# Managing AMD During Design and Construction of the Expanded Bunker Hill Central Treatment Plant

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## Introduction

Mining at the Bunker Hill Mine in Kellogg, Idaho began in 1885 and continued actively into the 1980s. The Bunker Hill Mine was one of the largest lead/zinc mines in the world at its peak operation. Tailings produced during mining were disposed of in a tailings impoundment area referred to as the Central Impoundment Area (CIA) located adjacent to the South Fork Coeur d'Alene River (SFCDR). Acid mine drainage (AMD) is collected and conveyed through the Kellogg Tunnel (KT) located at the Bunker Hill Mine. AMD discharges from the KT at the KT Portal and is collected and conveyed to the Bunker Hill Central Treatment Plant (CTP) for treatment. AMD discharged from the Mine is acidic with a pH of ~3.0 standard units (s.u.) and contains elevated levels of metals including manganese, cadmium, lead, and zinc.

The original CTP was built by the Bunker Hill Company and started operation in 1974 consisting of a lined earthen aeration basin, concrete floc basin, 236-foot (ft) clarifier, lime system, and outfall to Bunker Creek (a tributary to the SFCDR). A seven-million-gallon emergency lined storage pond and pump station were completed in 1996 and new mine water pipelines directing AMD to the CTP or the lined pond were completed in 2002. A new hydrated lime slaking and metering system was completed in 2004 to replace the original lime system. The CTP operated at a nominal rate of 1,380 gallons per minute (gpm) prior to being expanded in 2020. The original CTP was labour intensive and had difficulty managing periods of flow variability without resulting in CTP callouts or plant shutdown events. A process flow diagram of the original CTP is provided in Figure 1 of Attachment 1.

Expansion of the CTP for mine water management was started in 2017 and was required based on the Record of Decisions Amendment (RODA) from the U.S. Environmental Protection Agency's (EPA) Bunker Hill Operable Unit 2 preferred remedial alternative and the CTP Discharge Requirements Technical Memorandum (EPA, 2015) that established discharge requirements for the upgraded/expanded CTP to the SFCDR. Discharge limits for the existing CTP and the updated discharge limits for the expanded CTP are shown in Table 1 below.

**Table 1: Existing and Expanded CTP Average Discharge Limits**

| Parameter | Existing CTP Limits | Expanded CTP Limits |
|---|---|---|
| Cadmium (µg/L) | 50 | 2.76 |
| Copper (µg/L) | 150 | 57 |
| Lead (µg/L) | 300 | 16 |
| Mercury (µg/L) | 1.0 | 0.022 |
| Zinc (µg/L) | 730 | 244 |
| pH (std units) | 6.0-10.0 | 6.5-10.0 |
| TSS (mg/L) | 20 | 20 |

The existing CTP expansion was required to chemically treat and manage sludge for 8,000 gpm of AMD and mine tailings impacted groundwater with a 5,000-gpm filtration process using multimedia filters. The process had to be modified to meet lower discharge standards required for a new outfall in the SFCDR and was transitioned from producing a low-density sludge of ~8% solids by weight to producing high density sludge (HDS) of greater than 25% solids by weight to increase life of sludge ponds. The expansion of the CTP included several modifications and additions to the existing CTP including the following:

- Two new 125,000-gallon capacity concrete reactors to replace the existing aeration basin;
- Seven new 12-ft diameter multimedia pressure filters;
- New effluent piping to the SFCDR with a new outfall to replace the Bunker Creek outfall;
- Upgrades to the existing clarifier and sludge management system to improve reliability;
- One new 105-ft diameter sludge thickener; and
- New electrical motor control center and programmable logic controllers (PLCs) to control the expanded CTP and the existing CTP components.

A new groundwater collection system (GWCS) with nine wells and a nominal capacity of 2,000 gpm and a 7,500-ft soil bentonite cut-off wall downgradient of the CIA were also installed to prevent tailings impacted groundwater from flowing into the SFCDR. A 110,000-cubic yard Sludge Impoundment Area was installed on the CIA for HDS disposal produced in the upgraded/expanded CTP. A process flow diagram of the expanded CTP is provided in Figure 2 of Attachment 1.

