374WATER°

374Water AirSCWO™ System

City of Bellingham

Response to RFP: 76B-2023

Solids Handling Pilot Program RFP

October 30th, 2023

pioneering a new era
— in sustainability

10/30/2023

Subject: Solids Handling Pilot Program RFP

RFP # 76B-2023

The enclosed response is submitted in response to the above-referenced Request for Proposal. Through submission of this proposal, we agree to all of the terms and conditions of the Request for Proposal.

We have carefully read and examined the Request for Proposal and have conducted such other investigations as were prudent and reasonable in preparing the proposal. We agree to be bound by statements and representations made in this proposal and to any agreement resulting from the proposal.

Yours truly,

Sudhakar Viswanathan

Name: Sudhakar Viswanathan

Title: Vice President, Solutions

Legal name of proponent: 374Water Systems Inc.

Date: October 30th, 2023

Project Name	City of Bellingham – Solids Handling Pilot Program RFP	
Project No.	COB-103023	
Submitted to	City of Bellingham	Purchasing Office, RFP # 76B-2023
Date	10/30/23	
Owner/City	City of Bellingham, WA	
Owner's Engineer	—	
Revision	00	
Confidentiality	This document is confidential and may contain proprietary information, it is not to be disclosed to a third party without the written consent of 374Water Inc.	

Table of Contents

Executive Summary

374Water is excited by the prospect of partnering with the City of Bellingham ('the City'), to develop solutions for their ongoing sludge management needs. We believe 374Water's excellence in designing innovative solutions, manufacturing products in the US using the highest quality material and standards, and executing challenging projects in a cost effective manner, will bring to the City a strategic partner and offer the City a sustainable solution for waste management.

374Water's technology, AirSCWO™, is a safe, proven, and sustainable method for sludge management that utilizes a process called supercritical water oxidation (SCWO). The process transforms "waste" (e.g., sludge) to reusable water, energy, and minerals which eliminates organic pollutants and emerging contaminants and obviates the need for off-site waste hauling and disposal. Using AirSCWO™, the City can process municipal sludge on a 24x7 continuous basis, with very little operator interaction, and replace the hearth incinerators that are currently in use. This can move the City from treatment and costly disposal of sludge, to complete elimination and resource recovery.

The proposed AirSCWO™ system is compact, modular, prefabricated, and skidded for ease of installation into a new or existing building and requires minimal civil, mechanical or electrical work. Additionally, it is seamlessly integrated into the existing facility without disrupting existing processes. If required, additional pre-treatment processes such as screening and dewatering can be provided as a turn key equipment package. Similarly, post-treatment options for separating minerals from effluent streams can be included.

By partnering with 374Water, the City will be able to provide its ratepayers a product proudly manufactured in the US, capable of converting waste into valuable resources using a safe, reliable and a highly efficient process that will ensure contaminants of emerging concerns will be destroyed and removed from the ecosystem permanently.

1. Team Structure and Business Approach

1.1 Team Structure

The proposed team structure is outlined in Figure 1 below. 374Water is flexible and will work with the City, its engineers, any selected consulting firms, and onsite/contracting staff to determine the appropriate structure.

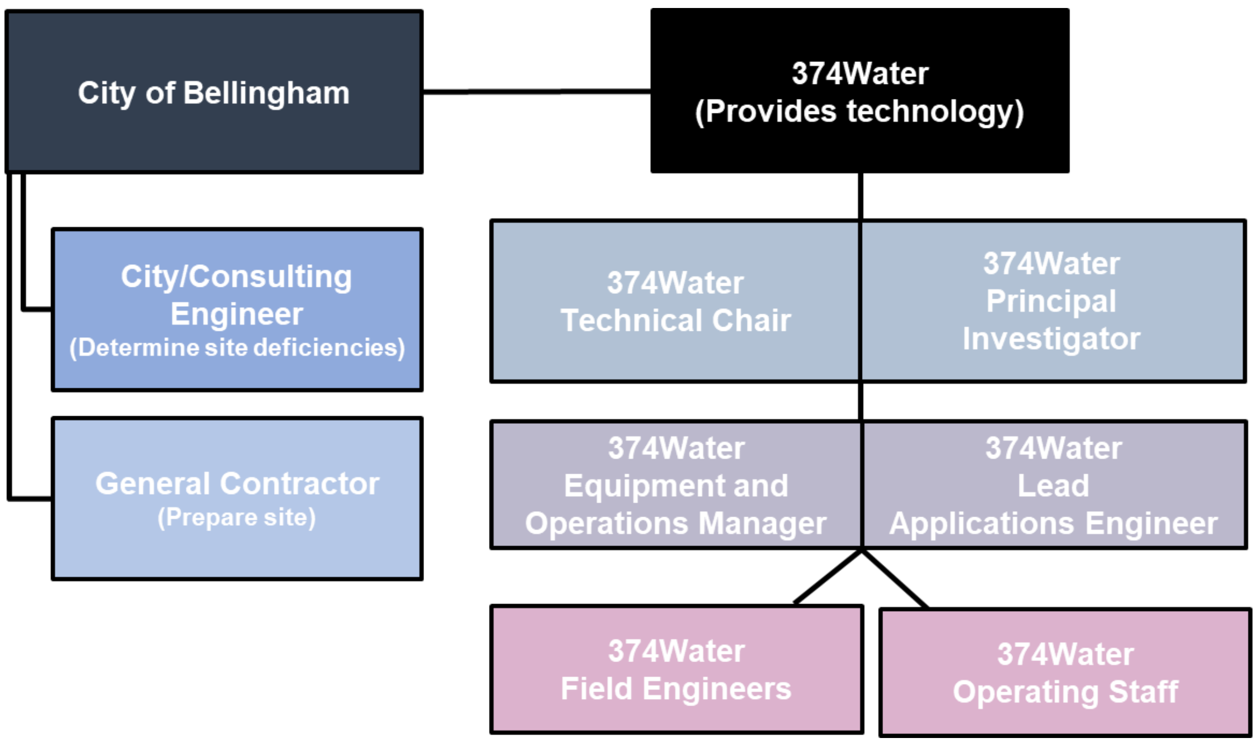

Figure 1. Proposed team structure. Credit: 374Water.

374Water will serve as the technology solution provider. Dr. Marc Deshusses, the Co-Founder of 374Water and patent inventor of the supercritical water oxidation AirSCWO™ system will serve as the Technical Chair. Sudhakar Viswanathan in the role of Vice President will be the principal investigator (PI) for this pilot project. David Garb will serve as Equipment and Operations manager. Naomi Senehi will serve as Lead Applications Engineer. The core technical team will be supported by field engineers during the demonstration and will also serve as trainers and support staff to the WRRF staff for commissioning the demonstration and full-scale units.

1.2 Team Qualifications

Attached in Appendix A are resumes from 374Water's core team.

1.3 Coordination and Communication

374Water will coordinate directly with the City and will participate as a technology and equipment provider only. The proposed scope for 374Water includes:

- Participation in all aspects of the project starting from kick-off, pre-design, and system review.
- Assistance in site preparation meetings, engineering design and specifications for bid (if required).
- Supporting the City and their consultants in environmental permitting efforts.
- Fabrication and deliverance of the AirSCWO™ unit, dewatering system, and ancillary equipment including tanks and hoses.
- Physical assistance at the site for integration of the unit within the existing facility in a manner that is least interruptive/disruptive.
- Assistance in the commissioning and startup of the process.
- Operation and monitoring of the operating systems for the duration of the pilot period.
- Collection and testing of system effluents to determine beneficial reuse potential.
- Decommissioning of the unit.

Services not provided by 374Water include the construction and installation work. This work will need to be performed by a qualified and licensed engineer in conjunction with a qualified and licensed general contractor with specialized subcontractors of various trades.

In one such arrangement, upon acceptance of a proposal, the City and 374Water will work together to determine all modifications to the proposed pilot location that are required. The City will be responsible for preparing the site and all utilities required to install and operate the proposed AirSCWO™ system.

It is 374Water's intention that this proposal communicates the site facilities required for 374Water to deploy an AirSCWO™ system, commission and commence operations on the City's waste activated sludge, operate the system for the duration of the pilot test, and remove the system from the site at the end of the pilot test. Once site prep is complete 374Water will deploy the proposed equipment for 3 months, of which the system will be operational and onsite for at least 2 months.

374Water personnel by project phase and pilot demonstration at the Post Point WWTP

Schedule 1 – System design, system preparedness and site preparation

- Participants during this stage will include the Technical Chair, Principal Investigator, Equipment and Operations Manager and Lead Applications Engineer.

Schedule 2 – Mobilization, installation, commissioning, and startup of the pilot system

- Participants during this stage will include the Technical Chair, Principal Investigator, Equipment and Operations Manager, Lead Applications Engineer, Field Engineers and Operating Staff.

