



Date: May 12, 2009
To: Madison Metropolitan Sewerage District
From: Steve McGowan, P.E., BCEE
Project Manager, Malcolm Pirnie, Inc.
Eric Wang, P.E.
Project Engineer, Malcolm Pirnie Inc
Subject: 50-Year Master Plan
TM-2: Flow and Loading Projections (Final)
Project No.: MMSD No. 8425001
MPI No. 6100-001

1. Introduction

This memorandum documents projected flows and loadings for the 50-year planning period. The memorandum presents information regarding the plant influent flow and loading projections, and internal loadings which will result from the projected influent flows and loadings. The projected internal flows and loadings were compared with the rated unit process capacities determined in Technical Memorandum 1 – Review of Existing Treatment Facilities. The comparison results provide information to be used for identifying the system needs for the planning period.

2. Influent Flows

Influent flows to the plant consist of raw wastewater delivered from the District service area via four force mains and of septage, holding tank, landfill leachate and other wastes that are trucked to the plant.

Raw Wastewater

The Capital Area Regional Planning Commission (CARPC) developed population and raw wastewater flow projections as part of the master planning for the District's sewerage collection system. The population and flow projections that CARPC developed are summarized in Table 2-1.

Table 2-1. Population and Flow Projection Summary

| Year | Population | Average Raw Wastewater Flow (MGD) |
|--------|------------|-----------------------------------|
| 2030* | 431,000 | 50 |
| 2030** | 555,000 | 60 |
| 2060* | 555,000 | 60 |
| 2060** | 605,000 | 70 |

* Population and flow based upon the projections developed by CARPC and represent the low estimates.

**Population and flow based upon the projections developed by CARPC and represent the high estimates.

Two estimates were generated for each planning year: the low estimate and the high estimate. The high estimates are based on the full build-out of each community’s service area based on the community’s Comprehensive Plan, while the low estimates are based on the Wisconsin Department of Administration (DOA) projected population data for Dane County.

The high estimate flow projections are used for the pumping station structures and conveyance system capacity evaluation since the service lives of these facilities are 75 to 100 years, and it is uncertain where higher growth will occur in the District’s service area. The low estimate flow projections are used for the Nine Springs Wastewater Treatment Plant (NSWTP) facility capacity evaluation because the DOA-based estimates reflect the more probable total population and flow data scenarios when analyzing future design conditions at the NSWTP.

Septage, Holding Tank, Landfill Leachate and Other Wastes

Wastes from septic tanks, holding tanks, landfill leachate and commercial establishments (grease traps, settling basins, and portable toilets) are trucked to the plant for treatment. Table 2-2 presents daily average flow of wastes from septage, holding tanks, grease traps and settling basins at a given year and the flow as percentage of the average daily flow of raw wastewater in that year.

Table 2-2. Septage, Holding Tank, Grease Trap and Settling Basin

| Year | Daily Average Flow (gpd) | Daily Average Flow (%) |
|------|--------------------------|------------------------|
| 1996 | 24,793 | 0.06 |
| 1997 | 23,975 | 0.06 |
| 1998 | 27,480 | 0.07 |
| 1999 | 25,806 | 0.06 |
| 2000 | 26,362 | 0.06 |
| 2001 | 31,242 | 0.07 |

| | | |
|----------------|--------|------|
| 2002 | 30,031 | 0.07 |
| 2003 | 31,197 | 0.08 |
| 2004 | 37,726 | 0.09 |
| 2005 | 35,929 | 0.09 |
| 2006 | 41,268 | 0.10 |
| 2007 | 45,962 | 0.11 |
| Average | 31,814 | 0.08 |

The monitoring records of landfill leachate and other wastes were only studied for January 2005 through December 2007 to determine the flows and loadings. This period was selected for analysis because this period represents the plant's current operation. The District terminated receiving whey from Bancroft Dairy Company in 2005 and the hauled-in wastes flow has been significantly reduced since then. Table 2-3 presents daily average flow of landfill leachate and other wastes at a given year and the flow as percentage of the daily average flow of raw wastewater in that year.

Table 2-3. Leachate and Other Wastes

| Year | Daily Average Flow (gpd) | Daily Average Flow (%) |
|----------------|--------------------------|------------------------|
| 2005 | 2,647 | 0.01 |
| 2006 | 2,906 | 0.01 |
| 2007 | 2,534 | 0.01 |
| Average | 2,696 | 0.01 |

The combined hauled-in waste flow accounts for approximately 0.1% of the raw wastewater daily average flow for a given year. The projected hauled-in waste flows and total plant flows are presented in Table 2-4.

Table 2-4. Plant Flow Projections

| Year | Raw Wastewater (MGD) | Hauled-in Wastes (MGD) | Total (MGD) |
|--------|----------------------|------------------------|-------------|
| 2030* | 50 | 0.054 | 50 |
| 2030** | 60 | 0.066 | 60 |
| 2060* | 60 | 0.064 | 60 |
| 2060** | 70 | 0.074 | 70 |

* Flow based upon the projections developed by CARPC and represents the low estimates.

**Flow based upon the projections developed by CARPC and represents the high estimates.

3. Influent Loadings

Influent loadings to the plant consist of raw wastewater delivered from the District service area via four force mains and of septage, holding tank, landfill leachate and other wastes that are trucked to the plant.

Raw Wastewater

In the previous facilities planning studies by the District, the following three methods have been used in projecting future loadings for 5-day biochemical oxygen demand (BOD₅), total suspended solids (TSS), total Kjeldahl nitrogen (TKN), and total phosphorus (TP):

- **Method based on per capita loading factors and projected future population.** This method determined the current per capita loading factors by dividing current average loadings by the current population of the District service area. The resulting per capita loading factors were then multiplied by projected future populations to project future loadings.
- **Method based on current waste-load strength and projected future raw wastewater flow rates.** This method involved determining the current average concentrations of the parameters of interest and then multiplying the concentrations by projected future flow rates to project future loadings.
- **Method based on historic loading trends.** This method involved plotting historical raw wastewater loadings and then projecting future loadings based on linear regression of the historical loading trends.

In the previous facilities planning studies by the District, the results generated by these three methods were compared and discussed. The method based on historic loading trends was selected as the most appropriate method for projecting future loads because it reflected actual consistent increasing trends in wastewater loading at the Nine Springs Wastewater Treatment Plant (NSWTP). Table 3-1 presents the comparison between the actual recorded loadings at the plant and the values projected in the Tenth Addition facilities planning.

Table 3-1. Loading Projection Comparison

| Parameter | Year 2000 | | Year 2005 | |
|--------------------------|---------------------------------------|--------|--|--------|
| | 10 th Addition Projections | Actual | 10 th Addition Projections* | Actual |
| BOD ₅ (lbs/d) | 73,000 | 75,424 | 81,500 | 81,648 |
| TSS (lbs/d) | 71,000 | 78,127 | 78,000 | 80,197 |
| TKN (lbs/d) | 10,700 | 11,045 | 11,750 | 12,439 |
| TP (lbs/d) | 2,210 | 2,102 | 2,430 | 2,132 |

* Projected loadings for Year 2005 were calculated assuming linear growth between Year 2000 and 2010.

The results show that the actual plant BOD₅, TSS and TKN loadings match fairly well with the projected values, while TP loadings do not show consistent growth trend as projected. The inaccurate TP projections may result from lack of long term monitoring data for plant influent TP loadings when the study was conducted. Overall, the results generated by linear projection based upon historical loading trends method provided fairly accurate and reasonable future loading projections. Therefore, this method was also used in projecting future loadings to the plant in this study. Figures 3-1 through 3-4 show historic and projected loadings for BOD₅, TSS, TKN, and TP, respectively. Each figure shows the historical monthly average loadings and a linear regression of the monthly average values projected out through the planning period.

