CHAPTER 3. EXISTING WASTEWATER FACILITIES

A review of McMinnville's existing wastewater treatment facilities forms the framework for the development of a long-term plant upgrade strategy. Analysis of historical plant operation can reveal any ongoing performance deficiencies. Identification of the design capacity of each existing unit process can indicate the need to expand facilities when compared to the projections of future flows and loads. In addition, the existing facilities information allows for the determination of how new facilities can be best integrated into the system upgrade to achieve long-term capacity and treatment objectives.

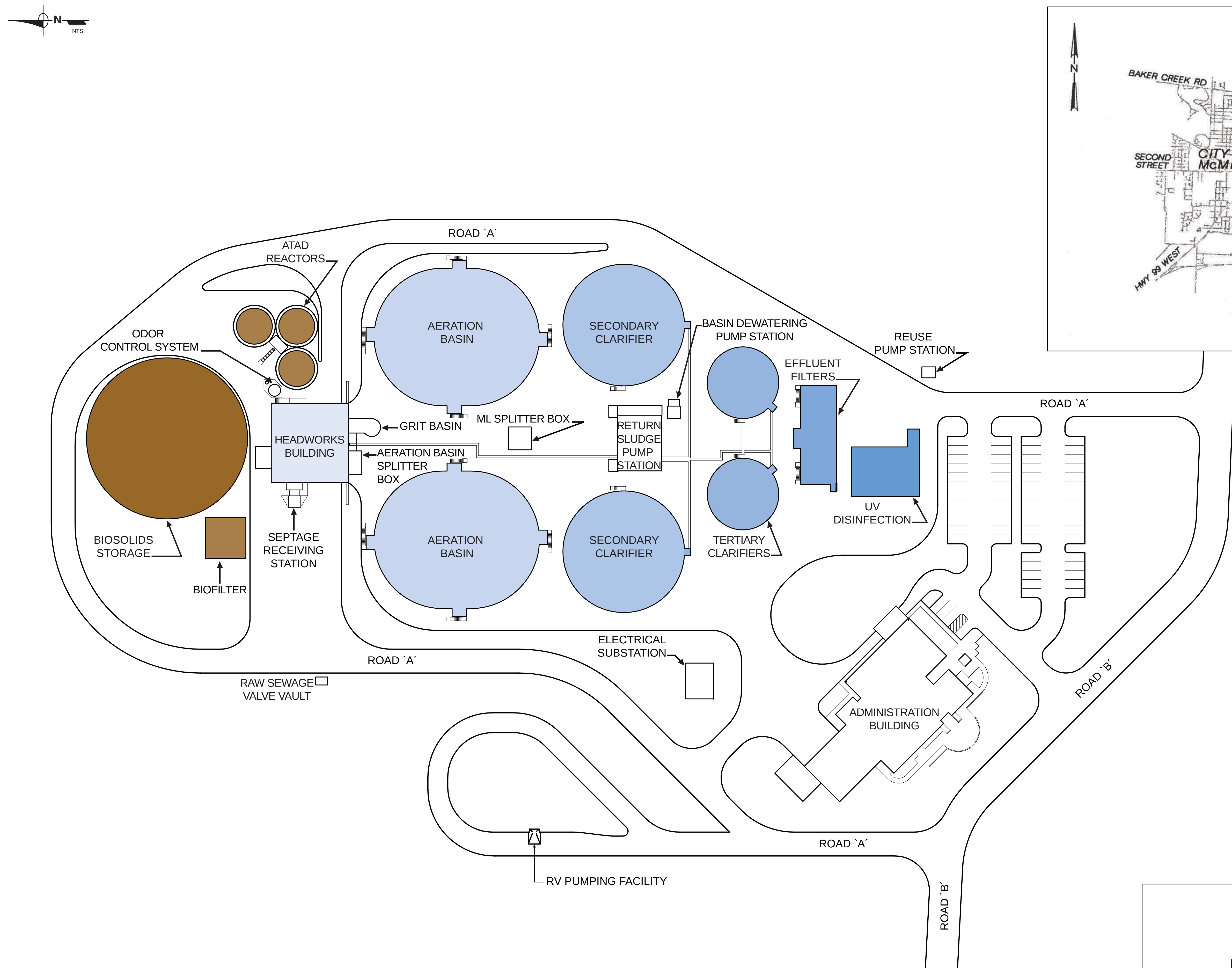
This chapter summarizes the design capacity and the current condition of the major treatment processes. The capacity and condition assessment presented in this chapter will be used in the planning process to help define the needs of a long-term wastewater management program. The capacity of each unit process is expressed in terms of wastewater parameters that can be tracked and compared with facilities planning projections such as average dry weather flow (ADWF) or peak hour flow (PHF).

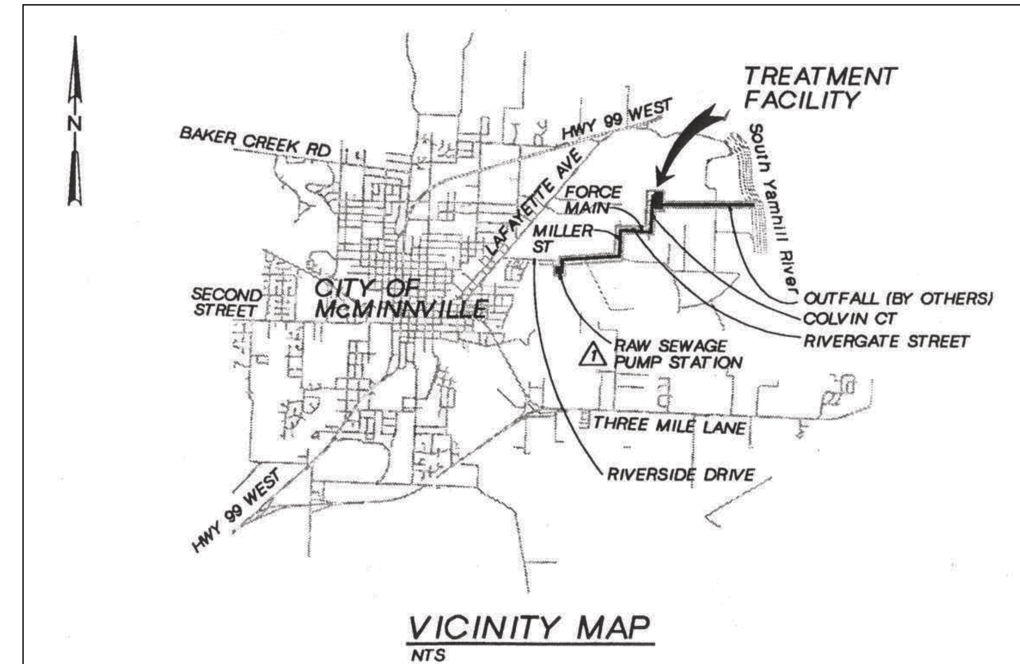
MCMINNVILLE WATER RECLAMATION FACILITY OVERVIEW

The McMinnville Water Reclamation facility (WRF) is located at 3500 NE Clearwater Drive, and serves the City of McMinnville. The original facility was initially constructed and began operation in the early 1950's. However, due to stringent environmental standards enforced on the South Yamhill River in 1989, the new WRF was built and began operation in early 1996. The City operates this facility year-round and maintains both the wastewater collection and treatment systems.

Major treatment processes at the new facility include offsite influent pumping, screening, grit removal, secondary treatment in advanced oxidation ditches (Orbals), secondary clarification, tertiary clarification, filtration, ultraviolet (UV) disinfection, and post aeration prior to discharge to the South Yamhill River. The solids treatment processes include thickening, autothermal thermophilic aerobic digestion (ATAD). Biosolids are stored on site during the wet weather months and land applied, in liquid form, during the dry weather months.

The site plan and layout of the existing treatment facility is presented in Figure 3-1. Figure 3-2 illustrates a simplified plant flow schematic.





NOTES:

1. HEADWORKS BUILDING CONTAINS:
   - CHEMICAL FEED / STORAGE SYSTEM
   - INFLUENT SCREENS
   - ATAD TRANSFER PUMPS
   - GRIT HANDLING
   - SEPTAGE RECEIVING
   - TS TRANSFER PUMPS
   - GBT(S)
   - BIOSOLIDS PUMPS
   - PLANT DRAIN PUMP STATION
   - AERATION BASIN SPLITTER BOX

Figure 3-1

McMinnville Water Reclamation Facility

EXISTING SITE PLAN AND PLANT LAYOUT

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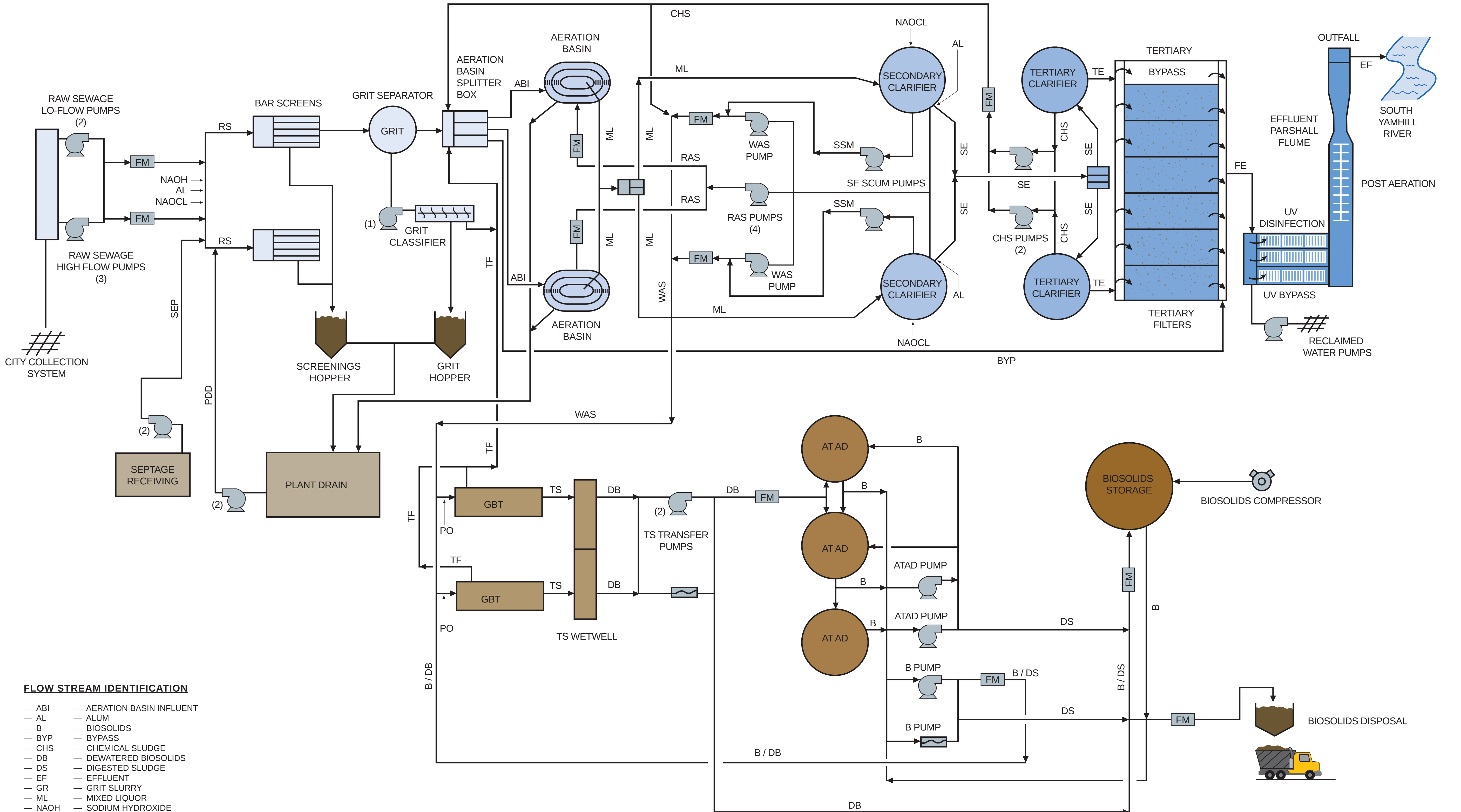