## Methodology

The CTP expansion project required reliable treatment of AMD during upgrades necessitating a Temporary Treatment System (TTS) and sequential system commissioning and start-up using existing infrastructure. Below is a summary of the approach used to treat AMD during demolition of the existing CTP:

- To replace the aeration basin, a 2,000-gpm TTS consisting of three 20,000-gallon frac tanks with mixers and process blowers were used to treat AMD.

- The existing lined pond and existing pumping system were used with a tie-in from the lined pond line to the TTS. To replace/reconnect piping to the influent of the new CTP, a tie-in with valving was installed on the lined pond line to allow for isolation to the existing CTP and connection to the TTS with provisions to allow for future connection to the upgraded CTP.
- A new local PLC for the TTS was used and integrated into the existing CTP system to allow for transition of process control from the existing to the new system in a controlled environment.
- To replace the existing outfall, a temporary discharge pipe to Bunker Creek was installed to direct flow to a new filter building or the existing outfall during commissioning of the expanded CTP.
- To demolish and upgrade the clarifier underflow system, temporary piping and valving were tied into the existing system to allow for sludge to be diverted to the old aeration basin or the TTS.
- To install new lime slurry loop piping and tie into the existing system, valving and piping were run to the TTS to allow for diversion of lime slurry to the existing aeration basin and the upgraded CTP or to a 20,000-gallon frac tank with mixers allocated adjacent to the TTS.

A process flow diagram of the TTS is provided in Figure 3 of Attachment 1. With the configuration described above, a sequencing and commissioning approach was used with onsite operators using operation of the existing CTP and the TTS in parallel during system testing and commissioning to mitigate risk during demolishing the existing CTP and constructing the expanded CTP.

## Discussion

Using the approach described above, the facility discharge during start-up of the expanded CTP was maintained with limited CTP shutdowns. Key tie-ins utilized in the existing CTP for the TTS with plans for future connection with the expanded CTP were used to manage the transition of systems as they were brought online. Integration of a separate PLC at the TTS allowed for parallel operations between the TTS, the existing CTP, and the expanded CTP. Once the upgraded CTP was commissioned, the TTS was isolated, removed, and the lined pond pipeline connected to the new reactors. Figure 1 shows the TTS at the CTP.

The expansion of the existing CTP project capital cost was approximately $40 million US dollars (M) or approximately $5,000 per gallon of system capacity. This cost includes design, procurement, construction, start-up, and commissioning. The cost of annual operations for the upgraded CTP is in the range of approximately $3M to $4M per year depending on the influent flow rate and chemical consumption. This operating cost range equates to an operating cost of approximately $1.50 to $2.50 per 1,000 gallons of mine water and ground water treated. The upgraded CTP requires four full time operators.

For comparison, the TTS installation cost was on the order of $1.3M or approximately $650 per gallon of system capacity. The cost of the TTS relied on using existing infrastructure as discussed above including the clarifier, sludge management system, and existing outfall. This cost included design, procurement, construction and tie-ins, start-up, and commissioning of the TTS. The cost of operations of both the TTS and the existing CTP were both approximately $2M per year or $2.50 per 1,000 gallons of mine water treated (not including rental costs). The existing CTP/TTS required three full time operators.

**Figure 1: TTS Layout**

## Conclusion

Water management for older operations that require upgrades and renovation to replace existing equipment or to update an existing process to meet more stringent discharge limits is a common challenge. The incorporation of modular systems to treat and allow for transitioning from outdated water management systems to newer systems may be a viable and cost-effective option. In the example of Bunker Hill, The TTS was less than 1:20$^{th}$ of the cost of the expanded CTP and during operation, the TTS was able to meet discharge standards for the new expanded CTP. In some cases, these modular systems may even be integrated into a more permanent configuration depending on project objectives, project requirements, and project durations. The transitioning between an existing system and a new system requires strategic planning and commissioning approaches to maintain reliability and continued operation.

## References

U.S. Environmental Protection Agency (USEPA). 2015. Central Treatment Plant (CTP) Discharge Requirements Technical Memorandum, Bunker Hill Superfund Site. Prepared in conjunction with CH2M Hill. February 12.