Figure 3-1. Raw Wastewater BOD₅ Loading Projection

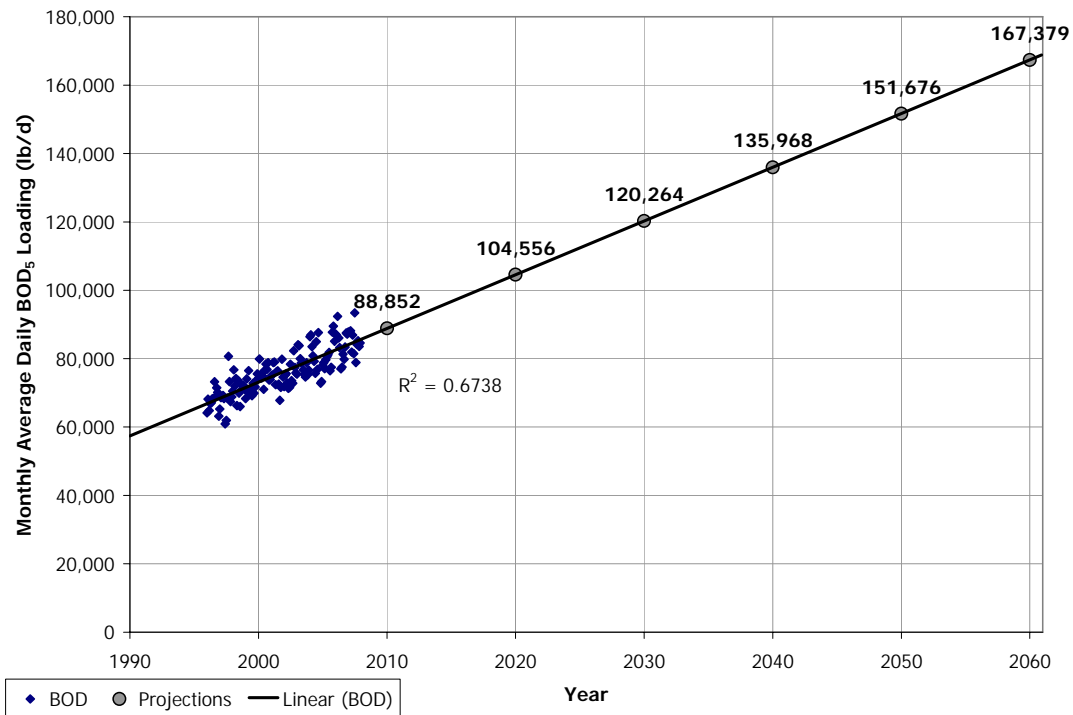


Figure 3-2. Raw Wastewater TSS Loading Projection

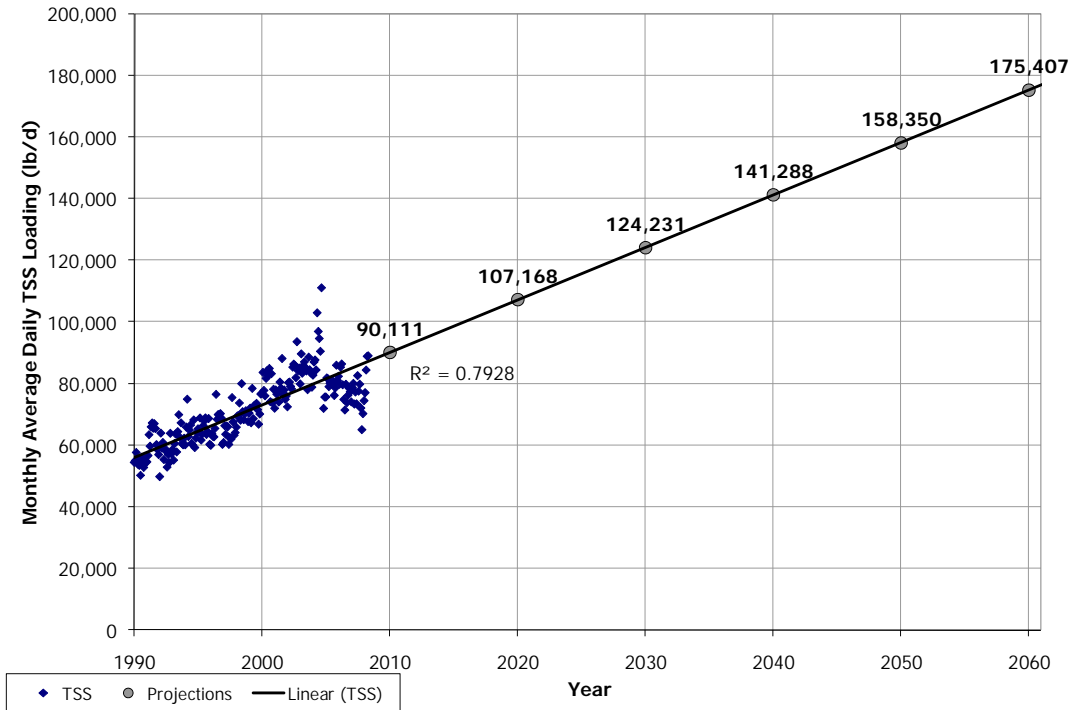


Figure 3-3. Raw Wastewater TKN Loading Projection

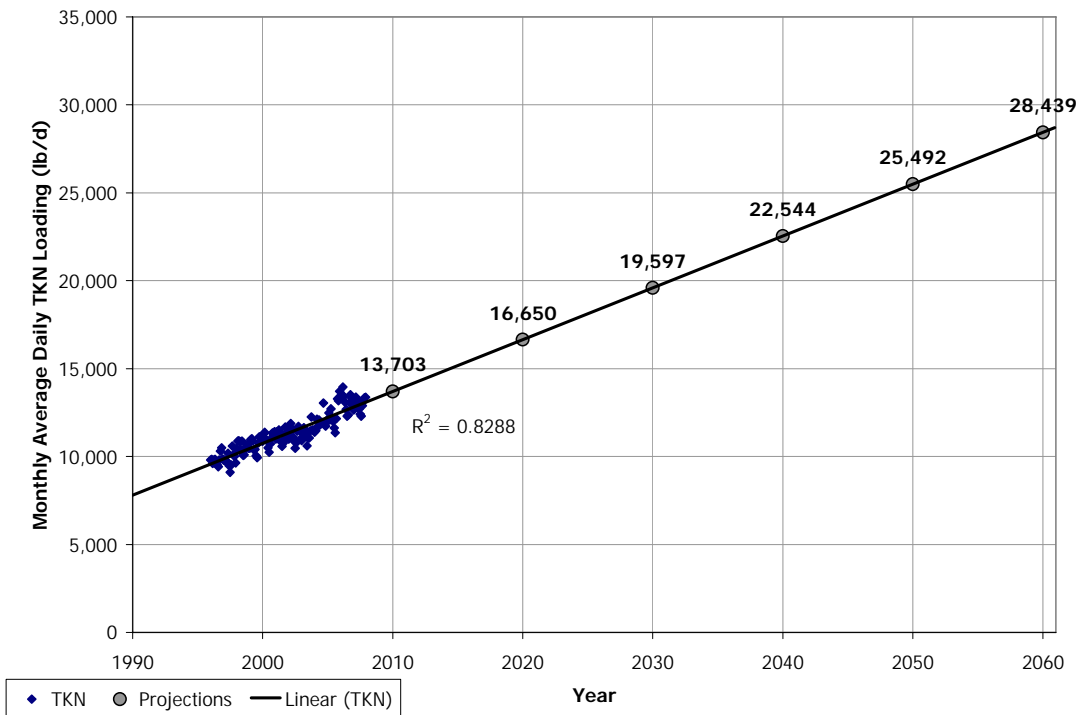


Figure 3-4. Raw Wastewater TP Loading Projection

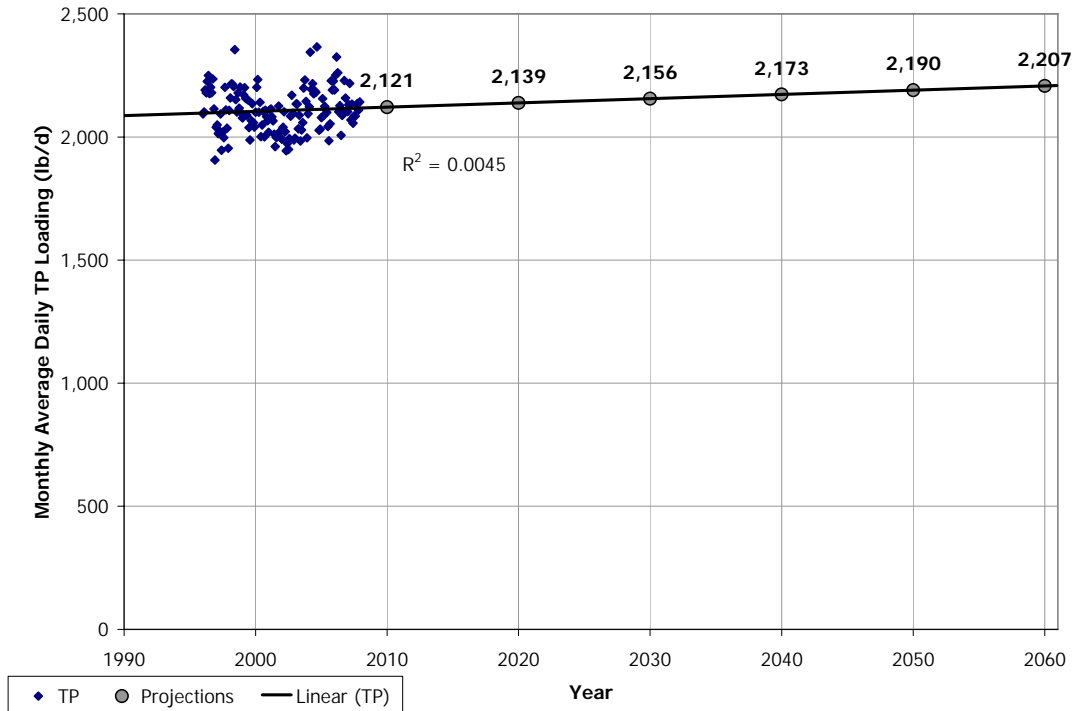


Table 3-2 presents the summary of projected raw wastewater loadings based upon historic loading trends.

Table 3-2. Loading Projections Based on Historic Loading Trends

| Parameter | Year 2030 | Year 2060 |
|--------------------------|-----------|-----------|
| BOD ₅ (lbs/d) | 120,000 | 170,000 |
| TSS (lbs/d) | 124,000 | 175,000 |
| TKN (lbs/d) | 20,000 | 28,000 |
| TP (lbs/d) | 2,150 | 2,200 |

Based on previous facilities planning studies by the District, linear projection based on historical loading trends has proven to be a reasonable and reliable method in predicting the BOD₅, TSS, and TKN loadings to the plant. However it is not appropriate in predicting TP loadings due to lack of long term influent TP monitoring data. The average TP concentrations of the raw influent were found to be fairly stable for the past 12 years, ranging from 5.9 – 6.8 mg/L. The results are presented in Table 3-3.

Table 3-3. Historical Raw Influent TP Concentrations

| Year | Average TP Loading (lbs/day) | Average Daily Flow (MGD) | Average TP Concentration (mg/L) |
|----------------|------------------------------|--------------------------|---------------------------------|
| 1996 | 2,150 | 38.2 | 6.8 |
| 1997 | 2,036 | 36.9 | 6.6 |
| 1998 | 2,180 | 41.1 | 6.4 |
| 1999 | 2,109 | 41.6 | 6.1 |
| 2000 | 2,102 | 42.1 | 6.0 |
| 2001 | 2,045 | 41.8 | 5.9 |
| 2002 | 2,039 | 40.1 | 6.1 |
| 2003 | 2,087 | 38.6 | 6.5 |
| 2004 | 2,186 | 41.9 | 6.3 |
| 2005 | 2,132 | 39.4 | 6.5 |
| 2006 | 2,165 | 41.2 | 6.3 |
| 2007 | 2,125 | 43.0 | 5.9 |
| Average | 2,113 | 40.5 | 6.3 |

Because of the stability of the influent TP concentration and unclear TP loading trends, the method based on waste-load strength was used to project TP loadings in the planning period. Table 3-4 lists projected TP loadings for 2030 and 2060. Projected loadings for the planning period were determined by multiplying the average TP concentration by the CARPC projected raw wastewater flow rates.

Table 3-4. TP Loading Projection Based on Waste-Load Strength

| Parameter | Value |
|--------------------------|---------------|
| Average TP Concentration | 6.3 mg/L |
| Year 2030 Flow* | 50 MGD |
| Year 2030 TP Loading | 2,700 lbs/day |
| Year 2060 Flow* | 60 MGD |
| Year 2060 TP Loading | 3,200 lbs/day |

**Flow based upon the projections developed by CARPC and represents the low estimates.*

Table 3-5 summarizes the raw wastewater loading projections for the planning period.

Table 3-5. Raw Wastewater Loading Projections

| Parameter | Year 2030 | Year 2060 |
|--------------------------|-----------|-----------|
| BOD ₅ (lbs/d) | 120,000 | 170,000 |
| TSS (lbs/d) | 124,000 | 175,000 |
| TKN (lbs/d) | 20,000 | 28,000 |
| TP (lbs/d) | 2,700 | 3,200 |

Septage, Holding Tank, Landfill Leachate and Other Wastes

Table 3-6 presents daily average loadings of septage, holding tank, grease trap and settling basin wastes at a given year as percentage of the raw wastewater average daily loadings of that year.

