PRE-DESIGN FOR UPGRADES TO THE NORM WOOD ENVIRONMENTAL CENTRE

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PRE-DESIGN FOR UPGRADES TO
THE NORM WOOD ENVIRONMENTAL CENTRE

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1.0 INTRODUCTION

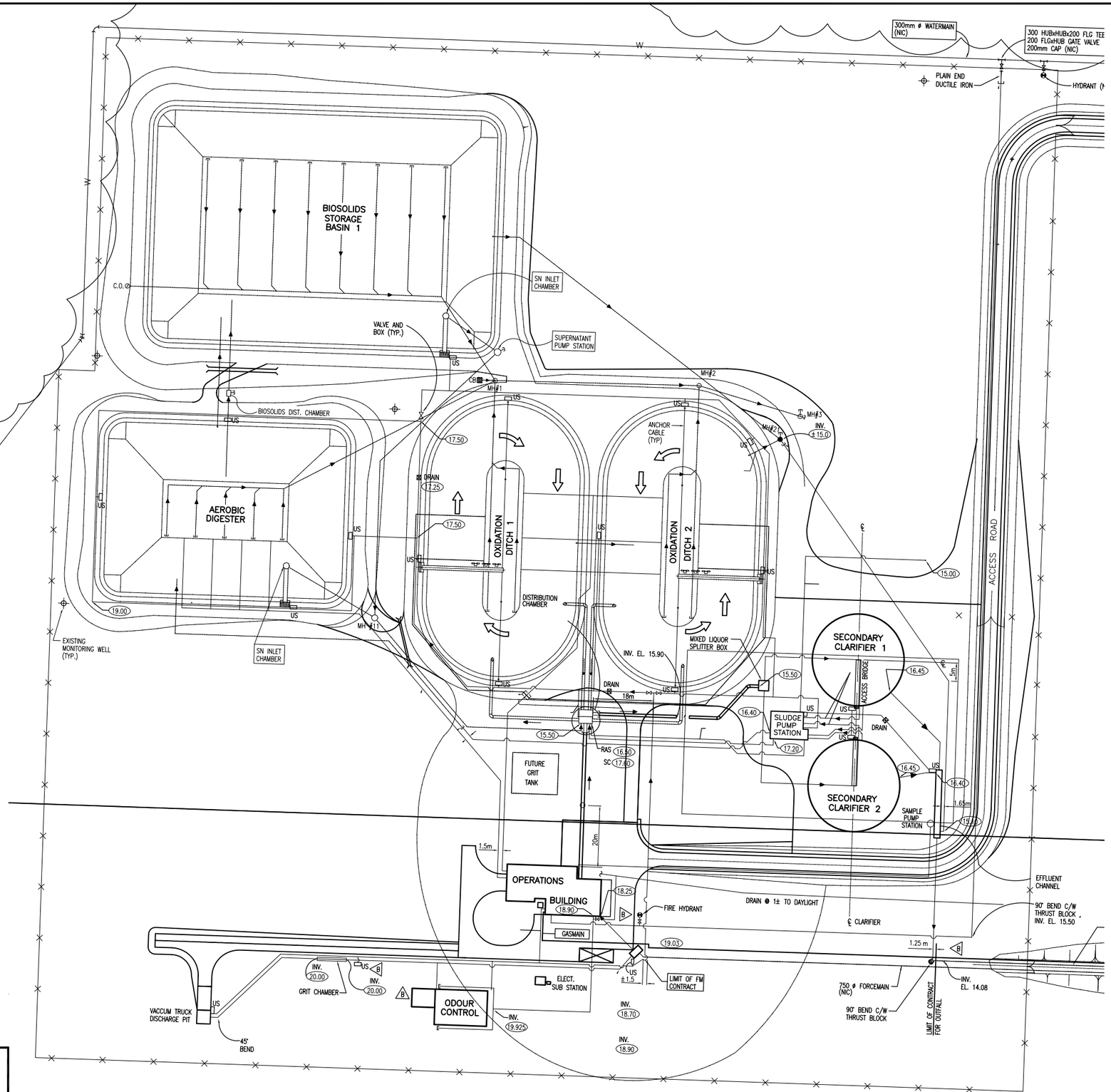
1.1 Background

The Norm Wood Environmental Centre (NWEC) owned by the City of Campbell River (a community of some 31,000 people) is a secondary treatment oxidation ditch facility with aerobic digestion of waste solids. The NWEC treats domestic wastewater generated within the City as well as trucked liquid waste (septage). The NWEC includes screening of the influent wastewater, followed by secondary (biological) treatment in two oxidation ditches with two secondary clarifiers. Treated effluent is discharged to Discovery Passage via an outfall and diffuser. Waste biological solids from the oxidation ditch process are stabilized in an aerobic digester, and then temporarily held in a biosolids storage basin; digested solids are periodically removed from the basin and used to fertilize the on-site poplar plantation. The NWEC was commissioned in 1996. A site layout is shown on Figure 1-1. A copy of the Operational Certificate is attached as Appendix A.

A number of issues associated with the plant operation have been identified as follows:

- the existing mechanical bar screen allows debris to pass through during high flows;

- the existing mechanical bar screen occasionally clogs (this is suspected to be due to slug loads of debris from pumper trucks) – the influent then flows to the manual



0 5 25 50 75 METRES

SCALE 1:1250

CITY OF CAMPBELL RIVER

NORM WOOD ENVIRONMENTAL CENTRE

EXISTING SITE PLAN

FIGURE 1-1

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DWG. No. 187.14.28

FILE: P:\PRODWGS\CAMPBELL-RIVER\187-14-28\FIGURES\187.14.28 FIGURE 1-1.dwg Tab FIGURE 1-1 09-01-20 chong

bypass screen, which also clogs if an operator is not present to clean it – this results in flooding of the screening room (3 or 5 times per year);

- the rock trap at the existing pumper truck discharge station is not effective;

- the influent flow meter is not operational and needs replacement;

- the existing Hoffman aeration blowers are the centrifugal, constant-speed type, with blower output controlled by an automated damper on the air inlet – new positive displacement or turbo-type blowers with variable speed controls can potentially reduce energy consumption at the plant, and will also improve control of dissolved oxygen concentration in the oxidation ditches which in turn will benefit process performance;

- the dissolved oxygen (DO) and oxidation reduction potential (ORP) feedback control system in the oxidation ditch was decommissioned in early 2008, due to chronic clogging of the macerator circulation pump (an operator-adjustable timer controls cycling of the aeration system when the ORP controller is not functioning);

- the existing method of allowing grit to accumulate in the duty oxidation ditch and switching to the standby ditch when removal of accumulated grit is necessary will no longer be viable when both ditches are required to be in continuous service (this may occur in the near future);

- a third secondary clarifier is needed to maintain the current operation when one of the two existing clarifiers is taken out of service for maintenance;

- construction of the third secondary clarifier will require an expansion of the return activated sludge (RAS) and waste activated sludge (WAS) pumping station;

- the existing flow split into the secondary clarifiers is by opening and closing sluice gates manually – an improved flow control to the three clarifiers will be required when the third secondary clarifier is built;

- control of the dissolved oxygen concentration in the aerobic digester is problematic, partly due to an over-supply of air from the constant speed 250 HP Lamson blower which is controlled by damping of the air inlet – this leads to excess energy consumption, as well as high operating dissolved oxygen concentration which results in increased lime addition for pH control in the digester;

- mixing in the aerobic digester is not optimal and relies solely on the turbulence resulting from the diffuser air – the addition of mechanical mixers would allow operation of the digester in an air on/air off cycle for denitrification, which would help to recover alkalinity and reduce lime consumption;

- the existing aerobic digester is a single-cell bioreactor – periodic replacement of the aeration diffuser membranes requires emptying of the digester – for the current operation, the standby oxidation ditch can be used as a back-up digester – however, when the standby oxidation ditch is needed for liquid treatment, there will be no standby digester;

- the biosolids storage basin has limited capacity - solids carry over in the return stream of supernatant from the biosolids storage basin has at times had a detrimental impact on the liquid treatment process by causing an accumulation of solids in the oxidation ditch process;

- the existing method of applying biosolids in liquid form to the onsite poplar plantation has a high cost, and problems are encountered due to saturation of the soil; and

- the existing administration building does not include a separate lunch room, office or meeting room, and the washroom facilities should be expanded.

Accordingly, the City commissioned this pre-design study to develop upgrade needs and priorities for improvements to the NWEC.

1.2 Acknowledgements

The assistance and contributions of the City of Campbell River engineering and operations staff in the preparation of this pre-design study is gratefully acknowledged.

2.0 PLANT FLOWS AND LOADS

2.1 Projected Service Population

The population of the City of Campbell River (adjusted for the Canada Census undercount) is summarized in Table 2-1.

TABLE 2-1
CITY OF CAMPBELL RIVER POPULATION 1991 TO 2006

Year	Population*	Percent Increase
1991	30,023	
1996	30,250	0.8%
2001	30,806	1.8%
2006	31,444	2.1%

* adjusted for Canada Census undercount by Stats B.C.

For design of wastewater treatment capacity, the City's Liquid Waste Management Plan adopted a growth rate of 2.5% to 3.5% per annum. According to Stantec (2004), the service area build-out population is about 65,000 people. This population would be reached by about 2030 at 2.5% annual growth, and by 2023 at 3.5% annual growth. The connection of additional service areas to the system (e.g. Area D in the Regional District of Comox Strathcona) could increase the estimated build-out population. The reported current population of Area D is about 3,700 people, and the build-out population if sewer

service were provided is estimated at about 10,000 people (Stantec, 2004). This would bring the ultimate NWEC service population (including Area D) to about 75,000 people. For the purpose of this study, an ultimate design service population of 75,000 people was adopted for the NWEC.

2.2 Plant Flows and Loads

2.2.1 Historic Flows and Loads

The 30-day moving average of plant influent daily flows is illustrated on Figure 2-1; as shown, there is a regularly repeating pattern, with higher flows observed during the late fall and winter (wet weather) months, and low flows occurring during summer and early fall. A slight increase in plant flows over time is evident. The 30-day moving averages of the plant influent mass loading of five-day biochemical oxygen demand (BOD_5) and total suspended solids (TSS) are illustrated on Figures 2-2 and 2-3, respectively; as with plant influent flow rate, there appears to be a slight increasing trend over time for plant TSS load, although the BOD_5 load appears to be relatively flat.

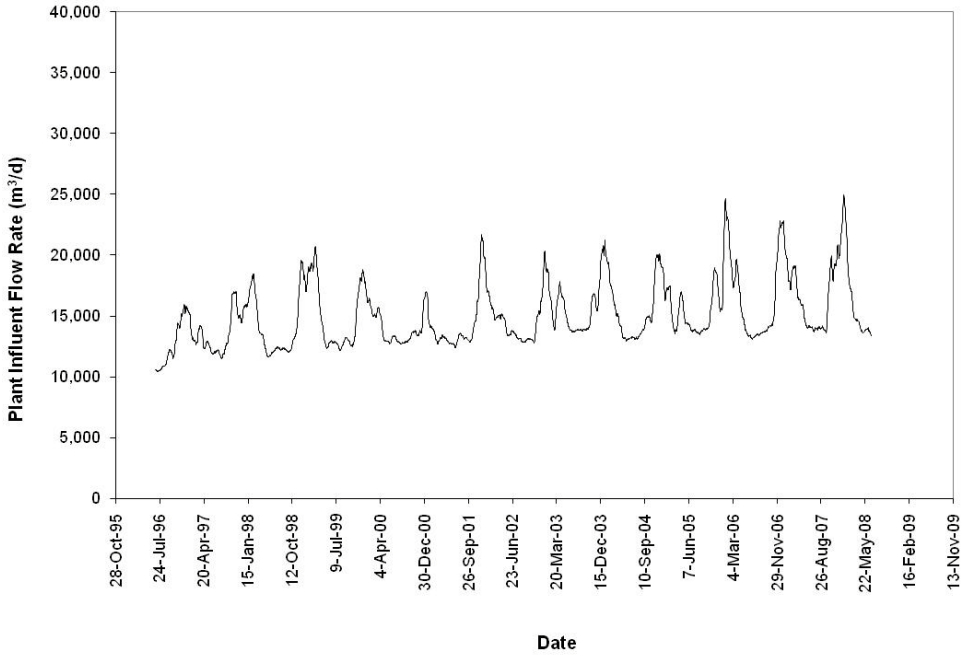


Figure 2-1: NWEC 30-Day Moving Average of Plant Effluent Flow

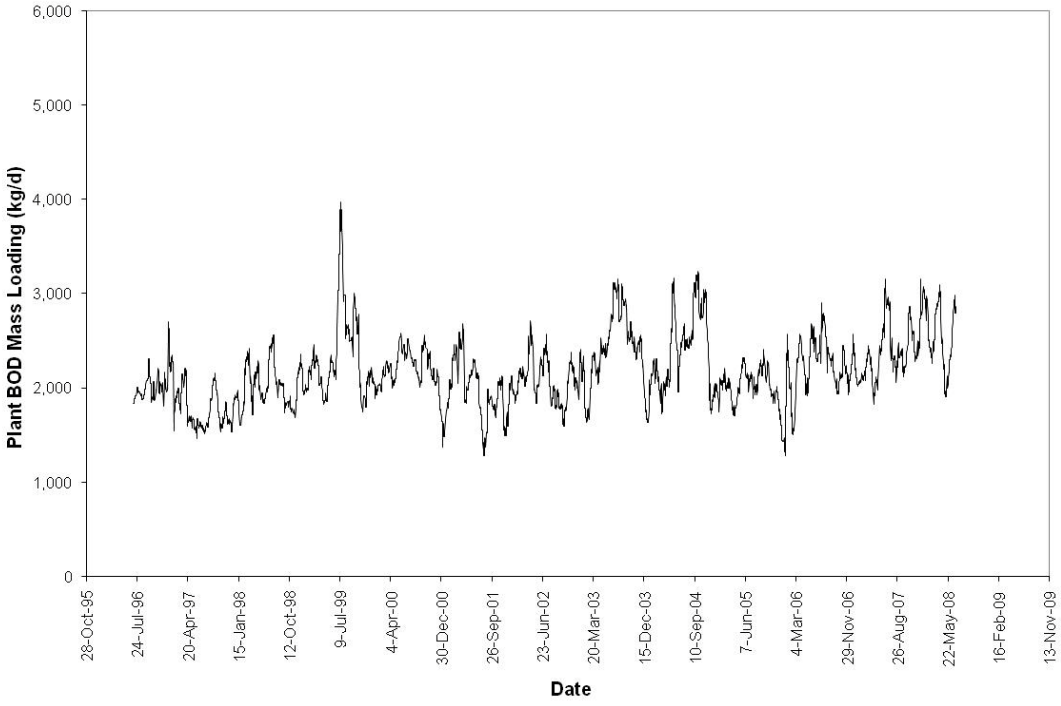


Figure 2-2: NWEC 30-Day Moving Average of Plant Influent BOD_5 Loading

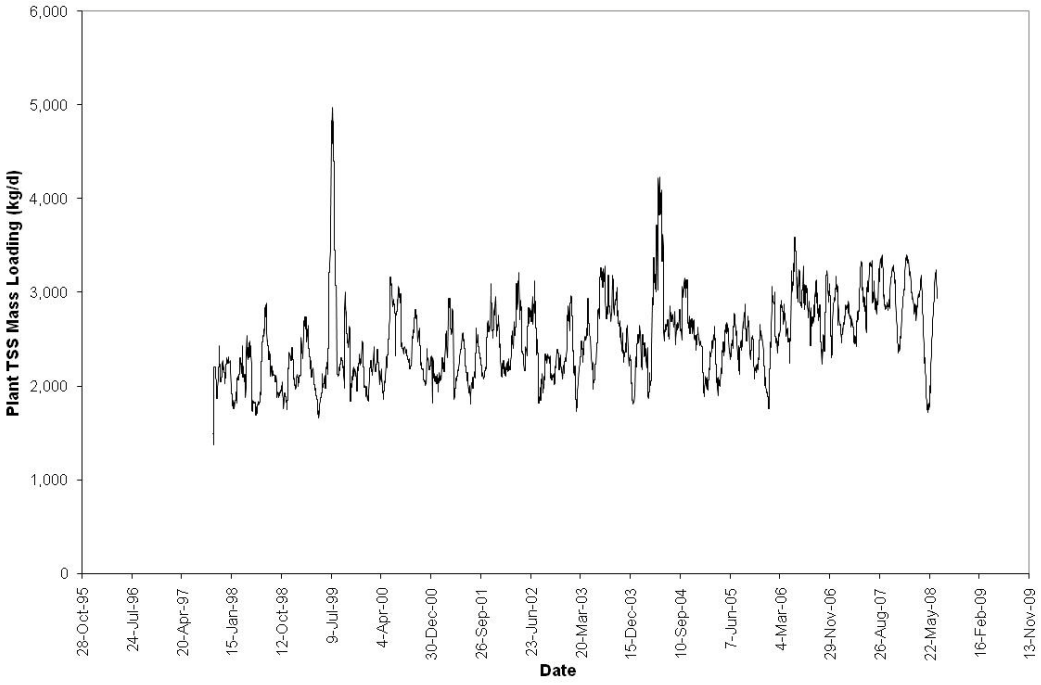


Figure 2-3: NWEC 30-Day Moving Average of Plant Influent TSS Loading

The plant influent average day flow and maximum month flow from 1997 through 2006 are summarized in Table 2-2. The corresponding mass loads of BOD_5 (BOD_5) and TSS are included in Table 2-2. The design parameters for the NWEC (single oxidation ditch operating) are included in the bottom row of Table 2-2 for convenience.

TABLE 2-2
SUMMARY OF ANNUAL PLANT FLOWS AND LOADS

Year	Flow (m^3/d)					BOD_5 Load (kg/d)[6]		TSS Load (kg/d)[6]	
	AAF[1]	ADWF[2]	MMF[3]	MDF[4]	Ratio MDF: ADWF	Annual Avg.	Max. Month	Annual Avg.	Max. Month
1997	13,750	11,830	17,100	27,160	2.3	1,800	2,330	2,170	2,430
1998	14,220	11,840	19,580	24,950	2.1	2,030	2,560	2,100	2,890
1999	15,030	12,550	20,620	29,560	2.4	2,330	3,980	2,380	4,980
2000	14,040	12,800	16,940	26,650	2.1	2,190	2,590	2,370	3,160
2001	14,260	12,590	21,720	29,750	2.4	1,990	2,690	2,350	3,100
2002	14,550	12,970	20,210	26,590	2.1	2,050	2,630	2,360	3,130
2003	15,780	13,780	21,190	35,980	2.6	2,410	3,160	2,530	3,280
2004	15,610	13,090	20,230	30,180	2.3	2,390	3,240	2,720	4,230
2005	15,220	13,700	23,490	25,450	1.9	2,000	2,570	2,340	2,790
2006	16,670	13,300	27,230	34,200	2.6	2,230	2,900	2,830	3,590
2007	16,890	13,840	24,930	30,020	2.2	2,390	3,080	2,910	3,380
Design[5]	11,900	N/A	16,500	41,400	N/A	2,620	2,620	2,380	3,380

1 AAF (Average Annual Flow) = average of daily flows each year
2 ADWF (Average Dry Weather Flow) = minimum of the 60-day moving average of daily flows each year
3 MMF (Maximum Monthly Flow) = maximum of the 30-day moving average of daily flows each year
4 MDF = maximum of daily flows each year
5 from NWEC design drawings – see Section 3.1.4 – numbers shown in Table 2-2 are based on a single oxidation ditch in operation
6 includes trucked liquid waste

As shown in Table 2-2, the average daily flows recorded at the plant over the past five years (14,550 m^3/d in 2002, increasing to 16,890 m^3/d in 2007) were much higher than the design value of 11,900 m^3/d. Similarly, the maximum month flows (20,210 m^3/d in 2003, increasing to 24,930 m^3/d in 2007) were much higher than the design value of 16,500 m^3/d. The recorded maximum month mass load of BOD_5 also consistently exceeded the design value (2,620 kg/d) over the past five years. This shows that the process is currently performing beyond its design parameters.

The main influent pump station for the NWEC is P.S. #11, which contains one 100 HP pump and two 250 HP pumps, all constant speed (soft-start) and controlled by water level detectors in the PS wet well. The small (100 HP) pump is activated first; if the water level continues to rise to a set elevation, the small pump shuts off and one of the large pumps is activated. The peak instantaneous flow at the plant effluent flow meter typically occurs when the water level causes one of the large (250 HP) pumps to be activated; this reportedly results in a sustained peak flow of about 420 L/s (36,300 m^3/d) at the plant effluent flow meter. Instantaneous peak flows as high as 530 L/s have occasionally been recorded at the plant, although these are transient events (suspected to be caused by large surface inflows of runoff or cross connections to the storm sewer system). It is important to note that the peak flows reflect the capacity of the pump station, and not the flow into the pump wet well. The peak flow could potentially be reduced by adding variable speed drive to the large (250 HP) pump. On occasion, the small pump and one of the large pumps have been manually activated; this reportedly results in a recorded flow of about 600 L/s at the plant flow meter.

2.2.2 Inflow and Infiltration

Inflow and Infiltration (I&I) into the sewer collection system can substantially increase the volume of wastewater arriving at treatment facilities. I&I varies depending on antecedent weather, soil moisture, groundwater levels, and the duration and intensity of storm events.

Infiltration can be divided into two components. Groundwater infiltration (GWI) enters the system through defects in pipes, which are located below the water table; GWI is relatively constant in intensity and is of long duration. Rainfall-derived infiltration (RDI) occurs during and immediately after rainfall events, and is caused by the seepage of percolating rainwater into defective pipes which lie near the ground surface; RDI is typically of relatively short duration and high intensity, compared to GWI.

Inflow can also be divided into two components. Dry weather inflow (DWI) results from surface water not caused by rain that enters the sewer system (e.g., street and vehicle washing). Stormwater inflow (SWI) results from the diversion of storm surface runoff into sanitary sewers (e.g., roof downspouts that are connected to the sanitary sewer and surface runoff entering manholes).

I&I affects the design of wastewater collection systems and treatment facilities. Collection systems must be designed to accommodate the peak instantaneous I&I that occurs during a precipitation (and/or snowmelt) event. At wastewater treatment facilities, hydraulic design must accommodate the peak instantaneous I&I, and the treatment processes must accommodate the sustained high hydraulic loads that occur over several hours or days during wet weather. The peak I&I flow for a particular system is normally developed from flow measurements, or, if accurate flow data are not available, typical design values may be adopted. For the City of Campbell River system, accurate flow records are available only at the NWEC; these data reflect only the flow rates at the plant effluent outfall, and do not provide the peak instantaneous flows for the various collection areas.

The Municipal Sewage Regulation (MSR) for British Columbia states that, where 2.0 times the average dry weather flow (ADWF) is exceeded at the treatment plant during rain or snowmelt events and if the contributory population exceeds 10,000 persons, the discharger should show how I&I can be reduced as part of a LWMP. The ADWF at the NWEC for the period from 1997 to 2007 is included in Table 2-2 in the previous section, together with the Maximum Day Flows (MDF) for the same period. The ADWF is the minimum 60-day moving average of the daily flows recorded in a given year. As shown on Figure 2-1 in the previous section, the ADWF normally occurs during the late autumn, and the AWWF typically occurs during March and April.

The ratio of MDF and ADWF for the years 1997 to 2007 is included in Table 2-2. As shown, the ratio has consistently exceeded 2:1 since 1997, and has ranged as high as

2.6:1. This indicates that I&I to the NWEC collection is excessive according to the MSR criterion. There may be significant sources of surface inflow or cross connections to the storm sewer system as noted in Section 2.2.1. Since these high flows are only evident at P.S. #11, it is suspected that the source is in the downtown area.

The high wet weather flows recorded at the NWEC and the need for I&I reduction have been highlighted in past correspondence with the City. The City should continue with the ongoing program to identify and eliminate sources of I&I during routine sewer maintenance, including elimination of cross connections between the storm and sanitary sewer systems. Further investigation is needed to assess the degree and location(s) of surface inflow and of groundwater infiltration into the collection system during both wet and dry weather. Smoke testing of the sanitary sewer system should be undertaken to help identify sources of inflow, particularly in the downtown area.

