green town

GreenTown Rockford

November 12 | Embassy Suites Rockford Riverfront

Four Rivers Sanitation Authority & Aqua-Aerobic Systems, Inc.

Research Collaboration for Green Technology Development & Economic Growth

---

Four Rivers Sanitation Authority

AQUA-AEROBIC SYSTEMS, INC.
A Metawater Company

Four Rivers Sanitation Authority (FRSA)

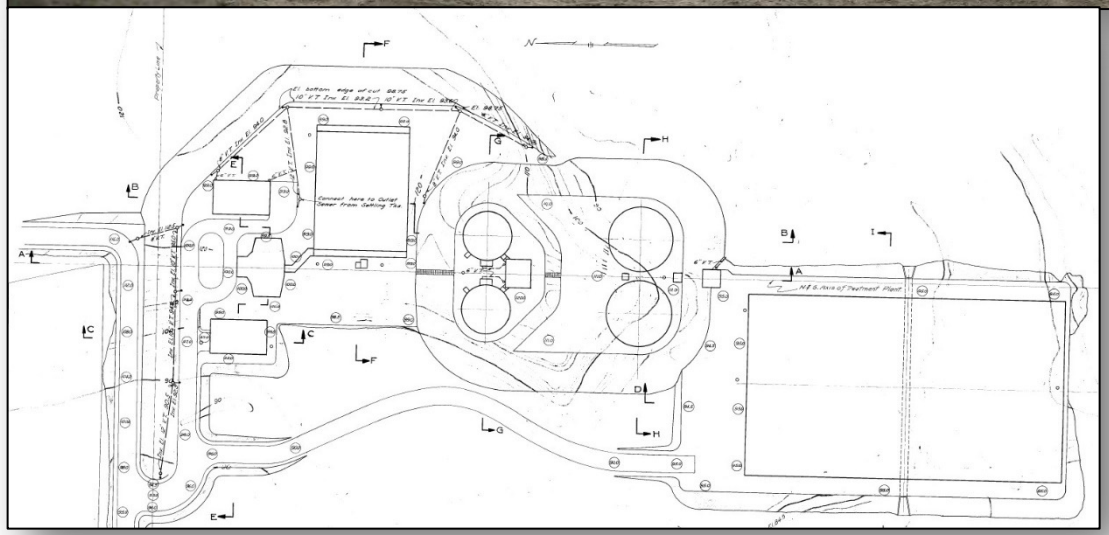
- A Brief History
- Commitment to Protecting our Environment
- Public/Private Partnership Provides Solutions for Future Needs

Aqua-Aerobic Systems

- Partnership History and Achievements
- AquaPrime® Advanced Primary Treatment Technology
- AquaNereda® Aerobic Granular Sludge Technology
- FRSA Projects
- The Big Picture

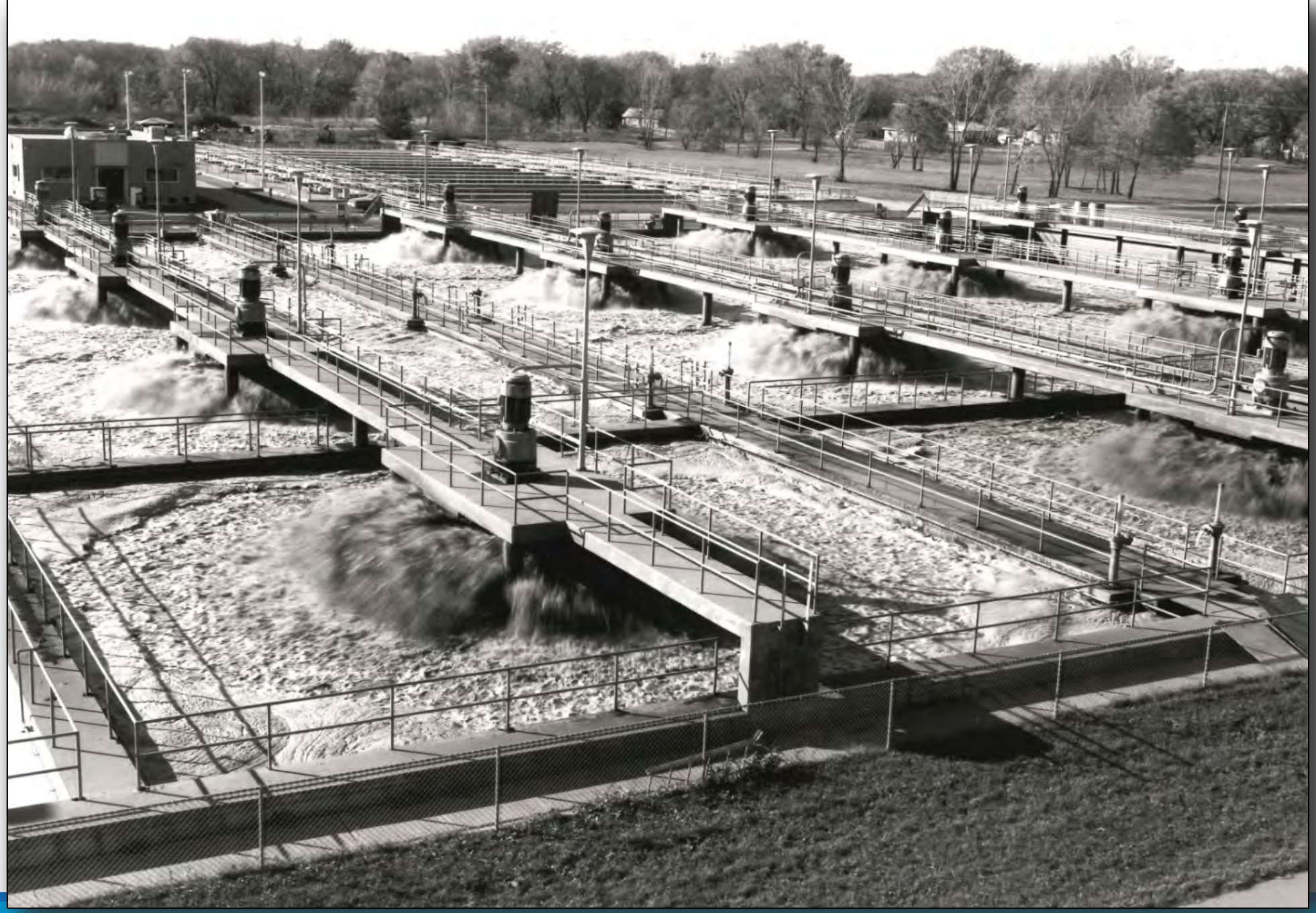
Four Rivers Sanitation Authority

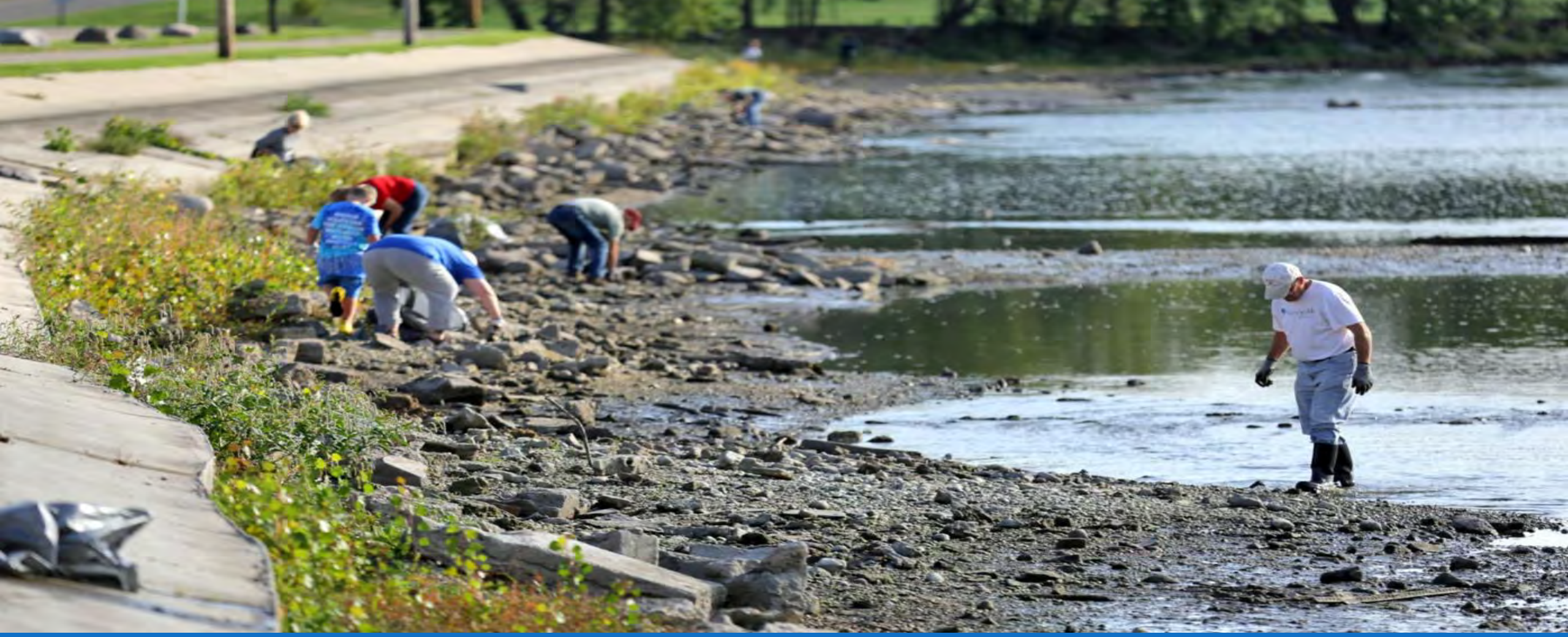
AQUA-AEROBIC SYSTEMS, INC.
A Metawater Company



Our mission has not changed since we were incorporated on February 1, 1932

Protect the environment and the health of our citizens through effective and efficient removal and treatment of wastewater.



