POLLUTION PREVENTION

INTERN PROGRAM CASE SUMMARIES 2017

WORKING TOGETHER TO ACHIEVE ECONOMIC AND ENVIRONMENTAL RESULTS

STUDENT PERSPECTIVES:

"Project management is an amazing skill to have experience in and this was exactly that. Interns are very much in control of their project's outcome."

— Jeremy Zeis, Iowa State University

"I learned a lot about what it is like to be in charge of a project as an engineer and successfully working through such an in-depth and impactful project was fulfilling and enjoyable."

— Michalee Leuthard, University of Wisconsin - Platteville

"This internship felt very rewarding personally because I was making a difference on something I care about, the environmental impacts. Having concrete results with numbers is very rewarding professionally because it is an effective way to present the results I am capable of."

— Sam Hartman, Iowa State University

"I definitely stretched out of my comfort zone and have grown as a student and employee."

— Emily Meerdink, South Dakota State University

COMPANY TESTIMONIALS:

"The intern project gave us the resource we needed to work on an improvement project and meet a plant goal and a business sustainability goal."

— Sarah Fersdahl, DuPont Industrial Biosciences

"The intern was able to put a focus on a couple of projects that our core team has had on our priority list. Due to his work, we will be able to properly assess the cost benefit analysis of implementation, including alternative implementation methods for us to consider."

— Kim Hagedorn, Principal Financial Group

"The benefit of having an intern that can focus solely on a problem like this is getting to the solution faster than just by ourselves here. We appreciate having a partner like P2 to find quality interns and provide them with tools to work on pollution prevention projects."

— Holly Ritter, Iowa Fertilizer Company

"Absolutely a valuable experience. Good to get input/trouble shooting from someone with zero historical influence or budgeting concerns."

— Daniel Lindgren, Tyson Fresh Meats, Inc. - Storm Lake

www.iowap2services.com

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2017 P2 Interns

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DIRECTOR'S NOTE

Congratulations to the 2017 Pollution Prevention Intern Program on another successful year! Since 2001, 179 Iowa companies have hosted upper-level university students through our Pollution Prevention (P2) Intern Program to identify and implement innovative changes that will help them utilize their resources more efficiently and improve their environmental performance. In turn, P2 interns gain valuable on-site engineering experience as they tackle complex projects that will help their host company make strides toward achieving environmental goals and reducing costs.

P2 involves the adoption of strategies that reduce or eliminate wastes at the source (source reduction) instead of at the end of the pipe or stack. By embracing a P2 approach, businesses can pursue continuous environmental improvement practices and reduce emissions, which could allow them to meet and voluntarily exceed their environmental requirements.

Through the Pollution Prevention Intern Program, businesses have reduced or eliminated toxic substances and lowered their hazardous waste classifications; reduced water consumption, effluent loading, and flows to wastewater plants; diverted landfill waste; and decreased their energy use. P2 is a pro-business strategy for tackling environmental improvements, generating significant company cost savings and environmental benefits for both local communities and the state of Iowa as a whole.

By implementing P2 methodologies, host companies have proven year after year that reduced costs and environmental stewardship do go hand-in-hand. We commend the interns and host companies of the Pollution Prevention Intern Program for their continued efforts to enhance our natural resources and improve the quality of life for all Iowans.

As you read the testimonials and project summaries that follow, I encourage you to look at your environmental priorities and consider how a P2 intern could help your company move forward in meeting your environmental goals. We look forward to partnering with you through our Pollution Prevention Intern Program in the summer of 2018!

Chuck Gipp

CHUCK GIPP, Director
Department of Natural Resources

TOTAL IMPLEMENTED SAVINGS 2001–2017			
POLLUTION/WASTE REDUCTION AND COST SAVINGS FROM IMPLEMENTED INTERN PROJECTS			
CATEGORY	**REDUCTION**	**UNITS**	**COST SAVINGS**
WATER	3,726,417,172	GALLONS	$8,710,688
SPECIAL WASTE	75,681	TONS	$943,275
SOLID WASTE	154,708	TONS	$15,871,129
HAZARDOUS WASTE	8,645	TONS	$15,044,624
MERCURY ABATED	42,817	GRAMS	
ENERGY	390,817,890 2,392,198 10,583,364	KWH *MMBTU THERMS	$22,132,228 $7,444,295
OTHER			$14,251,117
			TOTAL: $84,397,356

*MMBTUs are calculated from kWh and therms for special reporting only. All dollars for actual energy saved are reported under therms and kWh.

2017 GREENHOUSE GASES AND CONVENTIONAL AIR POLLUTANTS									
CONVENTIONAL AIR POLLUTANTS DIVERTED IN METRIC TONS					GREENHOUSE GASES DIVERTED IN METRIC TONS				
NH_3	NO_x	PM_{10}	SO_2	VOC	CO_2	CH_4	N_20	CFC	$MTCO_2e$
9.85	586.26	164.30	1,110.03	1,553.16	239,535.10	108,523.62	14,720.57	2,687.63	339,604.22

2017 EXECUTIVE SUMMARY

Eleven upper-level engineering students completed projects with the Department of Natural Resources' 2017 Pollution Prevention Intern Program to help companies utilize resources more efficiently and meet their environmental goals. This year saw a number of both new and returning company partnerships, an impressive class of student interns, a broad variety of project areas, and a significant return of tangible environmental impacts and cost savings for leading Iowa businesses across the state.

The interns conducted analyses and developed supporting information for recommended process and system improvements that could save Iowa companies more than 2.3 million dollars annually. Projects estimated to save host companies $362,000 annually have already been implemented or are in progress.

The program continues to offer 12-week and 24-week project opportunities. A 24-week internship offers benefits to both companies and students. Companies have the opportunity to pursue projects that would otherwise be too time-consuming. Additional time on site allows interns to conduct more in-depth research, collect data over time and evaluate systems through varying conditions. Recognizing a 24-week internship is not feasible for all companies or interns, it has proven to be a viable option for addressing larger projects.

The CF Industries project highlighted in the following pages represents the results of the 24-week internship completed in November of 2016. The final results for one 24-week project still underway this year at the Woodward Resource Center will be posted on the Pollution Prevention Intern Program website www.iowap2interns.com in January and printed in the 2018 Case Summary Booklet.

The 2017 case summaries highlighted in these pages continue to illustrate that environmental stewardship and sustainability are vital components of a sound strategic business plan.

2017 ENVIRONMENTAL SAVINGS

ACTUAL POLLUTION/WASTE REDUCTION AND COST SAVINGS FROM INTERN PROJECTS

CATEGORY	REDUCTION	UNITS	COST SAVINGS
WATER	15,846,987	GALLONS	$47,556
SOLID WASTE	7,200	TONS	$151,200
HAZARDOUS WASTE	1	TON	$16,602
ENERGY	449,600 1,943 4,085	KWH *MMBTU THERMS	$25,865 $1,037
OTHER			$119,850
			TOTAL: $362,110

*MMBTUs are calculated from kWh and therms for special reporting only. All dollars for actual energy saved are reported under therms and kWh.

2017 GREENHOUSE GASES AND CONVENTIONAL AIR POLLUTANTS

CONVENTIONAL AIR POLLUTANTS DIVERTED IN METRIC TONS

NH_3	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
0.20	0.89	0.19	0.11	1.37	0.32

2017 GREENHOUSE GASES AND CONVENTIONAL AIR POLLUTANTS

CONVENTIONAL AIR POLLUTANTS DIVERTED IN METRIC TONS

CO_2	CH_4	N_20	CFC	$MTCO_2e$
720.92	409.12	11.34	2.85	3,107.44

NOTE:

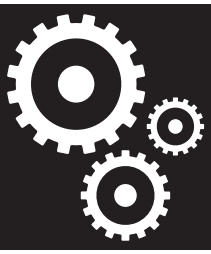
> Air emissions and greenhouse gases shown are life cycle estimates and include external activities such as purchasing utilities. Totals do not solely represent emissions generated at the plant sites.

> Greenhouse gas estimates for solid waste reduction projects are derived from U.S. EPA, Waste Reduction Model (WARM), Version 14, available at: http://www.epa.gov/warm

> Life cycle air emissions and greenhouse gas estimates for all sectors except solid waste are calculated using Carnegie Mellon University Green Design Institute, Economic Input-Output Life Cycle Assessment (EIO-LCA), US 2002 Industry Benchmark model [Internet], available from: http://www.eiolca.net

BRIDGESTONE AMERICAS TIRE OPERATIONS

SAMUEL HARTMAN
MECHANICAL ENGINEERING
IOWA STATE UNIVERSITY



COMPANY PROFILE

Bridgestone is the world's largest manufacturer of tires with a presence in more than 150 countries worldwide. They also produce a variety of other rubber products such as conveyor belts, hydraulic hoses, and golf equipment. The company was started in 1931 and has since formed a reputation for the high quality of their tires. The Des Moines, Iowa, facility produces their Firestone brand tires for industrial agriculture. Operating 24 hours a day, 5 days a week, with more than 1,300 employees, this large scale operation is a major component of the Bridgestone agriculture division.

PROJECT BACKGROUND

Tire manufacturing is a complex process with multiple steps requiring large amounts of water, steam, and heat. In recent years Bridgestone's Des Moines plant has used more than 100 million gallons of water annually, costing the company more than $700,000 every year. Bridgestone's mission for continuous improvement focuses on lowering their environmental impact, which includes reducing water and energy usage in manufacturing. By the year 2020, Bridgestone is aiming for a 35 percent reduction in water usage from 2005 levels.

