DRAFT

SIDESTREAM TREATMENT EVALUATION

Technical Memorandum

BLACK & VEATCH PROJECT NO. 422040

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1.0 Executive Summary

The Victor Valley Wastewater Reclamation Authority (VVWRA) currently treats high-ammonium sidestream filtrate—generated from thickening of anaerobically digested solids—using an energy- and chemical-intensive ammonia stripping process. This filtrate contributes approximately 30% of the total nitrogen load to the facility, posing a significant challenge to meeting nitrogen discharge limits and stressing the mainstream biological nutrient removal (BNR) process, which experiences periodic spikes in effluent ammonia. The facility also receives nitrogen-rich organic waste from Anaergia, with deepens VVWRA's challenge of meeting effluent permit requirements.

To address these challenges, VVWRA initiated a project to evaluate alternative sidestream nitrogen removal technologies that would:

- Reduce energy and chemical usage,
- Improve nitrogen removal reliability, and
- Integrate with existing infrastructure.

Black & Veatch conducted a comprehensive technology screening and conceptual evaluation. The study focused on biological deammonification using anammox-based processes, which offer reduced operational costs and lower sludge production compared to nitrification-denitrification in the mainstream BNR process. Two leading technologies were shortlisted for further evaluation:

- World Water Works' DEMON® (suspended growth anammox), and
- Veolia's ANITA™Mox (biofilm anammox in a moving bed biofilm reactor).

Both systems demonstrated compatibility with VVWRA's existing clarifier infrastructure and met the target of at least 60% sidestream nitrogen removal. Conceptual designs were developed for current and future loading scenarios, including anticipated upgrades to the digestate thickening process (e.g. belt filter press).

Key findings include:

- Both technologies can be phased using existing tanks, with one tank for immediate retrofit, one for future expansion, and one for flow equalization.
- DEMON® offers lower aeration energy requirements but is more sensitive to solids variability.
- ANITA™Mox is more resilient to influent fluctuations but requires higher aeration energy.
- Engineering capital costs for both systems are comparable, with Class 5 all-in project cost estimates ranging from $9.4M to $20M, depending on final design and implementation scope.
- The evaluation supports moving forward with preliminary design and vendor pre-selection, with further consideration of filtrate temperature management and planned thickening upgrades.

The purpose of this memorandum is to discuss findings to support technology selection, design, and implementation of an improved sidestream nitrogen removal system at VVWRA.

2.0 Introduction

The Victor Valley Wastewater Reclamation Authority (VVWRA) is undertaking a strategic upgrade to its sidestream treatment process to address operational inefficiencies and regulatory challenges. Currently, filtrate generated from thickening of anaerobically digested solids is treated in an underperforming ammonia stripping process. This approach has proven inconsistent in nitrogen removal performance and imposes a significant burden on the mainstream biological nutrient removal (BNR) system's nitrification capacity. Compounding this issue is the nitrogen-rich feedstock (ADM) from Anaergia, which has necessitated a cap on ADM loading to avoid exceeding effluent nitrogen limits. In response, VVWRA initiated a comprehensive screening and evaluation of alternative sidestream nitrogen removal technologies with the goal of improving treatment reliability, reducing operational costs, and enabling increased capacity to receive ADM.

2.1 Facility Overview

VVWRA currently operates 3 aeration basin trains in parallel, and all basins are typically in operation. Solids are separated in 4 secondary clarifiers (with one spare). Waste activated and primary sludge are thickened in separate dissolved air flotation units and anaerobically digested in five digesters. Digestate is stored in an open lagoon for approximately 10 days before thickening in a gravity belt thickener. Thickened digestate is pumped to solar drying beds. Filtrate generated from thickening is currently treated in 3 former secondary clarifiers, which have been retrofit with aeration systems and operated to strip ammoniaca-nitrogen. VVWRA plans to decommission these reactors and retrofit a sidestream treatment process that uses less chemical and less energy for reliable nitrogen removal from the sidestream flow. This will reduce the overall nitrogen loading in the mainstream activated sludge process, extending their treatment capacity for biological nutrient removal. The process flow diagram (Figure 1) includes the processes listed above, as well as the detailed flow of VVWRA.

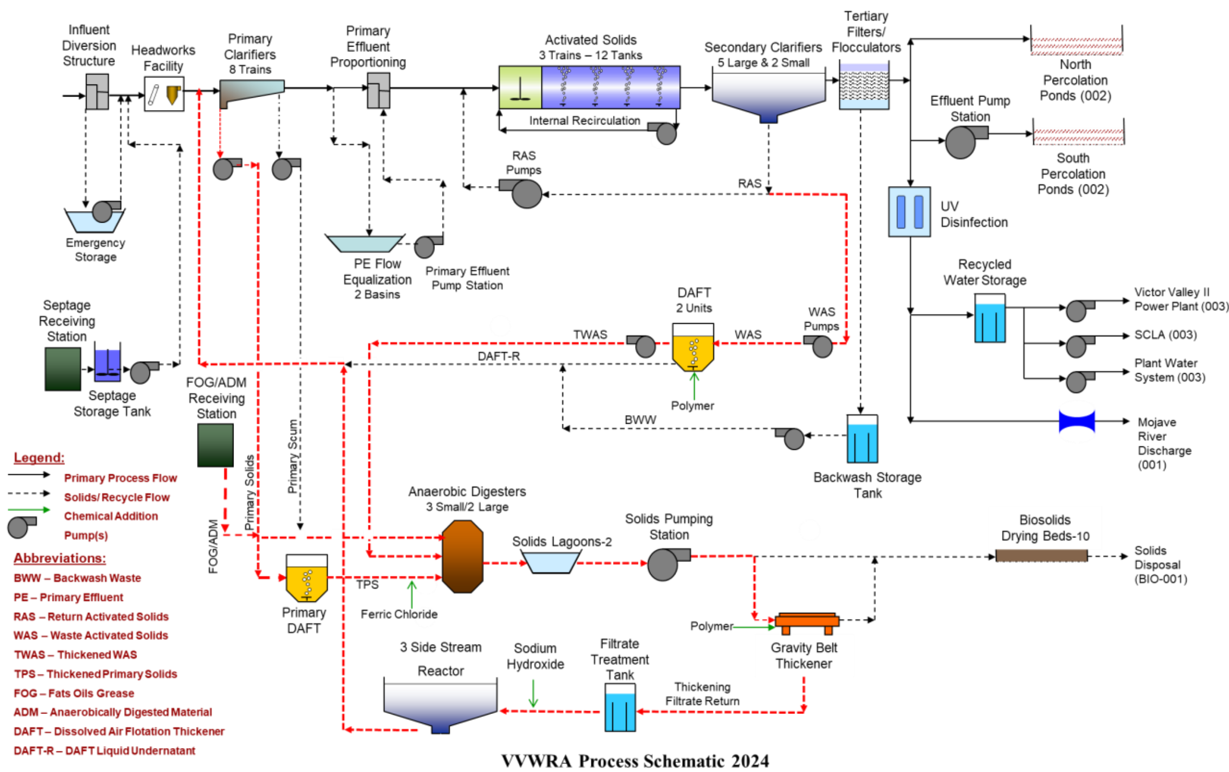

Figure 1. Process flow diagram at VVWRA. Bold red lines indicate solids/recycle flows assessed in this document.

2.2 Existing Thickening Operations

The conversion of particulate organic nitrogen to soluble ammonium is a natural byproduct of anaerobic digestion, and as a result, high-ammonium filtrate is generated through the biosolids thickening process. VVWRA operates a gravity belt thickener (GBT) approximately 15 hours per day, 5 days per week. The GBT has a rated capacity of 600,000 gpd. Thickened solids from the GBT are conveyed to solar drying beds, while the filtrate from the thickener is pH adjusted with sodium hydroxide and processed in the sidestream stripping reactor.

2.3 Existing Sidestream Treatment

VVWRA operates three reactors, each with a volume of approximately 220,000 gallons, for sidestream ammonia stripping. The reactors are secondary clarifiers (55-ft diameter) retrofitted with fine-bubble disc diffusers at the bottom of each tank. Some disc diffusers have been removed from the aeration grid to produce large volumes of coarse bubbles and promote mixing. The reactors are operated sequentially in batch mode. During GBT operation, one reactor is filled, while a second is aerated in react mode for up to 24 hours. The third reactor is pumped to the headworks of the facility beginning the midnight before the next GBT startup. Preliminary data from samples collected by VVWRA and analyzed by Black & Veatch are shown in Table 1Table . During this limited sampling period, sidestream filtrate contained approximately 675 mg/L as N of ammoniacal-nitrogen. The alkalinity to ammonium ratio was consistently above 4, which is desirable for biological treatment alternatives.

Table 1. Gravity belt thickener filtrate analysis

Date	*NHx-N (mg/L N)	*Alkalinity (mg/L CaCO3)	TSS (mg/L)	tCOD (mg/L)	*sCOD (mg/L)
2/17/2025	698	2,805	1,045	1,619	661
2/18/2025	571	2,300	850	1,274	516
2/23/2025	700	2,985	1,020	1,422	620
2/24/2025	699	2,940	660	1,114	636
2/25/2025	669	2,980	1,010	1,670	638
2/26/2025	660	2,950	695	1,329	568
2/27/2025	668	2,945	700	1,403	668
2/28/2025	666	2,980	805	1,464	551
3/3/2025	673	3,015	795	1,526	615
3/4/2025	691	2,855	842	1,376	636
3/5/2025	684	2,915	820	1,307	610
3/6/2025	694	2,905	816	1,420	591
3/7/2025	696	2,970	794	1,332	610
Average	675	2,888	800	1,404	609

All samples collected by VVWRA Staff on date specified and analyzed by Black & Veatch in Walnut Creek, CA.
*Samples filtered through a 0.45µm filter

3.0 Basis of Design

A basis of design was developed at the planning level to provide estimates of flows and nitrogen loads from the solids handling process (Figure 1). The solids and recycle flows considered were the primary sludge (PS), waste activated sludge (WAS), and screened food waste collected and fed by Anaergia (FOG/ADM). Planning scenarios were developed based on current conditions for a permitted average dry weather flow of 14 MGD, the maximum plant secondary capacity of 18 MGD, and maximum ADM loading (as defined by Anaergia). An anticipated digestate dewatering upgrade from the existing GBT (filtrate) to a process producing higher solids concentrations, such as a belt filter press (pressate), was also included to estimate future flows and loads for planning purposes.

Flows and loads were estimated using plant data, analysis of filtrate characteristics performed by BV in February 2025, and process modeling in SUMO. Based on discussions with VVWRA, filtrate flow estimates were adjusted to include wash water from the GBT, which adds approximately 30% to the base filtrate flow. This change impacts the flows associated with the GBT but does not impact the digestate dewatering upgrade since wash water was assumed to be piped separately from pressate. The model approach and outputs were corroborated with WEST model outputs from a capacity optimization study performed by DHI which evaluated existing treatment capacity of the whole plant. A summary of the basis of design flows and loads is in Table 2. The basis of design letter (Appendix A), filtrate sample characteristics, and summary of the process modeling approach (Appendix B) are attached. The sidestream ammonium concentration was set at a design maximum of 1000 mg/L as N based on commitments by Anaergia to balance ADM feeding to the digesters to remain below this effluent concentration.

Table 2. Basis of design flows and loads

Location	Unit	Scenario 1	Scenario 2	Scenario 3	Scenario 4
		Current conditions	Current conditions + Anaergia max load	18 MGD + Anaergia current load	18 MGD + Anaergia max load
Gravity belt thickener filtrate (5 days per week) – A					
Flow	MGD**	0.15	0.17	0.22	0.25
TSS	mg/L	1000	1000	1000	1000
Ammonium concentration	mg/L as N	600	1000	600	1000
Ammonium load	ppd N	751	1420	1094	2046
Digestate dewatering upgrade pressate (5 days per week) - B					
Flow	MGD**	0.18	0.21	0.27	0.31
Ammonium concentration	mg/L as N	600	1000	600	1000
Ammonium load	ppd N	904	1787	1372	2568

The SUMO process model was also used to identify the minimum nitrogen removal needed in the sidestream to maintain mainstream effluent permit limits. As shown in Figure 2, VVWRA needs a minimum of 40% sidestream nitrogen removal to reliably meet permit limits. To provide a buffer and reduce risk of exceedances, a sidestream removal target of 60% was chosen as the minimum treatment goal for the technology screening.

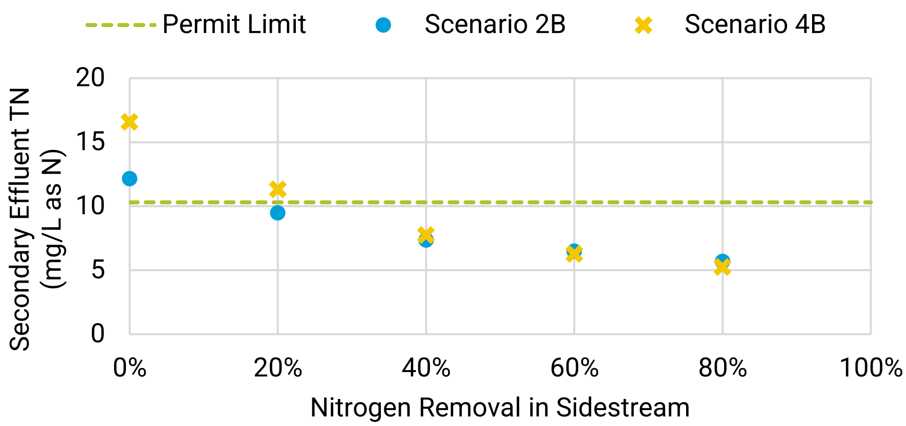

Figure 2. Modeling results for secondary effluent to guide sidestream removal goals.

4.0 Technology Screening

BV developed a list of both established and innovative technologies for sidestream nitrogen removal based on compatibility with the planning-level flows and loads. BV hosted a workshop with VVWRA on March 13, 2025 to present these options and shortlist technologies for further evaluation and vendor proposals. Technologies considered at the screening stage were conventional nitrification denitrification- (NDN), anammox-based bioprocesses, post-aerobic digestion, and stripping. A brief summary of each technology is provided in the following sections. Based on the key process goals identified by VVWRA (Table 3), anammox-based technologies were selected for further evaluation.

Table 3. Summary of initial technology screening results.

Goal	Ammonia Stripping	Conventional NDN	Post-Aerobic Digestion	Suspended Growth Anammox	Biofilm Anammox
Meet N-Removal Requirements for Mainstream BNR	Yes	Yes	Yes	Yes	Yes
Multiple Established / Operating US Municipal Installations	No	Yes	Yes	Yes	Yes
Utilizes Existing Tankage	No	Yes	Yes	Yes	Yes
Accommodative within existing tankage of increased WWTP & ADM flows & thickening upgrades	No	No	No	Yes	Yes
Minimal/Elimination of Chemicals	No	No	No	Yes	Yes
Lowest CapEx & OpEx	No	No	No	Yes	Yes

4.1 Conventional nitrification-denitrification (NDN)

Conventional, or two-step, nitrification-denitrification was proposed as an option in previous reports to VVWRA. NDN is a vetted, well-understood process that is an effective method of biologically converting ammonium to nitrate (nitrification) and nitrate to nitrogen gas (denitrification) (Figure 3). Nitrification is an aerobic autotrophic process, so aeration is required but no carbon is consumed. Conventional denitrification requires a separate anoxic zone with available carbon to convert nitrate to nitrogen gas. Conceptually, construction of a new NDN treatment train specifically to treat high-strength filtrate/pressate was evaluated. Key points of the NDN treatment system include:

- Operationally complex by requiring a RAS loop, wasting strategy, and aeration upgrades.
- Buildout conditions would require additional tank volume and the reconversion of existing reactors back to secondary clarifiers, or construction of an alternative solids separation system, such as MBR, resulting in high capital costs.
- High potential chemical costs for supplemental carbon to remove nitrate, and alkalinity to fully nitrify.
- Higher sludge production than competing options.
- Able to achieve high (>99%) removal rates for nitrogen, given sufficient alkalinity and carbon.

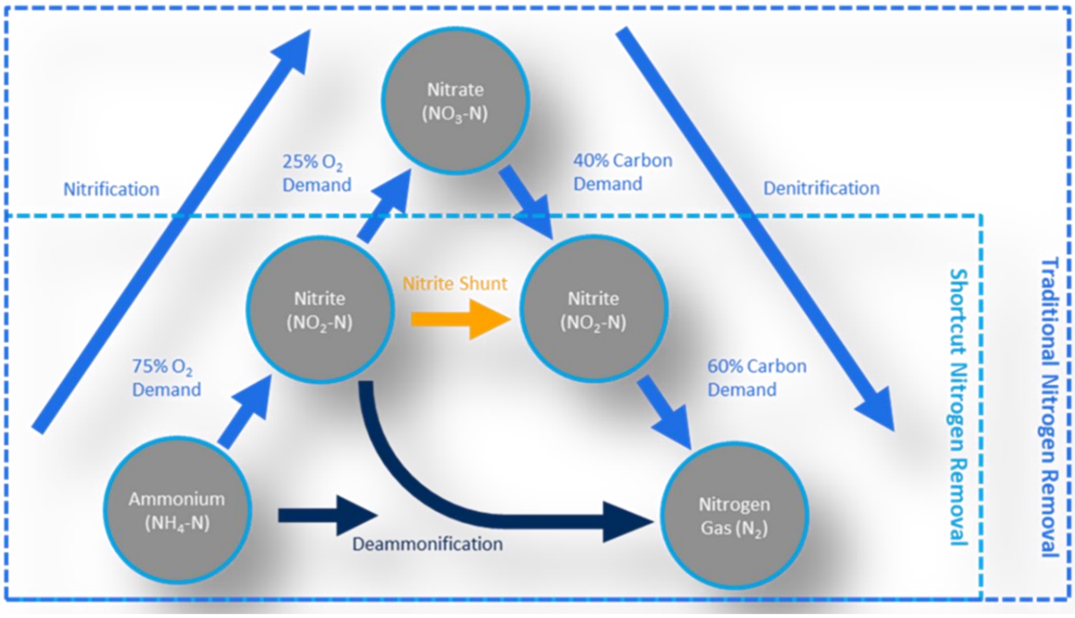

Figure 3. Biological processes for nitrogen removal, including NDN and deammonification or sidestream anammox.

4.2 Sidestream Anammox / Deammonification

Anammox, or anaerobic ammonium oxidation, is a biological process in which microorganisms convert ammonium and nitrite to nitrogen gas, bypassing complete nitrification to nitrate and denitrification. Approximately 40% of ammonium is partially oxidized to nitrite concurrently with anammox in a single-stage reactor. Avoiding nitrite oxidation and conventional denitrification reduces aeration and chemical requirements (carbon and alkalinity), and reduces sludge production, compared to conventional nitrification-denitrification (Figure 3). Anammox processes use fixed biofilms or suspended granules with selective wasting to retain anammox organisms in the process, which each have benefits and drawbacks. Anammox processes require significantly smaller footprints than conventional NDN due to high ammonium loading rates to the process. However, total nitrogen removal rates for anammox processes are generally limited to approximately 80%.

4.2.1 Biofilm Anammox

Biofilm anammox processes retain anammox organisms on biofilm carriers within a moving bed biofilm reactor (MBBR). Carriers are made of HDPE with a high surface area per unit volume and are retained in the reactor using coarse effluent screens. Seeded carriers are typically provided by the vendor during start up, representing around 10% of the total media supplied to the facility. Additional media can be added after startup to increase the biomass fraction in the reactor. Some MBBR installations have been in service for over 20 years without carrier replacement. Commercialized biofilm-based anammox processes include ANITA™Mox (Veolia Water Technologies) and DEANA (World Water Works). Key points of these anammox systems include:

- Greater aeration/mixing energy requirements than suspended growth anammox.
- Biomass can be retained through coarse screens while suspended growth is wasted.
- Typically, more resilient to high influent solid concentrations and shock loads compared to suspended growth anammox.

An integrated fixed-film activated sludge (IFAS) anammox configuration is also available, which uses a combination of biofilm carriers and suspended sludge inventory retained using a RAS recycle, though this configuration is generally only applied to installations with specific challenges such as high concentrations or upstream thermal hydrolysis. Since the IFAS configuration requires use of a clarifier, or construction of an integrated settling zone and return line, is more sensitive to solids slugs, and requires lower loading rates than the MBBR configuration, the IFAS configuration was eliminated from consideration for this project.

4.2.2 Suspended Growth Anammox

Suspended growth or granular anammox processes retain anammox organisms in dense biomass granules through screening and selective wasting. The most common biomass retention strategies use parabolic screens or plate settlers. Formerly, hydrocyclones were commonly used for retention. Seed biomass is provided by the vendor during start up. Commercialized suspended growth anammox processes include DEMON® (World Water Works) and AnammoPAQ™ (licensed to Ovivo in North America by Paques). Key points of suspended growth anammox include:

- More efficient aeration than biofilm-based anammox
- Requires a biomass separation unit to retain granules
- More sensitive to influent solids and shock loads than biofilm anammox

4.3 Post-Aerobic Digestion (PAD)

PAD is an aerated biological process designed to reduce volatile solids and total nitrogen of digestate immediately after anaerobic digestion and prior to thickening. PAD removes total nitrogen by providing sufficient aeration for nitrification to occur in the aerobic digester. High oxygen uptake rates and endogenous decay result in a high-carbon, low-oxygen environment that may facilitate simultaneous denitrification in the PAD reactor. DigestivorePAD™ (Ovivo) is a commercialized PAD process. Key points of PAD systems include:

- Processes digestate before thickening
- Requires solids loop back to anaerobic digester
- Reduces solids volume due to increased volatile solids destruction

- Requires careful heat management and more alkalinity than anammox processes to achieve equivalent ammonia removal rates
- Significantly more tankage and residence time required than anammox

4.4 Ammonia stripping

Ammonia stripping is a physicochemical process designed to remove ammonia in solution as a gas. VVWRA currently uses ammonia stripping for sidestream treatment in retrofit clarifiers. ByoFlex® (Byosis) is a commercialized ammonia stripping system that also produces a fertilizer product (ammonium sulfate). Key aspects of ammonia stripping systems include:

- Higher heat or chemical and aeration requirements
- Production of a recovered ammonium product
- Package systems that are often automated

4.5 Screening Summary

During the initial technology screening workshop dated 03/13/25, results of the alternatives analysis (summarized in Table 3) led BV and VVWRA to select biological deammonification via anammox (Section 4.2) for further evaluation and conceptual design proposals from vendors.

5.0 Evaluation of Deammonification Technologies

Three established vendors (Veolia, World Water Works, and Ovivo) were contacted with a request for conceptual design proposals and budgetary cost estimates for anammox-based deammonification, using both current and future flows and loads of thickening filtrate. Vendors were requested to evaluate whether the process could be retrofit into the existing clarifier tankage at current flows and loads as well as maximum buildout conditions. Ovivo declined to submit a proposed design for AnammoPAQ.