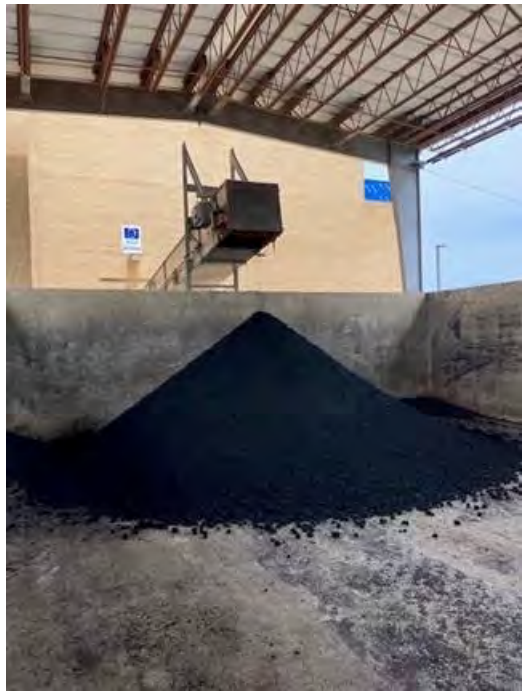


FRSA IS COMMITTED TO PROTECTING OUR ENVIRONMENT

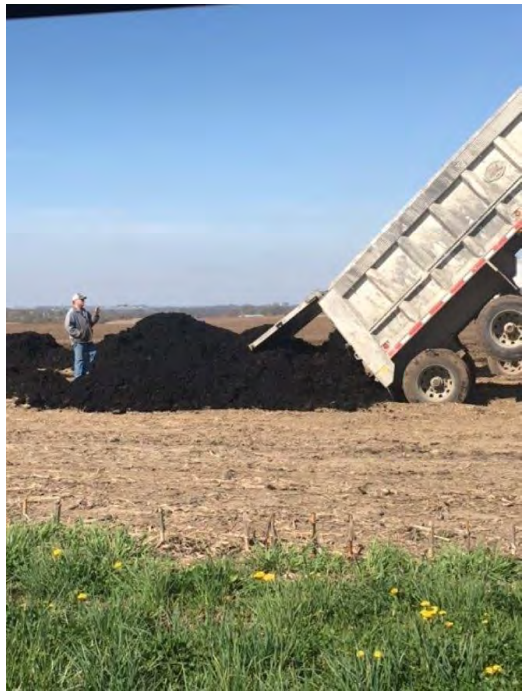
Four Rivers Sanitation Authority

AQUA-AEROBIC SYSTEMS, INC.
A Metawater Company

FRSA Resource Recovery



Biosolids used in agriculture as fertilizer.



15,000 wet tons produced per year.

600 acres of farmland fertilized annually.

FRSA Resource Recovery

Four Rivers high-strength waste receiving station.

Accepts high-strength food waste from local industries.

Methane gas capable of powering the average residential home for 108 days

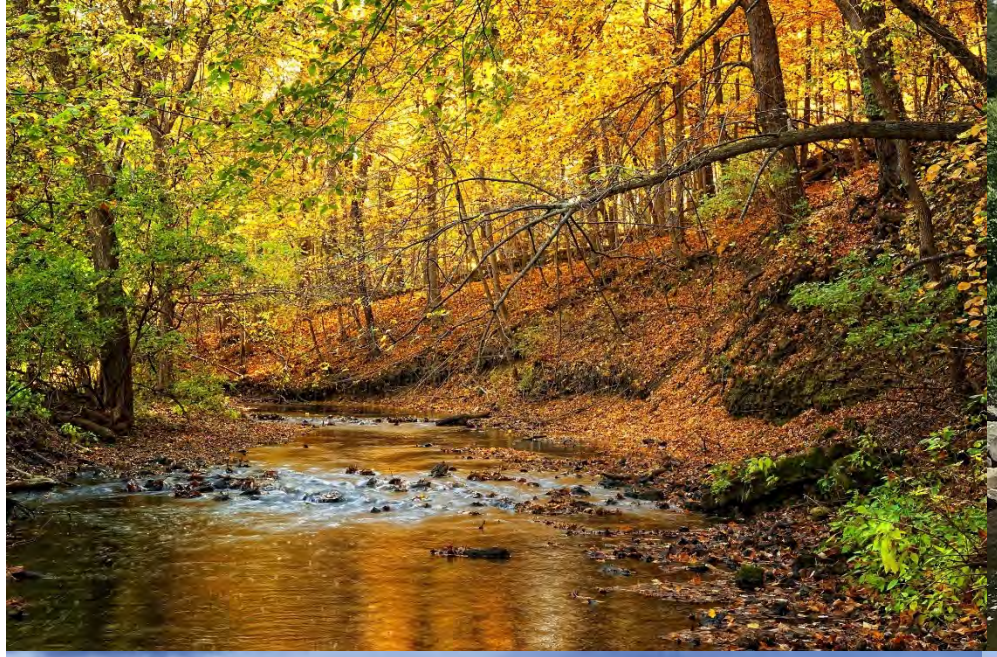
Four Rivers Sanitation Authority

AQUA-AEROBIC SYSTEMS, INC.
A Metawater Company

FRSA Resource Recovery

The engines have the capability of running the entire treatment plant and returning one megawatt (mWh) to the power grid.

Three 1400HP Co-Generation engines.
Capable of three megawatts (mWh) of electrical production.

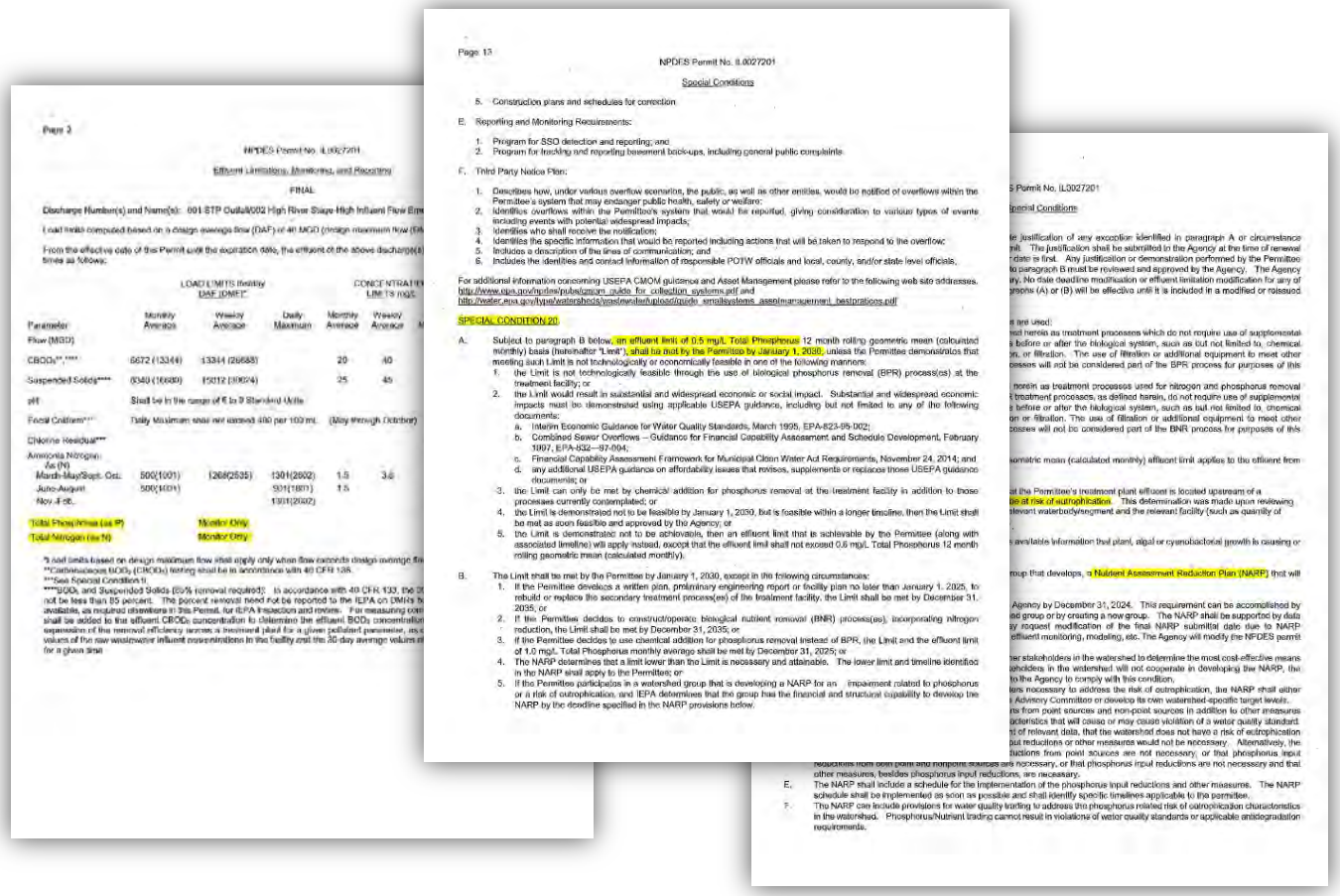


Protecting Our Watershed: Pecatonica, Sugar, Rock and Kishwaukee Rivers

Four Rivers Sanitation Authority

AQUA-AEROBIC SYSTEMS, INC.
A Metawater Company

FRSA IEPA Permit Requirements



Page 2

NPDES Permit No. IL0027201

Effluent Limitations, Monitoring, and Reporting

FINAL

Discharge Number(s) and Name(s): 001 STP Outfall/002 High River Slope High Influent Flow Eff