Schedule 3 – Operations for the duration of the pilot period

- Participants during this stage will include the Technical Chair, Principal Investigator, Equipment and Operations Manager, Lead Applications Engineer, Field Engineers and Operating Staff.

Schedule 4 – Decommissioning, disassembly and demobilization of the pilot system

- Participants during this stage will include the Technical Chair, Principal Investigator, Equipment and Operations Manager, Lead Applications Engineer, Field Engineers and Operating Staff.

1.4 Other Logistics

It is 374Water's intention that this proposal is inclusive of the labor, materials, equipment rentals, and delivery of all equipment required to install and operate the AirSCWO™ system exclusive of the work around the site prep and physical connections that may require a skilled tradesperson.

The City shall prepare and deliver the site in a manner that meets all specifications for the 374Water equipment to be safely installed and operated. 374Water will prepare a system layout drawing(s) ("Drawing(s)") and any required specifications of the System at the City's location. The drawing(s) will show the specific placement of the equipment, piping and utility connections, and other relevant features of the system needed to support site preparation by the City. 374Water shall be responsible for the professional quality, technical accuracy, completeness, and coordination of the drawing(s) and any necessary specifications. The drawing(s) will define and include the layout of the sludge preprocessing and feed ("pretreatment"). The drawing(s) shall be subject to a review period of ten (10) working days during which the City shall perform appropriate reviews (including any City-required compliance) of the drawing(s) and any necessary specifications. The City shall be responsible for any required permits to prepare the site for installation and operation of the System.

During the installation period, 374Water shall install the system per any designs, drawings, or specifications, as approved by 374Water and the City. City personnel shall be on site and available during the installation of the system. The City will provide the necessary support, and access to, facilities as specified in the applicable work order (for electrical, plumbing, civil and mechanical) at its expense and in accordance with the required timeframe set forth in such work order. The City, at its own expense, will provide the feedstock supply, electrical service, potable water service, reclaimed water service, and the sanitary sewer drain necessary for the system to operate. The specific utilities and types of connections needed will be defined in the drawings prepared.

Following installation, the preliminary testing, inspection, and checkout of the system and ancillary equipment shall be performed by qualified representatives of 374Water using standard checklists and procedures. The inspection and checkout will ensure equipment and components have been correctly installed; shall operate fully in the manner intended and are ready to perform their function as intended.

During commissioning, the necessary waste stream will be provided by the City by way of the agreed upon feed system. The required waste shall be within a percent solids range of 4 to 6, and a minimum of 4,000 GPD up to a maximum of 5,000 GPD.

374Water will operate the pretreatment system to sufficiently screen and dewater the sludge to acceptable parameters. During the start-up period, 374Water shall collect feedstock and system effluent samples two times per day at least 8-hours apart and send the samples to a third-party laboratory to analyze the samples for pH, total solids (TS), volatile solids (VS), chemical oxygen demand (COD), alkalinity, total dissolved solids (TDS), and chlorides at least two times each day. The City may collect samples and perform analyses on the system liquid effluents.

2. Proposed Technical Approach

The goals of this proposed onsite pilot demonstration are to provide the City with a first-hand understanding of the following:

1. The nutrient and reuse potential for the mineral solids generated by the AirSCWO™ process when using the City's sludge as feed.
2. The potential for reducing the overall greenhouse gas (GHG) footprint generated by the processing of the City's biosolids.
3. The ability of AirSCWO™ to destroy PFAS compounds (if present) in the City's sludge.
4. Potential modifications to the plant or dewatering operations such that full scale implementation of AirSCWO™ can be achieved.

The project will take place, and be phased per the following schedules and tasks:

Table 1. Proposed project schedule.

Schedule 1	System design, system preparedness and site preparation
Schedule 2	Mobilization, installation, commissioning, and startup of the pilot system
Schedule 3	Operations for the duration of the pilot period
Schedule 4	Decommissioning, disassembly and demobilization of the pilot system

2.1 Processing Technology

Technical Background

374Water offers a proprietary sustainable waste management technology (AirSCWO™). AirSCWO™ transforms both simple and complex wastes such as wastewater sludges, biosolids, landfill leachate, food, and gardening organic waste, agricultural and dairy wastes, and organic chemical wastes, including harmful contaminants (e.g., PFAS, drugs, microplastics), into reusable water, energy, and minerals. AirSCWO™ systems achieve new heights of operational performance and resource recovery, shifting the waste management paradigm from conventional treatment and disposal to innovative pollution elimination and resource recovery.

AirSCWO™ is a transformative technology that harnesses the process of SCWO. SCWO utilizes the unique properties of water above its critical point (374°C and 221 bar). Figure

2 shows the phase diagram with the critical point and supercritical phase of water shown in red.

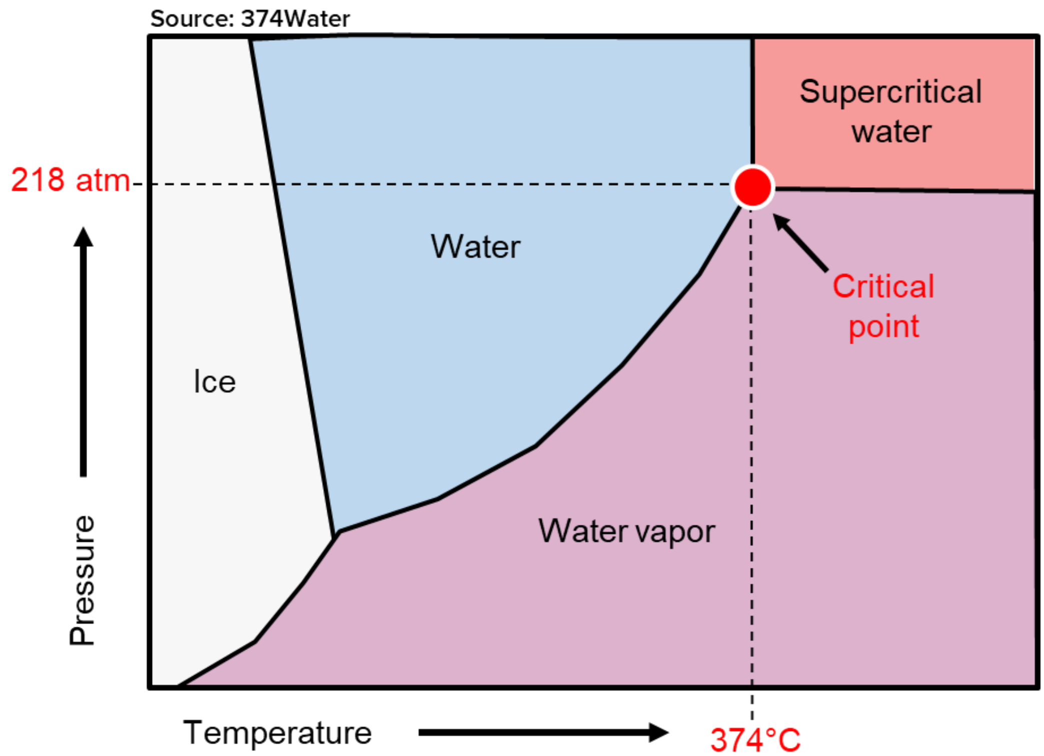

Figure 2. Phase diagram of water showing supercritical water. Credit: 374Water.

At supercritical conditions, in the presence of oxygen, organics are rapidly converted to water, inert solids, gases, and reusable heat with >99.9% reduction in volatile solids volume. The reaction is illustrated as shown in Figure 3.

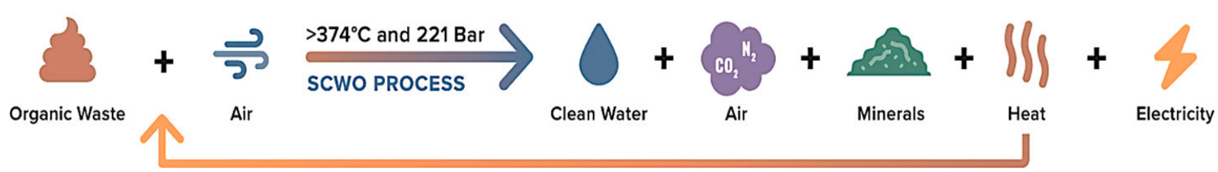

Figure 3. Supercritical water oxidation with AirSCWO™. Credit: 374Water.

AirSCWO™ is a continuously operating, auto-thermal process that utilizes the energy embedded in the waste for power. After a short heat-up period of 2-3 hours, an AirSCWO™ system is self-sufficient requiring little or no external power to operate (large units are net energy positive). The process is illustrated in Figure 4 below. An AirSCWO™ system is automated using sensors connected to a SCADA system and a real time data historian (PI) for live analysis of trends, key process indicators (KPIs) and performance measurements.

