SEWPCC Upgrading/Expansion
Conceptual Design Report

SECTION 6 - Process Flow Diagram / Mass Balance

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6.0 Process Flow Diagram and Mass Balance

6.1 INTRODUCTION TO THE PROCESS FLOW DIAGRAM (PFD)

The Process Flow Diagram (PFD) is a line and symbol graphic representation of the major wastewater and residual solids streams through the SEWPCC in the proposed expanded and upgraded configuration. The PFD is a drawing that is not to scale. The PFD drawing includes lines representing pipelines and channels, and symbols representing major treatment unit tanks and equipment, as well as valves. The PFD is prepared as an electronic drawing and has the capability to contain imbedded or linked information not immediately visible on the default drawing image. The PFD shows some chemical feed lines related to the liquid wastewater treatment and the residual solids treatment processes. However, the PFD for the SEWPCC does not show all plant systems and features, but provides the framework for those other systems.

The PFD is a design tool that is modified and refined through the detailed design and construction phases, and that will provide guidance for the operation of the upgraded plant.

To supplement the full PFD, which shows substantial detail, a simplified PFD is also prepared. The simplified PFD allows the quick development of easily recognizable simulations of different loading conditions that are then reflected in the mass balance. This simplified PFD is shown as Figure 6.1.

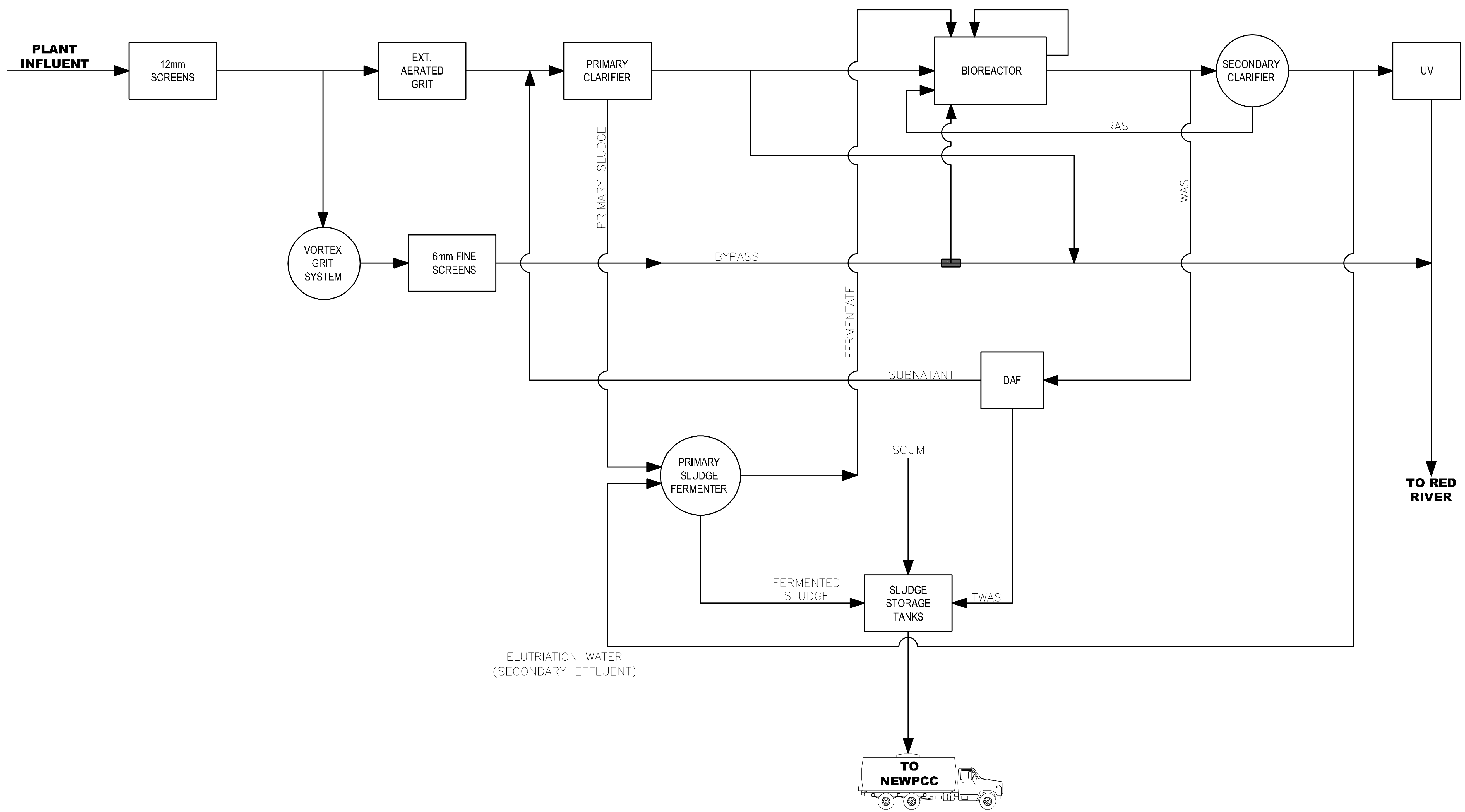
The current draft of the full PFD is included as two large-format prints and can be found in Appendix D.

6.2 FUNCTIONS OF THE PROCESS FLOW DIAGRAM

The PFD provides a representation of process material flows through the treatment plant for the following media:

- Wastewater.
- Wastewater treatment residual solids including sludge and sludge decant liquid.
- Wastewater treatment aeration air feed.
- Wastewater treatment chemical feeds.