Load limits computed based on a design average flow (DAF) of 40 MGD (design maximum flow (DM

From the effective date of this Permit until the expiration date, the effluent of the above discharge(s) shall be limited and monitored by the Permittee as follows:

Parameter	LOAD LIMITS lbs/day DAF (DMF)C Monthly Average	Weekly Average	Daily Maximum	CONCENTRATION LIMITS mg/L Monthly Average	Weekly Average
Flow (MGD)					
CBOD5**,***	6672 (13344)	13344 (26688)		20	40
Suspended Solids****	8340 (16680)	16012 (32024)		25	45
pH	Shall be in the range of 6 to 9 Standard Units				
Fecal Coliform***	Daily Maximum shall not exceed 400 per 100 mL			(May through October)	
Chlorine Residual***					
Ammonia Nitrogen as (N)					
March-May/Sept.-Oct.	500(1001)	1268(2535)	1301(2602)	1.5	3.0
June-August	500(1001)		931(1861)	1.5	
Nov.-Feb.			1301(2602)		
Total Phosphorus (as P)	Monitor Only				
Total Nitrogen (as N)	Monitor Only				

* load limits based on design maximum flow shall apply only when flow exceeds design average flo
**Carbonaceous BOD_5 ($CBOD_5$) testing shall be in accordance with 40 CFR 136.
***See Special Condition 9.
****BOD_5 and Suspended Solids (85% removal required): In accordance with 40 CFR 133, the 3
not be less than 85 percent. The percent removal need not be reported to the IEPA on DMRs b
available, as required elsewhere in this Permit, for IEPA inspection and review. For measuring com
shall be added to the effluent $CBOD_5$ concentration to determine the effluent BOD_5 concentration
expression of the removal efficiency across a treatment plant for a given pollutant parameter, as
values of the raw wastewater influent concentrations in the facility and the 30-day average values o
for a given limit

Page 13

NPDES Permit No. IL0027201

Special Conditions

5. Construction plans and schedules for correction

E. Reporting and Monitoring Requirements:

1. Program for SSO detection and reporting; and
2. Program for tracking and reporting basement back-ups, including general public complaints

F. Third Party Notice Plan:

1. Describes how, under various overflow scenarios, the public, as well as other entities, would be notified of overflows within the Permittee's system that may endanger public health, safety or welfare;
2. Identifies overflows within the Permittee's system that would be reported, giving consideration to various types of events including events with potential widespread impacts;
3. Identifies who shall receive the notification;
4. Identifies the specific information that would be reported including actions that will be taken to respond to the overflow;
5. Includes a description of the lines of communication; and
6. Includes the identities and contact information of responsible POTW officials and local, county, and/or state level officials.

For additional information concerning USEPA CMOM guidance and Asset Management please refer to the following web site addresses.
http://www.epa.gov/npdes/pubs/cmom_guide_for_collection_systems.pdf and
http://water.epa.gov/type/watersheds/wastewater/upload/guide_smallsystems_assetmanagement_bestpractices.pdf

SPECIAL CONDITION 20.

A. Subject to paragraph B below, an effluent limit of 0.5 mg/L Total Phosphorus 12 month rolling geometric mean (calculated monthly) basis (hereinafter "Limit"), shall be met by the Permittee by January 1, 2030, unless the Permittee demonstrates that meeting such Limit is not technologically or economically feasible in one of the following manners:
   1. the Limit is not technologically feasible through the use of biological phosphorus removal (BPR) process(es) at the treatment facility; or
   2. the Limit would result in substantial and widespread economic or social impact. Substantial and widespread economic impacts must be demonstrated using applicable USEPA guidance, including but not limited to any of the following documents:
      a. Interim Economic Guidance for Water Quality Standards, March 1995, EPA-823-95-002;
      b. Combined Sewer Overflows – Guidance for Financial Capability Assessment and Schedule Development, February 1997, EPA-832—97-004;
      c. Financial Capability Assessment Framework for Municipal Clean Water Act Requirements, November 24, 2014; and
      d. any additional USEPA guidance on affordability issues that revises, supplements or replaces those USEPA guidance documents; or
   3. the Limit can only be met by chemical addition for phosphorus removal at the treatment facility in addition to those processes currently contemplated; or
   4. the Limit is demonstrated not to be feasible by January 1, 2030, but is feasible within a longer timeline, then the Limit shall be met as soon feasible and approved by the Agency; or
   5. the Limit is demonstrated not to be achievable, then an effluent limit that is achievable by the Permittee (along with associated timeline) will apply instead, except that the effluent limit shall not exceed 0.5 mg/L Total Phosphorus 12 month rolling geometric mean (calculated monthly).

B. The Limit shall be met by the Permittee by January 1, 2030, except in the following circumstances:
   1. If the Permittee develops a written plan, preliminary engineering report or facility plan no later than January 1, 2025, to rebuild or replace the secondary treatment process(es) of the treatment facility, the Limit shall be met by December 31, 2035; or
   2. If the Permittee decides to construct/operate biological nutrient removal (BNR) process(es), incorporating nitrogen reduction, the Limit shall be met by December 31, 2035; or
   3. If the Permittee decides to use chemical addition for phosphorus removal instead of BPR, the Limit and the effluent limit of 1.0 mg/L Total Phosphorus monthly average shall be met by December 31, 2025; or
   4. The NARP determines that a limit lower than the Limit is necessary and attainable. The lower limit and timeline identified in the NARP shall apply to the Permittee; or
   5. If the Permittee participates in a watershed group that is developing a NARP for an impairment related to phosphorus or a risk of eutrophication, and IEPA determines that the group has the financial and structural capability to develop the NARP by the deadline specified in the NARP provisions below.

S Permit No. IL0027201

Special Conditions

...justification of any exception identified in paragraph A or circumstance ...mit. The justification shall be submitted to the Agency at the time of renewal ...date is first. Any justification or demonstration performed by the Permittee ...to paragraph B must be reviewed and approved by the Agency. The Agency ...ry. No state deadline modification or effluent limitation modification for any of ...provis (A) or (B) will be effective until it is included in a modified or reissued ...

...s are used:
...not herein as treatment processes which do not require use of supplemental ...s before or after the biological system, such as but not limited to, chemical ...on, or filtration. The use of filtration or additional equipment to meet other ...esses will not be considered part of the BPR process for purposes of this ...

...herein as treatment processes used for nitrogen and phosphorus removal ...t treatment processes, as defined herein, do not require use of supplemental ...s before or after the biological system, such as but not limited to, chemical ...on or filtration. The use of filtration or additional equipment to meet other ...esses will not be considered part of the BNR process for purposes of this ...

...ometric mean (calculated monthly) effluent limit applies to the effluent from ...

...at the Permittee's treatment plant effluent is located upstream of a ...be at risk of eutrophication. This determination was made upon reviewing ...elevant waterbody/segment and the relevant facility (such as quantity of ...

...s available information that plant, algal or cyanobacterial growth is causing or ...

...roup that develops, a Nutrient Assessment Reduction Plan (NARP) that will ...

...Agency by December 31, 2024. This requirement can be accomplished by ...ed group or by creating a new group. The NARP shall be supported by data ...y request modification of the final NARP submittal date due to NARP ...effluent monitoring, modeling), etc. The Agency will modify the NPDES permit ...

...her stakeholders in the watershed to determine the most cost-effective means ...eholders in the watershed will not cooperate in developing the NARP, the ...to the Agency to comply with this condition.
...ures necessary to address the risk of eutrophication, the NARP shall either ...Advisory Committee or develop its own watershed-specific target levels.
...ns from point sources and non-point sources in addition to other measures ...acteristics that will cause or may cause violation of a water quality standard. ...of relevant data, that the watershed does not have a risk of eutrophication ...put reductions or other measures would not be necessary. Alternatively, the ...ductions from point sources are not necessary, or that phosphorus input ...reductions from both point and nonpoint sources are necessary, or that phosphorus input reductions are not necessary and that other measures, besides phosphorus input reductions, are necessary.

E. The NARP shall include a schedule for the implementation of the phosphorus input reductions and other measures. The NARP schedule shall be implemented as soon as possible and shall identify specific timelines applicable to the permittee.

F. The NARP can include provisions for water quality trading to address the phosphorus related risk of eutrophication characteristics in the watershed. Phosphorus/Nutrient trading cannot result in violations of water quality standards or applicable antidegradation requirements.