5.1 Preliminary Design Criteria

Preliminary design criteria sent to vendors were developed using the basis of design estimates (Section 3.0) and discussions with VVWRA concerning current and future load estimates. Preliminary design criteria shared with Veolia, World Water Works, and Ovivo are shown below. Vendors were advised to consider Phase 1 and 2 for immediate design and implementation, and Phase 3 for long-term feasibility and implementation. Phase 1 considers Anaergia's commitment to balance ADM feeding to the digesters to achieve a sidestream ammonium concentration < 1000 mg/L as N, rather than observed nitrogen concentrations. This would allow for increased ADM nitrogen loading under the proposed treatment scenario. In material sent to vendors, the Phase 1 flow did not include the GBT wash water, which would increase the projected flow from 0.13 MGD to 0.17 MGD. The impact of this discrepancy is discussed at the end of this section. Vendors were asked to provide a minimum design temperature.

Table 4. Summary of design criteria provided to vendors for current, digestate thickening upgrades, and capacity buildout.

		Phase 1	Phase 2	Phase 3
Parameter	Unit	Current Conditions	Thickening Upgrades	Capacity Buildout
Flow*	MGD*	0.13	0.21	0.31
TSS	mg/L	500 – 1,000	500 – 1,000	500 – 1,000

Ammonium concentration	mg/L as N	1,000	1,000	1,000
Average N load	ppd N	1,085	1,750	2,585
Maximum Design load	ppd N	1,100	2,000	3,000
Alkalinity to ammonium ratio	mg $CaCO_3$/ mg N	4.3	4.3	4.3
Available Alkalinity**	ppd $CaCO_3$	4,400	7,000	10,000
pH	-	7.5	7.5	7.5
Temperature	°C	Please provide design limits.		
Total COD	mgCOD/L	1,400	1,400	1,400
Soluble COD	mgCOD/L	600	600	600

** Volume processed per day during the 5 days of digestate thickening (weekly average flow is proportionately lower)*
*** Available alkalinity includes a residual of at least 200 mg$CaCO_3$/L back to the mainstream*

For each loading scenario in Table 4, vendors were requested to provide a conceptual design and budgetary proposal with the following information:

1. Structural Upgrades
2. Process Design/Upgrades (pretreatment, mixers, aeration, blowers)
3. Components proprietary to manufacturer for deammonification and retention of anammox to include items such as sieves, media, chemical dosing
4. Internal pump systems, such as RAS/WAS pumps, recirculation within the system, etc.
5. Controls and instrumentation
6. System operation including design loading rates, temperature and airflow requirements
7. Documentation of performance guarantee and layout, and example control P&IDs
8. Provision of seed biomass
9. Budgetary cost estimate, including all equipment, installation, commission support, licensing, and guarantees with minimum 20 days of onsite technical support, 1 year warranty following start up, and anticipated lead times
10. Project references and experience

Vendor proposals are attached in the Appendix.

5.2 WWW DEMON®

World Water Works provided a conceptual design proposal for the DEMON suspended growth anammox process. A summary of their proposal is provided in Table 5. Key aspects of the proposal are summarized below:

- Compatibility with existing tankage
  - Volume: WWW recommends using one existing clarifier for Phases 1 and 2, bringing a second online for Phase 3, and using the third for flow equalization to provide consistent feed.
  - Key process equipment: WWW recommends installation of Messner panels for aeration, integrated settler for biomass retention, side-mounted mixers, PLC, and sensors.
    - Sensor package includes radar level sensor, DO probe, pH probe, conductivity probe, airflow meter, flow meter (per reactor)

  - Existing clarifier internals: WWW recommends removal of clarifier internals.

- Start-up
  - Reactor seed: Seed sludge is sourced from within the US.
  - Support: WWW will provide inspection, startup, and training services as well as offsite monitoring for 3-4 months.
- Operational considerations
  - Temperature: Recommended minimum operating temperature of 25°C
  - Flow: Converting the sidestream treatment system from batch operation to continuous flow is recommended, using one existing clarifier for flow equalization, and providing consistent feed independent of the digestate thickening schedule. Note that the equalization tank (retrofitted clarifier) can also be used for pre-settling but will need to be de-sludged periodically.
  - Influent solids: WWW recommends solids loading below 750 mg/L TSS and to limit higher influent solids to less than 1 day of peak loading at a time. If influent solids are higher than 750 mg/L consistently, WWW recommends pretreatment (e.x. pre-settling) to remove solids prior to the anammox reactor.
  - Maintenance: The Messner aeration panels require periodic pressure washing and acetic acid cleaning to remove build-up. During these maintenance events, the reactor would need to be emptied and anammox biomass would need to be transferred to another basin or storage area temporarily.
- Budget estimate (detailed further in Section 6.0)
  - Phase 1 and 2: $1,850,000
  - Phase 3 (additional equipment only): $1,400,000

Table 5. World Water Works proposal details for DEMON®

		Phase 1	Phase 2	Phase 3
Parameter	Unit	Current Conditions	Thickening Upgrades	Capacity Buildout
Flow	MGD	0.13	0.21	0.31
Tanks in Service	tanks	1	1	2
Maximum Design load	ppd N	1,100	2,000	3,000
Ammonium Removal	%	90	80	78
TIN Removal	%	80	71	69
Max. Ammonium Load in Effluent	ppd N	110	400	660
Max. Ammonium Concentration in Effluent	mg/L as N	101	228	255
Process Airflow Requirement	SCFM	691	1116	818

5.3 Veolia ANITA™Mox

Veolia provided a conceptual design proposal for the ANITA™Mox biofilm MBBR anammox process. A summary of their proposal is provided in Table 6. Key aspects of the proposal include:

- Compatibility with existing tankage
  - Volume: Veolia recommends using one existing clarifier for Phases 1 and 2, bringing a second online for Phase 3, and using the third for flow equalization to provide consistent feed.
  - Key process equipment: ANITA™Mox will require installation of medium bubble diffusers (perforated steel pipe), carrier media retention screens, mixer, PLC, and sensors.
    - Sensor package includes influent ammonia analyzer (EQ tank); high level float switch, DO probe, pH probe, airflow meter, flow meter, nitrate probe, effluent ammonia analyzer (per reactor)
  - Existing clarifier internals: Veolia recommends removal of existing internals.
- Start-up
  - Reactor seed: Biofilm carriers with anammox biomass will be sourced within the US.
  - Support: Veolia will provide inspection, startup, and training services.
- Operational considerations
  - Temperature: Recommended operating temperatures between 25-35°C, with optimal temperature of 30°C.
  - Flow: Conversion of the sidestream treatment system from batch operation to continuous flow and use of one existing clarifier as EQ to provide more consistent feeding independent of the digestate thickening schedule.
  - TSS: Veolia recommends influent solids concentrations below 1000 mg/L. Reactor performance could be impeded with consistent loading above 1500 mg/L TSS or short-term loadings above 10,000 mg/L TSS. Veolia recommends pretreatment (ex. settling) if influent solids are consistently higher than 1500 mg/L. Again, the equalization tank can be used for pre-settling with appropriate accommodations for sludge removal.
  - Maintenance: The diffusers do not require routine physical or chemical cleaning.
- Budget estimate (detailed further in Chapter 6)
  - Phase 1 and 2: $1,885,000
  - Phase 3 (additional equipment only): $1,352,000
  - Scope attachment

Table 6. Veolia Water Technologies Proposal details for ANITA™Mox

		Phase 1	Phase 2	Phase 3
Parameter	Unit	Current Conditions	Thickening Upgrades	Capacity Buildout
Flow	MGD	0.13	0.21	0.31
Tanks in Service	tanks	1	1	2
Carrier Fill	%	54	54	39

Media Volume	ft^3	17,690	17,690	25,847
Maximum Design load	ppd N	1,100	2,000	3,000
Ammonium Removal	%	80	80	80
TIN Removal	%	70	70	70
Max Ammonium Load in Effluent	ppd N	220	400	600
Max Ammonium Concentration in Effluent	mg/L as N	203	228	232
Process Airflow Requirement	SCFM	1400	2300	3400

5.4 Impact of current filtrate flow conditions

As noted above, initial filtrate estimates did not include wash water, which contributes an additional ~30% to the base filtrate flow. Based on this contribution, the revised filtrate flow estimate for Phase 1 (current conditions + maximum Anaergia loading) is 0.17 MGD. The flow rate and average ammonium loading are below the original Phase 2 estimate, which assumed a dewatering upgrade to a belt filter press and separate piping for wash water. Based on this comparison, there is no anticipated change to the staging or treatment capacity proposed for DEMON® or ANITA™Mox, where one clarifier is immediately used as an anammox reactor for Phases 1 and 2, and another is reserved for plant buildout.

Concerning solids, the solids estimates provided in the initial filtrate estimates are still relevant with the additional wash water assumption. Based on filtrate samples collected in February and March 2025 (Table 1), a GBT filtrate TSS range of 500-1000 mg/L was provided to vendors. VVWRA staff noted that filtrate TSS is typically around 500 mg/L and was elevated over the sampling period due to a polymer batch issue. Assuming the wash water has minimal solids, the anticipated TSS without the dilution of wash water would be 700-800 mg/L, which is well-within the range provided to vendors.

Table 7. Comparison of original and revised flow estimates.

		Phase 1	Phase 1	Phase 2
Parameter	Unit	Original estimate	Revised flows	Original estimate
Flow	MGD	0.13	0.17	0.21
Ammonium concentration	mg/L as N	1,000	1,000	1,000
Average N load	ppd N	1,085	1,420	1,750
TSS	mg/L	500 – 1,000	500 – 1,000	500 – 1,000

6.0 Cost Evaluation

Based on the concept and criteria detailed in this report, an Opinion of Probable Construction Cost (OPCC) Class 5 estimate was prepared to estimate the cost to implement anammox-based deammonification sidestream treatment. The OPCC includes an estimated range of construction costs, construction contingency, construction management costs, Engineering Design Fees, Engineering Services during construction, and administration costs to allow VVWRA to plan and budget for the project. A summary of the cost is included presented in Table 8 with the anticipated range of costs presented in Table 9.

The following subsections provide additional detail on the vendor basis as well as discussion on the work and facilities included in the OPCC.

Table 8. Class 5 OPCC Base Cost

Item	Cost Factor	Cost
Construction Costs		
Demolition and Temporary Systems		$150,000
Blower Building (including Electrical Room)		$750,000
Process Mechanical		$3,580,000
Veolia - ANITA™Mox		$3,000,000
Interconnection Piping and Valves		$200,000
Boiler System		$380,000
Electrical Allowances	20 % of Process Mechanical	$716,000
I&C Allowances	10 % of Process Mechanical	$358,000
Civil Allowances	5 % of Process Mechanical	$179,000
Construction Subtotal		$5,733,000
Contingency	30% of Construction Cost	$1,720,000
Contractor General Conditions, OH&P, Subcontractor Markups, Bonds & Insurance, Escalation, etc.	50% of Construction Cost	$2,870,000
Construction Total		$10,400,000
Soft Costs (Engineering Design, Construction Management, Engineering Services During Construction, Administration)		$2,810,000
Total "All In" Project Cost		$13,300,000

Table 9. Anticipated “All-in” Cost Range Based on Class 5 OPCC

Base Cost -30%	Base Cost	Base Cost +50%
$9,400,000	$13,300,000	$20,000,000

6.1 Vendor Cost Basis

Table 10 below summarizes the two cost proposals received for anammox-based deammonification treatment systems. During this study, a preferred vendor was not identified, and both options may be considered during preliminary design. To provide VVWRA with a conservative cost, the OPCC is based on the slightly higher cost proposal received from Veolia. Note that the vendor proposals do not include labor to install equipment.

Table 10. Vendor Cost Comparison

Supplier	Cost Information
Veolia	$1,885,000
World Water Works	$1,850,000

6.2 Ancillary Facilities Cost Information

To implement the anammox-based deammonification sidestream treatment, vendor supplied equipment will be installed in the existing clarifiers. It is assumed that the existing clarifiers are structurally sound and do not require civil upgrades and/or structural retrofit in order to operate as reactor tanks. However, additional improvements will be required in addition to the new treatment process. To develop a complete budgetary estimate, additional facilities and equipment were incorporated to the cost estimate as detailed in Table 11 below.

Table 11. Ancillary Facilities Details

Item	Description	Cost Assumptions
Blower Building	A detailed review of the blower system for the existing sidestream treatment process was not completed for this evaluation. This estimate includes the construction of a new blower building to house two blowers as well as well as electrical and controls equipment. Blower building requirements, including the use of existing facilities, can be evaluated during future phases of work.	• 1,000 square feet • $750/square foot
Boiler System	Both anammox process suppliers recommend average operating temperatures of 25°C or higher. Digested sludge is currently stored in open lagoons for up to 10 days prior to digestate thickening at the GBT. Due to the storage time in the lagoon, filtrate is anticipated to have temperatures less than 25°C during much of the year. A boiler system is included in the OPCC to account for the need to heat filtrate prior to treatment. Evaluation of heat management, including digestate storage and routing, may identify solutions that could eliminate the need for a boiler. This can be evaluated during future phases of work.	Boiler system includes budgetary quotes for the following items: • One boiler • One heat exchanger • Two Boiler loop water pumps (duty/standby) • Two Heat exchange loop water pump (duty/standby)

Item	Description	Cost Assumptions
Interconnecting Piping and Valves	To reconfigure the existing liquids stream and connect a new blower system to the anammox processes may require piping and valves not included in the vendors' scopes of services. The OPCC includes an allowance of $200,000 for additional piping and valves.	• $200,000 Allowance
Civil, Electrical, and Instrumentation and Controls (I&C)	Site-Civil, Electrical, and I&C work will be required for implementation of the anammox treatment system. Allowances for each discipline are included as a markup percentage of the Process Mechanical work.	• Civil markup: 5% • Electrical markup: 20% • I&C markup: 10%

7.0 Recommendations

7.1 Summary of Vendor Proposals

The suspended growth (DEMON) and biofilm (ANITA™Mox) anammox processes detailed above will meet the ammonium removal goals set out in the basis of design within the existing clarifier tankage. The vendor proposals also have key similarities for phasing the sidestream treatment and cost. In terms of phasing, both vendors recommend retrofitting one clarifier immediately to be used as a reactor for Phases 1 and 2, reserving one clarifier for full capacity buildout, and using the last clarifier for filtrate flow equalization. Both vendors also have similar cost estimates for their proposals. Due to these similarities, the decision between a biofilm and suspended growth process can be based on other priorities for constructing and operating the process, which are detailed in Table 12.

Table 12. Summary of Process Differences Between DEMON and ANITA™Mox Implementation

Process Differences	Suspended growth (DEMON)	Biofilm (ANITA™Mox)
Influent variability	Can tolerate TSS > 750 mg/L for less than 1 day, otherwise will require solids pretreatment. Higher risk of anammox loss in cases of major solids flow to the reactor.	Does not typically require solids pretreatment. Resilient to fluctuations in influent solids, temperature, and feed. Solids slugs can be "washed" out of the reactor without loss of media biofilm.
OpEx	Lower airflow needed in all phases (fine bubble aeration is more efficient).	More airflow needed in all phases (less efficient aeration system and more mixing energy required).
Maintenance	Routine diffuser maintenance schedule includes physical and chemical cleaning	No diffuser maintenance requirement
Clarifier modifications	Requires removal of clarifier internals and likely pouring a flat bottom or installation of an additional mixer to prevent solids buildup under aeration panels	Requires removal of clarifier internals

7.2 Overall Sidestream Considerations

The sidestream deammonification system can be operated more effectively if other aspects of the treatment process are considered holistically. Other important considerations include:

- Sidestream monitoring: BV recommends more frequent monitoring of sidestream characteristics, including routine measurements of ammoniacal nitrogen, alkalinity, TSS, tCOD, sCOD and temperature of the digestate thickening filtrate. Routine monitoring will also be useful to verify that ADM loads from Anaergia remain within the design criteria.
- Temperature management: Both anammox processes require average temperatures above 25ºC for minimum performance guarantees, and optimally at or above 30ºC for the best performance. As a base case, a boiler and heat exchanger system was considered for increasing the temperature of the GBT filtrate. To reduce energy use and operational complexity/cost, additional study is recommended to develop opportunities for reduction of heat loss from digestate storage lagoons. These potential opportunities could include adjustments to the digestate flow routing or dewatering schedule, subdivision or covering of sludge storage volume, or other process alterations.
- Digestate thickening process upgrade: VVWRA anticipates upgrading the current digestate gravity belt thickener to a belt filter press or similar. This upgrade would change the filtrate quality in terms of flow, solids content, COD, and polymer dose. The polymer dose associated with a belt filter press is estimated to increase the thickening flows by 5-10% depending on the polymer concentration and dosing rate. For example, polymer dosing with a 0.25% polymer solution may increase flow in Phase 3 from 0.31 MGD (Flow in Table 4) to 0.34 MGD. The additional flow from the polymer dose is not expected to impact ammonium removal performance directly. The dewatering upgrade will also provide an opportunity to tailor the dewatering schedule to minimize equalization time in the sludge holding lagoon, and therefore minimize heat loss.

Appendix A. Basis of Design Letter

BLACK & VEATCH

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March 21, 2025

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Kody Tompkins, Director of Operations & Maintenance
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Victorville, CA 92394

SUBJECT: SIDESTREAM TREATMENT TECHNOLOGY EVALUATION BASIS OF DESIGN

This letter summarizes the basis of design for planning sidestream ammonia treatment at Victor Valley Wastewater Reclamation Authority (VVWRA) and provides estimates of flows and nitrogen loads from the solids handling process (Figure 1). The sources of solids/recycle flows of interest for this document are the primary sludge (PS), waste activated sludge (WAS), and food waste from Anaergia (FOG/ADM).

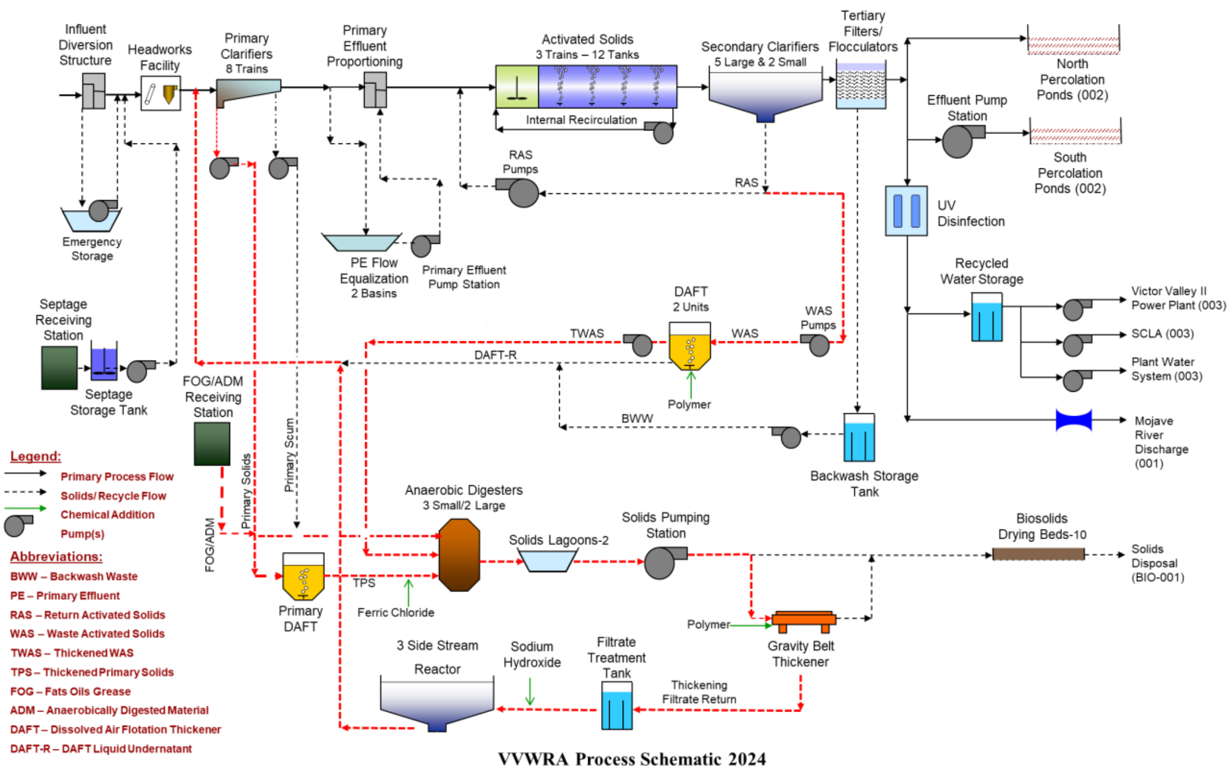

Figure 1. Process flow diagram at VVWRA. Bold red lines indicate solids/recycle flows assessed in this document.

Three primary scenarios for sidestream flows and loads for planning purposes are identified and summarized in Table 1.

Table 1. Flow and load scenarios

Scenario	Plant flow	ADM load	Description
Scenario 1	11.4 MGD	60%	Current conditions
Scenario 2	11.4 MGD	100%	Current conditions + maximum ADM loading
Scenario 3	18 MGD	60%	Plant design capacity + current ADM loading
Scenario 4	18 MGD	100%	Plant design capacity + maximum ADM loading

FLOW AND LOAD ESTIMATES

A summary of the flow and load estimates for the three planning scenarios are shown in Table 2. Flow and load information for Scenarios 1 and 2 are calculated using data provided by VVWRA from 2020-2024 and discussions with Anaergia concerning future loading and feedstocks. Projections for Scenarios 3 and 4 are estimated through analysis of 2020-2024 data, and process modelling of the primary clarifier and secondary treatment process in SUMO (Figure 2). More detailed rationale for each of these estimates is provided in the following sections.