## Attachment 1

- Figure 1 – Process Flow Diagram Original CTP
- Figure 2A – Process Flow Diagram Expanded CTP (1 of 2)
- Figure 2B – Process Flow Diagram Expanded CTP (2 of 2)
- Figure 3 – Process Flow Diagram TTS

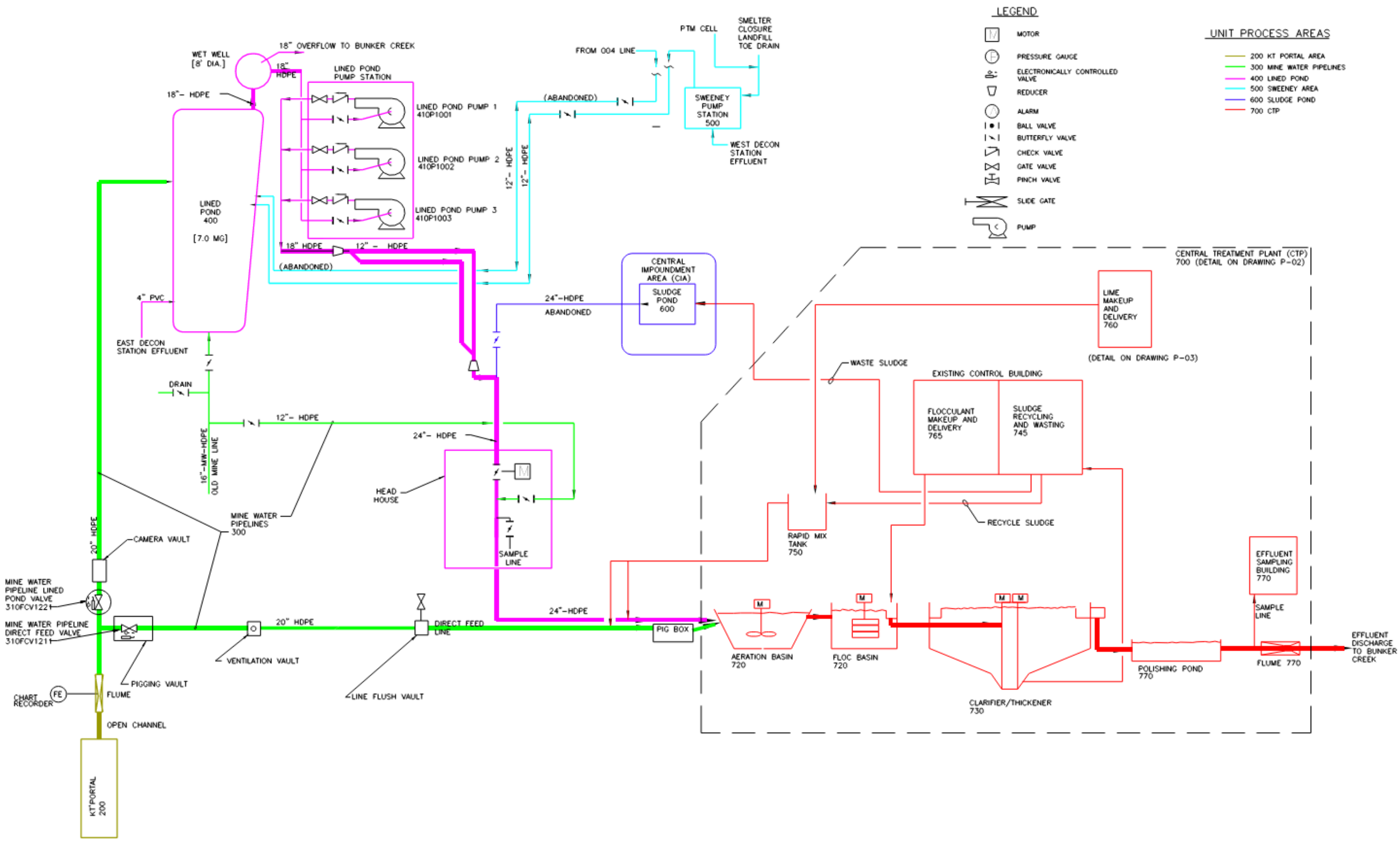


**Figure 1: Process Flow Diagram Original