Four Rivers Sanitation Authority

AQUA-AEROBIC SYSTEMS, INC.
A Metawater Company

FRSA Facility Plan

MAJOR PROCESS AND INFRASTRUCTURE IMPROVEMENTS

RECOMMENDED COMPONENTS

Component 1 - Primary Filtration

Component 2 - Sidestream Fermentation, Aeration Basin Modifications

Component 3 - Sidestream Fermentation Expansion

Component 4 - Thickening and Nutrient Harvesting

Component 5 - Deammonification

Component 6 - Aerobic Granular Sludge

Component 7 - Tertiary Filtration

Component 8 - Biosolids Drying (not shown)

Component 9 - WAS Hydrolysis

Component 10 - Influent Pumping Improvements

Component 11 - Effluent Diffuser

Four Rivers Sanitation Authority

AQUA-AEROBIC SYSTEMS, INC. A Metawater Company

FRSA Facility Plan

Near Term Components Recommended Over the Next 10 years to meet RRWRD's Drivers and Expected Triggers

NO.	CAPITAL IMPROVEMENT COMPONENT	PROJECTED START	PROJECT SUMMARY	ANTICIPATED PROJECT SCHEDULES AND PROBABLE PROJECT COST: IMPLEMENTATION DURATION (DESIGN/BID + CONSTRUCTION)	ANTICIPATED PROJECT SCHEDULES AND PROBABLE PROJECT COST: POTENTIAL COST RANGE
1a	Primary Filtration (Phase I)	*2020*	Replacement of existing Primary Clarifiers 3-4 with four new packaged Primary Filter units (PF1 and PF2 connected; PF3 and PF4 installed).	30-32 months	**$25.7 to 35.4M**
11	Effluent Diffuser	*2020*	Negotiations with IEPA around diffuser permit requirements with associated river study to support discussions.	9-11 months	**$220 to 330k**
6a	Aerobic Granular Sludge (Phase I)	*2021*	Installation of 10 mgd of Aerobic Granular Sludge (AGS) treatment capacity.	42-44 months	**$27.2 to 45.8M**
1b	Primary Filtration (Phase II)	*2024*	Hydraulic connection of Primary Filters (PF3 and PF4) and solids handling improvements.	14-16 months	**$3.8 to 5.2M**
2	Sidestream Fermentation	*2024*	Modification of existing Aeration Basins and conversion of existing abandoned tankage for RAS fermentation.	30-32 months	**$17.2 to 25.8M**
9	WAS Hydrolysis	*2024*	Digester capacity optimization and acceleration of the RAS fermentation process.	21 - 24 months	**$8.1 to 15.3M**
5	Deammonification	*2025*	Installation of a package system / reactor to remove nitrogen from plant recycle flows.	26-28 months	**$12.4 to 20.8M**
7	Tertiary Filtration	*2026*	Installation of Tertiary Filter units to remove phosphorus from plant effluent. Also includes hydraulic improvements including secondary effluent pumping.	42-44 months	**$32.7 to 53.4M**
TOTAL ANTICIPATED PROJECT COST (2020 DOLLARS)					**$127.4 to 202.1M**

A PUBLIC/PRIVATE PARTNERSHIP PROVIDES THE SOLUTION

FOUR RIVERS SANITATION AUTHORITY NEEDS:

NUTRIENT REDUCTION

RESOURCE RECOVERY

FLEXIBLE CAPACITY TO ENABLE GROWTH

AGING INFRASTRUCTURE

AQUA-AEROBIC TECHNOLOGY SOLUTONS:

ENERGY REDUCTION

ENERGY PRODUCTION

INCREASED CAPACITY

SIMPLE TO OPERATE & MAINTAIN

NPV SAVING

Four Rivers Sanitation Authority

AQUA-AEROBIC SYSTEMS, INC.
A Metawater Company

Aqua-Aerobic Systems

- Founded in Rockford Area in 1969
- Water and Wastewater Technology
- 155 Employees
- > 10% of Profits Back to R&D

Partnership History: 2011

FRSA & AASI sign Facilities Agreement for water and wastewater research

Partnership History: 2012

Aqua-Aerobic Systems opens Research & Technology Center at FRSA

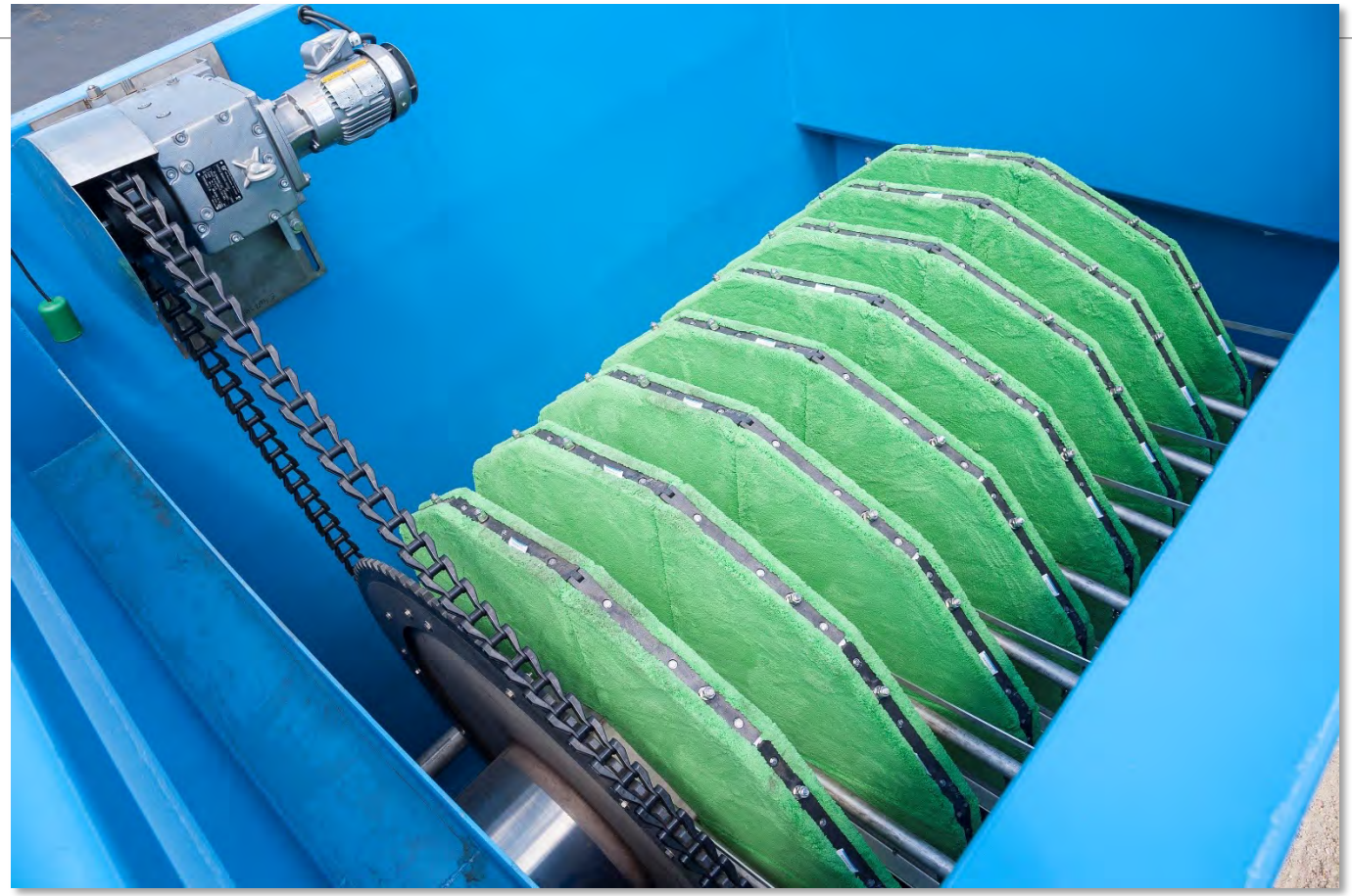
Partnership History: 2014

First demonstration of AquaPrime®/AquaStorm™ Filter

Partnership History: 2015

First Aqua MegaDisk® prototype installed at R&T Center

Partnership History: 2016



First full-scale (3 MGD) AquaPrime® Filter demonstration

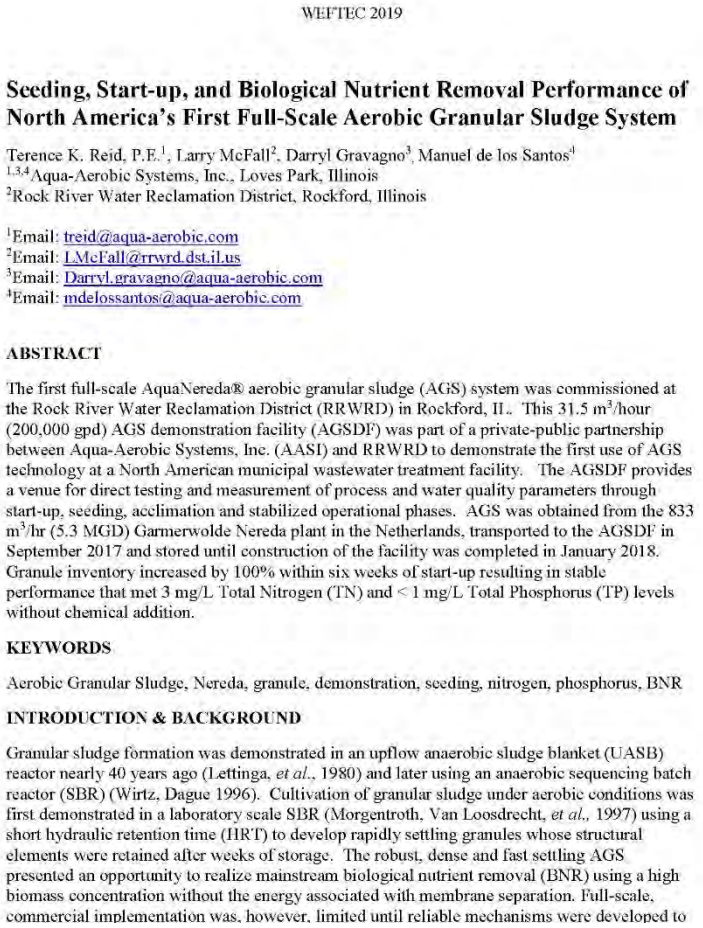
Partnership History: 2017

AASI breaks ground at FRSA for first AquaNereda® System in North America

Partnership History: 2018

FRSA & AASI joint AGS Workshop at WEFTEC 2018 Conference

Partnership History: 2019



WEFTEC 2019

Seeding, Start-up, and Biological Nutrient Removal Performance of North America's First Full-Scale Aerobic Granular Sludge System