2.2.3 Unit Flows and Loads

The unit flows and loads based on the recorded operating data at the NWEC from 1997 to 2007 are shown in Table 2-3. The average of the unit annual and maximum month flows from 1996 to 2007 shown in Table 2-3 are similar to the design values reported later in Section 3.5.1 (these are included at the bottom of Table 2-3 for convenience). The average of the recorded maximum month recorded per capita BOD_5 loads (95 g/c/d) is slightly lower than the design value of 100 g/c/d, and the average of the recorded maximum month TSS load (104 g/c/d) is slightly higher than the design value of 91 g/c/d. However, the recorded unit BOD_5 and TSS loads are both reasonably close to the design values. This confirms that the oxidation ditch process is performing beyond its design parameters (i.e., a single ditch is currently serving about 31,000 people, compared to the design service population of 26,000 people per ditch). The plant continues to produce an effluent that is well within the maximum values specified in the Operational Certificate (i.e. average effluent BOD_5 and TSS concentrations are both typically around 10 mg/L to 15 mg/L, compared to the allowable maximum values of 45 mg/L – see Section 2.3).

TABLE 2-3
NWEC UNIT FLOWS AND LOADS

Year	Estimated Population	Flow (L/c/d)			BOD_5 Load (g/c/d)		TSS Load (g/c/d)	
		Average Annual	Maximum Month	Maximum Day	Annual Average	Maximum Month	Annual Average	Maximum Month
1997	30,360	453	563	895	59	77	71	80
1998	30,471	467	642	819	67	84	69	95
1999	30,582	491	674	967	76	130	78	163
2000	30,694	458	552	868	71	84	77	103
2001	30,806	463	705	966	65	87	76	101
2002	30,933	470	653	860	66	85	76	101
2003	31,060	508	682	1,158	78	102	81	106
2004	31,187	501	649	968	77	104	87	136
2005	31,315	486	750	813	64	82	75	89
2006	31,444	530	866	1,088	71	92	90	114
2007	32,400	521	769	927	74	95	90	104
Average	**-**	**486**	**682**	**939**	**70**	**93**	**79**	**108**
Design*	**37,000**	**456**	**637**	**1,120**	**100**	**100**	**91**	**91**

[1] populations assumed linear between 1996 and 2001 and between 2001 and 2006
[2] from NWEC design drawings – see Section 3.1.4
[3] requires upgrade to serve 52,000 people with selected upgrades

2.3 Effluent Quality

The plant influent and effluent concentrations of BOD_5 and TSS from January of 2002 to the summer of 2008 are illustrated on Figures 2-4 and 2-5, respectively. As shown, except for occasional process upsets (mainly due to short-term mechanical failures), plant effluent concentrations of BOD_5 and TSS have been well below the allowable maximum values of 45 mg/L.

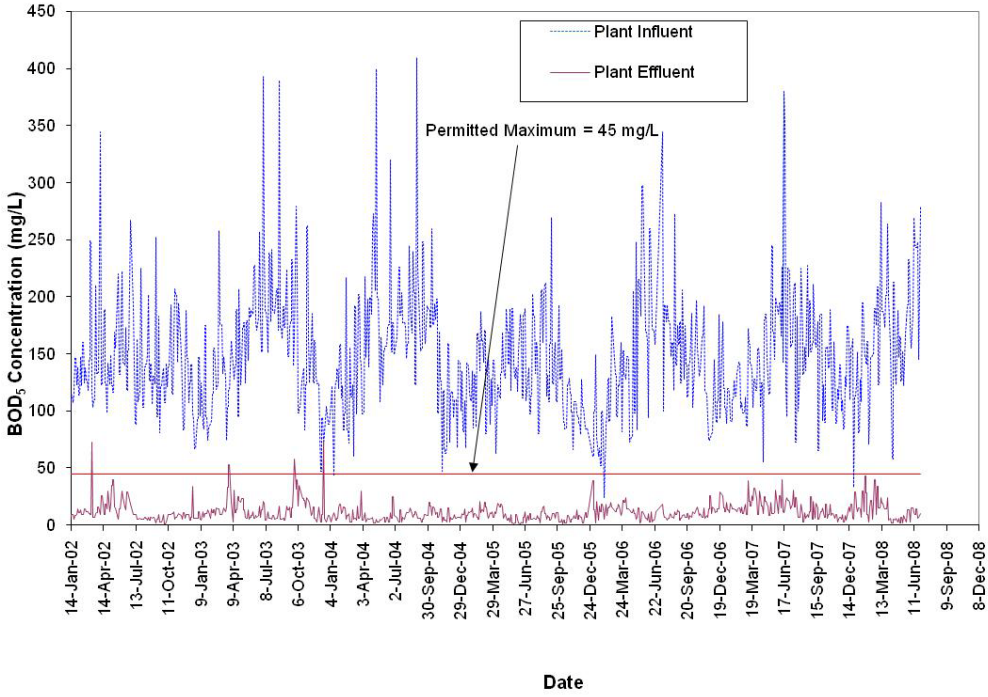


Figure 2-4: NWEC Plant Influent and Effluent BOD_5 Concentration

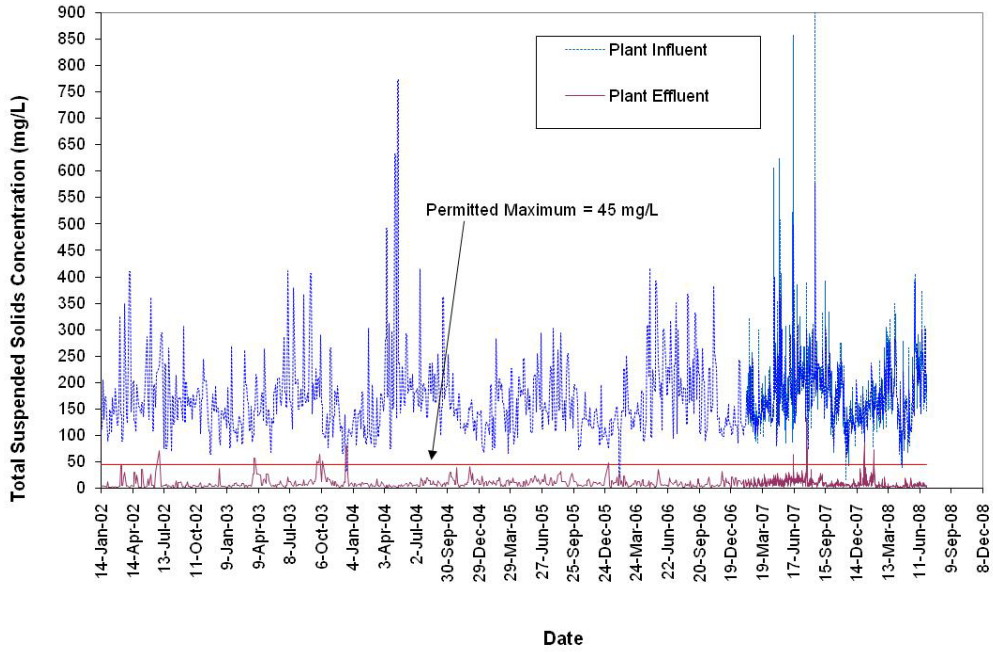


Figure 2-5: NWEC Plant Influent and Effluent TSS Concentration

The plant effluent average concentrations of BOD_5, TSS and Total Kjeldahl Nitrogen (TKN) from 2002 through 2007 are summarized in Table 2-4. As shown, effluent quality has been consistently excellent over the period of record. The low effluent TKN values (compared to typical influent TKN concentrations in the range 20 mg N/L to 25 mg N/L) show that oxidation of ammonia (i.e., nitrification) in the oxidation ditch process is achieving approximately 90% removal of TKN from the plant influent (note that TKN includes total ammonia as well as nitrogen compounds tied up in cellular material). This high degree of nitrification is indicative of a bioreactor that has low concentrations of organic material (measured as BOD_5) available, and it confirms that the process is functioning well despite BOD loading well beyond the design values.

TABLE 2-4
NWEC EFFLUENT QUALITY

Year	Effluent Average Concentration (mg/L)		
	BOD_5	TSS	TKN
2002	11	8	3.7
2003	14	13	2.5
2004	8	9	1.6
2005	8	11	1.7
2006	12	9	3.2
2007	15	11	3.6

2.4 Solids Handling

2.4.1 Historic Solids Production

Collection of information allowing the direct calculation of waste activated sludge (WAS) production at the NWEC (i.e. both the volume and concentration of the WAS stream sent to the digester) began in July of 2001. The average annual production of total and volatile waste biological solids (WAS) estimated from plant records since that time is

summarized in Table 2-5. The reported volatile content of the WAS was consistently in the range 80% to 83% by weight for the period of record, which is high for an extended aeration (oxidation ditch) process (a more typical value would be 70% to 75%).

TABLE 2-5
NWEC WASTE SOLIDS PRODUCTION

Year	WAS Production (dry tonnes/yr)		Plant BOD_5 Removal (dry tonnes/yr)	WAS Yield (kg WAS per kg BOD_5 removed)	Digested Biosolids Production (dry tonnes/yr)
	Total Solids	Volatile Solids			
2002	780	650	690	1.1	490
2003	740	610	790	0.9	510
2004	1,210	970	820	1.5	750
2005	820	680	690	1.2	470
2006	850	700	750	1.1	520
2007	870	720	780	1.1	350
Average	880	720	740	1.2	520

The average annual removal of BOD_5 in the oxidation ditch process is included in Table 2-5; as shown, the WAS yield was about 1.2 times the total BOD_5 removal (this is higher than the typical value of 1 kg WAS produced per kg BOD_5 removed, and may indicate inaccuracies in estimating WAS production).

The amount of solids produced after digestion is included in Table 2-5; this indicates that the total mass of solids (WAS) discharged to the aerobic digester was reduced by an average of about 41% in the digester. However, plant records show that destruction of volatile fraction of the solids in the digester averaged about 41% over the same period of record. This tends to confirm that WAS production may be over-estimated as noted above, since total solids destruction should be significantly less than volatile solids destruction. The production of WAS is based on grab sampling of the suspended solids concentration in the WAS line, and as such is subject to errors. Using a more typical

yield value of 1 kg WAS produced per kg BOD_5 removed, the average annual WAS production before digestion would be 740 dry tonnes per year; the calculated total solids destruction in the digester would then be about 35%, which is a more reasonable value. For the purpose of this study, a WAS yield of 1 kg WAS per kg BOD_5 removed was adopted, and 40% destruction of volatile solids in the digester was assumed.

2.4.2 Biosolids Land Application

Based on studies conducted between 2000 and 2003 where numerous potential beneficial uses for the NWEC biosolids were investigated, the City decided to land apply the biosolids generated on the NWEC on a parcel of adjacent land, and to use the land to grow hybrid poplars. The hybrid poplar plantation site is immediately south of the NWEC and is part of the same legal parcel. The total plantation area is about 10 hectares; however, with the unusable area and buffer zones excluded, the application area is approximately 9.4 hectares. The maximum elevation is approximately 30 meters above sea level (at the southwest corner) with an average slope to the northeast of about 1.5%.

Prior to the initial application of 2003, several public processes were undertaken, to ensure that the local stakeholders were aware of the application and understood the plan to beneficially re-use biosolids to establish a hybrid poplar plantation at NWEC. Prior to the 2003 application, two people expressed concerns about potential odour from the application of biosolids. However, there have been no odour complaints related to land application of the biosolids.

The City has land applied biosolids six times, starting with a fall application in 2003. All of the applications were approved by the appropriate authorities in accordance with the B.C. Organic Matter Recycling Regulation (OMRR). The biosolids application rates prescribed in the Land Application Plans were based on the nutrient requirements of the hybrid poplar, understory grass and winter cover crops. The biosolids land applications to date are summarized in Table 2-6. As shown, the average annual biosolids application

from 2003 to 2008 was 384 dry tonnes per year; this is less than the estimated annual production of digested biosolids (480 dry tonnes per year – see Table 2-5), and it helps to explain why ongoing difficulties were encountered in maintaining sufficient standby capacity in the storage basin.

TABLE 2-6
SUMMARY OF BIOSOLIDS APPLICATIONS TO ONSITE POPLAR PLANTATION

Application Period	Land Use	Biosolids Applied
2003	Fall rye hybrid crop	118 dry tonnes
2004	First year hybrid poplar	415 dry tonnes
2005	Second year hybrid poplar	463 dry tonnes
2006	Third year hybrid poplar	634 dry tonnes
2007	Fourth year hybrid poplar	237 dry tonnes
2008	Fifth year hybrid poplar	439 dry tonnes
Total Application 2003 through 2008		**2306 dry tonnes**
Average Annual Application		**384 dry tonnes**

The biosolids are well within the OMRR limits for Class B biosolids. Copper is the parameter that will limit long term land application on the poplar plantation. Additional constraints include excessive wetting of soils due to application of biosolids in liquid form and shading by the maturing tree canopy, with resulting limitations on machinery access due to boggy soil conditions. It is anticipated that only one more year of biosolids application to the poplar plantation will be possible. The City is currently pursuing the acquisition of additional adjacent property, and is also investigating the use of alternative seed crops that may uptake copper. Additional biosolids uses should also be revisited.

2.5 Projected Wastewater and Solids Quantities

The projected wastewater flows and mass loads of BOD_5 and TSS to the NWEC using the per capita amounts from Table 2-3 are shown in Table 2-7 (Area D not included) and Table 2-8 (Area D included). Solids production projections with and without Area D connected are shown in Tables 2-9 and 2-10. An annual population increase of 3% per year was assumed for the load projections.

TABLE 2-7
PROJECTED PLANT FLOWS AND LOADS WITHOUT AREA D

Year	Service Population[1]	Flow (m^3/d)			BOD_5 Load (kg/d)		TSS Load (kg/d)	
		Average Annual	Maximum Month	Maximum Day	Annual Average	Maximum Month	Annual Average	Maximum Month
2008	33,380	16,660	24,040	32,620	2,370	3,110	2,740	3,640
2010	35,430	17,680	25,510	34,620	2,520	3,300	2,910	3,870
2015	41,100	20,510	29,600	40,160	2,920	3,830	3,380	4,480
2020	47,670	23,790	34,330	46,580	3,390	4,440	3,910	5,200
2025	55,270	27,580	39,800	54,000	3,930	5,150	4,540	6,030
2030	64,080	31,980	46,140	62,610	4,550	5,960	5,260	6,990
2035	75,000	37,430	54,000	73,280	5,330	6,980	6,150	8,180

[1] assumes that Area D is not connected, 3% annual population growth
[2] based on unit design criteria developed from historic data – see Table 2-3

TABLE 2-8
PROJECTED PLANT FLOWS AND LOADS WITH AREA D

Year	Service Population[1]	Flow (m^3/d)			BOD_5 Load (kg/d)		TSS Load (kg/d)	
		Average	Maximum	Maximum	Annual	Maximum	Annual	Maximum
2008	37,300	18,620	26,860	36,450	2,650	3,470	3,060	4,070
2010	39,580	19,760	28,500	38,670	2,820	3,690	3,250	4,320
2015	45,900	22,910	33,050	44,850	3,260	4,270	3,770	5,010
2020	53,240	26,570	38,340	52,020	3,790	4,960	4,370	5,810
2025	61,720	30,800	44,440	60,310	4,390	5,740	5,070	6,730
2030	71,560	35,710	51,530	69,920	5,090	6,660	5,870	7,810
2032	75,000	37,430	54,000	73,280	5,330	6,980	6,150	8,180

[1] assumes that Area D is connected in 2008, 3% annual population growth
[2] based on unit design criteria developed from historic data – see Table 2-3

TABLE 2-9
PROJECTED SOLIDS PRODUCTION WITHOUT AREA D

Year	Service Population[1]	WAS Production (dry tonnes/yr)		Digested Solids Production[4] (dry tonnes/yr)
		Total Solids[2]	Volatile Solids[3]	
2008	33,360	780	620	510
2010	35,390	830	660	540
2015	41,100	960	770	620
2020	47,560	1,110	890	720
2025	55,140	1,290	1,030	840
2030	63,920	1,490	1,190	970
2035	75,000	1,750	1,400	1,140

[1] assumes that Area D is not connected, 3% annual population growth
[2] assumes 1 kg WAS produced per kg BOD_5 removed and 90% BOD_5 removal
[3] assumes volatile content of WAS is 80% by weight
[4] assumes 35% total solids destruction in digester

TABLE 2-10
PROJECT SOLIDS PRODUCTION WITH AREA D

Year	Service Population[1]	WAS Production (dry tonnes/yr)		Digested Solids Production[4] (dry tonnes/yr)
		Total Solids[2]	Volatile Solids[3]	
2008	37,280	870	700	570
2010	39,560	920	740	600
2015	45,900	1,070	860	700
2020	53,160	1,240	990	810
2025	61,630	1,440	1,150	940
2030	71,440	1,670	1,340	1,090
2032	75,000	1,750	1,400	1,140

[1] assumes that Area D is connected in 2008, 3% annual population growth
[2] assumes 1 kg WAS produced per kg BOD_5 removed and 90% BOD_5 removal
[3] assumes volatile content of WAS is 80% by weight
[4] assumes 35% total solids destruction in digester

3.0 EVALUATION OF PLANT UNIT PROCESSES

The Norm Wood Environmental Centre (NWEC) operates under the authorization of an Operational Certificate, and as such is not subject to the Municipal Sewage Regulation (MSR). Nevertheless, it was judged advisable to consider the requirements of the MSR in evaluating the existing plant unit processes, in particular the process reliability (redundancy) requirements that are set out in Appendix 1 to Schedule 7 of the MSR. The process reliability requirements specify standby (redundant) capacity needs for plant processes, assuming that the largest treatment unit in each process is out of service. This is designed to reduce the risk of process failure due to equipment breakdown, maintenance, etc. The NWEC was assumed to be a Category II treatment plant according to the MSR. The MSR defines a Category II treatment plant as "treatment works that discharge to waters or land that would not be permanently or unacceptably damaged by short term effluent degradation, but would be damaged by continued (several days) effluent quality degradation (for example discharges to recreational land and waters)" (MSR, B.C. Reg. 129/99O.C. 507/99).

As described in Section 1.1, the NWEC incorporates a liquid treatment system that includes a headworks, two oxidation ditches in parallel, and two secondary clarifiers. For current operation, only one of the oxidation ditches is required, and the second functions as a standby. The solids treatment system includes an aerobic digester and biosolids storage basin. Operational issues associated with the existing facilities are listed in Section 1.1 of this report. A review of the design capacity of each unit process is presented below. A site plan of the existing facilities is shown on Figure 1-1 in Section 1 of this report.

3.1 Headworks

3.1.1 Influent Screens

The headworks building contains a duty mechanically-raked bar screen and a bypass manual bar screen. Both screens have a 10 mm gap width. The channels containing the screens have dimensions of 1.2 m wide by 1.5 m deep. Influent raw sewage as well as pumper truck discharges pass through the mechanical bar screen to remove debris. Screenings are sent to landfill.

The capacity of the existing screens is shown in Table 3-1; capacities are shown for clean screens as well as with 30% blockage by debris. As noted earlier in Section 2.2, the sustained peak flow recorded at the plant effluent flow meter is about 420 L/s, and peak instantaneous flows of up to 530 L/s have been reported. The mechanical bar screen with 30% blockage appears marginally capable of handling the peak instantaneous flow.

TABLE 3-1
SUMMARY OF SCREEN LOADS

Equipment	Capacity (L/s)	Capacity (L/s) at 30% blockage
Infilco Degremont Climber Screen	740	520
Manual Bar Screen	740	520
Total Capacity	1,480	1,040

Plant staff report that the bar spacing (10 mm) of the existing mechanical bar screen allows some debris to pass through during peak flows. Accumulation of debris and clogging of the macerator pump that circulates mixed liquor through oxidation ditch process monitoring loop has been noted.

The mechanical bar screen is subject to occasional short-term clogging; this is suspected to be due to slug loads of debris from pumper truck discharges, which tends to block the mechanical screen until the automatic rake cycles on to remove the debris. Clogging of the mechanical screen causes some of the influent sewage to flow into the bypass channel containing the manual screen. If an operator is not present to clean the screen, the manual screen may also be blocked and cause raw sewage to overflow in the screen room (4 or 5 occurrences per year). A second mechanical (continuously cleaned) screen would eliminate nuisance overflows in the screen room.

Considering the age of the current mechanical bar screen, the performance of the manual bar screen, and future flow increases to the treatment plant, the existing manual bar screen should be replaced with a new continuously cleaned mechanical screen. The new mechanical screen can then function as the duty screen, with the older mechanical screen relegated to back-up duty. Recommendations and cost estimates for upgrading the influent screening at the NWEC are contained in Section 4.1 of this report.

Two duty mechanical screens will be required in future as flows increase. At that time, a third channel will be required for a new standby screen; this will require expansion of the existing headworks building. The timing for expansion of the screenings building will depend on population growth, as well as on the degree of inflow and infiltration (I&I) to the sewer collection system. As noted earlier in Section 2.2, the addition of variable speed drives to the large pumps in P.S. # 11 (main influent pump station) would reduce peak flows at the treatment plant. Ongoing reduction of I&I and water conservation may also reduce peak flows. Expansion of the screenings building is not anticipated until at least 2020, and may possibly be deferred well beyond that date.

3.1.2 Odour Control

Foul air from the screenings room is routed to a 10 m by 15 m biofilter for treatment. The biofilter is covered by a roof consisting of corrugated fiberglass panels resting on a

steel support structure (no sidewalls). The biofilter is functioning well, but significant corrosion is evident on the steel structure supporting the roof. Replacement of the roof support structure is recommended (see Section 4.1 for recommendations and cost estimates).

3.2 Influent Flow Meter and Flow Distribution

The existing influent flow meter downstream of the screens (Magmeter Magnum, probe insert type, installed in 1996) is not operational.

The existing distribution chamber has a similar structure to the flow splitter box for the secondary clarifiers (i.e., manual sluice gates are used to control the flow split).

Based on information provided by the plant staff, the distribution chamber that diverts flow to the oxidation ditches has occasionally flooded during high peak flows; this reportedly occurs when the large (250 HP) pump at Pump Station # 11 is manually activated along with the smaller (100 HP) pump, resulting in a flow of 600 L/s. If only one oxidation ditch is in operation, this amount of water will surpass the capacity of the 750 mm diameter pipe, causing flooding of the box. When both oxidation ditches are in operation, (i.e. when both of the manual sluice gates are fully open) flooding of the distribution chamber will not be an issue. In the meantime, manual activation of more than one of the pumps in PS #1 should be avoided.

Recommendations for improvements to influent flow metering are contained in Section 4.2 of this report.

3.3 Grit Removal

Grit that accumulates in the duty oxidation ditch is periodically removed after switching operation to the standby oxidation ditch. When increasing flows require activation of the

standby oxidation ditch, the current method of grit removal will no longer be viable. Options for adding grit removal to the plant together with cost estimates and recommendations are contained in Section 4.3 of this report.

3.4 Trucked Liquid Waste

According to plant staff, a maximum of ten pumper truck loads may be received at the NWEC in a single day, and a typical daily load is five trucks per day. Assuming a typical BOD_5 concentration of 7,000 mg/L for septage and an average pumper truck volume of about 6,825 L (1,500 Igal), the maximum day loading of BOD_5 to the plant from pumper truck discharges would be about 480 kg; this represents about 15% of the estimated 2008 maximum month BOD_5/load. The average day pumper truck discharge (5 trucks) represents about 240 kg/d or 9% of the estimated 2008 average day BOD_5 load. As the NWEC service population increases, pumper truck discharges will in all likelihood represent a diminishing percentage of the plant BOD_5 load. Plant loading from pumper truck discharges was included in the load analysis (Section 2).

Pumper trucks currently back on to a raised slab and discharge to a sump, which routes the truck discharges to the plant influent upstream of the influent screens. A flow meter records the volume of waste discharged to the sump. Plant staff report that the current method allows accumulated grit and rocks in the pumper trucks to be discharged to the plant influent, due to the incline of the raised slab (see Photo 3-1).

Photo 3-1 Existing Pumper Truck Discharge Station

3.5 Oxidation Ditch Process

3.5.1 Design Data

The design data for the oxidation ditch process at the NWEC with both oxidation ditches in service are as follows (from design drawings):

- Ultimate Service Population 52,000 people
- Design Service Population as presently configured 37,000 people
- Average Annual Flow 23,700 m^3/d (456 L/c/d)
- Maximum Day Flow 41,400 m^3/d (796 L/c/d)
- Maximum Month Flow 33,100 m^3/d (637 L/c/d)
- Total (carbonaceous) BOD_5 load (@ 220 mg/L 5,210 kg/d (100 g/c/d)
- TSS load (@ 200 mg/L 4,740 (91 g/c/d)
- Ammonia load (@ 20 mg/L 474 kg N/d (9.1 g/c/d)
- Oxidation Ditch volume 8,200 m^3 each

• Hydraulic detection time at average annual flow	17 hours
• Assumed operating MLSS concentration	4,000 mg/L
• Assumed operating MLVSS concentration	3,200 mg/L
• F/M ratio	0.10 kg/BOD_5/kg MLVSS/d
• Peak carbonaceous O_2 demand	7,800 kg/d (150 g/c/d)
• Nitrogenous O_2 demand	2,200 kg/d (42 g/c/d)
• Total design O_2 demand	10,000 kg/d (192 g/c/d)
• Number of diffusers per ditch	2,500 (1,500 per ditch currently installed)

3.5.2 Process Operation and Control

The NWEC oxidation ditch process is designed to allow operation as a continuous flow single reactor nitrogen removal process. The single reactor aerobic/anoxic process is designed to allow operation with a repeating sequence of an air-on period followed by an air-off period (both with full mixing), to generate sequential aerobic (dissolved oxygen present) and then anoxic (nitrate present but no dissolved oxygen) conditions in the same basin. Alternating aerobic and anoxic conditions in the oxidation ditch promotes biological nutrient removal through sequential oxidation of ammonia to nitrate (nitrification) and reduction of nitrate to inert nitrogen gas (denitrification).