INCENTIVES TO CHANGE

The long-term corporate environmental vision emphasizes improvements in three key areas: "being in harmony with nature," "valuing natural resources," and "reducing carbon dioxide emissions." Bridgestone acknowledges that the rising world population will continue to increase the demand for energy and natural resources. With this increased resource demand and possible challenges resulting from climate change, the company has set in place many benchmark goals to achieve a more sustainable future. Adding to the incentive for improvement is the cost savings associated with reducing water and resource usage.

RESULTS

Reverse Osmosis: The curing system represents a key opportunity for water conservation due to its high usage of steam and hot water. It was discovered that roughly 15 percent of the steam and water from the curing process is overflow water that is relatively clean and at 140 degrees Fahrenheit. This water could be better utilized for its heat and even filtered through a reverse osmosis (RO) system to be reused as boiler feedwater. This would reduce the demand for city feedwater and energy to heat the water, and greatly reduce boiler blowdown because RO water contains much fewer minerals and impurities. With less blowdown, the boilers will require less water and heat input to produce the same amount of steam.

Curing Overflow as Service Water: Another way to utilize a portion of the curing overflow water would be to add it to the service water reservoir. The service water is used for cooling and previously required city water to make up for evaporation at the cooling towers. Because the service water does not have strict quality requirements, overflow water can be added directly without any filtering. This would eliminate the need for adding city water to the service water system.

Pump Monitoring: Leaks and discharges account for another 15 percent of water loss from the curing system. These leaks drain through plant tunnels and currently get sent to the city wastewater treatment plant. In addition to the large expense associated with treating the wastewater, it is also a major loss of heat and water that has to be made up by adding more steam to the system. The amount of water coming from the tunnels could be monitored by installing current-transducers on the pumps. Tracking the amount of water being pumped would allow major leaks to be identified and repaired in a timelier manner, resulting in less loss through leaks and more overflow water that could be reused.

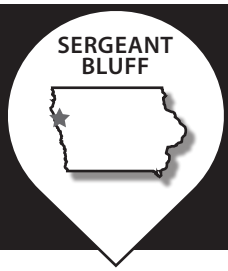
AC Condensate Recovery: There are many air conditioning units on the roof that are constantly disposing of condensation through the storm water drain. Several of these units are near a cooling tower which currently uses city water to make up for evaporation. This condensate water could be pumped into the cooling tower and reduce the amount of water needed to be added to the system.

Ecology Tank to Pond: The ecology tank collects about 30,000 gallons of wastewater per day from the curing tunnels and delivers it to the city wastewater treatment facility. Testing of samples from the tank showed this water could be processed through the on-site settling ponds, saving treatment chemicals and costs. In order to safely redirect this water to the pond system a continuous monitoring and control system would be required. An automated system would continuously monitor the flow before allowing the waste stream to flow to the ponds.

PROJECT	ANNUAL COST SAVINGS	ANNUAL ENVIRONMENTAL RESULTS	STATUS
REVERSE OSMOSIS	$107,550	6,212,907 gallons water 195,840 therms	RECOMMENDED
CURING OVERFLOW AS SERVICE WATER	$9,299	1,656,587 gallons water	IMPLEMENTED
PUMP MONITORING	$9,547	734,400 gallons water	IN PROGRESS
AC CONDENSATE RECOVERY	$398	73,715 gallons water	RECOMMENDED
ECOLOGY TANK TO POND	$43,281	6,885,000 gallons water	RECOMMENDED

CF INDUSTRIES

GRAHAM YOUNG
CHEMICAL ENGINEERING
THE UNIVERSITY OF IOWA



COMPANY PROFILE

CF Industries was founded in 1946 and is now a leading nitrogen fertilizer producer, with nine production facilities across the United States, Canada, and the United Kingdom. Recently completed expansion projects at the Donaldsonville, Louisiana, and the Port Neal, Iowa, locations have increased the company's nitrogen production capacity by more than 25 percent, making CF the largest nitrogen fertilizer producer in the world.

The Port Neal production facility employs approximately 270 people and produces ammonia, urea liquor, urea ammonium nitrate (UAN), diesel exhaust fluid (DEF), and granular urea.

PROJECT BACKGROUND

The Port Neal facility operates two nitric acid plants and a UAN plant. Water is currently cycled between the two acid plants and the UAN plant. Some of the water sent from the acid plants to the UAN plant can be recycled back to the acid plants for reuse. The rest of it must be evaporated, while fresh water is brought in to serve as makeup water. CF Industries partnered with Pollution Prevention Services to host a 24-week intern to devise ways to increase the amount of water able to be recycled between the three plants and decrease overall water demand.

INCENTIVES TO CHANGE

Responsible environmental stewardship is a core value of CF Industries. The company regularly invests in capital improvement projects that improve energy efficiency and reduce emissions. They also prioritize a life cycle approach to sustainability, working closely with farmers through the *4R Nutrient Stewardship Program* to support sustainable agricultural practices. This year's P2 intern project builds on CF Industries' commitment to sustainability by focusing on innovative opportunities to increase the amount of water that can be recycled and reused through the fertilizer production process. Solutions will not only reduce the facility's water demand, but will also reduce energy consumption, as less energy will be needed to evaporate the water.

RESULTS

The intern began by developing a rough mass and energy balance to better understand the complex production processes of the plant and how they relate to the overall water usage. Tracing out Piping and Instrumentation Diagrams (P&IDs) of the input and output streams for the processes enabled the intern to identify locations of flow sensors to aid in data collection. The intern then used the data to develop an analysis of the current water cycling process and identify areas of opportunity. The intern researched strategies to increase the rate of water reuse between the processes. The intern also collaborated on a comprehensive review of the plant's steam system.

Steam System Analysis: Steam is used in turbines, heat exchangers, process vessels, pipe/equipment heating, and other various pieces of equipment at the Port Neal site. A detailed study of the plant's complex steam system provides a roadmap to better understanding production needs and uses. This information will enable CF Industries to improve the efficiency of the steam system at the plant and identify additional opportunities to reduce energy usage. Working in collaboration with a third-party consultant hired by CF Industries, the intern collected steam flow, temperature, and pressure data for a study of the steam system. After compiling the data, it was estimated that the plant could potentially reduce steam production, resulting in annual savings of water, natural gas, and water treatment chemicals.

Water Recycling: In the UAN plant the process water being recycled is collected in a holding tank before being pumped back to the acid plants. Test results from the line connecting the tank to the pumps and the tank's atmospheric vent revealed that carbon dioxide gas from the water collection process is being passed from the tank to the pumps, resulting in decreased pump performance. This decreased pump performance can limit the amount of water able to be recycled.

After researching solutions, further testing confirmed that installation of a replacement pump that is capable of handling both liquids and gases could increase water recycling between the three plants by a rate of 17 gpm. This increase in water recycling could save 10.6 million gallons of water annually, along with reductions in associated steam and water treatment chemicals.

PROJECT	ANNUAL COST SAVINGS	ANNUAL ENVIRONMENTAL RESULTS	STATUS
WATER RECYCLING	$49,602	10,612,600 gallons water 177,284 therms 13.6 tons water treatment chemicals	RECOMMENDED
STEAM SYSTEM ANALYSIS	$740,259	26,702,600 gallons water 2,822,250 therms 34 tons water treatment chemicals	RECOMMENDED

CURRIES

TYLER SIMON
CHEMICAL ENGINEERING
THE UNIVERSITY OF IOWA

COMPANY PROFILE

Located in Mason City, Iowa, CURRIES is a leading manufacturer of steel and Fiberglass Reinforced Polyester© (FRP) doors as well as steel and aluminium frames. CURRIES currently employs 660 people at its 326,000 sq. ft. facility, divided into either door or frame production. The door production cells operate five or six days per week with two shifts per day and the frame production cells operate five days per week with three shifts per day. CURRIES utilizes an ISO 14001:2004 certified environmental management system.

PROJECT BACKGROUND

CURRIES follows a sustainability-based agenda and is committed to reducing their environmental impact. The purpose of the 2017 internship project was to determine possible substitutes for the solvent used at CURRIES, with the intention of reducing the use of volatile organic solvents and hazardous waste generation. A secondary project goal was to reduce the energy used by large processing equipment.

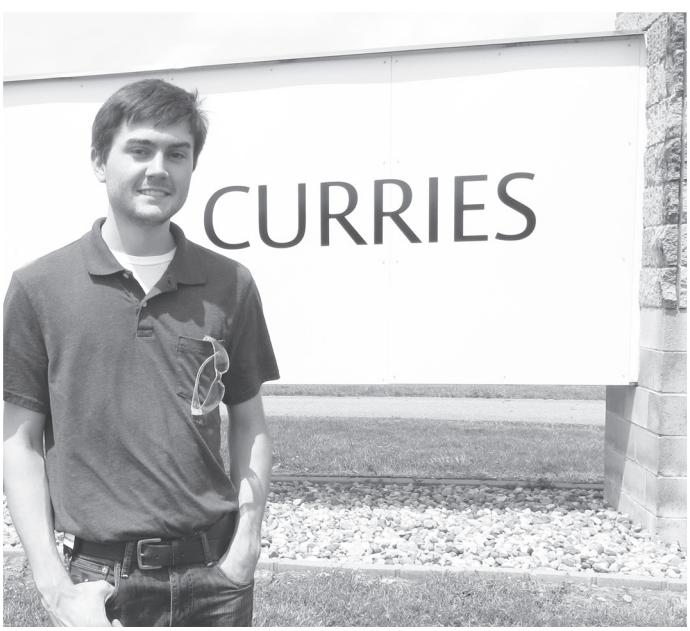
INCENTIVES TO CHANGE

CURRIES is a subsidiary of ASSA ABLOY, a Swedish lock manufacturer. Since 2006, ASSA ABLOY has been committed to a sustainable business model. This has led to the development of a global initiative aimed at reducing company environmental impact by decreasing volatile organic solvent usage, reducing hazardous waste generation, reducing energy usage, and preventing greenhouse gas creation. By replacing their current cleaning solvent with a less hazardous alternative, CURRIES will be able to take a large step towards reaching this goal.