FLOW STREAM IDENTIFICATION

- ABI — AERATION BASIN INFLUENT
- AL — ALUM
- B — BIOSOLIDS
- BYP — BYPASS
- CHS — CHEMICAL SLUDGE
- DB — DEWATERED BIOSOLIDS
- DS — DIGESTED SLUDGE
- EF — EFFLUENT
- GR — GRIT SLURRY
- ML — MIXED LIQUOR
- NAOH — SODIUM HYDROXIDE
- NAOCL — SODIUM HYPOCHLORITE
- PDD — PLANT DRAIN DISCHARGE
- PO — POLYMER SOLUTION
- RAS — RETURN ACTIVATED SLUDGE
- RS — RAW SEWAGE
- SE — SECONDARY EFFLUENT
- SEP — SEPTAGE
- SSM — SECONDARY SCUM
- TE — TERTIARY EFFLUENT
- TF — THICKENING FILTRATE
- TS — THICKENED SLUDGE
- WAS — WASTE ACTIVATED SLUDGE
- FM — FLOWMETER
- GBT — GRAVITY BELT THICKENERS

Figure 3-2

McMinnville Water Reclamation Facility

PROCESS FLOW SCHEMATIC

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Operational Modes

The WRF has two seasonal operating modes: wet weather and dry weather. During the wet weather season, all influent flow is pumped through the raw sewage pump station into the headworks for screening and grit removal. Secondary treatment was designed to provide treatment capacity for all the wet weather flow less than or equal to 24 mgd (including RAS flow) via the Orbals and secondary clarifiers. The secondary effluent is then disinfected prior to discharge into the South Yamhill River. Influent flows greater than the secondary treatment capacity are blended with secondary effluent and then disinfected prior to discharge.

During the dry weather season, the WRF provides preliminary, secondary, and tertiary treatment, as well as disinfection and re-aeration of all the effluent flow. Tertiary treatment with the tertiary clarifiers and filters assists in meeting the facility's effluent phosphorus limits. Screenings and grit are stored on-site, and then hauled off-site for disposal.

The waste activated sludge (WAS) produced from the secondary treatment processes is thickened and thermally digested to produce Class A biosolids. The solids process piping is configured to allow for recuperative thickening of the digested biosolids from the Biosolids Storage Tank. During dry weather, the biosolids are applied in liquid form to agricultural land as a soil amendment.

Process Unit Design Data

Table 3-1 summarizes the design flows and loadings, design effluent requirements, and design data for the treatment units and major equipment at the WRF. The design data for treatment units and major equipment presented in Table 3-1 were collected from the following sources:

- McMinnville Water Reclamation Facility Design Drawings, CH2M Hill, July 1993
- Plant Capacity Evaluation for the McMinnville WRF, Richwine Environmental, Inc., June 2002
- Discussions with WRF operations and maintenance personnel.

TREATMENT PERFORMANCE

The performance of the treatment plant was evaluated using 2006 effluent quality data for CBOD, TSS, phosphorus, TKN (N), and ammonia (N). Both concentration and mass loading were reviewed as part of the evaluation. The basis of the evaluation was to compare the treatment performance against the effluent limits required by the NPDES permit. The permit allows the plant to discharge into the South Yamhill River during the summer and winter season. However, the WRF's permit requirements become more stringent as the flow in the river decreases. Overall the WRF has complied with the effluent discharge requirements and there are no apparent issues with treatment performance. The effluent discharge requirements are described in Table 3-2, and the actual effluent quality for 2006 is illustrated in Table 3-3.

Table 3-1. Design Data for the Existing WRF

Description	Value
DESIGN FLOWS	
Dry Weather, mgd	
Average Day Dry Weather Flow (ADWF)	5.6
Maximum Month Dry Weather Flow (MMDWF)	6.6
Maximum Day Dry Weather Flow (MDDWF)	11.2
Wet Weather, mgd	
Average Day Wet Weather Flow (AWWF)	11.2
Maximum Month Wet Weather Flow (MMWWF)	16.8
Maximum Day Wet Weather Flow (MDWWF)	21.5
Peak Hour Flow (PHF)	32.3
DESIGN LOADS	
Biochemical Oxygen Demand (BOD), lbs/day (mg/L)	8,920 (191)
Total Suspended Solids (TSS), lbs/day (mg/L)	8,920 (191)
Ammonia-N, lbs/day (mg/L)	1,170 (25)
Phosphorus, lbs/day (mg/L)	300 (6.4)
EFFLUENT REQUIREMENTS	
May 1 – October 31, Monthly Average	Dependent on river flow
CBOD, lbs/day (mg/L)	230-470 (5-10)
TSS, lbs/day (mg/L)	230-470 (5-10)
Ammonia-N, lbs/day (mg/L)	23-230 (0.5-5)
Phosphorus, mg/L	
Max @ River Flow < 100 cfs	0.07
Dissolved Oxygen, daily average, minimum, mg/L	6.5
TDS, monthly average	Not to exceed 500 mg/L
E.coli Bacteria per 100 ml	126 monthly geometric mean and no single sample shall exceed 406
Excess Thermal Load, weekly average	160 Million kcals
November 1 – April 30, Monthly Average	Dependent on plant influent flow
CBOD lbs/day (mg/L)	1,200-3,000 (25)
TSS, lbs/day (mg/L)	1,400-3,600 (30)
E.coli per 100 mL	126 monthly geometric mean and no single sample shall exceed 406
TDS, monthly average	Not to exceed 500 mg/L
LIQUID UNIT PROCESSES	
Screens (at Flow Diversion Structure)	
Type	Articulated rake mechanically cleaned
Number	1
Opening, inches	0.5
Motor HP	3

Table 3-1. Design Data for the Existing WRF, Cont'd

Description	Value
Raw Sewage Pumps	
Type	Non-Clog Centrifugal, Adjustable Speed
Number	5
2 Pumps	
Capacity, gpm, each	1,500-5,500
TDH, ft, each	53-163
Motor HP	350
3 Pumps	
Capacity, gpm, each	4,000-8,750
TDH, ft, each	64-124
Motor HP	400
Screens (at WRF)	
Type	Mechanical Self Cleaning
Number	2
Opening	6 mm
Motor HP	0.75
Screenings Press	
Number	2
Max capacity, each, CF/hr	60
Motor HP	3
Grit Basin	
Type	Vortex
Diameter (ft)	16
Number	1
Capacity, mgd	20
Grit Pump	
Number	1
Type	Recessed Impeller Centrifugal
Capacity, gpm	200
Motor, HP	5
Grit Washer	
Type	Cyclone/Classifier
Number	1
Motor HP	1
Septage Receiving	
Tank Volume, gal	5,000

Table 3-1. Design Data for the Existing WRF, Cont'd

Description	Value
Septage Pumps	
Number	2
Pump Type	1 - Grinder 1 - Recessed Impeller
Capacity, each, gpm	Grinder @ 175 Recessed Impeller @ 200
Motor HP	Grinder @ 7.5 Recessed Impeller @ 10
Aeration Basins (Orbal Oxidation Ditches)	
Number	2
Size, each, ft	165 x 137
Sidewater Depth, ft	11.8
Total Volume, Million Gal	3.1
Hydraulic Retention Time at ADWF	12.9 hrs
Hydraulic Retention Time at AWWF	6.4 hrs
Solids Retention Time, days	7
Design MLSS, mg/L	3000
Aeration Equipment	
Type	Surface Disc
Number per basin	8
Capacity, lbs O_2/day	16,500
Total Connected Horsepower per basin	200
Secondary clarifiers	
Type	Suction Arm
Number	2
Diameter, ft	120
Sidewater Depth, ft	15.7
Surface Area, each, SF	11,310
Design Overflow, gpd/SF (year 2015)	
ADWF, 1 unit	495
AWWF, 2 units	495
MDWWF, 2 units	951
Peak hourly flow (24 mgd), 2 units	1,060
Return Sludge Pumps	
Type	Screw Induced Flow Adjustable Speed
Number	4
Capacity, each, gpm	900-2,000
Motor HP	15
Waste Sludge Pumps	
Type	Screw Induced Flow Adjustable Speed
Number	2
Capacity, each, gpm	200-500

Table 3-1. Design Data for the Existing WRF, Cont'd

Description	Value
Motor, HP	7.5
Scum Pumps	
Type	Progressing Cavity Constant Speed
Number	2
Capacity, gpm, each	50
Motor HP	3
Tertiary Clarifiers	
Type	Solids Contact
Number	2
Diameter, ft	70
Side Water depth, ft	20
Reactor Detention Time, min	30
Upflow Rate at MMDWF, gpm/SF (gpd/SF)	0.6 (864)
Chemical Sludge Pumps	
Type	Screw Induced Flow Centrifugal
Number	2
Capacity, gpm	150
Motor HP	1.5
Filters	
Type	Continuous Upflow
Number	6
Surface Area, each, sf	200
Basin Geometry	
Length, ft	14.21
Width, ft	17.61
Depth, ft	19.55
Loading Rate, gpm/SF @ 6.6 mgd, 6 operating	3.8
Air Requirements, scfm/filter module	2.5
Min Backwash Surface Loading Rate, gpm/SF	50
Disinfection	
Type	Low Intensity UV
Channels	3
Channel Dimensions	
Length, ft	48.42
Width, ft	6.00
Depth, ft	4.75
Lamp banks per channel	3
Total Lamps	1,368
Total Peak Power, kw	137
Post Aeration	
Blowers	

Table 3-1. Design Data for the Existing WRF, Cont'd

Description	Value
Number	2
Capacity @ 4.5 psig, scfm	250
Motor HP	20
Diffusers	
Type	Membrane Tube
Number	90
Capacity, lbs O_2/hr	31.04
CHEMICAL SYSTEMS	
Alum	
Storage Tanks	
Number	1
Capacity, ea, gal	6,500
Feed Pumps	
Number	2
Type	Chemical Metering - Adjustable Speed
Capacity, gph	0.1-8
Sodium Hypochlorite	
Storage Tanks	
Number	1
Capacity, each, gal	6,500
Feed Pumps	
Number	2
Type	Chemical Metering - Adjustable Speed
Capacity, each, gph	0.1-8
Sodium Hydroxide	
Storage Tanks	
Number	1
Capacity, gal	6,500
Feed Pumps	
Type	Chemical Metering - Adjustable Speed
Number	2
Capacity, each, gph	0.1-8
Aluminum Chlorohydrate	
Storage Tanks	
Number	2
Capacity, gal	6,500
Feed Pumps	
Type	Chemical Metering - Adjustable Speed
Number	2
Capacity, gph	0.1-8
Utilities	
W3 Pumps	

Table 3-1. Design Data for the Existing WRF, Cont'd

Description	Value
Type	Centrifugal Adjustable Speed
Number	3
Capacity, each, gpm	2 @ 250-600 1 @ 50 - 300
Motor, HP	2 @ 75 1 @ 20
W3 Strainers	
Type	Automatic
Number	1
Capacity, each, gpm	2,000
Motor HP	1
Air Compressor	
Type	Rotary Screw, Desiccant
Number	2
Capacity, scfm @ 100 psig	1 @ 186 1@ 24 -100
Biosolids Compressor	
Number	1
Capacity, scfm @ 20 psi	500
Odorous Air Compressor (no longer used)	
Number	1
Capacity, scfm @ 20 psi	500
Odorous Air Fans	
Number	2
Capacity, scfm	1@ 16,000
Odor Control	
Type	Biofilter with mist pre-ammonia removal
Number	
Capacity, cfm	10,000
Size (W x D x H), feet	40 x 40 x 4
Plant Drain	
Sump Volume, gallons	26,000
Plant Drain Pumps	
Type	Centrifugal Adjustable Speed
Number	2
Capacity, gpm, each	200-1,000
Motor HP	25