Terence K. Reid, P.E.[1], Larry McFall[2], Darryl Gravagno[3], Manuel de los Santos[4]
[1,3,4]Aqua-Aerobic Systems, Inc., Loves Park, Illinois
[2]Rock River Water Reclamation District, Rockford, Illinois

[1]Email: treid@aqua-aerobic.com
[2]Email: LMcFall@rrwrd.dst.il.us
[3]Email: Darryl.gravagno@aqua-aerobic.com
[4]Email: mdelossantos@aqua-aerobic.com

ABSTRACT

The first full-scale AquaNereda® aerobic granular sludge (AGS) system was commissioned at the Rock River Water Reclamation District (RRWRD) in Rockford, IL. This 31.5 m^3/hour (200,000 gpd) AGS demonstration facility (AGSDF) was part of a private-public partnership between Aqua-Aerobic Systems, Inc. (AASI) and RRWRD to demonstrate the first use of AGS technology at a North American municipal wastewater treatment facility. The AGSDF provides a venue for direct testing and measurement of process and water quality parameters through start-up, seeding, acclimation and stabilized operational phases. AGS was obtained from the 833 m^3/hr (5.3 MGD) Garmerwolde Nereda plant in the Netherlands, transported to the AGSDF in September 2017 and stored until construction of the facility was completed in January 2018. Granule inventory increased by 100% within six weeks of start-up resulting in stable performance that met 3 mg/L Total Nitrogen (TN) and < 1 mg/L Total Phosphorus (TP) levels without chemical addition.

KEYWORDS

Aerobic Granular Sludge, Nereda, granule, demonstration, seeding, nitrogen, phosphorus, BNR

INTRODUCTION & BACKGROUND

Granular sludge formation was demonstrated in an upflow anaerobic sludge blanket (UASB) reactor nearly 40 years ago (Lettinga, *et al.*, 1980) and later using an anaerobic sequencing batch reactor (SBR) (Wirtz, Dague 1996). Cultivation of granular sludge under aerobic conditions was first demonstrated in a laboratory scale SBR (Morgentroth, Van Loosdrecht, *et al.*, 1997) using a short hydraulic retention time (HRT) to develop rapidly settling granules whose structural elements were retained after weeks of storage. The robust, dense and fast settling AGS presented an opportunity to realize mainstream biological nutrient removal (BNR) using a high biomass concentration without the energy associated with membrane separation. Full-scale, commercial implementation was, however, limited until reliable mechanisms were developed to

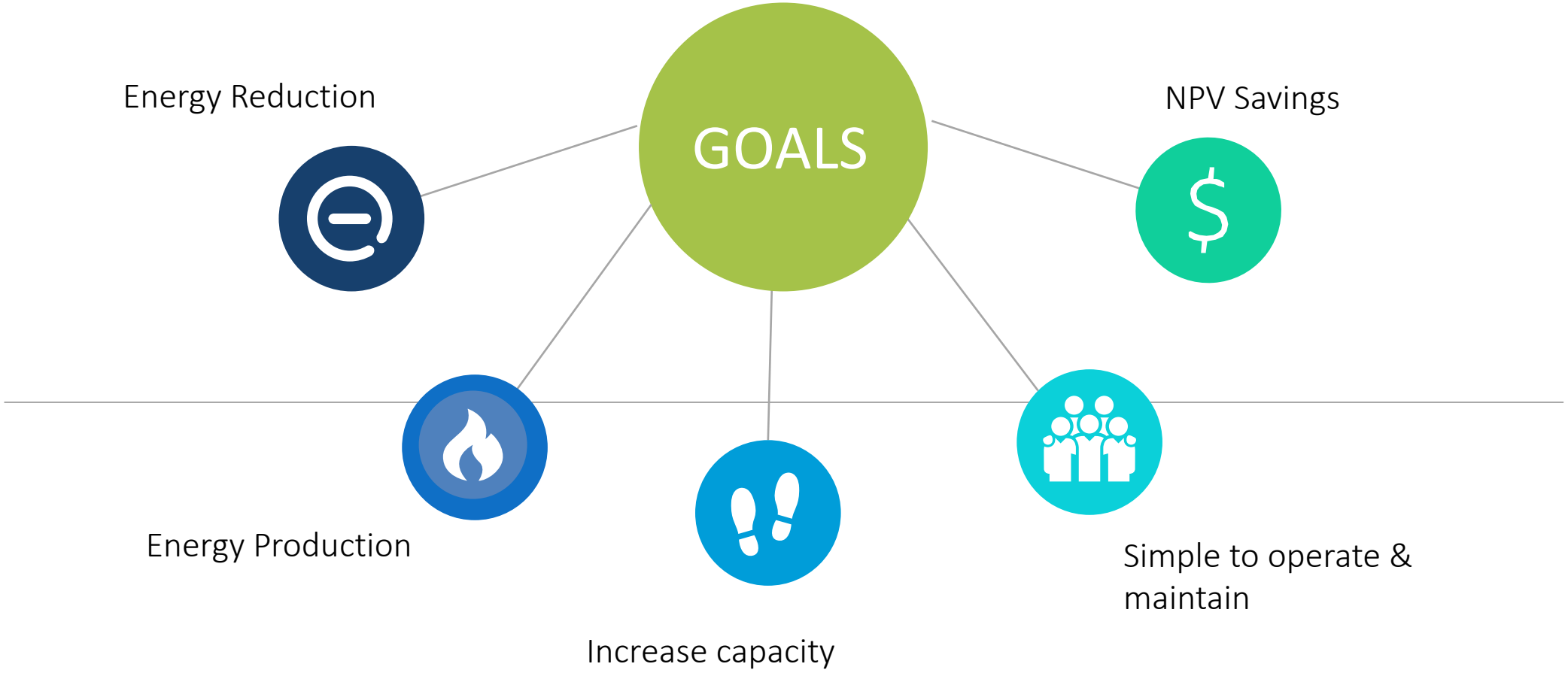
FRSA & AASI joint AquaNereda® presentation at WEFTEC 2019 Conference

Visitors to FRSA

In a typical year, over 200 people visit FRSA to get a first-hand view of the technologies on site.

