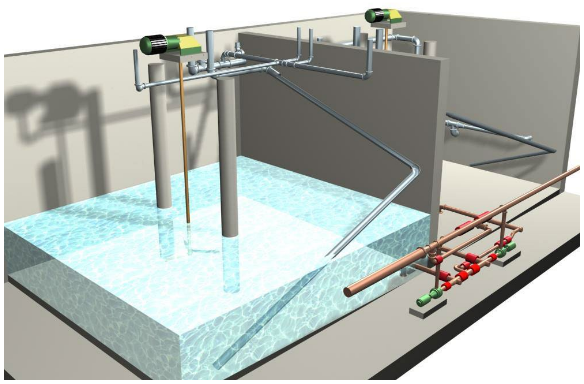
WRF 4973 Fact Sheet: ID 1610

Strategy: Reject Water Management

Sidestream Return Flow Management



Equalization.
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Extended Dewatering Schedule or Off Peak Dewatering.
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Reject water management does not remove any nutrients but controls the return load to attenuate variable nutrient loads. Dewatering equipment is frequently operated intermittently. Operational hours required depends on the capacity of dewatering equipment, the size of the water resource recovery facility (WRRF), and daily digested sludge production. Dewatering operations could be 1 day per week for part of the day, multiple days per week for part of the day, or continuous.

Attenuating the recycle load to the WRRF improves process reliability and results in lower effluent concentrations. Strategies for load attenuation include:

- Flow equalization. The return flow schedule can be adjusted to manage blower demand by returning water during low loading (overnight) periods or by simply spreading the load to achieve a continuous baseline load from the reject water.
- Using an off-peak dewatering schedule to manage blower demand.
- Continuous 24/7 dewatering.

Fact Sheet Application Checklist

R = fact sheet relevant to item
PR = fact sheet is potentially relevant to item depending on application, existing conditions, etc.

Category		
		Intensification
		Chemical addition
	R	Carbon management
		I&C strategies
	R	Sidestream mgmt.
	R	Energy savings
		Chemical savings
	R	Operational savings
	R	Other means of NutRem

Nutrient		
	R	Ammonia
	R	NOx
	R	TN
	R	Ortho-P
	R	TP

Scale (design flow)		
	PR	Small (<1 mgd)
	R	Medium (1–10 mgd)
	R	Large (>10 mgd)

Goal		
	R	Improve reliability
	R	Reduce nutrient
	R	Reduce O&M cost

Group		
	R	Optimize existing CNR
	R	Optimize existing TNR
		NutRem in secondary plant

Process		
		Small
		Pond
	R	Fixed film (secondary)
	R	Conventional act. sludge (CAS)
	R	Nitrifying act. sludge (NAS)
	R	Conventional NutRem (CNR)
	R	Tertiary NutRem (TNR)
		Other

CAS = conventional activated sludge (BOD only)
NAS = nitrifying activated sludge (without denitrification)
CNR = conventional nutrient removal no chemical/no filter, etc.
TNR = tertiary nutrient removal with chemical, filter, etc.

Technology Summary Evaluation

Footprint	1	Compared to conventional (1 = much smaller; 3 = conventional; 5 = much larger)
Development status*	5	Technology ranking based (LIFT) see below*
Energy use	2	Scale 1–5: 1 = use much less; 3 = use similar to conventional; 5 = use much more
O&M cost	4	Scale 1–5: 1 = cost much less; 3 = cost similar to conventional; 5 = cost much more
Material/consumables	2	Scale 1–3: minimal = 1; some = 2; significant = 3 (e.g., UV lamps/membranes)
Chemical use	1	Scale 1–3: minimal/none = 1; some = 2; significant = 3 (e.g., chemical process)

* Technology ranking based on Leaders Innovation Forum for Technology (LIFT) Water Research Foundation (WRF) Technology Development Level (TDL) definitions:
1 = bench research and development
2 = small-scale pilot
3 = full-scale pilot (demonstration)
4 = pioneer stage (production and implementation)
5 = conventional