RESULTS

Solvent Replacement: CURRIES currently uses a cleaning solvent listed as hazardous to remove paint and other compounds from equipment. Distillation is currently used to recover a large percentage of the solvent for reuse. To eliminate the use of the hazardous solvent, the intern conducted tests to verify the efficacy of non-hazardous substitutes. By replacing the current solvent with a viable a non-hazardous solvent, CURRIES could reduce hazardous waste generation by 11.36 tons per year, generate 60 percent less VOCs, and save $20,201 annually. Additionally, the new solvent could reduce staff time spent training on the safe use and handling procedures of the current solvent, and may also allow the facility to be reclassified to small quantity generator status.

Solvent Contaminated Wipe Exemption: CURRIES commonly uses machine shop rags or paper towels to dry tools or equipment of cleaning solvent. These wipes are currently disposed of as hazardous waste. It was recommended that CURRIES instead take advantage of the EPA's solvent contaminated wipe exemption, which would allow CURRIES to responsibly dispose of the wipes in a municipal solid waste landfill and save more than



$16,602 in disposal costs. Should this recommendation be implemented along with solvent replacement, savings figures would be impacted.

Distillation of Waste: Waste containing solvent from one of CURRIES' special production units is not currently distilled because a hazardous composition forms when waste streams are mixed. By isolating this waste upstream, part of the solvent could be recovered through distillation and up to 48 percent of the waste could be eliminated. This could save CURRIES $1,689 annually and prevent the creation of 0.77 tons of hazardous waste.

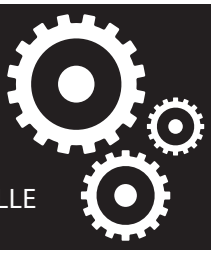
Dry-off Oven Adjustment: Prior to being painted, the frames CURRIES produces are washed and dried. It was unknown what oven temperature was required in order to ensure the frames were dry enough for the paint to adhere. By incrementally decreasing the temperature each day and monitoring the results, the minimum temperature required to maintain quality product was found. Permanently lowering the temperature of the oven to this optimal minimum temperature could reduce energy use by 4,085 therms and save CURRIES $1,037 annually.

Auto Idling System: When the conveyors transporting the product are stopped, the production equipment remains active. This equipment uses large amounts of electricity, water, and natural gas. It was recommended that CURRIES implement a control program that sets the production equipment to an idle state when the conveyor system is inactive. This recommendation could save 413 therms, 18,255 kWh, 316,486 gallons of water, and $3,550 annually.

PROJECT	ANNUAL COST SAVINGS	ANNUAL ENVIRONMENTAL RESULTS	STATUS
SOLVENT REPLACEMENT	$20,201	11.36 tons	RECOMMENDED
SOLVENT CONTAMINATED WIPE EXEMPTION	$16,602	0.10 tons	IN PROGRESS
DISTILLATION OF WASTE	$1,689	0.77 tons	RECOMMENDED
DRY-OFF OVEN ADJUSTMENT	$1,037	4,085 therms	IMPLEMENTED
AUTO IDLING SYSTEM	$3,550	316,486 gallons 18,255 kWh 413 therms	RECOMMENDED

DUPONT INDUSTRIAL BIOSCIENCES

MICHALEE LEUTHARD
ENVIRONMENTAL ENGINEERING
UNIVERSITY OF WISCONSIN - PLATTEVILLE



COMPANY PROFILE

DuPont is a science company that has been bringing world-class science and engineering to the global marketplace in the form of innovative products, materials, and services since 1802. One business within DuPont, Industrial Biosciences (IB), works with customers across a wide range of industries to improve products and make processes more sustainable. Through a unique combination of agricultural, biotechnology, chemical and material science capabilities, coupled with the power of 2,500 talented individuals worldwide, the organization focuses on providing biobased solutions to meet the needs of a growing population. The company follows four core values that guide the company's culture and practices; they are: respect for people, safety and health, environmental stewardship, and highest ethical behavior.

IB has numerous research and production facilities around the world, including our enzyme plant in Cedar Rapids, Iowa. The site opened in 1991, currently employs approximately 200 people and continues production 24/7. The Cedar Rapids facility produces industrial enzymes and fermentates via fermentation, which are used in detergents, animal feed, preservatives for food, and ethanol production. The products produced at the Cedar Rapids plant are shipped around the world.

PROJECT BACKGROUND

The intern focused on solid waste and water conservation to work towards DuPont Industrial Bioscience's sustainability goals. One of DuPont's methods of enzyme recovery produces solid waste. This waste is currently landfilled, so alternative disposal options and source reduction opportunities were investigated. Another enzyme recovery process that DuPont uses produces nutrient-rich sludge. To decrease the wastewater nutrient loading resulting from this process, the intern examined increasing the volume that is land applied. To decrease facility water usage, scrubber flow rates were studied and optimized.

INCENTIVES TO CHANGE

As a global business, Industrial Biosciences has committed to a set of sustainability goals to accomplish by 2020. The goals are to reduce solid waste, energy usage, and greenhouse gas emissions, and improve water stewardship. In addition, the wastewater treatment facility in Cedar Rapids has guaranteed rate increases to comply with the Iowa Nutrient Reduction Strategy. To jumpstart their environmental reduction goals, the Cedar Rapids DuPont facility partnered with the DNR's Pollution Prevention Intern Program to host an intern dedicated to compiling data and evaluating viable strategies.

RESULTS

Land Application: In order to divert the solid waste produced during enzyme recovery from the landfill, many options of disposal, recycling, and reuse were considered. This material contains nutrients and is continuously produced on site, creating a consistent source for an end use. Following a thorough analysis, the intern recommended agricultural land application. This recommendation is in progress, and when fully implemented, is expected to divert 7,200 tons of waste from the landfill, and save DuPont $151,200 annually. In addition, less commercial fertilizer will be used by farmers, with the goal of reducing leaching into neighboring water bodies. Once land application is implemented, it is recommended that DuPont continue looking into other, even more environmentally beneficial options for this waste stream, such as biochar and composting.

Bag Cincher: Source reduction opportunities were also investigated to reduce the amount of solid waste generated by enzyme recovery. The waste stream recommended for land application is produced from regular addition of raw materials. Decreasing any unnecessary addition of raw materials would decrease the volume of waste produced. It is recommended that DuPont install a bag cincher to existing equipment used to dump bags of raw materials. Currently only whole bags of material are dumped because there is no efficient way of handling partially full bags. A bag cincher will allow partial bags to be easily used, decreasing the amount of raw material wasted, and decreasing labor for the technicians. This option is recommended, and could eliminate 109 tons of overdosed material and provide an annual savings of $14,250 for DuPont.

Perlite Silo: A silo could provide another source reduction opportunity for one of the raw materials used in enzyme recovery. A silo would allow more precise metering of material, eliminating wasted material. The material could then be purchased in bulk, allowing reduced costs per kilogram, and warehouse storage space would no longer be required for this material. A silo would also eliminate the use of bags for this raw material, decreasing labor for the technicians. This option could eliminate 109 tons of wasted material and result in annual savings of $234,000 for DuPont. Should this reduction option be implemented, there would be associated impacts on the savings and environmental results of the previous bag cincher recommendation.

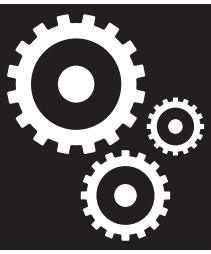
Land Application of Sludge: To comply with the Iowa Nutrient Reduction Strategy, the wastewater treatment facility in Cedar Rapids must increase their treatment charges to implement new treatment strategies. In response to this, DuPont investigated decreasing the nutrients in the plant's wastewater effluent through land applying more of the sludge produced from enzyme recovery. Samples were gathered and tested for land application requirements to verify feasibility. This project is currently in progress, and 4,500,000 gallons per year have been determined to be eligible for land application. This would divert a significant amount of nutrients from the wastewater treatment facility, and potentially save DuPont $55,000 annually. In addition, nutrients could provide crop benefit and commercial fertilizer use could be decreased.

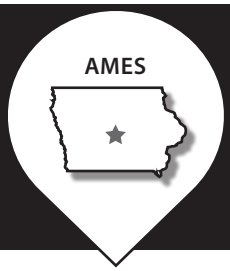
Scrubber Optimization: Optimization of the scrubbers could decrease the amount of water used at the Cedar Rapids facility. The scrubbers remove particulates efficiently, but use more water than necessary. This process was investigated by testing the solids content in the water retained in the scrubber and found that the flow rates of the scrubbers could be decreased while maintaining efficient particulate removal. By decreasing the flow rates through the scrubbers, more than 11,205,000 gallons could be saved each year, allowing potential annual savings of $22,000 for DuPont.

