MEMORANDUM

Date: July 10, 2013

To: The Honorable Chairman and Members
Pima County Board of Supervisors

From: C.H. Huckelberry
County Administrator

Re: **Potential Adaptive Reuse of the Roger Road Wastewater Reclamation Facility**

The Regional Optimization Master Plan envisioned that once the new water campus became operational, which is now scheduled for January 2014, the existing 1950s vintage Roger Road Wastewater Treatment Facility (RRWTF) would be demolished at an estimated cost of $32 million.

Our Regional Wastewater Reclamation staff and Real Property Services Manager Neil Konigsberg have been in contact with a number of individuals regarding adaptive, productive economic reuse of the RRWTF to eliminate having to spend the estimated $32 million for demolition.

The enclosed whitepaper from The University of Arizona College of Agriculture and Life Sciences conceptually outlines a number of options available to the County for the private and/or educational sectors adaptively reusing the facilities for aquaculture and aquaponics.

We are in the early stages of discussing various potential partnerships for the adaptive reuse of this facility for economically beneficial and productive uses. As additional information is forthcoming over the summer, I will provide it to the Board of Supervisors.

CHH/dph

Attachment

c: Dr. Ann Weaver Hart, President, The University of Arizona
Dr. Michael Proctor, Vice President-Academic Outreach, The University of Arizona
Dr. Robert Smith, Senior Associate Vice President-Business Affairs, The University of Arizona
Dr. Jan Cervelli, Dean, College of Architecture and Landscape Architecture, The University of Arizona
Dr. Shane Burgess, Dean, College of Agriculture and Life Sciences, The University of Arizona
Dr. Kevin Fitzsimmons, Associate Director, College of Agriculture and Life Sciences, The University of Arizona
Dr. Joel Cuello, Agricultural and Biosystems Engineering Department, The University of Arizona
John Bernal, Deputy County Administrator for Public Works
Jackson Jenkins, Director, Regional Wastewater Reclamation

THE UNIVERSITY OF ARIZONA.
College of Agriculture and Life Sciences

Office of the Vice Provost & Dean
College of Agriculture and Life Sciences

www.cals.arizona.edu

1140 E. So. Campus Drive
P.O. Box 210036
Tucson, AZ 85721-0036
Phone: 520-621-7621
Fax: 520-621-7196

sburgess@cals.arzona.edu
kevfitz@ag.arizona.edu
cuelloj@email.arizona.edu

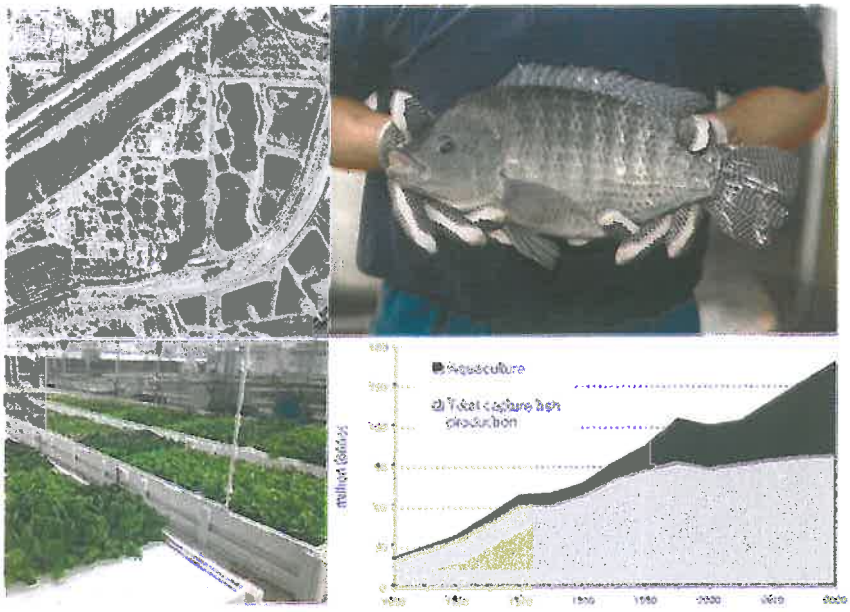
A vison for the Roger Road Water Plant Treatment Plant

Key Contacts: Kevin Fitzimmons, Joel Cuello, Shane Burgess

Imagine.....

a state-of-the-art multiple-purpose, multi-product aquaculture and aquaponics facility based public-private partnerships that will:

- be an example to, and magnet for, the world's companies focused on our sustainable water and food future;
- educate our future agriculturalists, engineers and scientists;
- produce innovations that will drive Pima County's economy forward today;
- create new jobs;
- add to the regions tourist attractions for lifestyle visitors;
- and be a cost-effective way to decommission the plant .