Table 2. Solids and recycle flow and load estimates

Location	Unit	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Influent					
Flow	MGD	11.4	11.4	18	18
BOD	mg/L	320	320	350	350
TSS	mg/L	460	460	500	500
Primary sludge					
*Flow	MGD	0.12	0.12	0.18	0.18
%TS	%	2.7	2.7	2.7	2.7
%VS	%	85.8	85.8	85.8	85.8
TS loading	Lbs/d	26251	26251	40532	40532
Thickened primary sludge (TPS)					
Flow	MGD	0.05	0.05	0.08	0.08
%TS	%	6.4	6.4	6.4	6.4
%VS	%	88.2	88.2	88.2	88.2
TS loading	Lbs/d	29247	29247	45159	45159
Waste activated sludge					
*Flow	MGD	0.28	0.28	0.57	0.57
TSS	mg/L	7300	7300	7300	7300
TS loading	Lbs/d	17008	17008	34703	34703
Thickened waste activated sludge (TWAS)					
Flow	MGD	0.04	0.04	0.09	0.09

%TS	%	4.4	4.4	4.4	4.4
%VS	%	83.6	83.6	83.6	83.6
TS loading	Lbs/d	16336	16336	33332	33332
Facility solids (TPS + TWAS)					
Flow	MGD	0.10	0.10	0.18	0.18
TS loading	Lbs/d	45583	45583	78491	78491
%TS	%	5.5	5.5	5.4	5.4
Anaergia ADM					
Trucks per week	loads/wk	70	110	70	110
Capacity per truckload	gal/load	4800	4800	4800	4800
Flow	MGD	0.048	0.075	0.048	0.075
Digestate (Facility solids + ADM Fed)					
Flow	MGD	0.15	0.17	0.22	0.25
Ammonia concentration	mgN/L	600	1000	600	1000
Ammonia load	Lbs/d	738	1459	1120	2096
%TS	%	2.5	2.5	2.5	2.5
Gravity belt thickener filtrate (5 days per week)					
Flow	MGD**	0.11	0.13	0.17	0.19
TSS	mg/L	1000	1000	1000	1000
Ammonia concentration	mgN/L	600	1000	600	1000
Ammonia load	Lbs/d	554	1096	841	1574
Dewatering upgrade pressate (5 days per week)					
Flow	MGD**	0.18	0.21	0.27	0.31
Ammonia concentration	mgN/L	600	1000	600	1000
Ammonia load	Lbs/d	904	1787	1372	2568

** Values for Scenarios 3 and 4 from Sumo process model*
***Volume processed per day during the 5 days of dewatering (weekly average flow is proportionately lower)*

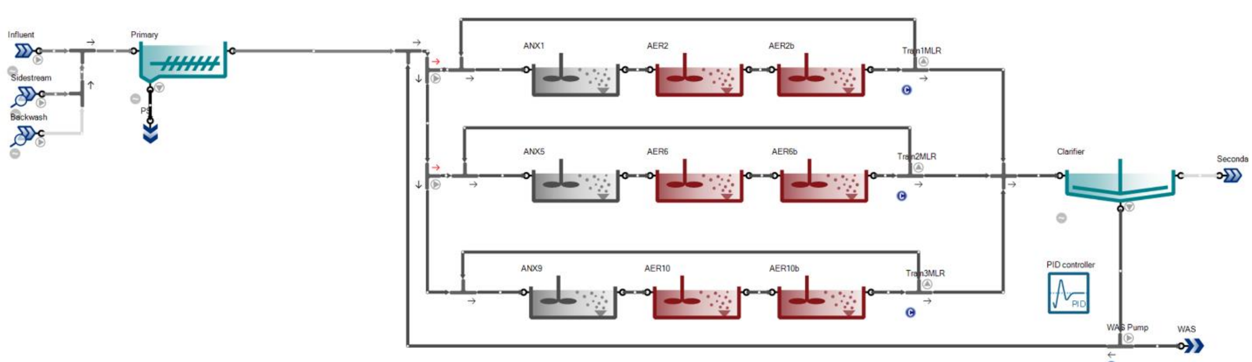

Figure 2. Layout of the SUMO model used to estimate primary sludge and WAS

PRIMARY SLUDGE

Primary sludge generation depends on raw influent flow rates, wastewater characteristics (BOD/COD, TSS), and primary clarifier performance. Typical influent characteristics for Scenarios 1 and 2 presented in Table 2 are estimated from averages of VVWRA raw influent data for 2020-24. Under typical flow and load conditions, the average primary sludge flow is approximately 0.12 MGD based on the 2020-24 data. For Scenarios 3 and 4, where influent flow is at the design maximum of 18 MGD, the following assumptions are used for modeling the scenario in SUMO:

- 75^{th} percentile of influent BOD and TSS in the raw influent (350 mg/L BOD and 500 mg/L TSS) from VVWRA raw influent data from 2020-24.
- 60% TSS removal in the primary clarifiers.

Primary sludge is sent to a dissolved air flotation (DAFT) unit for thickening. DAFT performance has been relatively consistent, and on average has increased total solids (TS) content from 2.7% in the primary sludge to 6.4% in the thickened sludge, with an average volume reduction of 53%. Thickening performance is calculated based on VVWRA data from 2022-24 of the metered thickened primary sludge. For Scenarios 3 and 4, it is assumed that the DAFT thickening performance will remain the same as current conditions and thickened sludge flows will increase linearly.

WASTE ACTIVATED SLUDGE

WAS flows are impacted by primary effluent flow rates and characteristics (BOD/COD, TSS, ammonia) as well as operational parameters such as MLSS and SRT. Under current conditions, the WAS flow is typically 0.28 MGD based on data provided by VVWRA for 2020-24. For Scenarios 3 and 4, where influent flow is at the design maximum of 18 MGD, the following assumptions are used for modeling the scenario in SUMO:

- 75^{th} percentile of influent BOD and TSS in the raw influent and 60% TSS removal in the primary clarifiers (same conditions as the primary sludge simulations)
- WAS concentration consistent with current conditions.
- SRT consistent with current conditions.

WAS is sent to a DAFT unit for thickening. DAFT performance has been consistent, achieving a thickened TS of 4.4%, and an average volume reduction of 84%. Thickening performance was calculated based on VVWRA data from 2022-24 of the metered thickened WAS (TWAS). For Scenarios 3 and 4, it is assumed that the DAFT thickening performance will remain the same as thickened sludge flows increase linearly. Note that VVWRA meters TWAS immediately after the DAFT and before feeding to each digester. The TWAS flows after the DAFT (average value of 0.04 MGD under current conditions) is used for the basis of design rather than the TWAS digester feed flows (0.10 MGD under current conditions) due to better solids balances with the WAS flow.

ANAERGIA ADM

VVWRA is partnered with Anaergia to co-digest FOG and food waste, collectively referred to as the ADM feed. Anaergia loading information is based on VVWRA data from 2022-2024 as well as discussion with Anaergia staff on February 18, 2025. Under current conditions, Anaergia loads are assumed as 60-80 trucks per week, with approximately 4,800 gal per truck. At these conditions, ADM loads from Anaergia are approximately 48,000 GPD. For Scenario 3, Anaergia anticipates increasing to a maximum of 110 trucks per week, resulting in approximately 75,000 GPD.

Anaergia anticipates introducing waste with higher nitrogen content than their current feedstocks at the maximum loading condition. As a result, Anaergia loadings will increase ammonia concentrations in the digestate from 600 mgN/L (current conditions) to 1,000 mgN/L at their maximum loading condition. Anaergia is expected to adjust ratios of feedstock feeing to the digesters to maintain no higher than a 1,000 mgN/L concentration in the digestate.

FACILITY SOLIDS AND DIGESTATE

Facility solids flows and TS loading are calculated by summing the average or predicted TPS and TWAS flows. The %TS changes slightly when influent flows increase to 18 MGD due to a slightly higher ratio of TWAS to TPS compared to current conditions. Digestate flows are calculated by summing the flows from TPS, TWAS, and ADM loading. The digestate %TS for all scenarios is assumed as 2.5% based on discussion with VVWRA. Further verification of the ADM feed %TS or digestate measurements are recommended to validate this number, especially if Anaergia feedstock compositions change over time.

GRAVITY BELT THICKENER AND DEWATERING UPGRADE FLOWS

Gravity belt thickener (GBT) filtrate flows are estimated using the digestate flows, assuming that the GBT is operated 5 days per week with a 54% volume reduction. This volume reduction is calculated based on the average digestate flow (0.15 MGD) and weekly average sludge flows fed to the drying beds from 2023-24 (0.08 MGD). Based on GBT filtrate samples collected in February 2025, typical filtrate TSS was assumed as 1000 mg/L. Currently, VVWRA operates three clarifiers as stripping units which each have a working volume of 0.22 MG. The clarifiers are currently operated as batch reactors, with one unit filling, one unit reacting, and one unit decanting per day. Note that the calculated filtrate flow at current conditions (0.11 MGD) is lower than the maximum expected flow of the batch configuration (0.22 MGD).

The dewatering upgrade pressate flow is calculated assuming a cake %TS of 20%, a higher-end estimate for a typical belt filter press. The higher-end solids estimate is conservative in this case, as it results in a larger volume of pressate and subsequently larger design value for sidestream treatment. Press performance could be adjusted to save on polymer, with no ill effects on downstream sidestream processes given this design basis. Assuming the approximately 2.5% TS content of the digestate, an upgraded dewatering system would provide an 86% volume reduction of the digestate. If no changes were made to the existing sidestream treatment system, the process would be hydraulically limited based on the estimated flows in Scenarios 3 and 4. Note that wash water is not considered in this flow value, meaning that volumetric flows may be higher, though mass loading of nitrogen is not affected by wash water usage. This will not impact sidestream reactor sizing but should be considered when sizing conveyance piping and pumps.

OTHER ASSUMPTIONS

Septage: At the 18 MGD flow projection, we assume that the septage received is the same as the average septage received in 2020-2024 (0.029 MGD). Septage is not anticipated to have a significant impact on these projections due to its relatively small contribution to influent flow (<1% of influent flow at current conditions). If septage receiving increases significantly or the composition changes, this assumption should be verified with special sampling of typical septage characteristics.

Backwash return: We have assumed the backwash return flows from tertiary filtration do not contribute substantial BOD, TSS, or ammonia back to the head of the plant, based on information provided by DHI.

Sincerely,

Phil Giori, P.E.
Project Manager

Appendix B. Process Model Development Letter

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May 23, 2025

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1 Process Model Development for Sidestream Evaluation

A dynamic process model was developed for Victor Valley Wastewater Reclamation Authority (VVWRA) by Black & Veatch (BV) in Dynamita's SUMO v22.1 modeling software. The model was developed for the plant's biological nutrient removal process with the goal of informing sizing and operational design of the new sidestream deammonification treatment process. The nitrification capacity of the secondary process was evaluated for several scenarios, assuming changes to sidestream nitrogen loading that reflect plant buildout flows and increases to the ADM loads received from Anaergia.

This modeling effort is consistent with a "Level 2" model per the Methods for Wastewater Characterization in Activated Sludge Modeling (2003) from the Water Research Foundation. A level 2 modeling effort means that historical data are available for major flows and loads into the process. Model defaults were used for most kinetics and initial influent fractionation, as well as for primary clarifier operation. Model results were used to calculate required process inputs (*e.g.*, chemical alkalinity, aeration energy) to reliably stay below the plant total nitrogen permit limit while minimizing operational costs. The model may be further developed from facility planning (current) to design, construction, and startup/commissioning phases of the project (Figure 1).

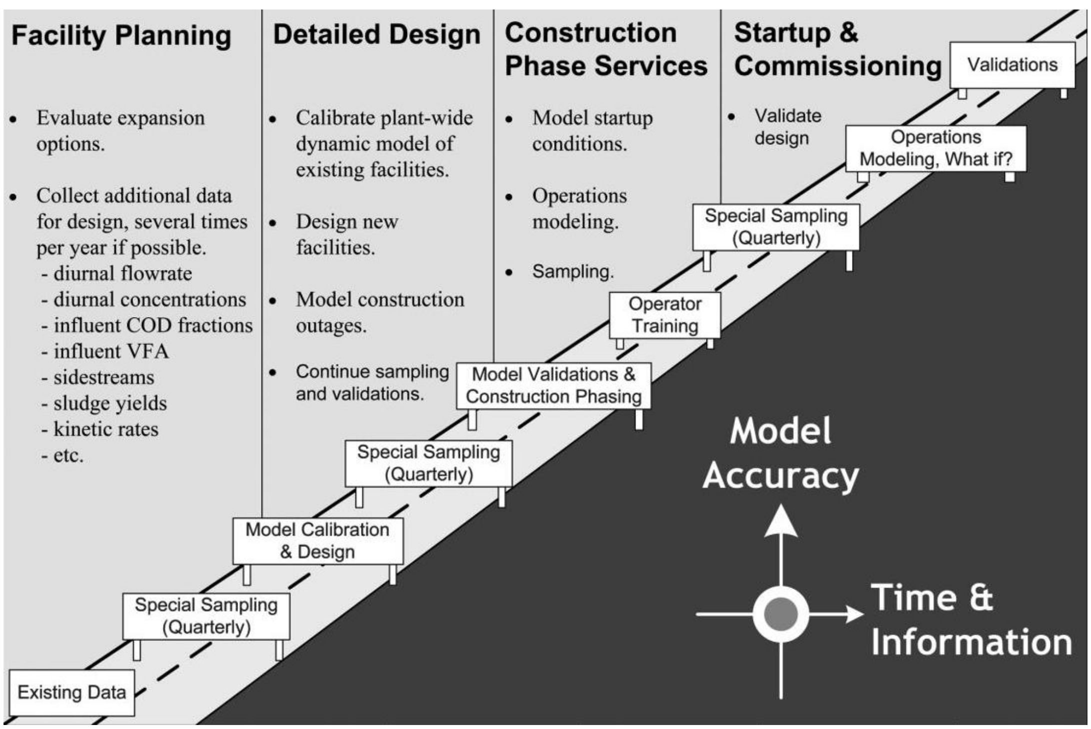


Figure 1. Model accuracy built over the phases of planning, design, construction, and commissioning.

The current planning level model can be used as a base for continued support of this project and others at VVWRA. For planning level, it's important to consider the level of effort put into calibration to maximize the return on time invested for value provided. For detailed design and process optimization, the model can be refined through additional special sampling, improved flow split definitions, online NH4 collection for calibration, and integration of the solids process into the model. Continuing to maintain and refine a single process model over time will provide deep understanding of the model characteristics and the full-scale process. A single process model could be adapted for future VVWRA projects for process optimization, capital improvement planning, capacity analysis, and resilience scenario testing. A single comprehensive model would also provide a well-developed base for future digital twin applications that could support predictive process control.

2 Model Overview

A process model of the existing primary and secondary treatment process was developed using Dynamita SUMO v22.1 process simulation software (Figure 2). A WEST process model, recently developed by DHI, was used as the starting point to inform the SUMO model parameters. The Sumo model was then calibrated using historical monthly average MLSS concentration, waste activated sludge (WAS) loading in pounds per day (ppd), and effluent total nitrogen data provided by VVWRA.

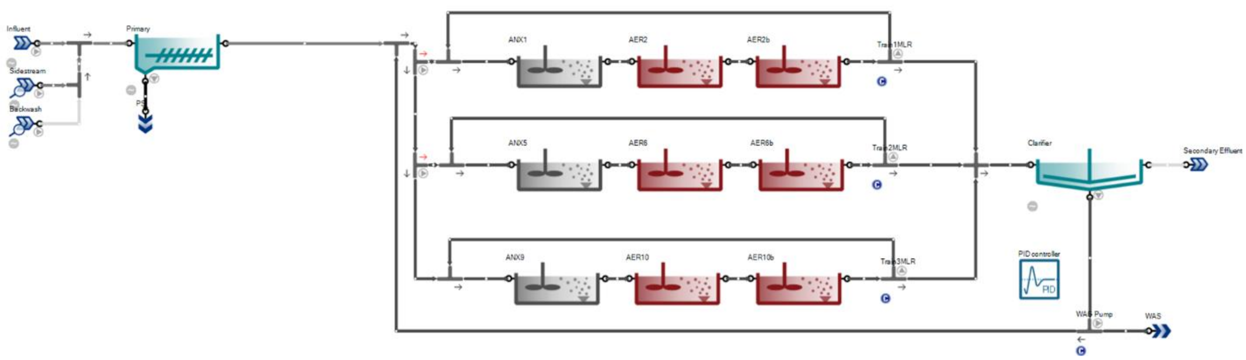


Figure 2. SUMO process model developed for VVWRA.

The model uses three influent nodes: raw wastewater, sidestream recycle, and tertiary filter backwash flows. Raw influent wastewater flow, temperature, and concentrations of COD, ammonia, and total phosphorus were averaged monthly from full-scale influent monitoring data. Sidestream recycle flows were defined as a state variable input using ammonium and TSS concentrations measured during a special sampling period in January and February of 2025.

The primary clarifier was modeled as a dimensionless, single-point clarifier. The model assumed 60% TSS removal and a 4% increase in the VSS:TSS ratio based on typical primary clarifier performance assumptions. Historical data included primary sludge TS concentration, which was input into the clarifier model to predict primary sludge flow rates. The mass flow (pounds per day, ppd) of solids in primary sludge was used as a calibration point, targeting <10% error.

The secondary process was developed using three separate trains for basins 1-4, 5-8, and 9-12. The total volumes for each of these trains were based on volumes in the WEST model and confirmed with plant drawings. Mixed liquor recycle flows were set at 3x the basin influent flows. Internal mixed liquor recycle is not monitored at full-scale, and the model setpoint was established by targeting the observed MLSS and effluent nitrate and nitrite concentrations. Influent flow and RAS were evenly split between the three treatment trains. This is far more simplified than flow splitting at VVWRA but was considered sufficient to model total nitrogen removal at the facility.

The secondary clarifier was also developed as a dimensionless, single-point separator, with a set effluent TSS. Monthly average effluent TSS at VVWRA was consistently 2-3 mg/L during 2023 and 2024. Clarifier performance impacts were deemed negligible to this modeling scope; however, MLSS results from the Sumo model could be applied in a spreadsheet-based state point analysis to evaluate clarifier capacity limitations.

The facility was modeled using basic reactors available using the Sumo2 model (Dynamita, 2022) for 2-step nitrification/denitrification that includes individual kinetics for heterotrophs, nitrifiers, denitrifiers, phosphorus accumulating organisms, and anammox-capable organisms. The model calculated pH dynamically (rather than assuming stable pH through the process), and precipitation reactions were on to allow for chemical additions within the model.

The following assumptions were made during calibration of the SUMO model:

- Daily average data are representative of plant flows and loads. No detailed diurnal data was available.
- Redirected flows from subregional plants are represented within historical raw influent data.
- Changes in raw influent water quality due to changes in industrial loadings were not considered.
- Headworks and primary effluent flow equalization were not considered.

3 Model Calibration

Monthly average influent flow, SRT, MLSS, RAS, WAS, and effluent nitrogen from January 2023 to October 2024 were used to calibrate and validate the process model. Special sampling data collected for gravity belt filtrate between December 2024 and March 2025 were used to supplement this data for sidestream recycle flow and load. IWA stop criteria were used for calibration of RAS, WAS, MLSS, and effluent nitrogen (Table 1).

Table 1. Modeling stop criteria used to calibrate the VVWRA Sumo Model.

Parameter	Unit	Stop Criteria[1]
Secondary/ Final Effluent TSS	mg/L	± 5 mg/L
Secondary/ Final Effluent NH_4-N	mg N/L	± 1.0 mg/L
Secondary/ Final Effluent TN or NO_x-N	mg N/L	± 1 mg/L
Secondary/ Final Effluent TP	mg/L	± 0.5 mg/L
MLSS	mg/L	± 10%
MLVSS/MLSS	--	± 5%
WAS Quantity	lb/d	± 10%
SRT	d	± 1 day

[1] IWA Publishing: Guidelines for Using Activated Sludge Models (2013)

Monthly average SRT was used as an input into the model, which controlled WAS pumping flow rate using the internal SRT calculator in Sumo. SRT at VVWRA typically ranged from 4-5 days during 2023 and 2024, with a median SRT of 4.4 d. The model considered all anoxic and aerobic biomass inventory in basins 1-12 as part of the SRT calculation. Secondary clarifier blankets were not considered in the SRT calculation, and secondary effluent TSS was found to have negligible impact on SRT. MLSS, WAS solids loading (ppd TSS) were used to calibrate the model.

Model calibration included adjustments to model influent fractionation. Through conversations with DHI and the Sumo influent tool, the following parameters were changed from Sumo defaults (Table 2).

Table 2. Model parameters and influent fractions changed from Sumo Defaults

Parameter	Unit	Sumo Default	VVWRA Model
COD of biodegradable substrate in volatile solids (XB)	g COD/ gVSS	1.80	1.60
COD of particulate unbiodegradable organics in volatile solids (XU)	g COD/ gVSS	1.30	1.10
Influent Fraction of filtered COD (sCOD) in total COD	%	40.5	30
Influent Fraction of flocculated filtered (SCOD, wo colloids) COD in total COD	%	20.2	15
Influent Fraction of soluble unbiodegradable organics (SU) in filtered COD (SCCOD, 1.5 µm, incl. colloids)	%	11.8	10.8
Influent Fraction of particulate unbiodegradable organics (XU) in total COD	%	14.0	20.0
Influent Fraction of PO4 in total phosphorus (TP)	%	58	50

Reducing the COD of biodegradable substrate in volatile solids from 1.8 default to 1.6 improved the calibration of WAS and primary sludge loading. This is a typical point of calibration for Sumo models to match solids production within the secondary treatment process at a facility.

The Sumo model was developed with two goals in mind: 1) to predict the increased WAS production and subsequent filtrate flows resulting from service area buildout, and 2) to bookend nitrification capacity in the secondary process. This allowed BV to develop targets for the required sidestream nitrogen removal efficiency required to maintain effluent TN below VVWRA's permit limit, assuming flows and loads increase to the plant rated capacity.

4 Model Application

To develop planning level design criteria for a sidestream nitrogen removal process, nitrification capacity of the VVWRA secondary treatment train was projected using the Sumo model developed by Black & Veatch. The sidestream influent node of the process model was manipulated to reflect 20%, 40%, 60%, 80%, and 100% total nitrogen (TN) removal. Sidestream ammonia concentrations in the recycle are shown in Table 3 for current conditions (11.4 MGD raw influent flow and 80% ADM capacity), Scenario 2B (11.4 MGD raw influent flow and 100% ADM capacity), and Scenario 4B (18 MGD raw influent flow and 100% ADM capacity).

Table 3. Sidestream ammonia concentrations in the modeled recycle flow.

Sidestream TIN Removal	Current (ppd as N)	Scenario 2B (ppd as N)	Scenario 4B (ppd as N)
0%	2000	3000	3000
20%	1600	2400	2400
40%	1200	1800	1800
60%	800	1200	1200
80%	400	600	600

Results from this model application are shown in Figure 3. These results demonstrate the impact of 0.31 MGD recycle flows to headworks of VVWRA. Effluent TN exceeds permit limits below 20% sidestream nitrogen elimination. At 40%, VVWRA could achieve permit, but this would likely require heavy supervision and tight control of the secondary process to ensure compliance. Above 60% removal will provide VVWRA more buffer against TN permit exceedances.