Table 3-6. Septage, Holding Tank, Grease Trap and Settling Basin Waste Loadings

| Year | BOD ₅ Daily Average Loading (%) | TSS Daily Average Loading (%) | TKN Daily Average Loading (%) | TP Daily Average Loading (%) |
|----------------|--|-------------------------------|-------------------------------|------------------------------|
| 1996 | - | 1.77 | - | - |
| 1997 | 0.56 | 1.72 | 0.38 | 0.44 |
| 1998 | 0.65 | 2.39 | 0.78 | 0.73 |
| 1999 | 0.68 | 2.97 | 0.62 | 0.76 |
| 2000 | 0.81 | 2.09 | 0.50 | 0.57 |
| 2001 | 0.63 | 2.47 | 0.59 | 0.68 |
| 2002 | 0.51 | 1.53 | 0.51 | 0.54 |
| 2003 | 0.76 | 1.73 | 0.56 | 0.62 |
| 2004 | 1.15 | 2.26 | 0.63 | 0.78 |
| 2005 | 0.75 | 1.88 | 0.54 | 0.70 |
| 2006 | 0.84 | 2.41 | 0.66 | 0.65 |
| 2007 | 0.92 | 2.03 | 0.69 | 0.80 |
| Average | 0.74 | 2.10 | 0.57 | 0.64 |

Table 3-7 presents daily average loadings of the landfill leachate and other wastes at a given year as percentage of the raw wastewater average daily loadings of that year. The combined hauled-in wastes account for approximately 1.52% of raw wastewater BOD₅ loadings; 2.29% of TSS loadings; 0.77% of TKN loadings, and 0.83% of TP loadings. The summary of the projected combined hauled-in waste loadings for the planning period are presented in Table 3-8.

Table 3-7. Leachate and Other Wastes Loadings

| Year | BOD ₅ Loading (%) | TSS Loading (%) | TKN Loading (%) | TP Loading (%) |
|----------------|------------------------------|-----------------|-----------------|----------------|
| 2005 | 0.79 | 0.18 | 0.21 | 0.19 |
| 2006 | 0.84 | 0.20 | 0.21 | 0.18 |
| 2007 | 0.73 | 0.18 | 0.19 | 0.19 |
| Average | 0.78 | 0.19 | 0.20 | 0.19 |

Table 3-8. Total Hauled-in Waste Loading Projections

| Parameter | Year 2030 | Year 2060 |
|--------------------------|-----------|-----------|
| BOD ₅ (lbs/d) | 1,800 | 2,600 |
| TSS (lbs/d) | 2,600 | 3,700 |
| TKN (lbs/d) | 150 | 220 |
| TP (lbs/d) | 22 | 27 |

Table 3-9 presents the projected loadings to the plant combining both raw wastewater and hauled-in wastes. These projected flows and loadings are used in developing projected internal loadings for each unit process at the NSWWTP.

Table 3-9. Total Plant Loading Projection

| Parameter | Year 2030 | Year 2060 |
|--------------------------|-----------|-----------|
| BOD ₅ (lbs/d) | 122,000 | 173,000 |
| TSS (lbs/d) | 127,000 | 179,000 |
| TKN (lbs/d) | 20,000 | 28,000 |
| TP (lbs/d) | 2,700 | 3,200 |

4. Internal Flows and Loadings

A mass balance spreadsheet developed in the Tenth Addition facilities planning was used to determine internal loadings to each unit process at the plant. The spreadsheet is configured to follow both the liquid and solids treatment trains at the plant. According to the Tenth Addition documents, the following assumptions were made in developing the mass balance spreadsheet:

- No new facilities have been constructed to handle future loads.
- Biosolids thickening performance would not be degraded with overloading of the existing facilities.

Table 4-1 and 4-2 list the results from this analysis, including internal loadings under the projected loadings in year 2020, 2030 and 2060. The results of internal flows and loadings were then compared with the rated plant unit process capacities determined in Technical Memorandum 1 – Review of Existing Treatment Facilities. The comparison results were presented in Table 4-3 and Figure 4-1 through 4-5.

Table 4-3. Unit Process Rated Capacity and Projected Utilizations

| Parameter | Unit | Rated Max Capacity | Year 2020 | | Year 2030 | | Year 2060 | |
|---|--------------|--------------------|----------------|----------------------|----------------|----------------------|----------------|----------------------|
| | | | Flow & Loading | Capacity Utilization | Flow & Loading | Capacity Utilization | Flow & Loading | Capacity Utilization |
| Influent Flowmeter Max Hour Flow | MGD | 163.3 | 129 | 79% | 135 | 83% | 173 | 106% |
| Fine Screening System Max Hour Flow | MGD | 180 | 129 | 72% | 135 | 75% | 173 | 96% |
| Grit System Max Hour Flow | MGD | 180 | 129 | 72% | 135 | 75% | 173 | 96% |
| Primary Tank Max Day Flow | MGD | 102 | 66.5 | 66% | 71 | 70% | 84 | 83% |
| Primary Tank Max Hour Flow | MGD | 102 | 129 | 126% | 135 | 132% | 173 | 170% |
| Aeration Basins Average Loading | lb O2/d | 107,744 | 99,924 | 93% | 117,002 | 109% | 164,295 | 152% |
| Aeration Basins Max Day Loading | lb O2/d | 154,604 | 153,711 | 99% | 180,306 | 117% | 250,329 | 162% |
| Aeration Blower Average Day Loading | scfm | 88,000 | 46,425 | 53% | 54,356 | 62% | 76,327 | 87% |
| Aeration Blower Max Day Loading | scfm | 88,000 | 71,414 | 81% | 83,765 | 95% | 116,296 | 132% |
| Secondary Clarifier Solids Loading | lbs/d | 5,537,560 | 3,544,193 | 64% | 4,321,631 | 78% | 8,307,678 | 150% |
| Secondary Clarifier Max Day Hydraulic Loading | MGD | 190 | 82.5 | 43% | 87.9 | 46% | 104.6 | 55% |
| Gravity Thickener Max Day Solids Loading | lbs/d | 118,800 | 162,966 | 137% | 185,438 | 156% | 289,334 | 244% |
| Gravity Thickener Max Day Hydraulic Loading | gpm | 1,980 | 900 | 45% | 1,000 | 51% | 1,400 | 71% |
| Dissolved Air Flotation Thickener Max Day Solids Loading | lbs/d | 83,160 | 107,716 | 130% | 123,595 | 149% | 179,539 | 216% |
| Dissolved Air Flotation Thickener Max Day Hydraulic Loading | gpm | 3,089 | 1,700 | 55% | 1,800 | 58% | 2,000 | 65% |
| Anaerobic Digester Max Month Solids Loading | lbs/d | 153,000 | 153,746 | 100% | 175,806 | 115% | 264,160 | 173% |
| Anaerobic Digester Max Month Hydraulic Loading | gpd | 389,000 | 386,461 | 99% | 442,324 | 114% | 661,333 | 170% |
| Gravity Belt Thickener Max Week Solids Loading | lbs/h | 6,600 | 4,072 | 62% | 4,994 | 76% | 9,420 | 143% |
| Gravity Belt Thickener Max Week Hydraulic Loading | gpm | 500 | 303 | 61% | 346 | 69% | 519 | 104% |
| Metrogro Biosolids Storage Tank Loading | gallon/180 d | 19,403,232 | 25,006,320 | 129% | 29,704,140 | 153% | 54,649,440 | 282% |