Repurposing the obsolete Roger Road Plant into a multiple-purpose/multi-product aquaculture/aquaponics facility suitable for public-private partnerships.

A. Summary

The University of Arizona, through the College of Agriculture and Life Sciences (UA CALS), proposes to partner with Pima County to find a new use for the obsolete Roger Road water treatment plant (Figure 1) as the new treatment facility comes on line. After several preliminary discussions with various county professional staff, and on site tours, we have focused on converting the facility for advanced water reuse and high-value aquaculture/aquaponics including public-private partnerships. Specifically the UA would enter into an arrangement with private sector stakeholders who would produce commercial quantities of fish and algae as well as high-value bio-products. UA CALS would manage the facility jointly with the county: in addition to education and research, the partnership would collaborate with for-profit and non-profit organizations (Audubon Society) to utilize treated effluent for progressively higher uses. This site would become one of a few such sites in a global network and so attract significant interest from companies in the water industries.

We propose that between July and December of 2013, the UA CALS and Pima County jointly produce business and economic development plans for the renovation of the Roger Road water treatment plant into a multiple-purpose/multi-product aquaculture/aquaponics facility suitable for public-private partnerships.

The next step is to write a MOU between Pima County and UA CALS to jointly develop the business and economic development plans.

Figure 1. The obsolete Roger Road Waste Water Treatment Plant.

1. Introduction

Pima County has indicated that the full demolition cost of the site is far greater than the potential sale value. Ideally the county would not only like to avoid as much demolition cost as possible but, at the same time have the obsolete plant contribute to the overall goal of having both the obsolete and new facilities support sustainability, reclamation economic and lifestyle themes. The UA CALS has a mandate that is completely in accordance with this overall goal as well as education and research missions.

Several UA CALS faculty members have toured the still operating obsolete Roger Road facility and have had conversations with operator Frank Gall. We have also discussed the plant history with Drs. Raymond Sierka and Peter Livingstone, who have also worked at the site as consultants in the past. We have also had phone and e-mail conversations with Dr. Steve Mims at Kentucky State University. Dr. Mims has converted two decommissioned plants (Frankfort and Winchester) in Kentucky to operational fish farms in recent years. Both operate as public-private partnerships. There is a tentative plan to have Dr. Mims come to visit in mid-July to examine the facility and provide his evaluation.

We have been in contact with Tark Rush, who manages the largest fish farm in Arizona. He is interested in becoming a private partner in high value aquaculture supplying the "local" Tucson, Phoenix, Las Vegas, San Diego and Los Angeles markets as well as live airfreight to lucrative Asian and South American markets. We have not yet discussed specific details of how lease, rent or other partnerships would be structured in this case, but we do have precedents and mechanisms.

We have had initial discussions with Heliae, the private algae production company based in the Phoenix suburb of Gilbert. Heliae is part of Mars Foods, and Mars has identified algae protein as a key source to replace increasingly expensive animal proteins in their pet food division (which generates more income than their candy division). Heliae / Mars are also focused on exceptionally high value bio-products such as Omega 3 oils worth $13B alone. The Heliae team is looking for a production facility in Arizona to provide scale-up of their demonstrations to commercial quantities. They have expressed interest to partnering with the UA and Pima County and would bring considerable resources.

The Audubon Society is looking for new office space and would like to be near the Sweetwater Wetland. There would appear to be plenty of office space in the main administration building to accommodate such a tenant, who might be able to contribute a rent, which could help to cover costs. In fact, it might be opportune to invite selected "environmental" groups to house there if they can contribute some rents and would provide some synergies to the UA mission there of supporting reclamation and pursue higher uses of treated effluent.