The upper boundary of the PFD is designated as the point where the interceptor sewer enters the influent pump station wet well. The lower boundary of the PFD is designated as the conceptual point where the outfall pipeline discharges treated wastewater (with any blended untreated wastewater component during extreme high flow conditions) to the Red River.



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SIMPLIFIED PROCESS FLOW DIAGRAM

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FIG. 6.1

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The PFD serves as the basis for:

- selection and layout of treatment equipment and conduits.
- development of the wastewater treatment Mass Balance.
- development of detailed Process and Instrumentation Diagrams (P&ID) for wastewater treatment.
- development of the Process Control Narrative.

The PFD provides the core clearinghouse function through the detailed design phase for coordination of design refinements.

Minor changes will likely be made to the PFD in the detailed design phase. The PFD does not show all of the details for some other plant systems, but serves as the framework for those systems, including the following:

1) Plant plumbing potable water distribution system.
2) Plant plumbing wastewater drainage system.
3) Plant non-potable water system.
4) HVAC ductwork and equipment.
5) Electrical power distribution.
6) Complete Instrumentation and Controls systems and devices, although some key instruments are shown on the PFD.
7) Instrument air systems.
8) Foul air conveyance ductwork and odor control treatment systems.
9) Complete detailed aeration system for wastewater treatment processes; although key components of the aeration system are shown on the PFD.

While the PFD does not show items such as those listed above, separate detailed diagrams are developed and provided for all of those other systems during the detailed design phase. Those detailed diagrams will be included in the construction tender drawings and will be reflected in the construction specifications.

6.3 BASIS FOR THE PROCESS FLOW DIAGRAM

The PFD was developed by using the existing plant PFD as a base, with the understanding that certain portions would change to reflect the developing preliminary design for the SEWPCC upgrade/expansion to meet the design year 2031. Processes were developed to treat incoming flows and pollutant loads to meet discharge and residuals regulatory requirements. Treatment concepts were developed through the Preliminary and Conceptual Design Technical Memoranda and Workshops and were reported in those memoranda and summarized in the PDR.

Where multiple parallel treatment units exist or will exist pursuant to the upgrade/expansion design, the full PFD indicates conceptually each of the multiple treatment units.

6.4 STATUS OF THE PROCESS FLOW DIAGRAM

- The current draft print display is an indication of PFD development.
- The PFD is a work in progress.
- Some minor refinements may be made during detailed design.
- The PFD will be incorporated into the Operations and Maintenance Manual (O&M) documentation.

6.5 INTRODUCTION TO THE MASS BALANCE

The mass balance is a diagrammatic representation of the quantities of liquid volume and pollutant mass flows through the treatment plant. Liquid volumetric flowrates are expressed in units of Million Litres per day or Mega Litres per day (ML/d). Pollutant mass flow rates are expressed in units of kilograms per day (kg/d). Different versions of the mass balance are developed to represent different loading and plant operating conditions. All of the different mass balance versions are based on the same PFD diagram, sometimes with different pathways active.

6.6 FUNCTIONS OF THE MASS BALANCE

The mass balance represents the balance of materials through the treatment process, including the liquid flowrate (in ML/d) and the flux of key pollutants (in kg/d) such as:

- Total Suspended Solids (TSS).
- Chemical Oxygen Demand (COD).
- Total Nitrogen (TN).
- Total Phosphorous (TP).

On the mass balance diagrams contained in this section, the concentrations of pollutants are not shown at each treatment step. The concentration of a specific pollutant, in milligrams per litre (mg/L) may be easily calculated by dividing the mass flux value (in kg/d) by the volumetric flowrate (in ML/d).

The mass balance indicates the fate (removal) of pollutants through the plant. It represents results of modeling and calculations (e.g. BioWin®), and indicates the efficiency performance of treatment steps. It provides a framework for evaluation of different flow splitting scenarios for different influent loading conditions.

The mass balance serves as a dynamic tool allowing simulation of the effect of many different conditions – e.g., a treatment unit out of service. It will serve as the basis for selection of operational coverage and duty cycle of equipment items, for:

- Peak service coverage requirements.
- Days per week, hours per day of operation.
- Downtime for equipment maintenance.
- Critical standby operations.
- Units temporarily out of service.
- Total installed capacity.
- Firm capacity.

6.7 INPUTS INTO THE MASS BALANCE

The SEWPCC raw wastewater influent loading values for the mass balance for different conditions were developed initially from the evaluation of flows and loads performed during the Preliminary Design phase. These values were reported in the Preliminary Design Technical Memoranda and were summarized in the PDR, specifically in the following sections of the PDR:

- Section 4.0 Population and Flow Projections.
- Section 5.0 Influent Characterization and Load Projections.
- Section 13.0 Septage Management.

The target pollutant flux values for the final discharge were developed during the preliminary design studies, with further evaluation based on review of subsequent draft license conditions issued by Manitoba Conservation. Section 3.0 of the PDR, Regulatory Framework, summarized the target effluent values in early 2007. Biological Nutrient Removal Process Options were

evaluated and reported in Section 8 and Section 15 of the PDR. Wet Weather Flow options and treatment evaluations were summarized in Sections 10 and 11 of the PDR.