The automated control system includes a dissolved oxygen (DO) probe and an oxidation reduction potential (ORP) probe, with a process liquid pumping loop installed in each ditch. The existing DO probe is an OxyGuard Model 420 Type II (dissolved oxygen range of 0 mg/L to 15 mg/L) with silver cathode, lead anode, and sodium carbonate electrolyte. The pH/ORP probe is a James Model 520-254. The DO/ORP system was decommissioned in early 2008, due to chronic plugging of the macerator circulation pump with debris. The DO and ORP sensors are also reported to require replacement.

The aeration control program is designed to allow an operator adjustable air-on period (typically 2 to 3 hours) to be entered on the computer control program. During the air-on phase, oxygen-demanding material in the wastewater is metabolized by the process bacteria, and bacterial oxidation of ammonia to nitrate (nitrification) also occurs. The aeration rate is automatically controlled to maintain a set DO concentration (normally 2 mg/L) in the process liquid during the air-on phase by a feedback signal from the DO probe mounted in the sample pumping loop. The blowers run at constant speed, and the amount of air provided to the diffusers in the aeration basin is regulated by automated damping valves located on the blower intakes.

At the end of the air-on period, the computer shuts the aeration blowers off, and the process bacteria continue to oxidize oxygen-demanding material during the air-off period, while at the same time reducing nitrate to nitrogen gas (denitrification). The contents of the oxidation ditch continue to be fully mixed during the air-off period by the submerged propeller mixers. The ORP probe detects the point at which all of the available nitrates have been removed from the process liquid, and at that point the aeration blowers are automatically restarted and the air-on phase beings again. A back-up timer restarts the blowers after a set time period if the ORP probe fails to detect elimination of nitrates. The air-on and air-off cycling reduces energy demand for aeration, and helps to stabilize process pH by recovering alkalinity during dentrification. The air-off part of the sequence also helps to reduce the generation of nuisance surface foam in the oxidation ditch and final clarifiers.

3.5.3 Oxidation Ditch Process Capacity

The process reliability requirements of the Municipal Sewage Regulation (MSR) state that activated sludge processes (of which the oxidation ditch is a variant) must be capable of treating 75% of the design load with the largest unit out of service. Although the NWEC is not registered under the MSR, these reliability standards were incorporated into this study as good engineering practice.

Typical design parameters for oxidation ditches are as follows (from Metcalf & Eddy, 2003):

- Volumetric Load 0.1 to 0.3 kg BOD_5/m^3 volume/day
- Hydraulic Retention Time 15 to 30 hours

Analysis of plant loading data (Section 2.2) shows that the oxidation ditch process at the NWEC is performing beyond recommended design limits. At the 2007 maximum month flow and load, the volumetric loading was 0.38 kg $BOD_5/m^3/d$, and the hydraulic retention time was about 8 hours with a single ditch in service. The 2007 maximum month BOD_5 load (0.38 kg $kg/m^3/d$) was about 1.3 times the maximum recommended value of 0.32 $kg/m^3/d$. The hydraulic retention time at maximum month flow (8 hrs) was only about 50% of the recommended minimum (15 hrs). Plant monitoring shows that effluent quality continues to be excellent for the current operation (i.e., effluent average concentrations during 2007 were 11 mg/L TSS and 15 mg/L BOD_5 – see Section 2.3 for more detail).

For the purpose of this analysis, the actual performance of the NWEC oxidation ditch process was used, rather than the text book design parameters. The projected process loading is summarized in Table 3-2.

TABLE 3-2
NWEC OXIDATION DITCH LOAD ANALYSIS

Year	Maximum Month Load [1]		Number of Units Available[2,4]	Volumetric Load (kg $BOD_5/m^3/d$)		Hydraulic Retention Time (hours)	
	Flow (m^3/d)	BOD_5 Load (kg/d)		All Units in Service	One Unit Out of Service[3]	All Units in Service	One Unit Out of Service[3]
2007	24,930	3,080	1	0.38	N/A	8	N/A
2010	28,500	3,690	2	0.23	0.34	14	9
2015	33,050	4,270	2	0.26	0.39	12	8
2020	38,340	4,960	3	0.20	0.23	15	14
2025	44,440	5,740	3	0.23	0.26	13	12
2030	51,530	6,660	3	0.27	0.30	11	10
2032	54,000	6,980	3	0.28	0.32	11	10

[1] from Table 2-8 in Section 2.4, assuming Area D is connected to the system

[2] oxidation ditch volume per ditch = 8,200 m^3

[3] assumes 75% of design flow and load according to MSR Process Reliability Requirements

[4] for 2008, second oxidation ditch also functions as standby digester

Assuming that the maximum capacity of a single oxidation ditch at the NWEC is about 37,000 people (i.e. approximately 10% higher than the estimated 2007 population of 33,400), the second ditch will have to be brought into service immediately if Area D is connected to the system; if Area D is not connected, this would not occur until around 2010 at 3% annual growth. Incorporating the MSR reliability (redundancy) standards, the two-ditch process will be adequate to serve a population of about 49,000 people (i.e., assuming that a single ditch can handle at least 37,000 people, which represents 75% of 49,000 people). When the service population exceeds about 49,000 people, a third oxidation ditch will be required if the MSR process reliability standards are to continue to be met.

Based on the performance of the single ditch currently operating, the three-ditch process could serve a total population of about 100,000 people if the MSR process reliability standards are used (i.e. two ditches operating with the third out of service would serve about 75,000 people, which represents about 75% of 100,000 people). Therefore,

construction of the third ditch should accommodate the build-out service population of 75,000 people according to the MSR process reliability standards.

The third oxidation ditch may be required around the year 2017 (assuming MSR process reliability standards, 3% annual growth and the connection of Area D, which would result in a service population of about 49,000 people by that time). If Area D is not connected, the third ditch would not be required until around 2021 (again assuming MSR process reliability standards are met and 3% annual growth). If Area D is not connected and if annual growth is less than 3%, construction of the third oxidation ditch may be deferred beyond 2021.

3.5.4 Oxidation Ditch Aeration Diffusers

Each of the oxidation ditches currently contains three grids of 504 aeration diffusers each (about 1,500 diffusers per ditch in total). These are located on the opposite side of the ditch from the propeller mixers. The diffusers are 225 mm (9 inch) diameter Sanitaire EPDM membrane-type fine bubble diffusers. New diffuser membranes were installed in Oxidation Ditch #1 during the summer of 2007 (commissioned in the spring of 2008). New diffuser membranes were installed in Oxidation Ditch #2 during the summer of 2008, but will not be used until process operation is switched to Oxidation Ditch #2 in the spring of 2009.

The design allows for the future addition of two additional diffuser grids, bringing the total number of diffusers to 2,500 per ditch. Installation of the additional diffusers would effectively increase the aeration capacity of each ditch by 40%, provided that the aeration blowers could supply the needed air. A more detailed analysis of aeration needs is presented in Section 4.5 of this report.

3.5.5 Oxidation Ditch Aeration Blowers

The three Hoffman centrifugal blowers (two duty and one standby) provide process air for the oxidation ditches. The Hoffman blowers were rebuilt with new impellers and the motors were upsized from 75 kW (100 HP) to 112 kW (150 HP) during the 1996 plant construction. The blowers are about 35 years old.

Control of blower output using the current system of inlet valve throttling means that control of the air flow is limited due to the potential for surging of the blowers if the inlet air flow is restricted too much. The operational pressure of the Hoffman blowers is about 7.6 psig, which is very close to the maximum output pressure of the blowers (i.e., the blowers are operating in a pressure range where a small increase in air pressure will result in a large decrease in blower output).

The maintenance and repair history of the Hoffman blowers is summarized in Appendix D. Bearing failures and automatic trip outs have chronically occurred. Two of the blowers have had fluid couplings installed, which has reduced bearing failures. Ongoing maintenance related to blower bearing failures is estimated by plant staff to cost about $8,000 per year. An analysis of aeration blower options and recommendations for improvements is contained in Section 4.5 of this report.

Photo 3-2 Hoffman 150 HP Centrifugal Blowers

3.6 Secondary Clarifiers

The mixed liquor from the oxidation ditch process flows to the secondary clarifiers. The flow of mixed liquor to the clarifiers is controlled by manually opening and closing sluice gates in the mixed liquor splitter box downstream of the oxidation ditches.

The process solids are separated from the treated liquid by gravity settling in the secondary clarifiers. Scum and other floating material are removed from the water surface by a rotating arm, which scrapes the scum into the skimmings box; skimmings are pumped from the sump into a Hycor Rotostrainer in the screen room that was installed in 1998. Plant staff report that the underwater metal components of the existing clarifiers are showing significant signs of corrosion and should be refurbished or replaced. In July 2008, the rake drive mechanism in Clarifier #1 jammed and the drive motor burned out; this fortunately occurred during dry weather, when flows at the plant were low enough so

that Clarifier #2 was adequate to handle the entire plant flow until Clarifier #1 was repaired.

Clarified effluent exits the clarifiers via the overflow weirs and is routed to the plant effluent flowmeter and outfall. Settled solids accumulating at the bottom of the clarifiers are pumped back to the oxidation ditches via the influent distribution chamber as returned activated sludge (RAS). A portion of the RAS is pumped to the aerobic digester as waste activated sludge (WAS) for further treatment. The two existing RAS pumps (duty/standby) are Flygt CP3152.181 type LT with a capacity of 128 L/s at 5.0 m head and 10.3 kW. The two WAS pumps (duty/standby) are Worthington 6MF11 with a capacity of 50 L/s at 6 m head. The existing common RAS pipe returning settled sludge to the oxidation ditch process is 450 mm in diameter, and the WAS pipe carrying waste sludge to the digester is 200 mm in diameter. The existing scum pump is a Flygt 3085-M with a capacity of 15 L/s at 5 m head and 2 kW. The common scum pipe to the screen room is 100 mm in diameter.

Design parameters for each of the two centre-feed secondary clarifiers are as follows:

- Diameter: 27 m
- Side water depth: 5 m
- Weir length: 78 m
- Weir overflow rate at AAF: 152 m^3/m-d (11,850 m^3/d)
- Weir overflow rate at PDF: 266 m^3/m-d (20,750 m^3/d)
- Detention time at AAF: 6 hours at 52,000 people

Typical design criteria for secondary clarifiers are shown in Table 3-2 (from the Metcalf and Eddy, 2003).

TABLE 3-3
SECONDARY CLARIFIER DESIGN PARAMETERS

Parameter	Metcalf & Eddy (2003)
Hydraulic loading – Average ($m^3/m^2/d$)	8-16
Hydraulic loading – Peak ($m^3/m^2/d$)	24-32
Solids loading – Average ($kg/m^2/d$)	24-120
Solids loading – Peak ($kg/m^2/d$)	168

Table 3-4 shows the projected loading and upgrade needs for the secondary clarifiers from 2006 to 2035, assuming that Area D is connected to the system. For the purpose of this study, the new clarifiers were assumed to have a diameter of 32 m (the two existing clarifiers have a diameter of 27 m). Increasing the clarifier diameter to 32 m increases the surface area by about 40% compared to a diameter of 27 m, at a relatively small (17%) cost increase (see cost estimates in Section 4.6 of this report). Upsizing of the two new clarifiers will avoid the need for a fifth clarifier to serve the ultimate population of 75,000 people.

A third clarifier is required immediately to ensure that adequate capacity is available in the event a clarifier is removed from service for repair or maintenance. As shown in Table 3-4, a fourth clarifier will be required by about 2020, assuming Area D is connected. If Area D is not connected, the third clarifier is still required immediately, but the construction of the fourth clarifier may be deferred until around 2025.

TABLE 3-4
SECONDARY CLARIFIER LOADING BOTH UNITS IN OPERATION
(AREA D CONNECTED)

Year	Population	Flow (m^3/day)		Number of Clarifiers in Service	Clarifier Area (m^2)	Hydraulic Load ($m^3/m^2/d$)		Solids Load ($kg/m^2/day$)		Upgrade Requirements
		Average Annual	Maximum Day			Average Annual	Maximum Day	Average Annual	Maximum Day	
2008	37,300	18,620	36,450	2	1145	16.3	31.8	98	191	
2010	39,580	19,760	38,670	3	1949	10.1	19.8	61	119	New Clarifier #3
2015	45,900	22,910	44,850	3	1949	11.8	23.0	71	138	
2020	53,240	26,570	52,020	4	2754	9.6	18.9	58	113	New Clarifier #4
2025	61,720	30,800	60,310	4	2754	11.2	21.9	67	131	
2030	71,560	35,710	69,920	4	2754	13.0	25.4	78	152	
2032	75,000	37,430	73,280	4	2754	13.6	26.6	82	160	

[1] assumed mixed liquor suspended solids concentration = 4,000 mg/L and assumed RAS pumping rate = 0.75 Q.

[2] peak hour solids load can be reduced by reducing the RAS pumping rate during peak flow periods

The process reliability requirements of the MSR state that final sedimentation process (i.e., the secondary clarifiers at the NWEC) must consist of multiple units, and must be capable of treating 50% of the design flow with the largest unit out of service for Category II receiving waters. However, for the purpose of this analysis, it was assumed that the clarifiers should meet the MSR redundancy standard for Category I receiving waters (i.e., the final sedimentation process must be capable of treating 75% of the design load with the largest unit out of service). The more stringent standard was adopted because the secondary clarifiers are the "last line of defense" prior to outfall discharge (i.e., if the clarifiers fail due to overloading, the process biological solids will be carried over the effluent weirs to the outfall, resulting in violations of the Operational Certificate and potential process failure). The clarifier upgrade needs shown in Table 3-4 will meet the Category I (75%) MSR redundancy requirements.

Installation of the third and fourth clarifiers will require the construction of additional dedicated RAS and WAS pumps. Construction of a new RAS pump station to serve Clarifiers #3 and #4 is recommended as described in Section 4.6 of this report.

3.7 Effluent Flow Monitor

The effluent parshall flume flow monitor is reported by plant staff to be near capacity at peak plant flows. A hydraulic analysis of the parshall flume conducted during this study confirmed that the flume is near capacity. Recommendations for improvements to the effluent flow monitor are contained in Section 4.7 of this report.

3.8 Effluent Outfall

The NWEC discharges treated effluent to Discovery Passage through an outfall with a multi-port diffuser located near McDonald Road. The McDonald Road Outfall was constructed as follows:

- the outfall extends approximately 540 m from the shoreline;
- the minimum discharge depth (low water) is about 35 m;
- the multiport diffuser consists of 38 ports spaced 1 m apart;
- the outfall is 724 mm internal diameter; and,
- the outfall is designed to provide service for a future average day flow of 66 ML/d and a maximum day flow of 116 ML/d, for an ultimate service population of 145,000 people.

The outfall was initially commissioned with 6 of the 38 diffuser ports left open (the other 32 ports were closed with blind flanges). In 2002, the flow and the hydraulic capacity were reviewed, outfall dilution modelling was conducted, and as a result an additional 9 ports were opened to address increased flows and to improve dilution. The ultimate design capacity of 116 ML/d for maximum day flow (145,000 service population) is well above the projected build-out maximum day flow of about 78 ML/d for the ultimate population of 75,000 people (see Table 2-6 in Section 2.4). Improvements to the outfall to increase capacity are therefore not anticipated.

An outfall receiving environment monitoring program was developed in consultation with the B.C. Ministry of Environment (MOE) and Environment Canada in 1996. Effluent discharge from the outfall began on June 17, 1996. The outfall monitoring program (with the outfall active) has been in place since 1997. Reference (baseline) data were collected in 1995 and 1996 prior to commissioning of the outfall. The monitoring program has historically involved annual sampling of sediments and the water column in and around the McDonald Road Outfall area during the summer months.

The results of the monitoring program from 1995 to 2004 did not show any detrimental effects on the receiving environment from the outfall discharge. However, in reviewing the monitoring results after the first 5 years (to 2000), it became apparent that the water and sediment sampling results did not provide information that could be used with confidence to assess the impacts of the outfall discharge on the receiving environment. The following limitations were identified:

- the sampling stations were located where surface runoff and the outflow from the Campbell River may have more influence than the outfall discharge;
- outfall discharges from Painter's Lodge and Dolphin's Resort might impact the results (these outfalls have since been inactivated); and
- obtaining sediment samples was difficult since there appeared to be little sediment deposition in the area of the outfall.

Discussions with the B.C. Ministry of Environment (MOE) Nanaimo office regarding the above issues were initiated at a meeting held on August 1, 2000. The primary purpose of the discussion was to consider modifications to the outfall monitoring program that would provide more meaningful results in terms of assessing the impacts of the outfall discharge. The revised outfall monitoring program was developed in consultation with MOE and Environment Canada, and was approved by the MOE in September of 2007, and was subsequently implemented during the fall of 2007. To date, the results of the

revised monitoring program have not demonstrated detrimental impacts on the water quality or sediment quality in the receiving environment due to the outfall discharge.

3.9 Aerobic Digester

3.9.1 Design Data

The biological solids (bacterial cells) wasted from the oxidation ditch process (referred to as waste activated sludge or WAS) are discharged to the aerobic digester for stabilization. The digester consists of a single earthen basin with an HDPE liner. Fine bubble diffusers provide aeration and mixing in the digester. According to the design drawings, the existing digester has the following design parameters:

- service population 37,000 people
- volume 6,000 m^3
- solids loading 2,800 kg/d
- detention time 21 days
- total air requirement 2,360 L/s (5,000 SCFM)
- number of diffusers 2,000

3.9.2 Process Operation and Control

The digester is operated as a semi-batch process. Waste solids (WAS) from the oxidation ditch process are fed to the digester using a pump that is controlled by an operator-adjustable timer. The process air in the digester is periodically turned off, and the mixed liquor solids are allowed to settle. Supernatant is then returned to the liquid treatment train, and settled digested solids are transferred by gravity to the biosolids storage basin.

Due to the low alkalinity water, lime must be added to the digester to prevent low pH (acidic) conditions from developing as a byproduct of bacterial oxidation of ammonia to

nitrate (nitrification). A lime hopper and feed auger have been installed at the digester for this purpose. To minimize lime use, recovery of alkalinity by bacterial conversion of nitrate to nitrogen gas (denitrification) in the digester is undertaken by cycling of the diffuser grids. The digester aeration system consists of four lateral pipes, each containing a grid of 500 fine bubble diffusers. The four aeration laterals are controlled by automated valves, so that only two of the laterals are active at a time. A timed program sequentially activates and then deactivates each set of two laterals in turn. This provides oxygen and mixing for stabilization of solids, while allowing periodic semi-anoxic (un-aerated) conditions for denitrification to recover alkalinity. (As described earlier, denitrification by automated cycling of the process air is also undertaken in the oxidation ditches through online feedback control, to maximize alkalinity recovery and minimize energy consumption). Additional discussion of digester aeration and mixing is provided in Section 3.8.4.

3.9.3 Digester Process Capacity

The digester loading based on the projected total solids production developed in Section 2.4 is summarized in Table 3-5 (Area D connected). As shown, the design total solids loading of 2,800 kg/d (from Section 3.8.1) will be exceeded by about 2013 if Area D is connected to the system. If Area D is not connected, the design total solids loading will be exceeded by about 2017 (assuming 3% annual growth).

TABLE 3-5
NWEC DIGESTER LOAD ANALYSIS (AREA D CONNECTED)

Year	WAS Production (dry tonnes/yr[1])		Digester Volume[3] (m^3)	Solids Load	
	Total Solids	Volatile Solids		Total Solids (kg/d)	Volatile Solids ($kg/m^3/d$)
2008 [2]	780	620	6,000	2,140	0.28
2010	920	740	12,000	2,520	0.17
2015	1,070	860	12,000	2,930	0.20
2020	1,240	990	12,000	3,400	0.23
2025	1,440	1,150	12,000	3,950	0.26
2030	1,670	1,340	12,000	4,580	0.31
2032	1,750	1,400	12,000	4,790	0.32

[1] from Table 2-8 in Section 2.4

[2] 2008 values do not include Area D

[3] assumes digester is twinned by 2010

Metcalf & Eddy (2003) recommend a design volatile solids (VSS) loading for aerobic digesters of 0.1 to 0.3 kg VSS/m^3 digester volume/day. The projected VSS loading on the aerobic digester is included in Table 3-5; as shown, the digester VSS load will exceed 0.3 kg VSS/m^3/d immediately if Area D is connected. The VSS loading criteria will not be exceeded until about 2010 if Area D is not connected.

The MSR process reliability standards for aerobic digesters require a minimum of two units, with the added requirement that the digestion process must treat 50% of the design load with the largest unit out of service. The standby oxidation currently functions as a back-up digester. However, when the second oxidation ditch is put into service for liquid treatment around 2010, twinning of the digester will be required to meet the MSR reliability standard. Activation of the second oxidation ditch for liquid treatment is expected to be required in the near future, particularly if Area D is connected to the system (see Section 3.5.3); this will initiate the need to twin the digester to ensure that

process operation can continue if one of the two digester basins have to be removed from service (e.g., for replacement of the diffuser membranes). Alternatively, the biosolids storage basin could possibly function as a standby digester if the floating aerators were re-installed; however, this would then eliminate the capacity for onsite storage of liquid biosolids.

In light of the above analysis, it is apparent that expansion (twinning) of the digester will be required in the near future.

3.9.4 Digester Aeration

The 250 HP Lamson centrifugal blower provides the air for the digester; the Lamson Model 1270, five-stage blower is rated at about 5,000 SCFM at 6.5 psi. Since the digester relies on diffuser aeration for mixing, independent control of mixing and aeration for solids stabilization is not possible (in contrast to the oxidation ditches). Cycling of the aeration laterals provides a partial solution, but continuous aeration of at least part of the basin is needed to ensure adequate mixing. This results in a high operating dissolved oxygen (DO) concentration in the digester, well in excess of the recommended 2 mg/L.

Aeration requirements for stabilization of biological solids (i.e., waste activated sludge) are typically about 2.3 kg oxygen required per kg volatile suspended solids (VSS) destroyed; diffused air requirements for mixing are typically about 0.03 m^3 air per m^3 digester volume per minute (Metcalf & Eddy, 2003). The projected digester aeration requirements for solids stabilization and for mixing are summarized in Table 3-6 (Area D connected). It was assumed for this exercise that the digester would be twinned by around 2010 (see Section 3.8.3). As shown in Table 3-6, the aeration requirement for mixing is about three times that for solids stabilization. It would be beneficial to install independent mechanical mixers in the digester; this would allow reduction of process air to meet the solids stabilization requirement, and would consequently reduce lime consumption for pH control through improved denitrification and reduce energy

consumption for aeration. Recommendations for improvements to the digester are contained in Section 4.7 of this report.