Additional possibilities:

1. UA and Pima County operate as a partnership with focus on sustainability, reclamation, job creation and human and environmental wellness. Request some of the "saved" $40,000,000 demolition expenses from the county to cover ongoing base operating expenses that cannot be recouped due to state law.

2. Treated effluent is the most important new supply of freshwater on a regional as well as global basis. This facility would become one of the world's few major hubs in a global network of cities leading practical reclamation uses and novel urban food and high value bio-product production.

3. Will become a site that can attract competitive funding.

4. Develop as a tourism destination.

5. Bring in youth and public service groups and others for education on the benefits of effluent dominated waters for fishing and other wildlife.

6. Potential to eventually have a market on site to sell produce and fish, or provide extra produce to Food Bank or other outlet.

This project would be mutually beneficial for the county and the University and would stimulate private industry growth that is consistent with the county's strategic focuses.

2.0 World demand for aquaculture and algae products

Aquaculture is widely recognized to be the fastest growing sector within all of agriculture. The domestication of aquatic animals and plants is retracing within a couple of generations all of the progress made in thousands of years of domestication of terrestrial plants and animals. Virtually all fields of science are being used to advance aquaculture knowledge and productivity at an astounding rate. **In 2012, FAO reported that global production and consumption of farmed fish exceeded the global production of beef for the first time in recorded history and from now on there will be significant growth in cultured fish but little (if any) in wild-caught** (Figure 2).

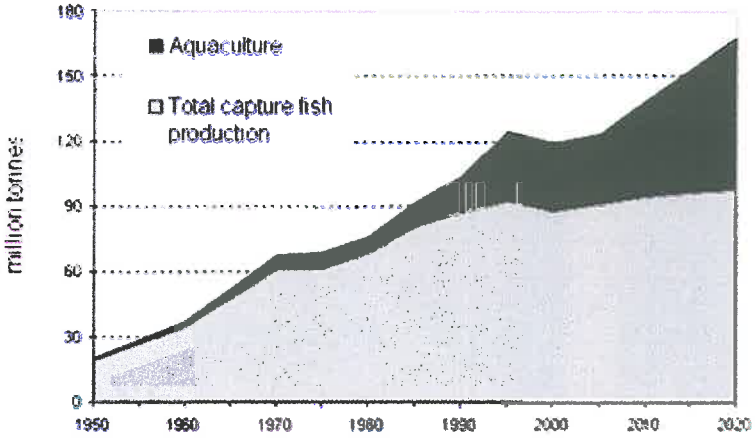


Figure 2. Tonnage of cultured vs wild-caught fish. Source: OECD Environmental Outlook.

Aquaculture is on track to supplant wild catches by 2030 and this is exemplified by salmon and bream (Figure 3). Farmed salmon (incl. Pacific salmon and trout) represented less than 10 % of the global market 20 years ago, but are now more than 60 % (1,500,000 tons). Sea bass and sea bream are similar and these trends are being replicated for other species.