Table 3-1. Design Data for the Existing WRF, Cont'd

Description	Value
SOLIDS UNIT PROCESSES	
Waste Sludge Summary	
WAS TSS, lbs/day	9,031
% Volatile	63%
WAS VSS, lbs/day	5,710
WAS NVSS, lbs/day	3,320
Alum Sludge, lbs/day	1,500
TSS, lbs/day	10,530
Gravity Belt Thickener	
Number	2
Belt Width, meters	2
Capacity, each, gpm	200-500
Thickened Sludge Concentration, %	5-6
Digestion	
Thickened Sludge Transfer Pumps	
Type	Induced Flow Centrifugal, Constant Speed
Number	2
Capacity, gpm	900
Motor HP	20
Type	Progressing Cavity Constant Speed
Number	1
Capacity, gpm	200
Motor HP	7.5
Digested Biosolids Transfer Pumps	
Type	Centrifugal
Number	1
Capacity, gpm	400
Motor HP	10
Type	Progressing Cavity
Number	1
Capacity, gpm	200
Motor HP	7.5
Digesters (ATAD)	
Type	Autothermal Thermophilic Aerobic Digestion
Number	3
Size	
Diameter, ft	35
Sludge Depth, ft	10
Volume, gal	67,628

Table 3-1. Design Data for the Existing WRF, Cont'd

Description	Value
Total Digestion Detention Time, days	8
Design Temperature, °C (°F)	60 (140)
Volatile Loading, lb/CF/Day	0.72
Minimum Volatile Solids	54%
Equipment per tank:	
#1 Digester	4 -Spiral Aspirating Aerators 10 HP
	2 - Turborator Aerators 10 HP
	6 – Foam Controllers
#2 Digester	4 -Spiral Aspirating Aerators 10 HP 8 – Foam Controllers
#3 Digester	4 -Spiral Aspirating Aerators 10 HP
	8 – Foam Controllers
Solids Reduction	38%
Digested Biosolids Storage	
Type	Covered
Number	1
Size	
Diameter, ft	160
Height, ft	20
Volume, gal	2,800,000
Design Solids Conc., %	6
Detention Time, days	210
Air Mix, No. of Diffusers	40
Supernating siphon, capacity gpm	20
Odor Scrubber System	1
ATAD Transfer Pumps	
Type	Centrifugal Constant Speed
Number	2
Capacity, gpm each	900
Motor HP	15

Table 3-2. Effluent Permit Limits, Permit No. 101062

Parameter	Average Effluent Concentrations		Monthly* Average, lb/day	Weekly* Average, lb/day	Daily* Maximum, lbs
	Monthly	Weekly			
May 1-October 31:					
(1) When Monthly Average Flow in the South Yamhill River is measured above the STP outfall is 100 cfs or less:					
$CBOD_5$***	5 mg/L	7.5 mg/L	230	350	470
TSS	5 mg/L	7.5 mg/L	230	350	470
Ammonia-N	0.5 mg/L	0.75 mg/L	23	35	47
Total Phosphorus	70 µg/L (See Note 1)	—	—	—	—
Dissolved Oxygen	Shall not be less than a daily average of 6.5 mg/L				
(2) When Monthly Average Flow in the South Yamhill River is Measured above the STP outfall is greater than 100 cfs but does not exceed 250 cfs:					
$CBOD_5$***	10 mg/L	15 mg/L	470	700	930
TSS	10 mg/L	15 mg/L	470	700	930
Ammonia-N	3.0 mg/L	4.5 mg/L	140	210	280
Total Phosphorus	—	—	9.6 (See Note 2)	—	—
(3) When Monthly Average Flow in the South Yamhill River as measured above the STP outfall is greater than 250 cfs:					
$CBOD_5$***	10 mg/L	15 mg/L	470	700	930
TSS	10 mg/L	15 mg/L	470	700	930
Ammonia-N	5.0 mg/L	7.5 mg/L	230	350	470
Total Phosphorus	No Limitations	—	—	—	—
(4) $CBOD_5$ and TSS (on a monthly average concentration basis) shall not be less than 85 percent.					
November 1-April 30:					
(1) When Monthly Average STP influent flow is 8.4 MGD or less:					
$CBOD_5$***	25 mg/L	40 mg/L	1200	1800	2300
TSS	30 mg/L	45 mg/L	1400	2100	2800
(2) When Monthly Average STP influent flow is greater than 8.4 MGD:					
$CBOD_5$***	25 mg/L	40 mg/L	3000	4500	6000
TSS	30 mg/L	45 mg/L	3600	5400	7200
(3) CBOD5 and TSS Removal Efficiency (on a monthly average concentration basis): (a) When monthly average daily influent flow is 8.4 MGD or less, shall not be less than 85 percent. (b) When monthly average daily influent flow is greater than 8.4 MGD, shall not be less than 65 percent.					

Table 3-2. Effluent Permit Limits, Permit No. 101062, Cont'd

* Mass Load limits for CBOD5, TSS and Ammonia-Nitrogen are based on average dry weather design flow of 5.6 MGD. The daily mass load limit is suspended on any day in which the flow to the treatment facility exceeds 11.2 MGD (twice the design average dry weather flow).

** Mass load limits for CBOD5 and TSS are based on two year, maximum wet weather monthly average daily design flow of 14.45 MGD. The daily mass load limit is suspended on any day in which the flow to the treatment facility exceeds 11.2 MGD (twice the design average dry weather flow).

*** The CBOD5 concentration limits are considered equivalent to the minimum design criteria for BOD5 specified in Oregon Administrative Rules (OAR) 340-041. These limits and CBOD5 mass limits may be adjusted (up or down) by permit action if more accurate information regarding Cbod5/BOD5 becomes available.

Other Parameters (year-round except as noted):

Parameter	Limitations
E.coli Bacteria	Shall not exceed 126 organisms per 100 ml monthly geometric mean. No single sample shall exceed 406 organisms per 100 ml (See Note 3).
pH	Shall be within the range of 6.0-9.0.
Total Dissolved Solids	Shall not exceed a monthly average of 500 mg/L.
Excess Thermal Load (May-October)	Shall not exceed a weekly average of 160 million kcals/day (See Note 4).

Chlorine and chlorine compounds shall not be used as a disinfecting agent of the treated effluent and no chlorine residual shall be allowed in the discharged effluent due to chlorine used for maintenance purposes.

NOTES ON OTHER PARAMETERS:

1. Compliance with the total phosphorus concentration limit shall be determined on a monthly median basis in accordance with OAR 340-041-0470(10)(a).
2. This mass load limitation for total phosphorus is based upon dry weather minimum monthly average design flow in 1995 of 2.6 MGD and has not changed from the previous permit. When this permit is being considered for renewal, the Department may recalculate this mass load limit based upon the dry weather minimum monthly average flow expected during the life of the renewed permit. Compliance with the total phosphorus mass limit shall be determined on a monthly median basis in accordance with OAR 340-041-0470(10)(a).
3. If a single sample exceeds 406 organisms per 100 mL, then five consecutive re-samples may be taken at four-hour intervals beginning within 28 hours after the original sample was taken. If the log mean of the five re-samples is less than or equal to 126 organisms per 100 mL, a violation shall not be triggered.
4. The thermal load limit was calculated using the average dry weather design flow and an estimated maximum weekly effluent temperature. This permit may be re-opened, and the maximum allowable thermal load modified, when more accurate effluent temperature data becomes available. In addition, upon approval of a Total Maximum Daily Load for temperature for this sub-basin, this permit may be re-opened to establish new thermal load limits and/or new temperature conditions or requirements.

Table 3-3. Plant Performance Data, 2006

Month	Influent Flow		Effluent Constituent										
	Average Day, mgd	Maximum Day, mgd	Average CBOD, mg/L	Average TSS, mg/L	Total P, lbs/d	Maximum Day Total P, mg/L	Maximum Day Total P, lbs/d	Average Ortho P, mg/L	Maximum Day Ortho P, mg/L	Average Ammonia, mg/L	Maximum Day Ammonia, mg/L	Average TKN,mg/L	Maximum Day TKN,mg/L
Discharge Requirements													
Dry Weather[1]	—	—	5	5	9.6	—	—	—	—	0.5	5	—	—
Wet Weather[2]	—	—	25	30	No Limit	—	—	—	—	No Limit	No Limit	—	—
2006 Plant Performance Data													
January	14.68	31.11	2.39	6.25	-	-	-	0.82	2.00	0.49	2.09	1.15	1.63
February	6.87	18.32	2.11	3.80	-	-	-	2.14	3.16	3.01	8.52	3.12	4.96
March	5.94	11.59	2.12	4.12	-	-	-	1.16	1.57	1.72	4.94	3.76	5.44
April	4.92	6.84	2.38	3.45	9.08	0.26	9.08	0.16	0.59	3.60	9.21	8.42	10.80
May	3.99	6.64	2.00	4.90	4.09	0.24	7.32	0.03	0.07	0.16	2.32	1.28	1.71
June	3.41	4.46	2.00	1.81	2.12	0.11	3.36	0.01	0.03	0.23	1.53	0.79	1.24
July	3.07	3.38	2.00	1.02	1.35	0.13	4.12	0.01	0.02	0.12	0.92	0.91	1.06
August	2.81	2.99	2.00	1.32	1.46	0.11	2.80	0.01	0.04	0.06	0.64	0.86	0.97
September	2.80	3.23	2.00	1.25	1.71	0.14	3.37	0.02	0.07	0.47	2.01	0.95	1.37
October	2.67	3.64	2.00	0.88	1.22	0.13	2.80	0.00	0.01	0.04	0.43	0.62	0.66
November	10.66	25.71	2.58	8.10	-	-	-	0.47	1.32	1.26	2.71	1.75	3.36
December	9.43	24.70	2.32	6.64	7.95	0.13	9.43	0.17	0.68	1.86	5.45	2.16	2.89

Notes:
1. Dry weather season is defined as May through October
2. Wet weather season is defined as November through April

HYDRAULIC EVALUATION

The hydraulic profile can be described as the free water surface elevation or hydraulic grade line (HGL) as the water flows through the liquid treatment processes. An analysis of the hydraulic profile was performed for the WRF as a component of the overall facility assessment. The objectives for the hydraulic analysis were to identify any hydraulic bottlenecks within the system that may affect the ability of the WRF to accommodate the maximum design hydraulic condition of 32.3 mgd.

The WRF consists of a series of channels, tanks, weir controlled flow splitter structures, surcharged conduits, launders, and bypass channels. The XP-SWMM desktop computerized hydraulic model was utilized to conduct the hydraulic evaluation.

Model Description

XP-SWMM is a commercial software package used throughout the engineering industry to evaluate and simulate storm, sanitary and combined sewer systems. It was designed based on the EPA Storm Water Management Model (EPA SWMM). The model is also used for the study and design of wet weather facilities, including the sizing of conveyance systems, storage facilities, pump stations and treatment plants.

