours	
	Mellin, Jason	9903.52
	272.00 hours	
	Pokhrel, Dikshya	7547.40
	420.00 hours	
	Smoot, Lindsey	18700.00
	992.00 hours	
	Thompson, Emily	17245.80
	780.00 hours	
E4175	Overtime - Covered by FLSA	
	Brinkman, Cynthia	45.59
	5.02 hours	

		$ 176581.73
Temporary/Irregular Help		
E4110	Temporary Employee	
	Holownia, Sam	2250.00
	125.00 hours	
E4135	Temporary Student	
	Alfaro Salmeron, Glenda	1500.00
	80.00 hours	
	Black, Edward	5810.75
	539.00 hours	
	Brower, Nicole	1125.00
	60.00 hours	
	Buonarati, Nickolas	459.25
	41.75 hours	
	Crites, Willow	6301.65
	576.00 hours	
	Cutler, Kylie	270.88
	25.00 hours	
	Deyo, Brent	2000.00
	80.00 hours	
	Emerick, Austin	1245.75

116.50 hours	
Guho, Nicholas	8972.98
323.00 hours	
Hurdman, Julie	688.50
38.25 hours	
Neupane, Saurav	10657.64
992.00 hours	
Thompson, Emily	6440.00
280.00 hours	
Walters, Riveraine	10448.00
434.00 hours	
Woodruff, Craig	3625.00
145.00 hours	
	$ 61795.40

Fringe Benefits	
E4280 Faculty CFR Benefit Expense	16697.67
E4281 Staff CFR Benefit Expense	3772.59
E4282 Student CFR Fringe Expense	3627.07
E4283 Temporary CFR Benefit Expense	177.75
	$ 24275.08

Travel	
E5360 Personal Vehicle - In-State	
E5367 Rental Vehicles - In-State	
E5396 Lodging & Per Diem ? In State	
	$ 2520.17

Operating Expenses
E5020 Postage & Mailing
E5023 Express Mail
E5025 Printing & Binding
E5070 Conference/Registration Fees
E5152 All Other Services
E5177 Program Fees
E5199 Other Professional Service
E5320 Software/Applications - Individual
E5330 Software/Applications - College/Dep
E5560 Technology - Supplies
E5640 R&M Sup - Technology Infrastructure
E5710 Tools
E5720 Educational Supplies
E5724 Research Supplies
E5741 Med Lab & Tech Supplies
E5747 Safety Supplies
E5910 Rent - Machinery & Equip

	$ 86662.06
Subawards	
ES001 Subaward 1 Expenses	
ES002 Subaward 2 Expenses	
	$ 240790.37
Small Equipment (<$5K)	
E7951 <5K Office Furniture	
	$ 84.79
Tuition Remission and Training	
E7140 Tuition and Fees - Grad Assistants	
	$ 63451.75
Total Expenses	$ 656161.35

BOISE STATE UNIVERSITY
OFFICE OF SPONSORED PROGRAMS

Final Invoice

105323

Invoice Date	Invoice Amount	Due Date
6/8/2021	$28,847.79	Payment due upon receipt

Bill To

University of Idaho
875 Perimeter Dr

Moscow, ID
83844
US

Attn: Kay Dee Holmes

Sponsor Award Number	Project Title	Department Number	BSU Award Number	Project Number	Invoice Period
SGA609-877862	Sustaining the Competitiveness of the Food Industry in Southern Idaho YR 3	70600	3221007	2000001742	5/1/2021 to 6/30/2021

Category	Budget	Current Expenditures	Cumulative Expenditures	Remaining Budget
Salary	$ 80,963.00	$ 17,691.24	$ 73,798.36	$ 7,164.64
Fringe	$ 10,106.00	$ 2,231.32	$ 11,293.78	$ -1,187.78
Other Expense	$ 13,000.00	$ 8,925.23	$ 12,353.64	$ 646.36
Student Costs	$ 19,276.00	$ 0.00	$ 19,276.00	$ 0.00

Original Budget	Total Current Expenditures	Total Expenditures	Remaining Budget
$ 123,345.00	$ 28,847.79	$ 116,721.78	$ 6,623.22

Total Expenditures:	$ 116,721.78
Less: Revenue Received:	$ 87,873.99
Less: Outstanding Invoices:	$ 0.00
Amount Now Due:	$ 28,847.79

Where required for federal or federal flow-through agreements, by signing this report, I certify to the best of my knowledge and belief that the report is true, complete, and accurate, and the expenditures, disbursements and cash receipts are for the purposes and objectives set forth in the terms and conditions of the Federal award. I am aware that any false, fictitious, or fraudulent information, or the omission of any material fact, may subject me to criminal, civil or administrative penalties for fraud, false statements, false claims or otherwise. (U.S. Code Title 18, Section 1001 and Title 31, Sections 3729-3730 and 3801-3812).

Please direct questions regarding this invoice to Diana Smlatic at postaward@boisestate.edu.

Payment Options

By Mail:

Boise State University
1910 University Drive
Accounts Receivable
Boise, ID 83725-1247

ACH/Wire Payments:

Account Name:	Boise State University
Account Number:	20000011141546
Bank:	JPMorgan Chase
ACH Routing Number:	028000024
Wire Routing Number:	021000021

Please reference invoice number on electronic payments

Idaho State University

ESTIMATED FINAL INVOICE

For information regarding this invoice contact:
Aaron Tolman
(208) 282-3056

Karen Humes
University of Idaho
875 Perimeter Dr. MS 1026
Moscow, ID 83844-1026
(208)885-7230

Date Prepared: June 10, 2021

Award Number: SG-3587-SB-877869
Invoice No.: RGEO2R-10
Reference invoice number on payment.

PERIOD COVERED: 03/01/2021 - 06/30/2021

DESCRIPTION	BUDGET	**CURRENT EXPENSES**	CUMULATIVE EXPENSES	(Over)/Under BUDGET
Salary & Fringe	$101,310.04	**$52,457.02**	$101,310.04	$0.00
Materials & Supplies	$8,500.00	**$7,764.87**	$8,499.59	$0.41
Travel	$0.00	**$0.00**	$0.00	$0.00
Tuition	$9,925.96	**$0.00**	$9,925.96	$0.00
Travel	$1,833.00	**$1,833.00**	$1,833.00	$0.00
Consultants	$2,500.00	**$2,500.00**	$2,500.00	$0.00
Totals	$124,069.00	$64,554.89	$124,068.59	$0.41

Cumulative Amount Received:	$59,513.70
Billed-Not Received*:	$0.00
Current Expenses:	$64,554.89

Total Due This Period $64,554.89

PLEASE NOTE

The Total Now Due represents the current billing amount and any prior billings that have not yet been received as of the invoice date. If you have already sent payment for an invoice listed as billed-not received, please remit the CURRENT expense amount rather than the cumulative total. THANK YOU!

Lisa Wood 6.11.2021
Lisa Wood, Director Sponsored Programs Accounting

Please make remittances payable to Idaho State University and remit to:
921 South 8th Avenue, Stop 8219
Pocatello, ID 83209-8219