Design Review Committee Briefing #40

Subject: Sidestream Treatment Evaluation

Date: December 15, 2020

The Issue

The sidestream treatment process serves as a means for reducing internal phosphorus recycle loads and reduces phosphorus precipitants (struvite) from building up in key processes of a wastewater treatment plant (WWTP). Struvite is a nuisance byproduct that forms through chemical reactions of magnesium, ammonium, and phosphate to produce hardened crystals. The configuration and performance of the sidestream treatment process is integral to achieving the required effluent discharge requirements for the Nampa WWTP. Three previous briefing on Sidestream treatment have been presented to the Design Review Committee (DRC), DRC Briefings #12, #16, and #29.

Background and Analysis

Sidestream treatment reduces the operational challenges related to struvite accumulation (e.g. clogged pipes and mechanical equipment failures), reduces the overall nutrient loading to the secondary treatment system thereby reducing the system size, and some technologies provide an opportunity to produce a revenue-generating product. This is a rapidly evolving technology and the various approaches presented below are closely tied to specific technology providers. The technologies evaluated are described below and process flow diagrams were provided in DRC Briefing #12.

- **Alternative 1 - Centrate Precipitation with Harvesting**: Alternative 1 involves installing a sidestream treatment reactor to treat centrate, which is the liquid removed through the solids dewatering process. This is a nutrient-rich stream that comprises approximately 20 to 30 percent of the overall nutrient load for the Nampa WWTP. Alternative 1 generates struvite from the centrate and harvests it for sale through a third-party contract, which is negotiated in conjunction with the equipment process selection. This alternative produces a higher quality (and higher valued) product than other options presented.
- **Alternative 2 - Direct Chemical Addition:** Alternative 2 involves installing an expanded ferric chloride dosing system which is dosed to the process at the primary digesters. This precipitates phosphorus out of the liquid stream and allows it to be disposed of in the biosolids. This approach does not provide a means to recover a product. This alternative involves construction of chemical storage tanks, mixers, and hauling infrastructure. With this alternative, the City would experience increased operations and maintenance to address struvite-related issues such as equipment failures.
- **Alternative 3 - Centrate and WAS Precipitation with Harvesting:** Alternative 3 builds upon Alternative 1. In addition to installing a sidestream treatment reactor similar to Alternative 1, a tank is added to allow release of phosphorus from the waste activated sludge (WAS) stream prior to thickening and digestion. When compared to Alternative 1, this increases phosphorus removal from the system and increases the quantity of product that can be harvested for sale.
- **Alternative 4 - Digested Sludge Precipitation with Harvesting:** Alternative 4 is the installation of sidestream treatment between the primary anaerobic digesters and the sludge dewatering process. This approach reduces the risk of struvite accumulation on the sludge dewatering equipment (i.e. centrifuges). However, because the struvite is recovered from the digested sludge, the struvite product created is lower quality than Alternatives 1 and 3 and, therefore, has a lower potential value.

- **Alternative 5 - Digested Sludge Precipitation without Harvesting:** Alternative 5 is similar to Alternative 4 except the product is not harvested and instead is sequestered in the biosolids which are sent to a landfill. This approach reduces the costs of having to process the product to a marketable quality but does result in a loss of financial benefit from the sale of the product.

A preliminary business case evaluation was prepared as during the preliminary design phase of the project. The results of this analysis were presented in DRC Briefing #16 and are presented below in Table 1. As shown in this table, Alternative 5 was the preferred approach with Alterative 2 a close second. Subsequent sampling, which is summarized in DRC Briefing #29, indicated that Alternative 2 was not a viable alternative. Therefore, the indicative design included Alternative 5 with the understanding that this analysis would be updated by the design-builder.