PROJECT	ANNUAL COST SAVINGS	ANNUAL ENVIRONMENTAL RESULTS	STATUS
LAND APPLICATION	$151,200	7,200 tons	IN PROGRESS
BAG CINCHER	$14,250	109 tons	RECOMMENDED
PERLITE SILO	$234,000	> 109 tons	RECOMMENDED
LAND APPLICATION OF SLUDGE	$55,000	4,439,000 gallons	IN PROGRESS
SCRUBBER OPTIMIZATION	$22,000	11,205,000 gallons	IN PROGRESS

HACH

AKSHAY KULKARNI
CHEMICAL ENGINEERING
IOWA STATE UNIVERSITY





COMPANY PROFILE

Hach is one of the world's leading companies in providing water testing equipment and innovative water testing methods. Hach was founded in Ames, Iowa, in 1947 and is now a global provider of water analysis and testing products. The headquarters is currently based in Loveland, Colorado. The Ames branch concentrates on manufacturing and shipping more than 100 reagents and powdered chemicals used for testing water. The Ames plant employs about 450 people and operates three shifts daily to ensure that the demands of the customers are met.

PROJECT BACKGROUND

Having limited existing data on water consumption, Hach tasked the P2 intern with conducting a facility-wide water balance and identifying opportunities to reduce process water usage and improve the quality of wastewater discharges. Once water use trends were determined, the intern focused on identifying water use reduction opportunities in the plant. The intern also analyzed the impacts on hazardous waste sources as a result of water reduction recommendations.

INCENTIVES TO CHANGE

As an ISO 14001 certified company, Hach is committed to understanding water use throughout the facility and implementing water conservation practices where possible. In addition to the environmental benefits of tracking and reducing water use, there are significant economic benefits associated with reduced city water purchasing and post-use treatment costs.

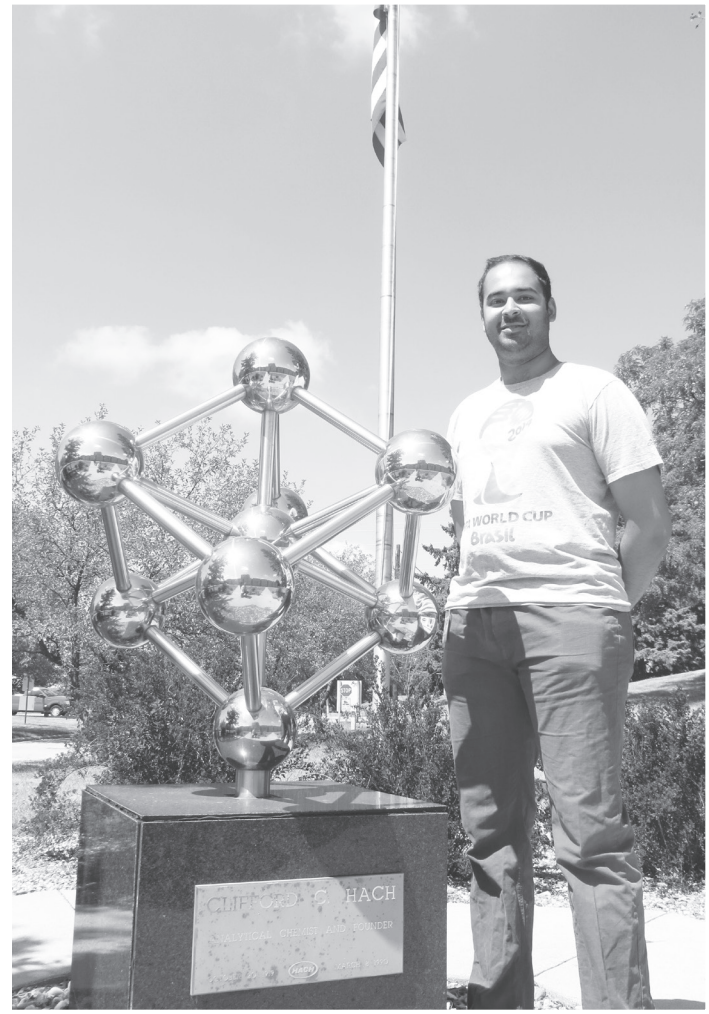
Hazardous waste reduction is a key objective of the Environmental Management System at Hach. In addition to improved environmental impacts of reducing hazardous waste, reduced disposal costs can add a significant cost savings for the company.

RESULTS

Flowmeter Installation: Installing flowmeters with a totalizer feature at strategic locations throughout the facility would provide cumulative water consumption data for tracking water use. A spreadsheet with visual analysis tools was developed for tracking the data from the flowmeters. It is expected that tracking and understanding water use in the facility will result in improved conservation practices with estimated annual savings of 650,000 gallons of water and $4,800.

High Pressure Water Gun: Equipment cleaning is a critical component to maintaining the company's high quality standards. However, there is great potential to reduce water use by altering the water hoses used to clean the equipment. Application of high pressure and low flowrate spray nozzles is recommended to replace the conventional water hoses currently used for cleaning. The spray nozzle not only reduces the water usage in the cleaning process eightfold, but also allows for more time-efficient cleaning. Using these nozzles would result in annual savings of 866,764 gallons of water and $2,202 in associated costs.

Solenoid Valve: Observations and results from the water balance indicated areas within the plant where water usage reduction opportunities exist. The flow through the city water line that supplies water to reactors for cooling is controlled by a manual valve. The valve is often left open when cooling water is not required. It is recommended that an automatic programmable



solenoid valve is installed that would result in annual savings of 900,000 gallons of water and $2,290.

Cooling Loop Installation: Installing a closed-loop, glycol cooling system could significantly reduce current water usage for cooling reactors. Furthermore, operators would have more control over the temperature of the coolant and be able to consistently maintain cooling temperatures. Implementing a glycol cooling loop could benefit production in addition to saving water. The implementation of this recommendation could result in annual savings of 1,728,000 gallons of water and $4,396.

Recycling Water to Vacuum Pumps: Two liquid ring vacuum pumps run 24 hours a day, seven days a week utilizing city water. Recycling water back into the water feed line for these two pumps could result in significant savings. Further studies are recommended to verify the viability of this strategy. If implemented, this recommendation could result in annual savings of approximately 1,632,960 gallons of water and $4,154.

SOP Modification and Employee Training: Modifications to standard operating procedures (SOPs) will result in reduced water usage, improved handling of hazardous waste, and reduced waste generation. Changes to SOPs include instructing operators on efficient rinsing strategies and establishing clear guidelines on when employees must collect hazardous waste. This will eliminate any ambiguity of how much cleaning needs to be performed until all the hazardous waste is collected and the rest of the rinse is safe to drain.

PROJECT	ANNUAL COST SAVINGS	ANNUAL ENVIRONMENTAL RESULTS	STATUS
WATER USE ANALYSIS	$5,600 (one time)	-	IMPLEMENTED
FLOWMETER INSTALLATION	$4,800	650,000 gallons	RECOMMENDED
HIGH PRESSURE WATER GUN	$2,202	866,764 gallons	RECOMMENDED
SOLENOID VALVE	$2,290	900,000 gallons	RECOMMENDED
COOLING LOOP INSTALLATION	$4,396	1,728,000 gallons	RECOMMENDED
RECYCLING WATER TO VACCUM PUMPS	$4,154	1,632,960 gallons	RECOMMENDED
SOP MODIFICATION AND EMPLOYEE TRAINING	$590	78,000 gallons	RECOMMENDED

IOWA FERTILIZER COMPANY

JAMES KLIEBHAN
CHEMICAL ENGINEERING
THE UNIVERSITY OF IOWA

COMPANY PROFILE

Iowa Fertilizer Company in Wever, Iowa, is the first greenfield nitrogen fertilizer facility built in the United States in more than 30 years. Iowa Fertilizer produces four commercial products: anhydrous ammonia, granulated urea, urea ammonium nitrate solution (UAN) and diesel exhaust fluid. Their mission is to provide a reliable, stable, and domestic source of nitrogen fertilizer to farmers in Iowa and throughout the United States. The site is equipped with both a production facility and a loadout terminal for their products. The facility is able to produce two million metric tons of nitrogen-based fertilizer products each year at full capacity and currently employs 200 full-time people to operate the plant.

PROJECT BACKGROUND

Iowa Fertilizer Company began initial production operations on April 20, 2017, and was still in the process of commissioning the ancillary facilities to support production throughout the 2017 intern project. These commissioning efforts aim to optimize the operating efficiency of the plant. Wastewater treatment is a part of daily operations and it is key to discharge water within permit limits. A specific process within wastewater treatment is treatment of the blowdown water from the cooling towers to remove any ammonia before discharge. This process design had been installed and needed to be tested and verified before being put into operation. The intern was tasked with verifying the accuracy and efficacy of the ammonia treatment system and recommending system improvements.

INCENTIVES TO CHANGE

As a brand new facility, Iowa Fertilizer Company has worked hard to create an environmentally responsible and safety-first culture among its employees. Iowa Fertilizer is largely invested in the surrounding community and the environment and continually takes precautionary steps to reduce their environmental impact. Commissioning this facility will ensure that all systems are operating at optimum efficiency and in harmony with other processes. Optimizing the performance of the ammonia treatment system for cooling water blowdown will reduce chemical usage and associated costs and help Iowa Fertilizer Company meet its environmental goals.

RESULTS

Blowdown Wastewater Treatment System Improvements: Iowa Fertilizer Company relies heavily on its cooling towers to remove process heat and cool the working fluid used in production. There are two cooling towers on site that continuously discharge water (known as blowdown) to control the buildup of minerals in the cooling water. This blowdown water could also carry trace amounts of ammonia that must be treated before leaving in the effluent water stream for discharge.