Subsequent to the PDR, treatment process selection and refinements have been made and are reported throughout this report, including:

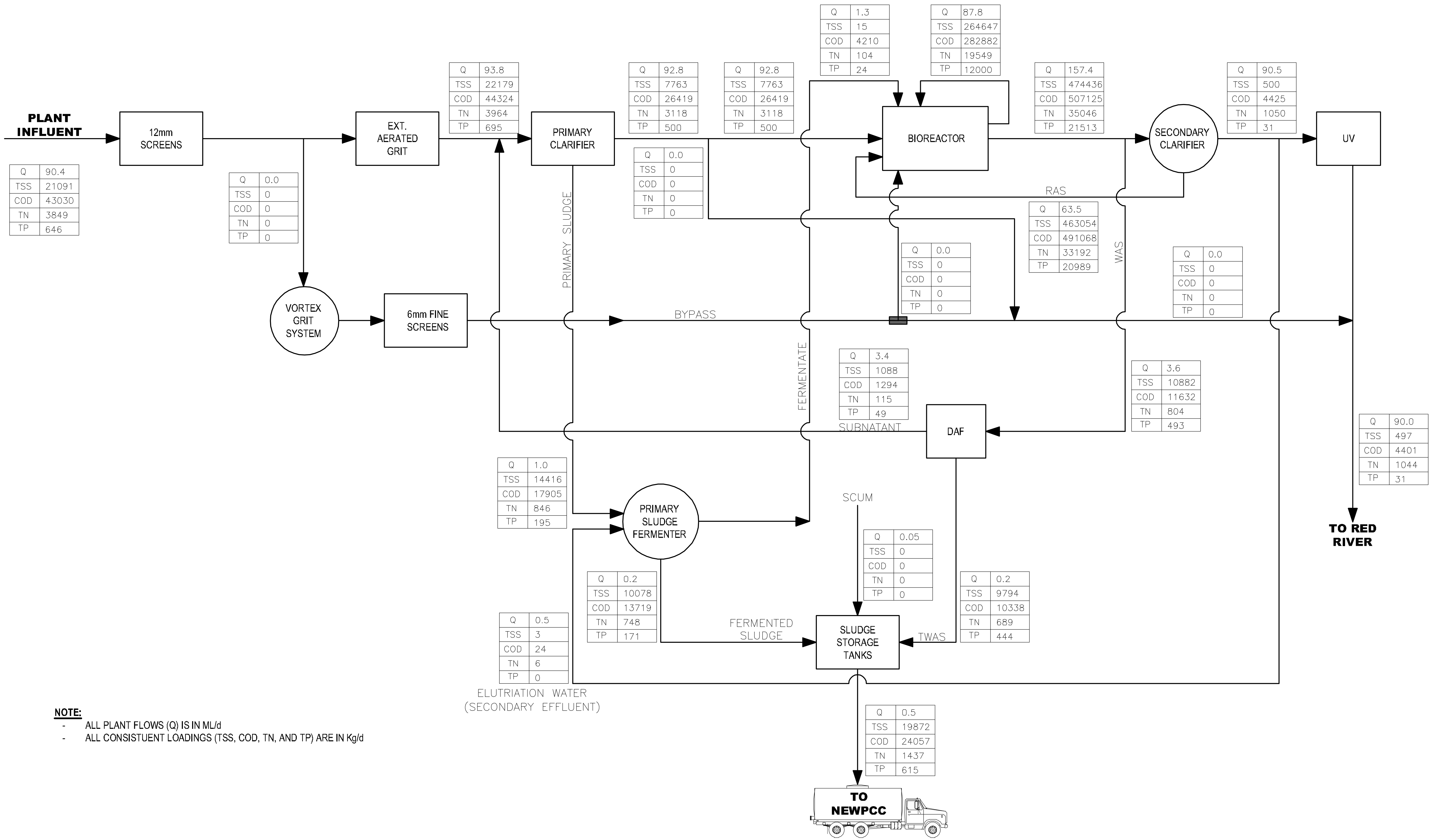
- Section 4 BNR Process Refinement.
- Section 5 BNR Process Selection.
- Section 8 Primary Treatment.
- Section 9 BNR Bioreactors.

The flowrate and pollutant flux values shown on the several versions of the current mass balance diagram (for different plant loading and temperature conditions) incorporate the current treatment process selection and performance capacities as reflected in the sections listed above, for removal of suspended solids, COD (and by indication BOD^5), and nutrients including TN and TP. In addition, the mass balance diagram values for solids processing units reflect the current design concepts as summarized in Section 14, Solids Handling. That section summarizes the projected function and performance of the fermenters, which generate Volatile Fatty Acids (VFAs) from the primary sludge, as well as the Dissolved Air Flotation (DAF) system for biological waste activated sludge (WAS); with subsequent temporary holding and hauling of the residual sludge to the North End Water Pollution Control Centre (NEWPCC). The mass balance accounts for the return of VFAs to the bioreactors.

6.8 STATUS OF THE MASS BALANCE

The mass balance diagrams have been substantially completed for all of the key wastewater influent flowrate loading scenarios identified below:

- Annual Average Day (Figure 6.2).
- Maximum Month Flow – Spring (Figure 6.3).
- Maximum Month Flow – Summer (Figure 6.4).
- Maximum Month Flow – Fall (Figure 6.5).
- Maximum Month Flow – Winter (Figure 6.6).
- Maximum Day Flow – Summer (Figure 6.7).
- Dry Weather Flow (Figure 6.8).