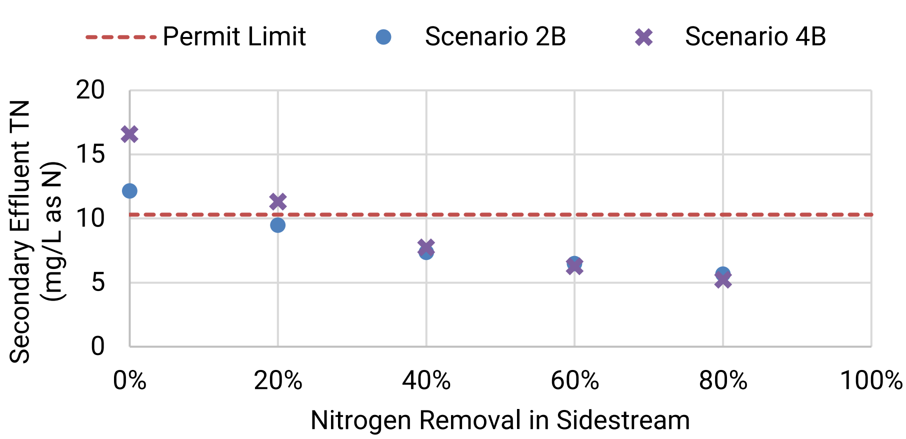


Figure 3. Mainstream effluent modeling results for percent removal assumptions in a sidestream nitrogen removal process.

5 Future Model Development

Flow splitting from the primary clarifiers to the aeration basins was generally assumed to be equal for the Sumo process model. Addition of more accurate flow splitting to the model to consider how raw influent, RAS, and MLR are operated at full-scale may improve nitrification and organic removal estimates in the model. In 2023 and 2024, flow splitting remained generally consistent across all three treatment trains, with approximately 30% of influent flow split to each basin (Figure 4). Because the model was calibrated using monthly averages for planning purposes, daily variability in flow splitting was not considered.

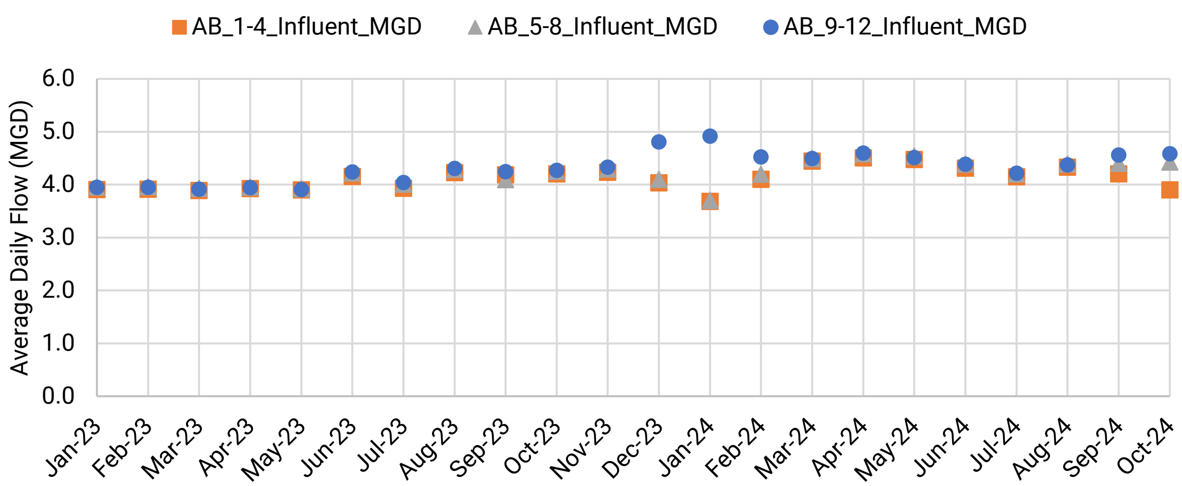


Figure 4. Influent flow split to 3 treatment trains.

For the planning level scope of this work, diurnal variability flows, loads, and operations were not considered. The model could be expanded by adding dynamic input tables to reflect diurnal variability. This would help capture some of the nuances of the process that may impact nitrification throughout the day.

Attachment A: Special Sampling Data for Belt Filter Press Filtrate

Table 4. Special sampling results for filtrate, completed by Black & Veatch

Date	Time	Total Ammonia (mg-N/L)	Alkalinity (mg/L CaCO3)	TSS (mg/L)	tCOD (mg/L)	sCOD (mg/L)
2/17/2025	10:04	698	2,805	1,045	1,619	661
2/18/2025	9:00	571	2,300	850	1,274	516
2/23/2025	10:00	700	2,985	1,020	1,422	620
2/24/2025	8:00	699	2,940	660	1,114	636
2/25/2025	10:05	669	2,980	1,010	1,670	638
2/26/2025	12:26	660	2,950	695	1,329	568
2/27/2025	10:37	668	2,945	700	1,403	668
2/28/2025	8:32	666	2,980	805	1,464	551
3/3/2025	10:11	673	3,015	795	1,526	615
3/4/2025	9:30	691	2,855	842	1,376	636
3/5/2025	10:50	684	2,915	820	1,307	610
3/6/2025	9:23	694	2,905	816	1,420	591
3/7/2025	7:53	696	2,970	794	1,332	610

Samples analyzed for ammonia, alkalinity, and soluble COD were filtered with 0.45 µm syringe filters.

Appendix C. World Water Works: DEMON® Proposal

DATE: 17 April, 2025
TO: Carolyn Coffey, Black & Veatch
FROM: Chandler Johnson – World Water Works (WWW)
CC: Halley Keating, Shakthi Jayavelu, Jason Calhoun – WWW
Jon Liberzon, McKenna Farmer, Phil Giori – B&V
RE: Information on DEMON® Anammox Process – Victor Valley WRA, CA – Rev0

Per your request for design and sizing for a DEMON® Anammox treatment system based on the **design criteria provided**, please find below our design summary based on the information provided. Below are some graphs showing the typical cycle of a DEMON® treatment system.

1. DEMON® TREATMENT PROCESS

Deammonification represents a short-cut in the N-metabolism pathway and comprises of 2 steps. About half the amount of ammonia is oxidized to nitrite and then residual ammonia and nitrite is anaerobically transformed to elementary nitrogen. See this shortcut in the diagram below. By using this process there is 60% less oxygen required and NO external carbon source to achieve nitrogen removal.

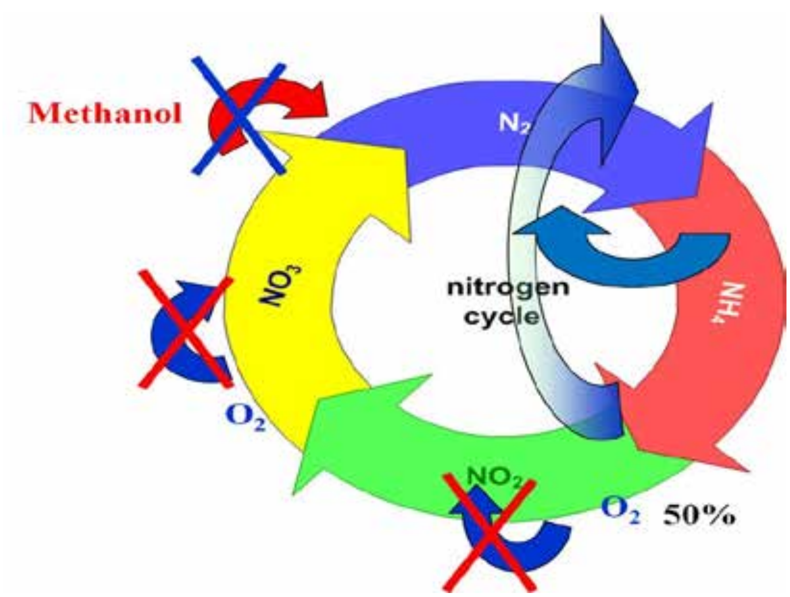


Figure 1 – NITROGEN CYCLE WITH SHORT CUT NITROGEN REMOVAL ADDED

Implementation of the University of Innsbruck pH control strategy for the DEMON® Anammox process for deammonification of reject water in a single sludge system is what this design is proposed around. The **specific energy demand of the side stream process results in 1.4 kWh per kg ammonia nitrogen removed comparing to about 6.5 kWh of mainstream treatment.** This process is achieving results of greater than 90% ammonia removal at the Strass WWTP (see data presented below). Biomass enrichment and start-up is key for this process to achieve its results in a short period of time and this proposal provides the seed sludge and start-up assistance to ensure achieving the goal of efficient nitrogen removal.

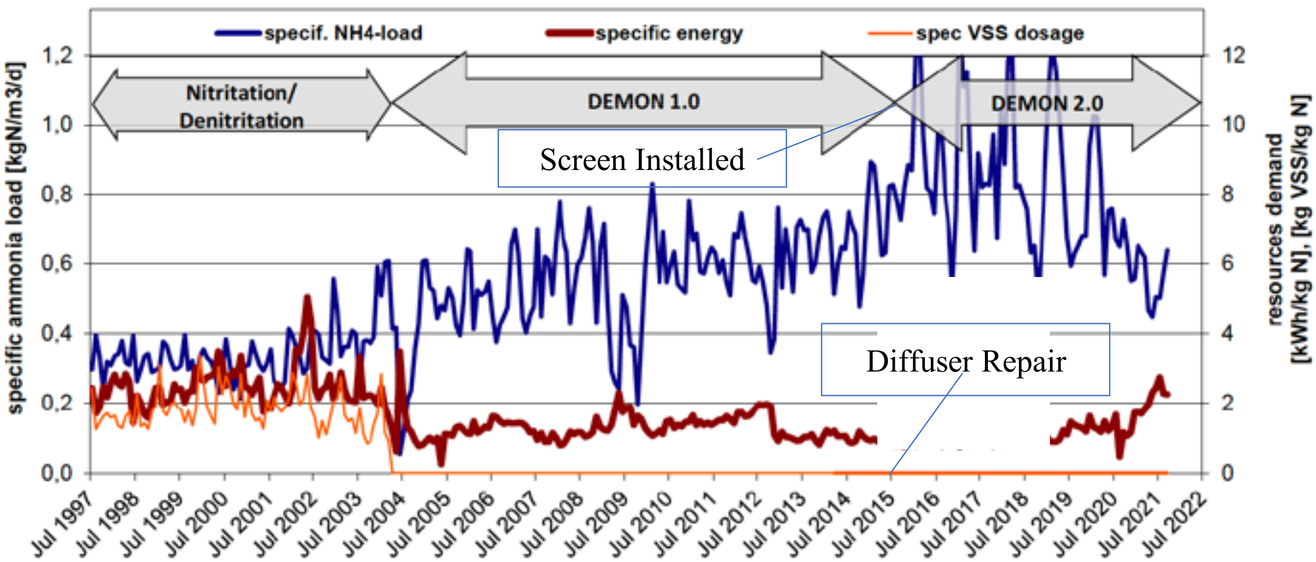


FIGURE 2 – STRASS NITROGEN PROFILE (1997 – 2022) WITH LOADING RATE AND SPECIFIC ENERGY

<u>Design Concept</u>

The overall design concept for is to use one (1) existing reactor to create DEMON® treatment system for Phase 1 and Phase 2 while converting the 2nd existing tank when the plant reaches Phase 3 flows and loads. We also recommend use of an EQ tank to handle dewatered liquid volumes should it not be 24 / 7 for the design conditions provided below.

Parameter	Phase 1	Phase 2	Phase 3
TSS, mg/L	< 750	< 750	< 750
Max TKN / Ammonia, mg/L	1,014	1,141	1,160
Soluble COD, mg/L	600	600	600
Alkalinity, mg/L as CaCO3	4,055	3,994	3,865
Temp, °C	20-35	20-35	20-35
Max Design TKN Loading	1,100 lb/day	2,000 lb/day	3,000 lb/day
Average Design TKN Loading	1,085 lb/day	1,750 lb/day	2,585 lb/day
Alkalinity, lb/day as CaCO3	4,400 lb/day	7,000 lb/day	10,000 lb/day
Design Flow	0.130 MGD	0.210 MGD	0.310 MGD

We envision using the existing tanks which are 55 ft diameter x 14 ft SWD for the DEMON® process. New mixers and aeration system will be placed in each reactor for providing the mixing energy for re-suspension of the granules, proper mixing distribution of the influent feed flow and provide the necessary aeration for nitritation. An internal settling zone will be used to settle out the MLSS / Anammox biomass and allow the treated wastewater to be discharged. A single control panel will be provided to control process.

Parameter	Phase 1	Phase 2	Phase 3
Number of Trains	1	1	2
Diameter (ft)	55	55	55
SWD (ft)	14	14	14

We see many advantages in operating the system as a continuous process as it will allow for a) lower installed HP for the blowers and feed pumps, b) will not require the Decanter and c) will operate continuously with higher Anammox biomass retention which allows for higher operating loading rates.

Strass WWTP has been operating with a new Anammox retention system, which has proven to be very successful at allowing for higher Anammox retention then

We have designed the system based on having removal efficiencies of 90% for ammonia and 80% for Total Inorganic Nitrogen (TIN). We have also assumed minimum operating temperature of 25C. Below is a summary of the designs presented.

Under design loads with influent ammonia loads for the different Phases we have the below Max Design Effluent Value.

Max Design Parameter	Phase 1	Phase 2	Phase 3
Effluent NH3-N (lb/day)	110	400	660
Effluent TIN (lb/day)	109	176	257

	Phase 1	Phase 2	Phase 3
Flow (MGD)	0.130	0.21	0.31
Ammonia Load	1,100 lb/day	2,000 lb/day	3,001 lb/day
Ammonia Removal	990 lb/day	1,600 lb/day	2,341 lb/day
% Ammonia Removal	90.00%	80.00%	78.00%
TIN Removal	881 lb/day	1,424 lb/day	2,083 lb/day
% TIN Removal	80.1%	71.2%	69.4%
VLR (kg N/m3-day)	0.530	0.964	0.723
Tanks	1	1	2
SWD	14.00 ft	14.00 ft	14.00 ft
Aeration Flow (SCFM)	691 SCFM	1,116 SCFM	818 SCFM
Blower Pressure (psig)	7.5	7.5	7.5
Blower bHP (bHP	39.2 bHP	62.8 bHP	45.5 bHP
Blower HP	100 HP	100 HP	100 HP
Messner Panels	50	50	50
Air flow per panel(m3/hr/panel)	23.5	38	28
Seed Sludge (m3)	30	30	30
# Settling Zone Panels	8 panels	8 panels	8 panels
Loading Rate on panels (m/hr)	1.60 meters / hr	2.40 meters / hr	1.90 meters / hr

Average Air Flow Needs

	Phase 1	Phase 2	Phase 3
Ammonia Load	1,085 lb/day	1,750 lb/day	2,585 lb/day
VLR (kg N/m3-day)	0.52	0.84	0.62
Aeration Flow (SCFM)	681 SCFM	976 SCFM	705 SCFM
Blower bHP (bHP	38.7 bHP	55.0 bHP	39.2 bHP

DEMON® TANK COMPONENTS

a) **Biomass Separation System** – A micro-screen will be used for this project and will have submerged pumps feeding it for a period time to waste out the AOB and NOB bacteria. The waste sludge of AOB and NOB bacteria will be discharged from the system while the underflow (Anammox bacteria) will be returned to the reactor.

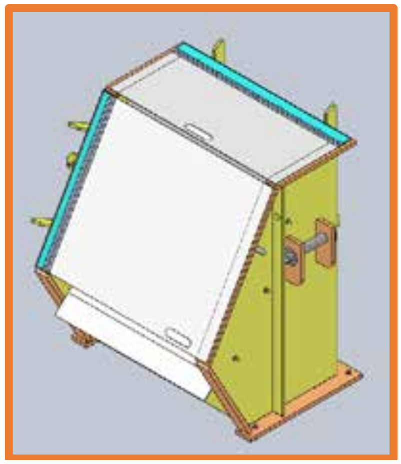
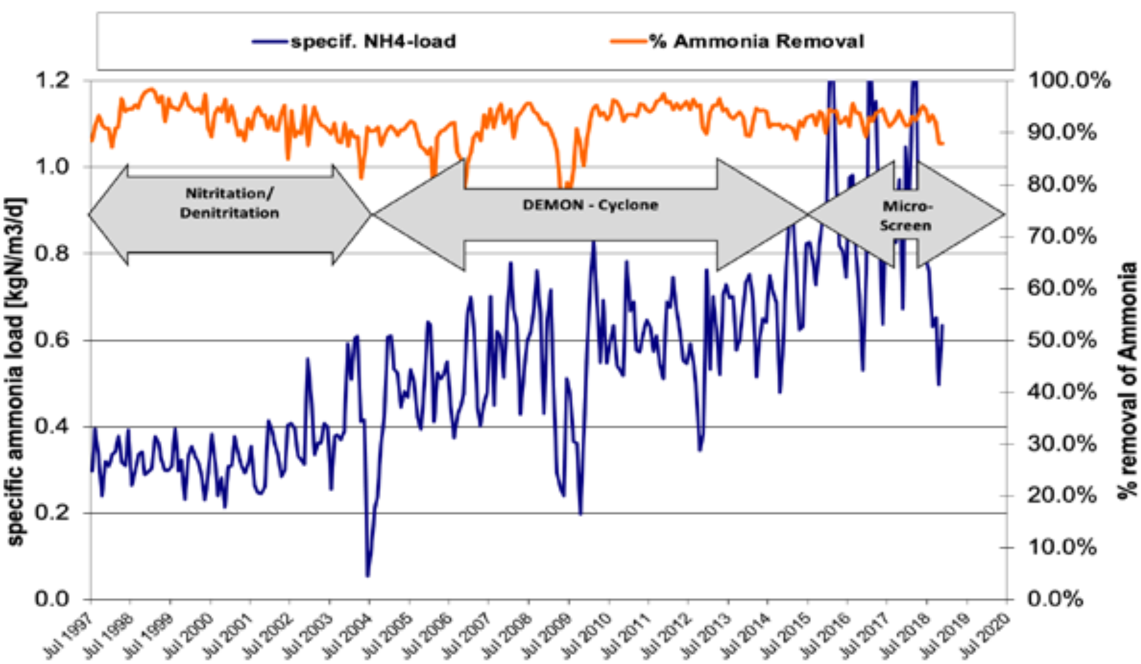


FIGURE 3 – MICRO-SCREEN VIEW

Below are graphs of the loading and % removal of the Anammox treatment system at Strass WWTP in Austria using the microscreen since fall 2015. In February 2016, the specific load was increased to over 1.4 kg/m3-day while still maintaining greater than 90% removal of Ammonia-nitrogen.



b) **Instrument Float** – the instruments for control of the process will be installed on a float system which will float with the level of the system. One (1) pH probe & one (1) DO probe for control of the overall operation of the process will be provided. A dedicated controller for the DO and pH is our recommendation. The conductivity probe is also to be provided with its own controller. Spare instrument locations will be provided in the instrument float for adding additional analyzers over time.

FIGURE 4 – INSTRUMENT FLOAT EQUIPMENT

c) **Seed Sludge** – for the quick start-up of the DEMON® treatment process, an adequate amount of seed sludge will be supplied. The seed sludge will be shipped in as dry content possible based on the harvesting technique used and will be added to the systems as they are started up.

FIGURE 5 – SEED SLUDGE SHIPPING CONTAINER

d) **<u>Aeration System</u>** – The Messner aeration system will be supplied in each tank. The number of panels is provided in the scope of supply section and is subject to final design.

FIGURE 6 – MESSNER PANEL INSTALLED / AERATION PATTERN TEST

e) **<u>Side Mounted Mixers</u>** – Landia side mounted mixers will be used to maintain mixing energy within each reactor. The mixers will help suspend the "reds" during the non-aerated cycles of the process. VFD's will be provided to allow the mixers to be turned down and save on energy during the overall operation of the cycle.

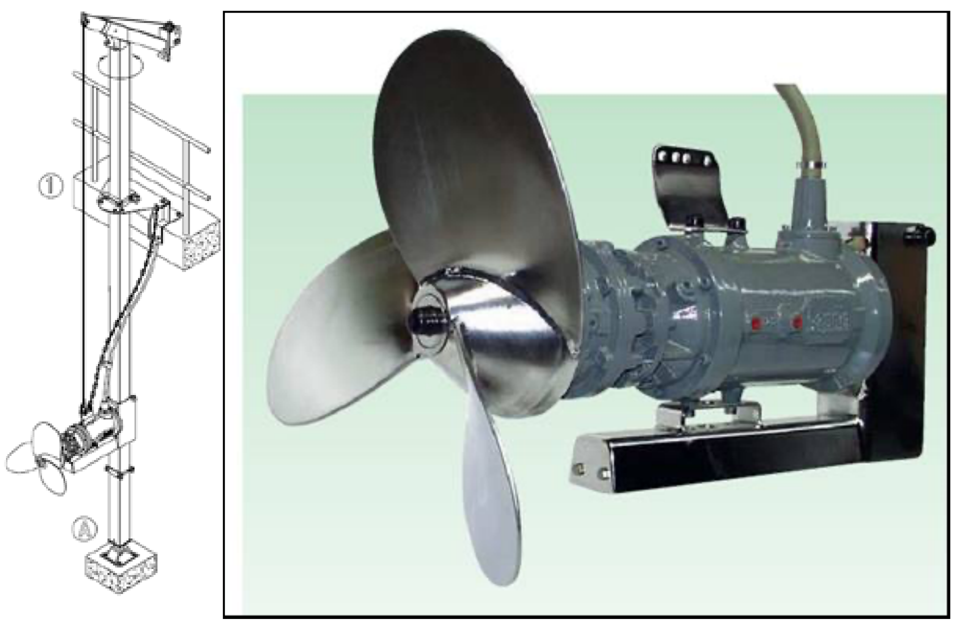


FIGURE 7 – LANDIA MIXER

f) **Internal Settling Zone** – An internal settling zone will be provided to allow for a continuous operation of the Anammox treatment system. Clarified effluent will be discharged back into the main process while the settled MLSS will be returned to the Anammox reactor. The waste stream enters the vessel and immediately the velocity is reduced to enhance particle separation. The "clarified" liquid is continuously removed from the top of the settling area and passes through vertical tubes in the center of the chamber connection to a single effluent pipe discharging the effluent. From the effluent collection piping system, the wastewater gravity flows out of the reactor. Heavy solids settle into the bottom where they fall back into the main DEMON® process tank on an automatic basis. The system is compact, robust, cleanable, and does not have moving parts.

Due to this being circular tanks, we will design something similar to that which was done for Kansas City (see below). For Victor Valley we envision having 4 panels per side for a total of 8 panels for the settling zone.