CTP**

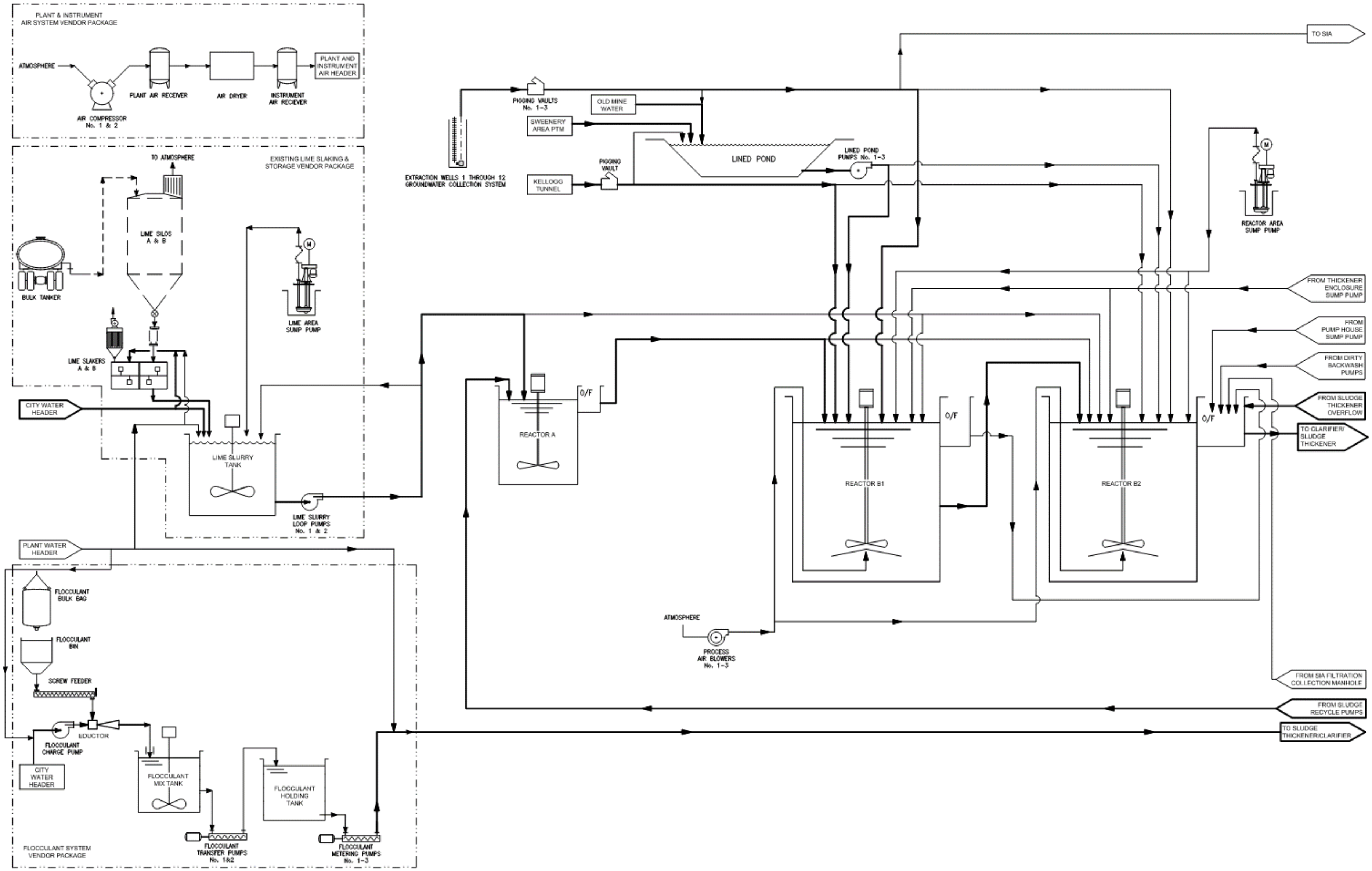


**Figure 2A: Process Flow Diagram Expanded CTP (1 of 2)**

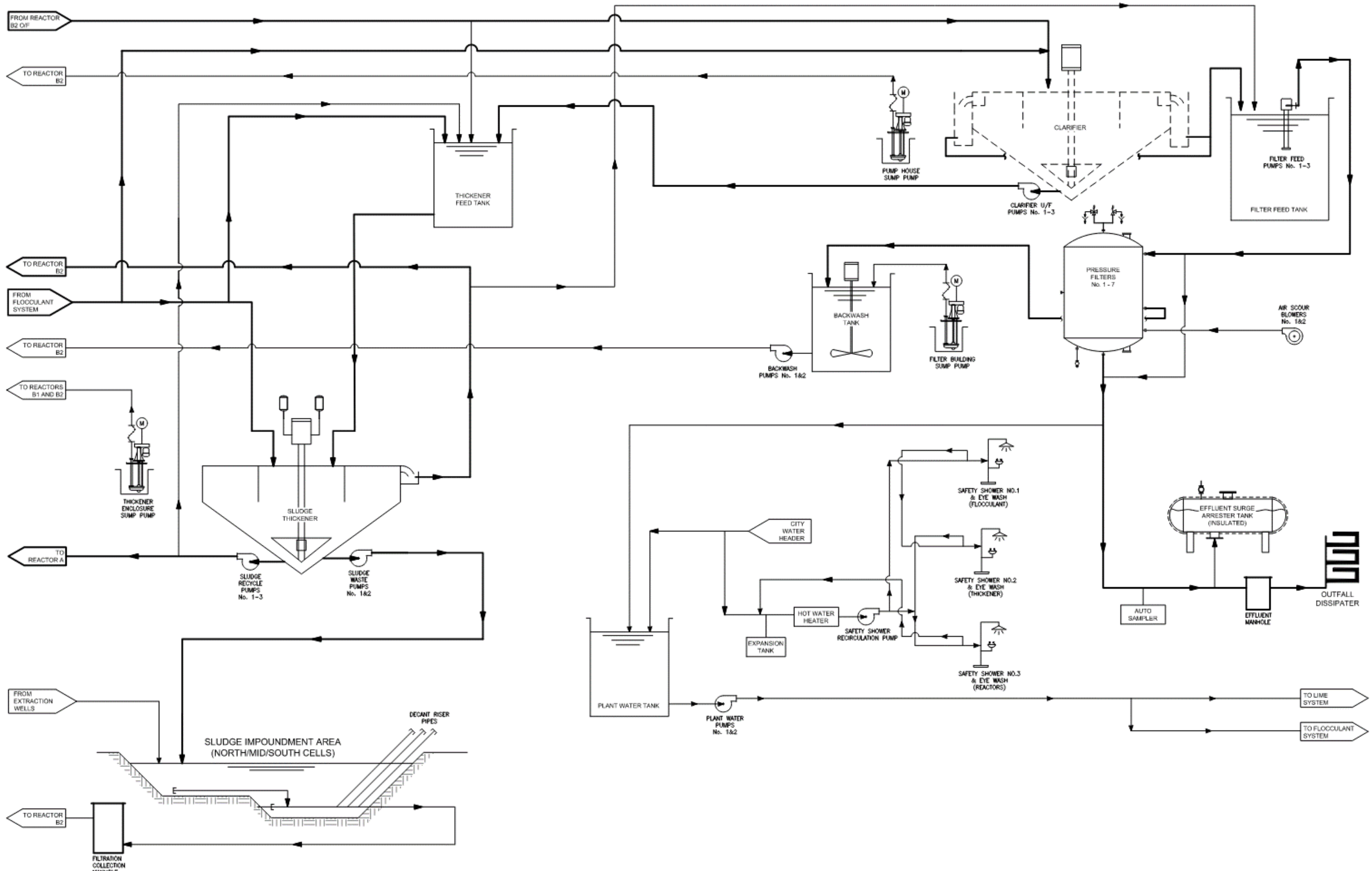