NOTE:
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SOUTH END WATER POLLUTION CONTROL CENTRE

MASS BALANCE DIAGRAM
ANNUAL AVERAGE FLOW

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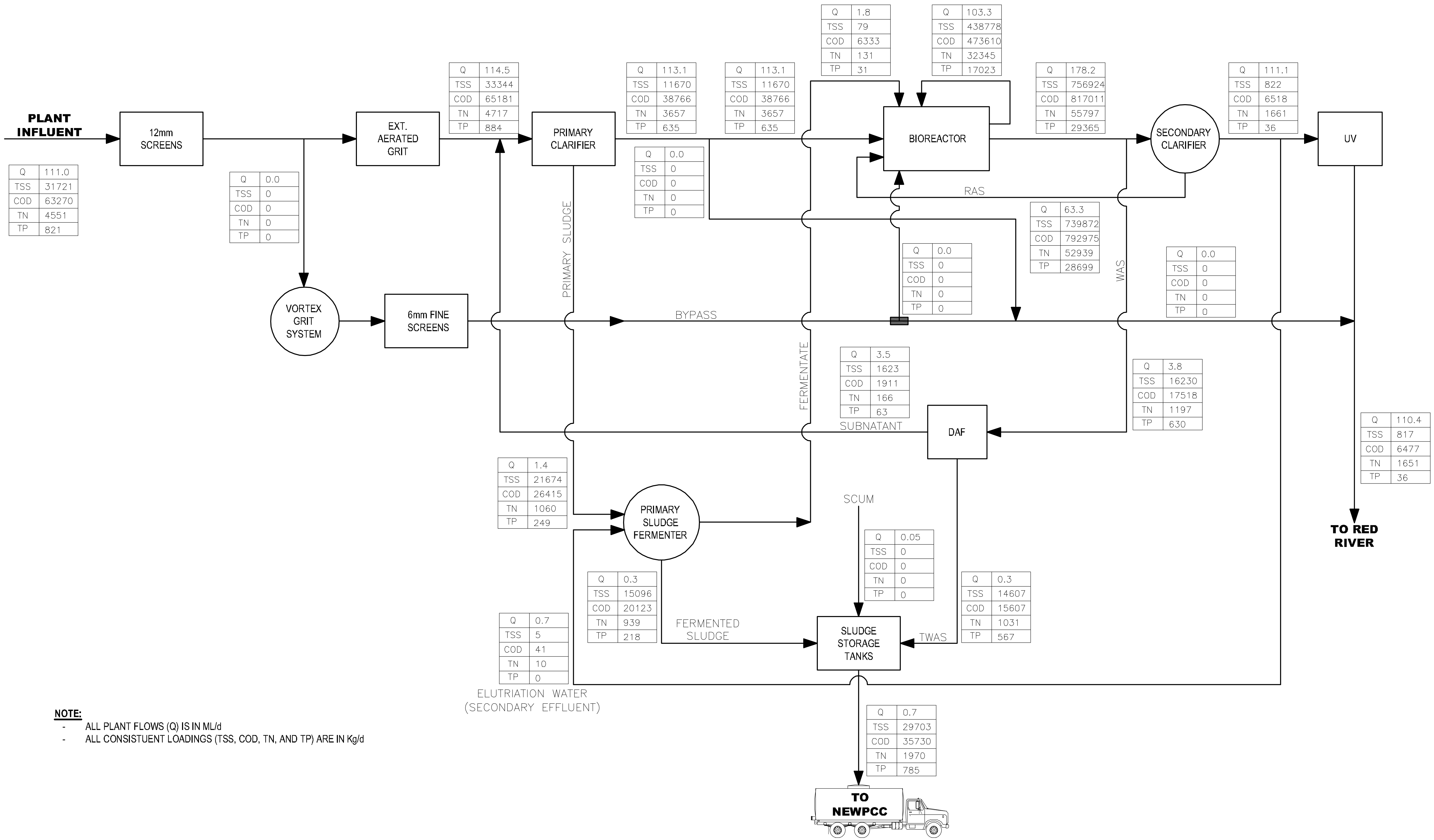