Table 1. Sidestream Treatment Process BCE Total Net Present Value Summary from Preliminary Design[1,2]

Alternative	Description	Capital	Benefit	O&M	Risk	R&R	NPV
1	Centrate Precipitation w/ Harvest (Ostara)	$15,072,000	$2,692,000	$8,988,000	$297,000	$1,462,000	($24,661,000)
2	Direct Chemical Addition	$1,130,000	$0	$14,226,000	$2,815,000	$92,000	($20,259,000)
3	Centrate and WAS Precipitation w/ Harvest (Ostara)	$16,950,000	$5,083,000	$16,439,000	$427,000	$1,503,000	($32,441,000)
4	Digested Sludge Precipitation w/ Harvest (AirPrex)	$13,568,000	$422,000	$8,278,000	$564,000	$1,097,000	($24,724,000)
5	Digested Sludge Precipitation w/ Sequester (AirPrex)	$9,540,000	$0	$8,244,000	$137,000	$799,000	($20,154,000)

[1]Cells highlighted in green indicate the lowest cost alternative for the conditions shown (recycled water discharge beginning in 2026).

[2]Total costs are shown in 2018 dollars, represent the period 2021 through 2040, and are rounded to the nearest $1,000

NPV = net present value.

Jacobs, the design-builder, update the sidestream treatment evaluation with new alternatives and updated pricing information. This updated the addition of Alternative 6, which is a variation on the originally considered Alternative 3 that recovers a lower value struvite product and reduces overall capital cost. Other alternatives considered during the indicative design were eliminated from consideration either due to a fatal flaw (Alternative 2) or high cost (Alternatives 1, 3, and 4). Jacobs obtained updated pricing information from vendors and developed refined estimates for operating costs, repair and replacement (R&R) costs, risks, and benefits. The results of this analysis are presented in Table 2.

As shown in Table 2, Alternative 5 remains the preferred alternative. Similar to the previous analysis, the lower capital cost for Alternative 5 outweighs the potential benefits associated with recovering a struvite product. Also of note, the capital costs for Alternative #5 has been reduced from the original estimate due to new pricing from the equipment supplier.

Table 2. Sidestream Treatment Process BCE Total Net Present Value Summary Updated by Design-Builder[1,2]							
Alternative	Description	Capital	Benefit	O&M	Risk	R&R	NPV
1	Centrate Precipitation w/ Harvest (Ostara)	No longer considered					
2	Direct Chemical Addition	No longer considered					
3	Centrate and WAS Precipitation w/ Harvest (Ostara)	No longer considered					
4	Digested Sludge Precipitation w/ Harvest (AirPrex)	No longer considered					
5	Digested Sludge Precipitation w/ Sequester (AirPrex)	$4,240,000	$0	$6,100,000	$142,000	$1,580,000	($12,050,000)
6	Centrate and WAS Precipitation w/ Low-Value Harvest (Ostara)	$7,910,000	$316,000	$5,010,000	$164,000	$2,870,000	($15,620,000)

[1]*Cells highlighted in green indicate the lowest cost alternative for the conditions shown.*

[2]*Total costs are shown in 2020 dollars, represent the period 2021 through 2040, and are rounded to the nearest $1,000*

NPV = net present value.

Potential Consequences

The Design Review Committee should be aware of the potential consequences of each alternative that may not be readily apparent from the BCE results. The primary consequences from this evaluation are described in further detail below:

- **Value of Recovered Product:** Alternative 6 provides an opportunity to recover a product that could be marketed and sold. Alternative does not include product recovery, although this could be added in the future if desired. Based on the assumed value of the harvested product, Alternative 6 does not have a positive return on investment (i.e. the revenue does not cover the costs). However, the City may see additional value in recovering this product beyond the potential revenue.
- **Modification Potential:** Alternative 5 does not include equipment for harvesting a revenue-generating product, however, the base technology used is the same to that used in Alternative 4, which does produce a product (see benefits presented in Table 1). Alternative 5 maintains the possibility to install harvesting equipment in the future if the City decides to pursue product sale.

Recommendation

The Technical Team recommends proceeding with Alternative 5 based on the consistent finding that this alternative provides to best value to the City.