**Table 4-1
Internal Liquid Process Mass Balance**

| | 2020 | | | | | | | | 2030 | | | | | | | | 2060 | | | | | | | |
|-----------------------------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|
| | Avg Day | | Max Month | | Max Week | | Max Day | | Avg Day | | Max Month | | Max Week | | Max Day | | Avg Day | | Max Month | | Max Week | | Max Day | |
| | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd |
| Raw Wastewater | | | | | | | | | | | | | | | | | | | | | | | | |
| Flow Rate, mgd | 46.90 | | 58.63 | | 63.32 | | 65.66 | | 50.00 | | 62.50 | | 67.50 | | 70.00 | | 60.00 | | 75.00 | | 81.00 | | 84.00 | |
| BOD | 267 | 104,556 | 257 | 125,467 | 257 | 135,923 | 325 | 177,745 | 288 | 120,264 | 277 | 144,317 | 278 | 156,343 | 350 | 204,449 | 346 | 173,000 | 332 | 207,600 | 333 | 224,900 | 420 | 294,100 |
| TSS | 259 | 101,459 | 15,996 | 121,751 | 18,578 | 142,043 | 30,155 | 233,356 | 276 | 115,118 | 18,216 | 138,142 | 21,150 | 161,165 | 34,313 | 264,771 | 358 | 179,000 | 28,205 | 214,800 | 32,782 | 250,600 | 53,537 | 411,700 |
| VSS | 220 | 86,240 | 13,347 | 103,488 | 15,527 | 120,736 | 25,372 | 198,352 | 235 | 97,850 | 15,212 | 117,420 | 17,693 | 136,990 | 28,899 | 225,056 | 304 | 152,150 | 23,709 | 182,580 | 27,598 | 213,010 | 45,387 | 349,945 |
| FSS | 39 | 15,219 | 37 | 18,263 | 40 | 21,306 | 64 | 35,003 | 41 | 17,268 | 40 | 20,721 | 43 | 24,175 | 68 | 39,716 | 54 | 26,850 | 52 | 32,220 | 56 | 37,590 | 88 | 61,755 |
| TKN | 42.6 | 16,650 | 40.9 | 19,980 | 39.4 | 20,813 | 42.6 | 23,310 | 47.0 | 19,597 | 45.1 | 23,516 | 43.5 | 24,496 | 47.0 | 27,436 | 56.0 | 28,000 | 53.7 | 33,600 | 51.8 | 35,000 | 56.0 | 39,200 |
| NH3-N | 26.4 | 10,323 | 25.3 | 12,388 | 24.4 | 12,904 | 26.4 | 14,452.2 | 29.1 | 12,150 | 28.0 | 14,580 | 27.0 | 15,188 | 29.1 | 17,010 | 34.7 | 17,360 | 33.3 | 20,832 | 32.1 | 21,700 | 34.7 | 24,304 |
| Organic N | 16 | 6,327 | 16 | 7,592 | 15 | 7,909 | 16 | 8,858 | 18 | 7,447 | 17 | 8,936 | 17 | 9,309 | 18 | 10,426 | 21 | 10,640 | 20 | 12,768 | 20 | 13,300 | 21 | 14,896 |
| TP | 6.4 | 2,500 | 5.6 | 2,750 | 5.7 | 3,000 | 5.9 | 3,250 | 6.8 | 2,824 | 6.0 | 3,106 | 6.0 | 3,389 | 6.3 | 3,671 | 6.4 | 3,200 | 5.6 | 3,520 | 5.7 | 3,840 | 5.9 | 4,160 |
| Particulate P - Organic | 2.6 | 1,000 | 2.2 | 1,100.0 | 2.3 | 1,200.0 | 2.4 | 1,300.0 | 2.7 | 1,130 | 2.4 | 1,243 | 2.4 | 1,356 | 2.5 | 1,468 | 2.6 | 1,280 | 2.3 | 1,408 | 2.3 | 1,536 | 2.4 | 1,664 |
| Particulate P - Chemical | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Soluble P | 3.8 | 1,500 | 3.4 | 1,650 | 3.4 | 1,800 | 3.6 | 1,950 | 4.1 | 1,694 | 3.6 | 1,864 | 3.6 | 2,033 | 3.8 | 2,203 | 3.8 | 1,920 | 3.4 | 2,112 | 3.4 | 2,304 | 3.6 | 2,496 |
| Septage | | | | | | | | | | | | | | | | | | | | | | | | |
| Flow Rate, mgd | 0.051 | | 0.051 | | 0.051 | | 0.051 | | 0.054 | | 0.054 | | 0.054 | | 0.054 | | 0.064 | | 0.064 | | 0.064 | | 0.064 | |
| BOD | 3,527 | 1,500 | 3,527 | 1,500 | 3,527 | 1,500 | 3,527 | 1,500 | 4,059 | 1,828 | 4,059 | 1,828 | 4,059 | 1,828 | 4,059 | 1,828 | 4,871 | 2,600 | 4,871 | 2,600 | 4,871 | 2,600 | 4,871 | 2,600 |
| TSS | 4,702 | 2,000 | 4,702 | 2,000 | 4,702 | 2,000 | 4,702 | 2,000 | 5,853 | 2,636 | 5,853 | 2,636 | 5,853 | 2,636 | 5,853 | 2,636 | 6,932 | 3,700 | 6,932 | 3,700 | 6,932 | 3,700 | 6,932 | 3,700 |
| VSS | 3,762 | 1,600 | 3,762 | 1,600 | 3,762 | 1,600 | 3,762 | 1,600 | 4,682 | 2,109 | 4,682 | 2,109 | 4,682 | 2,109 | 4,682 | 2,109 | 5,546 | 2,960 | 5,546 | 2,960 | 5,546 | 2,960 | 5,546 | 2,960 |
| FSS | 940 | 400 | 940 | 400 | 940 | 400 | 940 | 400 | 1,171 | 527 | 1,171 | 527 | 1,171 | 527 | 1,171 | 527 | 1,386 | 740 | 1,386 | 740 | 1,386 | 740 | 1,386 | 740 |
| TKN | 306 | 130 | 306 | 130 | 306 | 130 | 306 | 130 | 335 | 151 | 335 | 151 | 335 | 151 | 335 | 151 | 412 | 220 | 412 | 220 | 412 | 220 | 412 | 220 |
| NH3-N | 244.5 | 104.0 | 244.5 | 104.0 | 244.5 | 104.0 | 244.5 | 104.0 | 268.2 | 120.8 | 268.2 | 120.8 | 268.2 | 120.8 | 268.2 | 120.8 | 329.7 | 176.0 | 329.7 | 176.0 | 329.7 | 176.0 | 329.7 | 176.0 |
| Organic N | 61.1 | 26.0 | 61.1 | 26.0 | 61.1 | 26.0 | 61.1 | 26.0 | 67.1 | 30.2 | 67.1 | 30.2 | 67.1 | 30.2 | 67.1 | 30.2 | 82.4 | 44.0 | 82.4 | 44.0 | 82.4 | 44.0 | 82.4 | 44.0 |
| TP | 49 | 21 | 49 | 21 | 49 | 21 | 49 | 21 | 51 | 23 | 51 | 23 | 51 | 23 | 51 | 23 | 51 | 27 | 51 | 27 | 51 | 27 | 51 | 27 |
| Particulate P - Organic | 9.9 | 4.2 | 9.9 | 4.2 | 9.9 | 4.2 | 9.9 | 4.2 | 10.2 | 4.6 | 10.2 | 4.6 | 10.2 | 4.6 | 10.2 | 4.6 | 10.1 | 5.4 | 10.1 | 5.4 | 10.1 | 5.4 | 10.1 | 5.4 |
| Particulate P - Chemical | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Soluble P | 39 | 17 | 39 | 17 | 39 | 17 | 39 | 17 | 41 | 18 | 41 | 18 | 41 | 18 | 41 | 18 | 40 | 22 | 40 | 22 | 40 | 22 | 40 | 22 |
| Primary Clarifier Influent | | | | | | | | | | | | | | | | | | | | | | | | |
| Flow Rate, mgd | 47.96 | | 59.65 | | 64.31 | | 66.47 | | 51.04 | | 63.49 | | 68.45 | | 70.73 | | 60.86 | | 75.77 | | 81.68 | | 84.11 | |
| BOD | 275 | 109,830 | 264 | 131,195 | 265 | 141,931 | 333 | 184,856 | 297 | 126,316 | 285 | 150,859 | 286 | 163,190 | 360 | 212,435 | 357 | 181,154 | 342 | 216,384 | 344 | 234,022 | 433 | 303,740 |
| TSS | 278 | 111,342 | 267 | 132,998 | 288 | 154,465 | 452 | 250,716 | 298 | 126,766 | 286 | 151,456 | 308 | 175,845 | 484 | 285,289 | 386 | 196,004 | 371 | 234,508 | 400 | 272,563 | 635 | 445,128 |
| VSS | 232 | 92,641 | 223 | 110,968 | 241 | 129,100 | 380 | 210,948 | 248 | 105,559 | 239 | 126,481 | 258 | 147,104 | 407 | 240,274 | 324 | 164,360 | 312 | 197,127 | 337 | 229,462 | 538 | 377,363 |
| FSS | 47 | 18,701 | 44 | 22,030 | 47 | 25,365 | 72 | 39,768 | 50 | 21,207 | 47 | 24,974 | 50 | 28,741 | 76 | 45,014 | 62 | 31,643 | 59 | 37,381 | 63 | 43,101 | 97 | 67,766 |
| TKN | 47 | 18,826 | 45 | 22,438 | 43 | 23,311 | 47 | 25,866 | 52 | 22,057 | 50 | 26,236 | 48 | 27,244 | 51 | 30,137 | 61 | 31,050 | 58 | 36,859 | 56 | 38,170 | 58 | 40,971 |
| NH3-N | 30 | 12,034 | 29 | 14,298 | 28 | 14,816 | 29 | 16,273 | 33 | 14,072 | 31 | 16,666 | 30 | 17,259 | 32 | 18,863 | 39 | 19,634 | 37 | 23,175 | 35 | 23,892 | 35 | 24,851 |
| Organic N | 17 | 6,792 | 16 | 8,141 | 16 | 8,494 | 17 | 9,593 | 19 | 7,984 | 18 | 9,570 | 17 | 9,985 | 19 | 11,275 | 22 | 11,416 | 22 | 13,684 | 21 | 14,279 | 23 | 16,120 |
| TP | 7.4 | 2,945 | 6.3 | 3,142 | 6.4 | 3,407 | 6.5 | 3,624 | 7.6 | 3,238 | 6.7 | 3,530 | 6.7 | 3,828 | 6.9 | 4,061 | 7.1 | 3,608 | 6.2 | 3,926 | 6.2 | 4,247 | 6.3 | 4,394 |
| Particulate P - Organic | 2.9 | 1,172 | 2.5 | 1,224 | 2.5 | 1,335 | 2.6 | 1,445 | 3.0 | 1,259 | 2.6 | 1,383 | 2.6 | 1,507 | 2.8 | 1,631 | 2.8 | 1,425 | 2.5 | 1,565 | 2.5 | 1,706 | 2.6 | 1,843 |
| Particulate P - Chemical | 0.6 | 229 | 0.5 | 228 | 0.4 | 234 | 0.4 | 197 | 0.6 | 240 | 0.5 | 243 | 0.4 | 248 | 0.3 | 196 | 0.4 | 223 | 0.3 | 214 | 0.3 | 205 | 0.0 | 34 |
| Soluble P | 3.9 | 1,544 | 3.4 | 1,690 | 3.4 | 1,839 | 3.6 | 1,983 | 4.1 | 1,739 | 3.6 | 1,904 | 3.6 | 2,072 | 3.8 | 2,235 | 3.9 | 1,959 | 3.4 | 2,147 | 3.4 | 2,336 | 3.6 | 2,517 |
| Primary Clarifier Effluent | | | | | | | | | | | | | | | | | | | | | | | | |
| Flow Rate, mgd | 47.32 | | 59.00 | | 63.66 | | 65.83 | | 50.39 | | 62.84 | | 67.80 | | 70.08 | | 60.22 | | 75.12 | | 81.03 | | 83.46 | |
| BOD | 167 | 65,898 | 160 | 78,717 | 160 | 85,159 | 202 | 110,914 | 180 | 75,790 | 173 | 90,515 | 173 | 97,914 | 218 | 127,461 | 216 | 108,692 | 207 | 129,830 | 208 | 140,413 | 262 | 182,244 |
| TSS | 99 | 38,970 | 95 | 46,549 | 102 | 54,063 | 160 | 87,751 | 106 | 44,368 | 101 | 53,009 | 109 | 61,546 | 171 | 99,851 | 137 | 68,601 | 131 | 82,078 | 141 | 95,397 | 224 | 155,795 |
| VSS | 82 | 32,424 | 79 | 38,839 | 85 | 45,185 | 134 | 73,832 | 88 | 36,946 | 84 | 44,268 | 91 | 51,486 | 144 | 84,096 | 115 | 57,526 | 110 | 68,994 | 119 | 80,312 | 190 | 132,077 |
| FSS | 17 | 6,545 | 16 | 7,711 | 17 | 8,878 | 25 | 13,919 | 18 | 7,422 | 17 | 8,741 | 18 | 10,059 | 27 | 15,755 | 22 | 11,075 | 21 | 13,083 | 22 | 15,085 | 34 | 23,718 |
| TKN | 43 | 16,897 | 41 | 20,166 | 39 | 20,953 | 42 | 23,213 | 47 | 19,802 | 45 | 23,577 | 43 | 24,485 | 46 | 27,033 | 56 | 27,873 | 53 | 33,103 | 51 | 34,268 | 53 | 36,588 |
| NH3-N | 30 | 11,871 | 29 | 14,142 | 28 | 14,667 | 29 | 16,114 | 33 | 13,894 | 31 | 16,496 | 30 | 17,096 | 32 | 18,690 | 39 | 19,425 | 37 | 22,977 | 35 | 23,702 | 35 | 24,660 |
| Organic N | 13 | 5,026 | 12 | 6,024 | 12 | 6,286 | 13 | 7,099 | 14 | 5,908 | 14 | 7,082 | 13 | 7,389 | 14 | 8,343 | 17 | 8,448 | 16 | 10,126 | 16 | 10,566 | 17 | 11,929 |
| TP | 5.2 | 2,041 | 4.5 | 2,208.9 | 4.5 | 2,401 | 4.7 | 2,571 | 5.4 | 2,272 | 4.7 | 2,486.6 | 4.8 | 2,702 | 4.9 | 2,890 | 5.1 | 2,548 | 4.4 | 2,786.6 | 4.5 | 3,025 | 4.6 | 3,192 |
| Particulate P - Organic | 1.1 | 434 | 0.9 | 453 | 0.9 | 494 | 1.0 | 534 | 1.1 | 466 | 1.0 | 512 | 1.0 | 558 | 1.0 | 604 | 1.1 | 527 | 0.9 | 579 | 0.9 | 631 | 1.0 | 682 |
| Particulate P - Chemical | 0.2 | 85 | 0.2 | 84 | 0.2 | | | | | | | | | | | | | | | | | | | |

