Design Review Committee Briefing #20

Subject: Primary Sludge Thickening Approach Recommendation

Date: February 15, 2019

The Issue

Solids removed in the primary clarifiers, referred to as the primary sludge, are currently thickened in the primary clarifiers before being sent to the anaerobic digestion process. Solids thickening is important to help reduce hydraulic load on downstream processes such as anaerobic digestion. However, thickening in the primary clarifiers comes with process risks and could result in disruption of the liquid stream process, its treatment efficiency, and potentially its ability to meet effluent permit requirements. Mechanical thickening external to the primary clarifiers is a common approach used to limit the process risks while maintaining the benefit of reduced hydraulic load to the downstream processes. The Preliminary Design Technical Team (Technical Team) performed a business case evaluation (BCE) to evaluate the preferred approach to primary sludge thickening at the Nampa WWTP. The Technical Team is presenting the recommended primary sludge thickening approach technology to the Design Review Committee (DRC) for their concurrence.

Background and Analysis

The existing solids system thickens primary sludge (PS) in the primary clarifiers and waste activated sludge (WAS) will be thickened in rotary drum thickeners (RDTs) upon completion of the Phase I solids improvements. These two thickened raw sludge streams are sent to the primary anaerobic digesters. From the digesters, the digested sludge (or biosolids) is pumped to the dewatering process to remove excess water for disposal. The Technical Team evaluated four alternatives for thickening PS, which are noted in the following list and shown in the process flow diagrams in Figures 1 and 2. Due to the risk of process upset and the impact on the downstream anaerobic digestion process, the current approach of thickening in the primary clarifiers was not considered a viable alternative.

- **Primary Sludge Thickening Alternative 1 – Rotary Drum Thickeners:** Alternative 1 thickens PS by RDTs. This alternative includes a new thickening building with three RDTs and associated equipment. The proposed RDT configuration consists of three units each rated at 400 gallons per minute (gpm). One unit can thicken average sludge flows and loads. A second unit is needed to meet the 2040 peak day design condition. The third unit is provided for redundancy at the peak 2040 condition. The PS thickening system also requires solids feed pumps, PS equalization tanks with mixing pumps, thickened sludge pumps, a polymer makeup system, and a filtrate storage and pumping system.
- **Primary Sludge Thickening Alternative 2 – Centrifuges:** Alternative 2 thickens PS by centrifuges. This alternative has similar requirements as Alternative 1, except that three centrifuges are provided instead of RDTs. The building footprint is smaller for centrifuges. Centrifuges rotate at high speeds and so they require larger motors, 75hp each.
- **Primary Sludge Thickening Alternative 3 – Gravity Belt Thickeners:** Alternative 3 thickens PS with gravity belt thickeners (GBTs). This alternative has similar requirements as Alternative 1 and 2, except that three GBTs are provided. The building footprint is the largest for GBTs.
- **Primary Sludge Thickening Alternative 4 – Co-thickening:** Alternative 4 thickens PS and WAS by expanding the existing WAS-thickening RDTs in the Solids Handling Building (SHB). This alternative requires expansion of the SHB and three additional RDTs in order to provide n+1 redundancy. This alternative requires new sludge blending wells and solids thickening feed pumps in order to bring PS and WAS together upstream of thickening. A new basement will be required under the SHB to house the new pumping equipment and part of the sludge blending wells. The SHB will be expanded by constructing a new

structure against the existing east side of the SHB, and then creating opening in the existing east wall to tie-in the new and existing structures. The system also requires feed pumps, PS equalization tanks with mixing pumps, thickened sludge pumps, a polymer make up system and a filtrate storage and pumping system.

In order to do a holistic comparison between Alternative 4, which includes WAS thickening, and Alternatives 1 through 3, expansion of the existing WAS thickening system in the SHB as described in the Facility Plan was included in Alternatives 1 through 3. Two additional RDTs will be added to the existing WAS thickening system as well as two thickened sludge pumps and two more polymer feed pumps. The current feed configuration with one duty/one standby WAS pumps is unlikely to operate successfully with up to four operating RDTs. Therefore, the WAS facility expansion assumes that new WAS wet wells and RDT feed pumps will be provided for improved operability.