Descriptions/Evaluation

Strategy	Reject water (sidestream) flow management to minimize the impact of recycle loads on WRRF performance and reliability
Description	Mitigating the negative impact of sidestream variability on mainstream as well as sidestream performance. Many WRRFs operate dewatering intermittently, resulting in magnified return loads. Flow management does not involve treatment but rather equalization, longer equipment runtimes, changing operational practices, and controlled release for sludge storage lagoon overflow.
Application	Sidestream management is applicable to some degree at every WRRF that has anaerobic digesters and dewatering or sludge storage lagoons that generate a high-strength return flow stream. WRRFs that can benefit the most are: • Nitrifying WRRFs • WRRFs with total nitrogen (TN) or total phosphorus (TP) limits • Nitrifying WRRFs with insufficient alkalinity to nitrify the variable recycle load • WRRFs with a sludge storage lagoon that overflows back to the WRRF • WRRFs that practice decanting of solids storage tanks or digesters
Constituents removed	None directly, but load equalization results in lower average effluent nutrients
Development status*	LIFT TDL 5: Sidestream management consists mostly of operational practices.
O&M considerations	Sidestream management will generally reduce operation costs by smoothing out the load to the WRRF. Operational considerations are: • Equalization tanks for dewatering centrate are susceptible to struvite accumulation • Operator input and control of reject water flow to liquid treatment
Benefits	• Reduce effluent nutrient load variability • Increased secondary treatment capacity • Reduce peak blower demand • Flow attenuation is required for some sidestream treatment technologies
Limitations	Limitations are application specific: • Dewatering equipment capacity may be too high • Available tankage for flow equalization • Potential for struvite formation
Design considerations	It depends on selected method. Some general considerations are: • Risk of struvite scaling in piping and pipe fixtures require ability to clean. Use non-stick pipe materials to limit precipitants. • Risk of struvite precipitants accumulation in storage tanks.
Potential fatal flaws	None
Footprint requirements	Depends on the WRRF operation. Expect approximately 10%–20% of the total digester volume.
Residuals	No change
Cost considerations	Equalization requires additional tankage—new or repurpose available tanks. Schedule changes to operate 24/7 may require different equipment and increase operator monitoring time.
Past experience	Durham WRRF, Clean Water Services, Portland, Oregon: dewatering centrate equalization Coeur d'Alene, Idaho: dewatering centrate equalization Howard County, Maryland, Little Patuxent Water Reclamation Facility: dewatering centrate equalization

Publications	Kasi, M., W. Wehner, M. Benisch, A. Perreira, and J. Wodrich. 2017. "Paradigm Shift if Dewatering Operations Moved to the Center of the Plant Universe." Nutrient Symposium. Fort Lauderdale, Florida: WEF. Phillips, H.M., E. Kobylinski, J. Barnard, and C. Wallis-Lage. 2006. Nitrogen and phosphorus-rich sidestreams: Managing the nutrient merry-go-round. Proceedings of the Water Environment Federation, 2006(7), pp.5282–5304.
Related fact sheets	1601: Reject Water (Sidestream) Management Overview 1740: Reduce Power Demand 1901: Optimize Operation and Maintenance
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Note

* Technology ranking based on LIFT WRF TDL definitions:
1 = bench research and development
2 = small-scale pilot
3 = full-scale pilot (Demonstration)
4 = pioneer stage (production and implementation)
5 = conventional (https://www.waterrf.org/sites/default/files/file/2019-07/LIFT%20Scan%20Application-LIFT%20Link%2BHub_0.pdf : accessed September 2020)

Additional Information

Example Reject Flow Equalization

Intermittent reject stream carrying high ammonia and phosphate concentrations can negatively impact the mainstream process performance. Ammonia will bleed through into the effluent, creating short-term effluent ammonia peaks that can threaten meeting effluent ammonia limits and also impacting chlorine disinfection. Variable nutrient loadings will also impact the nitrogen (N)/chemical oxygen demand (COD) and phosphorus (P)/COD composition of the influent and can cause variability in biological nutrient removal (BNR) process performance. Reject flow equalization mitigates the impact of the sidestream load by managing how much and when the reject water is returned to the main process.

Flow equalization is the easiest and most cost-effective way to manage sidestreams. While equalization does not eliminate the nutrient cycle load, it enables operators to manage the additional nutrient loads by returning sidestreams in a controlled manner. The recycle load can be equalized either operationally with a continuous dewatering schedule (24 hours per day, 7 days per week), or by incorporating an equalization basin where the sidestream is stored and returned gradually.

With an equalization basin the operators can choose to return more of the recycle load during the off-peak hours of the day. In fact, the recycle load can be used to level out the WRRF load over the 24-hour period. When operating the off-peak return of high-ammonia recycle loads, one has to consider the change in the wastewater composition with respect to alkalinity for nitrification and available carbon for denitrification; unfavorable conditions for nitrification and/or N removal may occur.

Even partial equalization can reduce the peak load significantly. At most municipal facilities the diurnal peak influent load overlays with the day shift dewatering schedule, merely storing the recycle load for the duration of the diurnal influent peak will greatly reduce the impact of the recycle load on the liquid stream process.

Figure 1 illustrates how the different sidestream management options can impact the secondary treatment influent ammonia load and subsequent oxygen demand for nitrifying the load.