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MASS BALANCE DIAGRAM
MAXIMUM MONTH FLOW - SPRING

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FIG. 6.3
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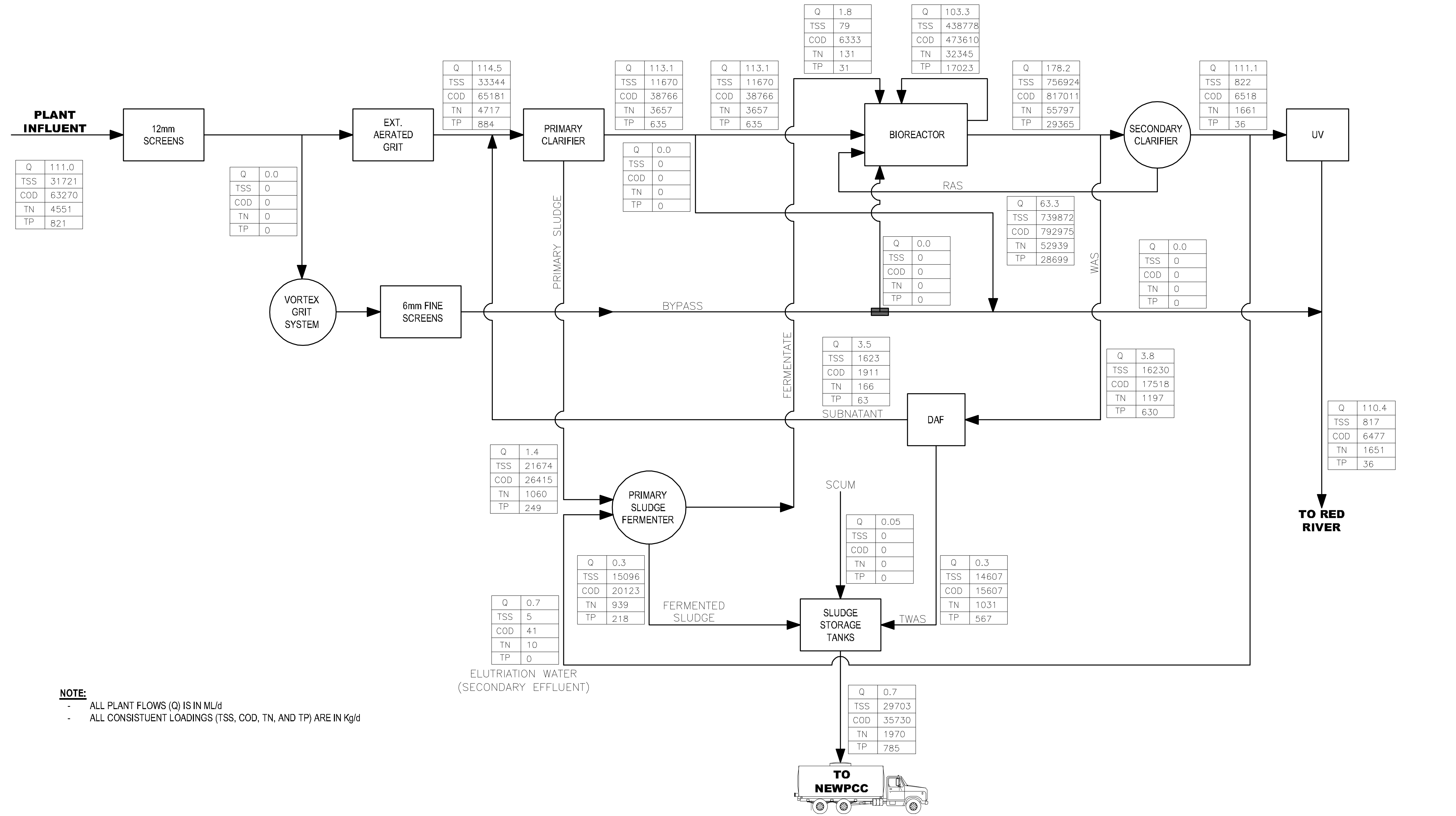

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MASS BALANCE DIAGRAM
MAXIMUM MONTH FLOW - SPRING

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FIG. 6.3
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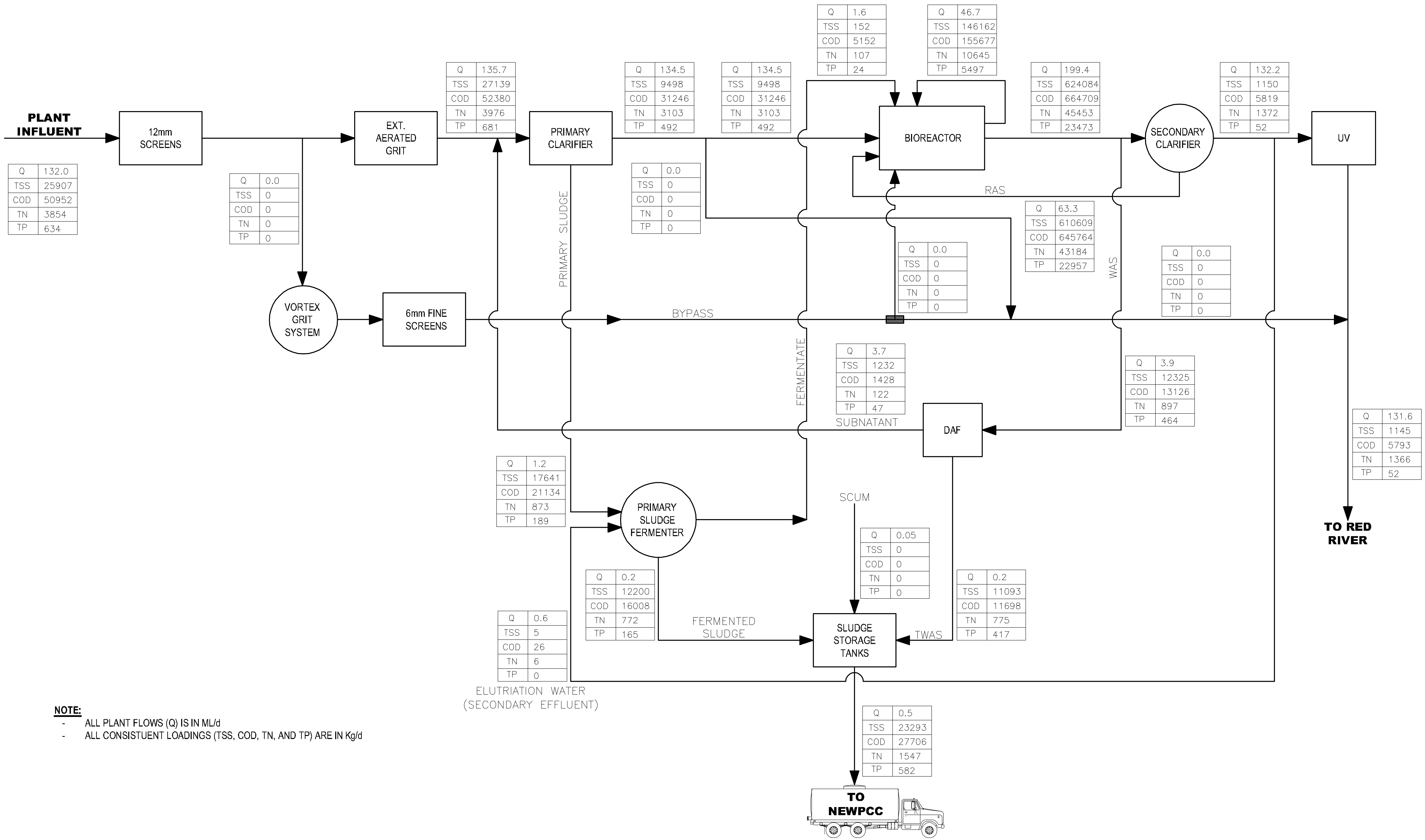