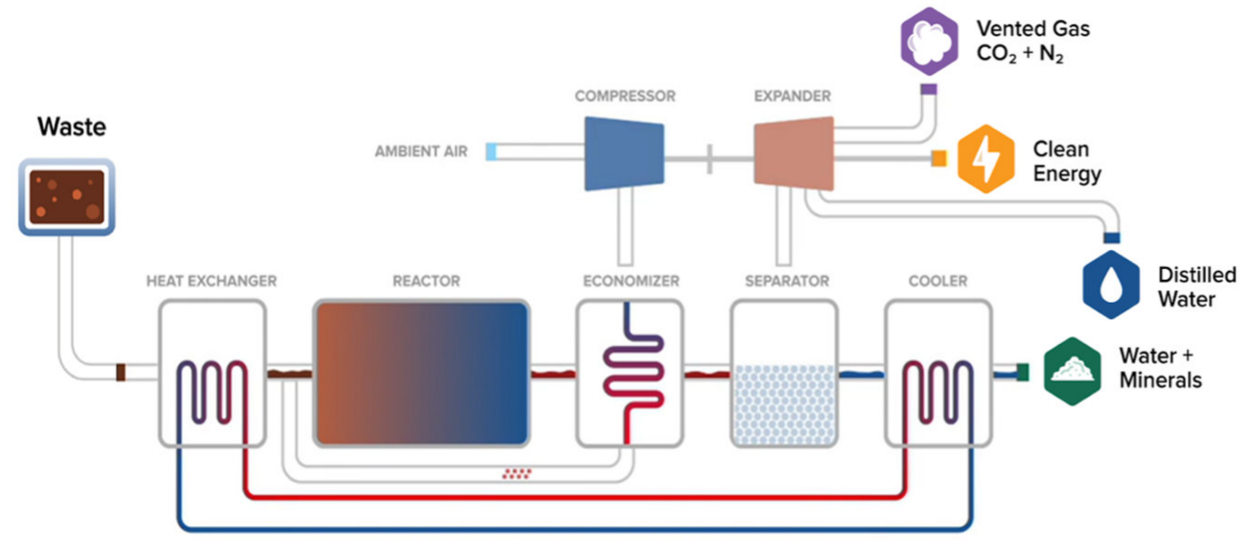

Figure 4. 374Water's AirSCWO™ process flow diagram. Credit: 374Water.

- **Heating and Pressurization:** Incoming organic waste and atmospheric air are heated and pressurized towards supercritical conditions (>374°C and 221 bar).
- **Reaction:** Hot pressurized organic waste is injected into a plug flow reactor alongside the pre-heated and pressurized air (oxidant). A rapid oxidation of the waste's organic compounds converts almost all the calories (or COD) in the waste into heat (supercritical mass).
- **Heat Recovery:** Supercritical water leaves the reactor and is split into gaseous and liquid streams; heat is recovered at various stages using a combination of heat exchangers and solid/liquid/gas phase separation vessels.
- **Superheated Steam**: Superheated steam is sent to a built-in expander to generate electricity that can be used onsite. Post expansion, this waste stream becomes vent gas and distilled quality water.
- **Energy Recovery:** An energy recovery unit converts superheated steam into electricity for the system to heat and pressurize the incoming waste and oxidant (air).
- **Air Emissions:** The gases emitted from the system are CO_2 and N_2. AirSCWO™ produces insignificant amounts of NO_x, SO_x, CO, acid gases, or hazardous and volatile organics, and condensed water vapor removed from the gaseous stream after the separator.
- **Effluent Water**: Approximately one-third of the feedstock (by weight), leaves the system in the form of a liquid mineral stream. The composition of the mineral stream will determine the potential post-treatment needs and mineral reuse potential.
- **Distilled Water:** Approximately two-thirds of the feedstock (by weight) leaves the system as distilled water which may be beneficially reused.

Advantages of AirSCWO™

AirSCWO™ addresses waste management challenges plaguing communities across the globe and tackles prior hurdles which prevented SCWO technology from widespread adoption and commercialization.

Since its introduction, commercial development of SCWO has been slow due to technical challenges; the complex nature of a high-pressure, high-temperature process can lead to corrosion, plugging and fouling. These technical issues have driven a need for change to critical design elements of SCWO processors - including innovating the reactor material, shape, and size. What's more, the pure oxygen used in older generation SCWO processes must be handled and stored safely, creating a need for expensive safety design and control processes to avoid hazards. With thermal energy being a byproduct of the SCWO process, early attempts to commercialize SCWO were also sidelined by unrealistic expectations that SCWO could produce power at a competitive retail electricity rate (approximately $0.03-0.05 per kWh). This goal proved to be unreachable, making SCWO adoption and commercialization that much more difficult.

Using technology invented and patented (US-11420891-B2) by engineers at Duke University in Durham, NC, U.S.A., 374Water developed the AirSCWO™ technology as the world's first self-sustaining, continuous flow SCWO omni processor. AirSCWO™ was labeled "the third generation of SCWO" during recent PFAS elimination work performed by the U.S. EPA PFAS Innovation Technology Team (PITT). The technology is in commercial production and has the potential to shift the wastewater paradigm from the traditional centralized, end-of-pipe treatment to innovative, decentralized resource recovery. 374Water has several pending U.S. patents for this technology (Table 2).

Table 2. 374Water Patents Pending.

Title	Filing Date	Application No.	Authors
SCWO System for Treatment of High-Strength Wastes	12/19/2022	18/068,287	Deshusses, M.A., Nagar, Y., Ballenghien, D., Harif, H.
Applying Chemical Oxygen Demand and Heating Value Diagnostics to Enhance Performance of a SCWO Process	11/29/2022	18/059,834	Nagar, Y., Ballenghien, D.; Deshusses, M. A
Monitoring Scheme and Method of Corrosion and Fouling Reduction for SCWO System	11/29/2022	18/059,850	Nagar, Y., Ballenghien; Deshusses, M. A.; D., Harif, H.

AirSCWO™ addresses prior hurdles by incorporating moderate preheating of the waste slurry, followed by mixing with supercritical water and air. Air serves as the oxidant which is much safer to use than pure oxygen. The internal mixing rapidly brings the waste undergoing treatment to supercritical conditions thereby minimizing corrosion and the risks of waste charring and plugging. All organics in the residuals are rapidly oxidized to CO_2, while the heat of oxidation is recovered to heat the influent waste, and water and minerals are recovered for reuse. The other critical innovation instrumental in overcoming corrosion, plugging and energy efficiency challenges is a multi-stream tubular reactor configuration that enables efficient and sustainable treatment. These unique design elements differentiate 374Water's AirSCWO™ technology from other SCWO technology providers.

Another unique feature of the system is the preheating of the waste slurry before mixing with supercritical water and air. This allows air to serve as the oxidant, a much safer alternative than pure oxygen and chemicals. Further, internal mixing brings waste to supercritical conditions rapidly, minimizing corrosion and risks of waste charring and plugging. Additionally, the heat of the oxidation process is recovered to heat the influent waste.

Input Requirements

AirSCWO™ is a waste agnostic process (i.e. the process is indiscriminate of the type of organic waste being processed) that has been applied to wastewater sludges and biosolids, spent GAC, spent IEX, RO reject, diluted AFFF, landfill leachate, groundwater, and rinsates from decontamination processes. AirSCWO™ can receive and process this variety of organic waste all together or individually.

We are looking for the following from a dewatered sludge to be suitable for AirSCWO™:

- Water content adjusted to achieve caloric target (HHV) of 1,000-1,200 BTU/lb wet[#]
  #feed specific but usually 12-20% for municipal sludges
- Pumpable slurry
- Screened to remove inert material > 4mm
- TDS of < 2% (20,000 mg/L) (*typically not of concern with municipal sludge*)
- Relatively low levels of halogens (*typically not of concern with municipal sludge*)

2.2 Proposed Pilot Scale Implementation for Bellingham, WA

Overview

All AirSCWO™ systems are modular and allow for partial usage, meaning the system can treat a portion (in this case 4,000 to 5,000 GPD out of a total of 70,000 GPD) of the incinerator feed while hearth furnaces/dewatering equipment are still in use.

It is 374Water's intention that the City provides 374Water with 4,000 to 5,000 gallons of 6% TWAS on a daily basis. 374Water will provide a mobile dewatering plant that is custom configured to take the 6% TWAS and output a 15% to 19% TS sludge which is screened for large particles that can jeopardize SCWO operations. The intent of this dewatering plant is to ensure operational success of the AirSCWO™ process along with providing the necessary modifications to the sludge dewatering with no impact on the plants normal day to day operations.

After dewatering to the specific TS required by the SCWO reaction, approximately 1,600 gallons of dewatered sludge (at 15% TS) will be pumped into the AirSCWO system to be thermally destroyed and converted into inorganic mineral byproducts.