TABLE 3-6
DIGESTER AERATION REQUIREMENTS (AREA D CONNECTED)

Year	Digester VSS Load (kg/d)[1]	Digester Aeration Requirements (m^3/hr)	
		For Solids Stabilization[2]	For Mixing [3]
2008	1,910	3,320	10,800
2010	2,030	3,520	21,600
2015	2,350	4,080	21,600
2020	2,730	4,740	21,600
2025	3,160	5,440	21,600
2030	3,670	6,370	21,600
2032	3,840	6,670	21,600

1 derived from Table 2-8 in Section 2.4

2 assumes 60% VSS destruction in digester (summer operation), 12% oxygen transfer efficiency, 2.3 kg O_2/kg VSS destroyed, density of air 1.2 kg/m^3

3 assumes 1.8 m^3 air/m^3 digester volume/hr, digester volume = 6,000 m^3 until 2010, increasing to 12,000 thereafter

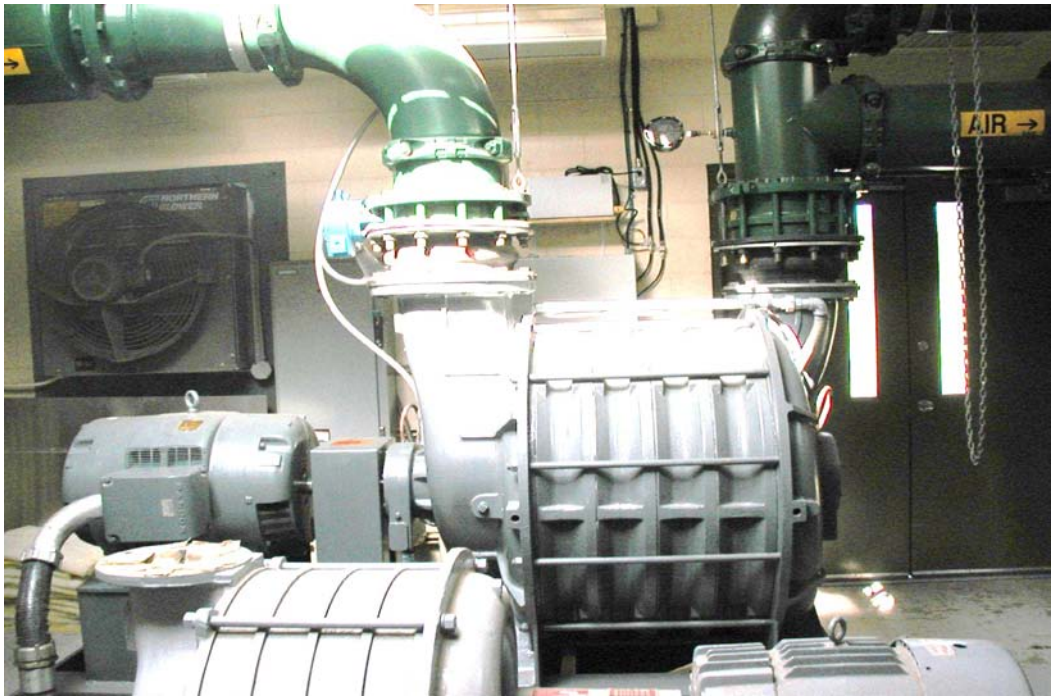


Photo 3-3 Lamson 250 HP Centrifugal Blower

3.10 Biosolids Handling

Digested biosolids at the NWEC are discharged to a lined storage basin adjacent to the digester. The total volume of the storage basin is about 18,000 m^3. Solids discharged to the basin settle to the bottom, and a water cap is normally maintained over the sludge blanket to minimize odours. Supernatant is returned to the liquid treatment process. The basin contents must periodically be removed, dewatered and disposed of or reused. Sampling to accurately determine the solids content of the basin is difficult, due to the extensive layer of vegetation that has developed over the basin surface.

Gravity thickening of the biosolids in the storage basin appears to have been less effective than anticipated; this results in a larger volume of biosolids for land application on the onsite poplar population, with an associated increase in operating cost. The existing poplar plantation has a limited life for biosolids applications, due primarily to accumulation of copper in the soil (see Section 2.6). The City is currently pursuing the purchase of additional land to expand the plantation, and is also considering alternative harvestable crops that may uptake copper and potentially be used for biofuel production. The City has also reviewed potential alternative land application strategies in the past.

For the long-term future, it may be beneficial to consider constructing a biosolids dewatering facility at the NWEC, thereby eliminating the need for the onsite storage of liquid biosolids. Dewatering of digested biosolids would also reduce application costs for the onsite poplar plantation, and/or transportation costs to alternative biosolids reuse sites. Alternatively, mechanical thickening of the biosolids could potentially increase the capacity of the storage basin. These alternatives are further explored in Section 4.7 and 4.8 of this report.

3.11 Administration Building

The existing administration building includes a control room, separate laboratory, and washroom facilities. There is no dedicated lunch room, office space or meeting room. The washroom facilities are adequate for the current operation, but include only a single shower in the men's room. The ladies washroom is marginal. Recommendations and cost estimates for expanding the administration building are included in Section 4.10 of this report.

3.12 Geotechnical and Seismic Issues

A geotechnical investigation of the NWEC site was conducted by Agra Earth & Environmental in 1994 before construction of the original facilities was undertaken; the following text is taken from the December 1994 report by Agra entitled "Geotechnical Investigation, District of Campbell River Wastewater Treatment Facilities". Recommendations for additional geotechnical investigation are contained in Section 4.14 of this report.

"The subsurface conditions encountered within this phase of the project confirm those identified in AGRA's April 1994 field program and are generally poor with respect to the proposed development. The sensitive surficial soils, high groundwater table, and potentially liquefiable deltaic/marine deposits necessitate specific geotechnical attention in the following areas.

- *the owner must accept the potential risk of severe damage and temporary closure of the facility after a large earthquake unless ground densification techniques are used to reduce the liquefaction potential of certain soil types.*

- *extensive temporary dewatering is required to enable construction of the proposed facility. Consideration in the design of the units which extend below the groundwater*

table is necessary to mitigate the effects of hydrostatic uplift forces on the clarifiers, oxidation ditch and lagoon liners.

- *the sensitive nature of the fine grained deltaic/marine deposits will result in construction difficulties, especially if the high groundwater table is not adequately controlled.*

The primary geotechnical issue related to the long term performance of the wastewater facility is the potential for adverse ground movement under seismic loading conditions. In this respect, the District of Campbell River (the District) must make a management decision related to the acceptable performance of the facility during a design earthquake. The outcome of the decision has a significant bearing on the necessary geotechnical recommendations. For example, if the facility is to be protected against damage during a large earthquake, (i.e., 1 in 475 year event) the ground should be densified using one of several ground improvement techniques. Additionally, certain structures, including the screen building, should be supported on pile foundations bearing on the sand till.

The District has proposed to design the facility to the 1 in 100 year seismic event and is prepared to accept the risk of adverse ground movements under the design 1 in 475 event.

In accordance with the National Building Code of Canada (NBCC), there is a 10 percent probability that the site area will be subjected to seismic accelerations of 44 percent of gravity within a 50 year period, (1 in 475 year event). This acceleration value is one of the highest in Canada. There is a 40 percent probability of peak amplified acceleration of 15 percent of gravity within a 50 year period, (1 in 100 year event).

A level ground liquefaction assessment conducted by Agra using CPT data indicates that the loose non-cohesive silt and silty sand deposits would liquefy under the 1 in 475 year event. The medium dense to dense silty sands which dominate the upper portion of the

deltaic/marine deposits do not appear to be contractive, and relative low displacements are anticipated under seismic loading.

Analysis indicates that the order of magnitude of movement which could be expected from the non-cohesive silts under the 1 in 475 event is greater than one metre. This movement would likely cause significant damage to structures such as the screen building, if supported on shallow strip footings bearings on the non-densified deltaic/marine deposits. Additionally, large lateral movements and potentially flow slides should be expected in the vicinity of the lagoons and oxidation ditch slopes would result in slumping and slope failures. The analysis indicates that liquefaction should not occur during the 1 in 100 year event, although some settlement and lateral spread should be expected.

The natural groundwater level at the time of fieldwork was typically 1 m to 2 m below existing grade and locally at surface in the low areas of the site. The generally flat topography in the area does not readily allow for gravity drainage of the entire site without the construction of a significant drainage system. Accordingly, it is Agra's opinion that an alternative, viable, and cost effective engineering solution would be to dewater specific areas of the site using a system of wellpoints, and possibly larger wells, to enable construction. Once the facility is in place and operational, the hydrostatic levels in the below ground structures (clarifiers, lagoons and ditches) would need to be maintained at, or above, the fully recovered groundwater level to eliminate a net hydrostatic uplift force on the base of these structures.

Maintenance work which would necessitate the emptying of below ground structures would require a further phase of temporary dewatering to drawdown the watertable below the base of the structures. Monitoring piezometers installed around each of the below ground structures would allow for accurate measurement of the natural groundwater level to ensure that net uplift forces do not occur when the operating water levels are lowered in the units.

Excavations into the sensitive clays and silts and the silty fine grained sands must be dewatered if reasonable working conditions are to be maintained. Further, failure to adequately dewater could result in piping conditions at the face of the excavation, resulting in reducing bearing capacity. It is recommended that the groundwater elevation be lowered to at least one metre below proposed base elevation of any excavation, prior to any site excavation.

The temporary wellpoint dewatering system should be designed by a specialist contractor and reviewed by the Geotechnical Engineer of Record."

4.0 RECOMMENDED UPGRADES AND COST ESTIMATES

The recommended upgrades described in this section are based on the analysis contained in Section 3 of this report. Cost estimates were developed in 2008 dollars, based on City of Campbell River Policy for Class C Estimates (Council Resolution No. IC06-0065); this specifies the following allowances as a percentage of estimated construction cost:

- 25% general contingency;
- 25% for engineering, legal, construction, financial and administration costs; and
- 20% for inflation.

Budget quotes for major mechanical equipment are attached in Appendix C, and details of construction cost estimates are contained in Appendix D. Manufacturer's literature for major equipment used in developing cost estimates is included in Appendix E. Where possible reference facilities were contacted, to obtain feedback on equipment performance and O&M needs (see Appendix F). Prioritization of the recommended upgrades and a site plan illustrating the improvements are contained in Section 5.

4.1 Headworks

4.1.1 Influent Screens

The existing manual bar screen should be replaced with a new continuously cleaned mechanical screen, which will then function as the duty screen. The existing mechanically-raked bar screen can be left in place as a standby. A continuous Finescreen Monster by JWC Environmental with 6 mm perforated panels, complete with a dewatering and compactor system, was used as an example of a suitable replacement for the current manual bar screen (refer to literature in Appendix E). The perforated screen was chosen instead of a bar screen because the perforated plate screen allows less debris to pass through than does the bar screen, particularly at high flows. The problem with chronic overflows in the screen room should be eliminated with the addition of a continuously-cleaned screen. The new screen should have a maximum flow capacity of at least 63,970 m^3/d. Odour in the screenings room should be reduced with the addition of the new screen and washer.

The estimated cost of the new 6 mm mechanical perforated plate continuous screen (including installation) is shown in Table 4-1 (see Appendices for more detail).

TABLE 4-1
ESTIMATED CAPITAL COST OF SCREENINGS UPGRADE

Description	Capital Cost
New perforated plate mechanical screen	$ 245,000
Washer and compactor	$ 110,000
Installation	$ 40,000
Electrical & SCADA	$ 25,000
Sub-total Construction	**$ 420,000**
General Contingency (25%)	$ 105,000
Engineering, Legal, Admin., etc. (25%)	$ 105,000
Inflation (20%)	$ 85,000
TOTAL	**$ 715,000**

As noted earlier in this report, a channel for a third (standby) screen will be required when increasing peak flows at the plant require two duty screens; this is estimated to occur around the year 2020. Construction of a third channel will require expansion of the headworks building at that time.

4.1.2 Odour Control

As noted in Section 3.1, the support structure for the biofilter roof is badly corroded, and should be replaced. Replacement of the media will also be required in the near future. The estimated construction cost for replacing the existing steel support structure and media, etc. is $60,000.

Plant operations staff requested that replacement of the biofilter with a Sol-Air odour control unit using ultra violet light be considered. A cost comparison of the two options is shown in Table 4-2 (to come from Andy). Note that the Sol-Air unit requires annual replacement of the lamps at approximately $3,000 per year. The biofilter requires replacement of the media at approximately five-year intervals. The biofilter has lower operating costs, but a higher space requirement.

TABLE 4-2
ESTIMATED CAPITAL COST COMPARISON OF ODOUR CONTROL UPGRADE

Description	Replacement of Media	Sol-air Unit
Replacement of the existing steel support and media	$ 60,000	$ -
Sol-air unit	$ -	$ 37,500
Installation	$ -	$ 5,000
Electrical & SCADA	$ -	$ 10,000
Sub-total Construction	**$ 60,000**	**$ 53,000**
General contingency (25%)*	$ 15,000	$ 15,000
Engineering, legal, construction, financial, and admin cost (25%)*	$ 15,000	$ 15,000
Inflation (20%)*	$ 10,000	$ 10,000
TOTAL	**$ 100,000**	**$ 93,000**

4.2 Influent Flow Metering and Flow Distribution

The influent distribution chamber will have to be expanded in order to accommodate another outlet when the third oxidation ditch is constructed in future (estimated to occur around 2016 with Area D connected or 2020 if Area D is not connected – see Section 3.5.3). No improvements to the distribution chamber are proposed until that time.

Accurate monitoring of the influent flows would be beneficial for design of future improvements. The addition of a new influent flow meter is discussed below in Section 4.3.

4.3 Grit Removal

The current method of grit removal (i.e., switching the process flow to the standby oxidation ditch and then emptying and cleaning the former duty oxidation ditch) will no longer be viable when both of the oxidation ditches are required for continuous service. Construction of a dedicated grit removal system will reduce or eliminate the need to remove the oxidation ditches from service for grit removal.

The grit removal system should be located downstream of the screens, and upstream of the oxidation ditches. The record drawings of the plant show a designated area for the future grit removal system, located at the north side of the operations building. This location is suitable for the grit removal system in the current process. An influent flow meter (Parshall Flume) should be included when grit removal is added to the plant.

Two options for grit removal are discussed below. Both are assumed to include a grit washer/conveyor with discharge to a covered truck bin. Both options are assumed to be outdoors (no building). The first option would be to use a conventional gravity channel system, and the second option would be to use a vortex separator. Regardless of the option chosen, a grit distribution analysis should be done prior to detailed design. The

analysis can be done using the accumulated grit in the duty oxidation ditch. This analysis is important for detailed design of the grit removal system to achieve the desired result.

The design criterion for both of the grit systems was assumed to be 90% to 95% removal of 100 mesh grit with a specific gravity of 2.65. Note that this analysis should be revised if necessary after the grit distribution analysis recommended above.

4.3.1 Option 1: Gravity Channel Grit Removal

Gravity channel grit removal systems consist of concrete channels that utilize the force of gravity to separate grit from the screened influent. The concrete channels are designed to result in a retention time where the minimum size of grit determined in the grit distribution analysis can settle and remain in the channel. A mechanical grit collection system is installed at the bottom of channel to automatically remove the accumulated grit. The grit can then be washed and dewatered before it goes to the landfill. For the NWEC, two channels, each with dimensions of 1.5 m by 21.6 m and 2.1 m deep would be required to provide 5 minutes detention time.

Gravity grit removal channels would have a lower head loss than a vortex separator, but would have a larger space requirement. Cost estimates for a gravity grit removal system are shown in Table 4-3 in Section 4.3.3.

4.3.2 Option 2: Vortex Grit Separator

Vortex separator grit removal systems incorporate a cone-shaped chamber which utilizes centrifugal and gravitational force to separate the grit from the screened influent. The grit accumulated at the bottom of the chamber can be removed to a classifier by a suction pump; the use of a suction pump eliminates the need to create an underground chamber to allow installation of a grit conveyor beneath the cone. The grit can then be washed and dewatered before it is discharged to a truck bin and sent to the landfill.

An example of a vortex grit removal system is the Mectan Grit Chamber by John Meunier, model number JMD-6-50; this unit is capable of treating 30 MGD (113,500 m^3/day). The Metcan JMD-6-50 unit consists of two cylindrical chambers, i.e. upper chamber and a concentric central grit collecting chamber. The transition between the two is sloped to reduce head loss in the system. The upper chamber has a diameter of 5 m while the central grit collection chamber has a diameter of 1.5 m. The total depth of the unit is 5 m. The literature for the Metcan JMD-6-50 is attached in Appendix E. Odour should not be an issue since the grit is washed. A single vortex unit was assumed, since these units are not prone to failure and in any case a short term interruption of grit removal is not considered to be critical.

Advantages of vortex separators include a small space requirement and high removal efficiency. Disadvantages include higher head loss than gravity channels and the need for a deep excavation to accommodate the unit into the plant hydraulic profile. Cost estimates for the vortex system are included in Table 4-3 in Section 4.3.3.

4.3.3 Cost Estimates for Grit Removal Options

The estimated capital costs for grit removal Options 1 and 2 described above are compared in Table 4-3. The cost for including a Parshall Flume influent flow meter at the grit removal facility is included. As shown in Table 4-3, the capital cost of the vortex system ($645,000) is approximately 55% of the gravity channel system ($1,200,000). In addition, the vortex system has a smaller space requirement. The vortex system is recommended.

TABLE 4-3
CAPITAL COST COMPARISON OF GRIT REMOVAL SYSTEM

Description	Gravity Channel (2 units)	Vortex System (1 unit)
Site dewatering	$ -	$ 25,000
Concrete work + earthwork	$ 320,000	$ 120,000
Grit separator	$ 335,000	$ 120,000
Grit classifier	$ 50,000	$ 50,000
Parshall flume	$ 25,000	$ 25,000
Installation	$ 40,000	$ 15,000
Electrical & SCADA	$ 25,000	$ 25,000
Sub-total Construction	**$ 795,000**	**$ 380,000**
General Contingency (25%)	$ 175,000	$ 95,000
Engineering, Legal, Admin., etc. (25%)	$ 175,000	$ 95,000
Inflation (20%)	$ 140,000	$ 75,000
TOTAL	**$ 1,200,000**	**$ 645,000**

4.4 Trucked Liquid Waste

As noted earlier in this report, the existing pumper truck discharge station results in excess grit being discharged to the plant influent stream (see Section 3.4). Leveling of the existing truck pad is recommended, so that only liquid waste is discharged to the plant. An improved rock trap should also be added to the pumper truck discharge station. An allowance of $20,000 should be identified for these improvements.

4.5 Oxidation Ditch Process

As described earlier in this report, replacement of the Hoffman aeration blowers would reduce energy demand and improve process control, as well as reduce maintenance requirements. It is important that the new blowers be compatible with the long-term needs at the NWEC.

Aspirating mechanical (Flo-Jet) mixer/aerators were considered as an alternative to upgrading the existing diffused aeration and blower system. However, the manufactuer

does not recommend operation of this type of aerator/mixer with the air inlet completely closed. This means that the current strategy of alternating the process air on and off could not be undertaken with the Flo-Jet type mixer/aerators. Since alternating of the process air has several inherent advantages (power savings, recovery of alkalinity, foam control, improved effluent quality), use of this type of aerator is not recommended for the oxidation ditch process at the NWEC.

For reduced energy demand and improved control of oxidation ditch dissolved oxygen concentration, variable speed blowers are recommended; this will allow the air supply rate to be directly controlled by regulating blower speed (compared to damping of the blower intakes as currently practiced with the existing constant-speed centrifugal blowers). A comparison of blower types is presented later in Section 4.5.

4.5.1 Expansion Needs for Oxidation Ditch Process

For the purpose of this analysis, it was assumed that the MSR process reliability requirements would apply, and that a third oxidation ditch would have to be constructed when the service population reaches about 49,000 people (see earlier discussion in Section 3.5). An alternative to constructing a third oxidation ditch would be to add primary sedimentation tanks for the NWEC. Costs for these two options are presented later in Section 4.5.7.

4.5.2 Aeration Needs for Oxidation Ditch Process

The projected plant flows and aeration demands were estimated using the unit design criteria developed from Table 3-2 and Section 2.1.1. At the assumed ultimate design population of 75,000 people, the plant average dry weather flow (ADWF) will increase to about 37,500 m^3/d, and the maximum month flow (MMF) will increase to 54,000 m^3/d.

As noted on Section 2.1.1, the NWEC design parameters for aeration demand include an allowance for peak carbonaceous and nitrogenous oxygen demand; the design parameter for total oxygen demand is 5,000 kg/d per oxidation ditch. At a total oxygen demand of 5,000 kg/ditch, the two-ditch process would require 10,000 kg/d of oxygen. By extrapolation, the three-ditch process would require 15,000 kg/d.

4.5.3 Design Air Flow Requirement for Oxidation Ditches

Each of the two oxidation ditches should be supplied by a dedicated variable speed blower; each blower should be capable of supplying the single-ditch design oxygen demand of 5,000 kg/d. As noted earlier, the use of variable speed blowers will reduce energy demand and improve dissolved oxygen control in the oxidation ditch process. When the third oxidation ditch is required, a third duty blower for the oxidation ditch process would have to be purchased (unless primary sedimentation is added instead of constructing the third oxidation ditch – see Section 4.5.7).

The existing 250 HP centrifugal Lamson Blower can be retained as an emergency standby for the oxidation ditches (and for the aerobic digester – see Section 4.7). It should be noted that the Lamson Blower has limited capacity when supplying the oxidation ditch (see Lamson Blower curve). The oxidation ditch aeration header is running at about 7.6 psig with fairly new diffuser; this pressure is near to the pressure that will cause the Lamson Blower to surge (about 8.0 psig); and this means that using the Lamson Blower in parallel with the new variable speed blowers would reduce its effectiveness. However, since the Lamson blower would only need to be used as an emergency standby, this is not regarded as a serious drawback.

4.5.4 Blower Sizing for Oxidation Ditches

As noted earlier, the design oxygen supply for two oxidation ditches is 10,000 kg/d (5,000 kg/d per ditch). The performance and air requirements for the oxidation ditches

based on the oxygen transfer data provided by the diffuser manufacturer are shown in Table 4-4. The first column of Table 4-4 shows the range of air flow for a single diffuser according to the manufacturer's recommendations (i.e. from 1 to 4 standard cubic feet of air per minute for a single diffuser). The second column shows the standard oxygen transfer efficiency (SOTE) at the four air flow rates. The third column shows the standard oxygen transfer rate to clean water (SOR) for a single diffuser at the four air flow rates, and the fourth column shows the corresponding oxygen transfer rate per diffuser adjusted for wastewater conditions. Columns five and six show the total oxygen transfer to wastewater and the associated airflow required per oxidation ditch for 2,500 diffusers (future) and for 1,500 diffusers (existing).

TABLE 4-4
OXYGEN TRANSFER RATES FOR EXISTING DIFFUSERS

Diffuser Performance (Single Diffuser)				Total Actual Oxygen Transfer Rate (kg O_2/d)		Total Air Flow (SCFM)	
Air Flow (SCFM)[1]	Standard Oxygen Transfer Efficiency	Oxygen Transfer Rate (kg O_2/d)					
		Standard[2] (SOR)	Actual[3] (AOR)	2,500 diffusers	1,500 diffusers	2,500 diffusers	1,500 diffusers
1	33%	3.40	1.56	3,910	2,350	2,500	1,500
2	31%	6.35	2.97	7,302	4,380	5,000	3,000
3	29%	8.94	4.11	10,281	6,170	7,500	4,500
4	28%	11.50	5.29	13,230	7,940	10,000	6,000

[1] Manufacturer's recommended air flow per diffuser is from 1 to 4 standard cubic feet per minute (SCFM) for a single diffuser.

[2] Standard oxygen transfer rate (SOR) is the oxygen transfer into clean water under standard conditions adjusted for 4.5 m diffuser submergence.

[3] Actual oxygen site transfer (AOR) is the oxygen transfer into wastewater under site-specific conditions, where AOR is calculated according to equation 1.

$$\frac{AOR}{SOR} = \alpha\ \theta^{\,T-20}\left[BC^{*}_{SAT\,20}\left\{\frac{Psite}{Pstd}\right\}*\left\{\frac{Csuf\ \ T}{9.07}\right\} - D.O.\right] \quad \text{(Equation 1)}$$

For the purposes of this report, the following factors were assumed.

- Alpha (α) = 0.6
- Beta (β) = 0.98
- Theta (θ) = 1.024
- Dissolved Oxygen = 2.0 mg/L
- P_{SITE} = 14.46 psia
- Water Temperature = 20°C
- $C_{SAT\ 20°C}$ = 10.5 mg/L
- $C_{SURF\ T}$ = 9.07 mg/L

It was assumed that the conditions at the Campbell River site were the "standard" conditions of atmospheric pressure at sea level, 20°C, and 36% relative humidity.

According to Table 4-4, to provide each oxidation ditch with the design oxygen requirement of about 5,000 kg/d, an air flow of about 1.3 SCFM per diffuser would be required if 2,500 diffusers per ditch were installed, for a total of about 3,300 SCFM or 93 m^3/min per ditch. For the existing 1,500 diffusers per ditch, the air flow requirement would be about 3.3 SCFM per diffuser, which is relatively inefficient in terms of oxygen transfer and near the maximum allowable flow of 45 SCFM per diffuser (see Table 4-3). Both air flow rates are within the desired diffuser air flow range of 1 to 4 SCFM (Table 4-4). The lower rate associated with 2,500 diffusers is relatively efficient in terms of oxygen transfer, and it allows for higher air flow rates under emergency conditions (i.e., the air flow per diffuser can be increased well beyond 1.3 SCFM per diffuser, provided that the blowers can supply the needed air).