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MASS BALANCE DIAGRAM
MAXIMUM MONTH FLOW - SUMMER

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FIG. 6.4
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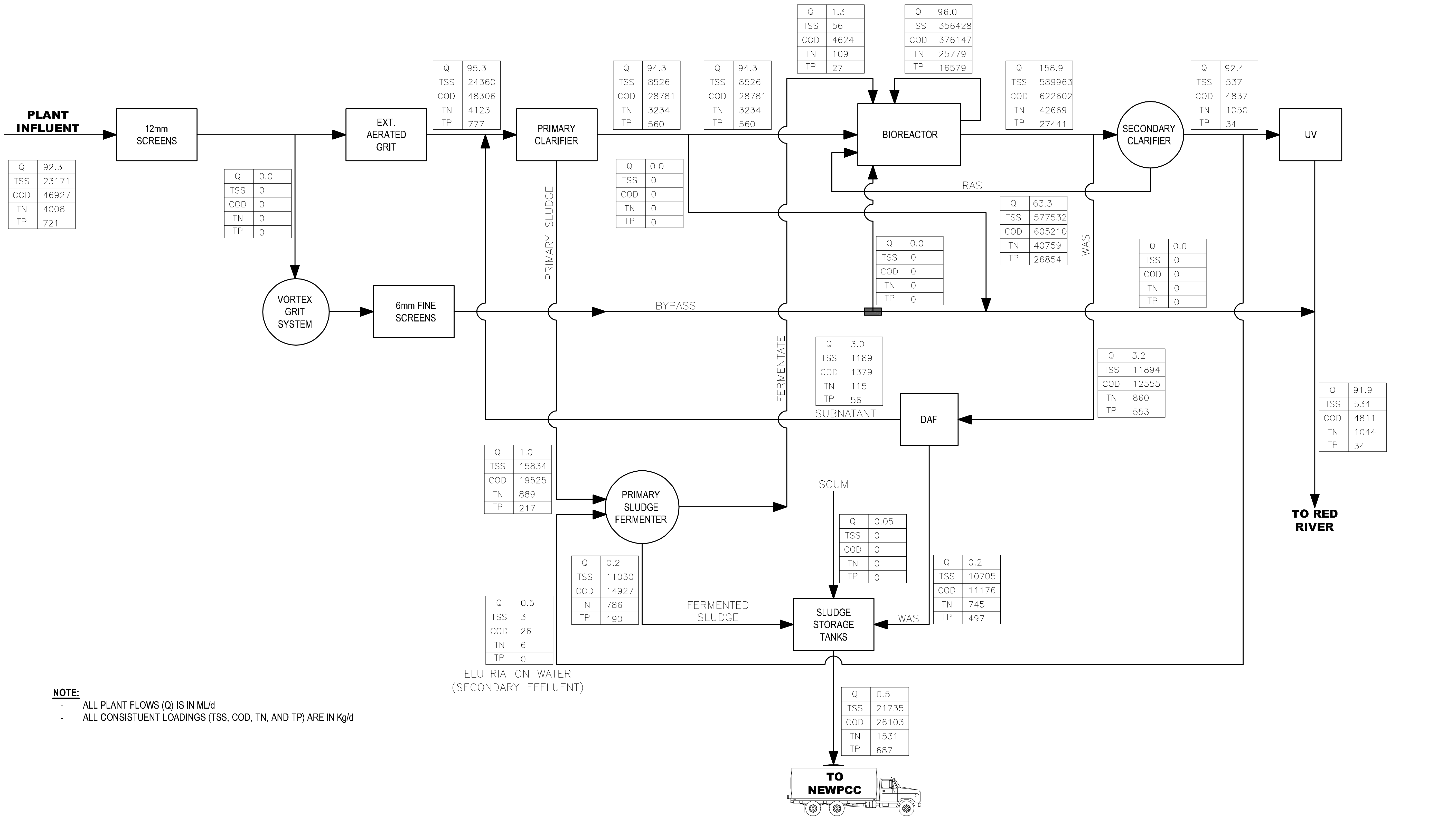