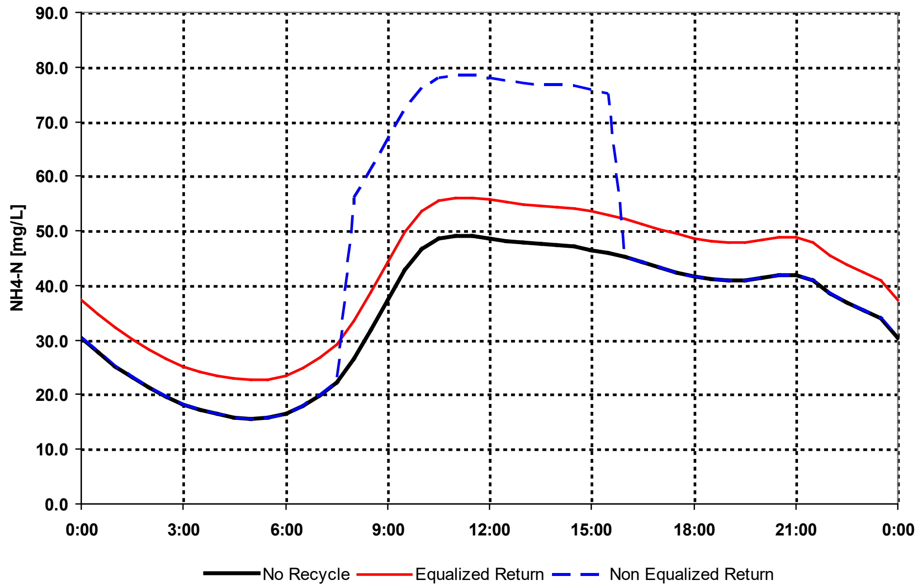

Figure 1. Illustration of Dewatering Recycle Ammonia Load Impact on Aeration Basin Influent Ammonia Concentration.
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Example Lagoon Overflow Control

A sludge storage lagoon can be a source of sporadic load spikes for biochemical oxygen demand (BOD), total suspended solids (TSS), ammonium-nitrogen (NH_4-N), and orthophosphate (PO_4-P). Under normal operation lagoon water from the lagoon is displaced when solids are fed. This usually results in a fairly steady recycle stream. Heavy rainfall, inversion within the lagoon, and dredging can increase the flow from the lagoon as well as quality of the decant flow. This is problematic when the storage lagoons are full.

Figure 2 shows a concept implemented at a WRRF to attenuate the flow return from lagoons. It relies on an indicator parameter measurement such as elevated PO_4-P or TSS in decant to trigger a submerged gate to move to the top position stopping any overflow from the lagoon. Depending on the available storage volume this will provide several hours to weeks of storage, which allow operators to mitigate secondary (mainstream) treatment upsets or permit violations. Mitigation could include chemical treatment of the lagoon return flow or waiting for overflow water quality to improve before returning the lagoon flow.

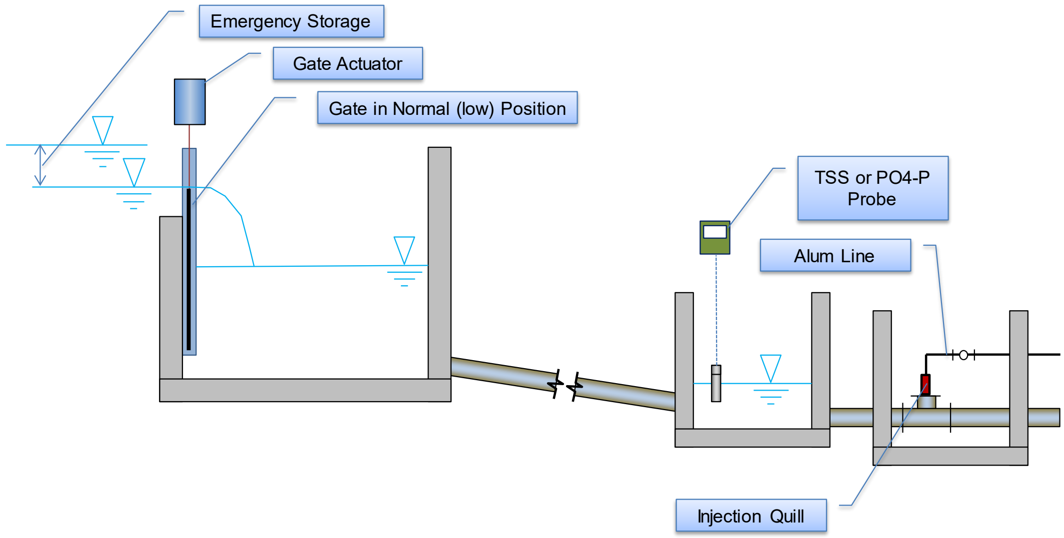

Figure 2: Lagoon Overflow Control Concept.
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Abbreviations

BNR	Biological nutrient removal
BOD	Biochemical oxygen demand
CAS	Conventional activated sludge: BOD removal only
CNR	Conventional nutrient removal
COD	Chemical oxygen demand
I&C	Instrumentation and controls
LIFT	Leaders Innovation Forum for Technology (now RIC and RISE)
mgd	Million gallons per day
N	Nitrogen
NAS	Nitrifying activated sludge
NH_4-N	Ammonium-nitrogen
NO_x	Oxidized nitrogen (nitrate + nitrite)
NutRem	Nutrient removal
O&M	Operations and maintenance
P	Phosphorus
PO_4-P	Orthophosphate
RIC	Research & Innovation Committee
RISE	Research and Innovation for Strengthening Engagement
TDL	Technology Development Level
TN	total nitrogen
TNR	Tertiary nutrient removal
TP	Total phosphorus
TSS	Total suspended solids
UV	Ultraviolet
WRF	The Water Research Foundation
WRRF	Water resource recovery facility