Model Development

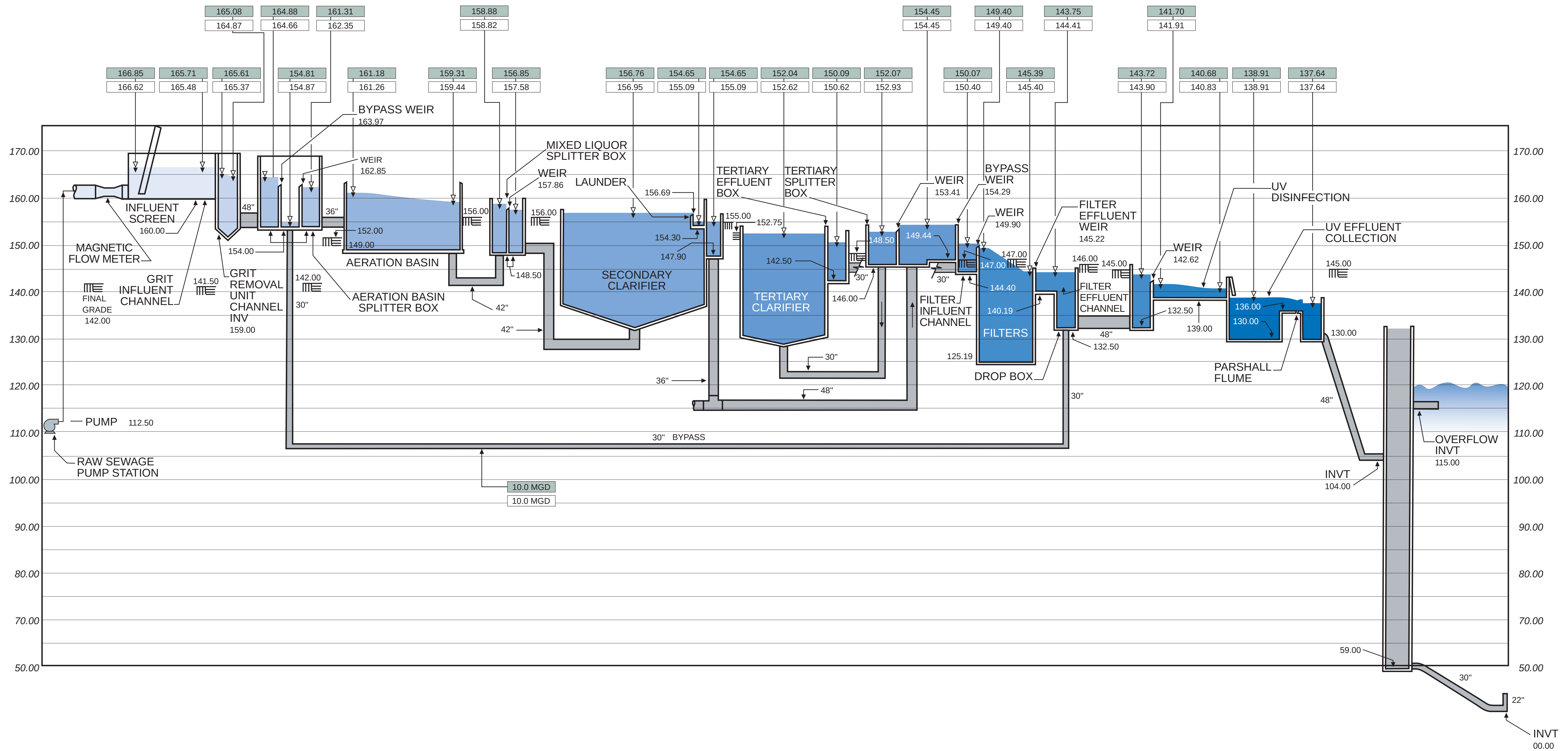
The development of the model involved several steps prior to running the scenarios, including the review of the:

- Original hydraulic profile and water balance included in the contract documents
- Contract drawings, noting all hydraulic control elevations
- Contract drawings to gather information to describe the channels, weirs, pipes, and tankage
- Field measurements of key weir elevations.

After the information was gathered and reviewed, it was used to build the XP-SWMM model for the WRF. To have confidence in any computer model, calibration is a necessity. In this case, the calibration was completed by comparing model results to the existing hydraulic profile and water balance included with the contract drawings to verify whether the model was consistent with the original design calculations. Figure 3-3 illustrates the comparison of the original hydraulic grade line and model predictions. The model produced results similar to the original hydraulic profile. The minor differences in the water surface elevations were deemed negligible.

Model Results

After confirming that the calibration results were within tolerance of the design water surface elevations, the model was run at peak wet weather flow conditions and assuming that a total of 10 mgd is bypassed around the secondary and tertiary treatment units.



KEY

(shaded box)	– Scenario A "Calibration Peak Flow" 32.2 MGD
(open box)	– Original Design HGL

Figure 3-3

McMinnville Water Reclamation Facility

HYDRAULIC PROFILE

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The model indicated that the plant hydraulic profile generally matched the predicted performance at design peak flow hydraulic conditions. The 30-inch bypass pipeline and bypass weir operated as designed.

The flow in excess of 24 mgd (aeration basin capacity) is diverted around the secondary and tertiary treatment units is made by the aeration basin splitter box located adjacent to the Headworks Building. The splitter box consists of fixed elevation weirs as shown in Figure 3-4, The elevation difference between the overflow weir and both aeration basin weirs is small - approximately 1.12-ft or 13.4-in. Consequently, a portion of the influent flow will begin to be routed around the secondary treatment processes and blend with secondary effluent as soon as the water depth to the oxidation ditches reaches the elevation of the bypass weir. This flow diversion can be further controlled by throttling of the two motorized gates leading to the oxidation ditches. In this manner, plant staff can control the elevation upstream on the weirs thereby maximizing flow to ditches and only directing the influent flow around the ditches that is necessary to prevent hydraulic overloading. Since the UV disinfection system performance is highly dependent upon the clarity of the secondary effluent, any introduction of influent into the secondary effluent will reduce the disinfection effectiveness and should be minimized to the extent feasible.

RELIABILITY/REDUNDANCY CRITERIA

Reliability/redundancy criteria were developed for the major unit processes at the WRF. System reliability and redundancy classifications and requirements for water works facilities were established by the EPA and are described in the EPA's Technical Bulletin "Design Criteria for Mechanical, Electric, and Fluid System and Component Reliability" EPA (430-99-74-001). These requirements are intended to maintain a minimum level of treatment if there is a failure of a process component. As stated in the 2002 Richwine evaluation, the WRF would be classified as a Class I facility due to the requirements of the WRF discharge permit. The Class I facility is defined in the EPA criteria as treatment works whose discharge, or potential discharge:

1. Is into public water supply, shellfish, or primary contact recreation waters, or
2. As a result of its volume and/or character, could permanently or unacceptably damage or affect the receiving waters or public health if normal operations were interrupted.

The criteria for reliability/redundancy applicable to the WRF and the design features that address these criteria are summarized in Table 3-4.

OPERATIONAL CONSIDERATIONS

As discussed previously, the operational strategy used by WRF personnel is dictated primarily by seasonal treatment requirements. This section reviews the elements of the two operating strategies.

Wet Weather Operations

During the wet weather season, managing peak flows, minimizing BOD and TSS discharges, and complying with effluent bacteria limits are top priorities at the WRF. The WRF is operated as a secondary treatment facility, with tertiary systems generally off-line.

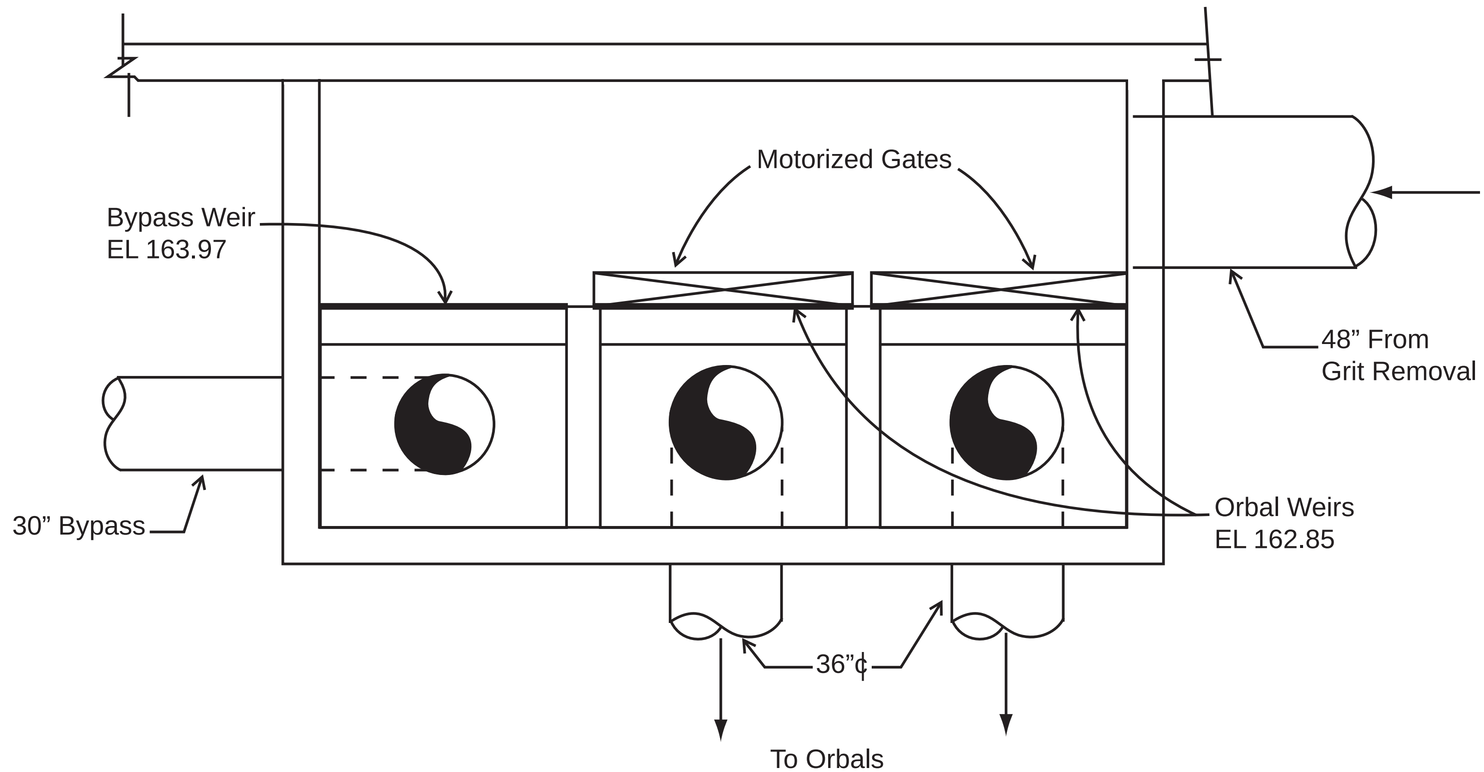

Figure 3-4

McMinnville Water Reclamation Facility

AERATION BASIN SPLITTER BOX

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Table 3-4. Process Reliability/Redundancy Criteria

Process	EPA Requirements[1]	WRF Design
RAW SEWAGE PUMP STATION		
	Multiple units and backup pumps must be included in the design so that peak flows can be handled if any pump is out of service.	Parallel pumps with ability to pump PHF with single largest unit out of service.
PRELIMINARY TREATMENT		
Screening System	At least two channels must be provided, each equipped with a bar screen. Provisions should be made to isolate flow from any screening unit and to dewater each unit. Works with only two bar screens must have one bar screen designed to permit manual cleaning.	Parallel channels sized to pass PHF with all units in service. Dry weather flow conditions can be handled by a single channel.
Grit Removal System	Where a single grit removal unit is utilized, a bypass must be provided.	One grit basin provided, sized to pass the PHF. Bypass provided.
Grit Pumps	A backup pump shall be provided for each set of pumps which performs the same function.	One pump provided.
Grit Cyclones & Classifiers	No requirement mentioned.	Cyclone feeding a single classifier, sized for maximum grit load.
Unit Operations Bypassing	The bypassing system shall be designed to provide control of the diverted flow such that only that portion of the flow in excess of the hydraulic capacity of the units in service need by bypassed.	Wet weather bypass of the secondary treatment system is determined by an overflow weir and operator adjustable motorized gates.
SECONDARY TREATMENT		
Orbals	At least two (2) equal volume basins must be provided.	Designed for MDWWF with all units in service.
Aeration System	There shall be a sufficient number of mechanical aerators to enable the design oxygen transfer to be maintained with the largest capacity unit out of service. The backup unit may be uninstalled, provided that the installed unit can be easily removed and replaced. At least two units shall be installed.	Each basin is equipped with a total of eight disc aerators. Two - four aerators are used in each process zone in the process.
Secondary Clarifiers	There must be at least two units designed so that, with the largest capacity unit out of service, the remaining unit(s) can handle at least 75% of the design flow.	Parallel clarifiers designed for PHF of 24.0 mgd with all units in service.