**Table 4-1
Internal Liquid Process Mass Balance**

| | 2020 | | | | | | | | 2030 | | | | | | | | 2060 | | | | | | | |
|---|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|
| | Avg Day | | Max Month | | Max Week | | Max Day | | Avg Day | | Max Month | | Max Week | | Max Day | | Avg Day | | Max Month | | Max Week | | Max Day | |
| | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd |
| <u>Aeration Tank Influent</u> | | | | | | | | | | | | | | | | | | | | | | | | |
| Flow Rate, mgd | 47.32 | | 59.00 | | 63.66 | | 65.83 | | 50.39 | | 62.84 | | 67.80 | | 70.08 | | 60.22 | | 75.12 | | 81.03 | | 83.46 | |
| BOD | 167 | 65,898 | 160 | 78,717 | 160 | 85,159 | 202 | 110,914 | 180 | 75,790 | 173 | 90,515 | 173 | 97,914 | 218 | 127,461 | 216 | 108,692 | 207 | 129,830 | 208 | 140,413 | 262 | 182,244 |
| TSS | 99 | 38,970 | 95 | 46,549 | 102 | 54,063 | 160 | 87,751 | 106 | 44,368 | 101 | 53,009 | 109 | 61,546 | 171 | 99,851 | 137 | 68,601 | 131 | 82,078 | 141 | 95,397 | 224 | 155,795 |
| VSS | 82 | 32,424 | 79 | 38,839 | 85 | 45,185 | 134 | 73,832 | 88 | 36,946 | 84 | 44,268 | 91 | 51,486 | 144 | 84,096 | 115 | 57,526 | 110 | 68,994 | 119 | 80,312 | 190 | 132,077 |
| FSS | 17 | 6,545 | 16 | 7,711 | 17 | 8,878 | 25 | 13,919 | 18 | 7,422 | 17 | 8,741 | 18 | 10,059 | 27 | 15,755 | 22 | 11,075 | 21 | 13,083 | 22 | 15,085 | 34 | 23,718 |
| TKN | 43 | 16,897 | 41 | 20,166 | 39 | 20,953 | 42 | 23,213 | 47 | 19,802 | 45 | 23,577 | 43 | 24,485 | 46 | 27,033 | 56 | 27,873 | 53 | 33,103 | 51 | 34,268 | 53 | 36,588 |
| NH3-N | 30 | 11,871 | 29 | 14,142 | 28 | 14,667 | 29 | 16,114 | 33 | 13,894 | 31 | 16,496 | 30 | 17,096 | 32 | 18,690 | 39 | 19,425 | 37 | 22,977 | 35 | 23,702 | 35 | 24,660 |
| Organic N | 13 | 5,026 | 12 | 6,024 | 12 | 6,286 | 12.9 | 7,099 | 14 | 5,908 | 14 | 7,082 | 13 | 7,389 | 14.3 | 8,343 | 17 | 8,448 | 16 | 10,126 | 16 | 10,566 | 17.1 | 11,929 |
| TP | 5.2 | 2,041 | 4.5 | 2,209 | 4.5 | 2,401 | 4.7 | 2,571 | 5.4 | 2,272 | 4.7 | 2,487 | 4.8 | 2,702 | 4.9 | 2,890 | 5.1 | 2,548 | 4.4 | 2,787 | 4.5 | 3,025 | 4.6 | 3,192 |
| Particulate P - Organic | 1.1 | 434 | 0.9 | 453 | 0.9 | 494 | 1.0 | 534 | 1.1 | 466 | 1.0 | 512 | 1.0 | 558 | 1.0 | 604 | 1.1 | 527 | 0.9 | 579 | 0.9 | 631 | 1.0 | 682 |
| Particulate P - Chemical | 0.2 | 85 | 0.2 | 84 | 0.2 | 87 | 0.1 | 73 | 0.2 | 89 | 0.2 | 90 | 0.2 | 92 | 0.1 | 72 | 0.2 | 83 | 0.1 | 79 | 0.1 | 76 | 0.0 | 12 |
| Soluble P | 3.9 | 1,523 | 3.4 | 1,672 | 3.4 | 1,820 | 3.6 | 1,963 | 4.1 | 1,717 | 3.6 | 1,885 | 3.6 | 2,053 | 3.8 | 2,214 | 3.9 | 1,939 | 3.4 | 2,128 | 3.4 | 2,318 | 3.6 | 2,498 |
| <u>Recycled Activated Sludge</u> | | | | | | | | | | | | | | | | | | | | | | | | |
| Flow Rate, mgd | 12.00 | | 14.96 | | 16.14 | | 16.69 | | 12.78 | | 15.94 | | 17.20 | | 17.77 | | 15.27 | | 19.05 | | 20.55 | | 21.17 | |
| TSS | 14,637 | 1,464,865 | 17,309 | 2,160,277 | 18,975 | 2,554,875 | 25,455 | 3,544,193 | 16,766 | 1,787,070 | 19,846 | 2,638,017 | 21,748 | 3,118,838 | 29,156 | 4,321,631 | 26,869 | 3,422,165 | 31,871 | 5,063,859 | 34,955 | 5,990,965 | 47,060 | 8,307,678 |
| VSS | 11,430 | 1,143,896 | 949,904 | 1,704,404 | 1,035,784 | 2,005,090 | 1,387,868 | 2,778,146 | 914,165 | 1,400,910 | 1,092,019 | 2,086,904 | 1,190,444 | 2,454,409 | 1,594,009 | 3,396,862 | 1,492,989 | 2,733,818 | 1,783,765 | 4,074,723 | 1,945,541 | 4,794,023 | 2,604,585 | 6,610,503 |
| FSS | 3,207 | 320,969 | 254,069 | 455,873 | 284,006 | 549,785 | 382,692 | 766,047 | 251,989 | 386,160 | 288,382 | 551,113 | 322,263 | 664,429 | 433,956 | 924,769 | 375,919 | 688,347 | 433,008 | 989,136 | 485,751 | 1,196,942 | 668,699 | 1,697,175 |
| <u>Plant Effluent</u> | | | | | | | | | | | | | | | | | | | | | | | | |
| Flow Rate, mgd | 46.81 | | 58.50 | | 63.16 | | 65.32 | | 49.89 | | 62.34 | | 67.30 | | 69.57 | | 59.76 | | 74.67 | | 80.58 | | 83.01 | |
| BOD | 5.0 | 1,952 | 5.0 | 2,440 | 5.0 | 2,634 | 5.0 | 2,724 | 5.0 | 2,080 | 5.0 | 2,600 | 5.0 | 2,806 | 5.0 | 2,901 | 5.0 | 2,492 | 5.0 | 3,114 | 5.0 | 3,360 | 5.0 | 3,461 |
| TSS | 5.0 | 1,952 | 5.0 | 2,440 | 5.0 | 2,634 | 5.0 | 2,724 | 5.0 | 2,080 | 5.0 | 2,600 | 5.0 | 2,806 | 5.0 | 2,901 | 5.0 | 2,492 | 5.0 | 3,114 | 5.0 | 3,360 | 5.0 | 3,461 |
| VSS | 3.9 | 1,524 | 3.9 | 1,925 | 3.9 | 2,067 | 3.9 | 2,135 | 3.9 | 1,631 | 4.0 | 2,056 | 3.9 | 2,208 | 3.9 | 2,280 | 4.0 | 1,991 | 4.0 | 2,505 | 4.0 | 2,689 | 4.0 | 2,754 |
| FSS | 1.1 | 428 | 1.1 | 515 | 1.1 | 567 | 1.1 | 589 | 1.1 | 450 | 1.0 | 543 | 1.1 | 598 | 1.1 | 621 | 1.0 | 501 | 1.0 | 608 | 1.0 | 671 | 1.0 | 707 |
| TKN | 0.9 | 366 | 0.9 | 459 | 0.9 | 492 | 0.9 | 499 | 0.9 | 391 | 0.9 | 490 | 0.9 | 525 | 0.0 | 0 | 0.9 | 470 | 0.9 | 589 | 0.9 | 631 | 0.9 | 635 |
| NH3-N | 0.5 | 195 | 0.5 | 244 | 0.5 | 263 | 0.5 | 272 | 0.5 | 208 | 0.5 | 260 | 0.5 | 281 | 0.0 | 0 | 0.5 | 249 | 0.5 | 311 | 0.5 | 336 | 0.5 | 346 |
| Organic N | 0.4 | 170 | 0.4 | 215 | 0.4 | 229 | 0.4 | 227 | 0.4 | 183 | 0.4 | 230 | 0.4 | 245 | 0.0 | 0 | 0.4 | 221 | 0.4 | 278 | 0.4 | 295 | 0.4 | 289 |
| TP | 0.4 | 138 | 0.3 | 166 | 0.3 | 179 | 0.3 | 170 | 0.4 | 146 | 0.3 | 176 | 0.3 | 189 | 0.3 | 180 | 0.3 | 158 | 0.3 | 191 | 0.3 | 206 | 0.3 | 196 |
| Particulate P - Organic | 0.1 | 58 | 0.1 | 66 | 0.1 | 71 | 0.1 | 59 | 0.1 | 60 | 0.1 | 69 | 0.1 | 74 | 0.1 | 62 | 0.1 | 56 | 0.1 | 65 | 0.1 | 70 | 0.1 | 58 |
| Particulate P - Chemical | 0.0 | 2.6 | 0.0 | 2.7 | 0.0 | 2.8 | 0.0 | 1.8 | 0.0 | 2.5 | 0.0 | 2.7 | 0.0 | 2.7 | 0.0 | 1.7 | 0.0 | 2.0 | 0.0 | 2.0 | 0.0 | 1.9 | 0.0 | 0.2 |
| Soluble P | 0.2 | 78 | 0.2 | 98 | 0.2 | 105 | 0.2 | 109 | 0.2 | 83 | 0.2 | 104 | 0.2 | 112 | 0.2 | 116 | 0.2 | 100 | 0.2 | 125 | 0.2 | 134 | 0.2 | 138 |