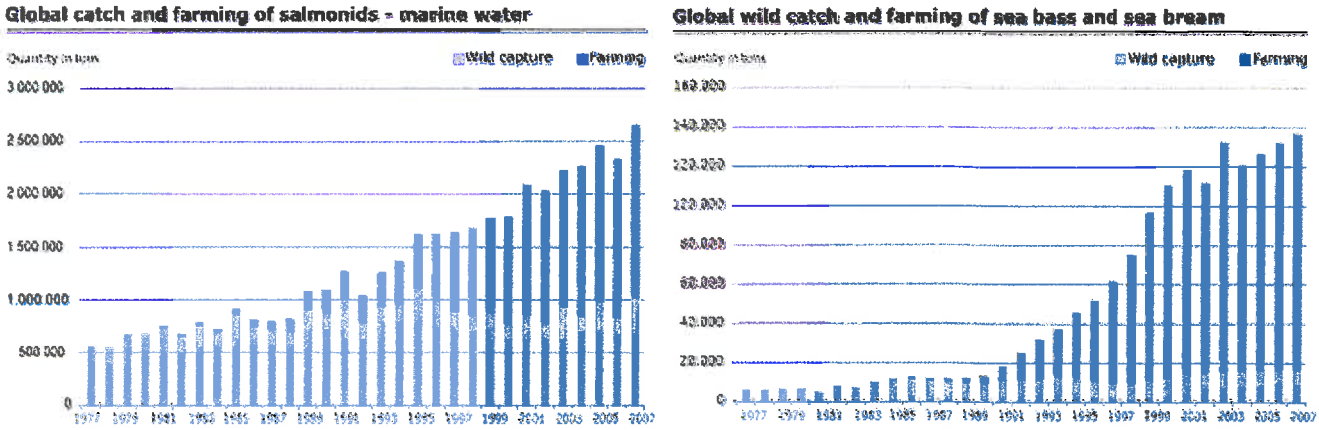


Figure 3. Aquaculture has become the major source of salmon, bass, tilapia, catfish, and bream (Source: FAO).

On average, each person on the planet is eating four times as much seafood as their counterparts were in 1950. The average per-capita consumption of *farmed* seafood has increased nearly 1,000 percent since 1970, in contrast per-capita terrestrial meat consumption grew 60 percent. Global production of aquatic plants, especially the macro-algae (seaweeds) has also risen steeply as we recognize their environmental and nutritional benefits.

UA is a world leader in aquaculture and one of the biggest tilapia farms in the US, Desert Springs Tilapia (Figure 4), is operated in Hyder Valley, AZ by UA alumnus and likely private partner, Tark Rush. A satellite farm for Desert Springs Tilapia has been proposed for the Roger Road site.

Figure 4. Ponds at Desert Springs Tilapia facility.

2.1 Aquaculture Products

The potential product classes will be described below in decreasing order of value.

A. Nutraceuticals and other products for humans

Micro- and macro-algae are a primary source for several nutraceutical compounds. The most valuable are Omega 3 fatty acids (DHA and EPA) and beta carotene. DHA is important to aid in the brain and eye development in infants and has been shown to support cardiovascular health in adults. Since 1990 manufacturers have been adding DHA in infant formula for premature and full-term infants. Meanwhile, the world wholesale market for infant formula is now estimated to be in excess of US$10 billion per year. Other valuable compounds include astaxanthin, canthaxanthin, agar, carrageenans and diatomaceous earth. These are produced in commercial quantities in many locations in the US and abroad. Use of sterilized treated effluent waters would be a cost-effective way to produce these compounds, with the side benefit of removing residual compounds from the water supply including stripping nitrogen, sulfur, phosphorus and several micronutrients. To help meet the Good Manufacturing Practice regulations of the US Food and Drug Administration, it would be best to grow algae for the foregoing applications – including animal feed production – by growing them in photobioreactors, such as the Accordion Photobioreactor shown in Figure 5, which minimizes contamination by pathogens and other microorganisms.

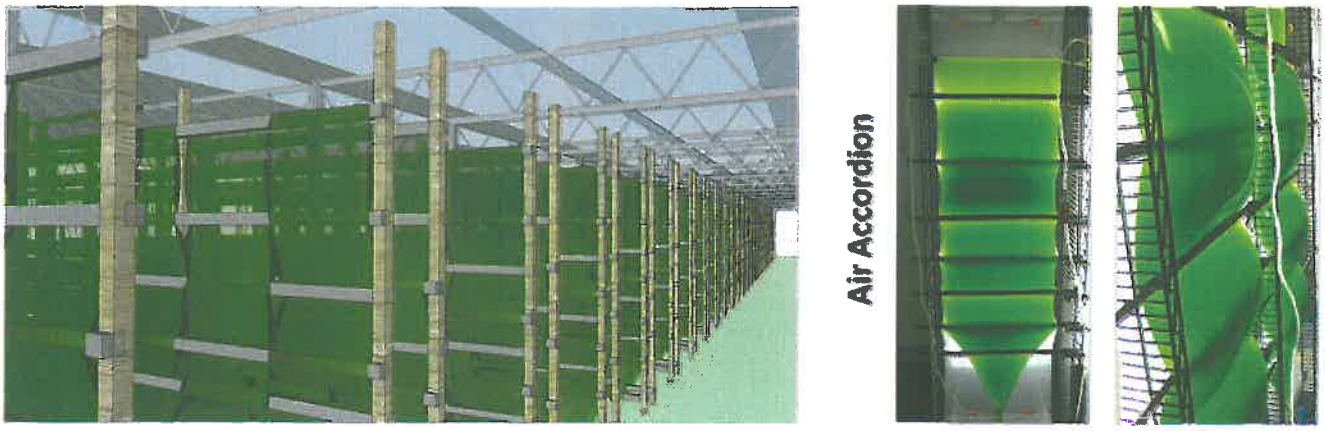


Figure 5. Accordion Photobioreactors growing microalgae for nutraceuticals and other high-value compounds.