Table 3-4. Process Reliability/Redundancy Criteria, cont'd…

Process	EPA Requirements[1]	WRF Design
RAS Pumps	A backup pump shall be provided for each set of pumps which performs the same function.	Parallel pumps designed to pump maximum RAS rate from each clarifier with single largest unit out of service.
WAS Pumps	A backup pump shall be provided for each set of pumps which performs the same function.	Pumps designed to pump maximum WAS rate from each secondary clarifier.
TERTIARY TREATMENT		
Tertiary Clarifiers	Unit operations with two or more units and involving open basins shall have provisions for bypassing if the peak wastewater flow cannot be handled hydraulically with the largest unit out of service.	Parallel clarifiers designed for MMDWF with all units in service (bypass weir provided at flow splitter structure).
Filters	Unit operations with two or more units and involving open basins shall have provisions for bypassing if the peak wastewater flow cannot be handled hydraulically with the largest unit out of service.	Parallel filters designed for MMDWF with all units in service. (Bypass channel provided)
DISINFECTION		
	Sufficient number of units shall be provided and sized, such that the capacity with the largest unit out of service is at least 50 percent of the total design flow to that unit operation.	Three parallel UV channels with ability to deliver design UV dose under PHF conditions (32 mgd) with single largest bank of lamps out of service. However, during wet weather conditions when total influent flow exceeds 24 mgd, some dilute raw sewage is blended with the secondary effluent prior to disinfection. Due to the increased turbidity during these events, compliance with the effluent bacteria standards can be compromised.
SOLIDS TREATMENT		
Thickeners	Alternate methods of sludge treatment shall be provided for each unit operation without installed backup capability.	Two units provided. Each is capable of handling the estimated solids production.
ATADs	At least two digestion tanks shall be provided. At least two aerators shall be provided per tank.	Three tanks provided with 4 – 6 aerators per tank.
Biosolids Storage	No requirement mentioned.	Designed for 6 months wet weather storage.

Notes:
1. "Design Criteria for Mechanical, Electric, and Fluid System and Component Reliability" EPA Technical Bulletin No. 430-99-74-001.

A key element of the wet weather season operating strategy occurs during peak flow events: managing the amount of raw sewage that is routed around the secondary process directly to the disinfection system. During peak flow events, WRF personnel generally maintain influent flow to the secondary process at 22 mgd. Additional Return Activated Sludge flow to the secondary process results in a peak flow rate of approximately 28 mgd (6 mgd RAS). Flows in excess of 22 mgd bypass secondary treatment and combine with the secondary effluent just upstream of the UV disinfection system. Although relatively dilute, when blended with the secondary effluent the raw sewage can cause significant increases in effluent BOD, TSS, and E. coli bacteria. Important considerations include:

- The WRF's discharge permit suspends daily mass discharge limits for BOD and TSS when the daily flow exceeds 11.2 mgd. However, compliance with weekly mass discharge limits is still required.
- The performance of the UV disinfection system is related to flow rate and the solids content and transmittance (clarity) of the treated water. With the inclusion of some diverted raw sewage, the solids content and turbidity of the disinfection system influent increases, making compliance with the bacteria limits more challenging. The UV disinfection system was not specifically designed to disinfect blended (combined raw sewage and secondary effluent) flows.

Dry Weather Operations

The WRF is subjected to some of the most stringent and complex effluent limits in the state. While providing some relief in terms of effluent limits, the river-flow-based requirements complicate permit compliance by introducing variable limits.

The WRF's tertiary treatment facilities consist of chemical addition, tertiary clarification, and filtration. It is well established that concurrent compliance with both phosphorus and ammonia limits can be a challenge due to competition between biological processes. Nitrates are created during ammonia oxidation (nitrification). The relatively unaerated zones in the Orbal oxidation ditches promote both denitrification (the conversion of nitrate to nitrogen gas) and biological phosphorus removal. However, the sets of organisms that perform these functions compete for the same food source: readily biodegradable organic material. This creates the potential for less than optimal performance.

Recognizing this potential issue, the designers of the WRF's secondary process included facilities for chemical phosphorus removal. In essence, the WRF was originally intended to provide biological nitrogen removal and chemical phosphorus removal. The combined biological and chemical treatment facilities performed adequately; however, chemical costs were substantial. Over the years, WRF operations personnel have worked to balance and optimize the biological phosphorus and nitrogen removal processes, greatly reducing chemical usage and overall operating costs.

The primary dry weather operational issues include:

- Nitrifying bacteria are susceptible to a wide range of substances that can inhibit their effectiveness and create high effluent ammonia levels.

- Nitrification consumes alkalinity. As alkalinity levels decrease below approximately 60 – 70 mg/L (as $CaCO_3$), pH depression can occur. Low pH levels inhibit nitrification.
- In an effort to reduce operating costs, WRF personnel have achieved a balance between biological phosphorus and nitrogen removal. Maintaining this balance requires constant monitoring and oversight, frequent process adjustments, and effluent "polishing" through supplemental chemical treatment.
- The filtration system has demonstrated relatively poor TSS removal performance. Its primary function is to serve as a backup during process upset conditions.

UNIT PROCESSES-CONDITION AND ASSESSMENT

The reliability/redundancy criteria were used to develop estimates of total capacity (assuming all units in service) and firm capacity (assuming one unit is a standby unit for reliability) at the facility. Capacity estimates assume that all treatment units are in service during wet weather design conditions. Redundant pumps and/or bypass channels are necessary to meet wet weather hydraulic capacity requirements. The major unit processes and their associated capacities are presented in Table 3-5.

As part of this analysis, a condition assessment of some of the existing facilities and unit processes was conducted. These facilities, for which the detailed condition assessments were performed, were identified during the Existing Facility Workshop. At that workshop, six unit processes were identified by staff needing a condition assessment (other plant processes were not evaluated). Plant staff decided that the condition and capacity evaluation would focus on the following unit processes:

- Raw Sewage Pump Station
- Grit Removal System
- Orbals
- Tertiary Filters
- Autothermal Thermophilic Aerobic Digestion (ATAD) System
- Biosolids Storage Facility

The condition assessment includes the evaluation of mechanical, structural, electrical, instrumentation and control for each unit process. A hydraulic profile review was also conducted to identify any hydraulic bottlenecks or potential hydraulic deficiencies, and verify the original design hydraulic profile.

Off-Site Screening

Description and Capacity. Located upstream of the raw sewage pump station, the off-site screening system consist of a single mechanically raked bar screen, a screenings washer/compactor, and a bypass channel. The screen has a rated capacity of 34 mgd and has a clear spacing between bars of ½ inch. The screening structure is configured such that peak flows could be diverted to a future off-line storage system.

Table 3-5. Unit Process Capacity Summary

Unit Process	Basis for Capacity	Design Criteria	Existing Plant Capacities	
			Firm Capacity	Total Capacity
Raw Sewage Pump Station	PHF/MDWWF	Firm capacity	41.0 mgd PHF[1]	53.4 mgd PHF[1]
Off Site Screening	PHF	Total capacity with screen in service. Full capacity bypass available.	—	34 mgd
Onsite Screening	PHF	Headloss across the screens	17 mgd	34 mgd
Grit Basin Capacity	PHF	Flow, Channel Depth and Channel Velocity of 2 to 3 FPS per manufacturer	Only one unit installed	20 mgd
Aeration Basin (Orbals)	HRT at MMWWF	4.4 hours at MMWWF; 6.6 hours HRT at AWWF; 13.3 hours HRT at ADWF	8.4 mgd MMWWF	16.8 mgd MMWWF
	SRT at Maximum Month Load	7 days SRT		
Secondary Clarifiers	Hydraulic overflow rate at peak flow	1,060 gpd/sf at peak flow of 24 mgd.	12 mgd peak flow	24 mgd peak flow
RAS Pumping	Design capacity	Firm capacity	6,000 gpm	8,000 gpm
WAS Pumping	Design capacity	Firm capacity	500 gpm	1,000 gpm
Tertiary Clarifiers	Hydraulic overflow rate at MMDWF	864 gpd/sf	3.3 mgd	6.6 mgd
Filters	Hydraulic overflow rate at MMDWF	3.8 gpm/sf	5.5 mgd	6.6 mgd
UV Disinfection	PHF	Design Dosage	22 mgd	32.2 mgd
Odor Control (Mist-Tower)			8,000 cfm	16,000 cfm
Odor Control (Biofilter)			8,000 cfm	16,000 cfm
Gravity Belt Thickeners	Design capacity	500 gpm each	500 gpm	1,000 gpm
ATAD	Detention Time	8 days	8 days	

[1]Determined based upon total pump capacities in Table 3-1. Does not consider the impact of TDH on pump output when all pumps are running and higher headlosses occur in the force mains.

Condition Assessment. A condition assessment was not performed on the off-site screening system.

Raw Sewage Pumping

Description and Capacity. Raw sewage is collected and conveyed to the existing flow diversion structure to provide pre-screening of the raw sewage prior to being conveyed to the raw sewage pump station. The flow diversion structure is equipped with an articulated rake mechanically cleaned bar screen. After screening, a 42-inch sewer conveys screened raw sewage into the raw sewage pump station. The Raw Sewage Pumping Station has a wet-pit/dry-pit configuration and is equipped with two 350-horsepower (hp), 8 mgd, and three 400 hp, 12.6 mgd, non-clog centrifugal pumps. Pump motors for the pumps are located approximately 35 feet above the pumps and are connected by vertical shafts.

The pump station is rated according to its firm capacity, which is the capacity of the station with the largest pump out of service. Without the head-flow curves for the particular pump and the design system curve, it is difficult to verify the true capacity of the raw sewage pump station. Space for additional pumps is not available; however, the two small pumps could be replaced with higher capacity units if needed.

An 18-inch diameter pipeline from the two smaller pumps and a 30-inch diameter pipeline from the larger pumps convey wastewater to the plant headworks for screening and grit removal. The two force mains are interconnected, allowing for a bypass of one of the lines if necessary. The flow meters are not located within the raw sewage pumping station site, but are located at the headworks building. The 18-inch diameter pipeline is normally used to convey dry weather flows and the 30-inch diameter pipeline is used during higher flow conditions. Under certain extreme high flow conditions, operations staff has the flexibility to use both pipelines to convey the raw sewage to the plant headworks. A cross-over pipe at the Raw Sewage Pump Station between the 18" and 30" lines can be used to lower head and pumping costs if hydrogen sulfide generation in the pipeline is not a concern. Sodium hypochlorite, alum, and sodium hydroxide may be added to the influent flow just prior to the headworks for odor control, alkalinity optimization, and chemical phosphorus treatment.