The existing oxidation ditch with 1,500 diffusers is adequate for current (2007) flows and loads. Air flow is not currently measured, but the air flow per diffuser is probably at or near the 3.3 SCFM per diffuser. When the second oxidation ditch is activated, the

oxygen demand in each ditch (and the required air flow per diffuser) will be greatly reduced. When increasing process loading causes air flow per diffuser with two ditches in service to increase beyond 2 SCFM, consideration should be given to installing the additional 1,000 diffusers in each ditch. (Note that the new turbo blowers recommended in Section 4.5.5 below include air flow monitors.) The estimated cost of installing the additional 1,000 diffusers in each ditch is $75,000 per ditch.

4.5.5 Blower Selection for Oxidation Ditches

There are various brands and configurations of blowers available on the market (e.g., centrifugal, turbo, and positive displacement types). The disadvantage of centrifugal blowers is the limited capacity for controlling the output air flow, particularly if damping of the air inlet is used as it is with the existing Hoffman blowers. Positive displacement (PD) blowers with variable speed drives allow precise control of air output without surging problems. Variable speed turbo blowers also often a much broader control over air output than centrifugal blowers. For the aeration upgrade at the NWEC, variable speed PD blowers and turbo blowers were considered as replacements for the existing centrifugal blowers.

For the purpose of this comparison, the Neuros NX150 turbo blower and the Aerzen 150S PD blower were selected as suitable units to replace the Hoffman blowers (see literature in Appendix E). The performance characteristics of these blowers are summarized in Table 4-5. As shown, the Neuros NX150 turbo blower with a 150 HP motor can supply about 3,595 SCFM, which meets the design requirement of 3,300 SCFM for a single oxidation ditch. For the Aerzen PD blower, a 250 HP motor would be required to meet the aeration needs of each oxidation ditch (Table 4-5). A cost comparison between the PD blower and the turbo blower is shown in Table 4-6.

TABLE 4-5
BLOWER PERFORMANCE

Blower Type	Blower Power (HP)	Air Supplied		Unit Footprint
		m^3/min	SCFM	
Turbo Blower	57	40	1,430	1.8 m x 0.8 m
	129	94	3,300	
	150	102	3,595	
PD Blower	225	75	2,650	2.5 m x 2.2 m
	250	100	3,740	
	300	150	5,300	

TABLE 4-6
CAPITAL COST COMPARISON OF PD AND TURBO BLOWERS

Description	PD Blower (3 units)	Turbo Blower (3 units)
Blowers	$ 225,000	$ 400,000
MCC VFD's	$ 300,000	Included
Piping & concrete modifications	$ 200,000	$ 200,000
Installation	$ 55,000	$ 45,000
Electrical & SCADA	$ 30,000	$ 30,000
Sub-total Construction	**$ 810,000**	**$ 675,000**
General contingency (25%)*	$ 205,000	$ 170,000
Engineering, legal, construction, financial, and admin cost (25%)*	$ 205,000	$ 170,000
Inflation (20%)*	$ 160,000	$ 135,000
TOTAL	**$ 1,380,000**	**$ 1,150,000**

Turbo blowers are recommended for the blower replacement at the NWEC, due to their lower cost, lower energy demand, quite operation and small footprint. Expansion of the blower building should not be required if turbo blowers are used; on the other hand, selection of PD blowers would require expansion of the blower building, due to the larger footprint of PD blowers and the need for individual sound enclosures (note that costs for building expansion are not included in Table 4-6). In addition, since the turbo blowers are supplied complete with on-board variable speed drives automated programmable controllers, expansion of the existing motor control centre (MCC) would not be required. Expansion of the MCC would be required if PD blowers were selected (space for MCC expansion in the existing building is minimal).

Variable speed turbo blowers are recommended, due to the lower costs, lower HP, and elimination of the need for building expansion. Three turbo blowers should be installed for the current operation; two can service the oxidation ditches, with the third temporarily supplying the aerobic digester (see Section 4.7.7). The new turbo blowers can be installed in place of the three existing Hoffman blowers. The Lamson blower can be retained as an emergency standby for both the oxidation ditches and the digester. The existing aeration piping will need to be modified to suit the new blower inlet and outlet locations. A suggested layout for the blower upgrade in the existing facility is shown on Figure 4-1.

4.5.6 Blower Controls

The new variable speed turbo blowers will have individual PLCs which will be tied into the existing plant SCADA system. Blower speed can be adjusted in hand mode on the SCADA system, and each blower control will be equipped with a Hand-Off-Auto selector switch. With the selector on Hand, the VFD speed will be controlled by the VFD speed potentiometer or VFD control panel. With the selector on Auto, the VFD will be controlled by the SCADA system with the oxic / anoxic cycle controls, and DO and ORP feedback loops. Recommendations for new oxygen and ORP sensors are included in Section 4.10.

An air flow sensor for each blower is also recommended. This will provide trending on the plant SCADA system of blower aeration delivery rates to the oxidation ditch and to the digester. The turbo blowers include on-board air flow monitors (the PD blowers do not include air flow monitors).

4.5.7 Cost Comparison of Third Oxidation Ditch vs. Primary Sedimentation

As noted earlier, an alternative to adding a third oxidation ditch when required due to increasing plant flows and loads would be to add primary sedimentation tanks, which

would reduce the BOD_5 loading to the oxidation ditch process by about 35%, and consequently allow servicing of the ultimate (75,000) population with the two existing oxidation ditches. The addition of primary sedimentation tanks would also allow future use of anaerobic digestion with recovery and combustion of biogas if desired. Anaerobic digestion for waste activated sludge without the addition of a significant quantity of primary sludge is problematic and is not recommended; therefore, the option of constructing the third oxidation ditch (no primary sedimentation) would not lend itself to future addition of anaerobic digestion. Conventional aerobic digestion could be continued with primary sedimentation, but the aerobic digester size and aeration requirements would have to be increased to accommodate the increased loading from primary sludge.

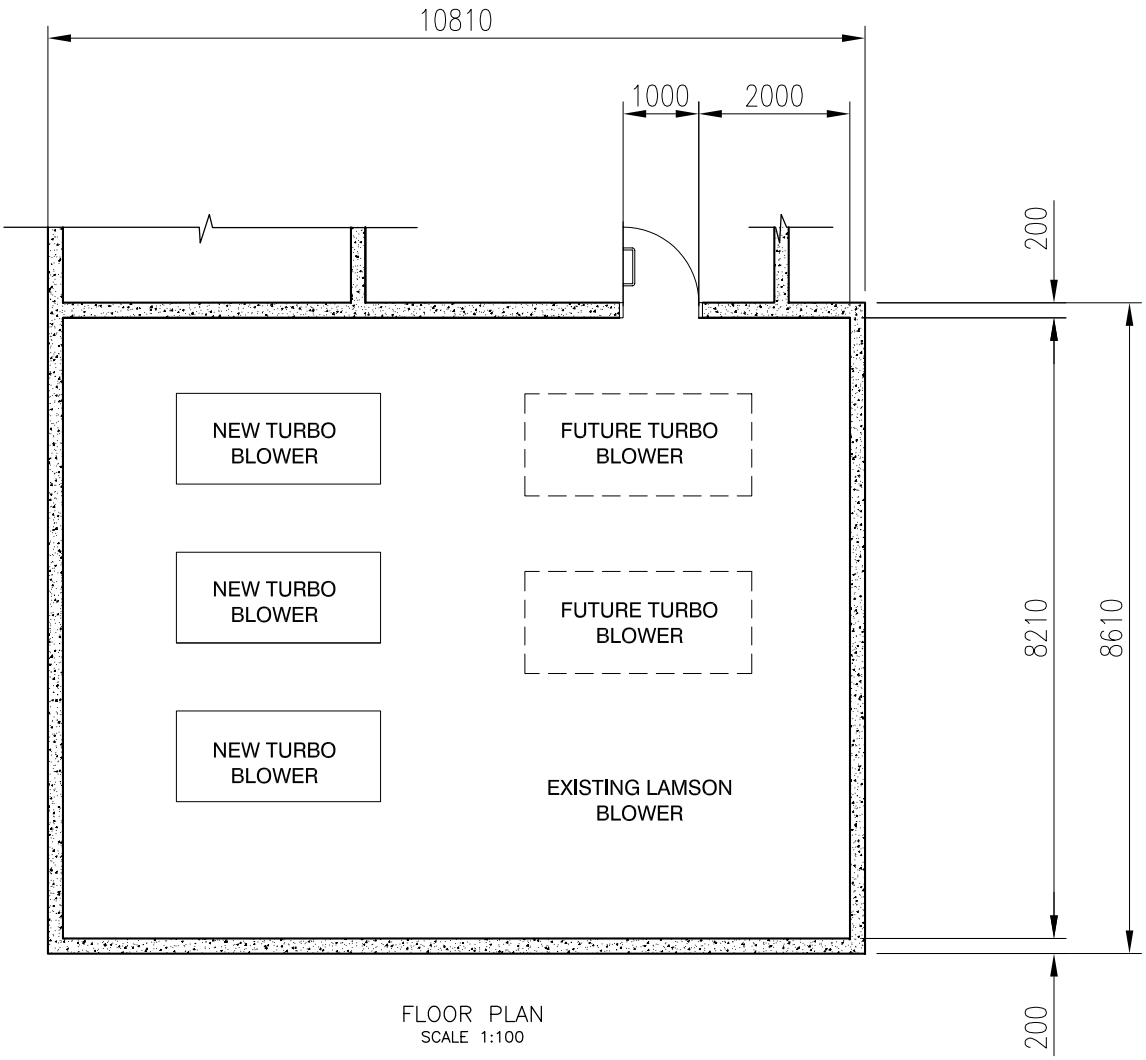
A cost estimate for construction of a third oxidation ditch of the same size and configuration as the two existing ditches is summarized in Table 4-7. The cost for adding primary sedimentation tanks (6 sedimentation channels, each 6 m wide by 35 m long) is summarized in Table 4-8 (see Appendix D for more detail). As shown, the capital cost of the third oxidation ditch is about $2.74 million, compared to about $4.35 million for primary sedimentation. The decision regarding which alternative is preferred need not be made until increasing plant flows and loads dictate improvements to the existing oxidation ditch process; as discussed earlier, this is not expected to occur until the service population reaches about 49,000 people (see Section 3.5.3). A service population of 49,000 people is not projected to occur until at least 2017, or possibly well beyond that date if Area D is not connected to the system and if growth is less than 3% annually (see Section 2.5).

TABLE 4-7
CAPITAL COST OF THIRD OXIDATION DITCH

Description	Capital Cost
Site dewatering	$ 150,000
Earthwork	$ 125,000
Concrete work	$ 40,000
Liner	$ 100,000
Diffusers (first 2,500 diffusers)	$ 150,000
Bridge	$ 20,000
Treated timber wall	$ 10,000
Mechanical mixer	$ 105,000
New turbo blower complete with VFD	$ 135,000
Piping and valving	$ 350,000
Influent distribution chamber modification	$ 250,000
Installation	$ 75,000
Electrical & SCADA	$ 100,000
Sub-total Construction	**$ 1,610,000**
General contingency (25%)*	$ 405,000
Engineering, legal, construction, financial, and admin cost (25%)*	$ 405,000
Inflation (20%)*	$ 320,000
TOTAL	**$ 2,740,000**

TABLE 4-8
CAPITAL COST OF PRIMARY SEDIMENTATION TANKS

Description	Capital Cost
Site dewatering	$ 100,000
Earthwork	$ 110,000
Concrete Work	$ 880,000
Mechanical Parts	$ 60,000
Scum and Primary Sludge Pumping	$ 1,000,000
Yard Piping	$ 250,000
Installation	$ 130,000
Electrical & SCADA	$ 25,000
Sub-total Construction	**$ 2,555,000**
General Contingency (25%)	$ 640,000
Engineering, Legal, Admin, etc. (25%)	$ 640,000
Inflation (20%)	$ 510,000
TOTAL	**$ 4,345,000**



FLOOR PLAN
SCALE 1:100

CITY OF CAMPBELL RIVER
NORM WOOD ENVIRONMENTAL CENTRE
BLOWER BUILDING LAYOUT
FOR TURBO BLOWERS

FIGURE 4-1

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DWG. No. 187.14.28

ACAD DWG.

FILE: P:\PROJWGS\CAMPBELL-RIVER\187-14-28\FIGURES\187.14.28 FIGURE 4-1 & 4-2.dwg 09-01-20 chong

4.6 Secondary Clarifiers

A third secondary clarifier is required in the immediate future as noted in Section 3.6. A fourth secondary clarifier will be required by around the year 2020 (depending on population growth). Both of the new clarifiers should be 32 metres in diameter (see discussion in Section 3.6). With the addition of the new clarifiers, an expansion of the return activated sludge (RAS) pumping station will also be required.

Construction of a new RAS/WAS pumping station to service new Clarifiers #3 and #4 is recommended. The new RAS pump station should be a duplicate of the existing RAS pump station. Two new WAS pumps (duty/standby) Worthington 6MF11B FR3A FPD-CI, with a capacity of 50 L/s at 6 m head and 7.5 HP and two new RAS pumps (duty/standby) Flygt Model NP-3153.181 type LT with a capacity of 128 L/s at 5.0 m head and 15 HP are recommended. The scum pump should be Flygt 3085-M with a capacity of 15 L/s at 5 m head and 2 kW.

The underwater metal work on both of the existing clarifiers exhibits significant corrosion at 10 years of age, and a total refurbishment or replacement of the metal work is required. Our understanding is that the City has obtained price quote of about $70,000 for refurbishing the underwater metal work in a single clarifier. This compares to a cost of approximately $330,000 for replacing the existing metal work with stainless steel. Refurbishment of the existing metal work is recommended.

The flow control weir box that divides flow to the secondary clarifiers will have to be modified to accommodate the new third and fourth clarifiers. Construction of a new weir box to service a total of four clarifiers is recommended. Mixed liquor leaving the oxidation ditches will flow into a distribution chamber in the new weir box, and exit via overflow weirs dedicated to each secondary clarifier. Since the water surface and weir elevations are the same for each clarifier, the proportion of the flow that is sent to each clarifier is dictated by the length of the weir. The twin new 32 metre diameter clarifiers

will each have a surface area of about 800 m^2, compared to 570 m^2 for each of the two existing 27 m diameter clarifiers. The overflow weirs to the new clarifiers will therefore be about 1.4 times longer than those for the existing clarifiers.

As soon as the third clarifier is constructed, the existing clarifiers can be taken out of service one at a time for refurbishment. The refurbishment should be done during low flow conditions. A cost estimate for construction of the third 32 metre diameter clarifier, including the new weir box and RAS pumping station, is shown in Table 4-9. The estimated total capital cost including yard piping is about $4.0 million; this cost includes several of the elements needed for the future fourth clarifier, including RAS/WAS pumps and some of the yard piping. Future addition of the fourth clarifier (around 2020) would cost an additional $2.7 million (Table 4-9).

The cost of a third 27 m diameter clarifier instead of the 32 m diameter clarifier described in Table 4-9 (including RAS/WAS pumping station as well as engineering and contingencies) would be about $3.46 million, or $540,000 (14%) less than the 32 m diameter clarifier. Similarly, a fourth 27 m diameter clarifier would cost about $540,000 less than a 32 m diameter unit (2008 dollars). However, selection of 27 m diameter Clarifiers #3 and #4 would result in the eventual need for a fifth 27 m diameter clarifier to serve the ultimate population of 75,000 people. Therefore, construction of two new 32 m diameter clarifiers is recommended.

TABLE 4-9
CAPITAL COST OF 32 m DIAMETER THIRD AND FOURTH CLARIFIERS

Description	3rd Clarifier	4th Clarifier
Site dewatering	$ 75,000	$ 75,000
Earthwork	$ 100,000	$ 100,000
Concrete	$ 770,000	$ 770,000
Flow splitter box	$ 250,000	$ -
Internal clarifier - Mechanical	$ 355,000	$ 355,000
RAS pumps	$ 45,000	$ -
WAS pumps	$ 35,000	$ -
Scum pump	$ 20,000	$ -
New RAS/WAS pump station	$ 250,000	$ -
Sludge level sensor	$ 10,000	$ 10,000
New piping & valving (750mm)	$ 100,000	$ 135,000
New piping & valving (450mm)	$ 150,000	$ 45,000
New piping & valving (150mm)	$ 25,000	$ 5,000
New piping & valving (200mm)	$ 55,000	$ 10,000
Installation	$ 80,000	$ 55,000
Electrical & SCADA	$ 30,000	$ 30,000
Sub-total Construction	**$ 2,350,000**	**$ 1,590,000**
General contingency (25%)*	$ 590,000	$ 400,000
Engineering, legal, construction, financial, and admin cost (25%)*	$ 590,000	$ 400,000
Inflation (20%)*	$ 470,000	$ 320,000
TOTAL	**$ 4,000,000**	**$ 2,710,000**

4.7 Effluent Flow Monitoring

As noted in Section 3.7 of this report, the existing parshall flume flow monitor is near capacity. To facilitate connection of the new third clarifier (and future fourth clarifier) to the effluent flow monitor and to minimize disruption during construction, twinning of the existing parshall flume flow monitor is recommended; a cost estimate for this work is shown in Table 4-10.

TABLE 4-10
ESTIMATED CAPITAL COST OF TWIN PARSHALL FLUME

Description	Capital Cost
Earthwork and concrete work	$ 85,000
Parshall flume and level sensor	$ 10,000
Installation	$ 10,000
Electrical & SCADA	$ 25,000
Sub-total Construction	**$ 130,000**
General contingency (25%)	$ 32,500
Engineering, legal, construction, financial, and admin cost (25%)*	$ 32,500
Inflation (20%)	$ 25,000
TOTAL	**$ 245,000**

4.8 Aerobic Digester

4.8.1 Digester Capacity

The design loading to the aerobic digester developed earlier in Section 3.8 shows that the digester will have to be expanded by around 2010. Two parallel identical basins are recommended, so that half of the digester can be removed from service for maintenance (e.g. for replacement of diffuser membranes or repair of aeration piping). Twinning of the digester will also meet the MSR process reliability requirements for aerobic digesters.

Two options are possible for expanding the digester. One option would be to construct a second (6,000 m^3) earthen basin identical to the existing basin. A second option would be to construct two identical concrete tanks on the site of the existing digester. The concrete tank option is recommended for the following reasons:

- reduced process footprint;
- improved mixing characteristics; and
- facilitates installation of submerged mechanical mixers, which will allow air-on/air-off operation similar to oxidation ditches.

The design volume of the digester could be significantly reduced if thickening of the WAS stream prior to digestion were undertaken; this would require the construction of a WAS thickening building. Thickening of the WAS to about 3% TS by weight would reduce the required digester volume to about 25% of that required for digestion of unthickened WAS at 0.75% TS. Potentially suitable thickening technologies include rotating drum thickeners or a gravity belt thickeners; both are capable of producing 3% to 5% solids concentration from a 0.75% feed solids concentration. A total of three gravity belt thickeners (2 m nominal belt width) would be required for the future design population of 75,000, with two units as duty and one as standby. One rotating drum thickener (1.37 m diameter by 2.87 m long) would be required for the future design population of 75,000, with an additional unit installed as a standby. Rotating drum thickeners are recommended over gravity belt thickeners, due to the reliability and mechanical simplicity, low power demand, and small space requirement of drum thickeners.

Regardless of the digester configuration, an on-line solids density probe linked to the plant SCADA system should be installed on the WAS line(s) leading to the aerobic digester; this will allow accurate trending of plant solids yield. Costs for solids density probes are included in Section 4.11.

4.8.2 Aeration Needs for Aerobic Digester

The aeration requirements for the aerobic digester as set out on the NWEC design drawings specify a total aeration requirement of 2,360 L/s (5,000 SCFM) for the existing 6,000 m^3 basin. A total of 2,000 diffusers are currently installed. Diffused air is used to provide both aeration and mixing. As described in Section 3.4, the air required for stabilization of solids is less than the amount needed to ensure adequate mixing. Provision of excess air for mixing results in an operating dissolved oxygen (DO) concentration higher than the recommended value of 2 mg/L; this in turn results in excess

use of energy for provision of blower air, and it also tends to create acidic conditions in the digester, which in turn increases lime use for pH control.

The addition of mechanical mixing to the digester would allow reduction of diffused air to the amount required for stabilization of solids. This improvement would allow better control of dissolved oxygen concentration, and it would also allow the digester to be operated using an air-on/air-off cycle similar to the oxidation ditches. The air-on/air-off operation would enhance digester performance, reduce lime consumption due to recovery of alkalinity by denitrification, and reduce digester energy consumption.

The use of aspirating mechanical mixers (e.g. Flo-Jet or similar) was considered for the aerobic digester, but was not pursued because the manufacturer does not recommend operating these units with the air intake fully closed (i.e., an air-off cycle with full mixing would not be possible).

Upgrading the aeration/mixing system in the existing aerobic digester could potentially be undertaken by using submersible aerator/mixer units, which are similar to submersible pumps. Aeration is provided by supplying compressed (blower) air into the unit via a flexible rubber hose. Continuous mixing could be undertaken while the air supplied from the blower can be shut-off or controlled to achieve the desired operating DO level. Use of submersible aerator/mixers means that the diffuser membranes would no longer needed. However, use of this type of aerator was not further pursued, due to a lack of available information on current reference installations.

It is recommended that aeration using fine bubble diffused air be continued for the digester, with the addition of submerged mechanical mixers. Two options for the digester expansion were developed, assuming that twin concrete tanks would be used as described below.

4.8.3 Option 1: Digestion of Unthickened WAS

Option 1 would be to construct two parallel 6,000 m^3 concrete tanks in the same location as the existing earthen basin. The existing aeration diffusers would be relocated to one of the new concrete tanks. An additional 2,000 aeration diffusers would have to be purchased to service the second tank. Flygt or other suitable submersible mechanical mixers would be installed in each tank to provide independent mixing. For the purpose of this analysis Flygt Model SR4430 mixers with 6.2 HP motors were identified as suitable (see literature in Appendix E).

As discussed in Section 3.8, the aeration requirement for solids stabilization in the digester is about 3,320 m^3/hr, increasing to 6,670 m^3/hr for the ultimate 75,000 population. As discussed in Section 4.5.4, the 150 HP turbo blowers recommended for the oxidation ditch can each supply about 6,120 m^3/hr (3,600 SCFM). The third 150 HP turbo blower recommended in Section 4.5.5 therefore has the capacity to supply the aeration needs for the twinned aerobic digester until the third oxidation ditch is constructed (around 2017 to 2021 – see Section 3.5.3), at which time a fourth turbo blower will be required. One of the four 150 HP turbo blowers would then be adequate to continue to supply the aeration needs of the twinned aerobic digester until the VSS loading increased to the point where the aeration need exceeded 6,120 m^3/hr (estimated to occur around 2033 – see Table 3-6 in Section 3.8.4), provided that supplemental mechanical mixing were supplied. Depending on the need at that time, a fifth turbo blower may have to be installed. A cost estimate for Option 1 is shown in Section 4.7.5.