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MASS BALANCE DIAGRAM
MAXIMUM MONTH FLOW - FALL

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FIG. 6.5

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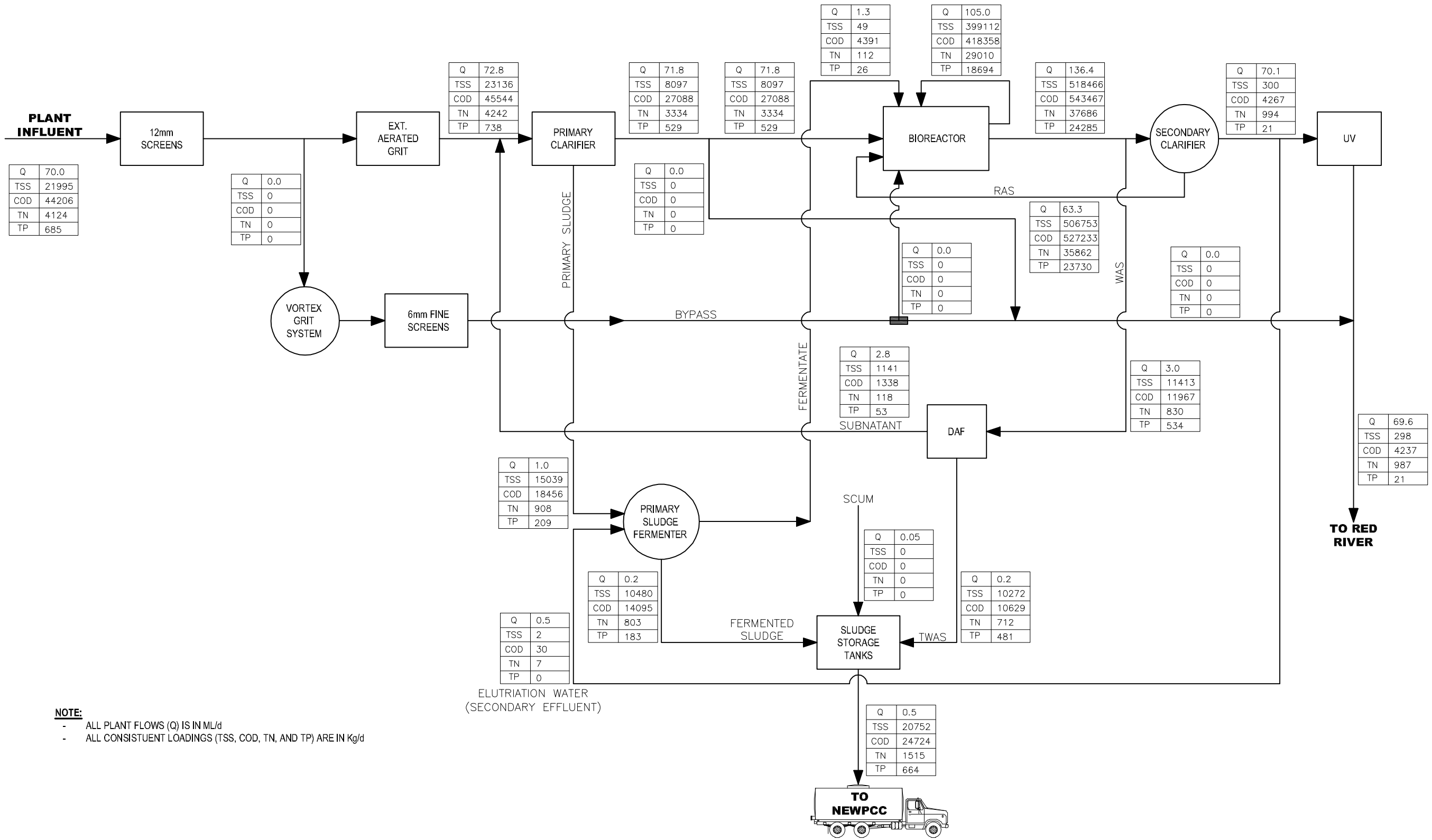

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MASS BALANCE DIAGRAM
MAXIMUM MONTH FLOW - WINTER

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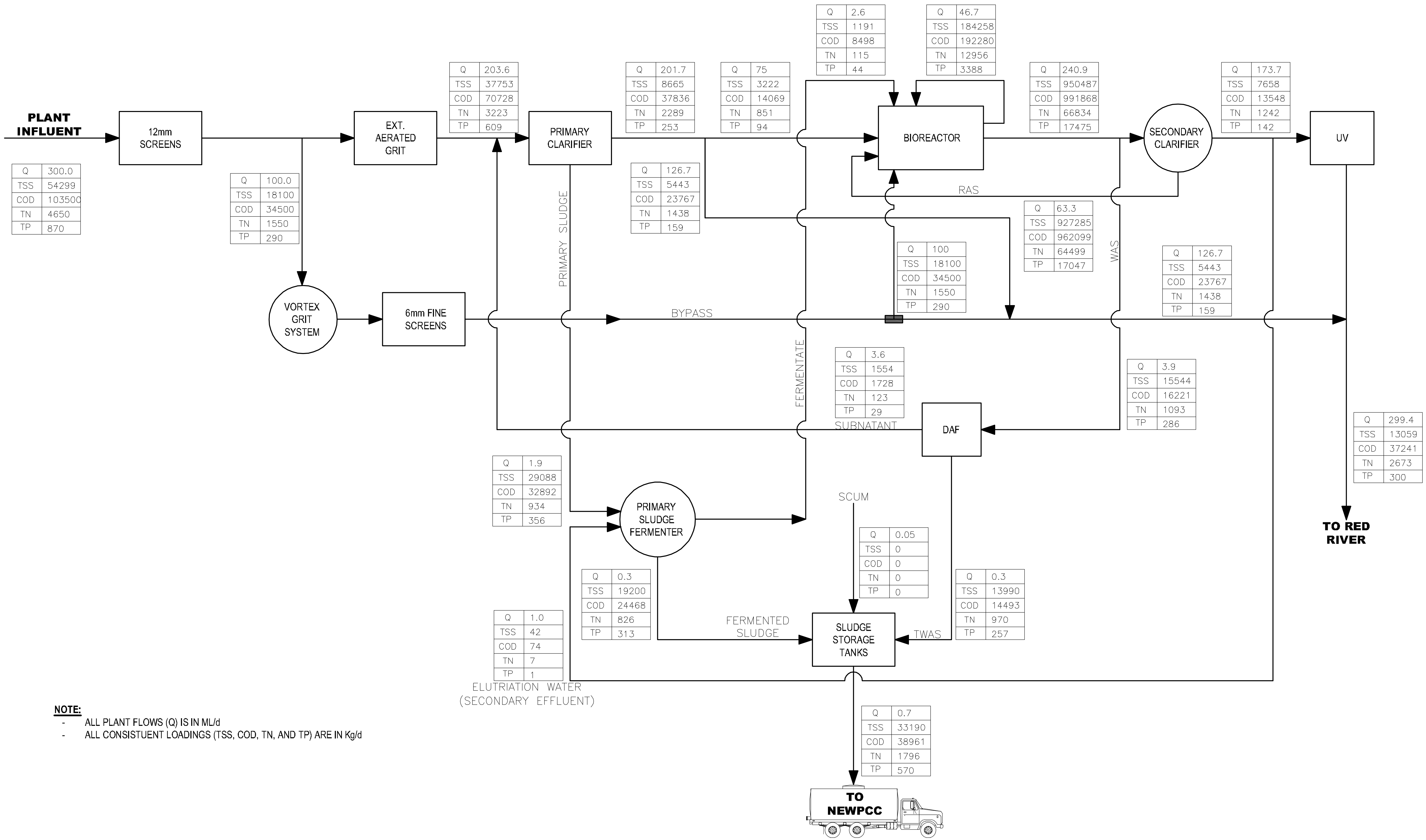