B. Human food

Virtually all nutrition experts tell us that we need to consume more fish products (i.e. to eat a "Mediterranean diet"). The health benefits of "seafood" products are well documented and the

beneficial role of the Omega 3 fatty acids, predominantly found in fish, crustaceans and shellfish, has been highlighted in numerous studies. Consumers worldwide are demanding more and more fish, but the wild catch continues to stagnate or decline rapidly (depending on species). Aquaculture is the only sustainable way to provide the increasing demand—a demand that will increase as the global middle class, 26% of the world's 6.8B people in 2009, grows to 60% of the world's predicted 8.2B people in 2030 (OECD Development Centre: "The emerging middle class in developing countries". Homi Kharas. January 2010. Working Paper No. 285).

The production of plant crops irrigated with treated effluent will be another critical aspect of the project. Treated municipal effluents are the only substantial source of new freshwater supply we have to supply (besides melting ice caps and glaciers, not exactly a renewable supply). Production of vegetable, tree and row crops could be demonstrated at the reclamation facility.

C. Animal feed

Providing nutrition for the animals we consume is becoming more and more an economic and ethical consideration. Use of wild-caught fishmeal for aquaculture and edible grains for terrestrial farm animals is questioned by many as inefficient use of limited resources and marginally ethical. Providing animal feeds using water that might be objectionable by some people and with crops that most persons would consider to be unpalatable, would be a valuable step forward. Microalgae can be incorporated as an ingredient into the feed for a wide variety of animals, including fish, pets and farm animals. Indeed, about 30% of the current world algal production is sold for animal feed applications and over 50% of the current world production of *Spirulina* is used as feed supplement for cows, breeding bulls, chickens, horses, cats, dogs, fish, and ornamental birds. What is more, microalgae are the natural food source for many aquaculture species. Furthermore, the UA CALS animal feed mill is at the West Campus Ag Center (within 2 miles) and can easily incorporate products from the proposed Roger Road center. Specifically, this mill can take any fish and algae by-products remaining after processing to remove valuable products (described above) and produce valuable animal feed with a high margin.

D. Fuels

Micro algae are widely acknowledged to be a sustainable source of biofuels that would be a minimally-consumptive user of low quality water. The use of algae to strip unwanted nutrients from waste waters has been proposed as both an environmental service as well as a source of biofuels. With the proliferation of petroleum products due to "fracking" technologies, biofuels from algae may not be economically feasible for several more years but will remain an attractive alternative if carbon emission decreases are mandated—algae are both a carbon sink and fuel source. This site could provide one of the world's centers for long-term trials needed to address some of the remaining technical hurdles in algae biofuels, while markets for specialty products including phytochemicals, aquaculture feeds, and nutraceuticals carry industry growth (see above).

2.2 Aquaponics products.

A. Nitrogen and phosphorus nutrification.

Nutrification (or eutrophication) is the process whereby water bodies (such as lakes and estuaries) receive excess nutrients in the form of nitrogen and phosphorus salts from a variety of sources primarily from agriculture run off, aquaculture (excreted from the fish and from feed waste and dead fish) and sewage. This sets off a cascade of undesirable of environmental changes. Nutrification is one of the biggest criticisms of fish farmed in wild environments such as lakes and rivers. Ironically the phosphorus, in particular, is a valuable commodity that is used in proportion to food production, and especially production of animal-derived human food (Figure 6).