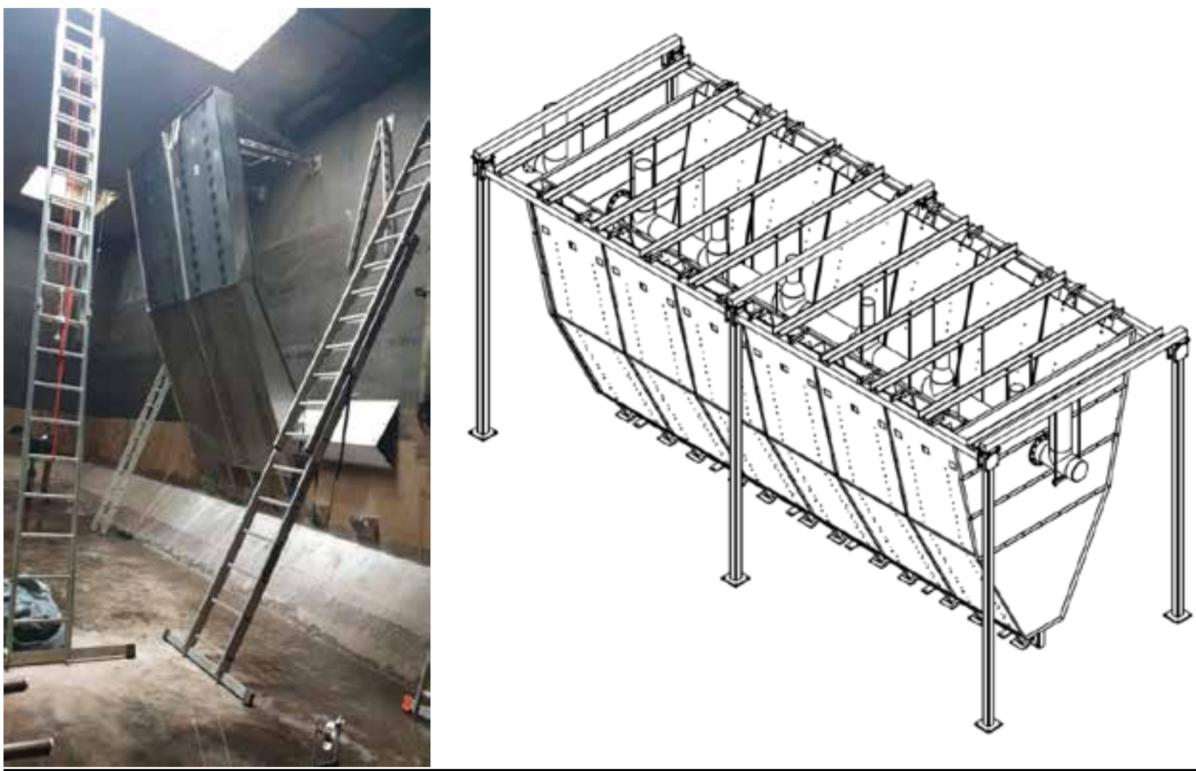


FIGURE 8 - View of the Settling Zone on side and circular tank concept.

g) **Blowers** – Positive displacement blowers capable of providing the necessary turndown for operation of the DEMON® system are to be provided.

Phase 1	**Model**	**Air Flow**	**Est. HP**	**Est. bHP**
1 duty + 1 standby per Process train (2 total provided)	GM 50L	681 SCFM 691 SCFM	100 HP	38.7 bHP – AM 39.2 bHP – MM
Phase 2	**Model**	**Air Flow**	**Est. HP**	**Est. bHP**
1 duty + 1 standby per Process train (2 total provided)	GM 50L	976 SCFM 1,116 SCFM	100 HP	55.0 bHP – AM 62.8 bHP – MM
Phase 3	**Model**	**Air Flow**	**Est. HP**	**Est. bHP**
1 duty + 1 standby per Process train (4 total provided)	GM 50L	705 SCFM / Tank 818 SCFM / Tank	100 HP	39.2 bHP – AM 45.5 bHP – MM

This blower design will allow the most flexibility in allowing the system to have efficient use of blower capacity during start up and low load periods of time. The blowers will each have its own sound enclosure to maintain < 75 db sound rating. Each blower will also be equipped with a variable frequency drive unit to allow efficient turndown of the blower while maintaining the proper dissolved oxygen concentration in the DEMON® reactor.

FIGURE 9 – AERZEN BLOWER WITH SOUND ENCLOSURE

h) Documentation / Design / License – All necessary documentation and design information will be provided as well as a license for treating the Maximum Month Loads.

2. CONTROLS

World Water Works provides pre-wired control panels to optimally control all equipment provided within the scope of this proposal. World Water Works includes an Ethernet connection with the control panel to allow remote access to the program and to assist in troubleshooting.

INSTRUMENTATION

Electrical Enclosure	**Hoffman, NEMA 4**
PLC	**Allen Bradley**
Software	**Allen Bradley**
Touchscreen	**15 inch Color Touch Screen**

ADDITIONAL OPTIONS PROVIDED

Remote Operation Capability

UL Listed Panel

FIGURE 10 – CONTROL PANEL WITH PLC

PLC Panel – The PLC panel and control program is the heart of the DEMON® process and its integral to our scope of supply. The PLC program will have each reactor created as a separate reactor. The reactor will have independent feed of raw centrate, aeration and mixing time. A touch panel with remote access is standard for allowing WWW access to the system and provides operational oversight.

DESIGN FOR 25C – Phase 1 – Max Loading

Influent Flow and Wastewater Characteristics	Design		Design	
Wastewater temperature in DEMON® Anammox-tank	20	°C	68	F
Daily water flow	492	m^3/d	0.130	MGD
Ammonia (NH3-N) Load	499	kg/d	1,100	lb/day
Ammonia (NH3-N) Concentration	1,014	mg/L	1,014	mg/L
Soluble COD, degradable (estimate)	600	mg/L	600	mg/L
Suspended Solids Concentration (TSS)	750	mg/L	750	mg/L
Soluble COD, degradable Load	295	kg/d	651	lbday
Suspended Solids Load (TSS)	369	kg/d	814	lb/day
Alkalinity Concentration	4,055	mg/L	4,055	mg/L
Alkalinity Load	1,995	kg/d	4,399	lbday
DEMON® Anammox Tank Information				
Number of tanks	1	in parallel	1	in parallel
Max. water depth	4.27	m	14.0	ft
Total volume per DEMON® Anammox Reactor	941	m^3	33,240	ft^3
Diameter of Each DEMON® Anammox Treatment Reactor	16.8	m	55	ft
Total Treatment Volume Provided	941	m^3	33,240	ft^3
Influent Feeding Design				
Feeding pump per tank	21	m^3/h	90	gpm
	492	m^3/day	130,000	gpd
Design of aeration system				
Biological Oxygen Requirements System Design				
Actual Oxygen Requirements (AOR), operating conditions	972	kg O2/d	2,142	lb O2/d
Actual Oxygen Required (AOR) in DEMON® Anammox tank	58	kg O2/h	127	lb O2/h
Aeration System & Blower Design Air Flow Requirements				
Design Air Flow (per DEMON® Anammox-tank)	1,173	Nm^3/h	691	SCFM

Air flows are based on 14 ft operating water level and discharge pressure of 7.5 psig

Rough Footprint would be one (1) basin at 55 ft diameter x 14 ft SWD.

DESIGN FOR 25C – Phase 2 – Max Loading

Influent Flow and Wastewater Characteristics	Design		Design	
Wastewater temperature in DEMON® Anammox-tank	20	°C	68	F
Daily water flow	795	m^3/d	0.210	MGD
Ammonia (NH3-N) Load	907	kg/d	2,000	lb/day
Ammonia (NH3-N) Concentration	1,141	mg/L	1,141	mg/L
Soluble COD, degradable (estimate)	600	mg/L	600	mg/L
Suspended Solids Concentration (TSS)	750	mg/L	750	mg/L
Soluble COD, degradable Load	477	kg/d	1,052	lbday
Suspended Solids Load (TSS)	596	kg/d	1,314	lb/day
Alkalinity Concentration	3,994	mg/L	3,994	mg/L
Alkalinity Load	3,175	kg/d	7,000	lbday
DEMON® Anammox Tank Information				
Number of tanks	1	in parallel	1	in parallel
Max. water depth	4.27	m	14.0	ft
Total volume per DEMON® Anammox Reactor	941	m^3	33,240	ft^3
Diameter of Each DEMON® Anammox Treatment Reactor	16.8	m	55	ft
Total Treatment Volume Provided	941	m^3	33,240	ft^3
Influent Feeding Design				
Feeding pump per tank	33	m^3/h	146	gpm
	795	m^3/day	210,000	gpd
Design of aeration system				
Biological Oxygen Requirements System Design				
Actual Oxygen Requirements (AOR), operating conditions	1,570	kg O2/d	3,460	lb O2/d
Actual Oxygen Required (AOR) in DEMON® Anammox tank	93	kg O2/h	206	lb O2/h
Aeration System & Blower Design Air Flow Requirements				
Design Air Flow (per DEMON® Anammox-tank)	1,896	Nm^3/h	1,116	SCFM

DESIGN FOR 25C – Phase 3 – Max Loading

Influent Flow and Wastewater Characteristics	**Design**		**Design**	
Wastewater temperature in DEMON® Anammox-tank	20	°C	68	F
Daily water flow	1,173	m^3/d	0.310	MGD
Ammonia (NH3-N) Load	1,361	kg/d	3,001	lb/day
Ammonia (NH3-N) Concentration	1,160	mg/L	1,160	mg/L
Soluble COD, degradable (estimate)	600	mg/L	600	mg/L
Suspended Solids Concentration (TSS)	750	mg/L	750	mg/L
Soluble COD, degradable Load	704	kg/d	1,552	lbday
Suspended Solids Load (TSS)	880	kg/d	1,940	lb/day
Alkalinity Concentration	3,865	mg/L	3,865	mg/L
Alkalinity Load	4,536	kg/d	9,999	lbday
DEMON® Anammox Tank Information				
Number of tanks	2	in parallel	2	in parallel
Max. water depth	4.27	m	14.0	ft
Total volume per DEMON® Anammox Reactor	941	m^3	33,240	ft^3
Diameter of Each DEMON® Anammox Treatment Reactor	16.8	m	55	ft
Total Treatment Volume Provided	1,883	m^3	66,481	ft^3
Influent Feeding Design				
Feeding pump per tank	24	m^3/h	108	gpm
	587	m^3/day	155,000	gpd
Design of aeration system				
Biological Oxygen Requirements System Design				
Actual Oxygen Requirements (AOR), operating conditions	2,303	kg O2/d	5,077	lb O2/d
Actual Oxygen Required (AOR) in DEMON® Anammox tank	69	kg O2/h	151	lb O2/h
Aeration System & Blower Design Air Flow Requirements				
Design Air Flow (per DEMON® Anammox-tank)	1,391	Nm^3/h	818	SCFM
Design Air Flow (per ALL TANKS)	2,782	Nm^3/h	1,637	SCFM

CONSUMABLES OF CONVENTIONAL VS. DEMON® TREATMENT SYSTEM - DESIGN CONDITIONS

Nitrogen-Load	2,000	lb/day
Energy costs	$0.150	USD $ /kWh
Specific energy costs	0.2268	kWh/lb O2
Methanol	$0.358	USD $ /lb
Sludge	$367	USD $ /US ton

Conventional Nitrification / Denitrification				**Specific Costs (USD $ / lb N)**	**Costs per Year**	
Oxygen	4.3	lb/lb N		0.1461	$	106,663
Methanol	2.3	lb/lb N		0.8232	$	600,842
Sludge	0.35	lb/lb N		0.0643	$	46,929
			TOTAL	**1.0337**	**$**	**754,433**

DEMON Anammox Treatment System				**Specific Costs (USD $ / lb N)**	**Costs per Year**	
Oxygen	1.6125	lb/lb N		0.0548	$	39,998
Methanol	0	lb/lb N		0.0000	$	-
Sludge	0.03	lb/lb N		0.0055	$	4,022
			TOTAL	**0.0603**	**$**	**44,021**

Savings per year on aeration	**$**	**66,664**
Savings per year on Methanol	**$**	**600,842**
Savings per year on Sludge disposal	**$**	**42,906**
Total Operational Savings per year	**$**	**710,412**

WWW Scope of Supply for Phase 1 and Phase 2

- Design & Engineering for System
- One (1) – 12 ft wide x 12 ft tall internal settling zone made of eight (8) panels each 4 ft wide in SS 304L with 4 per side and placed in center of tank.
- Fifty (50) Messner Aeration panels for the reactor
- Two (2) SS 304L Drop pipe with manifold to feed Messner panels
- One (1) DEMON® Biomass Separation System
- Two (2) submersible pumps (one duty + one standby) rated at 150 gpm and 4.0 HP motor with VFD's on each pump (operated 8 hrs per day)
- Two (2) Radar type level control for each DEMON® Tank & EQ Tank
- Two (2) influent feed pumps to the DEMON® reactor each rated for 146 gpm with VFD's on each pump. (operated 18 - 24 hrs per day) (1 duty + 1 standby)
- Two (2) Positive Displacement blowers (1,116 SCFM each) with VFD's on each blower (100 HP motors) (operated 14 hrs per day at design load) – (1 Duty + 1 Standby)
- Two (2) – 6.5 HP side mounted mixers with VFD's for each mixer (operated 6 hr/day)
- Seed Sludge for startup of system delivered to the site
- DEMON® Control program with panel with VFD's for blowers, submersible pump and mixers
- One (1) pH and DO probe with one (1) SC4500 controller
- One (1) Conductivity probe with one (1) SC4500 controller
- One (1) Air flow insertion meter and two (2) water flow magnetic meters
- Inspection, start up and training services (8 trips / 30 days)
- 3-4 months of off-site / remote monitoring services
- **Estimated Price for above scope of supply: $1,850,000 USD**
- **Estimated Submittal time – 8 weeks**
- **Estimated equipment fabrication after approved submittals – 16 – 26 weeks**

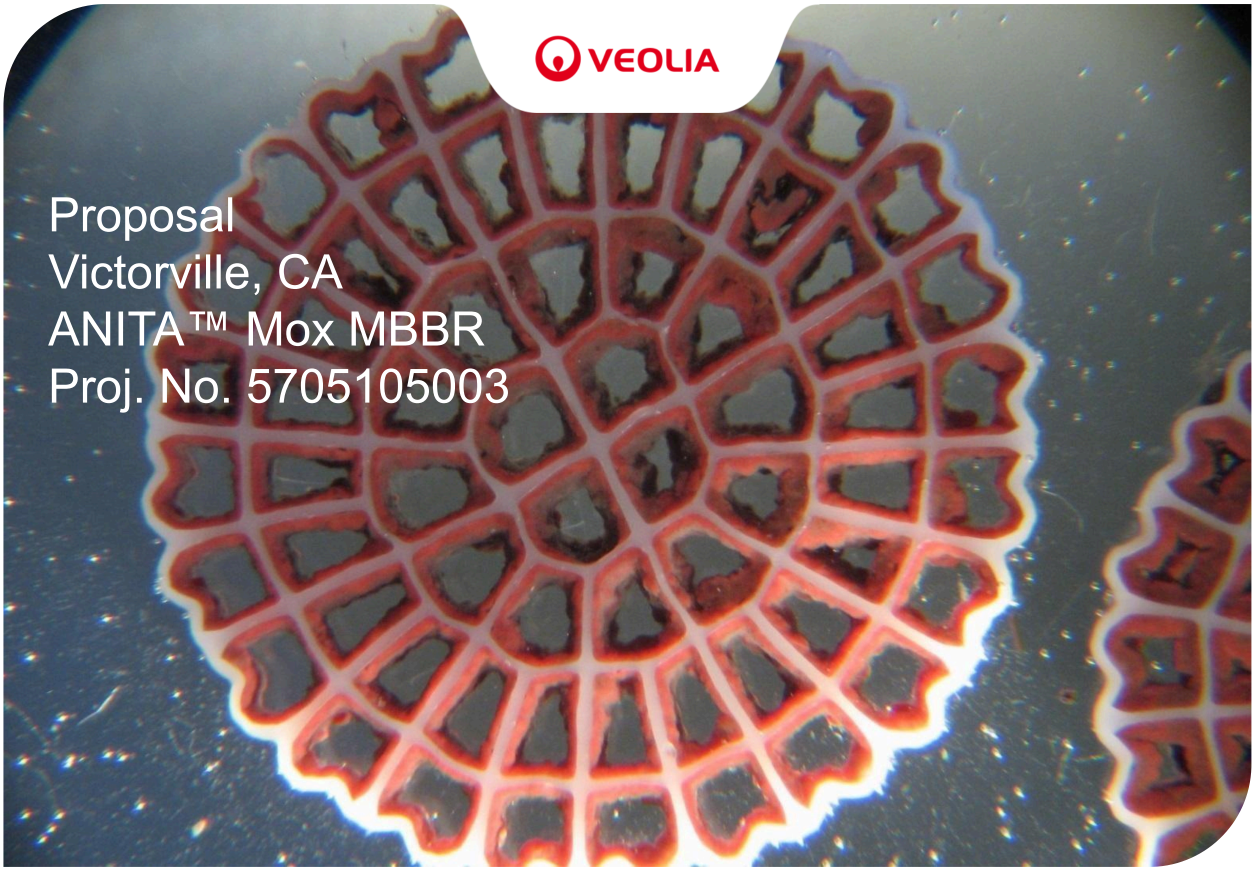
Items not included:

Tankage for EQ tank sized for 2 hours HRT (for systems with dewatering 24 hours per day or 8 – 12 hours for systems with dewatering 8 – 16 hours per day)
Conversion of the existing tank into a DEMON® reactor
Unloading, storage, installation of equipment
Electrical connections and interconnecting piping

<u>WWW Scope of Supply for Phase 3</u>

- Design & Engineering for System
- One (1) – 12 ft wide x 12 ft tall internal settling zone made of eight (8) panels each 4 ft wide in SS 304L with 4 per side and placed in center of tank.
- Fifty (50) Messner Aeration panels for the reactor
- Two (2) SS 304L Drop pipe with manifold to feed Messner panels
- One (1) DEMON® Biomass Separation System
- One (1) submersible pumps (one duty) rated at 150 gpm and 4.0 HP motor with VFD's on each pump (operated 8 hrs per day)
- One (1) Radar type level control for each DEMON® Tank
- One (1) influent feed pumps to the DEMON® reactor each rated for 146 gpm with VFD's on each pump. (operated 18 - 24 hrs per day) (1 duty)
- Two (2) Positive Displacement blowers (1,116 SCFM each) with VFD's on each blower (100 HP motors) (operated 14 hrs per day at design load) – (1 Duty + 1 Standby)
- Two (2) – 6.5 HP side mounted mixers with VFD's for each mixer (operated 6 hr/day)
- DEMON® Control program with panel with VFD's for blowers, submersible pump and mixers
- One (1) pH and DO probe with one (1) SC4500 controller
- One (1) Conductivity probe with one (1) SC4500 controller
- One (1) Air flow insertion meter and two (2) water flow magnetic meters
- Inspection, start up and training services (5 trips / 20 days)
- 3-4 months of off-site / remote monitoring services
- **Estimated Price for above scope of supply: $1,400,000 USD**
- **Assumes seed sludge will be provided by existing Phase 1 / 2 tank**
- **Assumes spares for Phase 1 / 2 will be used for influent pumps, micro-screen**
- **This will have new control panel**

Appendix D. Veolia: ANITA™Mox Proposal



Proposal
Victorville, CA
ANITA™ Mox MBBR
Proj. No. 5705105003

Submitted to:	Carolyn Coffey, Ph.D. Black & Veatch
Submitted by:	Sarah Spivey Application Engineer
Date:	April 9, 2025

Veolia Water Technologies Inc.
4001 Weston Parkway
Cary, NC 27513
tel. +1 919-677-8310 | fax. +1 919-677-0082
www.veoliawatertech.com

Water Technologies

Dear Carolyn,

Veolia Water Technologies, Inc. appreciates the project opportunity and is pleased to present this budgetary proposal for our ANITA™ Mox MBBR process for deammonification of the anaerobic digester centrate at Victor Valley Wastewater Reclamation Authority (VVWRA) in Victorville, California.

Based on the design basis provided, we have proposed a single train system for Phase 1 and 2. For the Phase 3 flows and loads an additional train/reactor will be needed. Some of the existing media in Phase 2 will need to be moved to the Phase 3 reactor so that both reactors have the same media fill percentage.

The dimensions and other details are summarized in Table 3 below. Please note that the number of trains and dimensions of each reactor can be adjusted if site-specific conditions or certain engineering design goals necessitate such adjustments.

Please also note that blowers have been included in our scope. If excess air and sufficient pressure are available from the main plant's blower station, it may be possible to tap air from the main blowers. Some of our full-scale plants get the air supply in this way.

- The current design is a retrofit design of the existing circular clarifiers. The ANITA Mox systems at James River VA, Howard County MD, South Durham NC, and Denver CO are all retrofits in existing tanks.
- Some equalization volume will provide benefits to the operations of the process. The volume of equalization recommended is often dependent on the plant's dewatering schedule. One of the three existing clarifiers for retrofit can serve as the EQ basin to provide constant and steady flow to the reactors.

The system has proven to be simple, stable and robust with more than thirty full-scale projects globally and multiple pilot studies. We sincerely hope that our unique ANITA Mox technology, Veolia's unparalleled experience and excellent services discussed above and below add value to your proposal and enable you to achieve your overall project goals in this endeavor.

In summary, this unique and proven technology, together with Veolia's successful experience and vast resources will ensure the ANITA Mox process for the sidestream nitrogen removal system is designed for optimum performance and best economic value.

We appreciate the opportunity to provide this proposal to you. If you have any questions or need further information, please contact our local Representative, Tarn Victor of JBI Water, or our Regional Sales Manager, Rodrigo Lara, at (503) 380-3995 (rodrigo.lara@veolia.com).

cc: Process, Sales, project file (Veolia)
Tarn Victor (JBI Water)

Revision	Date	Process Eng.	Comments
0	4/09/2025	XL, MJ	Initial, budgetary proposal.

ANITA Mox Unique Advantages

ANITA Mox provides several key differentiators for deammonification treatment:

- The media based process has been proven to be simple to operate and requires fewer specialized components than suspended/granular sludge technologies and, therefore, less maintenance and attention.
- All of Veolia's installations have demonstrated that the performance of the system is stable and less prone to process upset due to temporary fluctuations in sidestream characteristics.
- Anammox bacteria grow as a fixed biofilm on HDPE media carriers and are securely retained within the reactor by maintenance-free media retention screens. Unlike suspended growth/granular technologies, there is little risk of anammox washout, substantially improving operational simplicity and reducing maintenance and life cycle cost of the system.
- The AnoxK™ 5 media has a large protected surface area per unit volume (244 ft^2/ft^3) for biofilm growth, enabling a compact system design.
- The ANITA Mox system is tolerant of temporary limitations or fluctuations in pH, temperature and parameter concentrations. Therefore, the system can withstand a wide range of short-term influent variations and recovers when the conditions are corrected.
- The ANITA Mox MBBR process can tolerate higher design TSS concentrations than suspended growth systems without the need for pretreatment. This is another benefit of the anammox bacteria being securely retained on the carriers.
- The ANITA Mox System can be expanded without the need for additional construction. As flows and loads increase carriers can be incrementally added, which provides the ultimate flexibility for future system expansion.
- Carriers are manufactured from HDPE resins and are designed to last the life of the system. Veolia has MBBR installations in service for over 20 years without carrier replacement.
- Seed media is readily available from multiple US-based bio-farms for accelerated startup. In the case of systems with multiple trains, once one reactor is started up, the media in that reactor can be used as seed for the startup of other reactors.