Dewatering Unit

The dewatering unit (DWU) is designed to condition the liquid waste streams typically produced by a municipal wastewater treatment plant into suitable energy density for AirSCWO™. The system is capable of accepting thickened wastewater sludges and outputting a dewatered sludge of a specific TS that is suitable for the AirSCWO™ process.

Liquid feed sludge enters the DWU through a manifold and is initially processed with an inline macerator. Following maceration an inline pump pushes the sludge through a Huber STRAINPRESS® to screen inorganics and debris > 4 mm in size. The screened liquid sludge from the discharge side of the Huber STRAINPRESS® will flow into an equalization (EQ) Tank. A submersible electric mixer will equalize the liquid sludge in the EQ tank prior to dewatering. The screening from the Huber STRAINPRESS® will be discharged into an endless bagging system that will go into a small dumpster that is stored inside the DWU. A small cargo door will allow for the dumpster to be removed from the DWU and properly disposed of. Access will be provided from the road to remove the dumpster. A screening disposal service will be provided by the City.

Next, the sludge is dewatered using a screw press and emulsion polymer make down system. 374Water will provide the necessary polymer and screw press operation to produce a 12%-20% TS cake that will discharge into the sludge feed hopper (FH). The FH will have a live bottom screw conveyor system to move the cake sludge to the discharge that will feed the final sludge pump in the process that sends sludge at 60 psi to the AirSCWO™ unit. The DWU will receive the mineral water that is produced from the SCWO process and discharge it into the filtrate pumping system. From the filtrate pumping system we prefer to discharge directly to the plants headworks via a sewer or hose.

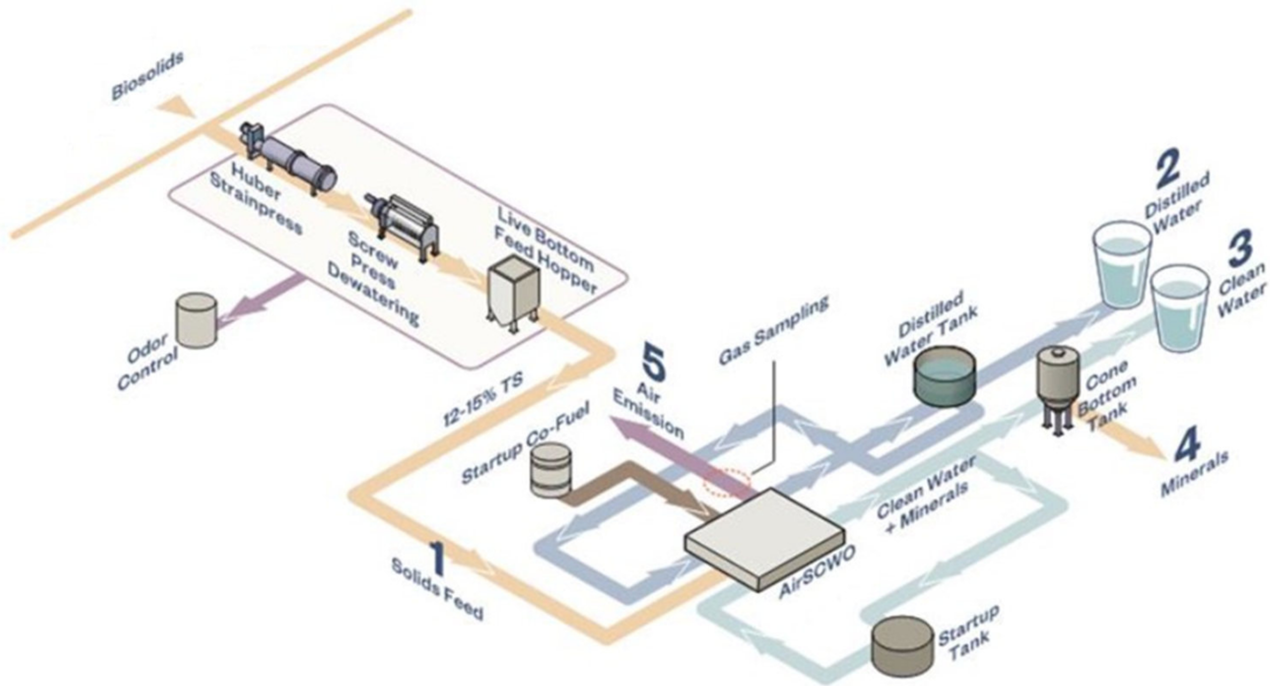

Figure 5. Typical AirSCWO™ process flow diagram. Credit: 374Water.

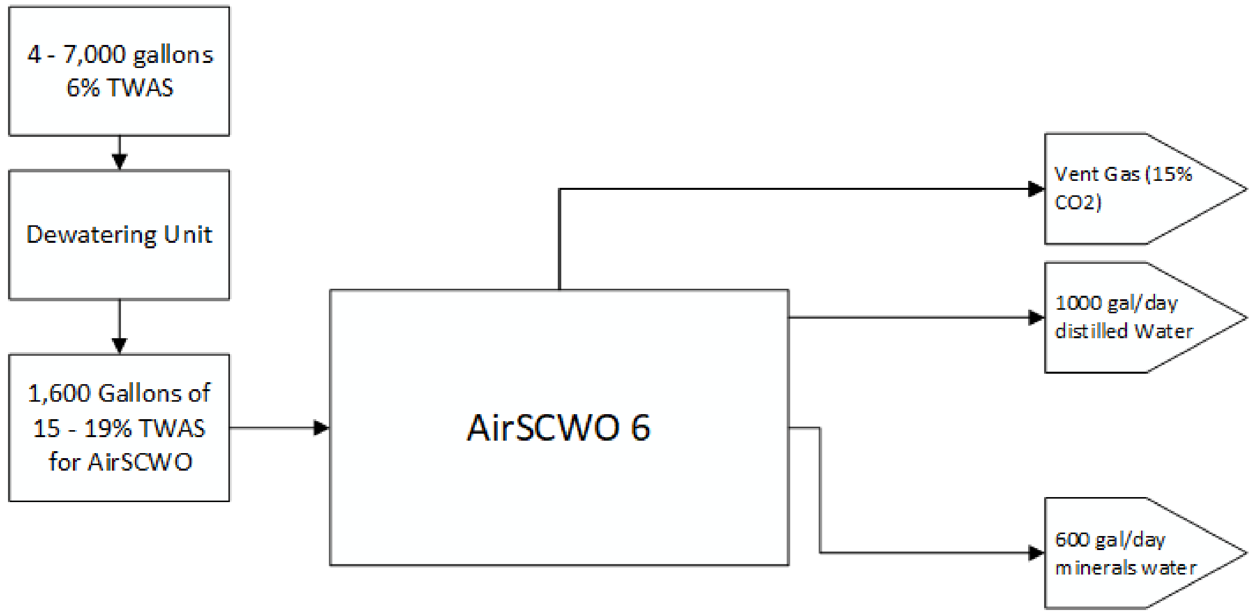

Figure 6. Proposed liquid in and out flows for the AirSCWO system and dewatering unit.

Table 3. SCWO operation and utilities.

	Pilot (AirSCWO™ 6)
Proposed Operational Schedule	5 days per week of continuous operations.
Total Electricity Consumption	The AirSCWO 6 unit is nearly net-neutral with a small amount of electrical energy (roughly -0,080 MWh) consumed each year.
Total Natural Gas Consumption	Not applicable, the process requires no natural gas. Initial reactor heating is via electric heaters. Per operating day = 0 therms consumed.
Total Fuel/Chemical Consumption	Glycol, isopropyl alcohol or diesel can be used as fuel during startup and shutdowns. A high estimate is 20 startups and shutdowns annually, needing ~200 gallons of fuel each year.
Potable Water Demand	Potable water required for this process is 9,000 GPY.

	During steady state operation, the distilled water stream will be used for any process needs. Approximately 351,000 GPY of distilled water (non potable) is produced from sludge processing and suitable for use within the sludge management process.
Treated Effluent(s)	The distilled water (~351,000 GPY) and effluent + minerals stream of 148,000 GPY will require a drain that brings the effluent back to the head of the WWTP.

Table 4. Details of the major utilities required for installation, startup, operation and shut down.

Installation Surface	Both the AirSCWO™ system and dewatering unit require a level and stable surface for installation. Concrete, asphalt, or leveled crushed stone are generally considered acceptable.
Water	Access to a source of reliable water (like a hose, 10-20 GPM) should be available at all times for the 374Water team to access for tasks like filling tanks.
Electricity	**AirSCWO™:** 400/480 3 Phase, 300 Amps max draw. **Dewatering unit:** 400/480 3 Phase, 200 Amps max draw.
Consumables	**AirSCWO™:** Onsite storage required for 50 gallons of fuel to be used during start up and shut down. **Dewatering unit:** Polymer will be provided by the City (the same as one being used at the full-scale City run dewatering system).
Drain	**AirSCWO™:** Capability to discharge 2 GPM to the plant's headworks. **Dewatering unit:** Drain access to intermittently discharge up to 60 GPM of dewatering filtrate to the plant's headworks.
Effluent Handling	It is proposed that all system effluents be routed to a single drain line that feeds back into the plants' headworks. Individual process lines are able to be sampled and stockpiled for data collection purposes.