The intern conducted a field test on the blowdown wastewater treatment facility to collect pertinent data and information to make recommendations for the company. Numerous tests were conducted that concluded that the treatment system had opportunities to function better. Based on the concentration of ammonia, there could be insufficient reaction time between successive chemical treatments which, if left unaddressed, could potentially result in the discharge of untreated wastewater. To solve this issue, it is recommended that the chemical injection points be relocated to increase the contact time between contaminated water and the chlorinating agent.

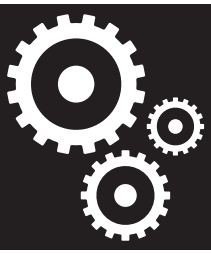
The intern developed and completed extensive supplementary tests to determine where the injection points should be placed for optimum treatment. Multiple options were evaluated, with the intern recommending that the reaction length distance be quadrupled as compared to its current length. This recommended design also includes the implementation of an additional static mixer to increase contact time. An additional static mixer in the line will act as a safeguard to ensure that as the flow rate of the blowdown varies, the chlorination reaction will proceed to completion prior to the dechlorination step. This project is a preventative measure that would improve ammonia removal and reduce the risk of unintended releases.

Downsize the Sodium Bisulfite Pump: Even at its lowest setting, the sodium bisulfite (SBS) pump currently doses six times the required amount of sodium bisulfite to the blowdown stream. Plans are currently underway to replace this oversized pump with a smaller one by the same manufacturer that is already onsite but currently unused. If dosed correctly with the substituted pump, Iowa Fertilizer Company could reduce their annual use of sodium bisulfite by nearly 69 tons. In addition to reduced chemical usage, the smaller pump would also consume less energy. Downsizing the sodium bisulfate pump could save Iowa Fertilizer $23,147 per year.

PROJECT	ANNUAL COST SAVINGS	ANNUAL ENVIRONMENTAL RESULTS	STATUS
BLOWDOWN WASTEWATER TREATMENT SYSTEM ANALYSIS	$35,850 (one time)	-	IMPLEMENTED
BLOWDOWN WASTEWATER TREATMENT SYSTEM IMPROVEMENTS	-	0.88 tons NH_3	IN PROGRESS
DOWNSIZE SBS PUMP	$23,147	68.99 tons SBS 1,778 kWh	RECOMMENDED

JBS USA, LLC

JEREMY ZEIS
MECHANICAL ENGINEERING
IOWA STATE UNIVERSITY



COMPANY PROFILE

JBS, founded in 1953, is the world's largest meat processing company by sales. Headquartered in São Paulo, Brazil, JBS provides quality meat products to countries all over the world. The JBS facility located in Marshalltown, Iowa, produces, stores, and distributes the Swift Premium® and La Herencia® brands of pork and spends more than $950 million on livestock purchases annually. With more than 2,200 employees representing several countries across the globe, the Marshalltown facility runs two processing shifts and one cleaning shift during each day, five to six days per week.

PROJECT BACKGROUND

The JBS Marshalltown plant uses more than 740 million gallons of water annually. In an effort to reduce the amount of water used, a 12-week project was conducted to complete a full water usage analysis, identify water reduction opportunities, and recommend solutions that will reduce the water usage at the JBS Marshalltown plant. The goal of the project was to reduce the annual water usage by ten percent in order to increase utility efficiency and lower operating costs at the plant.

INCENTIVES TO CHANGE

As a leading protein processor, JBS continuously seeks ways to maximize revenue, but also to emphasize environmental sustainability. JBS obtains 25 to 30 percent of the plant's water from the city, and 70 to 75 percent from underground aquifers. With the amount of water needed, the costs to obtain, treat and discharge this water are significant. A 10 percent reduction in well water usage could save JBS more than $250,000 annually in associated costs. Identifying and implementing water-saving solutions will help JBS meet their environmental goals, reduce operating costs and increase company profit.

RESULTS

Kill Floor Water Turn-Off Program: Sinks, eye wash stations, 180°F sanitary hot boxes, rotating saws, tray sprayers, and a visceral pan sprayer all use water throughout both processing shifts. During each kill-floor employee break, several of these applications still run water. These applications are also left running during three hours of overnight cleanup, resulting in a total of approximately 300 minutes of excess water usage for each running application daily. Adding conveniently placed shut-off valves and manually turning off the water to these applications when processing stops could eliminate nearly 4.9 million gallons of water annually.

Addition of a Wastewater Cooled Condenser: Every production day, 800,000 to 1,200,000 gallons of well water are used to condense steam created from cooking inedible products, increasing the temperature of the cooling water to 140°F. The plant houses two hot water tanks that can store a total of about 320,000 gallons of

Closed-loop Cooling Process: Cold water is used to cool a meat harvester located in the ham boning area of the plant as well as two large bearings located in the rendering area. Each stream of cooling water currently runs through their respective machines as a once-through process. By adding small ammonia cooled chillers near each of the machines and running both of these cooling processes through their chillers, each process can be set up as a closed loop cooling process instead of a once-through system. This process could save 7,185,000 gallons of water that is currently used each year for cooling.

Hog Barn Spray Repairs: In order to keep hogs cool throughout the day, sprinkler-like sprays controlled by solenoid valves are turned on for one minute, two to 12 times every hour depending on the time of year. The sprays run at an average of three gallons per minute, and two of the solenoid valves controlling four of the sprays were malfunctioning. The malfunctioning solenoid valves caused the sprays to run 24 hours per day. By repairing the broken solenoid valves, 1,051,000 gallons of water were saved annually.

this water, but once the tanks overflow, the overflow 140° water is sent to the anaerobic lagoon as wastewater. Adding a third shell and tube condenser that runs in parallel with the existing condensers and is cooled by DAF effluent wastewater, could significantly reduce the loading on the two existing condensers. With reduced loads, the existing condensers would only require enough well water to fill the plant's hot water tanks every day, reducing the annual water usage by 119,354,809 gallons. An added benefit of a third condenser is that the temperature of water entering the anaerobic lagoon can be more easily maintained in order to maximize the efficiency of the lagoon without having to heat the wastewater with an additional process.

PROJECT	ANNUAL COST SAVINGS	ANNUAL ENVIRONMENTAL RESULTS	STATUS
KILL FLOOR WATER TURN-OFF PROGRAM	$19,366	4,880,694 gallons	RECOMMENDED
ADDITION OF A WASTEWATER COOLED CONDENSER	$421,129	119,300,000 gallons	RECOMMENDED
CLOSED-LOOP COOLING PROCESS	$25,925	7,185,000 gallons	RECOMMENDED
HOG BARN SPRAY REPAIRS	$3,710	1,051,000 gallons	IMPLEMENTED

PRINCIPAL FINANCIAL GROUP

OMAR SANOUSI
MECHANICAL ENGINEERING
IOWA STATE UNIVERSITY

COMPANY PROFILE

Principal Financial Group is a global financial investment management leader founded in 1879. The company employs around 14,600 people worldwide and manages retirement assets across equities, fixed income, and real estate investments in 11 countries, including the United States. Headquartered in Des Moines, Iowa, the company continues to attract customers, delivering more than $19 billion in positive net cash flows in 2016 alone and increasing assets under management to $592 billion. These achievements have allowed Principal to climb the Fortune 500 List, where they are currently ranked 227th. The company is also a 500 Climate Disclosure Project (CDP) Leader.

PROJECT BACKGROUND

The focus of the 2017 Pollution Prevention Intern project was to assess processes and procedures within specified areas of Principal's corporate campus operations and recommend strategies that will reduce energy and water consumption to advance Principal's sustainability program. Specifically, the intern focused on evaluating the practices of Principal's campus food services contract vendors to identify energy savings. In addition, the intern analyzed Principal's cooling tower water treatment processes and controls and evaluated strategies to reduce the cooling towers' make-up water intake and blowdown.

INCENTIVES TO CHANGE

Principal Financial Group maintains being "environmentally responsible" as one of the company's operating fundamentals. Their goal is to improve communities through global sustainability initiatives that reduce the company's carbon footprint and water usage. They are striving to increase the energy efficiency of their operations by adopting a science-based greenhouse gas reduction goal. In 2016, Principal reduced their overall carbon emissions by 25 percent, exceeding their goal to reduce baseline 2011 carbon emissions by 10 percent.

RESULTS

Café Appliances and Electronics:

Walk-In Cooler: An analysis was done of the café's numerous walk-in coolers that are used to store all perishable food products. The intern found some of these coolers were underutilized or unused, even though all were running continuously. A decommissioning plan was developed to eliminate the energy consumption of the unused coolers. Controls and the temperature-increase alarm systems of the coolers were improved to eliminate potential product loss in case of a cooler failure.

Dishwasher: The kitchen dishwashers were also evaluated by the intern. The dishwashers are equipped with an energy-saving feature that puts them in stand-by mode

between wash cycles. This default stand-by mode was found to be set at two hours before automatically shutting down. The control settings could be modified to optimize the amount of time the dishwashers are able to enter a reduced power mode and to automatically shut down when not in operation for a set duration.

Large Screen TV's: Numerous large screen TV's throughout the café were left on 24 hours a day, 7 days a week. An operational change was made to ensure the TV's were only on during café operating hours, yielding additional energy savings.