**Table 4-2
Internal Solids Process Mass Balance**

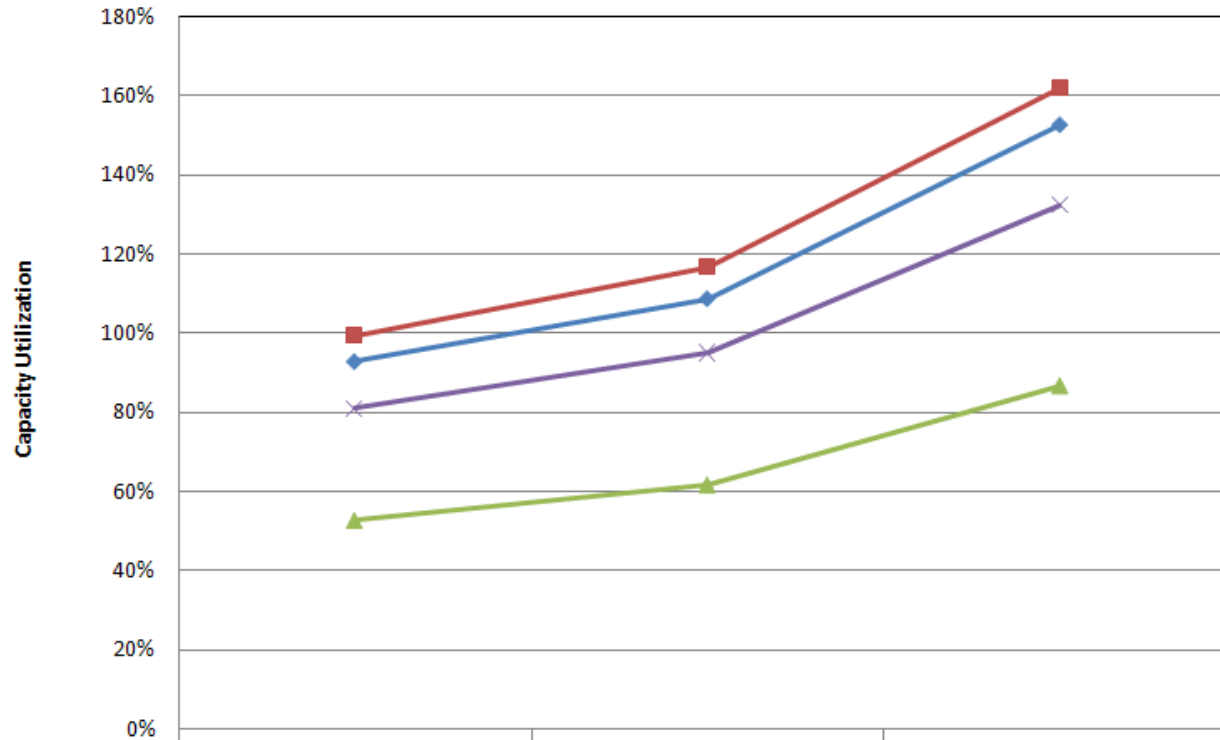
| | 2020 | | | | | | | | 2030 | | | | | | | | 2060 | | | | | | | | |
|--|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|-----------|
| | Avg Day | | Max Month | | Max Week | | Max Day | | Avg Day | | Max Month | | Max Week | | Max Day | | Avg Day | | Max Month | | Max Week | | Max Day | | |
| | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | |
| Primary Sludge Production | | | | | | | | | | | | | | | | | | | | | | | | | |
| Primary Sludge Flow Rate, gpd | 648,000 | | 648,000 | | 648,000 | | 648,000 | | 648,000 | | 648,000 | | 648,000 | | 648,000 | | 648,000 | | 648,000 | | 648,000 | | 648,000 | | 648,000 |
| Primary Sludge TSS | 13,392 | 72,372 | 15,996 | 86,449 | 18,578 | 100,402 | 30,155 | 162,965 | 15,247 | 82,398 | 18,216 | 98,446 | 21,150 | 114,299 | 34,313 | 185,438 | 23,574 | 127,402 | 28,205 | 152,430 | 32,782 | 177,166 | 53,537 | 289,333 | |
| Primary Sludge VSS | 11,142 | 60,217 | 13,347 | 72,129 | 15,527 | 83,915 | 25,372 | 137,116 | 12,696 | 68,613 | 15,212 | 82,213 | 17,693 | 95,618 | 28,899 | 156,178 | 19,768 | 106,834 | 23,709 | 128,133 | 27,598 | 149,150 | 45,387 | 245,286 | |
| Primary Sludge Soluble NH3-N | 30 | 163 | 29 | 155 | 28 | 149 | 29 | 159 | 33 | 179 | 31 | 170 | 30 | 163 | 32 | 173 | 39 | 209 | 37 | 198 | 35 | 190 | 35 | 191 | |
| Primary Sludge TKN | 357 | 1,928 | 420 | 2,272 | 436 | 2,358 | 491 | 2,653 | 417 | 2,255 | 492 | 2,658 | 511 | 2,760 | 574 | 3,104 | 588 | 3,177 | 695 | 3,756 | 722 | 3,902 | 811 | 4,383 | |
| Primary Sludge Soluble P | 4 | 21 | 3 | 18 | 3 | 19 | 4 | 19 | 4 | 22 | 4 | 19 | 4 | 20 | 4 | 20 | 4 | 21 | 3 | 18 | 3 | 19 | 4 | 19 | |
| Primary Sludge Total P | 167 | 904 | 173 | 933 | 186 | 1,007 | 195 | 1,054 | 179 | 966 | 193 | 1,044 | 208 | 1,125 | 217 | 1,171 | 196 | 1,059 | 211 | 1,139 | 226 | 1,222 | 222 | 1,202 | |
| Waste Activated Sludge (WAS) Production | | | | | | | | | | | | | | | | | | | | | | | | | |
| WAS Flow Rate, gpd | 504,222 | | 503,315 | | 503,571 | | 507,383 | | 505,335 | | 504,508 | | 504,742 | | 508,283 | | 455,145 | | 454,552 | | 454,740 | | 457,446 | | 457,446 |
| WAS TSS | 14,637 | 61,551 | 17,309 | 72,659 | 18,975 | 79,689 | 25,455 | 107,716 | 16,766 | 70,659 | 19,846 | 83,504 | 21,748 | 91,550 | 29,156 | 123,595 | 26,869 | 101,993 | 31,871 | 120,820 | 34,955 | 132,567 | 47,060 | 179,539 | |
| WAS VSS | 11,430 | 48,065 | 13,657 | 57,326 | 14,891 | 62,541 | 19,953 | 84,434 | 13,143 | 55,391 | 15,700 | 66,059 | 17,115 | 72,046 | 22,917 | 97,147 | 21,465 | 81,478 | 25,645 | 97,220 | 27,971 | 106,081 | 37,446 | 142,861 | |
| WAS NH3-N | 2.2 | 9 | 2.2 | 9 | 2.2 | 9 | 2.2 | 9 | 2.2 | 9 | 2.2 | 9 | 2.2 | 9 | 2.2 | 9 | 2.4 | 9 | 2.4 | 9 | 2.4 | 9 | 2.4 | 9 | |
| WAS TKN | 1,281 | 5,385 | 1,529 | 6,420 | 1,649 | 6,926 | 2,123 | 8,984 | 1,475 | 6,217 | 1,761 | 7,410 | 1,899 | 7,993 | 2,444 | 10,358 | 2,385 | 9,052 | 2,847 | 10,794 | 3,069 | 11,639 | 3,932 | 15,003 | |
| WAS Soluble P | 0.2 | 0.8 | 0.2 | 0.8 | 0.2 | 0.8 | 0.2 | 0.8 | 0.2 | 0.8 | 0.2 | 0.8 | 0.2 | 0.8 | 0.2 | 0.8 | 0.2 | 0.8 | 0.2 | 0.8 | 0.2 | 0.8 | 0.2 | 0.8 | |
| WAS Total P | 453 | 1,903 | 487 | 2,043 | 529 | 2,222 | 567 | 2,401 | 504 | 2,126 | 549 | 2,311 | 597 | 2,513 | 639 | 2,710 | 630 | 2,390 | 685 | 2,595 | 743 | 2,819 | 785 | 2,996 | |
| Gravity Thickening of Primary Sludge | | | | | | | | | | | | | | | | | | | | | | | | | |
| Number of units in service | 2 | | 2 | | 2 | | 2 | | 2 | | 2 | | 2 | | 2 | | 2 | | 2 | | 2 | | 2 | | 2 |
| Type | Circular | | Circular | | Circular | | Circular | | Circular | | Circular | | Circular | | Circular | | Circular | | Circular | | Circular | | Circular | | Circular |
| Diameter, ft | 55 | | 55 | | 55 | | 55 | | 55 | | 55 | | 55 | | 55 | | 55 | | 55 | | 55 | | 55 | | 55 |
| Total Surface Area, sf | 4752 | | 4752 | | 4752 | | 4752 | | 4752 | | 4752 | | 4752 | | 4752 | | 4752 | | 4752 | | 4752 | | 4752 | | 4752 |
| Solids Loading Rate, lb/d/sf | 15.2 | | 18.2 | | 21.1 | | 34.3 | | 17.3 | | 20.7 | | 24.1 | | 39.0 | | 26.8 | | 32.1 | | 37.3 | | 60.9 | | 60.9 |
| Hydraulic Loading Rate, gpd/sf | 136 | | 136 | | 136 | | 136 | | 136 | | 136 | | 136 | | 136 | | 136 | | 136 | | 136 | | 136 | | 136 |
| Gravity Thickened Primary Sludge Production | | | | | | | | | | | | | | | | | | | | | | | | | |
| TPSD Flow Rate, gpd | 154,621 | | 184,695 | | 214,507 | | 348,171 | | 176,041 | | 210,328 | | 244,197 | | 396,183 | | 272,191 | | 325,663 | | 378,510 | | 618,153 | | 618,153 |
| TPSD TSS | 5.5% | 70,925 | 5.5% | 84,720 | 5.5% | 98,394 | 5.5% | 159,706 | 5.5% | 80,750 | 5.5% | 96,477 | 5.5% | 112,013 | 5.5% | 181,729 | 5.5% | 124,854 | 5.5% | 149,382 | 5.5% | 173,622 | 5.5% | 283,547 | |