Table 5. Sizing details of the major components installation requirements.

Equipment	Size and Utilities Needed
AirSCWO 6	● Dimensions: 40 ft x 8 ft x 9.5 ft (L x W x H) ● Electricity: 3 phase, 480 V, 300 A connection ● Water (potable water line, normal tap pressure) ● Drain (access to drain water to headworks/sewer) ● 1 x 4-inch connections sludge inlet from DWU ● 2 x 1-inch connections for effluent drain lines
Dewatering Unit	● Dimensions: 40 ft x 8 ft x 9.5 ft (L x W x H) ● Electricity: 3 phase, 480 V, 200 A connection ● Sludge feed from TWAS storage to DWU ● Semi regular changeout of bagging system ● Polymer supplied for duration of demonstration

2.3 Final Product

The AirSCWO™ 6 generates two liquid streams that require handling. One, a distilled water that is ideally returned to the head of the plant. The second effluent stream is a mineral brine with a combination of dissolved and precipitated solids that closely represent the sludge's mineral content. This stream is easily separated to produce water and mineral streams using a clarification and filtration step. Aside from the aforementioned clarification and filtration steps, it is possible that an additional step of refining the minerals to obtain a Phosphorus product for valorization and distribution is possible.

At this scale, when combined with an acceptable dewatering process, the total offering will convert approximately 18.9 metric wet tonnes of sludge each day at 6% TS into a filtrate fraction, 1,000 gallons of distilled water, available for reuse, 600 gallons of effluent water that can be discharged after disinfection. From the effluent water, on a daily basis, approximately 600 lbs of nutrient rich minerals can be extracted for beneficial reuse.

A typical mineral content table is presented below, potentially, up to 20% of this salts is typically phosphorus in the form of P_2O_5, which can be used as a soil amendments or a slow release phosphorus fertilizer. Additional steps might be required to separate this fraction from the other metals and minerals should the heavy metal ceiling concentrations be above the limits for biosolids land application per the CFR 40 Part 503.

Table 6. Typical mineral content of effluent.

	Percent (%) of total minerals	Pounds per ton of total minerals	Nutrient (lbs/ton) bioavailability
Nitrogen - Total	0.14	2.8	0.84
P_2O_5 - Total	19.3	386	231.6
K_2O - Total	0.4	8	6.4
Calcium	8.9	178	106.8
Magnesium	2.31	46.2	27.72
Sulfur	1.3	26	15.6
Boron	0.01	0.2	0.12
Zinc	0.17	3.4	2.04
Manganese	1.34	26.8	16.08
Iron	16.68	333.6	200.16
Copper	0.07	1.4	0.84
Sodium	1.57	31.4	31.4
SiO_2 - Silica	46.72	965	1406

Mined phosphorus (Phosphate Rock with 4 to 25% P_2O_5 - analogous to minerals recovered from SCWO process) can be purchased for $200 to $400 per metric tonne. While the value for this product exists, there is no established marketplace for the sale of wastewater recovered Phosphorus. In order to valorize this product in the US, wastewater derived Phosphorus, especially when it is not partitioned from the other minerals, would be distributed to a local soil blender that can use this product as a raw material or into the agricultural markets as a free slow release phosphorus source. This will reduce the cost of landfilling the minerals.

3. Proposed Fees/Costs

Table 7. Proposed fees and costs.

Task	Total Cost
Schedule 1 - Site prep	$4,500
Schedule 2 - Mobilization, installation, commissioning, and startup	$118,000
Schedule 3 - Equipment operation and maintenance (2 months)	$386,000
Schedule 4 - Demobilization	$62,000
Total:	**$570,500**

374Water shall submit invoices to the City monthly based upon the work completed during the prior 30 days.

4. References

At this time, only one full scale system is operational in the world.

1. The AirSCWO™ 6 system will be in operation for one year treating wastes including untreated sludges, digested biosolids and food waste at the Orange County Sanitation District's (OC San's) Fountain Valley facility. At the conclusion of the year, the process will be upgraded to a AirSCWO™ 30 system and operated for another year. At the successful conclusion of the second year, the process will be upsized to a AirSCWO™ 200 system(s) to replace the existing digestion (Class B) system. Reference: Mr. Rob Thompson <rthompson@ocsan.gov> General Manager at OC San, phone: (714) 593-7310.

Others considering implementation of 374Water's AirSCWO™ 6 system include:

1. US Municipality - (Grant received from Bipartisan Infrastructure Law) - Demonstration followed by AirSCWO™ 30 system installation.
2. US Municipality - (Grant received from Legislative-Citizen Commission on Minnesota Resources) - Demonstration possibly followed by development of a regional facility.
3. US Municipality - (City funded study) - Demonstration possibly followed by a centralized facility.
4. US Private Treatment, Storage and Disposal Facility (TSDF) - (Privately funded project) - For the destruction of aqueous film forming foam and PFAS derived wastes.
5. US Private TSDF - North Carolina (Privately funded project) - For the destruction of Resource Conservation and Recovery Act regulated wastes.
6. US Department of Defense (DOD) - Two (2) US Air Force Bases - For the destruction of classified waste.
7. US DOD Project #1 - One (1) US Air Force Base - For the destruction of classified waste.
8. US DOD Project #2 - One (1) US Air Force Base - For the destruction of classified waste.
9. US DOD - One (1) US Navy Base - For the destruction of unclassified waste.
10. US Real Estate - Texas (Privately funded project) - As a small decentralized WW facility.

Note the above information is confidential and shared with details redacted, references contacts for ongoing contracts can be provided with a confidentiality agreement executed between 374Water, the City and the Owner's Engineer.

5. Contractual Arrangement

5.1 Type of Contract

374Water has no preference with regards to the structure and format of any proposed long term contract. The scope of any full scale proposed solution will depend on the success of the pilot program and if expanding the proposed services to include other sources of biomass help the City of Bellingham achieve their project objectives.

5.2 Contract Term

We have no additional input regarding the City's proposed contract term.

5.3 Merchant Solutions

The proposed solution would allow the City to use 374Water's AirSCWO™ technology for its full-scale application as well.

Implementation of an AirSCWO™ system unique to the City's pilot testing conditions was presented in Section 2.2 ('Proposed Pilot Scale Implementation for Bellingham, WA'). The following illustrates a proposed location for the deployment of one (1) AirSCWO™ 6 for pilot testing at the City's wastewater treatment facility, but will be determined in collaboration with the City. The estimated footprint (area) required for the implementation of one (1) AirSCWO™ 6 system is 40' by 8' by 9.5' (LxWxH) with a surrounding working perimeter.

Once the pilot has been completed, a full-scale implementation to replace the hearth furnaces may be considered by the City and 374Water.

This system would treat all of the feed (10,000 GPD at 24% solids) by detuning the centrifuge to achieve 19% solids prior to SCWO treatment. The feed would then be sent to two (2) AirSCWO™ 30 units.

At this scale, without processing any external solids, the process will convert approximately 47.64 metric wet tonnes of sludge each day at 19% DS into 2,808,000 gallons of distilled water that can be reused, 1,188,000 gallons of effluent water that can be discharged after disinfection, and 475.88 metric dry tonnes tons of nutrient rich minerals that can be applied to soil to improve its macro and micro constituents, all while generating roughly 200 MWh/year of excess electrical energy and 27,269 Million BTU/year of excess thermal energy for use at the facility.

6. Additional Information

6.1 GHG Impact

AirSCWO™ has the potential to dramatically reduce the GHG emission potential contained within and generated by the associated transport of municipally derived biosolids. From the perspective of sludge, when landfilled or land applied, portions of the carbon will be released into the atmosphere as CH_4 and N_2O. Even if the CH_4 generated in a landfill is flared or converted into electricity, its ultimate fate is still CO_2. This is an underestimate of the impact as this scenario does not include the combined impact of the trucks and fuel that is consumed to move the sludge (even when dewatered) from the point of treatment to the ultimate site of disposal (landfill or farm field).

The potential for GHG reduction in addition to renewable energy production makes AirSCWO™ a unique and sustainable technology.