4.8.4 Option 2: WAS Thickening Prior to Digestion

Option 2 would be similar to Option 1, except that WAS thickening would be added to reduce the required volume of the digester to about 25% of that required for Option 1 (see earlier discussion in Section 4.7.1). Aeration needs for solids stabilization would be the

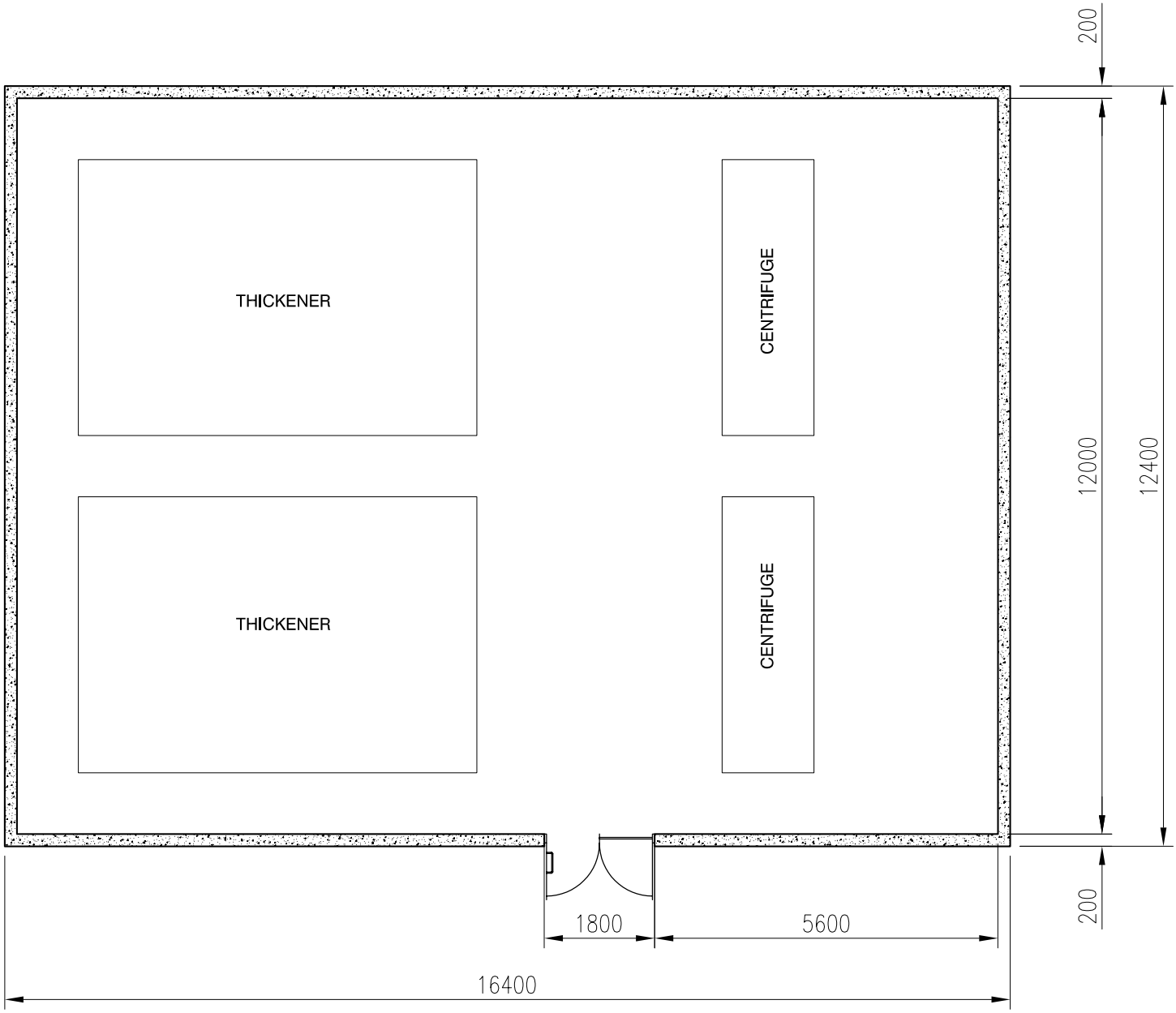
same as for Option 1. Mixing horsepower requirements would also be similar (i.e., the smaller basin volume would be offset by the higher density of the process liquid).

4.8.5 Cost Estimates for Digester Options

Cost estimates for Options 1 and 2 are shown in Table 4-11. Option 2 (addition of WAS thickening) is recommended, due to the lower capital cost (about $3.1 million compared to $4.3 million for Option 1) and smaller digester footprint. Option 2 will also produce a thicker stream of digested biosolids for discharge to the storage basin (or for biosolids dewatering if selected). A floor plan for the WAS thickening facility (in conjunction with biosolids dewatering – see Section 4.8) is illustrated on Figure 4-2.

TABLE 4-11
CAPITAL COST COMPARISON OF DIGESTER UPGRADE

Description	Option 1 Unthickened WAS	Option 2 WAS Thickening
Earthwork	$ 240,000	$ 80,000
Concrete	$ 1,825,000	$ 640,000
Rotating Drum Thickener	$ -	$ 195,000
Mechanical mixers	$ 45,000	$ 45,000
Aeration diffusers	$ 150,000	$ 150,000
Piping and valving	$ 200,000	$ 200,000
Thickener building	$ -	$ 400,000
Installation	$ 40,000	$ 60,000
Electrical & SCADA	$ 30,000	$ 30,000
Sub-total Construction	**$ 2,530,000**	**$ 1,800,000**
General Contingency (25%)	$ 635,000	$ 450,000
Engineering, Legal, Admin., etc. (25%)	$ 635,000	$ 450,000
Inflation (20%)	$ 505,000	$ 360,000
TOTAL	**$ 4,305,000**	**$ 3,060,000**



FLOOR PLAN
SCALE 1:100

CITY OF CAMPBELL RIVER

NORM WOOD ENVIRONMENTAL CENTRE

WAS THICKENING AND BIOSOLIDS DEWATERING BUILDING

FLOOR PLAN

FIGURE 4-2

ACAD DWG.

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CONSULTING ENGINEERS
DRAWN BY: CWW
DWG. No. 187.14.28

FILE: P:\ PRODWGS\ CAMPBELL-RIVER\ 187-14-28\ FIGURES\ 187.14.28 FIGURE 4-1 & 4-2.dwg 09-01-20 chong

4.9 Biosolids Handling

As discussed earlier, digested biosolids are currently stored temporarily in liquid form in the biosolids storage basin before being applied to the onsite poplar plantation. An alternative to the current system would be to add mechanical dewatering of the digested biosolids; this would eliminate problems associated with the existing liquid biosolids storage basin, and it would also reduce transportation and land application costs the onsite plantation and/or for other potential future options (see Section 3.9 for additional discussion).

Centrifuges are currently in common use in B.C. for dewatering of digested biosolids. Centrifuges are effective in dewatering biosolids to 20% to 30% total solids; if lower moisture content is required, other technologies can be used (e.g., plate press, or driers). Advantages of centrifuges include a relatively small footprint, low odour generation and minimal housekeeping problems (e.g., splatter, aerosols). A capital cost estimate for the construction of a centrifuge dewatering facility at the NWEC is shown in Table 4-12. Two centrifuges were assumed, each with sufficient capacity for a service population of 75,000 people. A typical floor plan is included on Figure 4-2.

TABLE 4-12
CAPITAL COST OF CENTRIFUGE DEWATERING FACILITY

Description	Capital Cost
Building	$ 275,000
Centrifuge	$ 420,000
Polymer system	$ 50,000
Sludge feed pumps	$ 35,000
Dewatered sludge pumps	$ 35,000
Storage bin	$ 50,000
Truck loading bay	$ 20,000
Piping and valving	$ 80,000
Installation	$ 60,000
Electrical & SCADA	$ 30,000
Sub-total Construction	**$ 1,055,000**
General contingency (25%)*	$ 265,000
Engineering, legal, construction, financial, and admin cost (25%)*	$ 265,000
Inflation (20%)*	$ 210,000
TOTAL	**$ 1,795,000**

4.10 Electrical Upgrades

A new 800 kW dedicated diesel genset should be installed at the plant to provide standby power in the event of a power outage. The 800 kW is based on the total power requirement from all of the mechanical equipments, both existing and proposed, as shown in Table 4-13 below. The capital cost of the genset is estimated below in Table 4-14. A new transfer switch will also be required at an additional cost of $100,000 for a total cost of about $1.1 million (including allowances).

TABLE 4-13
ESTIMATED TOTAL POWER REQUIREMENT FOR GENSET UPGRADE

Item	Amount of Unit	HP per unit	Total HP	Total kW
Mechanical screen	2	2	4	3
Odour control system	1	2	2	1.5
Vortex grit separator	1	2	2	1
Grit classifier	1	2	2	1
Secondary clarifier	4	2	8	6
RAS pump	4	14	55	41
WAS pump	4	8	30	22
Scum pump	2	2	4	3
Mixer SR4650	4	8	33	25
Mixer SR4430	6	6	37	28
Turbo blower	4	150	600	448
Rotating drum thickener	1	2	2	1
Centrifuge	1	90	90	67
UV system - lamp	320	0.2	70	53
Total			938	700

TABLE 4-14
ESTIMATED CAPITAL COST OF GENSET UPGRADE

Description	Capital Cost
New 800 kW genset	$ 355,000
Genset building	$ 125,000
Installation	$ 45,000
Electrical & SCADA	$ 25,000
Transfer Switch	$ 100,000
Sub-total Construction	**$ 650,000**
General contingency (25%)*	$ 165,000
Engineering, legal, construction, financial, and admin cost (25%)*	$ 165,000
Inflation (20%)*	$ 130,000
TOTAL	**$ 1,110,000**

4.11 Administration Building

The administration building should be expanded to incorporate a new lunchroom and kitchen area, and a new men's washroom with three shower stalls and lockers. The existing men's room can then be converted to a ladies washroom and shower room.

Based on the previous geotechnical investigation (Section 3.11), it is not recommended to upgrade the operating building with a second floor. A new lunch room and kitchen area and washroom with showers, and laundry area should be constructed at grade. The proposed location to build the additional areas is next to the laboratory, on the north side of the operating building. This area was chosen with the future expansion of the treatment facilities in mind. There is a possibility of expanding the screen room to accommodate future flow increases (see Section 4.1).

All rooms in the administration building are equipped with fire sprinkler systems with the exception of the blower room and the headworks. A recent fire inspection recommended that these two area also be supplied with sprinkler systems.

Cost estimates for improvements to the administration building are shown in Table 4-15. An additional allowance of $100,000 should be identified for constructing the building on piles if this is recommended by the updated geotechnical investigation (see Section 4.13).

TABLE 4-15
CAPITAL COST OF ADMINISTRATION BUILDING EXPANSION

Description	Capital Cost [1]
Lunch room (27 m^2)	$ 70,000
Meeting room (12 m^2)	$ 30,000
Wastewater foreman's office (9 m^2)	$ 25,000
Male lavatory (21 m^2)	$ 55,000
Corridor (12 m^2)	$ 30,000
Sub-total Construction	**$ 210,000**
General contingency (25%)*	$ 55,000
Engineering, legal, construction, financial, and admin cost (25%)*	$ 55,000
Inflation (20%)*	$ 40,000
TOTAL	**$ 360,000**

[1] assumed cost $2,500 / m^2

4.12 Instrumentation Upgrade

The existing sensors for measuring dissolved oxygen (DO) concentration and oxidation reduction potential (ORP) in the oxidation ditches have reached the end of their design life, and need to be replaced. The new sensors should be mounted on swing-up wands for ease of inspection and cleaning; this will eliminate the need for the process monitoring pumping loop with macerator pump. The cost of replacing the DO and ORP monitors for the two oxidation ditches as well as the cost of installing DO and ORP monitors for the twinned aerobic digester are shown in Table 4-16. Costs for adding online monitors for monitoring the pH and operating mixed liquor suspended solids concentration in the oxidation ditches and the digester, as well as solids density probes for the WAS lines are also shown.

TABLE 4-16
CAPITAL COST OF INSTRUMENTATION

Description	Oxidation Ditches (2)	Aerobic Digesters (2)	WAS line (2)
New DO meter	$ 10,000	$ 10,000	$ -
New ORP meter	$ 5,000	$ 5,000	$ -
New pH meter	$ 5,000	$ 5,000	$ -
New Suspendid Solids meter	$ 15,000	$ 15,000	$ -
New solids probes for WAS pump discharges	$ -	$ -	$ 15,000
Installation	$ 5,000	$ 20,000	$ 20,000
Electrical & SCADA	$ 5,000	$ 5,000	$ 5,000
Sub-total Construction	**$ 45,000**	**$ 60,000**	**$ 40,000**
General contingency (25%)*	$ 10,000	$ 15,000	$ 10,000
Engineering, legal, construction, financial, and admin cost (25%)*	$ 10,000	$ 15,000	$ 10,000
Inflation (20%)*	$ 10,000	$ 10,000	$ 10,000
TOTAL	**$ 75,000**	**$ 100,000**	**$ 70,000**

[1] dissolved oxygen analyzer: Royce model 9100-2-2-1-1-1-1-1, includes 95A-1-3-1-1-6-1-1 sensor and Royce 58060 jet head assembly to fit 95A probe – two in oxidation ditches and two in digester tanks

[2] ORP analyzer: ATI model Q45R-2-1-1, includes Q25-R1-1-1 platinum sensor – two in oxidation ditches and two in digester tanks

[3] pH analyzer: ATI model Q45P-2-1-1, includes Q25-P2-1-1 sensor – two in oxidation ditches and two in digester tanks

[4] suspended solids analyzer: Royce model 7011A-2-2-1-1-1, includes 73B-1-2-2-1 sensor – two in oxidation ditches and two in digester tanks

[5] solid analyzer for WAS line = Endress & Hauser TurbiMax WCUS41/CUS41-W with Liquisys MCUM5 223/253 Transmitter – WAS lines at RAS/WAS pump stations

4.13 Potential Future Disinfection

Disinfection of the effluent prior to discharge to Discovery Passage may be required in future, if the need is identified by ongoing environmental monitoring (see Section 3.7). A suggested location for a disinfection system using UV light is identified on Figure 5-1 in Section 5. A cost estimate for adding UV disinfection at the NWEC to serve the ultimate (75,000) population is shown in Table 4-17.

TABLE 4-17
CAPITAL COST OF UV DISINFECTION SYSTEM

Description	Capital Cost
Site dewatering	$ 50,000
Earthwork and concrete work	$ 85,000
Jib crane system	$ 5,000
UV package system	$ 450,000
Installation	$ 45,000
Electrical & SCADA	$ 25,000
Sub-total Construction	**$ 660,000**
General Contingency (25%)	$ 165,000
Engineering, Legal, Admin., etc. (25%)	$ 165,000
Inflation (20%)	$ 130,000
TOTAL	**$ 1,120,000**

4.14 Plant Hydraulics

The hydraulic profile contained in the original design drawings was used to assess the hydraulic capacity of the plant treatment units and interconnecting piping, and to identify potential bottlenecks.

Plant operations staff report that the clarifier weirs are occasionally submerged at peak flows; this indicates that there may be a bottleneck downstream of the weirs. No hydraulic bottlenecks were identified, including the piping and appurtenances downstream of the clarifier weirs; however, it must be emphasized that the drawing used is not a record drawing, and the elevations shown may not reflect actual as-constructed values. A survey to produce a record drawing of the plant hydraulic profile should be undertaken as an initial component of detailed design.

4.15 Geotechnical

As discussed earlier in Section 3.11, soil conditions on the NWEC are subject to liquefaction during earthquake. In addition, new (updated) building codes have come into effect since the NWEC was constructed. An update to the previous geotechnical investigation should be conducted, with a minimum of three test holes drilled under proposed new structures (administration building expansion, new secondary clarifier, expanded digester). An allowance of $40,000 for the geotechnical investigation should be identified.

4.16 Reclaimed Water

A system to use reclaimed effluent for non-potable applications at the NWEC should be considered. The system would include a small disinfection facility and clearwell with pump and distribution piping. This should be included in the next major upgrade at the plant. An allowance of $300,000 for design and construction of this system should be identified.

5.0 RECOMMENDATIONS AND PRIORITIES FOR PLANT IMPROVEMENTS

5.1 Conclusions

The following conclusions are based on the analysis in this report:

1. The sewer collection system servicing the NWEC is subject to excessive inflow and infiltration (I&I) during wet weather. In particular, there appears to be a significant source of inflow in the downtown area. Manual operation of the pumps at PS #11 can also cause high peak flows at the plant. High wet weather flows have a detrimental impact on plant performance due to the resulting peak hydraulic loads.

2. The projected plant flow and mass loading of BOD_5 and TSS that were developed for assessing upgrade needs in this study were based unit criteria derived from historic plant data, with an assumed population growth of 3% per annum. Expansion of the plant service area (e.g., to incorporate Area D) is also possible in the short-term future. If population growth is less than 3% per annum and/or if the service area is not expanded, then the schedule for some of the recommended plant improvements may be revised (see Recommendations in Section 5.2).

3. The existing plant influent automated bar screen is subject to occasional short-term clogging caused by slug loads of debris, possibly from pumper truck

discharges. The automated rake that cleans the screen cannot react quickly enough to clear the slug loads of debris; this results in overflows to the bypass channel, with consequent clogging of the manually raked screen and overflows of raw sewage in the screenings room. High flows also force some debris through the 10 mm gaps between the bars, with resulting problems downstream. Installation of a continuously cleaned 6 mm perforated plate screen would eliminate overflows and improve screen performance. A third screen will be required when the service population reaches about 53,000 people; addition of the third screen will require expansion of the headworks building.

4. The oxidation ditch process at the NWEC (currently operating with a single bioreactor in service) has been loaded well beyond its theoretical design capacity for the past several years. The estimated 2007 service population was about 32,400 people, compared to the design population of 26,000 people for a single oxidation ditch. The recorded maximum month flow in 2007 was about 1.5 times the design value for a single oxidation ditch, and the 2007 maximum month BOD_5 load was about 1.2 times the design value. Despite the high process loading, the NWEC continues to produce a high-quality effluent (average effluent concentrations of BOD_5 and TSS in 2007 were 15 mg/L and 11 mg/L, respectively). The ultimate capacity of the oxidation ditch process at the NWEC cannot be stated with certainty. When the process loading approaches the ultimate capacity, stress on the existing process will be signaled by a consistent increase in the plant effluent concentration of BOD_5. In light of current process loading, it can be assumed that the second oxidation ditch will have to be activated in the near future if the City's population continues to increase, or if the service area is expanded (e.g., connection of Area D to the City sewer system). When the second oxidation ditch is brought into continuous service, the consequences will be as follows:

a. the current method of grit removal (i.e., periodic switching of the duty and standby oxidation ditches to allow removal of accumulated grit) will no longer be viable; and
b. the second oxidation ditch will no longer be available as a back-up aerobic digester.

5. The existing process monitors for dissolved oxygen and oxidation reduction potential in the oxidation ditches have reached the end of their design life, and need to be replaced. These monitors benefit process operation by allowing automated control of the plant blowers to minimize energy consumption. The addition of on-line monitors for process liquid pH would also be beneficial. (Similar monitors added to the aerobic digester would help to optimize process performance.)

6. Assuming that the process reliability standards set out in the provincial Municipal Sewage Regulation (MSR) apply, a third oxidation ditch (identical to the two existing basins) will be required when the service population reaches about 49,000 people; the third ditch will be adequate for the projected ultimate service population of 75,000 people (again assuming that the MSR process reliability standards apply).

7. Additional aeration diffusers for the oxidation ditches are not required at this time. Monitoring of the air flow to each oxidation ditch will indicate when the new diffusers are required (see Recommendations in Section 5.2).

8. The existing constant speed, centrifugal aeration blowers that supply process air to the oxidation ditches (and to the aerobic digester) are relatively inefficient in terms of energy consumption. Replacement of the centrifugal blowers with modern variable speed turbo blowers would significantly reduce energy consumption at the plant. (A separate study is currently underway to quantify

potential energy savings; pending the results of the study, funding assistance may be available from B.C. Hydro for replacement of the plant blowers.)

9. An alternative to adding a third oxidation ditch when the service population reaches 49,000 people (Item 6 above) would be to add primary sedimentation tanks; this would bring the capacity of the NWEC to 75,000 people without expanding the oxidation ditch process. The addition of primary sedimentation would also allow use of anaerobic digestion with biogas recovery and use for heating and generation of electrical power. However, the addition of primary sedimentation would have a significantly higher capital cost than addition of a third oxidation ditch. Selection of the preferred alternative does not need to be made until the service population approaches 49,000 people (not projected to occur until at least 2017, and possibly later depending on population growth).

10. The two existing secondary clarifiers are adequate for current plant flows, provided that both are continuously in service. However, if one of the existing clarifiers were to fail during high wet weather flows at the plant, the loading on the remaining clarifier would be well beyond its design capacity; this could result in large amounts of the process biological solids being carried over the effluent weirs, resulting in violation of the effluent limits set out in the Operational Certificate, and possibly an extended period of poor process performance while the lost biological solids regenerate. A third clarifier is needed in the immediate future, to provide emergency standby capacity; this will also allow the two existing clarifiers to be sequentially removed from service for refurbishing of the (corroded) interior metal components and inspection and maintenance of the rake drive mechanisms. Addition of the third clarifier will require the construction of a new pumping station for return activated sludge (RAS) and waste activated sludge (WAS); this pumping station can also accommodate a fourth (future) clarifier, which will be required when the service population reaches about 53,000 people.

11. If the third and fourth secondary clarifiers (Item 9 above) are 32 meters in diameter, this will increase the surface area by about 40% compared to the existing 27 metre diameter clarifiers. The cost premium for the larger clarifiers would be about 17%. Construction of the larger clarifiers would also avoid the need for a fifth clarifier to serve the ultimate population of 75,000 people.

12. The existing plant effluent (parshall flume) flow monitor is near capacity at peak flows.

13. The existing drawing of the plant hydraulic profile is not a record drawing and the elevations shown may not be accurate.

14. The existing plant outfall is more than adequate for the ultimate service population, provided that additional diffuser ports are opened as required.

15. The existing aerobic digester consists of a single (earthen) basin. In the event that the digester has to be removed from service (e.g., for periodic replacement of the aeration diffuser membranes or repair of aeration piping), the second (standby) oxidation ditch can function as a temporary standby digester. However, the second oxidation ditch is expected to be activated in the near future for continuous duty in the liquid treatment process (see Item 4 above). Twinning of the digester will then be required, to provide standby capacity (i.e., two parallel treatment reactors so that process operation can continue while one reactor is out of service for maintenance). The digester process volume will also have to be expanded in the near future, to address increasing plant organic loading. Reconstruction of the digester as two (parallel) concrete basins would greatly reduce the process footprint, and it would also facilitate the installation of submerged mechanical mixers and improve mixing characteristics (see Item 16 below).

16. The current method of method of using diffused air to supply mixing energy as well as process oxygen to the aerobic digester results in excess consumption of energy. The addition of submerged mechanical mixers to the digester would allow a significant reduction in energy consumption for blower air, since the air flow requirement for mixing greatly exceeds that for process oxygen supply. The addition of mechanical mixers would also allow the digester air to be turned on and off on a timed cycle to promote denitrification (similar to the strategy currently employed for the oxidation ditch process); this would further reduce the process air requirement, and it would also reduce lime addition for pH control by recovering alkalinity.

17. The addition of mechanical thickening of waste activated sludge (WAS) in advance of digestion would allow a significant (75%) reduction in the required process volume of the aerobic digester, and would result in a significant capital cost saving for the digestion upgrade.

18. The current method of estimated production of WAS and of digested biosolids is based on grab samples, and as such is subject to significant errors. The addition of on-line sludge density probes on the WAS piping would allow accurate trending of WAS production.

19. The amount of biosolids that is land applied to the onsite poplar plantation is less than the estimated annual biosolids production at the NWEC; this may be due in part to the method of application (see Item 18 below). Sampling to accurately determine the amount of biosolids currently held in the storage basin is difficult, due to the covering mat of vegetation. It appears that gravity thickening of the stored solids is less effective than originally anticipated. Mechanical thickening of WAS prior to digestion (see Item 15 above) would result in a thicker digested product as well, and should increase the capacity of the storage basin.

20. The current method of land applying liquid biosolids on the poplar plantation limits the amount that can be annually applied, due to excessive accumulation of soil moisture associated with application of the biosolids slurry. Dewatering of the biosolids prior to application would eliminate this complication, and should also reduce annual application costs. A biosolids “flinger” for applying dewatered product is reported to be located in the Nanaimo area and may potentially be available to the City on a contract basis.

21. The existing biosolids land application site is nearing the end of its life, due to accumulation of the limiting metal (copper) in the soil. An expansion of the existing land application site or an alternative method of biosolids use is needed in the immediate future.

22. The trucked liquid waste receiving station does not have an adequate rock trap, and the inclined truck ramp tends to increase the amount of rocks and other debris that is discharged from the trucks.

23. The existing genset at the NWEC does not have the capacity to provide the necessary power to continue operation of the plant aeration blowers in the event of a power outage.