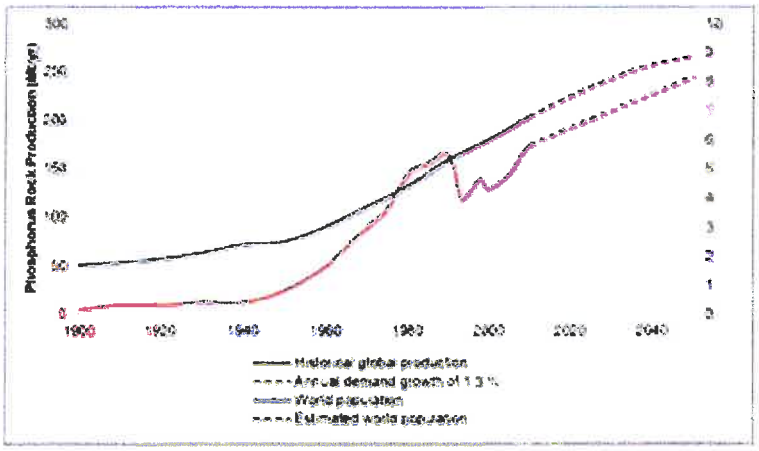


Figure 6. Phosphate rock production and world population (historic situation and future trends). This figure likely under-predicts the future as it does not take into account the rapidly rising middle class that demands more animal-derived protein. (Source: Kroiss1, Rechberger and Egle. Institute of Water Quality, Resources and Waste Management Vienna University of Technology, Austria)

Two advantages of this proposal are that it *solves the nitrification problem* as it is (1) a closed system, preventing the nitrogen and phosphorus salts from entering the ecosystem and (2) the salts can be captured for reuse in aquaponics.

B. Aquaponics.

Aquaponics is the combination of aquaculture and plant agriculture by hydroponics (i.e., requiring no soil), and UA CALS is one of the world's leaders in this technology. In aquaponics a recirculating water system takes "wastewater" from the fish and this serves as organic fertilizer for the plants, while the plants clean the water of fish feces and urine and the water is circulated back (Figure 7). The net result is a >90% reduction in freshwater use compared with conventional aquaculture, no nutrification risk and a significant reduction in added nutrients such as fossil fertilizers. The system can be run without pesticides and antibiotics because the fish environment is controlled and closed.

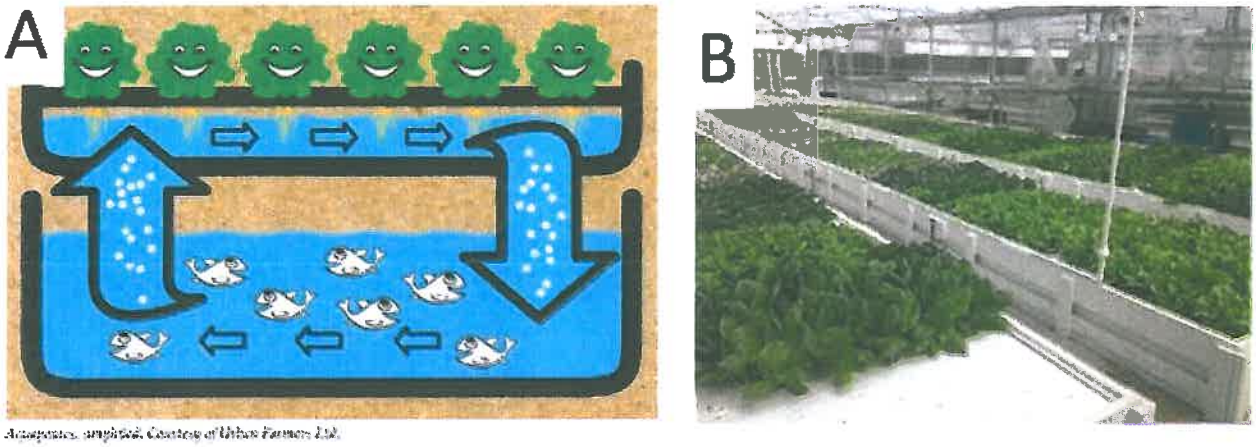


Figure 7. The recircultaing model that allows aquaponics (A) and a typical aquaponic greenhouse (B).

High value crops such as herbs, peppers and specialty lettuce can be grown in sustainable organic ways and these can be shipped locally to high value outlets such as "Whole Foods Market" and restaurants. These crops are also "locally sourced", commanding another price premium.