- Efficient and complete combustion: Achieving near-total oxidation, AirSCWO™ minimizes the formation of harmful byproducts, such as incomplete combustion products and toxic gases, which are often associated with traditional incineration methods.
- Minimal air pollution: AirSCWO™ utilizes water in its supercritical state as the reaction medium. This means the process emits little to no air pollutants like nitrogen oxides (NO_x) and sulfur dioxides (SO_x), which are major contributors to air pollution and smog formation. Typical criteria pollutants like PM, SO_X, and NO_x are found at insignificant concentrations.
- Greenhouse gas destruction: AirSCWO™ goes beyond merely reducing waste volume or converting waste into less harmful forms. It actively contributes to GHG reduction by breaking down organic materials into carbon dioxide (CO_2) and water (H_2O), both of which are environmentally benign. While CO_2 is a GHG, its impact is significantly lower compared to other waste compounds, and its emission can be mitigated through various carbon capture and utilization technologies. This highlights how the AirSCWO technology avoids emission of more harmful GHGs/emissions such as CH_4 and N_2O.
- Energy recovery: The high temperatures and pressures within the AirSCWO™ process generate substantial heat energy. This energy can be harnessed and used for various purposes, such as powering the AirSCWO™ system itself, and generating electricity. Energy recovery enhances the overall efficiency of the AirSCWO™ process and reduces the reliance on fossil fuels for energy production.
- Reduced land and water impact: Traditional waste disposal methods often involve landfills and incinerators, both of which can have detrimental environmental impacts. AirSCWO™ reduces the need for landfills, efficiently reducing GHGs.
- Regulatory: AirSCWO™ aligns with regulatory requirements and can improve environmental impacts from the WWTP.

6.2 Destruction of CECs (e.g., PFAS)

SCWO has emerged as a leading technology candidate for the complete destruction of PFAS and PFAS laden waste. Since the reaction time is short, SCWO systems can be relatively compact when compared to other thermal destruction technologies. When treating halogenated wastes like PFAS, the carbon-fluorine bonds are broken and released into solution as an anionic halide. With the right additives the halides are mineralized and rendered completely inert. When compared to incineration, SCWO has relatively low energy requirements and much cleaner air emissions for criteria pollutants. The nature of the enclosed and homogeneous reaction environment is such that the complete oxidation of PFAS and organic (bio)sludges can occur simultaneously.

So far, 374water has used AirSCWO™ to destroy a variety of PFAS laden/contaminated waste streams, including wastewater sludge, aqueous film forming foam (AFFF), ion exchange resin (IER), granulated activated carbon (GAC), landfill leachate, foam fractionate, and reverse osmosis (RO) reject. In the event the PFAS in sludge exceeds 1,000 mg/L (PPM) or 1,000,000,000 ng/L (PPT), 374Water will propose adding a GAC filter to the vent gas to ensure non-detect levels of PFAS in emissions.

374Water is including summary data from a similar wastewater sludge that was treated to demonstrate, among other parameters, PFAS elimination. A list of the DRE for each PFAS can be provided upon request.

Test Conditions:

- Temperature: ~ 571°C
- Pressure: 240 bars
- Reactor retention time: 5.87 seconds

Waste Composition:

- Sludge, dewatered and lime stabilized
- No cofuel
- ~16% DS

Parameter	Influent	Effluent	% Removal
COD (mg/L)	220,000	200	99.91%
Total N (mg-N/L)	15,000	500	96.67%
PO_4^{3-} (mg-P/L)	6000	150	97.50%
pH	8	7	
Conductivity (µS/cm)	5000	300	

	Influent	Effluent	Removal
	ng/kg, ppt	ng/L, ppt	%
Total PFCA	104,550	431.04	99.59%
Total PFSA	141,201	8.04	99.99%
Precursors	216,450	35.57	99.98%
Short chain (C<6)	115,951	379.30	99.67%
TOTAL	462,201	474.65	99.90%

APPENDIX A

Resumes

Technology Leader – Marc Deshusses, Ph.D.

Education

Postdoctoral Fellow-Biochemistry, Swiss Federal Inst. Technol. Zurich - ETHZ (1994)

Ph.D. Techn. Sciences, Swiss Federal Inst. Technol. Zurich - EAWAG & ETHZ (1990 – 1994)

BS-MS Chemical Engineering, Swiss Federal Institute of Technol. Lausanne (1985 – 1990)

Summary of Experience Relevant to this Project

Dr. Deshusses has close to 30 years of experience managing environmental remediation laboratory research and field demonstration projects. Dr Deshusses has broad expertise in the development, analysis and optimization of novel processes for waste remediation and resources recovery. He is a Fellow of the American Association for the Advancement of Science (AAAS).

Relevant Experience

Supercritical Water Oxidation (SCWO) Demonstration at Plant No. 1, 374Water, Orange County Sanitation District (2021-2023). This project will deploy a full-scale AirSCWO system to continuously process municipal wastewater sludge, biosolids and food slurry waste eliminating PFAS, microplastics, and other CECs while recovering resources. The scope includes detailed engineering and construction of a full-scale AirSCWO system, environmental permitting support, mobilization and integration of the system into an existing treatment plant, and a controlled conditions study.

Supercritical Water Oxidation for Complete PFAS Destruction, Duke University, ESTCP (2019-2022). The overall objective of this project is to demonstrate the technical and economic feasibility of SCWO for the treatment of investigation derived wastes (mostly rinsates) contaminated with PFAS. The scope includes designing and conducting various treatability runs with an existing pilot SCWO system, optimizing treatment performance, and conducting a techno-economic evaluation of SCWO at scale.

Supercritical Water Oxidation Treatability Evaluation, 374Water, different confidential clients (2020-Present). The overall objective of these limited scope contracts was to determine the technical suitability or AirSCWO to treat specific waste streams (food and beverage, chemical, and PFAS waste, spent sorbents, etc.). The scope included developing the sampling and run plans, conducting the run, and data curation for the different clients.

Testing Concentrated PFAS Treatment by Supercritical Water Oxidation (SCWO), 374Water, US-EPA PITT (2019-2020). The objective of this project was to evaluate SCWO's ability to eliminate PFAS in unspent AFFF dilutions. The scope included conducting four SCWO runs with 300x and 30x diluted AFFF and analyzing treated effluent liquid and vented gas for PFAS, and determining PFAS elimination.

Techno-Economic Evaluation of Supercritical Water Oxidation for Landfill Leachate and Condensate Management, Duke University, Environmental Research & Education Foundation (EREF) (2020-2022). The objective of this project was to determine the technical and economic feasibility of using SCWO for the management of landfill leachates and condensates. The scope included treatability evaluation with selected wastes, and a techno-economic evaluation of SCWO deployment at landfills.

Multiplexed Biofiltration of Volatile Organic Compounds, Duke University, DARPA/WPBI (prime) (2018-2020). The objective of this collaborative project with the

Warner Babcock Institute for Green Chemistry was to develop a novel, modular and scalable approach to biofiltration for effective management of air pollutants in closed environments. The scope included the development of microbioreactors for organics biodegradation, process modeling, and integration of the microbioreactors with a concentration-desorption system.

Neighborhood Sanitation Using Supercritical Water Oxidation, Duke University, Bill & Melinda Gates Foundation (2013-2019). The overall objective of this project was to develop and demonstrate SCWO as a possibly autonomous treatment methodology for fecal waste management in resources limited settings. The scope included designing and constructing a new pilot SCWO system, developing and conducting experimental campaigns and derisking technology progression by advancing the TRL from about 3 to a TRL of 6-7.

Ultra-High Throughput Animal Waste Treatment Using Supercritical Water Processing, Duke University, USDA (2015-2017). The overall objective of this project was to determine the technical feasibility of SCWO for the management of animal waste at confined animal feeding operations (CAFOs). The scope included treatability evaluation of animal manure using SCWO, and a techno-economic evaluation of SCWO deployment at CAFOs.

Employment History

- 374Water, Inc.
  Co-founder and Head of Technology (2018 – Present)
- Duke University
  -Professor, Dept. Civil & Environmental Engineering (2008 – Present)

-Director, Energy Engineering Program, Pratt School of Engineering (2012 – Present)

- University of California, Riverside, Dept. Chemical & Environmental Engineering
  Assistant, Associate, Full Professor and Department Chair (1994 – 2008)

Publications/Presentations

- Deshusses, M. A. and Ferguson, P. L Supercritical water oxidation (SCWO) for complete PFAS destruction (oral presentation and poster). SERDP & ESTCP Special Symposium on PFAS. July 19-22, 2021. San Pedro, CA.
- Deshusses, M. A. Supercritical Water Oxidation for On-Site Biosolids and Emerging Contaminants Elimination. Invited Keynote Presentation. Leading Edge Technology (LET 2022), March 27 – April 2, 2022 Reno, NV
- Forbis-Stokes, A. A.; Kalimuthu, A.; Ravindran, J.; Deshusses, M. A. Technical evaluation and optimization of a mobile septage treatment unit. J. Env. Manage., 2020, 277, 111361.
- Schaefer, C. E.; Lavorgna, G. M.; Webster, T. S.; Deshusses, M. A.; Andaya, C.; Urtiaga, A., Pilot-scale electrochemical disinfection of surface water: Assessing disinfection by-product and free chlorine formation. Wat. Sci. Technol. 2017, 17(2), 526-536.
- Adair, C. W.; Xu, J.; Elliott, J. S.; Simmons, W. G.; Cavanaugh, M.; Vujic, T.; Deshusses, M. A., Design and assessment of an innovative swine waste to renewable energy system. Trans. ASABE 2016, 59(5), 1009-1018.
- Karatum, O.; Deshusses, M. A., A comparative study of dilute VOCs treatment in a non-thermal plasma reactor. Chem. Eng. J. 2016, 294, 308-315.
- Miller, A.; Espanani, R.; Junker, A.; Hendry, D.; Wilkinson, N.; Bollinger, D.; Abelleira-Pereira, J. M.; Deshusses, M. A.; Inniss, E.; Jacoby, W., Supercritical water oxidation of a model fecal sludge without the use of a co-fuel. Chemosphere, 2015, 141, 189–196.