Capital costs, operating and maintenance (O&M) costs, and repair and replacement (R&R) costs were estimated for Alternatives 1 through 4. Alternatives 1 through 3 include these costs for the WAS facility expansion in addition to the PS thickening facility to be comparable with Alternative 4. Life cycle costs were used to determine the net present value (NPV) for each alternative. The results indicate that Alternative 4 has the lowest cost for all parameters and Alternative 2 has the highest cost. The NPV results confirmed co-thickening has the greatest NPV. Table 1 summaries the PS BCE results.

Table 1. BCE Total NPV Summary

Alternative	Capital	O&M	R&R	Risks	Benefits	NPV
Alternative 1: RDTs	$13,851,000	$10,670,000	$7,651,000	$1,279,000	–	($36,576,000)
Alternative 2: Centrifuge	$17,394,000	$10,449,000	$10,461,000	$1,286,000	–	($43,021,000)
Alternative 3: GBTs	$14,582,000	$11,283,000	$7,651,000	$1,279,000	–	($37,911,000)
Alternative 4: Co-Thickening	$9,480,000	$9,253,000	$4,548,000	$1,332,000	–	($26,947,000)

Table 1 indicates that Alternative 4 has the lowest total cost of asset ownership. By combining the thickening of PS and WAS, the capital and O&M costs are reduced for this alternative. The Technical Team performed sensitivity analyses on this decision to test its robustness. The results of the evaluation favored Alternative 4 in all cases suggesting that this is a robust decision.

Potential Consequences

The Design Review Committee should be aware of the following potential consequences associated with the alternatives that may not be readily apparent from the BCE results:

- **SHB Modifications:** Alternative 4 requires modifications to the SHB that are beyond the scope of the original expansion plans from the Phase I Upgrades. As a result, modifications to the structure and mechanical system are expected and the existing yard pipes and an electrical ductbank may need to be relocated to accommodate this option.
- **Additional Capital Savings:** The costs presented for Alternative 4 was based on expanding the SHB to allow for a future 7th RDT. As the design has been refined it has become apparent that only six units will provide n+1 redundancy for separate and co-thickening at 2040 flows, which presents an opportunity for further cost savings for Alternative 4. This same savings would not be expected in other alternatives.

Recommendation

The preliminary Design Technical Team recommends moving forward with Alternative 4 bas4ed on the results of the BCE.