24. The existing administration building is not adequate for current staff needs.

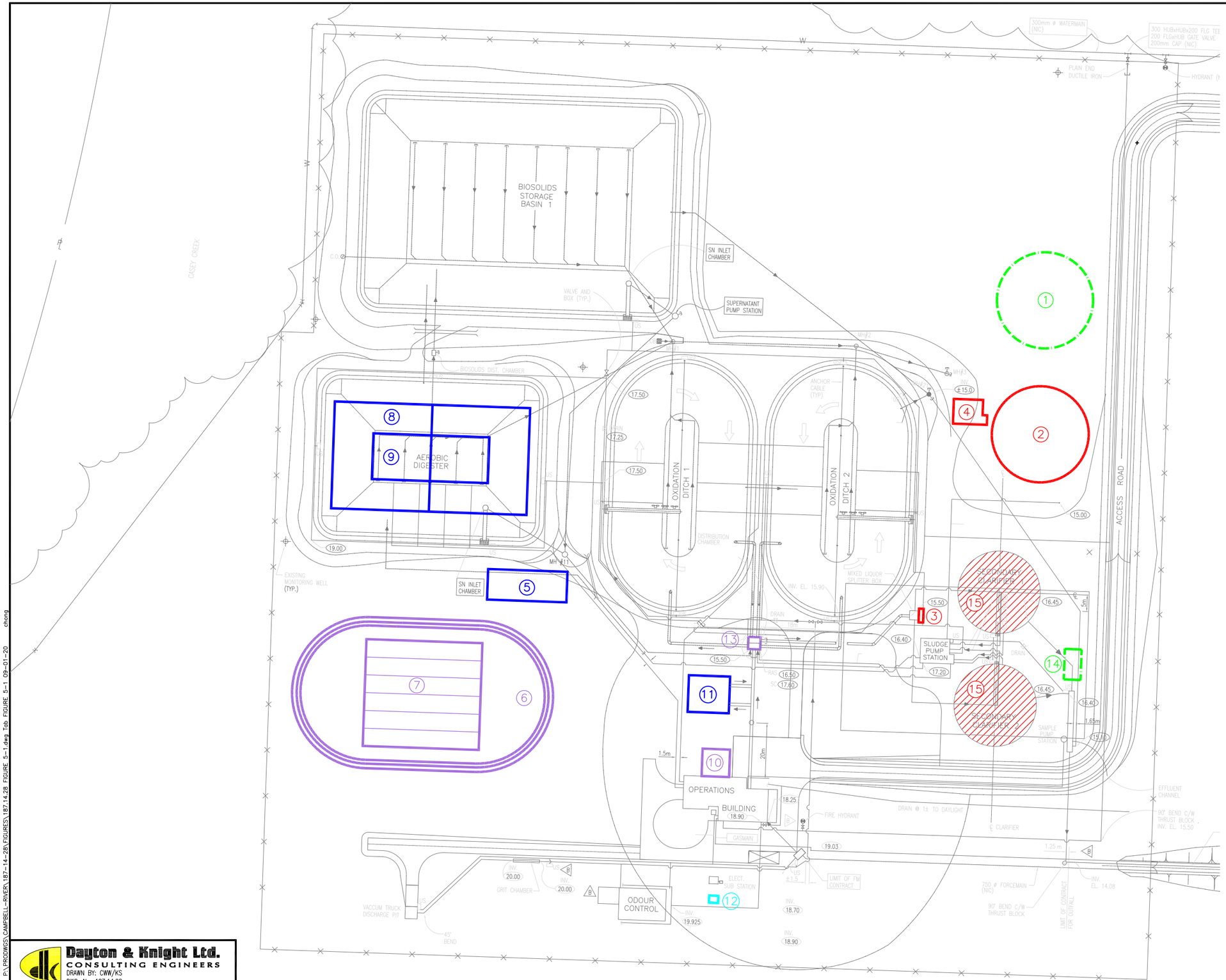
25. Geotechnical reports completed prior to construction of the NWEC indicate that soils on the site are subject to liquefaction in an earthquake. New structures may require piling or other measures to ensure that foundations are adequate to meet current codes for earthquake protection.

26. There are opportunities for use of reclaimed effluent for non-potable applications at the NWEC (e.g., equipment sprays, wash down water, landscape irrigation, etc.

5.2 Recommendations

5.2.1 NWEC Capital Upgrades

Recommendations for capital improvements to the NWEC and associated cost estimates are discussed in Section 4 of this report, and are summarized in Table 5-1. The capital costs do not include site improvements to meet current earthquake protection standards (e.g., soil densification, piling under structures). Included for each item listed in Table 5-1 is the estimated capital cost and the priority of the improvement. The estimated additional operating and maintenance (O&M) costs (beyond existing O&M costs) associated with each upgrade are included in Table 5-1. A site plan illustrating the improvements and their priorities is shown on Figure 5-1.



LEGEND

1. FUTURE CLARIFIER No. 4
2. NEW CLARIFIER No. 3
3. NEW FLOW SPLITTER BOX
4. NEW RAS/WAS PUMP STATION
5. BIOSOLIDS DEWATERING AND WAS THICKENING BUILDING (OPTION 2)
6. FUTURE OXIDATION DITCH No. 3 (OPTION 1)
7. FUTURE PRIMARY SEDIMENTATION TANKS (OPTION 2)
8. TWO CONCRETE TANKS AEROBIC DIGESTER 6000m³ EACH (OPTION 1 – NO WAS THICKENING)
9. TWO CONCRETE TANKS AEROBIC DIGESTER 1500m³ EACH (OPTION 2 – WITH WAS THICKENING)
10. ADMIN. BUILDING EXPANSION
11. NEW GRIT REMOVAL SYSTEM
12. NEW GENSET & TRANSFER SWITCH
13. MODIFIED INFLUENT DISTRIBUTION CHAMBER
14. FUTURE DISINFECTION
15. REFURBISH EXISTING CLARIFIERS

PRIORITY 1
PRIORITY 2
PRIORITY 3
PRIORITY 4
PRIORITY 5

0 5 25 50 75 METRES

SCALE 1:1250

CITY OF CAMPBELL RIVER

NORM WOOD ENVIRONMENTAL CENTRE
PROPOSED SITE PLAN
FOR PLANT IMPROVEMENTS

FIGURE 5-1

Dayton & Knight Ltd.
CONSULTING ENGINEERS
DRAWN BY: CWW/KS
DWG. No. 187.14.28

FILE: P:\PRODWGS\CAMPBELL-RIVER\187-14-28\FIGURES\187.14.28 FIGURE 5-1.dwg Tab FIGURE 5-1 09-01-20 chong

TABLE 5-1
SUMMARY OF COSTS AND PRIORITIES

Item	Construction Cost	70% allowance	Total Capital Cost	Yearly O&M Cost				Priority	Update Trigger
				Labour	Chemicals	Power	Maintenance		
Geotechnical investigation	$ 40,000	$ -	$ 40,000	$ -	$ -	$ -	$ -	1	Building Code, Safety
Secondary Clarifier #3	$ 2,350,000	$ 1,650,000	$ 4,000,000	$ 26,000	$ -	$ 5,816	$ 38,000	1	Regulatory, Capacity
Replace Aeration Blowers	$ 675,000	$ 475,000	$ 1,150,000	$ -	$ -	$ -	$ -	1	Energy Efficiency, Age
Grit Removal System	$ 380,000	$ 265,000	$ 645,000	$ 23,400	$ -	$ 1,307	$ 8,500	1	Capacity
Upgrade Aerobic Digester (incl. WAS Thickening)	$ 1,800,000	$ 1,260,000	$ 3,060,000	$ 26,000	$ 19,040	$ 8,528	$ 22,000	1	Regulatory, Capacity
Instrumentation upgrade	$ 145,000	$ 100,000	$ 245,000	$ 13,000	$ -	$ -	$ 4,250	1	Energy Efficiency, Process
Refurbish Clarifier #1 and #2	$ 140,000	$ -	$ 140,000	$ -	$ -	$ -	$ -	1	Age
Replace Biofilter support structure	$ 60,000	$ 40,000	$ 100,000	$ -	$ -	$ -	$ -	1	Age
Sol-air unit for foul air	$ 53,000	$ 40,000	$ 93,000	$ 2,600	$ 100	$ 657	$ 2,752	1	Alternate to Biofilter
Improve Trucked Liquid Waste Receiving Station, including screen, and rock trap	$ 250,000	$ -	$ 250,000	$ 26,000	$ -	$ 5,816	$ 10,000	1	Process Efficiency
Twin effluent parshall flume flow meter complete with instrumentation	$ 130,000	$ 90,000	$ 245,000	$ -	$ -	$ -	$ -	1	Capacity, Redundancy
Subtotal Priority 1	**$ 6,023,000**	**$ 3,920,000**	**$ 9,968,000**	**$ 117,000**	**$ 19,140**	**$ 22,124**	**$ 85,502**		
Genset Upgrade	$ 650,000	$ 460,000	$ 1,110,000	$ 2,600	$ -	$ -	$ 17,750	2	Regulatory
Reclaimed Water System	$ 300,000	$ -	$ 300,000	$ 10,400	$ 1,000	$ -	$ 10,000	2	Resource Recovery
Administration Building Improvements	$ 210,000	$ 150,000	$ 360,000	$ -	$ -	$ -	$ 10,000	2	Capacity
New Influent Screen	$ 420,000	$ 295,000	$ 715,000	$ -	$ -	$ -	$ 17,750	2	Process Efficiency, Capacity
Subtotal Priority 2	**$ 1,580,000**	**$ 905,000**	**$ 2,485,000**	**$ 13,000**	**$ 1,000**	**$ -**	**$ 55,500**		
Add 1000 Air Diffusers to Oxidation Ditches #1 & #2	$ 75,000	$ -	$ 75,000	$ 536	$ -	$ -	$ 10,714	3	Capacity
Biosolids Dewatering	$ 1,055,000	$ 740,000	$ 1,795,000	$ 10,400	$ 89,700	$ 49,012	$ 31,000	3	Operating Cost
Subtotal Priority 3	**$ 1,130,000**	**$ 740,000**	**$ 1,870,000**	**$ 10,936**	**$ 89,700**	**$ 49,012**	**$ 41,714**		
Secondary Clarifier #4	$ 1,590,000	$ 1,120,000	$ 2,710,000	$ 26,000	$ -	$ 5,816	$ 28,000	4	Regulatory, Capacity
Oxidation Ditch #3	$ 1,610,000	$ 1,130,000	$ 2,740,000	$ 13,107	$ -	$ 55,090	$ 51,929	4	Regulatory, Capacity
Future UV Disinfection	$ 660,000	$ 460,000	$ 1,120,000	$ 13,000	$ 109	$ 23,003	$ 3,600	4	Regulatory
Subtotal Priority 4	**$ 3,860,000**	**$ 2,710,000**	**$ 6,570,000**	**$ 52,107**	**$ 109**	**$ 83,909**	**$ 83,529**		

As shown in Table 5-1 and on Figure 5-1, the improvements rated Priority 1 (immediate need) include the following items:

- geotechnical investigation;
- construct Secondary Clarifier #3 with new RAS and WAS pumping station and associated controls and yard piping;
- replace aeration blowers (pending completion of energy audit currently underway);
- construct vortex grit removal system;
- upgrade and expand aerobic digester;
- instrumentation upgrade;
- refurbish Clarifier #1 and #2;
- replace biofilter roof supports;
- improve trucked liquid waste receiving station; and
- twin effluent parshall flume flow monitor.

The improvements rated Priority 2 include the following items:

- upgrade genset;
- construct reclaimed water system;
- expand and improve administration building; and
- install new perforated plate influent screen.

The improvements rated Priority 3 include the following items:

- add 1,000 aeration diffusers to Oxidation Ditches #1 and #2; and
- construction biosolids dewatering facility.

The improvements rated Priority 4, include the following:

- construct Secondary Clarifier #4;

- construct Oxidation Ditch #3 (incl. Aeration Blower #4); and
- construct effluent UV disinfection system (pending demonstration of need by receiving environment monitoring program).

5.2.2 Additional Recommendations

1. The City should undertake smoke testing of sanitary sewers in the downtown area, to identify potential sources of inflow. Ongoing I&I reduction should continue for the entire collection system.

2. Addition of variable speed drives for the large (250 HP) pumps at PS #11 should be investigated.

3. A grit distribution analysis should be conducted on a sample of accumulated grit the next time the duty oxidation ditch is removed from service.

4. The City should pursue funding support from B.C. Hydro for replacement of the existing constant speed centrifugal blowers with more energy efficient variable speed turbo blowers.

5. The City should investigate additional sources of funding to support upgrades at the NWEC.

PRE-DESIGN FOR UPGRADES TO THE NORM WOOD ENVIRONMENTAL CENTRE

APPENDIX A

NWEC OPERATIONAL CERTIFICATE

Province of
British Columbia

MINISTRY OF
ENVIRONMENT,
LANDS AND PARKS

BC Environment

Vancouver Island Region
Environmental Protection
2569 Kenworth Road
Nanaimo, British Columbia
V9T 4P7
Telephone: (604) 751-3100
Fax: (604) 751-3103

Date: JUN 14 1996 File: PE-14625

REGISTERED MAIL

District of Campbell River
301 St. Ann's Rd
Campbell River BC V9W 4C7

Dear District of Campbell River:

Enclosed is a copy of Operational Certificate PE-14625 issued under the provisions of the Waste Management Act. Your attention is respectfully directed to the conditions outlined in the Operational Certificate. An annual fee will be determined according to the Waste Management Permit Fees Regulation.

This Operational Certificate does not authorize entry upon, crossing over, or use for any purpose of private or Crown lands or works, unless and except as authorized by the owner of such lands or works. The responsibility for obtaining such authority shall rest with the District of Campbell River.

The District of Campbell River shall ensure that all activities conducted under this authorization are carried out with regard to the rights of third parties, and comply with other applicable legislation that may be in force.

The District of Campbell River is directed to the Minister's letter of July 17, 1995, which requires the District of Campbell River to submit plans for stormwater management, source control, biosolids management, and operation of the collection and sewerage system to the Regional Waste Manager for his approval.

This Operational Certificate may be appealed by persons who consider themselves aggrieved by this decision in accordance with Part 5 of the Waste Management Act. Written notice of intent to appeal must be received by the Regional Waste Manager within twenty-one (21) days.

Administration of this Operational Certificate will be carried out by staff from our Regional office located at 2569 Kenworth Road, Nanaimo, British Columbia, V9T 4P7 (telephone 751-3100). Plans, data and reports pertinent to the Operational Certificate are to be submitted to the Regional Waste Manager at this address.

Yours truly,

G. E. Oldham

G. E. Oldham, P.Eng.
Regional Waste Manager
Vancouver Island Region

Enclosure

PROVINCE OF
BRITISH COLUMBIA

Environmental Protection
2569 Kenworth Road
Nanaimo
British Columbia, V9T 4P7
Telephone: (604) 751-3100

MINISTRY OF ENVIRONMENT,
LANDS AND PARKS

OPERATIONAL CERTIFICATE

PE-14625

Under the Provisions of the Waste Management Act and in accordance with the District of Campbell River's Liquid Waste Management Plan, the

District of Campbell River

301 St. Ann's Road

Campbell River, British Columbia

V9W 4C7

is authorized to discharge effluent from a municipal wastewater collection and treatment system located at Campbell River, British Columbia to Discovery Passage, subject to the conditions listed below. Contravention of any of these conditions is a violation of the Waste Management Act and may result in prosecution.

1. AUTHORIZED DISCHARGES

1.1 This subsection applies to the discharge of effluent from the District of Campbell River. The site reference number for this discharge is E223064.

1.1.1 The maximum authorized rate of discharge is 41,400 m^3/d.

1.1.2 The average daily rate of discharge based on an annual averaging period is calculated as follows:

Ave. daily flow = 11,800 m^3d * $(1.035^{\text{calendar year - 1996}})$ to a maximum of 23,600 m^3/d in the year 2016.

1.1.3 The characteristics of the discharge shall be equivalent of better than:

5-day Biochemical Oxygen Demand	- 45 mg/L
Total Suspended Solids	- 45 mg/L
pH	- 6 - 9 pH units
Toxicity (non-acutely toxic)	- 100% LC_{50} at 96 hr

JUN 14 1996

Date Issued:
Date Amended:
(most recent)

G. E. Oldham

G. E. Oldham, P. Eng.
Regional Waste Manager

1.1.4 The authorized works are a septage receiving area, mechanical screens, two oxidation ditches, two secondary clarifiers, aerobic digester, biosolids storage basin, odour control facilities for the screen room, an outfall extending 435 m from mean low water to a depth of 35 m below mean low water, standby power, and related appurtenances approximately located as shown on attached Site Plan A.

1.1.5 The authorized works must be complete and in operation when discharge commences.

1.1.6 The location of the facilities from which the discharge originates is Lot 1, Plan 57724, District Lot 52 and District Lot 120, Sayward Land District.

1.1.7 The location of the point of discharge is Discovery Passage.

2. GENERAL REQUIREMENTS

2.1 Maintenance of Works and Emergency Procedures

The District of Campbell River shall inspect the pollution control works regularly and maintain them in good working order. In the event of an emergency or condition beyond the control of the District of Campbell River, which prevents continuing operation of the approved method of pollution control, the District of Campbell River shall immediately notify the Regional Waste Manager and take appropriate remedial action.

2.2 Bypasses

The discharge of effluent which has bypassed the designated treatment works is prohibited unless the approval of the Regional Waste Manager is obtained and confirmed in writing.

2.3 Process Modifications

The District of Campbell River shall notify the Regional Waste Manager prior to implementing changes to any process that may affect the quality and/or quantity of the discharge.

G. E. Oldham

G. E. Oldham, P. Eng.
Regional Waste Manager

2.4 Plans

Plans and specifications of works authorized in Subsection 1.1.4 shall be submitted to the Regional Waste Manager within 90 days of the date of this Operational Certificate. Plans of the authorized works shall be signed and sealed by a Professional Engineer licensed to practice in the Province of British Columbia.

2.5 Posting of Outfall

The District of Campbell River shall erect a sign along the alignment of the outfall above high water mark. The sign shall identify the nature of the works. The wording and size of the sign requires the approval of the Regional Waste Manager.

2.6 Outfall Inspection

The District of Campbell River shall conduct a dye test on the outfall line (or inspect by another method approved by the Regional Waste Manager). The test shall be conducted every five years. An outfall inspection report shall be submitted to the Regional Waste Manager within 60 days from the date of inspection.

2.7 Sludge Wasting and Disposal

Sludge wasted from the treatment plant shall be disposed of to a site and in a manner approved by the Regional Waste Manager.

2.8 Standby Power

The District of Campbell River shall provide auxiliary power facilities to insure the continuous operation of the screening works and operations building during power outages.

2.9 Odour Control

Should objectionable odours, attributable to the operation of the sewage treatment plant, occur beyond the property boundary, as determined by the Regional Waste Manager, measures or additional works will be required to reduce odour to acceptable levels.

G. E. Oldham

G. E. Oldham, P. Eng.
Regional Waste Manager

Date Issued: JUN 14 1996
Date Amended:
(most recent)

2.10 Disinfection

Although disinfection of the effluent is not required at this time, suitable provisions should be made to include disinfection facilities in the future. If disinfection is by chlorination, dechlorination facilities will also be required.

2.11 Facility Classification and Operator Certification

The District of Campbell River shall have the works authorized by this permit classified (and the classification shall be maintained) by the "Environmental Operators Certification Program Society" (Society). The works shall be operated and maintained by persons certified within and according to the program provided by the Society. Certification must be completed to the satisfaction of the Regional Waste Manager. In addition, the Regional Waste Manager shall be notified of the classification level of the facility and certification level of the operators, and changes of operators and/or operator certification levels within 30 days of any change.

Alternatively, the works authorized by this operational certificate shall be operated and maintained by persons who the District of Campbell River can demonstrate to the satisfaction of the Director, are qualified in the safe and proper operation of the facility for the protection of the environment.

2.12 Effluent Upgrading

Based on receiving environment monitoring data and/or other information obtained in connection with this discharge, the District of Campbell River may be required to provide additional treatment facilities.

3. MONITORING AND REPORTING REQUIREMENTS

3.1 Discharge Monitoring

3.1.1 Flow Measurement

Provide and maintain a suitable flow measuring device and record once per day the effluent volume discharged over a 24-hour period.

JUN 14 1996

G. E. Oldham, P. Eng.
Regional Waste Manager

3.1.2 Sampling and Analysis

The District of Campbell River shall install a suitable sampling facility and obtain samples of the effluent in accordance with the following schedule:

Parameter	Frequency	Type
5-day Biochemical Oxygen Demand	twice per week	8-hr composite
Total Suspended Solids	twice per week	8-hr composite
pH	twice per week	grab
Faecal Coliform	monthly	grab
Enterococci	monthly	grab
Toxicity	twice per year	grab
Other selected parameters	as directed	as directed

The composite sample is to consist of four grab samples taken over an 8-hour period at maximum flow and mixed to form a single sample (or approved flow proportional continuous sampler may be used) for subsequent analysis. Proper care should be taken in sampling, storing and transporting the samples to adequately control temperature and avoid contamination, breakage, etc.

3.2 Receiving Environment Monitoring

A receiving environment monitoring program shall be carried out by the District of Campbell River. The program shall be established in consultation with the Regional Waste Manager. Based on the results of this monitoring program, the District of Campbell River's monitoring requirements may be extended or altered by the Regional Waste Manager.

JUN 1 4 1996

G. E. Oldham

G. E. Oldham, P. Eng.
Regional Waste Manager

3.3 Monitoring Procedures

3.3.1 Sampling and Analytical Procedures

Sampling and flow measurement shall be carried out in accordance with the procedures described in "Field Criteria for Sampling Effluents and Receiving Waters," April 1989, or by suitable alternative procedures as authorized by the Regional Waste Manager.

Copies of the above manual are available from the Environmental Protection Division, Ministry of Environment, Lands and Parks, 777 Broughton Street, Victoria, British Columbia, V8V 1X4, at a cost of $20, and are also available for inspection at all Environmental Protection offices.

Analyses are to be carried out in accordance with procedures described in the latest version of "British Columbia Environmental Laboratory Manual for the Analysis of Water, Wastewater, Sediment and Biological Materials (March 1994 Permittee Edition)," or by suitable alternative procedures as authorized by the Regional Waste Manager.

Copies of the above manual may be purchased from Queens Printer Publications Centre, 2nd Floor, 563 Superior Street, Victoria, British Columbia, V8V 4R6 (1-800-663-6105). A copy of the manual is also available for inspection at all Environmental Protection offices.

Effluent may be adjusted for ammonia toxicity prior to the 96-hour LC_{50} toxicity test. Ammonia toxicity may be removed from a parallel set of test samples by lowering the pH of the water or by removing the ammonia. An additional 96-hour LC_{50} toxicity test may also be required to be undertaken on one or more samples from the set with ammonia re-added where it is considered that other toxicants may have been removed during the ammonia removal process.

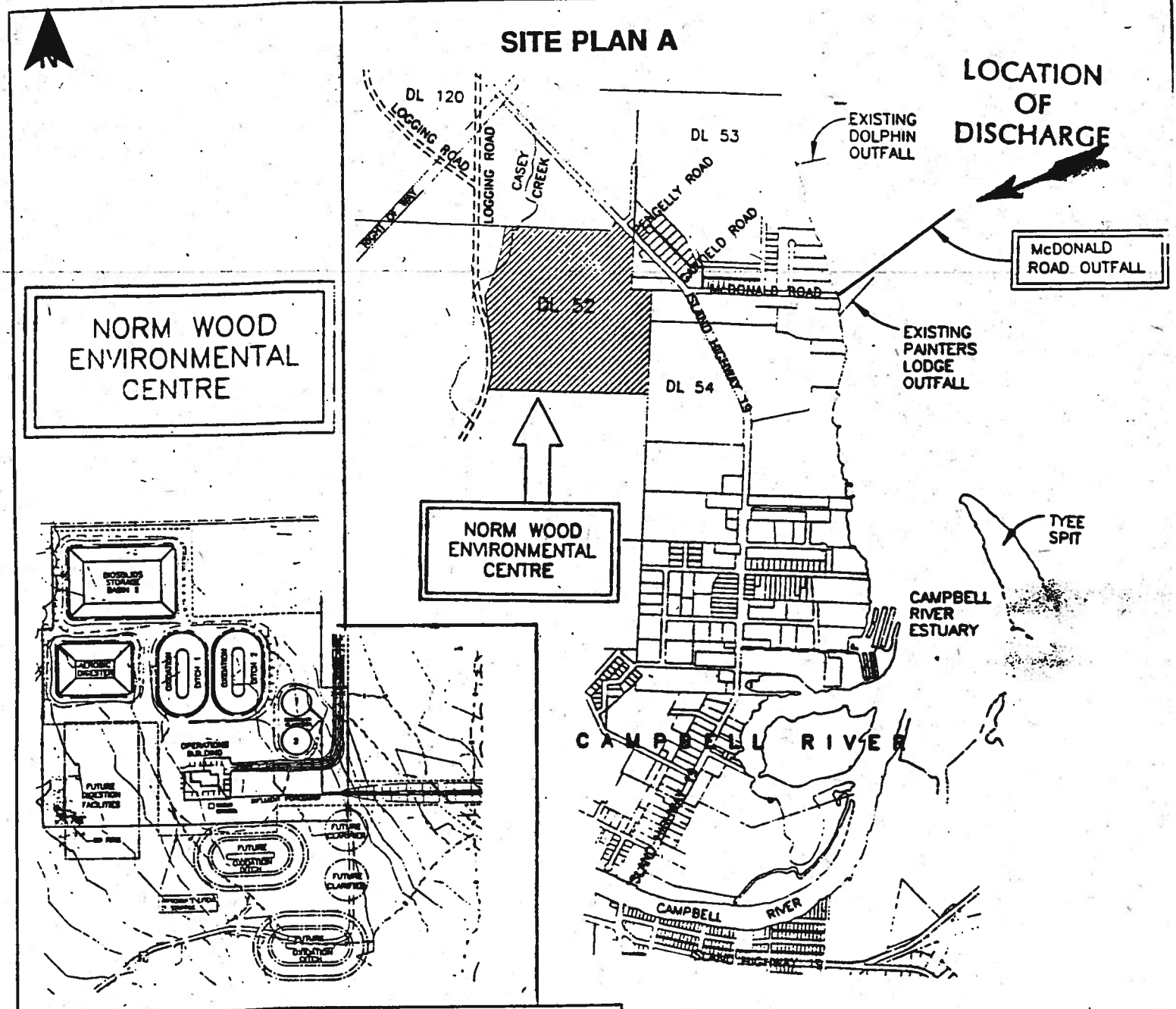
3.4 Reporting

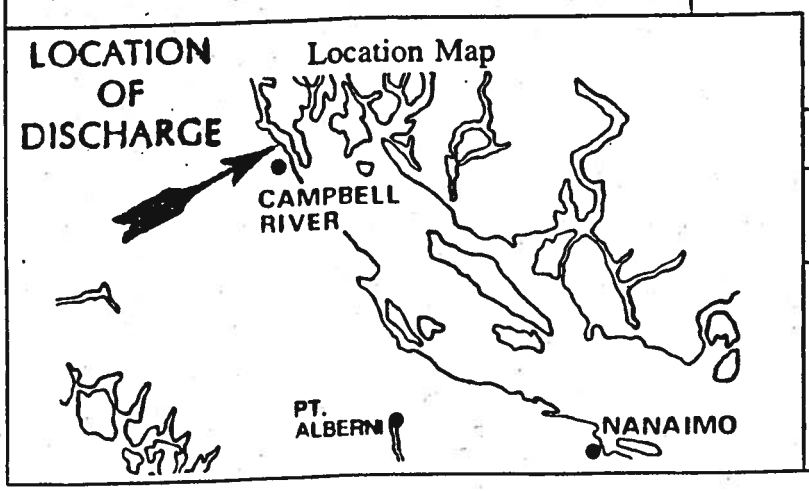
Maintain data of analyses and flow measurements for inspection, and every three months, submit the data, suitably tabulated, to the Regional Waste Manager for the previous quarter. All reports shall be submitted within 30 days of the end of the quarter.