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MASS BALANCE DIAGRAM
MAXIMUM DAY FLOW - SUMMER

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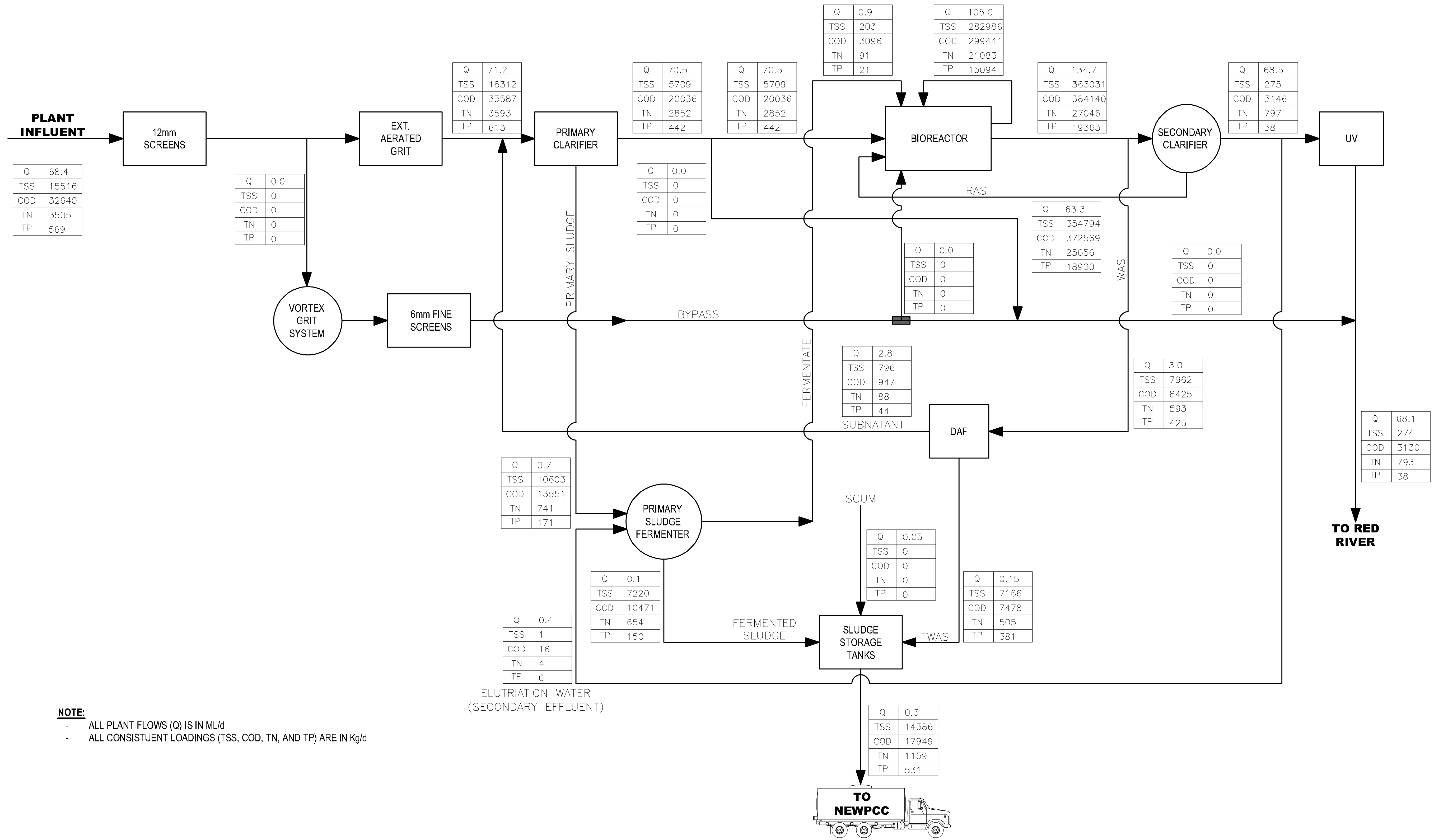

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MASS BALANCE DIAGRAM
DRY WEATHER FLOW

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