| TPSD VSS | 45,762 | 59,012 | 45,890 | 70,686 | 45,968 | 82,237 | 46,276 | 134,374 | 45,799 | 67,241 | 45,931 | 80,569 | 46,011 | 93,705 | 46,322 | 153,055 | 46,121 | 104,697 | 46,233 | 125,570 | 46,303 | 146,167 | 46,627 | 240,380 | |
| TPSD Soluble NH3-N | 30 | 39 | 29 | 44 | 28 | 49 | 29 | 85 | 33 | 49 | 31 | 55 | 30 | 62 | 32 | 106 | 39 | 88 | 37 | 100 | 35 | 111 | 35 | 183 | |
| TPSD TKN | 1,372 | 1,769 | 1,375 | 2,118 | 1,237 | 2,214 | 871 | 2,530 | 1,419 | 2,083 | 1,422 | 2,494 | 1,279 | 2,606 | 901 | 2,978 | 1,320 | 2,997 | 1,320 | 3,586 | 1,188 | 3,749 | 832 | 4,290 | |
| TPSD Total P | 675 | 870 | 585 | 902 | 545 | 975 | 353 | 1,024 | 634 | 931 | 576 | 1,010 | 536 | 1,091 | 345 | 1,140 | 452 | 1,027 | 408 | 1,108 | 377 | 1,190 | 228 | 1,177 | |
| TPSD Soluble P | 3.9 | 5.0 | 3.4 | 5.2 | 3.4 | 6.1 | 3.6 | 10.4 | 4.1 | 6.0 | 3.6 | 6.3 | 3.6 | 7.4 | 3.8 | 12.5 | 3.9 | 8.8 | 3.4 | 9.2 | 3.4 | 10.8 | 3.6 | 18.5 | |
| Dissolved Air Flotation Thickening of WAS | | | | | | | | | | | | | | | | | | | | | | | | | |
| Number of units in service | 2 | | 2 | | 2 | | 2 | | 2 | | 2 | | 2 | | 2 | | 2 | | 2 | | 2 | | 2 | | 2 |
| Type | Circular | | Circular | | Circular | | Circular | | Circular | | Circular | | Circular | | Circular | | Circular | | Circular | | Circular | | Circular | | Circular |
| Diameter, ft | 55 | | 55 | | 55 | | 55 | | 55 | | 55 | | 55 | | 55 | | 55 | | 55 | | 55 | | 55 | | 55 |
| Total Effective Surface Area, sf | 4562 | | 4562 | | 4562 | | 4562 | | 4562 | | 4562 | | 4562 | | 4562 | | 4562 | | 4562 | | 4562 | | 4562 | | 4562 |
| Recycle Rate Per DAF, gpd | 900,000 | | 900,000 | | 900,000 | | 900,000 | | 900,000 | | 900,000 | | 900,000 | | 900,000 | | 900,000 | | 900,000 | | 900,000 | | 900,000 | | 900,000 |
| Solids Loading Rate, lb/d/sf | 13.49 | | 15.93 | | 17.47 | | 23.61 | | 15.49 | | 18.31 | | 20.07 | | 27.09 | | 22.36 | | 26.49 | | 29.06 | | 39.36 | | 39.36 |
| Hydraulic Loading Rate, gpm/sf | 0.35 | | 0.35 | | 0.35 | | 0.35 | | 0.35 | | 0.35 | | 0.35 | | 0.35 | | 0.34 | | 0.34 | | 0.34 | | 0.34 | | 0.34 |
| Thickened WAS Production | | | | | | | | | | | | | | | | | | | | | | | | | |
| TWAS Flow Rate, gpd | 171,006 | | 201,866 | | 221,398 | | 299,264 | | 196,310 | | 231,996 | | 254,350 | | 343,379 | | 283,364 | | 335,670 | | 368,305 | | 498,806 | | 498,806 |
| TWAS TSS | 41,000 | 58,474 | 41,000 | 69,026 | 41,000 | 75,705 | 41,000 | 102,330 | 41,000 | 67,126 | 41,000 | 79,329 | 41,000 | 86,972 | 41,000 | 117,415 | 41,000 | 96,894 | 41,000 | 114,779 | 41,000 | 125,938 | 41,000 | 170,562 | |
| TWAS VSS | 32,016 | 45,662 | 32,348 | 54,460 | 32,177 | 59,414 | 32,138 | 80,213 | 32,140 | 52,621 | 32,435 | 62,756 | 32,265 | 68,444 | 32,227 | 92,290 | 32,753 | 77,404 | 32,991 | 92,359 | 32,809 | 100,777 | 32,624 | 135,718 | |
| TWAS Soluble NH3-N | 2.2 | 3.1 | 2.2 | 3.7 | 2.2 | 4.1 | 2.2 | 5.4 | 2.2 | 3.6 | 2.2 | 4.2 | 2.2 | 4.7 | 2.2 | 6.2 | 2.4 | 5.8 | 2.4 | 6.8 | 2.4 | 7.5 | 2.4 | 10.1 | |
| TWAS TKN | 3,583 | 5,110 | 3,619 | 6,094 | 3,561 | 6,575 | 3,418 | 8,531 | 3,604 | 5,901 | 3,636 | 7,035 | 3,578 | 7,589 | 3,435 | 9,838 | 3,637 | 8,596 | 3,662 | 10,253 | 3,599 | 11,056 | 3,426 | 14,254 | |
| TWAS Soluble P | 4.0 | 5.7 | 4.0 | 6.7 | 4.0 | 7.4 | 4.0 | 10.0 | 4.0 | 6.5 | 4.0 | 7.7 | 4.0 | 8.5 | 4.0 | 11.5 | 4.0 | 9.5 | 4.0 | 11.2 | 4.0 | 12.3 | 4.0 | 16.6 | |
| TWAS TP | 1,260 | 1,797 | 1,147 | 1,931 | 1,138 | 2,101 | 911 | 2,274 | 1,227 | 2,009 | 1,130 | 2,186 | 1,121 | 2,379 | 897 | 2,569 | 959 | 2,265 | 879 | 2,462 | 871 | 2,675 | 684 | 2,847 | |
| Anaerobic Digester Feed Sludge | | | | | | | | | | | | | | | | | | | | | | | | | |
| Flow Rate, gpd | 325,627 | | 386,561 | | 435,905 | | 647,435 | | 372,351 | | 442,324 | | 498,547 | | 739,562 | | 555,556 | | 661,333 | | 746,814 | | 1,116,959 | | 1,116,959 |
| TSS | 47,648 | 129,398 | 47,689 | 153,746 | 47,889 | 174,099 | 48,529 | 262,037 | 47,619 | 147,876 | 47,657 | 175,806 | 47,857 | 198,986 | 48,500 | 299,144 | 47,859 | 221,748 | 47,894 | 264,160 | 48,096 | 299,561 | 48,748 | 454,109 | |
| VSS | 38,544 | 104,674 | 38,818 | 125,146 | 38,964 | 141,651 | 39,741 | 214,586 | 38,598 | 119,862 | 38,852 | 143,325 | 38,998 | 162,149 | 39,777 | 245,345 | 39,302 | 182,101 | 39,512 | 217,929 | 39,648 | 246,944 | 40,374 | 376,098 | |
| FSS | 9,104 | 24,725 | 8,871 | 28,599 | 8,926 | 32,448 | 8,788 | 47,450 | 9,021 | 28,014 | 8,805 | 32,481 | 8,859 | 36,836 | 8,722 | 53,799 | 8,557 | 46,232 | 8,382 | 52,617 | 8,448 | 52,617 | 8,374 | 78,011 | |
| Org-N | 2,518 | 6,838 | 2,532 | 8,164 | 2,403 | 8,735 | 2,032 | 10,970 | 2,554 | 7,931 | 2,567 | 9,469 | 2,436 | 10,129 | 2,060 | 12,704 | 2,482 | 11,499 | 2,490 | 13,732 | 2,358 | 14,687 | 1,970 | 18,351 | |
| NH3-N | 15.4 | 41.9 | 14.9 | 48.0 | 14.7 | 53.5 | 16.8 | 90.7 | 16.8 | 52.1 | 16.1 | 59.5 | 15.9 | 66.2 | 18.1 | 111.9 | 20.2 | 93.6 | 19.3 | 106.4 | 19.0 | 118.2</ | | | |