Vice President – Sudhakar Viswanathan

Education

Bachelors of Engineering in Environmental Engineering, University of Mysore, India 1993 to 1997

Master of Science in Environmental Engineering, Syracuse University, NY. 1999 to 2000

Summary of Experience Relevant to this Project

Mr. Viswanathan is Vice President at 374Water. He spearheads the commercialization and business development of the Supercritical Water Oxidation technology. Mr. Viswanathan has 23 years of work experience in our industry. He has been involved in all aspects of the water and wastewater treatment and served in roles ranging from pilot plant engineer, research and development, product management and technical sales.

Relevant Experience

Supercritical Water Oxidation (SCWO) Demonstration at Plant No. 1, 374Water, Orange County Sanitation District (2021-2023). This project will deploy a full-scale AirSCWO system to continuously process municipal wastewater sludge, biosolids and food slurry waste eliminating PFAS, microplastics, and other CECs while recovering resources. The scope includes detailed engineering and construction of a full-scale AirSCWO system, environmental permitting support, mobilization and integration of the system into an existing treatment plant, and a controlled conditions study.

Employment History

- 2022 - Vice President, 374Water, Durham, NC
    - Responsible for business development in private and public municipal markets. Pioneering efforts to support solutions based on Supercritical Water Oxidation
- 2016 to 2022 - National Sales Manager, Biosolids & Bioenergy, VEOLIA, Cary, NC
    - Successfully introduced Veolia’s first EcrusorTM organics extractor, and BioThelys THP systems to the US/North American market. Diversified use of BioCon ERS thermal oxidation for PFAS destruction. Led research efforts in addressing emerging contaminants in municipal sludge. Responsible for generating over $583 million dollars in sales pipeline over 5 years
- 2013 to 2016 - Group Manager, Biosolids Group, SUEZ, Richmond, VA
    - Responsible for managing Suez’s biosolids portfolio for the US and Canada. Increased sales of non-thermal products in North America by 6% annually since 2013. Participate in national and international conferences as key biosolids business developer. Assist in determining bid strategy. Managed a group of technical sales engineers, application engineers and product managers to support internal and external sales representatives.
- 2010 to 2013 - Product Manager, Biosolids Group, SUEZ, Richmond, VA
    - Increased market shares for advanced anaerobic digesters by 50%. Diversified use of digester mixing technology to water management applications. Deployed solar drying technology into the North American market.
- 2008 to 2010 - Principal Engineer, Biosolids Group, SUEZ, Richmond, VA

  - Championed technical sales and developed market for advanced anaerobic digestion technology nationally, and increased sales for digester mixer technology internationally. Assisted in preparation of product related sales tools such as product bulletins and media.
- 2006 to 2008 - Senior Research Engineer, Research Development & Industrialization Group, SUEZ, Richmond, VA
  - Responsible for transfer of Integrated Fixed-Film Activated Sludge (IFAS) technology to the US market; developed detailed design models for applications including IFAS and Moving Bed Biological Reactor (MBBR). Assist in developing new Ultrafiltration Membrane for the US market; developed test protocols in collaboration with engineering team; oversight of construction and commissioning of pilot plant units. Developed new Biological Nutrient Removal (BNR) Filter Technology to address low total nitrogen requirements for Chesapeake Bay watershed applications. Championed Stage-Gate Project Management with accountability throughout the "New Technology" RDI Cycle. Managed technology transfers to various business units within organization. Developed intellectual property, internal invention disclosures and patents. Managed process box to strengthen technical expertise of the organization; developed detailed design models.
- 2002 to 2006 - Research Engineer, Research Development & Industrialization Group, SUEZ, Richmond, VA
  - Lead the research team involved in optimization of innovative physical-chemical and biological technologies. Supervised transfer of Dissolved Air Flotation (DAF) Technology to the US market, developed new saturator nozzles to minimize differential pressure loss and diversified technology to nutrient removal applications in wastewater.
- 2000 to 2002 - Pilot Plant Engineer, Research Development & Industrialization Group, SUEZ, Richmond, VA
  - Designed and developed testing protocols, programs and implemented start-up and optimization of pilot plant units. Provided support for the regulatory approval process and served as a liaison with federal, state, and universities addressing contemporary environmental issues via pilot scale testing.

Publications/Presentations

- Patent: September 13, 2022- US 11,440,828 B2. Co-authored patent titled 'A method of treating sludge including solids containing phosphorus, ammonia and magnesium and enhancing the dewaterability of the sludge.' Invented the use of a short retention time acid - thermophilic fermenter to simultaneously release ammonia and phosphorus from waste activated sludge to intentionally form struvite crystals as a means to recover phosphorus for agricultural use.
- Viswanathan, S, Deshusses, M, Hatler, D, Nagar, K. (2023) "Quantifying supercritical water oxidation efficiency treating PFAS laden sludge, ion exchange resin and aqueous film forming foam." Water Environment Federation Residuals and Biosolids Conference. May, 2023
- Goss, C., Wurm, R., and Viswanathan, S. (May, 2022) "Harnessing the Power of Dried Biosolids - A Decade of Experience" DOI10.2175/193864718825158436

- Viswanathan, S. DiMassimo, R., Zhao, H., Perry, T., Yamada, T., Kahandawala, M., Morgan, A. (March, 2020) "Thermal treatment of PFAS contaminated sludge: experimentation, design consideration and challenges" DOI10.2175/193864718825157597
- Stephens, N., Viswanathan, S., DiMassimo, R., Schmidt, H., Parez, G., Rose, J. (March, 2020) "Pilot-scale demonstration of intensified anaerobic digestion through thermal hydrolysis pre-treatment at the Moccasin Bend WWTP" DOI10.2175/193864718825157609
- Goss, C., Viswanathan, S., DiMassimo, R., Mocock, J., Wurm, R. (March, 2020) "Using dried biosolids as a sustainable fuel source: A decade of experience" DOI10.2175/193864718825157642
- Zhao, H., Avila, I., Geer, G., McQuarrie, J., Wood, L., Viswanathan, S., Mrdjenovich, B., DiMassimo, R. (March, 2020) "Ammonia and Phosphate Releases from Waste Activated Sludge in Short HRT Thermophilic Pre-treatment Reactor" DOI10.2175/193864718825157660
- Hollowed, M., Viswanathan, S., Anderssonchan, A., Li. L. (March, 2020) "Impact of Digestion Intensification on Sidestream: Lessons Learned from Scandinavian Full-Scale Experiences" DOI10.2175/193864718825157681
- Viswanathan, S., Darby, T., Wert, J. (May, 2021) "Case study of Pennsylvania's first net positive resource recovery facility - The Hermitage Success Story" DOI10.2175/193864718825157953
- Zhao, H., Lemaire, R., Hollowed, M., Viswanathan, S., Andersson, A., Chan M. (September, 2019) "Implementation of IFAS ANITA Mox Deammonification Process: How Sundets WWTP Converted Its Existing MBBR To Tackle High Strength Thermal Hydrolysis Sidestream" DOI10.2175/193864718825157153
- Thomson, C., Dimassimo, R., Clay, R., Viswanathan, S., Kim, J., Landes, N. (April, 2017) "Batch vs. Continuous Thermal Hydrolysis — Which is right for you?" DOI10.2175/193864717821495717
- Viswanathan, S., Kim, J. (May, 2014) "High Solids Anaerobic Digestion Process to Treat High Strength Municipal and Industrial Organic Waste" DOI10.2175/193864714816196808
- Viswanathan, S., Chowdhury, N., Kim, J. (October, 2013) "High Solid Anaerobic Digestion Technology for Poultry Waste Management" DOI10.2175/193864713813692315
- Viswanathan, S., Kim, J. (October, 2013) "Start up and operational optimization of phased digestion system" DOI10.2175/193864713813716264
- Viswanathan, S., Dangtran, K., Diorka, S., Grant, T., Livingston, K. (January, 2010) "From Brown to Green-Reducing Carbon Footprint via Biogas Cogeneration in a Phased Digestion Process Producing Class A Biosolids" DOI10.2175/193864710802766921
- Kaldate, A., Pham, H., Viswanathan, S., Watson, C. (January, 2009) "Meeting the Low Total Nitrogen Discharge Limit Challenge Using Advanced Biological Anoxic Filter" DOI10.2175/193864709793956293
- Viswanathan, S., Pham, H., Kelly, R., Redmon, W. (January, 2008) "Evaluation of Oxygen Transfer Efficiency via Off-gas Testing at Full Scale Integrated Fixed film Activated Sludge Installation" DOI10.2175/193864708788804900