Café Ventilation System Improvements: The café's ventilation system consists of a variety of different components. Exhaust fans installed in the numerous kitchen hoods modulate the performance of the make-up air unit inside the cafeteria. The kitchen hoods are each equipped with a temperature sensor system that allows the exhaust fans to operate continuously in a set range of temperatures until the hood reaches a satisfactory temperature. The make-up air unit itself consists of an electrical preheat, a chilled water cooling coil, and a supply fan equipped with a variable frequency drive and an airflow measuring station.

The energy audit of the ventilation system identified inefficiencies with the controls of the temperature system that allowed the exhaust fans and make-up air unit to operate continuously outside of normal kitchen working hours. Modifying the controls to set operating hours will help optimize efficiency of the ventilation system and reduce energy usage. Installation of a variable frequency drive (VFD) and a smoke optic sensor, in addition to the existing temperature sensor, would achieve further energy savings.

Cooling Tower Improvements: The intern analyzed the performance, water consumption, and treatment controls of the three main corporate campus cooling towers and identified several strategies to minimize their water consumption. Two of the cooling towers were not equipped with make-up and blowdown water gauges. The installation of a gauge meter will eliminate the uncertainty in the overall water consumption of the towers. The intern also designed a detailed strategic maintenance plan to minimize leaks and reduce the total make-up water usage of the towers. Cleaning the cooling towers twice a year and maintaining up-to-date recirculation rates will improve the current water treatment process, increase the efficiency of the towers, and reduce water consumption.

PROJECT	ANNUAL COST SAVINGS	ANNUAL ENVIRONMENTAL RESULTS	STATUS
CAFÉ APPLIANCES AND ELECTRONICS	$8,385	121,200 kWh	IN PROGRESS
CAFÉ VENTILATION SYSTEM IMPROVEMENTS	$5,000	55,275 kWh	RECOMMENDED
COOLING TOWER IMPROVEMENTS	$3,000	1,200,000 gallons	IN PROGRESS

SMITHFIELD SIOUX CITY

EMILY MEERDINK
ENVIRONMENTAL ENGINEERING
SOUTH DAKOTA STATE UNIVERSITY

COMPANY PROFILE

Smithfield is a global company founded in 1936 in Smithfield, Virginia. The company has grown to employ 52,000 people and leads the nation in pork processing and packaged meats. The Sioux City, Iowa, plant is part of Smithfield's packaged meats division. Smithfield Sioux City (Smithfield) has 673 employees and is capable of producing more than 270 different products. The Smithfield plant originally operated as Curly's and has its origins in selling specialty cut ribs. Smithfield still specializes in barbeque meats and precooked ribs.

PROJECT BACKGROUND

The project goal was to improve grease recovery from Smithfield's wastewater. On-site storage and increasing the volume of collected grease were priorities. The secondary project was to identify opportunities to reduce waste going to the landfill with a specific emphasis on the plastic waste stream. Concerns included plastic with meat or sauce residue. These waste streams are largely undesirable to recycling companies due to their contamination.

INCENTIVES TO CHANGE

Smithfield is committed to continuous improvement and its responsibility to the community as well as the environment. Smithfield maintains a grease pit as part of their wastewater system and previously ran a rope skimmer to collect grease. Incentives to resume and improve grease recovery include potential financial gains and ease of cleaning the grease pit. Smithfield has a goal of zero-waste to landfill by 2020. This is a corporate goal and will meet Smithfield's sustainability requirements.

RESULTS

Surface Sludge Scraper: A surface sludge scraper would provide effective grease removal from the on-site grease pit. This type of equipment is recommended due to limitations incurred by Smithfield's current infrastructure and grease characteristics that make other recovery systems infeasible. Currently, the pit is cleaned weekly and the removed solids are landfilled. An effective collection process could enable the grease to be sold to a local rendering company for reuse.

To fully implement this recommendation, Smithfield would also need appropriate on-site storage for the grease. For effective and efficient containment, a double-walled storage tank that is heated and insulated was recommended. The tank must be heated so the grease can be pumped. A tank designed with a cone bottom is recommended to decant water. Improved recovery and sale of the grease for reuse could yield annual revenue of approximately $38,770 and divert 5.4 tons from the landfill.

Dry Cleaning: Observations were made while working in the grease pit that indicated an opportunity for improving dry clean-up procedures. Whole meat scraps in the wastewater contribute to the total suspended solids of the effluent. Additionally, other solid items make pit clean-out more challenging. Specific process areas were identified by the intern for Smithfield to target for improved dry clean-up practices. Economic benefits of improving dry clean-up include reduced effluent surcharges and decreased pit cleaning frequency. Improved dry clean-up would also result in reduced waste to landfill, as captured solids could be used by a local rendering vendor.

Wood Ash Reuse: Smithfield produces wood ash from its smokehouses and currently landfills the ash. Wood ash can be used as a soil amendment as it contains lime and potassium as well as other nutrients. Potential beneficial use outlets for composting or land application were identified, but continued exploration is required. In addition to acquiring an end user, the material should be tested for nutrient content and various compositional characteristics. By donating its wood ash to a beneficial use, Smithfield will be contributing to the local community, diverting 31 tons of waste from the landfill each year, and saving $5,700 annually.

Contaminated LDPE: A local recycling company will take Smithfield's clean LDPE plastic free of charge, but a significant percentage of the LDPE waste generated at the Sioux City plant is considered contaminated due to a meat or sauce residue. This residue can interfere with the recycling process so there are limited options for vendors in Smithfield Sioux City's geographical area that will accept contaminated plastic for recycling. A non-local company was identified that would accept contaminated plastic; however, Smithfield Sioux City does not produce a large enough volume to sustain the increased transportation costs. Collaborating with other nearby Smithfield plants to group shipments of LDPE plastic could provide a cost effective strategy for diverting this waste stream from the landfill.

PROJECT	ANNUAL COST SAVINGS	ANNUAL ENVIRONMENTAL RESULTS	STATUS
SURFACE SLUDGE SCRAPER & STORAGE TANK	$38,770	5.4 tons	RECOMMENDED
DRY CLEANING	-	-	RECOMMENDED
GREASE RECOVERY ANALYSIS	$10,800 (one time)	-	IMPLEMENTED
WOOD ASH REUSE	$5,700	31 tons	RECOMMENDED
CONTAMINATED LDPE	-	155 tons	RECOMMENDED
LANDFILL REDUCTION ANALYSIS	$12,600 (one time)	-	IMPLEMENTED

TYSON FRESH MEATS, INC.

FAYE ASSMANN
CHEMICAL ENGINEERING
IOWA STATE UNIVERSITY

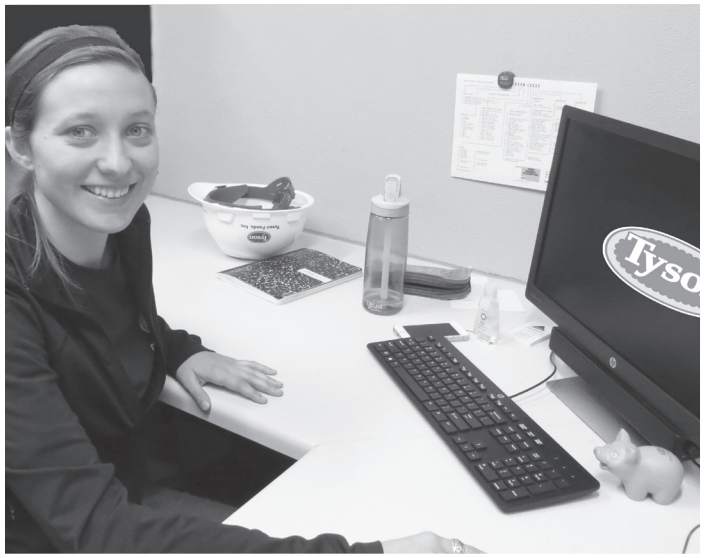
COMPANY PROFILE
Tyson Foods was founded in 1935 and has grown into a multi-national corporation with $37 billion in net sales in 2016. There are 12 beef and pork harvest plants and the Tyson plant in Storm Lake, Iowa, is one of nine pork processing facilities and employs 1,850 people.

PROJECT BACKGROUND
Pork processing requires significant amounts of water for production, sanitation, and maintenance of the plant. After it is used in the plant, water is sent to Tyson's wastewater facility where it is treated before being released back into the environment. The goal of the intern's project at the Storm Lake plant was to reduce the overall water usage by 1 percent from the previous fiscal year's usage. The intern conducted an economic and environmental analysis of water use at the plant and made recommendations to conserve water and reduce operating costs.

INCENTIVES TO CHANGE
One of Tyson's core values is, "to serve as stewards of the animals, land, and environment entrusted to them." Since 2006, Tyson has published an annual sustainability report with one of its focuses on improvement in water usage. Without compromising the wholesomeness and safety of their food products, the company has set a goal to reduce the water used to make each pound of product by 12 percent by the end of 2020. To contribute to the company-wide goal, Storm Lake partnered with the 2017 Pollution Prevention Intern Program.

RESULTS
Knee-Activated Water System: Current production of the chitterlings, or pork intestines, involves a large amount of water used while they are disentangled and washed before getting prepped for packaging. The employees who unravel the product use 140°F water from hoses that run continuously during production to rinse their gloved hands after handling each one. On average, the employees rinse their hands two times a minute. By installing a knee-activated water system for this step, water can conveniently be turned on and off and would only be running when the employees needed to rinse off their gloves. With this system in place, the water demand for the chitterlings hoses could be reduced by more than 18 million gallons of water and 152,000 therms annually.