Robustness

- The ANITA Mox system is tolerant of temporary limitations or fluctuations in pH, temperature and parameter concentrations. Therefore, the system can withstand a wide range of short-term influent variations without being upset.
  - Tolerates variability in dewatering schedules and dewatering starts/stops
  - Tolerates higher TSS and swings in TSS, does not typically require solids pretreatment.
  - Tolerates episodes of high polymer residual
  - Tolerates wide range of DO, BOD, TP, pH and other parameters
  - Tolerates episodes of high NO_2-N and ammonia residual
  - Proven by third-party robustness testing (by LA County) to be an incredibly resilient process that overcomes operational perturbations. For each of the following, LA County purposely upset the biofilm system for a 24-hour period and timed the system's recovery. In each case, ANITA Mox rebounded quickly and efficiently:

Scenario	Recovery Time
24 hour power outage	0 hr
24 hr no feed	0 hr
240 hr Excess Polymer (10x normal)	32 hr
24 hr Excess Polymer (3x normal)	8 hr
24 hr no aeration	16 hrs
24 hr over aeration (23% more)	0 hr
24 hr overfeed (2x)	16 hr

  - Proven at various installations, the ANITA Mox system is able to withstand short term or even prolonged system shutdowns. The system can be placed into low-loading mode. This allows the facility to have flexibility in dewatering schedules and perform routine or even emergency maintenance to their digesters and/or dewatering equipment without significant impact to system performance.

Unparalleled ANITA Mox Expertise in Both the US and Rest of World

Veolia is a leader in providing the media based deammonification solution to the US municipal market. The Veolia US team works directly with our counterparts at Veolia Engineering and Research Institute in France and AnoxKaldnes AB in Sweden to incorporate the latest knowledge and developments in the design of the media based deammonification technology. The delivery of cutting edge and global knowledge, coupled with the robustness of the technology, has enabled us to gain the trust of our customers and resulted in rapid adoption. Veolia has a total of more than thirty five (35) full scale ANITA Mox projects worldwide (including

10 projects in the US since 2013) since 2010 with more than one hundred years of combined successful operating history. The team has published numerous papers on the technology at various national and international conferences.

Strongest US Technical Support and Customer Service

The Veolia US team, has served the US municipal market for more than 25 years and is headquartered in Cary, NC. A group of more than 10 core process and project experts have each been with Veolia for more than 10 to 25 years. All these experts have been involved in the modeling, design, delivery, startup and troubleshooting of our full scale ANITA Mox projects in the US and to some extent in those of the international installations. These experts have more than 250 years of combined experience and work as a team to provide critical technical support to our customers whenever it is needed.

For services and parts, we have a customer support center and warehouse in Raleigh, NC to respond to your needs in a timely manner. Our local representative, JBI Water, can also provide immediate support and spare parts in most cases.

Strongest Financial Backing

Veolia is the world's #1 ranked waste and water treatment company, bringing not only expertise and experience, but also vast resources and financial backing that can be leveraged by your project team and the City. Veolia will guarantee process performance and is willing to support such guarantee with a process performance Guarantee Bond. A bid bond and/or payment and performance bonds can also be supplied if desired. We believe such bonds provide more value and protection to your interest.

State of the Art Digital Services Offer

The ANITA Mox process includes the use of our Hubgrade Performance Plant start-up kit, which offers many advantages during the critical period of growth and acclimation of the Anammox bacteria. With the use of a Veolia-provided temporary nitrite probe and remote PLC access provided through a highly secure OPC bridge on a separate "DMZ" network, Veolia's advanced algorithms and ANITA Mox expert input ensure that the system is fully optimized 24/7 for the proper reactor conditions. Continued use of the Hubgrade Performance Plant system for full-time optimization is also available via an additional service contract. Key benefits include:

	Hubgrade Performance ANITA™Mox Start-Up Kit	**+Hubgrade Performance Advanced Offer**
Focus/Driver	Start-up Time Minimized Start-up Labor Minimized Sampling Minimized Optimized Conditions 24/7	Optimized Conditions 24/7 Energy Minimized

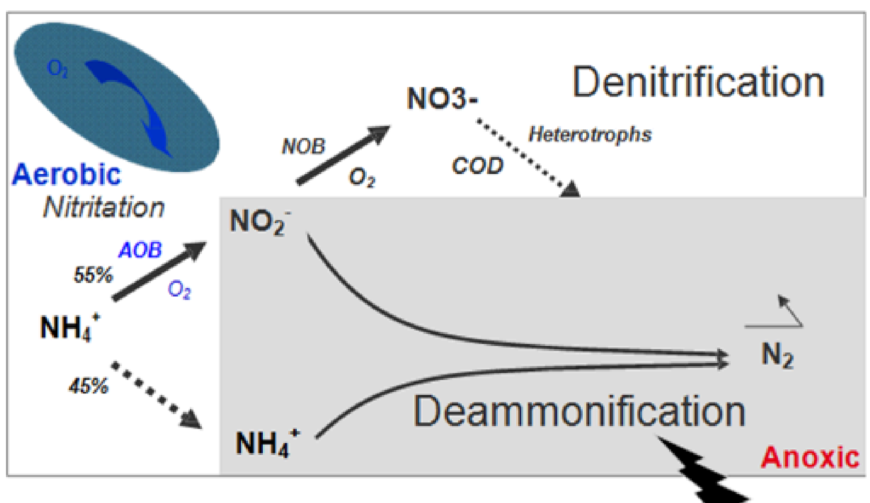
Process Description

AnoxKaldnes MBBR

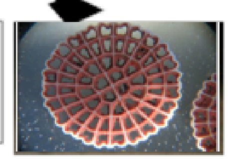
The ANITA™ Mox MBBR process is a single-stage nitrogen removal process based on the MBBR platform. It is a continuous-flow, non-clogging biofilm reactor containing moving “carrier elements” or media. The media flows with the water currents in the reactor and does not require backwashing or cleaning. The process is specifically designed for treatment of waste streams with high ammonia concentrations. The system can achieve ammonia removals of up to 80-90% and total nitrogen removals of up to 75-85%. The treatment method uses only 40% of the oxygen demand of conventional nitrification, and it requires no external carbon source.

The anammox biofilm (bacteria) that is critical to the deammonification process is attached to and securely protected by the surfaces of the media. The media is designed to provide a large protected surface area for the biofilm and optimal conditions for biological activity when suspended in water. Media of different shapes and sizes provide flexibility to use the most suitable type depending on wastewater characteristics, discharge standards and available volumes. In addition, a phased approach with different media fill percentage makes expansion of the ANITA Mox system much easier. More media can simply be added for future increase of flow and loads. AnoxKaldnes media is made from virgin HDPE and has a density slightly less than water.

Nitrogen removal with ANITA Mox

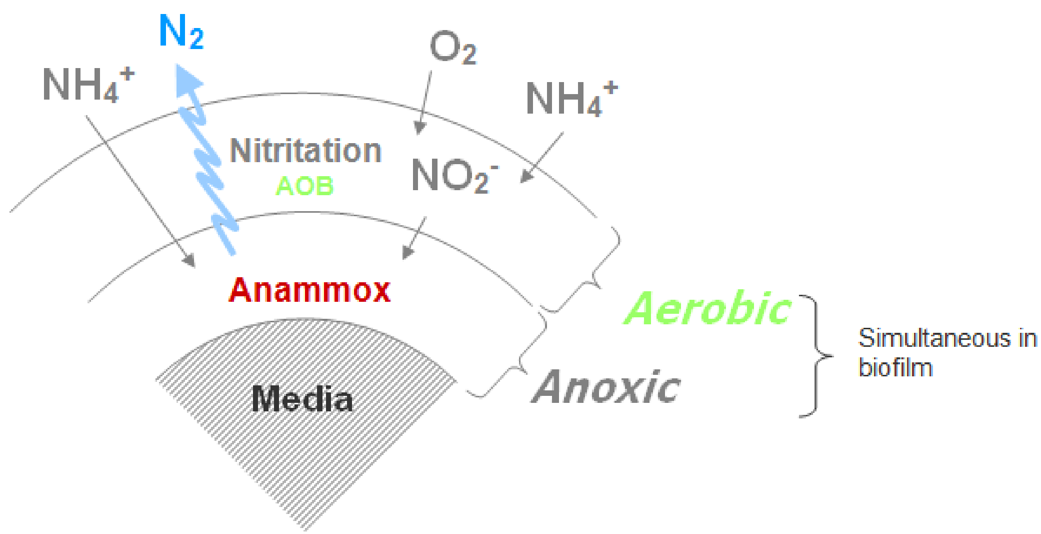


$$NH_4^+ + 1.32\,NO_2^- + .066\,HCO_3^- + .13\,H^+ \rightarrow$$
$$1.02\,N_2 + .26\,NO_3^- + .066\,CH_2O_{0.5}N_{0.15} + 2.03\,H_2O$$



Anammox Reaction

The ANITA Mox process consists of an aerobic nitritation reaction and an anoxic ammonia oxidation (anammox) reaction. The two steps take place simultaneously in different layers of the biofilm. Nitritation occurs in the outer layer of the biofilm. Approximately 55% of the influent ammonia is oxidized to nitrite (NO_2^-). Anammox activity occurs in the inner layer. In this step, the nitrite produced and the remaining ammonia are utilized by the anammox bacteria and converted to nitrogen gas (N_2) and a small amount of nitrate (NO_3^-).



ANITA Mox minimizes the risk of anammox washout. With ANITA Mox, the retention of the anammox bacteria within the reactor is easily achieved through the retention of the AnoxKaldnes media by stainless steel media screens. This bacteria retention method is proven to be simple and effective in more than 1,000 AnoxKaldnes MBBR/IFAS systems. Unlike other anammox retention systems, this system is designed to be maintenance free and requires little attention/maintenance from the operators. Anammox retention is an important characteristic of the system, since the anammox bacteria growth rate is very slow compared to conventional wastewater bacteria growth rates. Washout of the anammox bacteria can cause serious upsets of the deammonification process and even irreversible loss of performance.

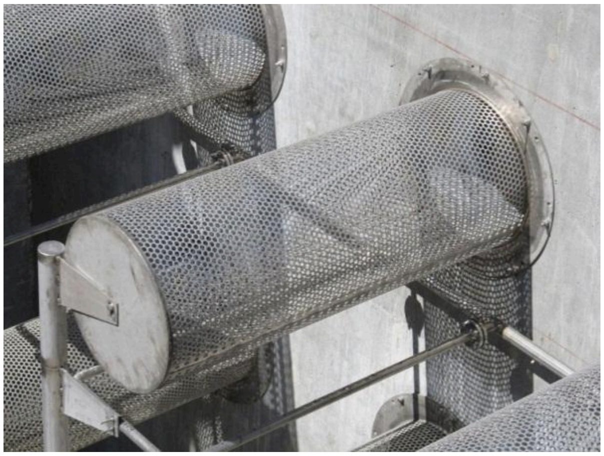
The ANITA Mox MBBR system consists of four major in-basin mechanical components, media, media retaining screens, air grids and mixers. The media, media retaining screens and air grids are designed to be maintenance-free throughout the lifetime of the system.

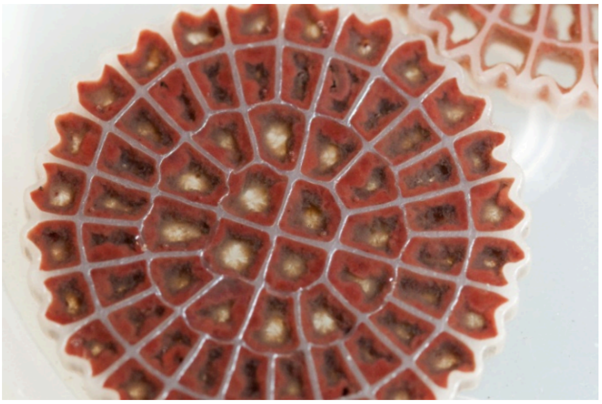
The ANITA Mox MBBR system does not require RAS/WAS pumps or recirculation pumps within the system. Moreover, it requires neither internal nor external sludge settlers because it's a biofilm system with all biofilms attached to and securely protected by the media carriers.

Another benefit of the ANTIA Mox MBBR system is that it does not require the addition of micronutrients for the process to work. Unlike certain suspended growth systems that need micronutrients for sludge conditioning or granule formation, the ANITA Mox system takes advantage of the more robust and adaptive biofilm that is more resistant to adverse influent centrate/filtrate conditions.

AnoxKaldnes ANITA™ Mox System Configuration

Veolia's scope of supply includes the AnoxKaldnes media, screen assemblies (to keep media in each reactor), medium bubble aeration grids, and mixers. In cases where they are needed, Veolia also provides the blowers, instrumentation and controls, SCADA, and field instruments (dissolved oxygen, nitrate, ammonia, etc.) for single-source responsibility.





Design Summary

The ANITA Mox influent design basis is summarized in Table 1. The target effluent criteria for the ANITA Mox system are listed in Table 2. The process design is summarized in Table 3.

It is important that each reactor has the capability for independent control of influent feed and aeration. This can be accomplished through dedicated pumps and blowers or by using high-performance modulating valves. Depending on the facility's dewatering schedule some equalization volume may provide benefits to the operations of the process.

The design assumes that the side stream entering into the proposed ANITA Mox system contains no toxic compounds and has sufficient alkalinity and that none of the equipment provided would be used in a classified area (e.g. Class 1, Division 1 or Class 1, Division 2).

Table 1: Influent Design Basis

Parameter	Units	Phase 1	Phase 2	Phase 3
Flow, Design	MGD	0.13	0.21	0.31
BOD_5, Design Flow*	mg/L	200*		
COD, Design Flow	mg/L	1,400		
Soluble COD, Design Flow	mg/L	600		
TSS, Design Flow	mg/L	500 - 1,000		
TKN, Design Flow*	mg/L	1,200*		
NH_4-N, Design Flow	mg/L	1,000		
Max NH_4-N (from max N load)	mg/L	1,015	1,142	1,161
TP*, Design Flow	mg/L	150*		
Available Alkalinity**	lbs/d	4,400	7,000	10,000
Alkalinity, Design Flow, calculated from available loads	mg/L	4,058	3,997	3,868
Elevation*	ft	3,000*		
Design / Max Temperatures***	°C	28.0 / 35.0		

*Assumed Values
** Available alkalinity includes a residual of at least 200 mg/L in the effluent.
*** Veolia recommends a temperature range of 25 - 35°C with an optimal of 30°C. Lower temperatures reduce the surface removal rate and thus require more media.

Table 2: Target Effluent Concentrations- 30-Day Average

Parameter	Units	Value
NH_4-N	Removal %	>= 80%
Total Inorganic Nitrogen	Removal %	>= 70%

1. Effluent values indicate anticipated performance and do not imply guarantees.
2. This design is for the maximum removal based on the given influent (Table 1) without alkalinity supplementation. If less % removal is desired then the media quantity can be reduced (as well as capital costs).

Table 3: Process Design Summary

<table>
<tr><th>Parameter</th><th>Units</th><th>Phase 1</th><th>Phase 2</th><th>Phase 3</th></tr>
<tr><td>Number of Process Trains</td><td>-</td><td>1</td><td>1</td><td>2</td></tr>
<tr><td>Reactor Dimensions (Each)</td><td>ft</td><td colspan="3">55 diameter × 14 SWD</td></tr>
<tr><td>Reactor Volume (Each)</td><td>ft^3</td><td colspan="3">~ 33,000</td></tr>
<tr><td>Reactor Volume (2 Trains)</td><td>ft^3</td><td colspan="3">~ 66,000</td></tr>
<tr><td>Recommended Freeboard</td><td>ft</td><td colspan="3">2 – 3</td></tr>
<tr><td>Media Type</td><td>-</td><td colspan="3">AnoxK™5</td></tr>
<tr><td>Fill of Biofilm Carriers</td><td>%</td><td colspan="2">~ 54</td><td>~ 39</td></tr>
<tr><td>Media Volume (All Reactors)</td><td>ft^3</td><td colspan="2">17,690</td><td>25,847</td></tr>
<tr><td>Aeration System Type</td><td>-</td><td colspan="3">Medium Bubble</td></tr>
<tr><td>Residual DO, Design</td><td>mg/L</td><td colspan="3">1.5</td></tr>
<tr><td>Estimated Process Air Requirement, Design</td><td>SCFM</td><td>1,400</td><td>2,300</td><td>3,400</td></tr>
<tr><td>Pressure at Top of Drop Pipe*</td><td>psi</td><td colspan="3">6.0</td></tr>
<tr><td>Estimated Blower Airflow (each train, with safety factor)</td><td>SCFM</td><td colspan="3">2,200**</td></tr>
<tr><td>Estimated Blower Discharge Pressure</td><td>psig</td><td colspan="3">7.5</td></tr>
</table>

* Does not include pressure losses between the blowers and reactor drop pipes.
** Blower selection and airgrid design are based on Phase 3.

Scope of Supply

Veolia is pleased to present our scope of supply which includes process engineering design, equipment procurement, and field services required for the proposed treatment system, as related to the equipment specified. The work will be performed to Veolia's high standards under the direction of a Project Manager. All matters related to the design, installation, or performance of the system shall be communicated through the Veolia representative giving the Engineer and Owner ready access to Veolia's extensive capabilities.

Process and Design Engineering

Veolia will provide process engineering and design support for the system as follows:

- Process Engineering consisting of aeration system sizing and configuration, sieve and outlet design.
- Review and approval of P&I Diagram for the AnoxKaldnes ANITA Mox portion of the process. Preliminary General Arrangement Drawings and review and approval of final General Arrangement Drawings for the process. Review of reactor drawings with respect to penetrations and dimensions, excluding structural design.
- Equipment installation instructions for all equipment supplied by Veolia.

Field Services

Veolia will furnish a Service Engineer to perform the following tasks:

- Inspect installation of key pieces of equipment during construction.
- Inspect the completed system prior to startup.
- Assist the Contractor with initial startup of the system.
- Train the Owner's staff in the proper operation and maintenance of the AnoxKaldnes ANITA Mox system.
- Test and start any Veolia - supplied control equipment, including PLC programming and SCADA systems.

Hubgrade Performance Plant - ANITA Mox Start-up Kit

The start-up kit includes software implementation and expert assistance during the start-up period. Specifically, Veolia will:

- Provide the temporary use of one (1) EZ Series nitrite analyzer
- Deliver the communication software package OPC Bridge (UA client to client) software along with all functional specifications for proper implementation with the PLC/SCADA, including Watchdog interaction for safe communication
- Work with the client's systems integrator to complete implementation of the software package and verify communication to/from the Hubgrade Performance cloud server
- Implement, configure, tune and test of the Hubgrade Performance Plant features
- Provide remote expert review of system operation via the Hubgrade Performance Plant cloud platform throughout the start-up phase and completion of effluent performance tests

AnoxKaldnes ANITA™ Mox System Equipment

Mechanical Equipment Items	1-train (Ph.1, & 2)	2-train (Ph.3) Additional Equipment Only	Description
AnoxKaldnes AnoxK™5 Media (ft^3)	See table 3	See table 3	Carrier elements are made of high-density polyethylene. The total media quantity will include a fraction of seed media to help start up the system.
Cylindrical Screen Assemblies	2	2	Two (2) per reactor. 304L SS. 23”ø perforated plate construction terminated in custom flanges for mounting directly to the tank wall.
Medium Bubble Aeration System	1	1	One (1) air grid system per reactor. 304L SS including headers, lateral piping, and hardware (excluding concrete anchor bolts).
Specially Designed Mechanical Mixers	1	1	One (1) per ANITA Mox Reactor. Includes VFD. Estimated to be 10 HP or 7.5 kW for each mixer.
Modulating Airflow Control Valves	1	1	One (1) actuated Butterfly Valve for each reactor. Estimated to be 8”
Manual Air Valves	6	6	One (1) manual Butterfly Valve for each air grid drop pipe. Estimated to be 6”
Process Aeration Blowers	1	1	One (1) duty per reactor (one existing blower will be the standby). Each blower will be rated for 2,500 SCFM at 7.5 psig. 150HP. VFDs by others.

Instrumentation and Controls Equipment Items	1-train (Ph.1 & 2)	2-train (Ph.3)	Description
PLC Control Panel	1	0	NEMA 12 Freestanding or Wall Mount Control Panel (For Indoor Use). ControlLogix PLC; Panelview HMI; 120V Feed.
High Level Float Switch	1	1	One (1) for each reactor.
DO Probe (LDO)	1	1	One (1) for each reactor, with a protective cage.
pH meter	1	1	One (1) pH meter for each reactor, with a protective cage.
Influent Ammonia Analyzer	1	0	One (1) Filtrax + Amtax ammonia nitrogen analyzer for the ANITA Mox influent, in EQ tank.
Effluent Ammonia Analyzer	1	1	One (1) Filtrax + Amtax ammonia nitrogen analyzer for each ANITA Mox reactor, with a protective cage.
Nitrate ISE Probe	1	1	One (1) submersible probe for each reactor.
Thermal Mass Airflow Meter	1	1	One (1) for each reactor for airflow control.
Ancillary Equipment (NOT INCLUDED)*	**1-train (Ph.1 & 2)**	**2-train (Ph.3)**	**Description**
Centrate/Filtrate Feed Pumps	1+1	1	One (1) duty for each reactor plus one (1) standby to feed Centrate/Filtrate from the equalization tank. Operated by VFD.
Mixer in the EQ tank	1	0	One (1) for mixing the EQ tank
Modulating Influent Control Valves	1	1	One (1) actuated Butterfly Valve for each train to regulate feed flow into the reactor.
Magnetic Flowmeter	1	1	One (1) magnetic flow meter per reactor to measure influent flow.

Notes Regarding System Design and Installation

- A note on concrete specifications: For any MBBR or IFAS systems, it is sound practice to require good, quality concrete work for the process reactors. The Consulting Engineer's standard concrete specification section is typically adequate to eliminate large holes, excessive form marks, large pockets, and excessively rough areas. It is particularly important to eliminate the potential for annular space around media retention screens.
- A note on construction sequencing: It is important, particularly for IFAS installations, to have level detection and level communication systems in place and operational prior to the filling of process tanks with water and media.

Scope of Supply BY INSTALLER/PURCHASER

The scope of supply by others for the AnoxKaldnes ANITA™ Mox system should include, but is not limited to, the following items:

- All civil/site and electrical work.
- A concrete foundation for the tanks.
- Reactors to house the MBBR treatment equipment.
- All provisions for interconnecting piping.
- Unloading, storage and installation of equipment.
- Install and test all level floats, level transmitters, level alarms, and alarm communication devices prior to filling a process tank with media and water
- Centrate equalization tanks
- Cover for reactor tanks (if necessary)
- Temporary provisions for screened primary or secondary effluent during startup.
- Temporary reactor heating during startup.
- Mixer bridges and other structural modifications for the reactors.
- Video recording of any training activities.