- Viswanathan, S., Pham, H., Kelly, R. (January, 2008) “Evaluation of Plastic Carrier Media Impact on Oxygen Transfer Efficiency with Coarse and Fine Bubble Diffusers” DOI10.2175/193864708788805378
- Pham, H., Viswanathan, S., Kelly, R., Watson, C. (January, 2007) “Management of Filtration and Idle Periods in a Multi-cell Biofilter to Optimize Performance” DOI10.2175/193864707787970151
- Viswanathan, S., Pham, H., Kelly, R. (January, 2007) “Nutrient Crisis: Evaluation of a Biological Filter to meet low total Nitrogen discharge limits” DOI10.2175/193864707787976768
- Letterman, R., Johnson, C., Viswanathan, S. (August 2004) “Low–Level Turbidity Measurements: A Comparison of Instruments” DOI:10.1002/j.1551-8833.2004.tb10684.x
- Letterman, R., Johnson, C., Viswanathan, S. (July, 2002) “A Study of Low-Level Turbidity Measurements” Paperback on AWWA

Applications Engineer – David Garb

Education
BS, Engineering Mechanics, University of Illinois, @ Urbana Champaign

Summary of Experience Relevant to this Project
Sales Engineer with over 10 years of experience in the water and wastewater industry. Works with multiple industries to understand and develop potential SCWO applications. During client meetings, helps communicate the most important pieces of technical and commercial information between Sales and Engineering teams.

Relevant Experience

Procurement Engineer, Nix6, assisted with HAZOP, and procurement of the Nix 6 Supercritical Water Oxidation systems Worked as part of the Engineering group to develop and procure the components required to build the Nix 6. Conduct detailed design reviews of critical operating and safety systems. Coordinate shipment deliveries and quality checks of components as they arrive onsite.

SCWO Treatability Evaluations, Durham, NC, Confidential clients and partners, (2022-Present). Developed treatability reports and supported the completion of supercritical water oxidation treatability evaluations. 374Water evaluated the treatment of PFAS-contaminated residuals including groundwater, sludge, landfill leachate, RO reject, still bottoms, granular activated carbon, and ion exchange resin.

Project Sales Engineer, Shand & Jurs, Wards Island, NY WWTP improvements project (2021) Developed understanding of 1bil+ WWTP improvements project. Proposed scope of supply and provided pricing to bidding contractors. Verified Gas safety improvements section is compliant with EPA American Iron and Steel requirements

Project Sales Engineer, Shand & Jurs, Fargo Wastewater treatment plant improvements project (2019-2022) Coordinated sales and engineering groups to develop scopes of work and bid federally funded municipal WW projects. Check materials and propose alternative components for American Iron and Steel requirements, depending on the types of equipment provided.

Sales Engineer, Shand & Jurs, Quality Issue Documentation (2020-2022) Worked with field service, L&J Engineering, L&J Quality Assurance department, and end user to resolve equipment performance issues experienced in the field. Documented and communicated build issues in order for the QA department to develop solutions and repair damaged equipment.

Shand & Jurs, Inside Sales, Spare Parts Specialist (2019-2022) Maintained database of existing Waste Gas Burners and WWTPs. Provided spare parts and procurement guidance for existing users.

Employment History

- 374Water/Durham, NC/Applications Engineer/2022-Present
- Shand & Jurs a L&J Technologies Company/Applications Engineer/2019-2022
- Flexstorm a division of Advanced Drainage Companies/Sales Engineer/2013-2018

Applications Engineer – Naomi Lynn Senehi

Education

Bachelors of Science in Environmental Engineering, University of Florida, US, 2013-2018

Master of Science in Environmental Engineering, Rice University, TX, 2019-2021

Summary of Experience Relevant to this Project

Naomi is an Applications Engineer at 374Water. She works collaboratively to apply the Supercritical Water Oxidation technology to various waste streams from interested parties. Naomi has nearly 5 years of research experience in R&D, consulting, and municipalities.

Relevant Experience

Testing and plant re-mapping of CAMBI biosolids at DC Water (2015). This project involved the deployment of a CAMBI^{TM} thermal hydrolysis system at the DC Water Resource Recovery Plant to continuously process municipal wastewater sludge to produce Class A biosolids. Naomi assisted in research efforts to test the biosolids for Triclosan and remap plant infrastructure systems post-installation.

Employment History

- 2023 - Applications Engineer, 374Water, Costa Mesa, CA
  - Provides engineering support for the application of Supercritical Water Oxidation to various waste streams and client implementation.
- 2021 to 2023 - Researcher, the University of California, Irvine, Irvine, CA
  - Led research efforts to collect and analyze household wastewater samples from over 29 residents in Orange County, CA for 40 PFAS compounds (EPA 1633 method).
  - Spearheaded a review paper on the mass balance of PFAS in WWTPs.
  - Designed and synthesized a novel material for PFAS adsorption and mineralization.
- 2019 to 2021 - Researcher, Rice University, Houston, TX
  - Developed the first molecularly imprinted polymer to specifically capture coronaviruses from water
  - Intellectually contributed to the development of an electrochemical sensor that achieved picomolar detection of SARS-CoV-2 glycoproteins
  - Worked closely with 3 professors in different departments to write (and be awarded) multidisciplinary grants from the NSF and DARPA which amounted to over $520,000
- 2019 - Podcast Manager, the Energy Impact Center, Washington, DC
  - Recruited and managed a team of 3 audio/video engineers to produce and release 1-2 podcasts per week
  - Hosted the podcast and interviewed over 15 experts in the nuclear field over 6 months in the US, Canada and France

Publications/Presentations

- Senehi, N.; Adeleye, A.: A mass balance on per- and polyfluoroalkyl substances (PFAS) in wastewater treatment plants on a global scale. *In preparation 2023.*
- Alli,Y.; Oladoye, P.; Matebese, F.; Senehi, N.; Alimi, O.; Ogunlaja, A.; Abdi, F.; Anuar, H.; Adeleye, A.; Philippot, K. Step-scheme photocatalysts: Promising hybrid nanomaterials for optimum conversion of CO_2, Nano Today, Volume 53, 2023, 102006, ISSN 1748-0132.

- Huang, P.C., Zhou, Y., Porter, E.B., Saxena, R.G., Gomez, A., Ykema, M., Senehi, N.L., Lee, D., Tseng, C.P., Alvarez, P.J. and Tao, Y.J. Organic Electrochemical Transistors functionalized with Protein Minibinders for Sensitive and Specific Detection of SARS‐CoV‐2. *Advanced Materials Interfaces*. 2023 *(continued on next page)*
- Senehi, N.; Ykema, J.; Sun, R.; Verduzco, R.; Stadler, L.; Tao, Y.; Alvarez, P.; Protein-imprinted particles for coronavirus capture from solution. Journal of Separation Science. 2022, 45, 4318–4326.
- Cheng, Y.; Lu, J.; Fu, S.; Wang, S.; Senehi, N.; Yuan, Q. Enhanced propagation of intracellular and extracellular antibiotic resistance genes in municipal wastewater by microplastics. Environ. Pollut. 2022, 292, 118284.
- Senehi, N.L.; Zenobio, J.E.; Salawu, O.A; Han, Z.; Adeyemi, A.S. “Global trends in contributions and compositions of PFAS in wastewater by discharger type.” The Association of Environmental Engineering and Science Professors Conference, June 28-30, 2022, St. Louis, MO, USA.
- Senehi, N.L.; Tao, Y.Z.; Alvarez, P.J.J; “RAPID: Molecular Imprinting of Coronavirus Attachment Factors to Enhance Disinfection by a Selective Photocatalytic "Trap-and-Zap" Approach.” COVID Information Commons Webinar, February 22, 2022, Columbia University.
- He, Y.; Yuan, Q.; Mathieu, J.; Stadler, L.; Senehi, N.; Sun, R.; Alvarez, P. J. J. Antibiotic resistance genes from livestock waste: occurrence, dissemination, and treatment. npj Clean Water 2020, 3 (1), 1–11.

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