Sanitation Shift Water Reduction: During the night shift, the sanitation crew comes to the plant and works to remove the meat and scraps from the production floors that accumulate during the day and sanitize the equipment before production begins again. The sanitation shift utilizes 140°F water from hoses for the first step to knock meat/scraps off belts, equipment, and machines to the floor. After using a cleaning detergent on all the equipment, the workers use hoses again to rinse off the soap. The nozzles on the hoses are



continuously flowing and currently don't provide a way to easily turn the water supply on and off. Periodically throughout the night, employees experience downtime to readjust their hoses or ladders or go on break. Installing ball valves next to the nozzles so water can be momentarily turned off and on during these downtimes could reduce water usage during night shift by approximately 2 percent, or 1,658,560 gallons, and save more than 13,000 therms annually.

Water and Chemical Reduction During Breaks: During production, water flows continuously to numerous pieces of equipment to keep machine blades cool, clear blades of particle dust, and to rinse gloved hands and finished product before packaging. Depending on the task, the sprayers will also perform an antimicrobial spray in addition to water spray. The water and chemicals for this process flow continuously during production hours, including employee breaks that represent 135 minutes each day. Next to each piece of equipment is a ball valve and lever that allows for simple manual water supply control. Turning off this water supply during breaks could cut back on 21 gallons of antimicrobial chemical and reduce water usage by more than 2.7 million gallons of water annually.

Reduce Sink Water Use: On the harvest floor, the ambient temperature of the room can get very hot due to numerous pieces of heat-emitting equipment. The water pipes that feed the floor's hand washing sinks and water fountain faucets are indirectly heated and the water comes out warm. To combat the warm water, faucets are left running continuously so that cooler water can flow instantly. The drinking water is only used intermittently during a production shift. Additionally, the intern's analysis revealed the time delay to get cooler water from the faucets was usually less than five seconds. Turning on the water only as needed could save a significant amount of water and associated costs.

Water Conservation Training: Ongoing training is recommended for all Tyson employees to educate and encourage water-conserving behavior. Including specific information about water usage and conservation opportunities would help employees understand the impact and value of their efforts. Also, establishing a system for employees to report leaks or broken equipment on the production floor would enable these situations to be addressed quickly and reduce inefficient water use and potential downtime. Finally, recognizing behaviors that reduce water use could help engage employees in meeting the plant's water reduction goals.

PROJECT	ANNUAL COST SAVINGS	ANNUAL ENVIRONMENTAL RESULTS	STATUS
KNEE-ACTIVATED WATER SYSTEM	$155,095	18,233,940 gallons 152,103 therms	RECOMMENDED
SANITATION SHIFT WATER REDUCTION	$14,107	1,658,560 gallons 13,835 therms	RECOMMENDED
WATER AND CHEMICAL REDUCTION DURING BREAKS	$16,980	2,786,626 gallons 21 gallons of chemical	RECOMMENDED
REDUCE SINK WATER USE	$6,651	1,108,462 gallons	RECOMMENDED

WOODWARD RESOURCE CENTER

ETHAN MORAN
MECHANICAL ENGINEERING
IOWA STATE UNIVERSITY

COMPANY PROFILE

The Woodward Resource Center was established in 1917 and is operated by the Iowa Department of Human Services. The main purpose of the facility is to provide services as a licensed Intermediate Care Facility for the Intellectually Disabled. The mission is to prepare and support individuals to live in a community of their choice. There are currently 129 individuals living on campus being supported by more than 500 employees.

The Woodward Academy, a juvenile treatment facility, leases building space located in the middle of campus. It employs 235 staff to provide clinical services in addition to an education for more than 265 students. Woodward Academy is operated 24 hours per day, 365 days per year.

The Woodward-Granger Community School District also leases building space utilized as a stand-alone special needs public school based on a state defined consortia model.

PROJECT BACKGROUND

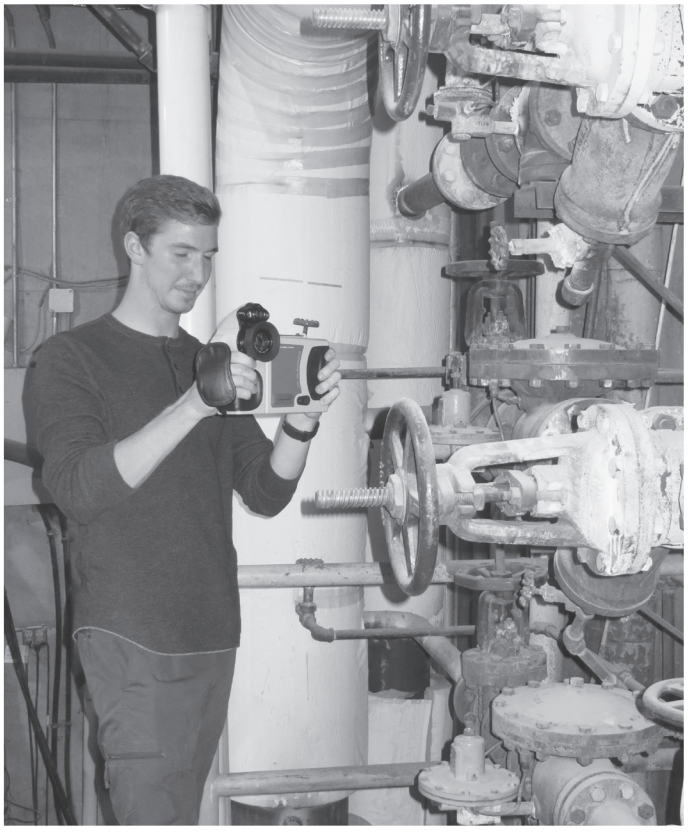
The facility uses a steam heating system for 19 buildings on campus, which includes the Woodward Academy. Two 50-year-old water tube boilers burn natural gas to produce the steam. It is delivered to more than 475,000 square feet of building space through a utility tunnel system that is 8,000 feet long. The steam is used for dryers, kitchen appliances, chillers, and room heating. Woodward Resource Center requested a 24-week intern project through the Iowa Pollution Prevention Intern Program to research opportunities and make recommendations to improve the efficiency of the steam system and reduce energy usage and associated costs.

INCENTIVES TO CHANGE

Since installation, less than 50 percent of the steam infrastructure has been replaced. Over the years, the condition of much of the piping, insulation, and steam traps has deteriorated. This has led to inconsistent heating in employee work spaces. Pipes leaking condensate has also been a major concern in the basements of buildings and the utility tunnels. Improving the steam infrastructure and reducing the amount of heat loss would increase the efficiency of the steam system, decrease the amount of emissions produced, and result in significant cost savings.

RESULTS

Steam System Analysis: In the first 12 weeks, the intern has been focusing on the processes of the steam system and determining where the biggest inefficiencies and energy losses are occurring. The majority of the intern's time has been dedicated to collecting data and conducting surveys of the steam traps, piping, and insulation. The surveys encompass the entire campus and all steam tunnels to determine the total extent of



heat energy being wasted. The collected information is being organized into a database for the steam system. This database catalogues the steam trap brands, models, sizes, temperatures, features, applications, and the status of each trap's condition. It also includes the diameter and length of uninsulated pipe sections. Floor plans of each building and tunnel were created to map out the locations of all the corresponding traps and uninsulated piping in the database.

In order to quantify the amount of steam loss in the system, a comprehensive trap audit is being performed for all of the tunnels and buildings on the facility's campus. The trap audit includes a combination of visual, temperature, and ultrasonic testing to determine whether a trap has failed or not. Research for various trap orifice sizes was done to calculate the amount of steam escaping through a failed trap. At the completion of the audit, the total number of failed traps will be tabulated and the total amount of steam loss and associated expense will be calculated.

In concurrence with the trap audit, an insulation audit is also being performed for each building and in all tunnels to identify steam piping with missing or damaged insulation that would result in heat loss. The result of this audit will be an estimation of the heat loss from sections of piping that are insufficiently insulated and the associated expense to Woodward.

The estimated cost to produce steam for the Resource Center was calculated by summating the annual cost of multiple factors. The factors included actual fuel, feed water, chemicals, environmental emissions control, maintenance and labor, repairs, and management oversight costs. The intern will continue to use these costs to determine the total cost of heat loss from failed traps and poor insulation. In addition to the economic impacts, the intern will quantify the environmental impacts of wasted water and energy.

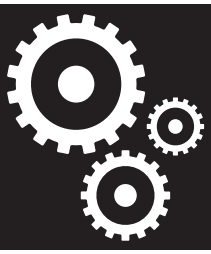
Next Steps: The next steps in the 24-week project will include analyzing the results of these audits in order to make accurate recommendations on how to improve the efficiency of the steam system. Focus areas for potential recommendations include steam trap repairs and replacements, insulation repair and replacement, and the development of sustainable management programs.

Time permitting, the intern will also complete a lighting audit and recommend options for improved efficiency in some of the buildings on campus that have been prioritized for lighting upgrades. A few locations have already been upgraded to LEDs, but most of the bulbs on campus are either fluorescent or incandescent and there is significant opportunity for energy savings.

A final case summary for this project will be posted on the Pollution Prevention Intern Program website at www.iowap2interns.com in January and printed in the 2018 case summary booklet.

ZOETIS

KEVIN TOBIN
CHEMICAL ENGINEERING
THE UNIVERSITY OF IOWA



COMPANY PROFILE
Zoetis is a world renowned leader in the animal health industry. With over 60 years of experience, Zoetis discovers, develops, and manufactures many different types of animal health vaccines and medicines for more than 100 counties. Eight species of livestock and companion animals are supported under the wide umbrella of animal health products. The Charles City, Iowa, site has grown over the years to become the lead producer of Zoetis' products in the world.