FRSA Project

Planning Goals



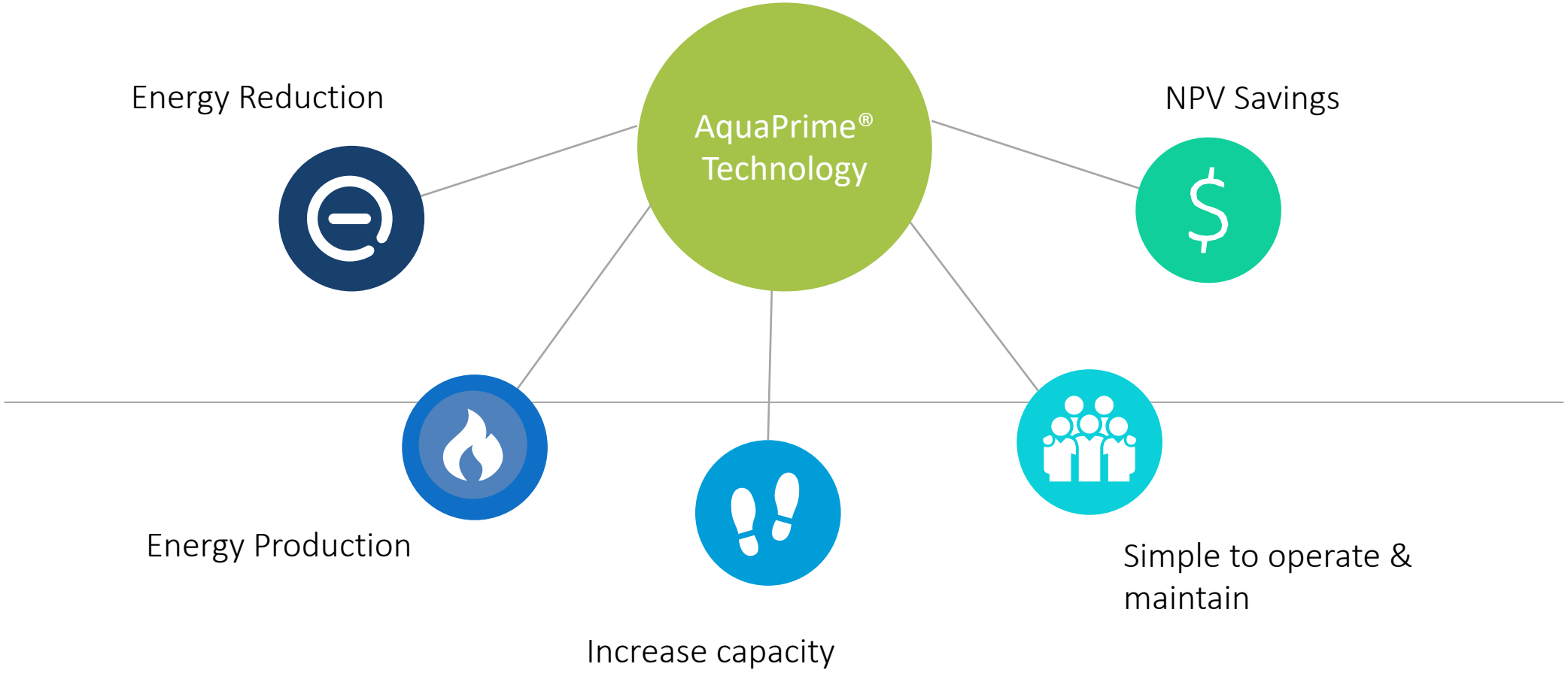
AquaPrime® Overview

Four Rivers Sanitation Authority

AQUA-AEROBIC SYSTEMS, INC.
A Metawater Company

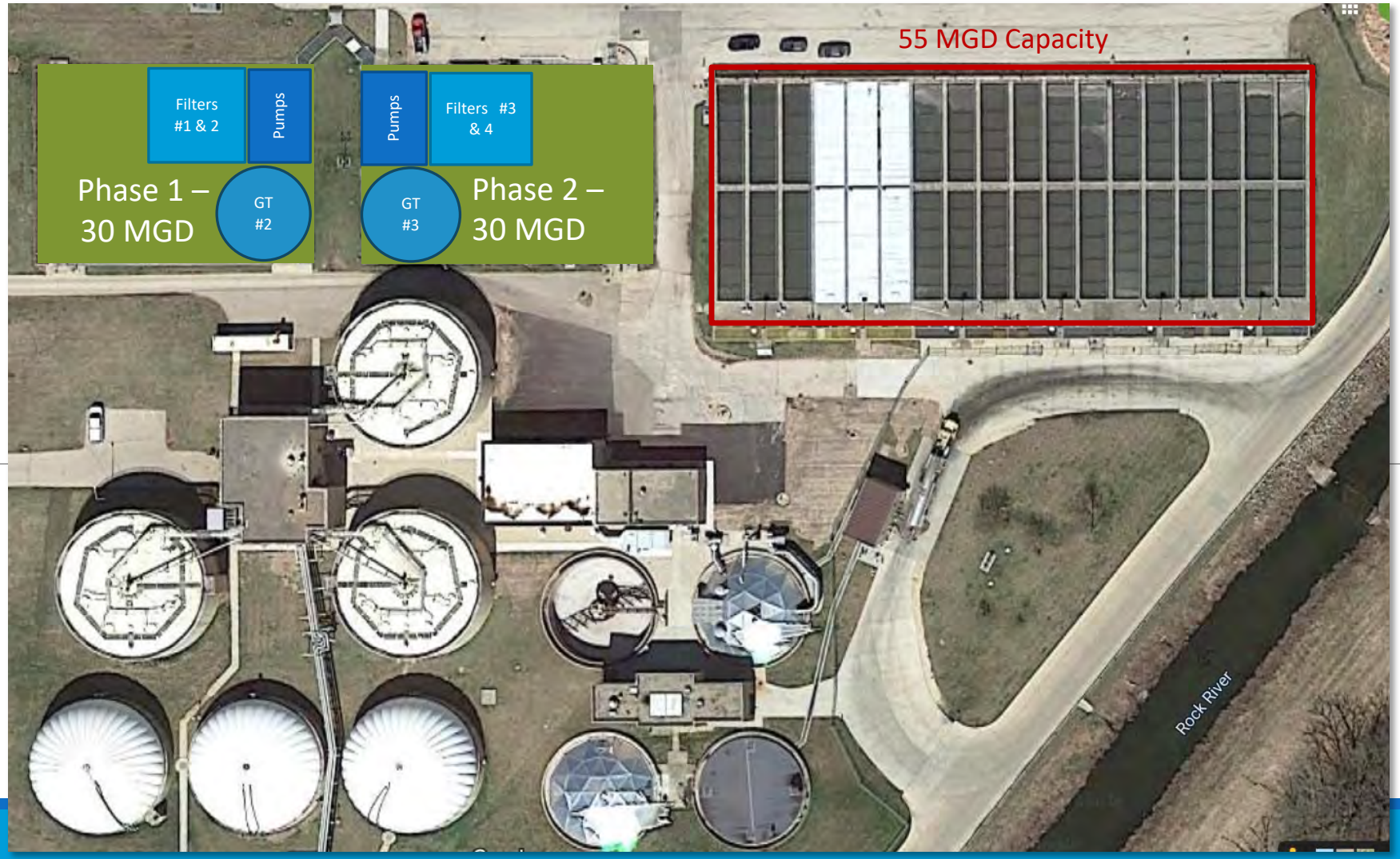
FRSA Project

AquaPrime® Technology



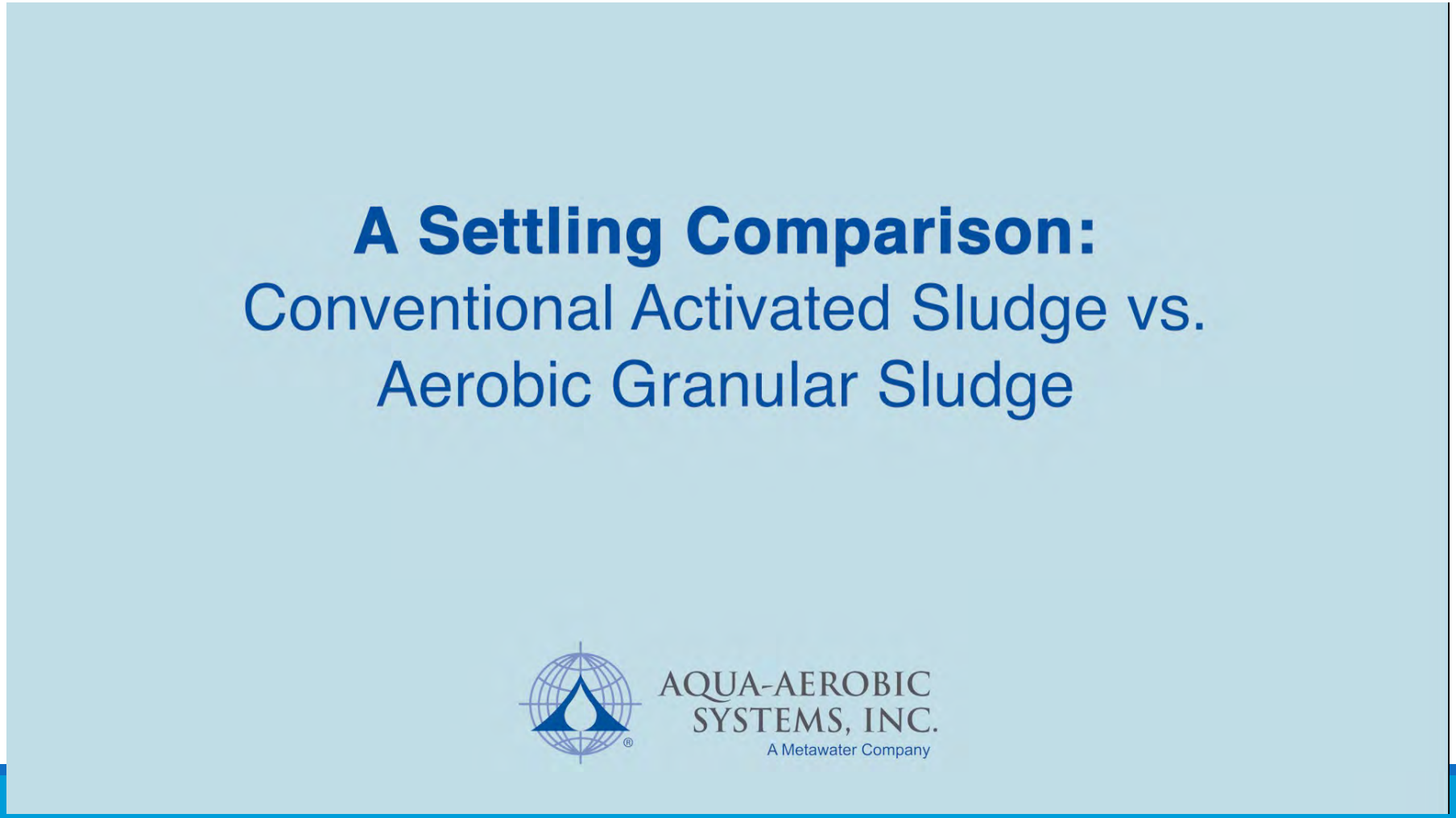
FRSA Project

Project Design Phases



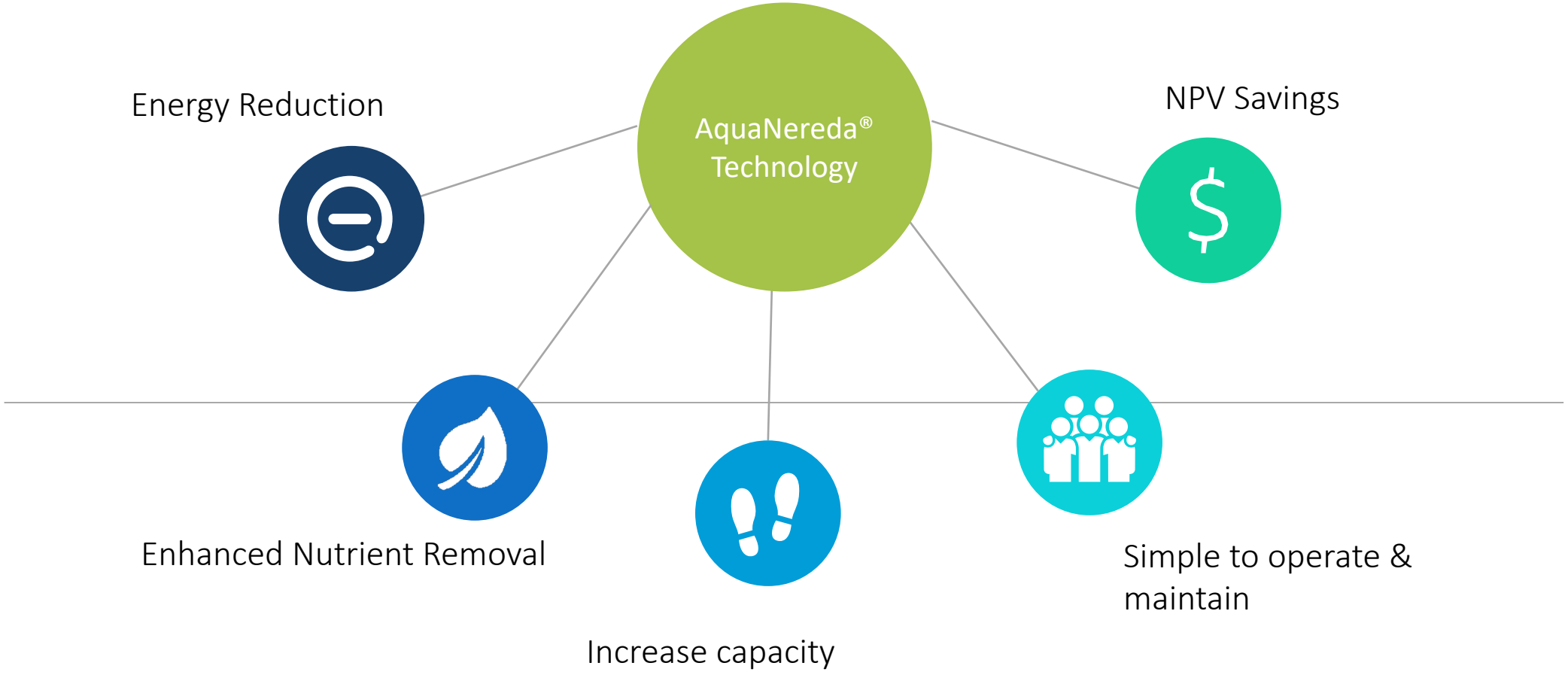
AquaNereda® Aerobic Granular Sludge

Settleability Video



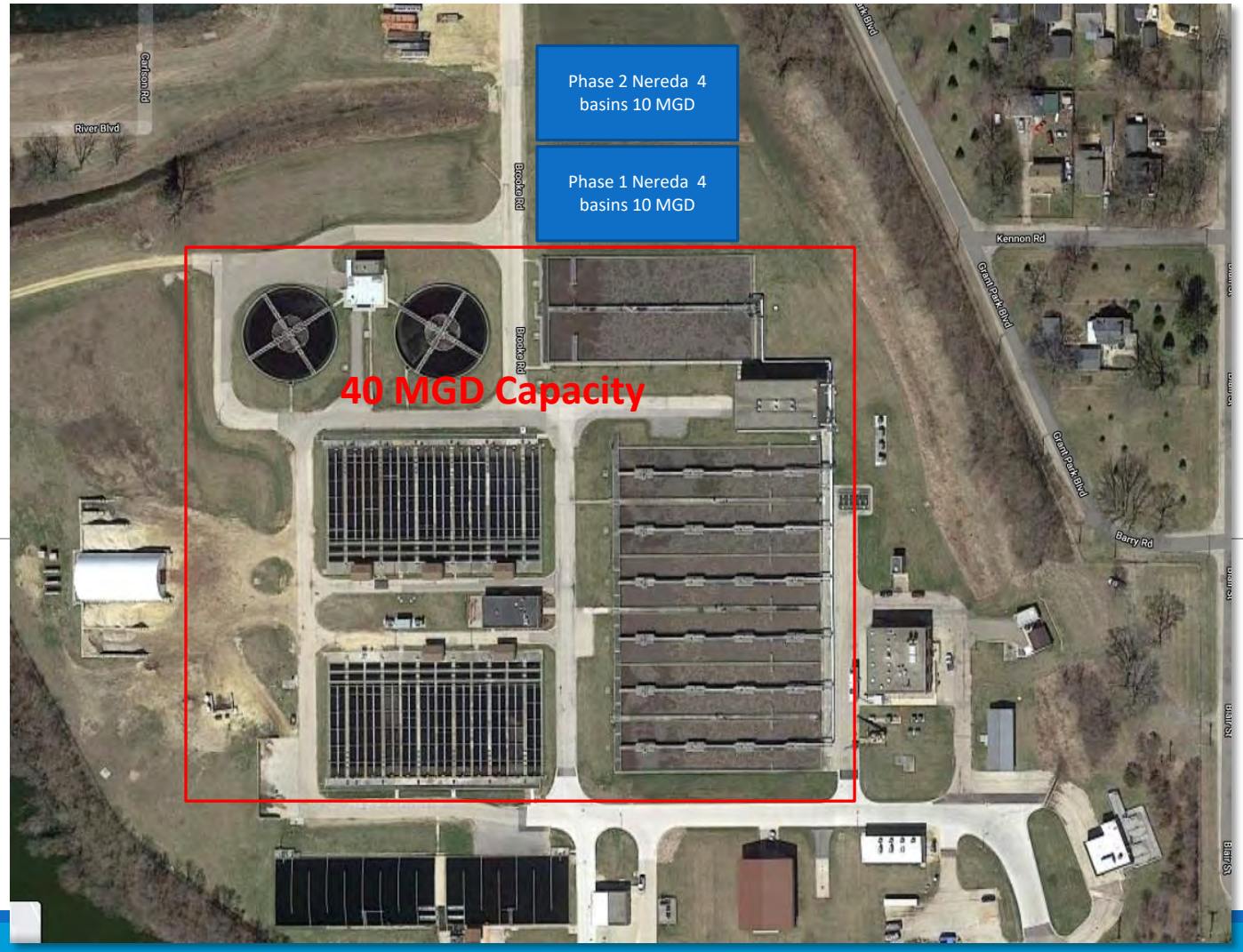
FRSA Project

AquaNereda® Technology

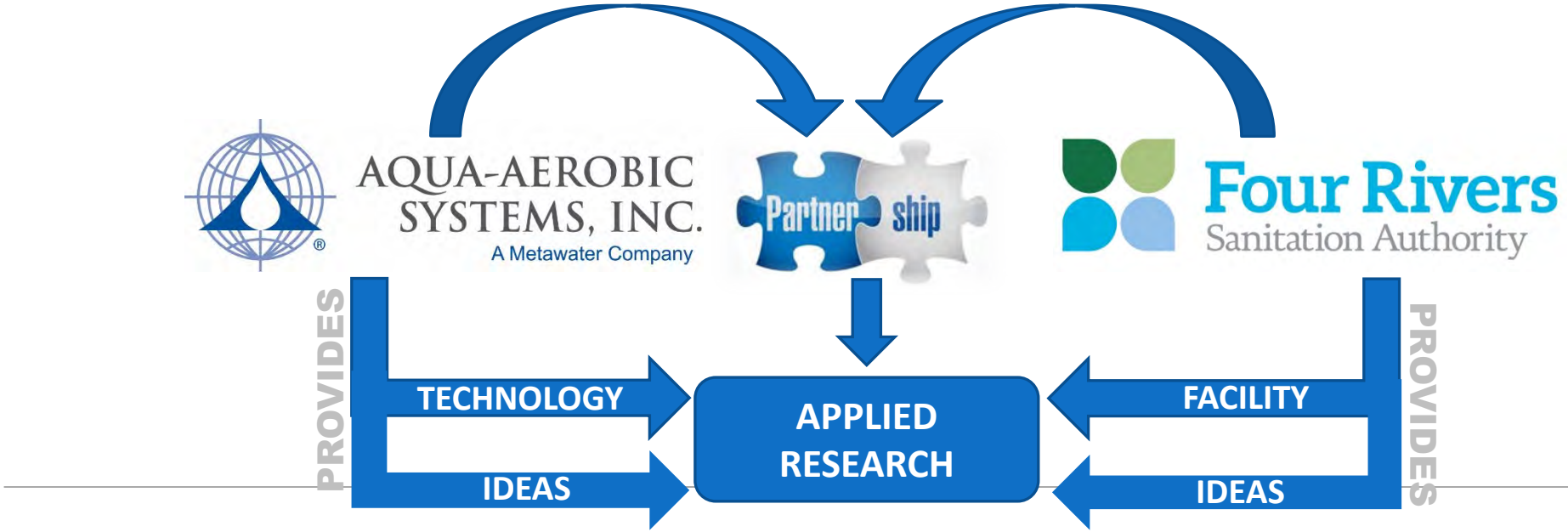


FRSA Project

Project Design Phase-AquaNereda®

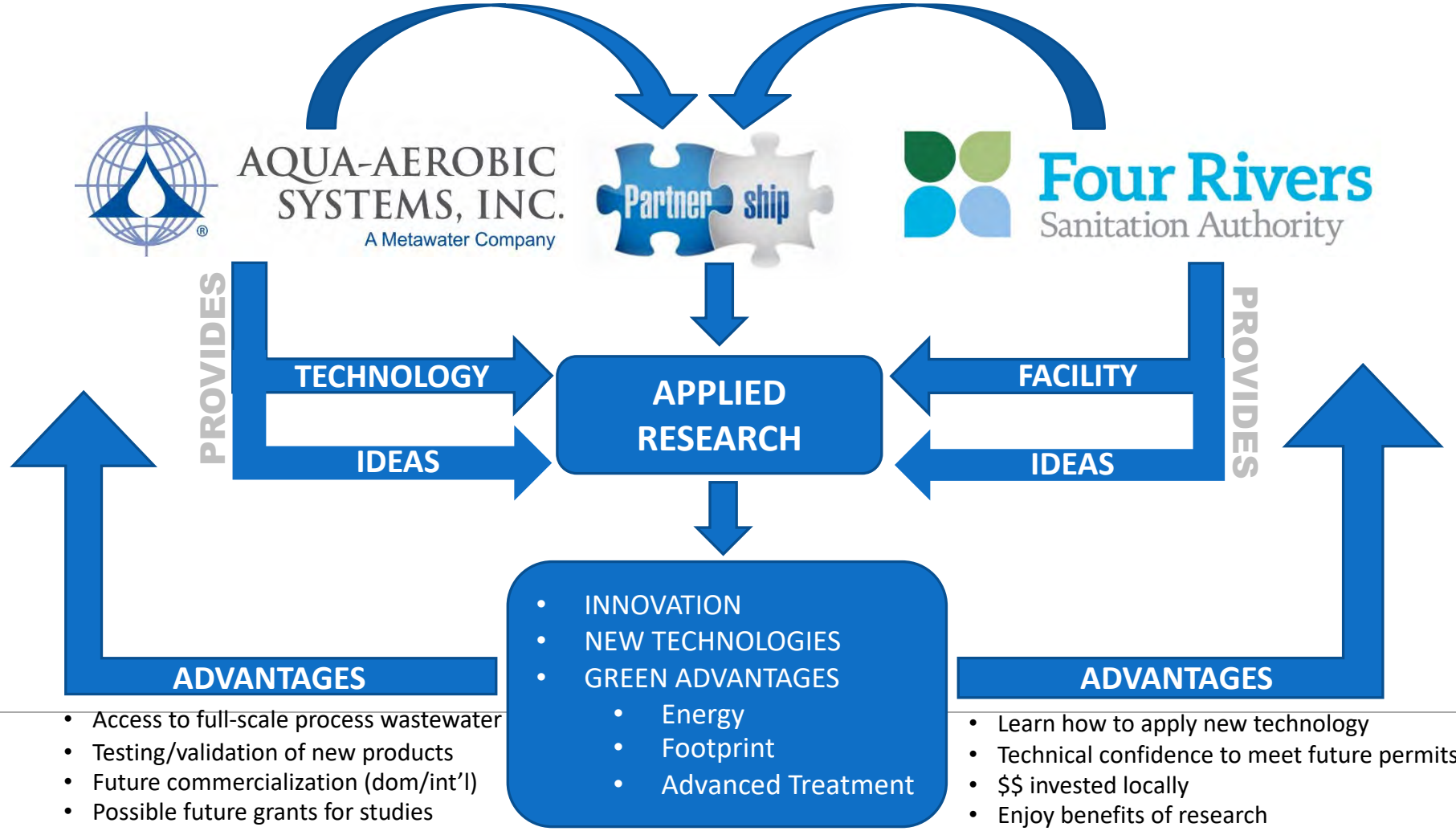