**Table 4-2
Internal Solids Process Mass Balance**

| | 2020 | | | | | | | | 2030 | | | | | | | | 2060 | | | | | | | |
|---|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|
| | Avg Day | | Max Month | | Max Week | | Max Day | | Avg Day | | Max Month | | Max Week | | Max Day | | Avg Day | | Max Month | | Max Week | | Max Day | |
| | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd | Conc mg/l | MASS ppd |
| Digested Sludge Production | | | | | | | | | | | | | | | | | | | | | | | | |
| Digested Sludge Flow Rate, gpd | 325,627 | | 386,561 | | 435,905 | | 647,435 | | 372,351 | | 442,324 | | 498,547 | | 739,562 | | 555,556 | | 661,333 | | 746,814 | | 1,116,959 | |
| Digested Sludge TSS w/ Chem | 23,751 | 64,501 | 25,109 | 80,950 | 26,885 | 97,741 | 33,676 | 181,838 | 24,673 | 76,618 | 26,922 | 99,314 | 28,823 | 119,843 | 36,441 | 224,768 | 30,423 | 140,962 | 33,544 | 185,010 | 36,301 | 226,100 | 52,778 | 491,647 |
| Digested Sludge VSS | 14,647 | 39,776 | 16,238 | 52,351 | 17,960 | 65,292 | 24,888 | 134,387 | 15,652 | 48,605 | 18,117 | 66,832 | 19,964 | 83,007 | 27,719 | 170,969 | 21,867 | 101,315 | 25,161 | 138,778 | 27,853 | 173,484 | 44,403 | 413,636 |
| Soluble NH3-N in Digested Sludge | 952 | 2,587 | 958 | 3,088 | 909 | 3,305 | 770 | 4,159 | 967 | 3,002 | 971 | 3,583 | 922 | 3,833 | 781 | 4,819 | 941 | 4,359 | 943 | 5,203 | 894 | 5,567 | 748 | 6,972 |
| Digested Sludge TKN | 2,533 | 6,880 | 2,547 | 8,212 | 2,417 | 8,789 | 2,048 | 11,061 | 2,571 | 7,984 | 2,583 | 9,529 | 2,452 | 10,195 | 2,078 | 12,816 | 2,502 | 11,593 | 2,509 | 13,839 | 2,377 | 14,805 | 1,991 | 18,544 |
| Digested Sludge Soluble P | 139 | 376 | 125 | 402 | 121 | 439 | 90 | 484 | 134 | 417 | 124 | 456 | 120 | 498 | 89 | 549 | 103 | 477 | 95 | 522 | 92 | 570 | 67 | 629 |
| Digested Sludge TP | 982 | 2,667 | 879 | 2,832 | 846 | 3,076 | 611 | 3,298 | 947 | 2,940 | 866 | 3,196 | 835 | 3,470 | 601 | 3,710 | 710 | 3,292 | 647 | 3,569 | 621 | 3,865 | 432 | 4,024 |
| Digester Gas Production | | | | | | | | | | | | | | | | | | | | | | | | |
| Digester Gas Produced, scf/day | 895,590 | | 1,004,575 | | 1,053,748 | | 1,106,745 | | 983,355 | | 1,055,594 | | 1,092,164 | | 1,026,383 | | 1,114,848 | | 1,092,279 | | 1,013,751 | | -518,031 | |
| Digester Gas Energy Produced | 4.93E+08 | | 5.53E+08 | | 5.80E+08 | | 6.09E+08 | | 5.41E+08 | | 5.81E+08 | | 6.01E+08 | | 5.65E+08 | | 6.13E+08 | | 6.01E+08 | | 5.58E+08 | | -2.85E+08 | |
| Gravity Belt Thickening of Digested Sludge | | | | | | | | | | | | | | | | | | | | | | | | |
| Number of Units | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | |
| Width, meters | 2 | | 2 | | 2 | | 2 | | 2 | | 2 | | 2 | | 2 | | 2 | | 2 | | 2 | | 2 | |
| Digested Sludge Flowrate, gpd | 325,627 | | 386,561 | | 435,905 | | 647,435 | | 372,351 | | 442,324 | | 498,547 | | 739,562 | | 555,556 | | 661,333 | | 746,814 | | 1,116,959 | |
| Hydraulic Loading Rate, gpm/ft | 113 | | 134 | | 151 | | 225 | | 129 | | 154 | | 173 | | 257 | | 193 | | 230 | | 259 | | 388 | |
| Solids Loading Rate, lb/hr/m | 1,344 | | 1,686 | | 2,036 | | 3,788 | | 1,596 | | 2,069 | | 2,497 | | 4,683 | | 2,937 | | 3,854 | | 4,710 | | 10,243 | |
| Thickened Digested Sludge Production | | | | | | | | | | | | | | | | | | | | | | | | |
| Cake Flow Rate, gpd | 138,924 | | 174,354 | | 210,517 | | 391,648 | | 165,023 | | 213,905 | | 258,123 | | 484,113 | | 303,608 | | 398,480 | | 486,982 | | 1,058,925 | |
| Cake TSS | | 62,566 | | 78,522 | | 94,808 | | 176,382 | | 74,320 | | 96,334 | | 116,248 | | 218,025 | | 136,733 | | 179,460 | | 219,317 | | 476,898 |
| Cake VSS | 33,301 | 38,583 | 34,922 | 50,780 | 36,073 | 63,333 | 39,909 | 130,356 | 34,256 | 47,147 | 36,339 | 64,827 | 37,402 | 80,517 | 41,075 | 165,840 | 38,812 | 98,276 | 40,506 | 134,615 | 41,433 | 168,279 | 45,432 | 401,227 |
| Cake Soluble NH3-N | | 1,104 | | 1,393 | | 1,596 | | 2,516 | | 1,330 | | 1,733 | | 1,985 | | 3,154 | | 2,382 | | 3,135 | | 3,630 | | 6,610 |
| Cake TKN | 4,546 | 5,268 | 4,376 | 6,363 | 3,939 | 6,915 | 2,820 | 9,211 | 4,478 | 6,163 | 4,204 | 7,500 | 3,788 | 8,156 | 2,703 | 10,912 | 3,712 | 9,399 | 3,464 | 11,512 | 3,100 | 12,591 | 2,019 | 17,834 |
| Cake Soluble P | 139 | 160 | 125 | 181 | 121 | 212 | 90 | 293 | 134 | 185 | 124 | 221 | 120 | 258 | 89 | 359 | 103 | 261 | 95 | 314 | 92 | 372 | 67 | 596 |
| Cake TP | 2056 | 2,383 | 1746 | 2,539 | 1578 | 2,770 | 925 | 3,023 | 1913 | 2,632 | 1613 | 2,878 | 1459 | 3,141 | 848 | 3,425 | 1181 | 2,991 | 984 | 3,270 | 879 | 3,568 | 440 | 3,890 |
| Metrogro Storage Tanks | | | | | | | | | | | | | | | | | | | | | | | | |
| Number of Tanks | 3 | | 3 | | 3 | | 3 | | 3 | | 3 | | 3 | | 3 | | 3 | | 3 | | 3 | | 3 | |
| Tank Diameter | 160 | | 160 | | 160 | | 160 | | 160 | | 160 | | 160 | | 160 | | 160 | | 160 | | 160 | | 160 | |
| Volume Each Tank | 864,672 | | 864,672 | | 864,672 | | 864,672 | | 864,672 | | 864,672 | | 864,672 | | 864,672 | | 864,672 | | 864,672 | | 864,672 | | 864,672 | |
| Total Volume | 2,594,015 | | 2,594,015 | | 2,594,015 | | 2,594,015 | | 2,594,015 | | 2,594,015 | | 2,594,015 | | 2,594,015 | | 2,594,015 | | 2,594,015 | | 2,594,015 | | 2,594,015 | |
| Detention Time | 140 | | 111 | | 92 | | 50 | | 118 | | 91 | | 75 | | 40 | | 64 | | 49 | | 40 | | 18 | |

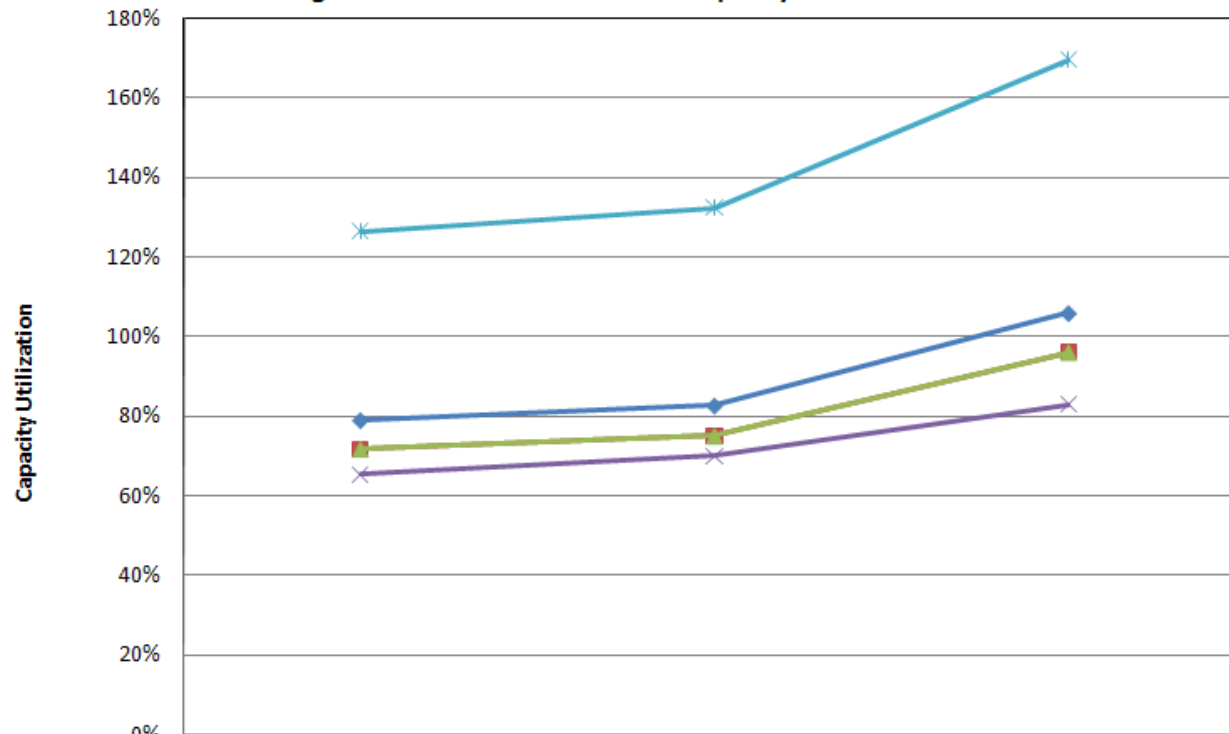
Notes:
1. Maximum month.

Figure 4-2: NSWTP Unit Process Capacity Utilization No.2



| | Year 2020 | Year 2030 | Year 2060 |
|---------------------------------------|-----------|-----------|-----------|
| ◆ Aeration Basins Average Loading | 93% | 109% | 152% |
| ■ Aeration Basins Max Day Loading | 99% | 117% | 162% |
| ▲ Aeration Blower Average Day Loading | 53% | 62% | 87% |
| × Aeration Blower Max Day Loading | 81% | 95% | 132% |

Figure 4-1: NSWTP Unit Process Capacity Utilization No.1



| | Year 2020 | Year 2030 | Year 2060 |
|-------------------------------------|-----------|-----------|-----------|
| Influent Flowmeter Max Hour Flow | 79% | 83% | 106% |
| Fine Screening System Max Hour Flow | 72% | 75% | 96% |
| Grit System Max Hour Flow | 72% | 75% | 96% |
| Primary Tank Max Day Flow | 66% | 70% | 83% |
| Primary Tank Max Hour Flow | 126% | 132% | 170% |

Figure 4-3: NSWTP Unit Process Capacity Utilization No.3