Condition Assessment. Issues associated with this facility include:

1. Pump Vibration. These pumps appear to exhibit excessive vibration that may lead to premature wear and tear on the equipment. The intensity of the vibration increases at higher flow conditions, when the pump speed increases to keep up with increased inflow. Certain adjustments have been made by plant staff to help minimize the effects of vibration. For example, Pump-3 (high-flow pump) has been prohibited from operating at speeds that cause the pump to vibrate. WRF personnel expressed concern that the vertical shaft configuration may contribute to the excessive vibration. It is suggested that vibration testing be done to determine the degree of vibration and begin determining solutions to rectify the problem.
2. Pump Run Times. The pumps have uneven run times. This is due, in large part, to the different sized pumps provided at the station and the flow characteristics that occur. However, it is suggested that WRF staff review the PLC programming related to pump sequencing and make the necessary modifications to the program to balance the run times to the extent feasible.

3. Valve Maintenance: The isolation knife gate valves on pump suction piping are difficult to service. To perform any maintenance on the valve, the wet well must be shut down and an isolation plug be placed in the suction bell to further isolate the valve. Due to wastewater storage limitations there is minimum time available to isolate valves for maintenance.
4. Station Drain Pumps. The pump station drain pump motors are not rated for submergence. Thus, if the pump station experiences any flooding, there is a high probability that the motors could be submerged and not operate.
5. Sulfide Generation in the Force Main. Plant staff indicated that hydrogen sulfide is present in the force mains and it was suggested that adding sodium nitrate at the pump station could minimize the generation of hydrogen sulfide gases at the end of the line. There is no way to inspect the 7,000-foot long force mains. A remote controlled television camera could be used to visually inspect the force main. However, there are not enough required access locations to retrieve the camera unit. Because the pipeline is a force main, there is no reason to suspect corrosion other than where the hydrogen sulfide gas can accumulate at the high spots along the alignment. WRF staff report that the air release valves occasionally become plugged with grease, which could result in air pocket accumulations and sulfide damage to the pipeline crown.
6. Hydraulic Surges. The wet well is small and contributes to pumping instability. Off line storage for wet weather could be used to reduce surges to the wet well. Screen rake cycling also cause surging in the wet well, momentarily impacting the wet well water surface elevations. This surging causes the station to react to the wet well level increase by increasing the speed of the pumps to maintain the operational set point level. However, this increase in flow extends this surge downstream to the WRF. It has been suggested that operating the wet well at higher levels may prevent the downstream surging to the WRF. Currently, the water level setpoint is below the crown of the inlet pipe and the station is sensitive to changes in the wet well elevations. However, operating at higher wet well levels does not provide adequate operational cushion and may also increase the risk an overflow incident.
7. Clearing Pump Failures. As currently configured, if a raw sewage pump fails (example – check valve fails to open), it is necessary to drive to the remote facility and manually clear the fail. Operators would find it beneficial to be able to clear the fail via the SCADA connection at the control computers.
8. Structural-Concrete. Some cracks and calcification stains were observed in the pump station floor and walls. Staff stated that the cracks appeared after initial construction and that leakage of water through the cracks occurred at that time. Epoxy was injected to seal the cracks.

WRF Screening System

Description and Capacity. The WRF screening system consists of two fine screens. The screens are mechanically raked bar screens with ¼-inch (6mm) openings located in 3-foot wide channels at the headworks. The screenings dump into two dedicated screening presses that discharge into a dumpster. Each screen has a hydraulic capacity rating of 17 mgd. There are no provisions for bypassing the screens.

Condition. The influent screens were not included as part of the condition assessment.

Grit Removal System

Description and Capacity. Following screening, the wastewater flows into a single 16-foot diameter vortex grit chamber. The grit chamber has a rated total capacity of 20 mgd (peak flow) with no redundancy. This compares to the WRF's design PHF of 32.3 mgd. In the event of a maintenance issue, WRF personnel could bypass the flow from the grit basin downstream into the aeration basin splitter box.

A recessed impeller pump conveys grit slurry to a grit cyclone/classifier. Following concentration in the cyclone, the grit is washed and conveyed to a dumpster for landfill disposal.

Condition. Overall, the grit removal system is in adequate operational condition. However, issues associated with this facility include:

1. Ineffective Grit Removal. WRF staff has not collected samples to fully evaluate the performance of the system. Grit removal is not effective and grit accumulations have been observed in the two Orbal tanks. The grit chamber is rated for a maximum flowrate of 20.0 mgd although the plant is capable of sending as much as 32.3 mgd through the process. Other hydraulic issues that could result in poor removals are discussed below. There is also grit accumulation in the upstream entrance channel. Staff has installed drains and pinch valves to remove accumulated grit from the grit inlet channel.
2. Grit Chamber Hydraulics. The HGL upstream and downstream of the grit chamber differs from the manufacturer's recommended HGL. The hydraulic profile for 32.2 mgd shows a grit influent channel water surface elevation of 165.61 and the influent channel floor is shown at an elevation of 160.00, giving a water depth of 5.61 feet. The minimum depth would be determined by the elevation of the downstream flow splitter box weir which is at an elevation 162.85. The manufacturer's standard maximum inlet channel depth is 2.5 feet. Thus the minimum water depth in the outlet channel is 0.35 feet deeper than the manufacturers suggested maximum depth and the maximum water depth is 3.11 feet deeper than the manufacturers suggested maximum depth. The channel would experience very low velocities during normal flow conditions allowing grit to settle in the inlet channel. According to the manufacturer, under these conditions, the chamber velocities will be too low to create the vortex to properly capture the grit.
3. Design Issues. Inspection and analysis revealed that water level in the grit chamber is controlled by downstream weirs in the flow splitter box. Further evaluation of the splitter box showed that the weirs are installed at the design elevation and cannot be adjusted without structural modification. The grit channels and the downstream control weirs play a major role in the performance of the grit removal system, controlling channel depths and entrance/exit velocities. All these components have a direct effect on the performance of the system.

4. Use of Air Scour. After further discussion with Smith and Loveless (manufacturer of the grit removal system), there is a concern regarding the use of the air scour. This feature has been dropped from the manufacturer's recommended design as it had been found to be counterproductive. In addition to the removal of the air scour, it is suggested that plant staff verify that the paddles are in place and the hopper plates are still in the proper position. The lowest portion of the blade on the paddles needs to be 3 inches from the hopper plate.
5. Corrosion. The copper air line is corroded and some of the plumbing valves and the tie in for the I-beam are also corroded. Corrosion could be caused by a number of reasons including: incompatible materials, loss of protective coatings, excessive moisture, and corrosive gases.
6. Channel Gate Operation. The gates upstream and downstream of the screens are motorized to permit isolation of the screen channels during low flow periods in order to match channel flow to screen capacity. This would also keep velocities in the screen channels up so that grit deposition would be minimized. Operation staff does shut one channel during periods of predicted low flow to the extent possible. However, complete automatic operation as designed is not possible because the gate speed is too slow and won't react quickly enough to flow surges caused by influent pump operation. Consequently, during periods of transitional flow, both channels are kept open to eliminate the potential for water backing up at the screens. However, this reduces the velocities in the channels and leads to greater grit accumulations.
7. Ingress-Egress. Another access, located at the south end of the headworks building, would improve access for operations and maintenance.
8. Ventilation. A leak was observed in the air handling ductwork.
9. Structural – Concrete. In general, the structure had some minor cracking observed in concrete walls.

Orbals

Description and Capacity. The WRF has two oxidation ditch style aeration basins, also referred to as Orbals – the proprietary name for the process. Screened and de-gritted raw sewage is conveyed to the Orbals via a flow splitter box where weir level is used to meter flow. The Orbal is a series of concentric channels, with wastewater passing through the channels in a series fashion. The total reactor volume of the Orbals is 3.1 million gallons.

The Orbals were configured as three concentric channels, with screened raw sewage and return activated sludge (RAS) entering the outer channel (Channel “A”) and moving sequentially in toward the center. Although slightly aerated, the outer channel is intended to operate with no measurable dissolved oxygen (DO). This facilitates conditions to cause specialized microorganisms to release stored phosphorus in Channel “A” and create conditions favorable to subsequent uptake of phosphorus in the middle (Channel “B”) and inner channel (Channel “C”). Simultaneous nitrification and denitrification occurs typically in Channel “B” and the nitrification of any remaining ammonia occurs in Channel “C”. The partially aerated outer channel also serves as an anaerobic or anoxic selector, discouraging the growth of unwanted filamentous organisms and improving sludge settleability. The Orbals have the capability of removing phosphorus by utilizing enhanced biological phosphorus removal as indicated above. This method of operation allows Orbals to reduce phosphorus without the addition of chemicals. Under aerobic conditions, certain microorganisms are capable of storing excess phosphorus within their cellular mass. Under anaerobic conditions, the same microorganisms release the phosphorus, which the microorganisms store and use when conditions become aerobic again. By sequencing the activated sludge through the anaerobic zone prior to the aerobic zone, it is possible to develop a biomass capable of biologically removing a significant amount of phosphorus.

The basins are each equipped with eight surface disc aerators having a combined total oxygen transfer capacity of 16,500 pounds per day (lbs/day). Two aerators serve the outer channel (Channel A); four serve the middle channel (Channel B); and two serve the inner channel (Channel C). Although there are eight aerators, a single drive motor operates two aerators each. The aeration basins can be drained by gravity back to the plant drain pump station. These features are schematically shown in Figure 3-5.

Mixed liquor leaves each Orbal via a 10-foot long overflow weir at the center of the tank and flows through a 42-inch pipe to the mixed liquor distribution structure. The distribution structure splits flow from both Orbals and conveys it to the secondary clarifiers via 42-inch pipelines.

Orbals are generally sized to provide comparatively long solids retention times (SRT) and hydraulic retention times (HRT). For the existing basins, approximately 6-hour HRT is provided during AWWF and 12-hours during ADWF to facilitate nitrification. An SRT of 7 days is typically provided during maximum month loading conditions.

Condition. Issues associated with this facility include:

1. Flow Balance. A balanced flow split between the two Orbals was operationally challenging. This issue was resolved by offsetting Orbal weir elevations. After the weir adjustments were made, the flow split through the Orbals has no longer been an issue.

2. Aerator Control. The eight aerators were originally driven with two speed motors. Currently two aerators (one motor) on each basin have been equipped with an adjustable speed drive for Channels “B” & “C”.