Partnership: Effects & Advantages



Four Rivers Sanitation Authority

AQUA-AEROBIC SYSTEMS, INC.
A Metawater Company



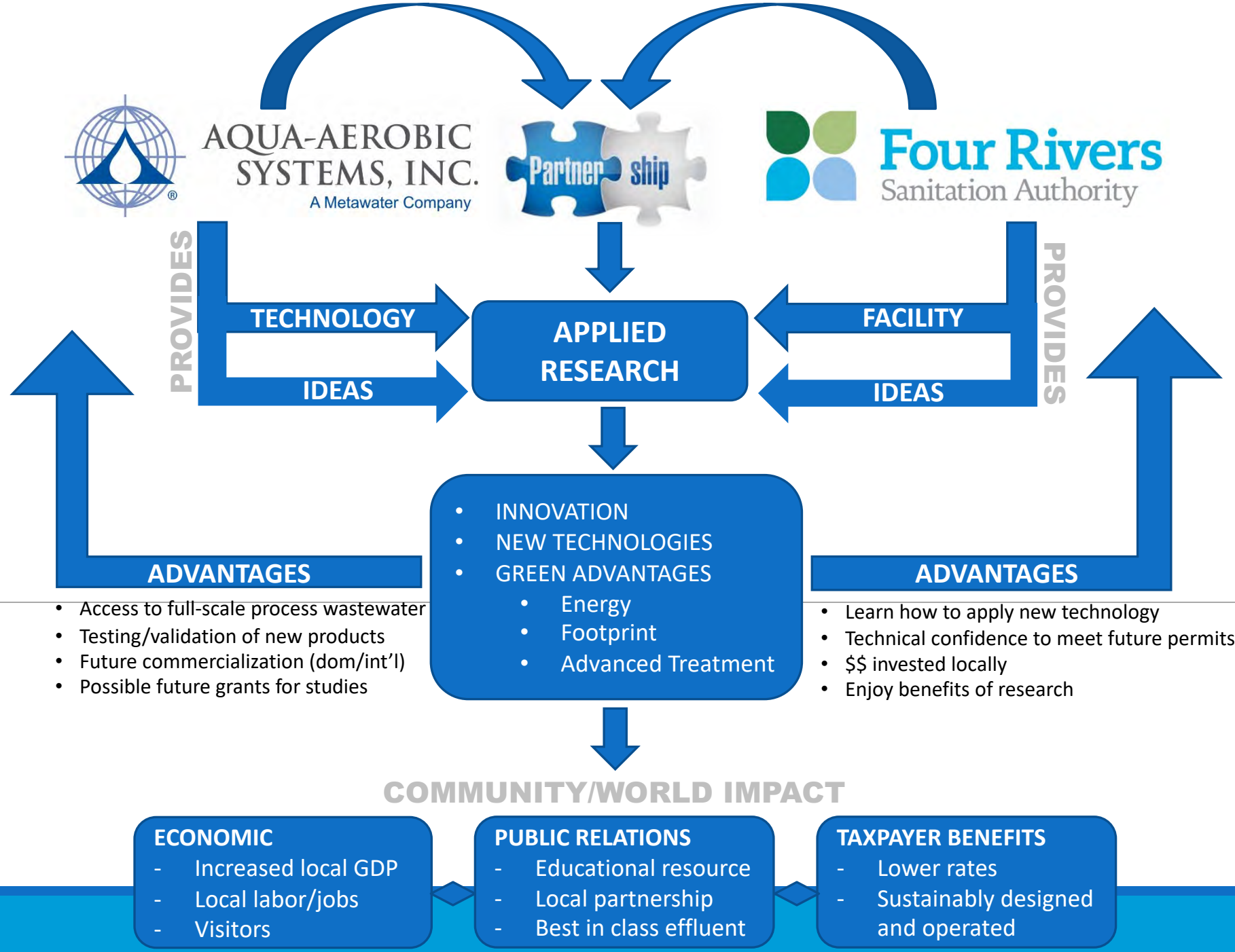
Four Rivers Sanitation Authority

AQUA-AEROBIC SYSTEMS, INC. A Metawater Company

Partnership: Effects & Advantages

Four Rivers Sanitation Authority

AQUA-AEROBIC SYSTEMS, INC.
A Metawater Company


AQUA-AEROBIC SYSTEMS, INC.
A Metawater Company
Partner ship
Four Rivers Sanitation Authority
PROVIDES
TECHNOLOGY
IDEAS
APPLIED RESEARCH
FACILITY
IDEAS
PROVIDES
ADVANTAGES
Access to full-scale process wastewater
Testing/validation of new products
Future commercialization (dom/int'l)
Possible future grants for studies
INNOVATION
NEW TECHNOLOGIES
GREEN ADVANTAGES
Energy
Footprint
Advanced Treatment
ADVANTAGES
Learn how to apply new technology
Technical confidence to meet future permits
$$ invested locally
Enjoy benefits of research
COMMUNITY/WORLD IMPACT
ECONOMIC
- Increased local GDP
- Local labor/jobs
- Visitors
PUBLIC RELATIONS
- Educational resource
- Local partnership
- Best in class effluent
TAXPAYER BENEFITS
- Lower rates
- Sustainably designed and operated

Thank you


Four Rivers
Sanitation Authority


AQUA-AEROBIC SYSTEMS, INC.
A Metawater Company

green town

GreenTown Rockford

November 12 | Embassy Suites Rockford Riverfront