PROJECT BACKGROUND
The primary goal of this project was to identify potential areas for water conservation and formulate alternatives without compromising Zoetis' drive for efficiency and maintaining a bio-secure process. Zoetis uses a great majority of their water in cooling systems, and also purifies a significant amount to be used for heating systems, cleaning equipment, and manufacturing products. The intern analyzed these processes, gathered and interpreted data, and researched and evaluated solutions for reducing water usage. A secondary goal for this project was to improve the efficiency of the chilled water system used for cooling in the main production building.

INCENTIVES TO CHANGE
Zoetis strives to be a leader in environmental responsibility and stresses the importance of meeting the needs of the present without compromising the ability of future generations to meet their own needs. Water conservation is one of the corporate environmental priorities for Zoetis. With utility costs constantly rising, the need to assess how water is used in the facility becomes increasingly important. The company could save a significant amount of water and associated treatment costs and make strides toward meeting their environmental goals.

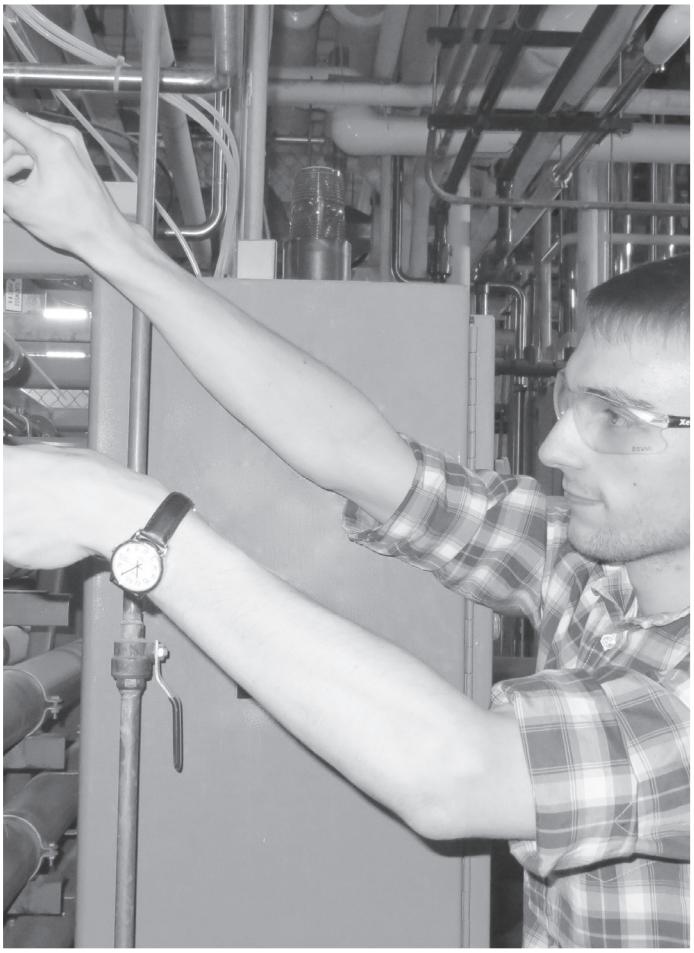
RESULTS
Concentrate Recovery RO System: Zoetis currently uses two reverse osmosis (RO) systems to produce purified water used in production for cleaning, making product and making pure steam. Reverse osmosis is the process of applying pressure to impure water, forcing clean water to pass through a semi-permeable membrane. These systems, by design, have a constant stream of water concentrated with the leftover impurities that is sent directly to the drain. The purity of this reject water was analyzed and determined to be mainly unusable as-is. Running the reject stream through a concentrate recovery RO system would filter the impurities and leave filtered water of a pure enough quality to be fed back through the original RO system. Up to 75 percent, or approximately 4.5 million gallons, of the original reject water could be recovered through this additional concentrate recovery RO system to be reused elsewhere in the plant.

WFI Production: Water for Injection (WFI) is extremely pure water that is suitable for use in pharmaceutical

production. Currently, Zoetis produces their WFI through a distillation process. Distillation is one of the most effective methods of purifying water, though the heating and cooling steps of the process can be extremely energy intensive. Zoetis is currently evaluating the effectiveness of an ultrafiltration system for WFI production. An ultrafiltration process could meet the rigorous water purity standards without the heating and cooling demands that the current distillation process requires. Eliminating these demands could reduce the overall operational costs of WFI production and save energy in the process.

Actuator Replacement: Room temperatures at Zoetis are controlled by actuators that adjust the flow of hot water through heating coils that increase the temperature of the delivered air. Currently, Zoetis' Research and Administration building uses pneumatic, air controlled actuators. However, compressed air can very easily leak without being noticed, leading to overworked compressors. Additionally, the room temperatures are currently being manually controlled directly in the individual rooms which can lead to accidental wastes of heating. Electric actuators could allow Zoetis to more easily adjust the room temperatures through remote control. Decommissioning the compressor and switching to electric actuators could reduce energy usage and decrease maintenance costs of the compressed air system.

Chilled Water System Improvements: Zoetis uses two water-cooled, centrifugal chillers to produce enough chilled water for the cooling demand in their main production building. Each chiller uses an individual cooling tower unit for cooling its refrigerant. Adding a cooling tower cell could decrease the condenser water temperature and increase chiller efficiency. In addition to decreasing the energy needed to operate the chillers, this project could generate additional cost savings by lowering the company's peak electrical demand. It could also provide redundancy and improve the chilled water system's ability to meet the cooling load requirements on the hottest days of the year.



PROJECT	ANNUAL COST SAVINGS	ANNUAL ENVIRONMENTAL RESULTS	STATUS
CONCENTRATE RECOVERY RO SYSTEM	$15,380	3,088,600 gallons	RECOMMENDED
WFI PRODUCTION	$4,630	38,160 therms	FURTHER RESEARCH NEEDED
ACTUATOR REPLACEMENT	$2,510	51,870 kWh	IN PROGRESS
CHILLED WATER SYSTEM IMPROVEMENTS	$14,970	276,530 kWh	IN PROGRESS

2017 PROJECT INDEX

POLLUTION PREVENTION INTERN PROGRAM

BOILERS/STEAM

- Bridgestone Americas Tire Operations
- Woodward Resource Center

COOLING TOWERS/CHILLERS

- Principal Financial Group
- Zoetis

ENERGY REDUCTION

- Bridgestone Americas Tire Operations
- CF Industries - 2016 24-week project
- CURRIES
- Iowa Fertilizer Company
- Principal Financial Group
- Tyson Fresh Meats, Inc. - Storm Lake
- Woodward Resource Center
- Zoetis

HAZARDOUS WASTE

- CF Industries - 2016 24-week project
- CURRIES
- Iowa Fertilizer Company
- Tyson Fresh Meats, Inc. - Storm Lake

SOLID WASTE MANAGEMENT

- DuPont Industrial Biosciences
- Smithfield Sioux City

PROCESS IMPROVEMENT

- Bridgestone Americas Tire Operations
- CF Industries - 2016 24-week project
- CURRIES
- DuPont Industrial Biosciences
- Hach
- JBS USA, LLC
- Principal Financial Group
- Smithfield Sioux City
- Tyson Fresh Meats, Inc. - Storm Lake
- Zoetis

WASTEWATER

- Bridgestone Americas Tire Operations
- Iowa Fertilizer Company
- JBS USA, LLC

WATER USE REDUCTION

- Bridgestone Americas Tire Operations
- CF Industries - 2016 24-week project
- CURRIES
- DuPont Industrial Biosciences
- Hach
- JBS USA, LLC
- Principal Financial Group
- Tyson Fresh Meats, Inc. - Storm Lake
- Zoetis

» Join the P2 INTERN PROGRAM in 2018!

FOR COMPANIES

Pollution Prevention Services is currently accepting requests for 2018 intern projects. Companies must submit a project request that identifies a focus project and outlines the desired objectives and deliverables. Company project requests must be submitted by **December 1, 2017** to be considered for 2018 intern placement.

Project requests will be reviewed upon receipt and companies contacted within two weeks for additional project development. Final determination of acceptance will be made within 30 days after project development is completed. Intern assignments for finalized projects will begin in January of 2018.

Please note: Students are not trained in or qualified to assess regulatory compliance issues.

FOR STUDENTS

Graduate and junior or senior-level undergraduate engineering students are encouraged to submit the following documents for consideration:

- Application Form
- Résumé
- Cover Letter
- Unofficial copy of transcripts
- List of Fall 2017 and Spring 2018 classes

Selection of 2018 interns will begin in November and continue into the spring until project assignments are finalized.

Pollution Prevention Services is offering internships for 12-weeks (May 21–August 10) or for 24-weeks (May 21–November 9) in 2018.

Selected applicants will be matched to a project based on academic performance, relative experience and technical skills.

SUBMIT PROJECT REQUESTS & APPLICATIONS TO:

DANIELLE DILKS
Iowa Dept. of Natural Resources
Pollution Prevention Intern Program Coordinator
502 East Ninth Street, Des Moines, IA 50319-0034
Phone: (515) 725-8363
Danielle.Dilks@dnr.iowa.gov

STUDENT APPLICATION & BUSINESS REQUEST FORMS ARE AVAILABLE ONLINE AT:

www.iowap2interns.com

Forms may be submitted electronically, faxed or mailed.

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