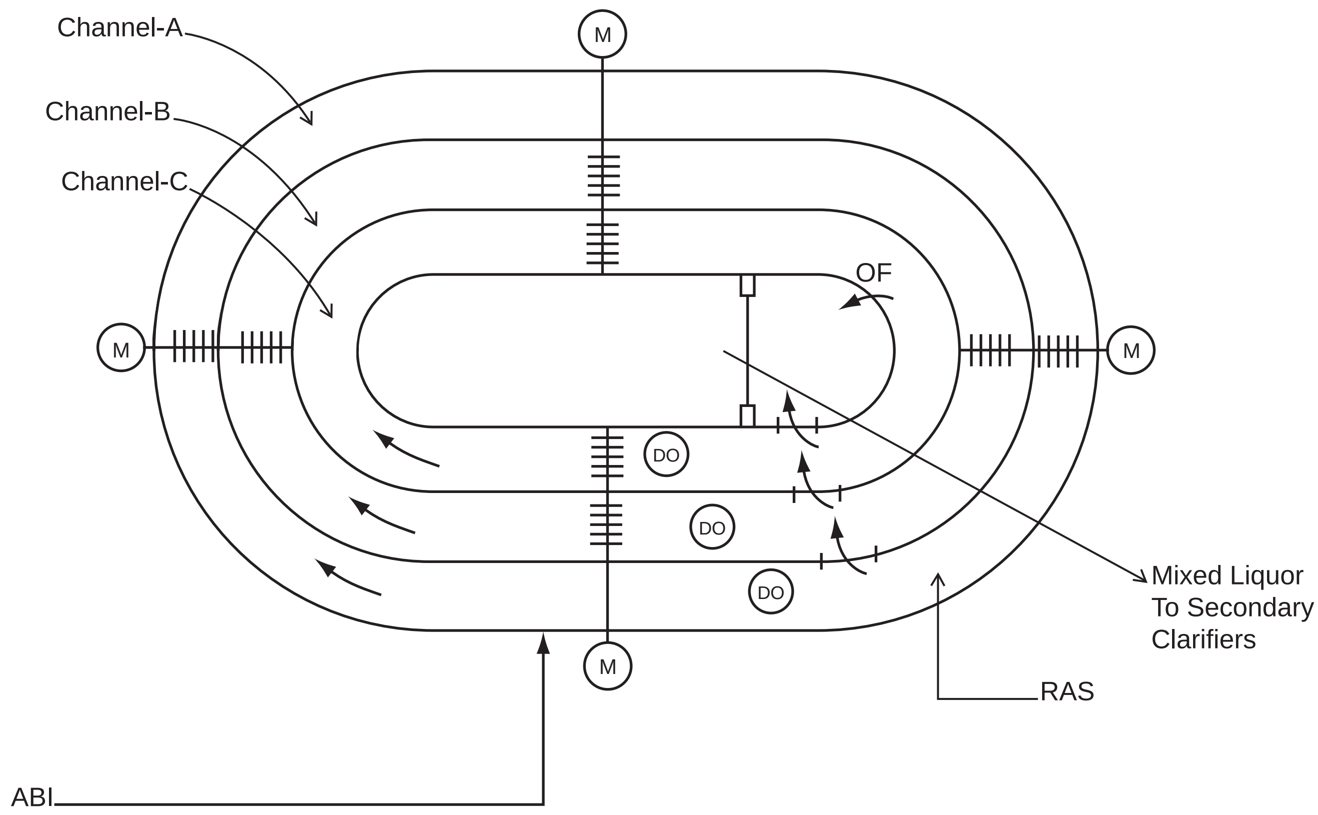

Figure 3-5

McMinnville Water Reclamation Facility

TYPICAL ORBAL

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3. DO Control. Achieving the balance of both nitrogen and phosphorus removal in the Orbals can be challenging. The Orbals are designed to control and maintain DO levels by monitoring DO in two of the three channels (Channels B & C). Channel A (outer channel) is operated at an oxygen deficit, Channel-B (middle channel) is operated at a DO level of approximately 0.5 mg/L, and Channel-C (inner channel) is operated at approximately 2-3 mg/L DO. Controlling the aeration is performed by controlling speed of the VFD controlled aerator located in the middle channel (Channel-B) and the inner channel (Channel-C) by monitoring the DO level in Channel-C.
4. Orbal Maintenance. Currently, there is no way to take an Orbal off line to perform maintenance for extended periods of time. The remaining unit would be unable to reliably meet discharge requirements at current flows and loads.
5. Peak Flow Capacity. Under peak flow conditions, where a portion of the raw sewage is directed to the disinfection system, the Orbals appear to have adequate capacity. Plant staff report that solids in the Orbals are not being washed out, thus validating that capacity under peak flow conditions is not an issue.
6. Level Control. Due to system shortcomings, WRF staff does not use the variable water level feature to enhance the oxygen supply rate. Aerator bearings became submerged when flow surges occurred. Automated level control is utilized to maintain transfer efficiency and to protect bearings during high flow periods.
7. Structural-Concrete. Several minor to moderate cracks were observed in the exterior face of the oxidation ditch walls. One crack was actively seeping water and was observed to have significant algae/moss growth on the side of the wall.

Secondary Clarifiers

Description and Capacity. The WRF has two 120-foot diameter secondary clarifiers. The basic clarifier configuration consists of a center-feed well with perimeter overflow weirs. The clarifier mechanisms are suction withdrawal type; return activated sludge is drawn into suction headers.

At the design surface overflow rate of 951 gal/SF/d, each clarifier has a PHF capacity of 10.7 mgd. A solid flux analysis was performed on the clarifiers using average mixed liquor suspended solids (MLSS) and sludge volume index (SVI) values from both oxidation ditches. All combinations of high and low MLSS and SVI values were evaluated to determine the worst case conditions for two clarifiers. It was concluded that the secondary clarification process can handle all dry weather flows and just beyond the maximum wet weather flow. At critical summer MLSS and SVI values, the flux analysis indicated that the two clarifiers have a combined capacity of 22.7 mgd. At winter MLSS and SVI values, the combined capacity was 18.7 mgd.

Condition. The secondary clarifiers were not included in this condition assessment.

Return Activated Sludge (RAS)/Waste Activated Sludge (WAS) Pump Station

Description and Capacity. The RAS/WAS Pump Station is located between the two secondary clarifiers. The station houses two screw induced flow WAS pumps, two progressive cavity scum pumps and four screw induced flow RAS pumps. This building also houses the plant air compressors, tertiary polymer equipment and other associated equipment.

The 2,000-gpm pumps convey RAS from the secondary clarifiers to the aeration basins. Under normal operation, RAS from each clarifier is conveyed directly to its associated Orbal ditch.

WAS and scum from the secondary clarifiers are combined and metered prior to being conveyed to the gravity belt thickeners located in the headworks building. Each WAS pump has a rated capacity of 500 gpm. However, the total dynamic head on the pumps during normal operation of multiple pumps, results in a unit maximum capacity is about 350 gpm.

Condition. The WAS and Scum Pumps were not included in this condition assessment.

Tertiary Clarifiers

Description and Capacity. The WRF has two 70-foot diameter tertiary clarifiers. These clarifiers were designed for dry weather flow when phosphorus removal is required prior to discharge into the South Yamhill River. The basic clarifier configuration consists of a center-feed line with perimeter overflow weirs, similar to the secondary clarifiers. Secondary effluent from the tertiary splitter box is conveyed to the clarifiers via 30-inch pipelines. Alum is fed to the flow stream to precipitate and settle phosphorus.

At the design surface overflow rate of 864 gal/SF/day at MMDWF, each tertiary clarifier has a capacity of 3.3 mgd.

Condition. The tertiary clarifiers were not included in this condition assessment.

Chemical Sludge Pump Station

Description and Capacity. Two chemical sludge pumps route sludge from the tertiary clarifiers to the gravity belt thickeners. These pumps are screw induced centrifugal flow pumps with a capacity of 150 gpm each. The output of these pumps is metered.

Condition. The chemical sludge pumps were not included in the condition assessment.

Alum System

Description and Capacity. Alum is fed to the liquid stream before the tertiary clarifiers to improve settling and enhance phosphorus removal during summer months. The system consists of one 6,500 gallon storage tank and three mechanical metering pumps having 0.1 – 8 gph capacity each.

Condition. The alum storage and feed system was not included with the evaluation.

Effluent Filters

Description and Capacity. Similar to the tertiary clarifiers, the effluent filters were designed for dry weather flows when phosphorus removal is required. The WRF operates six 200 square foot continuous upflow Parkson Dynasand filter units, each designed for 3.8 gpm/sf at MMDWF (6.6 mgd total design capacity). Effluent from the tertiary clarifiers enters the filter influent channel through one of two 30-inch pipes and a weir gate. The flow passes through the channel and a weir gate to the filters. The final tertiary effluent is conveyed to the disinfection process via a 48-inch pipe. If the flow to the tertiary filters exceeds 6.6 mgd, the tertiary process is equipped with a bypass to convey excess flow to disinfection.

Condition. The following issues were identified with this facility:

1. <u>Filter Performance Issues</u>. Filter performance is mediocre; typically producing 1.0 ppm mg/L when influent is 1.5 mg/L TSS, and 5 mg/L when the influent is 8 mg/L or less. WRF staff has experimented with polymers to improve the filter efficiency; however the filters became susceptible to blinding. There is a plan to install turbidity meters so that plant staff can better monitor the filter performance. When the filters are off line in the winter, solids tend to collect in the filter headbox. The filter head box does not currently have any way to be drained.
2. <u>Filter Media</u>. WRF staff has stated that the filter media has never been replaced. The design called for the media to be comprised of 10 micron particles but they may be smaller than 10 micron. The finer media may be causing plugging.
3. <u>Filter Operations</u>. When a filter is put back on line, effluent solids concentrations tend to be excessively high. Effluent must be diverted to the headworks to assure plant effluent compliance. Currently, the plant operators do not have the ability to automatically bring other filters on line or to monitor real-time filter headloss via SCADA. This ability would improve the operability of the filtration process.
4. <u>Filter Piping Material</u>. The originally installed air lift pipes in the filters exhibited excessive wear and staff replaced them with stainless steel. However, the new Parkson Dynasand filter designs now use PVC piping at this location and may give better service than the stainless steel pipes.
5. <u>Structural-Concrete.</u> Minor cracking of concrete walls was observed.
6. <u>Structural-Corrosion.</u> Beams supporting checker plating appear to be holding up well and little to no corrosion was observed.

Ultraviolet (UV) Disinfection and Post Aeration System

Description and Capacity. The UV system consists of nine banks of low intensity UV lamps manufactured by Trojan Technologies. The lamps are located within three parallel channels. Each UV channel can disinfect 11 mgd (peak flow). Following disinfection, the effluent is conveyed to the post aeration channel. Flow is measured via a parshall flume located between the UV effluent channel and post aeration channel.

Post aeration is accomplished with ninety membrane tube diffusers having a total oxygen supply capability of 31 lb O_2/hr. Air is supplied to the system by a 4-inch air pipe and two 250 scfm blowers. Typically effluent aeration is not necessary to maintain permit compliance due to passive aeration of the flow between the facility and the river outfall.

Condition. The disinfection and post aeration systems were not included in the condition assessment.

Sodium Hypochlorite System

Sodium hypochlorite is used at the plant for algae and odor control.

Description and Capacity. Sodium hypochlorite can be fed to the liquid stream in seven locations: at the headworks, the secondary clarifiers (weir algae control), secondary clarifier scum pits, after the tertiary clarifiers (upstream of the filters), to the plant recycled water, the return activated sludge (RAS), and to the odorous air mist scrubber. The system consists of one 6,500 gallon storage tank and two 0.1-8 gph chemical metering pumps.

Condition. The sodium hypochlorite system was not included in the condition assessment.

Sodium Hydroxide System

Description and Capacity. Sodium hydroxide is fed to the liquid stream at the head of the plant to adjust pH. The system consists of one 6,500 gallon storage tank and two 0.1- 8 gph mechanical metering pumps. The plant staff is currently pilot testing calcium hydroxide for alkalinity adjustment using temporary tanks and application to Channel B of the oxidation ditches.

Condition. The sodium hydroxide system was not included in the condition assessment.

Thickening/Dewatering

Description and Capacity. Thickening and dewatering is accomplished with the gravity belt thickeners (GBTs) located in the headworks building.

WAS and scum from the secondary clarifiers are metered and conveyed to the GBTs via 6-inch lines. Polymer is added to the solids prior to feeding into the GBTs to flocculate the solids as needed to achieve solids capture and the desired level of thickening. The polymer system originally consisted of a 6,500 gallon storage tank and four mechanical metering pumps with a capacity of 3-20 gph each. However, the storage tank is not used and 250 gallon totes are used for the storage of polymer stock. The mechanical thickening process reduces the volume of liquid sludge that is transferred to the ATADs for digestion.

Condition. The thickening and dewatering system was not included in the condition assessment.