Design Options

In addition to the proposed system as detailed herein, Veolia is able to further incorporate our process and controls expertise into wastewater treatment plants, allowing municipalities to meet stringent effluent requirements and future plant upgrades. Veolia is also able to offer our instrumentation and controls expertise to build upon the proposed system by providing a **customized plant-wide SCADA system** or designing a **Motor Control Center (MCC)**, providing clients a single source responsibility for plant controls. Please contact Veolia if the options above are of interest or to be included in the current proposed system or future upgrades. ***Please note that the design options listed above are not included in the pricing noted herein.*

Schedule

- Shop drawings will be submitted within 6-8 weeks of receipt of an executed contract by all parties.

- All equipment will be delivered within 18-28 weeks after receipt of written approval of the shop drawings.
- Installation manuals will be furnished upon delivery of equipment.
- Operation and Maintenance Manuals will be submitted within 90 days after receipt of approved shop drawings.

Pricing

The price for the AnoxKaldnes ANITA™ Mox system, as defined herein, including process and design engineering, field services, and equipment supply is:

Phase 1 or 2: $1,885,000
Phase 3 (Additional Equipment Only): $1,352,000

Pricing is DAP to the job site. This pricing does not include any tariffs, sales or use taxes. In addition, pricing is valid for thirty (30) days from the date of issue. Due to the evolving governmental/political landscape, all prices are based on United States tariffs and trade laws/agreements in effect as of Jan 1, 2025. Veolia reserves the right to re-evaluate the Proposal offering prior to order acceptance, including any impacts in costs or schedule due to any tariffs and/or trade laws/agreements in North America after such date.

Please note that the above pricing is expressly contingent upon the items in this proposal and are subject to Veolia's Standard Terms of Sale detailed herein.

Veolia Standard Terms of Payment

The terms of payment are as follows:

- 10% on receipt of fully executed contract
- 15% on submittal of shop drawings
- 75% on the delivery of equipment to the site

Payment shall not be contingent upon receipt of funds by the Contractor from the Owner. There shall be no retention in payments due to Veolia. All other terms per our Standard Terms of Sale are attached.

All payment terms are net 30 days from the date of invoice. Final payment not to exceed 120 days from delivery of equipment.

Standard Terms of Sale

1. Applicable Terms. These terms govern the purchase and sale of the equipment and related services, if any (collectively, "Equipment"), referred to in Seller's purchase order, quotation, proposal or acknowledgment, as the case may be ("Seller's Documentation"). Whether these terms are included in an offer or an acceptance by Seller, such offer or acceptance is conditioned on Buyer's assent to these terms. Seller rejects all additional or different terms in any of Buyer's forms or documents.

2. Payment. Buyer shall pay Seller the full purchase price as set forth in Seller's Documentation. Unless Seller's Documentation provides otherwise, freight, storage, insurance and all taxes, duties or other governmental charges relating to the Equipment shall be paid by Buyer. If Seller is required to pay any such charges, Buyer shall immediately reimburse Seller. All payments are due within 30 days after receipt of invoice. Buyer shall be charged the lower of 1 ½% interest per month or the maximum legal rate on all amounts not received by the due date and shall pay all of Seller's reasonable costs (including attorneys' fees) of collecting amounts due but unpaid. All orders are subject to credit approval.

3. Delivery. Delivery of the Equipment shall be in material compliance with the schedule in Seller's Documentation. Unless Seller's Documentation provides otherwise, Delivery terms are DAP to jobsite.

4. Ownership of Materials. All devices, designs (including drawings, plans and specifications), estimates, prices, notes, electronic data and other documents or information disclosed by Seller or prepared solely by Seller or Buyer or jointly by Seller and Buyer in connection with this Agreement, and all intellectual property rights therein, shall be and remain the confidential and proprietary property of Seller, whether or not patented by Seller ("Work Product"). Buyer hereby irrevocably assigns all rights in any Work Product to Seller. Seller grants Buyer a non-exclusive, non-transferable (except to a successor-in interest to the ownership of the Equipment), paid-up license to use the Work Product solely in connection with Buyer's use, operation, repair and maintenance of the Equipment at the Jobsite defined in this Agreement. Buyer may not disclose, share, transfer, or sell any such Work Product to third parties without Seller's prior written consent and such consent may be arbitrarily withheld. Buyer agrees not to resell, transfer or give any of the biologically colonized media or bacteria from the system to any party other than Seller or any of Seller's affiliates without the prior written consent of Seller for a period of fifteen (15) years from the effective date of this Agreement. Buyer shall not cultivate bacteria or use biomass carriers retrieved from the ANITA Mox system for any research or non-research purposes without prior written consent of the Seller. Any new developments, discoveries or inventions resulting from the operation of the ANITA Mox system in which the ANITA Mox process is a component or is in any way incorporated in whole or in part shall be owned solely by the Seller.

5. Changes. Seller shall not implement any changes in the scope of work described in Seller's Documentation unless Buyer and Seller agree in writing to the details of the change and any resulting price, schedule or other contractual modifications. This includes any changes necessitated by a change in applicable law occurring after the effective date of any contract including these terms.

6. Warranty. Subject to the following sentence, Seller warrants to Buyer that the Equipment shall materially conform to the description in Seller's Documentation and shall be free from defects in material and workmanship. The foregoing warranty shall not apply to any Equipment that is specified or otherwise demanded by Buyer and is not manufactured or selected by Seller, as to which (i) Seller hereby assigns to Buyer, to the extent assignable, any warranties made to Seller and (ii) Seller shall have no other liability to Buyer under warranty, tort or any other legal theory. If Buyer gives Seller prompt written notice of breach of this warranty within 18 months from delivery or 1 year from beneficial use, whichever occurs first (the "Warranty Period"), Seller shall, at its sole option and as Buyer's sole remedy, repair or replace the subject parts or refund the purchase price therefore. If Seller determines that any claimed breach is not, in fact, covered by this warranty, Buyer shall pay Seller its then customary charges for any repair or replacement made by Seller. Seller's warranty is conditioned on Buyer's (a) operating and maintaining the Equipment in accordance with Seller's instructions, (b) not making any unauthorized repairs or alterations, and (c) not being in default of any payment obligation to Seller. Seller's warranty does not cover damage caused by chemical action or abrasive material, misuse or improper installation (unless installed by Seller). THE WARRANTIES SET FORTH IN THIS SECTION ARE SELLER'S SOLE AND EXCLUSIVE WARRANTIES AND ARE SUBJECT TO SECTION 10 BELOW. SELLER MAKES NO OTHER WARRANTIES OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR PURPOSE.

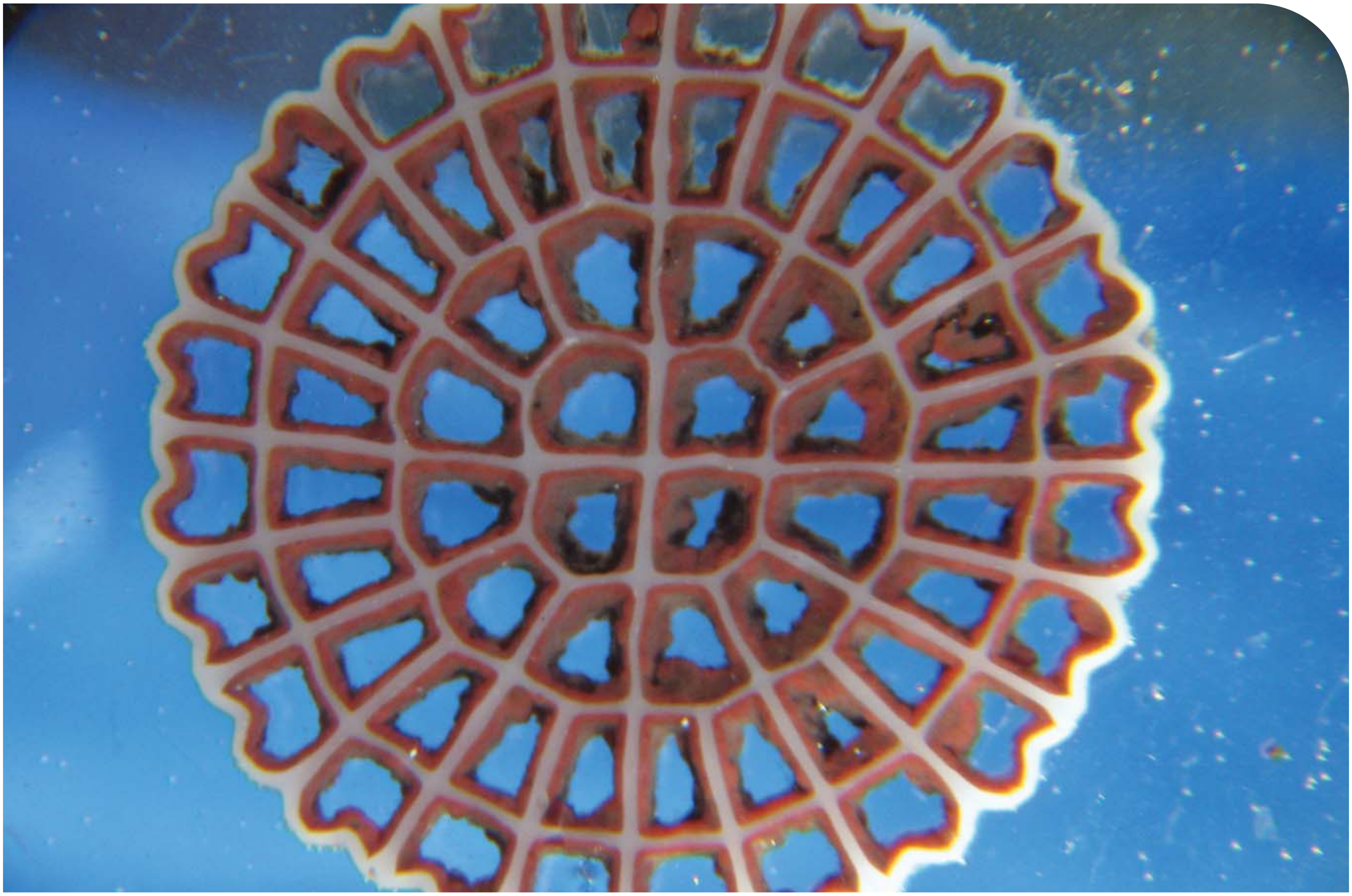
7. Indemnity. Seller shall indemnify, defend and hold Buyer harmless from any claim, cause of action or liability incurred by Buyer as a result of third party claims for personal injury, death or damage to tangible property, to the extent caused by Seller's negligence. Seller shall have the sole authority to direct the defense of and settle any indemnified claim. Seller's indemnification is conditioned on Buyer (a) promptly, within the Warranty Period, notifying Seller of any claim, and (b) providing reasonable cooperation in the defense of any claim.

8. Force Majeure. Neither Seller nor Buyer shall have any liability for any breach (except for breach of payment obligations) caused by extreme weather or other act of God, strike or other labor shortage or disturbance, fire, accident, war or civil disturbance, delay of carriers, failure of normal sources of supply, act of government or any other cause beyond such party's reasonable control.

9. Cancellation. If Buyer cancels or suspends its order for any reason other than Seller's breach, Buyer shall promptly pay Seller for work performed prior to cancellation or suspension and any other direct costs incurred by Seller as a result of such cancellation or suspension.

10. LIMITATION OF LIABILITY. NOTWITHSTANDING ANYTHING ELSE TO THE CONTRARY, SELLER SHALL NOT BE LIABLE FOR ANY CONSEQUENTIAL, INCIDENTAL, SPECIAL, PUNITIVE OR OTHER INDIRECT DAMAGES, AND SELLER'S TOTAL LIABILITY ARISING AT ANY TIME FROM THE SALE OR USE OF THE EQUIPMENT SHALL NOT EXCEED THE PURCHASE PRICE PAID FOR THE EQUIPMENT. THESE LIMITATIONS APPLY WHETHER THE LIABILITY IS BASED ON CONTRACT, TORT, STRICT LIABILITY OR ANY OTHER THEORY.

11. Miscellaneous. If these terms are issued in connection with a government contract, they shall be deemed to include those federal acquisition regulations that are required by law to be included. These terms, together with any quotation, purchase order or acknowledgement issued or signed by the Seller, comprise the complete and exclusive statement of the agreement between the parties (the "Agreement") and supersede any terms contained in Buyer's documents, unless separately signed by Seller. No part of the Agreement may be changed or cancelled except by a written document signed by Seller and Buyer. No course of dealing or performance, usage of trade or failure to enforce any term shall be used to modify the Agreement. If any of these terms is unenforceable, such term shall be limited only to the extent necessary to make it enforceable, and all other terms shall remain in full force and effect. Buyer may not assign or permit any other transfer of the Agreement without Seller's prior written consent. The Agreement shall be governed by the laws of the State of North Carolina without regard to its conflict of laws provisions.



VEOLIA

ANITA™ Mox

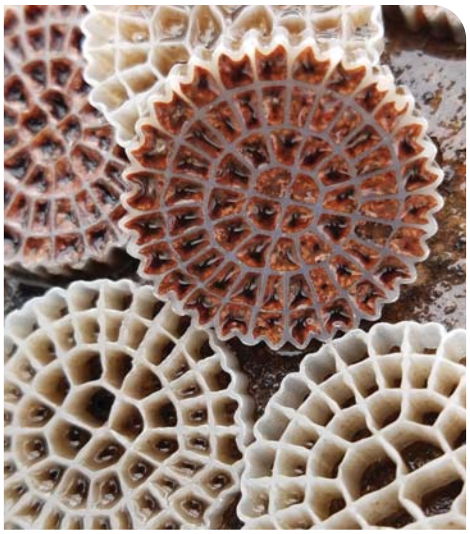
Deammonification Process
Simple, Stable and Robust

WATER TECHNOLOGIES

ANITA™ Mox

Sidestream Deammonification

ANITA™ Mox is a robust, single-stage ammonia and total nitrogen removal biofilm process based on the Moving Bed Bioreactor (MBBR) or Integrated Fixed-film Activated Sludge (IFAS) platform. It utilizes the AnoxK™ 5 media to cultivate anaerobic ammonia oxidizing bacteria (anammox) and ammonia oxidizing bacteria (AOB) enriched biomass for both mainstream and sidestream deammonification applications. It is the simplest and most stable technology in the market in terms of operation and maintenance in treating centrate or filtrate from either conventional anaerobic digestion (AD) or AD following thermal hydrolysis process (THP).



Sidestream Benefits Compared to Conventional Nitrification/ Denitrification

- 3x lower in total cost per pound of nitrogen removed
- Much smaller footprint with high loading/removal rates
- 90% less sludge production
- 60% less in energy consumption
- No external carbon required; less carbon footprint

System Configuration

- **MBBR** - for centrate from conventional anaerobic digestion
- **IFAS** - for centrate from thermal hydrolysis process + anaerobic digestion
- **Phased IFAS** - for centrate from any anaerobic digestion

Unique Advantages

- The simplest and most stable technology in the market
- Robust and forgiving design/operating parameters
- 90% ammonia removal and 80% TIN Removal
- Can work with both shallow (< 10 ft) and high side water depth (> 26 ft)
- Media-based solution eliminates the risk of anammox washout without the need for anammox/MLSS separation equipment
- Small footprint and easliy expandable by adding media or converting MBBR to IFAS with higher loading rates.
- Zero maintenance needed for in-basin components such as SS media screens, SS medium bubble diffusers and media carriers.
- Seed media readily available from multiple large US-based bio-farms for quick startup
- No need for media replacement

Full scale performance data has demonstrated ANITA Mox's ability to withstand:

- High TSS and swings in TSS (between 1,500 and 17,000 mg/L) without the need of pretreatment unit process
- High polymer residual
- Wide DO concentration and PH ranges
- Variations in dewatering schedules and dewatering starts/stops
- Extended shutdowns due to dewatering equipment maintenance
- High NO2-N residual with less NOB suppression requirements
- Inhibitory effects of recalcitrant COD and complex nitrogen compounds generated by THP or other special processes

Mainstream Deammonification

Paving the Way for Energy Neutrality

ANITA Mox is now offered as a compact and robust media based process for ammonia and nitrogen removal in mainstream applications while unlocking the possibility for energy production through COD diversion to digestion.

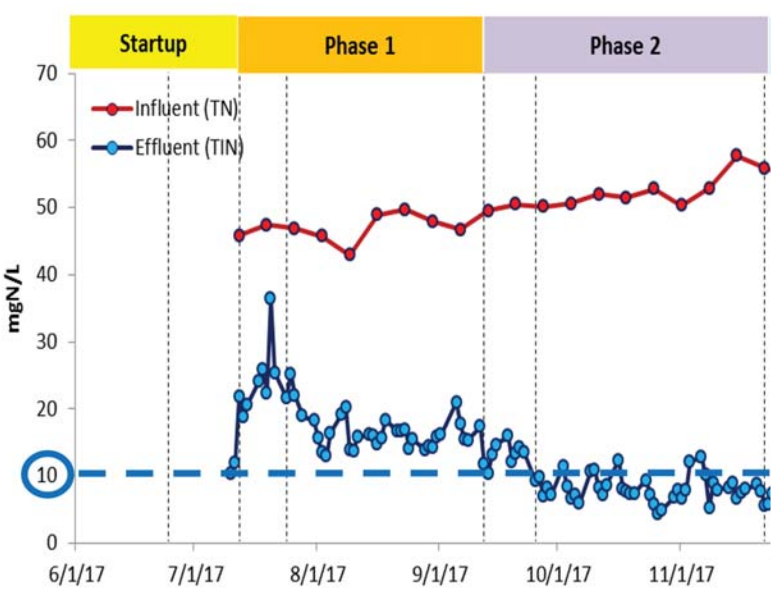
For mainstream deammonification, ANITA Mox provides an easy and purely mechanical solution to securely retain anammox biomass with the combination of biofilm carriers and retention screens. This simple and maintenance-free physical separation between anammox-rich biofilm carriers and nitrifier-rich suspended sludge allows for easy control of the sludge and therefore better AOB selection and control and better selective wash-out of NOB while retaining anammox.

Compared to conventional BNR treatment, Mainstream ANITA™ Mox reduces aeration demand by 60% and eliminates the need for carbon. Minimizing the operating cost of nitrogen removal and generating power through COD diversion, Mainstream ANITA™ Mox makes it possible for facilities to achieve energy neutrality.

Benefits of Mainstream ANITA™ Mox

- Eliminates carbon needs, enables power generation through COD diversion
- 60% less aeration required
- Targets 10-15 mg/L effluent TN concentration
- Works at low temperatures (15°C)
- Simple to control and operate
- Retains anammox easily
- Sidestream/Maintstream ANITA™ Mox ecosystem

Proven Results



Pilot Services

Veolia offers the following Pilot Services:

- On-site pilot testing trailors
- Startup and remote data collection
- Monitoring through Veolia's Aquavista™ smart water management system

ANITA™ Mox Mobile

"Plug and Play" Centrate Deammonification Solution

Complete Solution for Smaller Facilities

Do you have a plant that is 15 to 20 MGD or smaller? Do you need a complete centate solution that can be shipped to your facility on skids and ready to be connected and functional? If the answers to these questions are yes, the ANITA Mox Mobile will be exactly what you are looking for. It is a complete package plant ready to take and treat centrate and remove nitrogen as soon as it's connected.

Realizing the Advantages

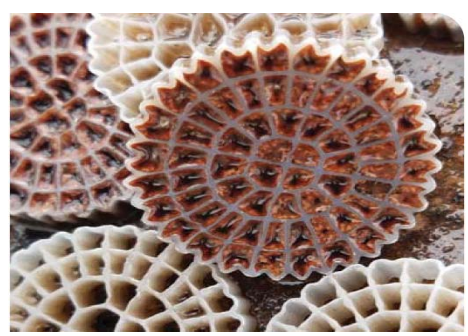
- Plug and play
- Minimizes onsite construction and plant interference
- Fast project delivery
- Lowest overall CAPEX & OPEX cost
- Zero external carbon requirement
- Lowest sludge production
- Proven simple, stable and robust technology
- Fully automated requiring minimal operator attention

System Components

The ANITA Mox Mobile MBBR package consists of a reactor, AnoxK™ 5 media, aeration diffusers, media retaining screens, mixers, blowers, air and/or liquid control valves, control panel, instrumentation and pipe connection ports. The IFAS package would also include a clarifier and RAS/WAS pumps. Other system options such as centrate feed pumps and access walkway can also be included per customer requirements.

Unit Design Capacity

The ANITA Mox Mobile package comes with different models and sizes. For regular centrate, the rated ammonia removal capacity for one MBBR unit ranges from 100 to 500 lbs NH_3-N/day; the rated ammonia removal capacity for the more robust IFAS unit ranges from 200 to 1,000 lbs NH_3-N/day. For THP centrate with high COD concentrations, the rated ammonia removal capacity for an IFAS unit can be up to 300 to 500 lbs NH_3-N/day depending on COD loading.



Contact Us for More Information

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usmunicipal@veolia.com • www.veoliawatertech.com

ANITA™ Mox: Simple Start Up with High Influent TSS

Deammonification | Case Study

Little Patuxent Water Reclamation Plant

The Client

Little Patuxent Water Reclamation Plant (LPWRP) is located in Howard County, Maryland. This is a 29 MGD ENR (Enhanced Nutrient Removal) plant that discharges to the Little Patuxent River which goes to the Chesapeake Bay.

Design Criteria

- Design flow: 0.176 MGD
- Influent NH_4-N: 1,100 mg/L

Effluent criteria:
- 80-85% of NH_4-N Removal
- 70-75% TN Removal

The Client's Needs

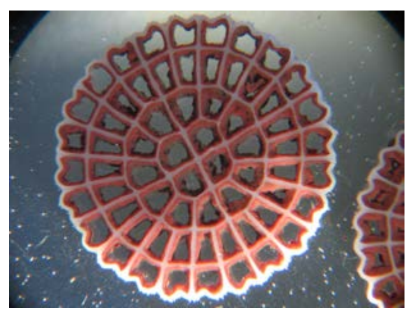
In 2013, Howard County began plans for an upgrade to its biosolids management facilities at LPWRP with high rate anaerobic digestion, rebuilt centrifuges for dewatering, a phosphorus recovery system and a sidestream deammonification system. The sidestream process is designed to reduce the impact of nitrogen load returned back to the mainstream treatment process and ensure that the plant meets the stringent discharge TN limit of 3 mg/L. LPWRP required the sidestream process to meet the following:

- Treat centrate with a high solids concentration (800 mg/L or higher) without requiring solids pretreatment.
- Proven, simple and robust treatment process that is supported by successful installations throughout the US.
- Easy to operate and requires minimal maintenance.
- Stable system that retains anammox bacteria easily and is not prone to washout, and more importantly,
- Fit into existing tankage.

The Solution

Howard County and the CMAR team chose Veolia's ANITA™ Mox MBBR sidestream deammonification process to meet the plant's requirements while offering project cost savings.