**Figure 2B: Process Flow Diagram Expanded CTP (2 of 2)**

# Attachment 1

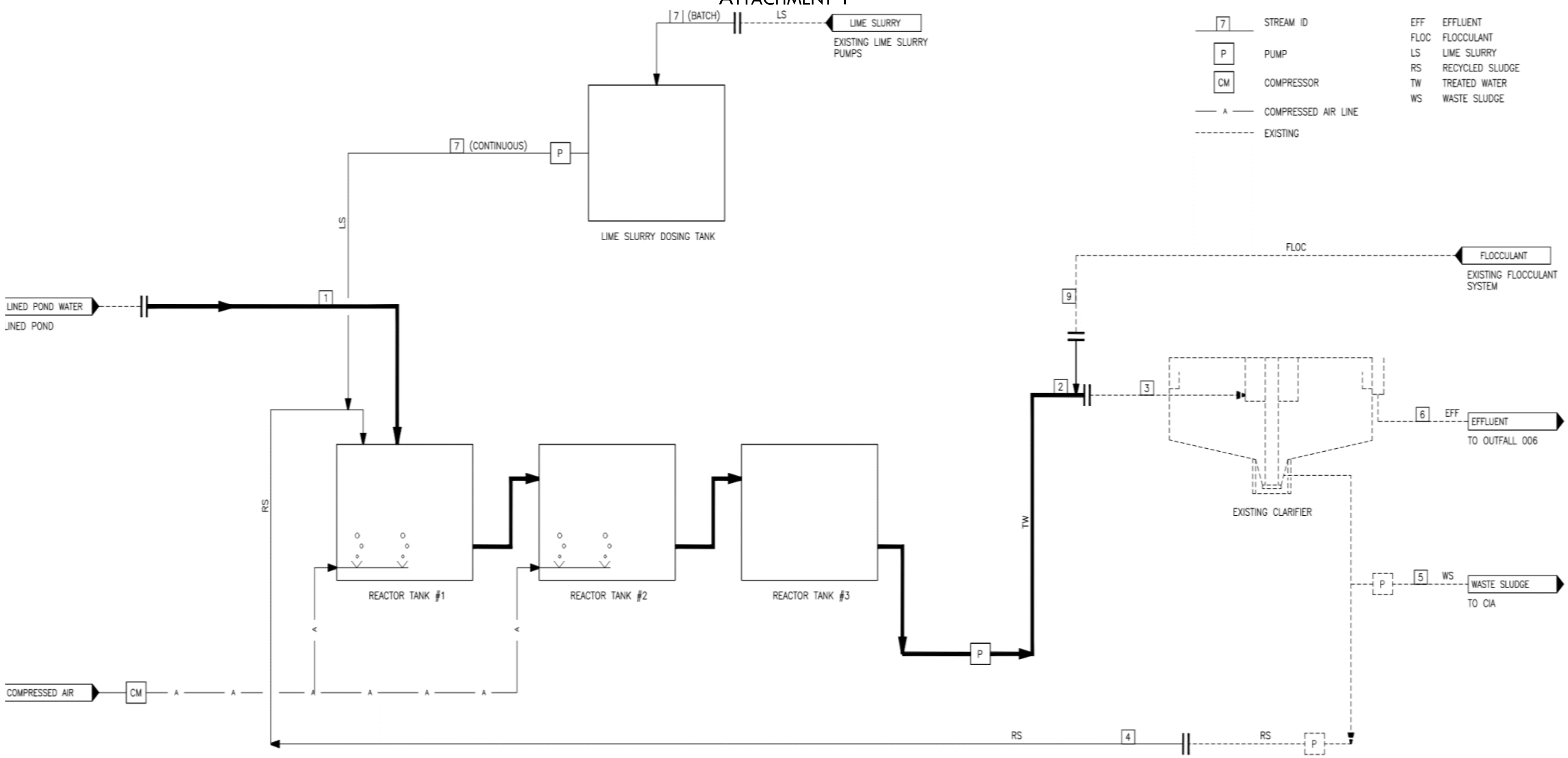


**Figure 3: Process Flow Diagram TTS**