ATAD Digestion

Description and Capacity. The Autothermal Thermophilic Aerobic Digestion (ATAD) process stabilizes the biological solids removed from the plant's secondary treatment system. The process utilizes mixers and aerators to support the biological activity that stabilizes the solids. The biological activity produces heat which raises the temperature of the solids to ~ 60 degrees Celsius. The combination of temperature and time held in the process results in the reduction of pathogenic bacteria in the solids such that it meets the EPA 503 requirements for Class A biosolids – the highest bacteriological quality solids that can be produced.

The WRF has three ATAD tanks, each 35 feet in diameter and 13 feet deep each. These digesters each have a capacity of 67,600 gallons and are operated at approximately 8 days of detention time. Two reactors have a capacity of approximately 6,500 lbs/day, while three reactors are able to process 9,500 lbs/day. Peak loading for two or three days above 9,500 lbs/day is tolerable. However, an extended period loading high loadings would lead to process instability. Mixing and aeration was initially provided by four aspirating aerators arranged around the perimeter of each tank. Alternative equipment has been installed in #1 ATAD tank as discussed below. The aerators are oriented such that they induce a spiral flow pattern in the tanks to enhance mixing and distribution of the air and feed solids. Each tank is also equipped with six to eight motor driven foam controllers.

Normally, all solids are initially fed into ATAD Tank-1. Following ATAD Tank-1, the solids are then directed to ATAD Tank-2 or ATAD Tank-3 or both. Withdrawal is controlled automatically by the operation of four motorized control valves mounted on the outlet piping of ATAD Tank-1. ATAD Tank-2 and ATAD Tank-3 are each provided with two motorized control valves on the outlet piping. Transfer pumps are then utilized to move the solids to the Biosolids Storage Tank or between ATAD tanks.

Condition. The following issues have been identified with this process.

1. Mixing and Aeration Systems Performance and Control. Plant staff has purchased four variable speed Turborators aerators, for mixing and aeration of ATAD tanks. ATAD tanks #1 and #2 have two Turborators in each tank. Performance of the Turborators has been good and has extended the capacity of the ATAD system by an undefined amount. Control of the orifice opening of the Turborators could be done with plastic caps fitted with various orifice sizes. Staff has operated the Turborators with the shafts open at 83% of rated speed to meet the required mixing and aeration. The speed of the Turborator could be controlled by temperature and/or time after transfer in order to maintain the optimal conditions for stabilization.

   A recent technical memorandum evaluated aeration alternatives for the ATAD system. The objective of this work was to determine an alternative that would improve mixing, air flow control, and temperature control; simplify mechanical components; reduce odors; reduce O&M costs; improve operational flexibility; and improve volatile solids reduction. The technical memorandum concluded that there were apparent benefits to vertical aspirating aerators, such as Turborators.

2. Chemical Addition. Winter volatile solids are so low that staff adds molasses to increase the volatile solids of the digester contents to levels that can support a level of biological activity capable of keeping the process self-heating.

3. Foaming. Foam cutters and aerators require frequent maintenance. Currently, the foam cutters operate constantly and alarm if they fail. Foam detectors could be used to allow the foam cutters to be called on only when foam is present, thereby reducing their run time and associated operation and maintenance costs.
4. Isolation Valves. Maintaining valves between tanks requires taking two tanks down. However, this is not a high priority item.
5. Area Storm Drainage. Runoff containment is needed near the ATAD units.
6. ATAD Capacity. There is a question as to the true capacity of the ATAD system. Capacity is a function of a number of factors, including: feed solids quantity, volatility, and temperature; detention time in the reactors; and air temperature. Per the 2002 Plant Capacity Evaluation, the design intent for the ATAD system was to have the process produce Class A biosolids and meet the pathogen and vector attraction reduction standards with two ATAD units in service. Performance of the system was historically inconsistent at loadings below the specified capacity while thickened sludge typically exceeded the 5% total solids and 54% volatile solids. The evaluation also reported that the manufacturer understood that the system was only to process the design quantity for short durations with one tank out of service.
7. Corrosion. There was some corrosion in the tanks but the tanks were re-coated and, except for minor corrosion around the hatches, they appear to be in good condition. Tank 1 was re-coated three years ago and should be checked. Some corrosion was observed on the roof, mostly originating from equipment bases and supports.

Biosolids Storage

Description and Capacity. Following the thermal digestion in ATADs, the biosolids are stored in a covered biosolids storage tank with a volume of 380,000 cu-ft. Diffusers are mounted on the floor of the tank to mix and aerate the contents.

Condition. The following issues were identified with this facility.

1. Decanting. Decanting is done with an adjustable pipe. The quantity of supernatant is significant – three million gallons were decanted last year. The ability to meter supernatant volume may prove to be operationally beneficial. Supernatant contains alkalinity needed for the secondary treatment process, however, it also increases ammonia loading. Consistent supernatant return flow rates are important for plant performance and reliability,. Supernatant is usually siphoned or pumped from the storage tank. Pumping has proven to work well although it presents the risk of drawing excessive amounts of decant. There is also no protection from running the pump dry.
2. Tank Solids Profile. WRF staff stated that solids tend to build up to about a foot deep in the bottom of the tank, then slough to the bottom during draw-off.

3. Tank Mixing. Additional mixing could be added for a more homogenous product. Users of the treated biosolids seem to like the thicker product produced in the fall, but still prefer a more homogeneous product. Although the tank is already equipped with forty air diffusers, WRF personnel have considered the idea of adding a Turberator without air, and have the Turberator serve as a tank mixer. Another thought was to incorporate recuperative thickening to increase solids storage capacity, however the possibility of short-circuiting in the tank is probable.
4. Structural-Concrete. Very minor cracking was observed in exterior shotcrete.

ELECTRICAL DISTRIBUTION/CONTROL AND INSTRUMENTATION SYSTEM

General

The electrical systems of the McMinnville WRF are generally in good condition. However, some issues were identified as follows:

Raw Sewage Pump Station and Main Switchgear

Plant operations personnel pointed out two basic problems with the switchgear. First, the automatic transfer scheme does not function reliably. Second, the multifunction meters installed on each of the two incoming lines do not function at all.

1. Automatic Transfer Scheme. The switchgear is normally fed from the preferred utility source (A) through the left-hand main circuit breaker (52-A). The alternate source (B) is normally available through the right-hand main circuit breaker (52-B). An interlock system prevents both sources from being connected at the same time through the switchboard. The system is normally set to transfer automatically, however re-transfer is set to occur manually. This means that after power source transfer an individual needs to initiate re-transfer back to the preferred source.

   There have been instances when the preferred source was set to the “B” side that automatic transfer did not occur when a power interruption occurred. Due to this issue, the preferred source should always be left on the “A” side unless in an emergency condition.
2. Malfunction Meters. The electronic malfunction meters display data, but the data shown is incorrect. As an example, data is suggestive of missing or erroneous voltage and or current input signals to the meter.
3. Operating Environment. The location where the switchgear is installed does not provide a good operating environment. The main floor of the pump station is an open high bay space with no filtering of the air. The switchgear (and other electrical equipment in the room) was covered with a layer of gritty, sandy dirt. Because of the openings in the switchgear doors for ventilation, there is reason to believe that the same dirt is present throughout the interior of the switchgear and in the circuit breaker operating mechanisms. None of the circuit breaker bays bore maintenance stickers commonly found on equipment serviced by a contract technician. It is possible that some of the issues related to the transfer switchgear and multifunction meters could be resolved by a thorough cleaning of the switchgear.

Recommendation:

The plant should contract with a switchgear services company to evaluate the cause(s) of the failures of the multifunction meters and the automatic transfer scheme and recommend a course of repair. The logical entity for this work is General Electric because they manufactured the switchgear. However, there are other competent and capable firms that offer these services. After this initial service work, a service contract should be secured to provide the switchgear with regular preventive maintenance services. The switchgear is a little more than ten years old and will provide many more years of service if adequately maintained.

Headworks Building – Push Button Station

The south half of the upper floor of the headworks building is classified as a hazardous location (see Note 2 on Drawing No. 30-E-142). There are two pushbutton stations on the south wall of the room that could not be identified as being suitable for installation in such spaces. The two pushbutton stations are JB-32-01-1 and CS-32-07-1. The pushbuttons and pilot lights used on both stations appear to be common industrial-grade devices.

Recommendation:

A qualified electrician should open the boxes and verify that the devices inside are suitable for use in a Class I, Division 2, Group D location. If they cannot be identified as such, they should be replaced with devices that are suitable.

Headworks Building – HVAC/Mechanical Room

The northeast corner of the upper level of the headworks building (Room 30208) is occupied by HVAC and mechanical equipment, most of which is associated with odor control systems. The discharge ductwork from the fans leaks into the room. The vapors are heavy with ammonia, which may have an effect on electrical equipment in the room. Ammonia will corrode copper.

Recommendation:

The source of leaks in the ductwork should be investigated and leaks repaired. Additional fresh air should be delivered to the room to ensure that it provides a more pleasant working environment.

Headworks Building – Motor Control Center

The motor control center (MCC) for the headworks building is located on the ground floor in Room 30103. The circuit breakers in the spare motor starter cubicles are inoperative. The years spent sitting in the "off" position have left them unable to be switched to any other position. The result is that if the plant needs to place one of these motor starters into service, the circuit breaker must first be replaced.

Recommendation:

These circuit breakers should be tested individually before use to determine if they work satisfactorily.

CONDITION ASSESSMENT METHODOLOGY

The purpose of the condition assessment is to identify deficiencies for each treatment unit process and provide a general condition rating for mechanical equipment, treatment units, structures, electrical, instrumentation and control systems. The information gathered during the condition assessment will be used during the planning process to determine which portions of the facility provide adequate capacity, are in acceptable condition, and which would need upgrade and/or expansion.

Approach

The condition assessment consisted of the following steps:

1. Review existing facility drawings and design criteria.
2. Meet with plant staff to discuss maintenance history, facility shortcomings, hydraulic issues, and operational experience.
3. Conduct field inspections of the plant’s mechanical, structural, electrical, instrumentation and control systems.
4. Document the findings made during the field investigation.
5. Rate the condition of each component of the plant’s unit processes.

Condition Rating System

As part of the inspection process, each treatment system, structure, and ancillary system was independently rated in terms of the condition of its mechanical, structural, electrical, instrumentation and control systems.

Evaluation of the structural components addressed the overall structural condition of the selected process units. The structural evaluation focused on the condition of the structural steel, concrete, and other materials of construction. General assessments included coating systems, roofing systems, pipe penetrations, pipe supports, and seismic restraints.

Evaluation of mechanical equipment and process components addressed the overall mechanical and operational condition of the equipment. Obvious lack of compliance with the NFPA 820 requirements, and other applicable code requirements was taken into account. The NFPA 820 standard establishes minimum requirements for protection against fire and explosion hazards in wastewater treatment plants and associated collection systems, including the hazard classification of specific areas and processes. Input was obtained from plant staff on performance, O&M requirements and accessibility.

Evaluation of the electrical, instrumentation and control systems included power distribution equipment, local and remote control systems, and PLC(s). National Electric Code requirements were taken into account.

A numeric rating system was developed and assigned to the mechanical, structural, electrical, instrumentation and control components of each unit process. The rating system, which is described in Table 3-6, classifies the long term condition of each process. A qualitative discussion summarizes the condition and deficiencies of each process.

Table 3-6. Condition Rating System

Value	Condition
1	Lowest priority for replacement – New or like new condition; proven to provide intended function.
2	Low priority for replacement – Signs of moderate wear; will provide service life with preventive maintenance.
3	Medium priority for replacement – Serviceable but worn; should provide additional service life with maintenance, repair, or replacement of components.
4	High priority for replacement – Serviceable but heavily worn; requires extensive rebuild, upgrade, or replacement for extended service life.
5	Highest priority for replacement – Unit includes heavily worn or outdated equipment; service life is limited without replacement.

The resulting assessment of each plant component is summarized in Appendix A.