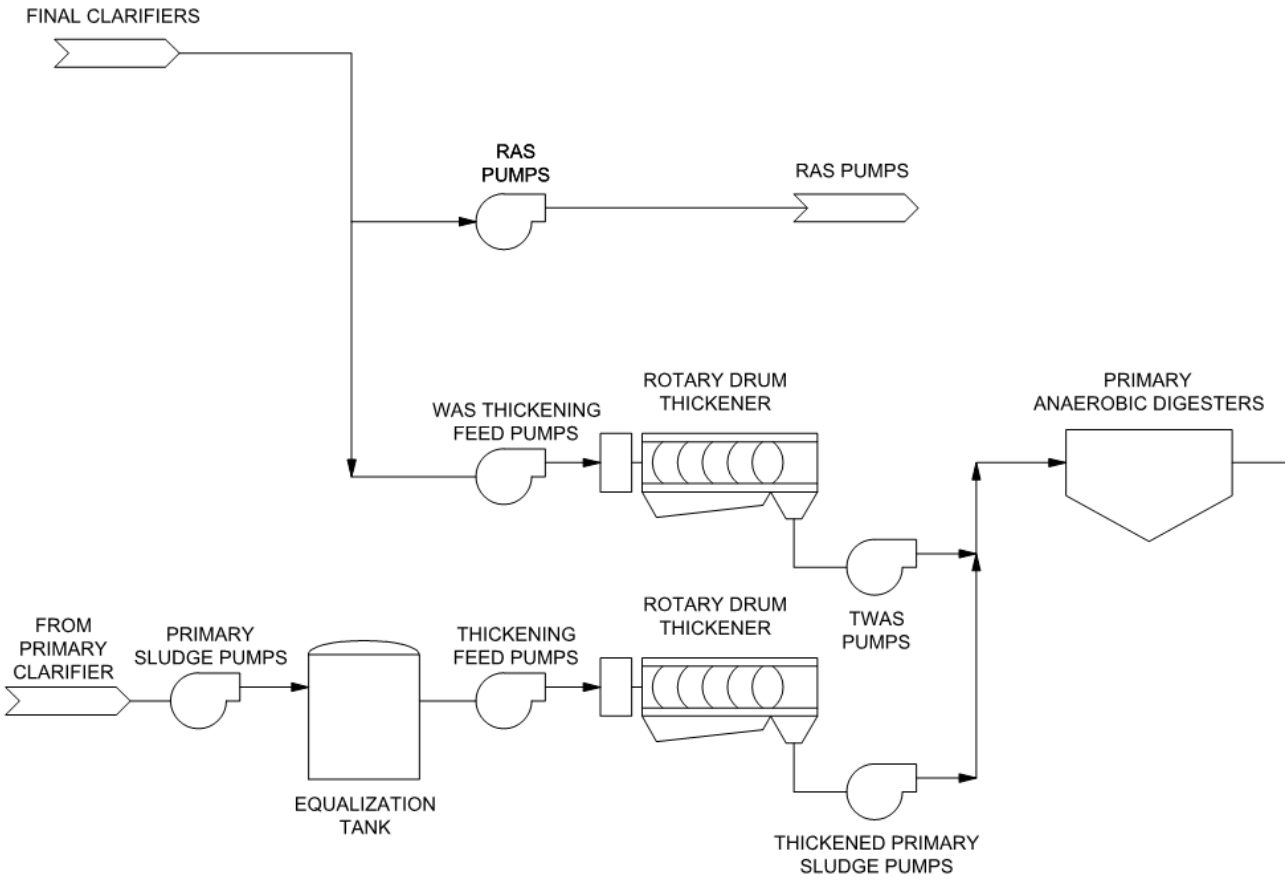

Figure 1. Process flow diagram for separate WAS thickening in the SHB and PS thickening in a new building as in Alternatives 1 through 3 (showing RDTs for PS thickening per Alternative 1)

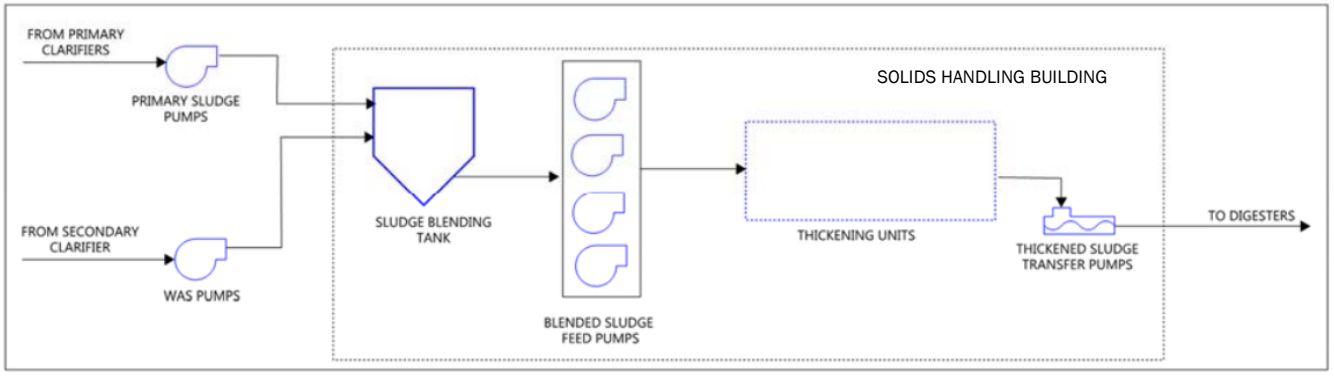

Figure 2. Process flow diagram for Co-thickening (Alternative 4) all housed in the Solids Handling Building