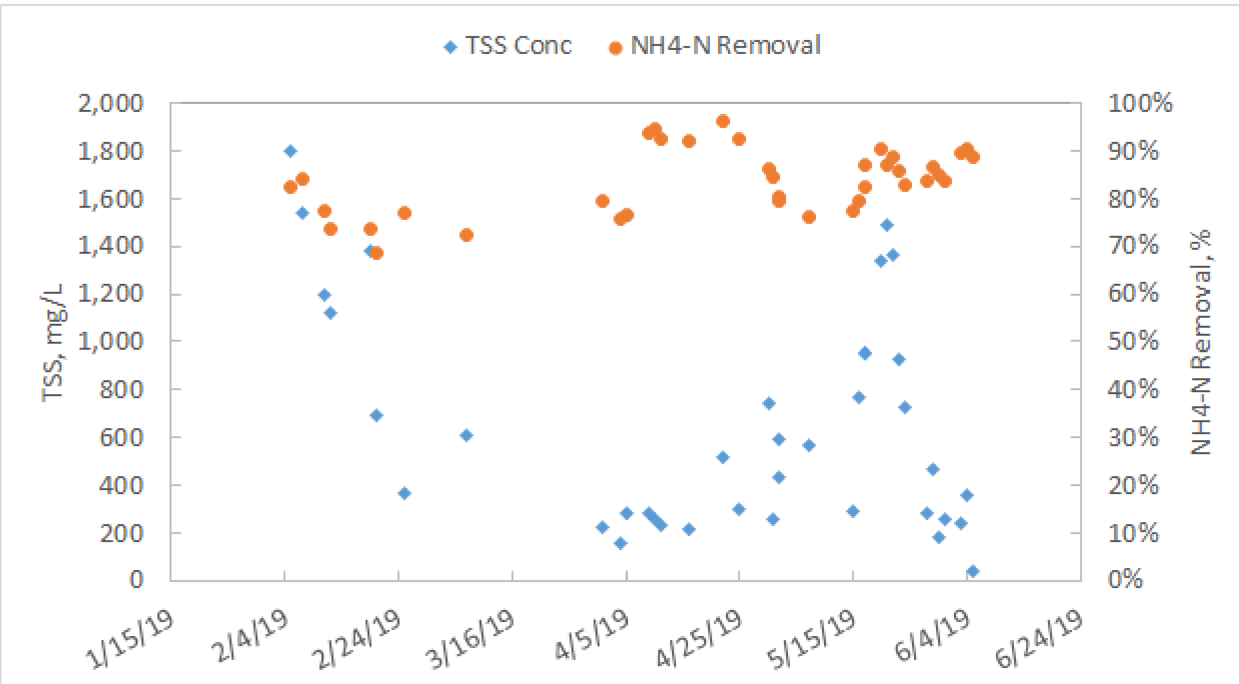
ANITA™ Mox utilizes K5 biofilm carriers and media retaining screens, eliminating anammox washout. Biomass (including anammox and AOBs) remains attached to the carriers as high TSS passes through the system.



ANITA™ Mox: Simple Start Up with High Influent TSS

Process Description

The ANITA™ Mox system was retrofitted into existing tanks with relatively shallow side water depth. The tanks were originally aeration tanks for an industrial waste pretreatment system that was mothballed before the Biosolids Project started. The system components such as the media, media retaining screens and medium bubble aeration diffusers are designed to be maintenance free for the lifetime of the system. The media fill volume of each of the two reactors leaves room for future expansion by simply adding more media if ammonia loading increases. Air for the ANITA™ Mox system is supplied via dedicated blowers as required by the plant. The small footprint of the system is able to save room for two small EQ tanks, designed to provide consistent loading to the reactors for enhanced performance. The patented ANITA™ Mox process controls strategy has the flexibility to be controlled by DO, pH, and/or ammonia for optimal energy savings.



Results

After adding seeded media from an existing BioFarm in the US, the reactors reached the design loading and removal rates despite high influent TSS concentrations. Reactor operation and performance is largely unaffected by high TSS concentrations. Since startup in early 2019, the ANITA™ Mox system continues to meet the design Nitrogen removal rates. The two small ANITA™ Mox reactors are able to remove approximately 15% of the total nitrogen load of the plant with low cost.

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Meeting Strict TN Limits: ANITA™ Mox

Biological Treatment | Case Study

South Durham Water Reclamation Facility

The Client

The City of Durham is located in the Research Triangle Region of North Carolina. The City operates two wastewater treatment plants – the North Durham Water Reclamation Facility and the South Durham Water Reclamation Facility, both permitted to treat 20 million gallons per day (MGD).

Design Flow: 0.08 MGD;
Peak Design Flow: 0.16 MGD
Effluent Criteria:
- ≥75% NH_4-N Removal
- ≥65% TN Removal

The Client's Needs

In 2011, the City of Durham completed a comprehensive wastewater master plan that evaluated different treatment techniques for meeting strict total nitrogen (TN) limits at the South Durham Water Reclamation Facility (SDWRF). The SDWRF will need to meet a TN limit of 3 mg/L at its design flow to comply with the total maximum daily load (TMDL) in the Jordan Lake Watershed, which serves as a source of drinking water in the region. The SDWRF uses anaerobic digesters to break down the plant's sludge. Downstream of the digesters, the plant uses belt filter presses for dewatering. The resulting liquid – the pressate from dewatering, or what is referred to as "sidestream" flow – historically accounted for about 20 percent of the nitrogen load in the plant's biological nutrient removal (BNR) process. While this sidestream nitrogen contribution sounds high, it is typical for many plants with anaerobic digestion.

The Solution

As a result of the evaluation, Durham selected Veolia's ANITA™ Mox sidestream deammonification system for ammonia and total nitrogen removal. The City studied mainstream and sidestream treatment alternatives to meet its TN limits. In its cost comparisons, ANITA™ Mox was calculated to be three times lower in cost per pound of nitrogen removed when capital and operating costs were considered. ANITA™ Mox was estimated to cost \$0.93 per pound of nitrogen removed (\$/lb N), while the most cost-effective mainstream BNR solution was estimated at \$2.66/lb N. The City thus selected ANITA™ Mox as the most cost-effective nitrogen removal alternative.

Process Description

ANITA™ Mox is Veolia's sidestream deammonification technology for short-cut nitrogen removal. When compared to conventional mainstream nitrification/denitrification, ANITA™ Mox uses about 60% less oxygen, requires no external carbon source, and produces less sludge.

ANITA™ Mox is offered in both Moving Bed Biofilm Reactor (MBBR) and Integrated Fixed Film Activated Sludge (IFAS) configurations, depending on site conditions. As such, the system consists of engineered polyethylene carriers – in this case AnoxKaldnes™ K5 media – to provide ample protected surface area for biofilm to thrive. The K5 media (approximately the diameter of a quarter) host two types of bacteria in the same reactor. The outer layer consists primarily of ammonia oxidizing bacteria (AOBs) which convert about half of the ammonia to nitrite. The inner layer consists mainly of anammox (anaerobic autotrophic ammonia oxidizer) bacteria. These bacteria utilize the resulting nitrite and much of the remaining residual ammonia and convert them to nitrogen gas, which is released harmlessly to the atmosphere.

Since ANITA™ Mox has a high removal rate and treats the smaller sidestream flow at a wastewater plant, it has a compact treatment footprint. At many plants, the system can fit into a spare or abandoned tank on site. At the SDWRF, for example, the MBBR system was constructed in an abandoned aerobic digester.

SDWRF – Nitrogen Returned to the Influent Pump Station Requiring Additional Treatment

Parameter	With ANITA™ Mox (pounds per year)*	Before ANITA™ Mox (pounds per year)*	Guaranteed Removal by ANITA™ Mox
Ammonia Nitrogen	**< 61,000**	244,000	≥ 75%
Total Nitrogen	**< 94,000**	268,000	≥ 65%

* Values based on Design Flow and Loads for 365 days per year.

ANITA™ Mox Removes Nitrogen Efficiently – Requiring Less Aeration Energy, Chemical Usage, and Sludge Management than Conventional Nitrogen Removal

Parameter	ANITA™ Mox	Conventional Nitrogen Removal	Sidestream Savings with ANITA™ Mox
Oxygen Requirement (lb O_2 / lb N)	**1.9**	4.6	60%
Methanol Consumption (lb / lb N)	**0**	3.0	100%
Sludge Production (lb VSS / lb N)	**0.1**	0.5 – 1.0	80% to 90%

Results

At the SDWRF, the ANITA™ Mox MBBR system was started up in 12 weeks – an efficient time given the slow growth of anammox bacteria. Now operating full-scale, the system is achieving greater than 80% ammonia removal and 70% total inorganic nitrogen (TIN) removal – both exceeding guaranteed values. The ANITA™ Mox system is thus helping the SDWRF meet its strict effluent nitrogen limits using the most cost-effective solution.

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What are clients saying about ANITA™ Mox?

JOHNSON COUNTY KANSAS
Wastewater

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

METRO WASTEWATER RECLAMATION DISTRICT
DENVER, CO

CITY OF DURHAM

SANITATION DISTRICTS OF LOS ANGELES COUNTY
Converting Waste Into Resources

CITY OF SAN LUIS OBISPO

HRSD
Cleaning wastewater every day for a better Bay.

ANITA™ Mox Testimonial

- Evaluated sidestream Technologies:
  - Chicago piloted granular deammonification process
  - Denver piloted ANITA™ Mox (fixed film)
- Shared results through the LIFT Group:
- Both Facilities Chose ANITA™ Mox:
  - Fit within existing reactors
  - More robust system = more forgiving
  - No risk of anammox washout due to upset conditions
  - Operational flexibility
  - Ease of Operation

Egan WRP (Chicago, IL)

Piloted Granular

Installed ANITA Mox

MWRD (Denver, CO)

Piloted ANITA Mox

Installed ANITA Mox

ANITA™ Mox Testimonial - MWRDGC (Chicago, IL)

Chicago's published reasons for selecting ANITA Mox:

The justification for the sole source request is as follows:

- This process is the only nitrogen removal process available on the market that does not require management of a separate sludge. The Biofilm process does not produce sludge.
- The biological process of the ANITA Mox MBBR can withstand weekend shutdown based on the Monday through Friday operating cycle of the centrifuges.
- The only other process that is currently marketed to completely remove most of the nitrogen from centrate requires a sludge management system and very close pH control.
- The agreement with VWSNA will include performance standards that guarantee greater than 75% ammonia removed from the process stream.

ANITA™ Mox Testimonial - SDWRF (Durham, NC)

DURHAM
1869
CITY OF MEDICINE

CITY OF DURHAM | NORTH CAROLINA

Date: January 3, 2013

To: Thomas J. Bonfield, City Manager

Through: W. Bowman Ferguson, Deputy City Manager

From: Donald F. Greeley, Director, Water Management

Subject: Sole Source Purchase Agreement with I. Krüger Inc. for the Purchase of the ANITA Mox Ammonia Removal System

Executive Summary

The Falls Lake and Jordan Lake rules that become effective in 2016 will require significant reductions in the amounts of nutrients discharged from the North and South Durham Water Reclamation Facilities (NDWRF and SDWRF). The recent Water Reclamation Facility Master Plan developed by Hazen and Sawyer recommended that that the Department utilize the patented and proprietary ANITA Mox nitrogen removal system ("ANITA Mox System") owned by I. Krüger Inc. (Krüger) as the preferred approach to meet the stringent nutrient limits at SDWRF. There is no competitive process that performs at the same level of the ANITA Mox System, and Krüger is the only source and vendor of the ANITA Mox System. Staff recommends the direct purchase of the system equipment from Krüger. The equipment will be installed in an upcoming construction contract at the SDWRF.

the lowest cost over time. In other words, none of the other available nitrogen reducing side stream technologies could perform at the level of the ANITA Mox System. The ultimate selection of the ANITA Mox System requires that we also select the sole vendor and company authorized to sell the ANITA Mox System. The SDWRF Master Plan recommends the ANITA Mox system as being the best suited technology for the SDWRF application.

Advantages of ANITA^{TM} Mox over other Arrangements

- Less prone to loss of annamox organisms – attached growth
- Increased SRT with plastic carrier media
- Easily increase capacity of the process by adding media
- Reduced operational complexity
  - Continuous flow-through process
    - SBRs require settling and wasting phase
  - Single phase system with smaller footprint
    - SBRs require aerobic and anoxic phase

ANITA™ Mox Testimonial - Tomahawk WWTF (Johnson County, KS)

Tomahawk Creek WWTF Section objectives:

- Provide the most cost-effective, long-term solutions for customers.
- Improve water quality using the latest, <u>proven technologies.</u>
- Preserve the high quality of life enjoyed by Jonson County residents.

3.5.2 Nitrogen Removal

Nitrogen removal via separate centrate treatment offers efficiency through the use of specialized bacteria, such as anammox, capable of removing nitrogen without organic carbon (such as methanol) and at 60% less aeration energy by taking equal parts of nitrite and ammonia to produce nitrogen gas. Anammox bacteria coexist with nitrifying bacteria in a relatively low DO environment.

The candidate vendors offer differing systems, all utilizing the slow-growing anammox bacteria, each having certain advantages and disadvantages. For this evaluation the moving-bed bio reactor (MBBR) style, marketed as Anita-Mox by Veolia, was selected as the best technology due to robustness and operational simplicity. Certain design considerations are listed in Table 3-8.

Technical Memorandum – Tomahawk Wastewater Treatment Facility expansion - June 2016

ANITA™ Mox Testimonial - SLO WRRF (San Luis Obispo, CA)

Preferred Vendor Selection

A workshop to discuss the different sidestream treatment options and to select a vendor package to base the design upon was held with City of San Luis Obispo staff on May 17, 2017. The ANAMMOX® process was eliminated from further consideration because there are few installations in the United States. A triple-bottom-line analysis of the remaining two processes resulted in selection of the Anita™ Mox system. Robustness of response to flow and load variability, and ease of operation and maintenance, were the main differentiators between systems.

Final Predesign Report – San Luis Obispo Water Resource Recovery Facility – October 2017

ANITA™ Mox Testimonial - LA County Sanitation District

SANITATION DISTRICTS OF LOS ANGELES COUNTY

Converting Waste Into Resources

"We tested both the MBBR version and the IFAS version of the ANITA Mox process. I was very impressed by the performance of the system. It was **easy to control, robust, and did what we expected it to do**. We're currently pilot testing the MBBR version at another plant (Valencia, 15 MGD). When we started a couple of weeks ago, there was a problem with the pipe feeding the pilot system. The pipe was clogged over the weekend, but the compressor continued to operate. Consequently the system got over-aerated (DO>9 mg/L) and the pH was down to ~5.5 when we came back on Monday. Once we fixed the problem, **the system quickly responded and started removing N** (I guess it was an unplanned robustness test). After one week of operation, we've observed **very high volumetric and surface N removal rates.** "

– Chi-Chung Tang, LACWSD

ANITA™ Mox Testimonial - MWRD (Denver, CO)

- "The pilot-scale evaluation of the ANITA Mox MBBR technology at the RWHTF supported the conclusion that performance of the continuous flow deammonification process was **compact, consistent, and reliable.**"

- "The **aeration control strategy** used for operating the pilot system **was straightforward and simple to operate**."

- "The pilot system **was able to recover in about two days after an extended interruption to aeration and feed**."

- – from *Evaluation of the Anita-Mox Moving Bed Biofilm Reactor Process for Sidestream Deammonification at the Robert W. Hite Treatment Facility, Denver Colorado* by Hollowed, Meg, et al.

METRO WASTEWATER RECLAMATION DISTRICT

VEOLIA

Corporate Description

Company Overview

Veolia Water Technologies, Inc. (dba Kruger) is a water and wastewater solutions provider specializing in advanced and differentiating technologies. Kruger provides complete processes and systems ranging from biological nutrient removal to mobile surface water treatment. The AnoxKaldness Hybas and MBBR processes, ANITA Mox Deammonification Process, BioCon Dryer, BIOSTYR Biological Aerated Filter (BAF), NEOSEP MBR and HYDROTECH Discfilters are just a few of the innovative technologies offered by Kruger. Kruger is a subsidiary of Veolia Water Technologies, a world leader in engineering and technological solutions in water treatment for industrial companies and municipal authorities.

Veolia, present throughout the world, develops a global approach responding to specific needs of customers at each of their production facilities. This has allowed Veolia to become the world leader in design, project management and execution of projects for water and wastewater treatment plants. The company also creates dedicated technology solutions to meet its customer's needs. Its unique portfolio of differentiating technologies, developed by the group's R&D centers, ensures unsurpassed innovation and control of each treatment line for public organizations and industries. Furthermore, a whole range of associated services is offered on each site to guarantee the technical efficiency and life expectancy of the installed solutions. Veolia continually extends and enriches its offer, to guarantee expertise and competence at every step of the projects it undertakes.

Kruger prides itself for being a customer-focused organization that provides solutions to challenges faced by municipalities and not just another equipment supplier. To achieve this, Kruger has gathered a force of process experts, trained sales staff, and project managers that share our vision and priorities. Please see the attached information describing the experience and expertise of Our People. We are proud of our staff and know that they are the most qualified team in the market to provide your project the right solution to meet the plant's needs and future goals.

Location and Addresses of Corporate and Regional Offices

Kruger's corporate office is located in the Raleigh, NC area.

Kruger	Customer Support Center
4001 Weston Parkway	1500 Garner Road, Suite C
Cary, NC 27513	Raleigh, NC 27610

In addition, Veolia hosts multiple regional offices across North America in support of our clients, including the Customer Support Center (i.e. aftermarket services and equipment spare parts), within 20 minutes from Veolia’s corporate office. See the Summary of Support Services section below for more details.

Date and State of Incorporation

Veolia celebrates 160 years of service to cities, regions and local communities. Established in 1853, Veolia’s long history proves our stability and financial strength. Veolia Water Technologies, Inc. (dba Kruger) was incorporated on May 27, 2004 and is incorporated in Delaware. Kruger further builds on Veolia’s expertise, offering more than 30 years of experience servicing the US municipal market.

Bonding Qualifications

Veolia Water Technologies, Inc. (dba Kruger) has sufficient financial stability and backing to provide the performance bond as required by the specifications. Kruger can provide a pre-qualification letter for proof of ability to provide such a bond as requested within the specifications upon request.

Corporate and Financial Stability

The Veolia companies in North America, including Veolia Water Technologies, Inc. dba Kruger (Kruger), are part of Veolia Environnement, S.A. (Veolia). Veolia traces its history to the establishment of Compagnie Générale des Eaux (CGE) on December 14, 1853. Since that time and over 160 years, Veolia has continued to focus on new frontiers of environmental business and its traditional markets, in emerging and developed countries. In support of this progress and in line with our commitments, Veolia has strengthened its operating and financial performance.

Veolia is the global leader in optimized resource management. With nearly 171,000 employees worldwide, Veolia designs and provides water, waste and energy management solutions that contribute to the sustainable development of communities and industries. Through its three complementary business activities, Veolia helps to develop access to resources, preserve available resources and replenish them.

In 2018, the Veolia group supplied 95 million people with drinking water and 63 million people with wastewater service, produced nearly 56 million megawatt hours of energy and converted 49 million metric tons of waste into new materials and energy. Veolia Environnement, operating in five continents, realized $30.1 billion (€25.91 billion) in revenue for 2018.

Kruger, as part of the Veolia family of companies, provides financial strength and stability to our customers. Veolia offers the support structure desired by municipal authorities, assuring project stakeholders of Kruger's commitment to meeting performance guarantees, extended project schedules and ongoing warranties. Veolia has been in business for over 160 years, providing the comfort to our customers that Kruger will remain supportive for the life of the project and beyond.

Veolia's 2018 financial statement is available online. Please see the following website for more information.

https://www.veolia.com/en/veolia-group/finance

Corporate Sustainability

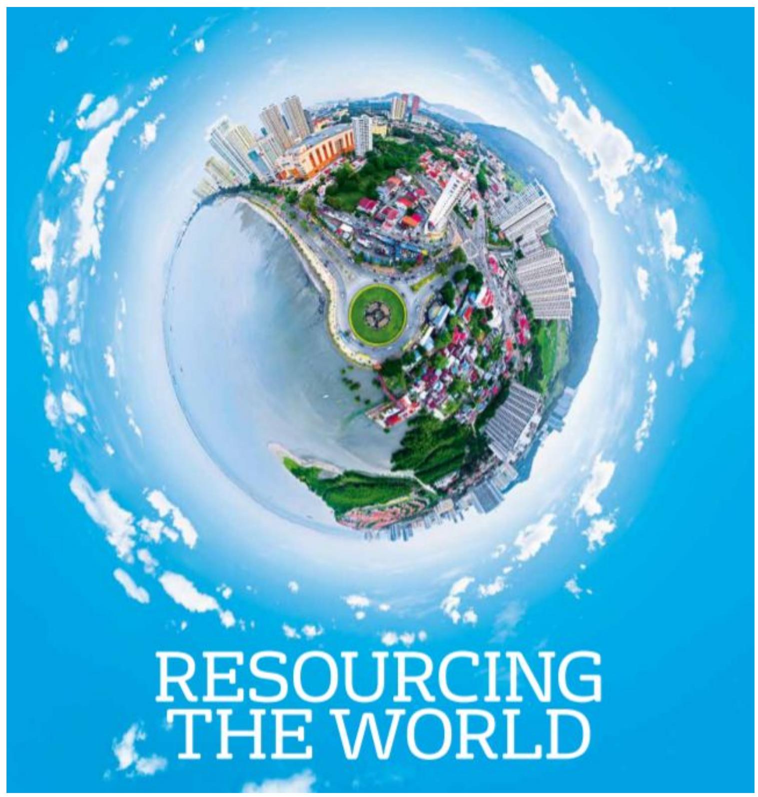
Veolia's 'Resourcing the world' mission is based on a vision of our environment that is shared by our employees, including those at Kruger: the world as it should be. In this world, fewer resources are wasted and they are shared fairly; waste has a value and uses are found for wastewater; and energy is efficiently managed and reused. In this world, companies as well as government bodies play a central role in anticipating and supporting major global transitions. In this world, companies voluntarily ask themselves what is their purpose and their use. This vision both drives and commits us. Our goal is not only to be the world leader but also the standard setter for environmental businesses: *the company that resolves, prepares the ground and invents, inspires and shows the way.*

Resourcing the World

The world has to rethink its relationship with resources and come up with new social and economic growth models that are more efficient, better balanced and more sustainable.

With 160 years of expertise in the areas of water, energy and waste, Veolia applies its capacity for innovation to pursue human progress and wellbeing, and improving the performance of businesses and regions.

To make the switch from a resource consumption rationale to a use-and-recover approach in today's circular economy, Veolia designs and implements solutions aimed at improving access to resources while at the same time protecting and renewing those same resources.



This is how Veolia and its employees contribute each and every day to resourcing the world.

https://www.livingcircular.veolia.com/en

Resourcing the world

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