3.0 Local and regional economic development

We believe the county and the rest of the state will benefit economically from new jobs developed through the project and from the products that will be developed on-site and marketed outside the county. Significant quantities of fish and algae products could be sold locally and exported. We are constantly searching for additional ways to diversify the county and Arizona economy generally. As a technology development and demonstration location, we could market products as well as technical know-how and the learning environment to teach others or to be paid to go share with

others, especially in the Middle East.

Although the physical products, which include fish (live, fresh on ice or as fingerlings for later grow-out off-site) and algae products, will be valuable revenue streams, the technical knowhow that will be developed may be even more valuable. Opportunities for grant, consulting contracts and demonstration projects here and abroad, would be considerable (e.g. Sustainable Agriculture Research and Education (SARE) grants. Western Regional Aquaculture Center grants. USDA and NSF Small Business Innovation Research (SBIR) grants; joint research with King Abdullah University of Science and Technology, Qatar Foundation Research program, and Oman's Sultan Qaboos University). The intellectual property development could be considerable and should be reviewed.

In addition to Desert Springs and Heliea other firms will likely wish to become a part of the project: initial opportunities include Pentair-Aquatic Ecosystems, Americulture, and CalCot. There is an opportunity to develop allied business especially in food processing.

4. Environmental and Social advantages.

In addition to the advantages of demonstrating the safe use of recycled water, Fish production is by far the most efficient source of animal protein production today. Fin fish and shrimp, for example, require about one pound of feed to produce one pound of meat, compared to poultry, which requires two pounds, and pigs, which require three (USDA ARS).

4.1 Water use/reuse

Tucson already uses treated effluents to a greater degree than almost any city in the US. Treated effluent water is sold for just a few cents less per acre foot than the regular potable water supply. Golf courses, schools, parks, ball fields, and road medians all use treated effluent. Farmers in Marana have long used the effluent, water utilities want effluent to put into recharge basins to replenish ground water and environmental groups demand that more effluent be put into dry stream beds to replenish riparian vegetation and the wildlife that depends upon it.

4.2 Making reclaimed water more accepted

Despite the wide acceptance of treated effluents for landscaping and industrial reuse, the general public is still not convinced that treated effluent can be devoted to higher uses including irrigation of vegetable crops or growing food fish. Careful documentation of the actual product quality of vegetables, fruits, and fish grown with highly treated effluent should be a primary goal of our research from this proposed facility.

5. Costs

We cannot produce a reasonable estimate of costs in this report but instead propose that between July and December of 2013, the UA CALS and Pima County jointly produce business and economic development plans for the renovation of the Roger Road water treatment plant into a multiple-purpose/multi-product aquaculture facility suitable for public-private partnerships.

Some critical elements of the proposal to keep in mind are that the county already has sunk costs and that these can be mitigated. There is considerable savings in re-engineering if the site is not damaged during decommissioning and this also has the added benefit of markedly decreasing the cost to dismantle.

Ongoing operating costs will be fees for treated water, other utilities, salaries and nutrients for the algae and fish. However, these are typical agricultural costs and the public-private model provides the foundation to create profits for the private partner and mitigate costs/provide margins for the public partners.

In terms of revenues, tilapia is more than likely the first product we would consider at the site as tilapia sales are continuing to increase across the country. We can typically produce fish at a density of 0.25 lb per 1 gallon of water volume (about30 kg/m^3). We would expect to recycle most of our water. Desert Springs gets about $2.50 per pound for live tilapia at the farm and harvest about 4,000 lbs per week for live sales. The other 90 percent of production is sold for $1.50 /lb with fish packed fresh on ice in 40 lb boxes and shipped to California (about 35,000 lbs/week). Tilapia

could be raised at the plant and Desert Springs could avoid the costs of building additional ponds, tanks and raceways. The facilities may not be ideal, or what Desert Springs would construct new, but it could be done with relatively small investments. More than 50 % of production cost is feeds. With our algae project, we hope to develop algal based diets to lower these costs. At Desert Springs, pumping water is another significant cost. If the cost of water for the project were significantly less than his current pumping cost, this would encourage even greater production.

Other immediate revenues include: rent of space to Desert Springs, Heliea and the Audubon Society; student fees; grant and contract funding; sales of produce–fingerlings, edible fish, vegetable produce; entrance tickets for public tour of integrated showcase; and saved funds from avoided demolition costs.