G. E. Oldham

G. E. Oldham, P. Eng.
Regional Waste Manager

SITE PLAN A





Scale: NTS

Operational Certificate: PE-14625

Date: JUN 14 1996

G.E. Oldham, P.Eng.
Regional Waste Manager

City of Campbell River

PRE-DESIGN FOR UPGRADES TO THE NORM WOOD ENVIRONMENTAL CENTRE

APPENDIX B

MAINTENANCE AND REPAIR HISTORY OF HOFFMAN BLOWERS

Campbell River Blowers
Problems from January 2000 to July 2007

Date	Blower	Problem
13-Jan-00	Hoffman Blower 131	Hoffman Blower 131 repaired and put in service. Replaced blower inboard bearing and coupling. Put Lamson blower of stand-by.
14-Jan-00	Hoffman Blower 131	Put Hoffman Blower 131 out of service and put Lamson Blower in service. Blower shutting down on vibration.
24-Jan-00	Hoffman Blower 131	North Island Chrome repaired Hoffman Blower 131 but the motor bearing needs replacing.
28-Jan-00	Hoffman Blower 131	Shipped motor for Haffamn Blower 131 to Duncan Electric for overhaul. Back and in service Feb 10th.
10-Feb-00	Hoffman Blower 131	Hoffman Blower 131 back in service, but still shutting down on vibration. Also Blower will noit shut off by using SCADA screen. Taken out of service again.
14-Feb-00	Lamson Blower	Lamson Blower will not start. EMCO Resources shortened ramp time for soft start to get it working. Long ramp time was causing the blower to heat up too much.
16-Feb-00	Hoffman Blower 131	Notified D&K that Hoffman Blower 131 is not shutting off at SCADA screen.
17-Feb-00	Hoffman Blower 131	Replaced outboard bearing for Hoffman Blower 131. Can still not run because of vibration.
20-Feb-00	Hoffman Blower 130	Hoffman Blower 130 shut off on vibration. Reset alarms and back on-line.
24-Feb-00	Hoffman Blower 130	D&K suspects PLC Control Card for the blowers is defective. That explains why the Hoffman Blower 131 will not shut off on the SCADA screen. Recommends having electrician check and replace card if necessary. Hoffman Blower shut down on vibration. Reset alarms and checked. Okay.
28-Feb-00	Blowers	EMCO Resources checked and replaced the PLC card for the blowers.
29-Feb-00	Hoffman Blower 131	Sanded faces of vibration monitor pick up and bearing housing. Blower still shuts down on vibration.
1-Mar-00	Blowers	Myles Optical / Laser Alignment Services out to check and repair all air blowers and bases to stop consistant vibration problems.
8-Mar-00	Hoffman Blower 131	Hoffman Blower 131 will not run because of vibration.
17-Mar-00	Hoffman Blowers 130 & 131	Primac Reliability Consultants in to check out air dynamics and balancing of the impellers in Hoffman Blowers 130 and 131.
21-Mar-00	Hoffman Blowers	Installed supports for intake air lines at elbows for each Hoffman air blower and re-aligned the intake piping. Piping was causing severe stress on the blowers.
28-Mar-00	Hoffman Blowers 130 & 131	Hoffman Blowers 130 and 131 completed and back in service. Replaced bearings, oil seals, carbon rings, couplings and base pads. Aligned all piping, blower bases, motors and blowers. Blower 132 shut down for same procedure.
4-Apr-00	Hoffman Blower 132	Hoffman Blower 132 ready for operation. Replaced blower base, motor and blower.
5-Apr-00	Lamson Blower 133	Lamson Blower 133 shut down to be serviced by Leo Myles.
5-Apr-00	Hoffman Blower 132	Hoffman Blower 132 put in service to the Digester

12-Apr-00	Lamson Blower 133	Lamson Blower 133 ready for service. Leo Myles checked over and aligned base, motor, coupling and blower. Also added support and aligned the intake and discharge piping
14-Apr-00	Hoffman Blower 132	Leo Myles made modifications to the East side center shim under the base for Hoffman Blower 132.
10-May-00	Blowers	Put D.O. probe directly into Oxidation Ditch so that the Blowers can run on auto.
7-Jul-00	Hoffman & Lamson Blowers	Hoffman and Lamson Blowers surging when No. 1 and 2 air banks (the West end) are open in the Digester. Had to open No. 3 air bank on hand to keep blowers running
20-Jul-00	Blowers	Started up blower to make sure air is getting to the header pipe while pipe is open. All okay. Put all together and put blower back in operation.
26-Jul-00	All 3 Hoffman Blowers	Set up all 3 Hoffman air blowers to No.1 Oxidation Ditch.
26-Jul-00	Lamson Blower	Set up the Lamson Blower to the Aerobic Digester.
30-Jul-00	Lamson Blower	Lamson Blower surging.
1-Aug-00	Blowers	Myles Optical / Laser Alignment Services did scheduled inspection of all air blowers. Some minor adujustments.
1-Aug-00	Lamson Blower	Lamson Blower surging out again when only the two West banks are open in the Digester.
4-Aug-00	Lamson Blower	Lamson Blower surging again.
4-Aug-00	Blowers	22:00 hydro off in plant. All main equipment shut down.
5-Aug-00	Blowers	06:30 hydro back on and all equipment back in surface.
9-Aug-00	Blower	Air blower for Digester surging again. Have to open both No.3 and 4 air banks on manual for the Digester to keep blower running.
5-Sep-00	Blower	Air blower for the Aerobic Digester to operate on an air on/air off cycle at 2 hours on and 1/2 hour off.
5-Sep-00	Lamson Blower	Lamson Blower failed. Trying to run on single phase. Put out of service.
6-Sep-00	Lamson Blower	Soft start control board for the Lamson Blower failed. Replaced same and okay.
29-Sep-00	Blowers	Changed air cycle time for air blower for the Aerobic Digester to 2 hours on and 1 hour off.
1-Nov-00	Blowers	Ventillation Fan No. EF-136 for Air Blower failed. Will not start. Siemens variable speed drive failed.
22-Nov-00	Blowers	Replaced Siemens variable speed driver for ventillation fan No. EF-136. Back in service
2-Dec-00	Blowers	Set up air blowers for No. W Oxidation Ditch to operate on auto control with the ORP probe
6-Feb-01	Blowers	Myles Laser / Optical Alignment Services checked out and re-aligned all air blowers.
23-May-01	Hoffman Blowers	Opened air valves to 100% on manual and put Hoffman Blowers on continuous operation to both Oxidation Ditches
29-May-01	Hoffman Blower 132	Myles Optical / Laser Alignment Services installed the fluid coupling for Hoffman Blower 132.
1-Jun-01	Hoffman Blower 132	Myles Optical / Laser Alignment Services completed installing the fluid coupling for Hoffman Blower 132. Also replaced the outboard bearing of the Blower.
20-Jun-01	Lamson Blower	Level in the Aerobic Digester too high for the Lamson Blower to run, keeps shutting down on surge. Set up Lamson Blower to the Oxidation Ditch.
20-Jun-01	Hoffman Blowers	Set up one Hoffman Blower to the Oxidation Ditch and one Hoffman blower to the Digester on continuous operation.
20-Jul-01	Blowers	Set up Oxidation Ditch air blowers to operate on auto.

10-Aug-01	Lamson Blower	Lamson Blower put on standby. It cannot be used for the digester as it keeps surging out even with all four air banks open.
19-Sep-01	Lamson Blower	Lamson Blower put out of service. It keeps giving a "thermistor" alarm even thought it is not running.
2-Oct-01	Lamson Blower	Lamson Blower back in service. Installed a resistor for the control circuit.
18-Oct-01	Blowers	D&K improved the D.O. set points programming for the air blowers.
20-Nov-01	Lamson Blower	Motor for Lamson Blower taken to Weismer Rawlings for cleaning and bearing replacement.
20-Nov-01	Hofmman Blower 130	Myles Optical / Laser Alignment Services serviced and realigned Hoffman Blower 130. Ordered fluid coupling for the airblower from Industrial Equipment.
27-Nov-01	Lamson Blower	Motor for Lamson Blower back from Weismer Rawlings. Installed and aligned by Myles Optical / Laser Alignment Services. Lamson Blower put in service.
27-Nov-01	Hoffman Blower 131	Myles Optical / Laser Alignment Services serviced and realigned Hoffman Blower 131. Blower put in service.
5-Dec-01	Hoffman Blower 132	Motor for Hoffman Blower 132 removed and shipped to Weismer Rawlings for cleaning and bearing replacement.
18-Dec-01	Hoffman Blower 132	Motor for Hoffman Blower 132 back from Weismer Rawlings.
4-Jan-02	Hoffman Blower 132	Hoffman Blower 132 realigned by Myles Laser and Optical Services and back in operation.
6-Jan-02	Blowers	Have to run blowers by timer only. Oxyguard D.O. probe failed for No.2 Oxidation Ditch.
22-Jan-02	Blowers	Set up air blowers to run on ORP system
6-Mar-02	Hoffman Blower 131	Air Blower 131 out of service. Motor sent to Duncan Electric for servicing.
12-Mar-02	Hoffman Blower 131	Blower Motor 131 overhauling completed by Duncan Electric and delivered.
14-Mar-02	Hoffman Blower 131	Duncan Electric explains that Blower Motor 131 baffles were modified (partially cut away).
19-Mar-02	Hoffman Blower 131	New fluid coupling installed on Hoffman Blower 131.
24-Mar-02	Hoffman Blower 132	Hoffman Blower 132 put out of service due to shot outward bearing.
24-Mar-02	Hoffman Blower 131	Hoffman Blower 131 put in service.
27-Mar-02	Hoffman Blower 132	Bearing replaced on Blower 132, realigned and ready for service.
2-Apr-02	Hoffman Blower 130	Hoffman Blower 130 out of service due to motor bearing being gone. Motor shipped to Duncan Electric for overhaul.
29-Apr-02	Hoffman Blower 130	Blower Motor 130 back from Duncan Electric.
7-May-02	Hoffman Blower 130	Blower Motor 130 installed and realigned by Myles Optical and Laser Services. Blower put in service.
9-Aug-02	Lamson Blower	Siemens controller for the Lamson Blower failed. Emco resources got it going temporarily but need to replace control card.
22-Aug-02	Lamson Blower	Emco Resources installed new control card for the Lamson Blower Siemens controller.
27-Sep-02	Blowers	Myles Optical and Laser Services checked all air blowers and checked alignment of all blowers.
27-Sep-02	Hoffman Blower 130	Myles Optical and Laser Services replaced outboard bearing for Hoffman Blower 130.
22-Nov-02	Hoffman Blower 131	Hoffman Blower 131 failed, very noisy, and put out of service.
27-Nov-02	Hoffman Blower 131	Hoffman Blower 131 repaired by Myles Optical/Laser Alignment Services. The outboard shaft and bearing housing were rebuilt, the bearing replaced, and it was realigned.

12-Apr-03	Hoffman Blowers	Put all 3 Hoffman Blowers in service on auto for No.1 Oxidation Ditch.
7-May-03	Blowers	New alarms installed for all air blowers in the event of a power disruption.
15-Jul-03	Blowers	Myles Optical and Laser Sevices checked over all air blowers for the semi annual inspection and found no problems.
22-Jul-03	Lamson Blower	Lamson Blower put on standby (hot outside temperature causing it to trip out on surge).
22-Jul-03	Hoffman Blower 132	Hoffman Blower 132 put in service for the Digester.
27-Jul-03	Blower	Large Blower fan (EF 122) in the headworks for the Odour Control Facility very noisy and put out of service.
5-Aug-03	Headworks Blower	Myles Optical and Laser Services replaced bearing and balanced Headworks Blower fan
28-Sep-03	Blowers	Set up blowers to run only on time cycle set at 2 hours on and 1 hour off.
23-Oct-03	Hoffman Blower 132	Hoffman Blower 132 put out of service due to problem at control panel.
23-Oct-03	Lamson Blower 133	Put Lamson Blower 133 in service to the Aerobic Digester.
12-Nov-03	Hoffman Blower 132	Replaced contacts at control panel for Blower 132. Put Blower 132 in service
12-Nov-03	Lamson Blower 133	Blower 133 put on standby.
2-Dec-03	Hoffman Blowers 130 and 131	Replaced main contacts at Control Panel for Hoffman Blowers 130 and 131.
11-Dec-03	Blowers	Set air blowers on auto contol.
14-Dec-03	Blowers	Put the air blowers back on timer operation.
8-Jan-04	Blowers	Myles Optical and Laser Services did semi annual servicing of all air blowers with no problems to report.
14-Jan-04	Blowers	Blowers set up for auto operation using DO and ORP system for No. 1 Oxidation Ditch
19-Jan-04	Blowers	Victor Wong of D&K called because he cannot determine why air blowers are shutting down in manual mode when timer still on.
18-Mar-04	Blowers	Put ORP knee control out of service for No.1 Oxidation Ditch to see if on/off blower stops decrease.
30-Mar-04		ORP system put back in service using knee control.
6-May-04	Lamson Blower	Lamson Blower failed due to bearing failure and it was put out of service.
17-May-04	Lamson Blower	Leo Myles of Myles Optical Laser/Laser Alignment Services Inc. came to repair Lamson Blower, which requires complete teardown.
27-May-04	Lamson Blower	Lamson Blower overhauled and put on standby.
2-Jun-04	Lamson Blower	Lamson Blower tripping out on surge. Put on standby.
2-Jun-04	Hoffman Blower 131	Hoffman Blower 131 put in service for the Digester.
22-Jun-04	Hoffman Blower 131	Hoffman Blower 131 tripped out, won't run, low amperage.
22-Jun-04	Lamson Blower	Lamson Blower put in service.
24-Jun-04	Hoffman Blower 131	Hoffman Blower 131 back in service.
24-Jun-04	Lamson Blower	Lamson Blower put back on standby
23-Jul-04	Lamson Blower	Kept tripping out on surge to the Digester, weather very hot, opened all valves to the Oxidation Ditch to alleviate this problem.

23-Jul-04	Hoffman Blowers	Kept tripping out on surge to the Digester, weather very hot, opened all valves to the Oxidation Ditch to alleviate this problem.
1-Aug-04	Blowers	Put air blowers for No.2 Oxidation Ditch back on auto using the ORP/DO system.
22-Sep-04	Blowers	Put blowers on hand control due to shutting down too many times on auto control, causing damage. Will be shutting blowers off manually during the day for denitrification.
3-Oct-04	Lamson Blower	Lamson Blower put in service to the Digester, set up to run continuous.
4-Oct-04	Lamson Blower	Lamson Blower failed, inboard bearing very noisy.
4-Oct-04	Hoffman Blower 131	Hoffman Blower 131 put in service for the Digester.
8-Oct-04	Lamson Blower	Myles Laser and Optical Services repaired the Lamson Blower. Very serious damage done to the inboard bearing and bearing housing. The vibration monitor failed to shut down th blower in time. Looking at options to prevent this from happening in the future. The blower put on back on standby service, will be operating during the day only and will be monitored every coule hours for a number of days.
8-Nov-04	Hoffman Blowers	Checked out Keystone valve actuators for Hoffman air blowers. Found problems with set point adjustments. Physical damage. All actuators need to be serviced by technician including the four actuators at the Aerobic Digester.
17-Nov-04	Blowers	Shut down knee control for blowers. Operating by timer only.
10-Dec-04	Hoffman Blower 132	Hoffman Blower 132 put out of service. Bearing on blower motor noisy.
10-Dec-04	Lamson Blower 133	Lamson Blower 133 put in service to the Digester.
12-Dec-04	Hoffman Blower 130	Hoffman Blower 130 put out of service due to noise and bad vibration.
12-Dec-04	Hoffman Blower 132	Hoffman Blower 132 put back in service.
3-Jan-05	Blowers	Leo Myles of Myles Laser / Optical Services completed preventative maintenance of all 4 air blowers. No major problems.
9-Feb-05	Blowers	PLC crashed at 00:25. Set up all mjor equipment on hand control only. 10:20 PLC back in opertion. Set equipment back to normal operation.
1-Mar-05	Blowers	PLC failed. All equipment set up to run on hand control.
3-Mar-05	Blowers	PLC in operation. All equipment set up to operate through the PLC.
21-Mar-05	Hoffman Blowers	Victor Wong of D&K fine tuned knee value to operate the valves for the Hoffman air blowers.
7-Apr-05	Hoffman Blower 130	Hoffman Blower 130 shut down several times on fault.
11-Apr-05	Hoffman Blower 130	Keystone actuator for Blower 130 failed. Very hot.
11-Apr-05	Hoffman Blower 131	Actuator also questionable.
11-Apr-05	Blowers	Set up all electric valves for the Blowers on manual control at 100% open.
12-Apr-05	Blowers	Notified Rick Gill of Unified Alloys to set up a time to service the Blower Keystone actuators.
21-Apr-05	Hoffman Blower 131	Put out of service due to tripping out on undercurrent.
21-Apr-05	Lamson Blower	Put in service
26-Apr-05	Hoffman Blowers	Blowers 131 and 132 both tripping out on undercurrent.
3-May-05	Hoffman Blower 130	Rick and Sheldon of Unified Alloy replaced actuator for Blower 130 Keystone valve.
3-May-05	Hoffman Blowers	Checked and calibrated actuators for Blowers 131 and 132.

7-May-05	Hoffman Blower 131	Out of service due to noisy bearing on motor.
12-May-05	Hoffman Blower 131	Leo Myles of Myles Laser and Optical Services removed motor for Hoffman Blower 131 and sent it to Duncan Electric for cleaning and repair.
20-May-05	Hoffman Blower 131	Duncan Electric delivered motor for Blower 131 and it was set up by Leo Myles. Ready for service.
24-May-05	Hoffman Blower 131	Put in service, bearing on outboard end of motor very noisy. Checked by Leo Myles. Put out of service.
26-May-05	Blowers	Trip set points reduced for the Lamson and Hoffman blowers to try an prevent the blowers from tripping out on undercurrent and surge. Contacted Al Gibb of D&K to try and resolve the problem of the blowers tripping out.
26-May-05	Hoffman Blower 131	Duncan Electric listened to the motor and took back to Duncan Electric.
26-May-05	Blowers	Set up one Hoffman Blower and the Lamson Blower to the Oxidation Ditch and the Temporary Sludge Storage Basin. Blowers set up on timer only.
26-May-05	Hoffman Blower	Other Hoffman Blower used for the Aerobic Digester. Cannot use Lamson Blower for the Digester because amps drop off and it trips out.
30-May-05	Hoffman Blower 131	Leo Myles of Myles Laser and Optical Services removed motor for Hoffman Blower 131 and Duncan Electric picked it up.
6-Jun-05	Hoffman Blower 131	Duncan Electric delivered motor for Hoffman Blower 131.
7-Jun-05	Hoffman Blower 131	Myles Laser and Optical Services completed the maintenance for Hoffman Blower 131 and it was put back in service.
7-Jun-05	Hoffman Blowers	Hoffman Blowers 131 and 132 set up to the Oxidation Ditch.
11-Jun-05	Hoffman Blower 132 & Lamson Blower	Set up blowers 132 and 133 (Lamson Blower) to the Oxidation Ditch and the Temporary Sludge Storage Basin
11-Jun-05	Hoffman Blower 130	Set up to the Aerobic Digester.
14-Jun-05	Blowers	Myles Laser and Optical Services completed semi-annual maintenance of the air blowers.
19-Jul-05	Blowes	Al Gibb and John Boyle of D&K check out and discuss problems of the blowers and air line for the Aerobic Digester. Tried running the Lamson Blower to the Aerobic Digester but doesn't work and Blower surges out.
20-Jul-05	Hoffman Blower 130	Hoffman Blower 130 very noisy and put out of service.
28-Jul-05	Hoffman Blower 130	Leo Myles of Myles Laser and Optical Services repaired Hoffman Blower 130. Outboard bearing of the blower was destroyed.
29-Jul-05	Lamson Blower	Leo Myles removed and inspected the check valve on the discharge side of the Lamson Blower. No problems.
31-Jul-05	Blowers	Wrote and e-mailed detailed report referring to the Blowers and the Aerobic Digester to Al Gibb of D&K.
9-Aug-05	Hoffman Blower 132 & Lamson Blower 133	Set up to run on auto at 2hrs on and 0.75 hrs off for the Oxidation Ditch and the Temp. Storage Basin.
25-Aug-05	Blowers	Operating air blowers continuous during night and on cycle during day until the weather changes. Received odour complaint from citizen 2200hrs.

6-Sep-05	Hoffman Blower 131	Replaced breaker.
16-Sep-05	Blowers	Air blowers for the Oxidation Ditch set up to run continuous.
22-Aug-05	Lamson Blower 133	Put on standby.
22-Aug-05	Hoffman Blower 130	Put in service to No. 1 Oxidation Ditch.
28-Sep-05	Blowers	Set up air blowers for No.1 Oxidation Ditch to run on auto.
13-Oct-05	Hoffman Blower 130	Tripping out on undercurrent and put out of service.
13-Oct-05	Hoffman Blowers 131 & 132	Set up to the Oxidation Ditch.
13-Oct-05	Lamson Blower	Tried running to the Digester. Will not run. Surges out. Set back to the Oxidation Ditch.
13-Oct-05	Hoffman Blower 132	In service to the Digester.
14-Oct-05	Hoffman Blower 130	Actuator for Keystone valve for Blower 130 failed. Set up the valve on manual control and put the blower back in service to the Ox. Ditch.
14-Oct-05	Lamson Blower	Put on standby.
15-Nov-05	Hoffman Blower 130	Kevin George installed new Keystone actuator for Hoffman Blower 130.
18-Nov-05	Hoffman Blower 130	Rick Gill of Unified Alloy picked up failed keystone Actuator for Hoffman Blower 130 to see if it will be a warranty failure. He will send to shop in Edmonton.
22-Dec-05	Hoffman Blower 131	Put on standby because keeps tripping out on undercurrent.
22-Dec-05	Lamson Blower	Put in service.
22-Dec-05	Hoffman Blower 130	New actuator for Hoffman Blower 130 Keystone inlet valve now working properly and noisy. Had to set up on manual control at 100% open.
3-Jan-06	Blowers	Leo Myles of Myles Optical/Laser Alignment Services completed semi-annual maintenance of all air blowers.
11-Jan-06	Hoffman Blower 130	Norm Ismail of Tyco checked out actuator for Hoffman Blower 130 Keystone valve. Found gears stripped. Will replace under warranty.
2-Feb-06	Hoffman Blower 130	Norm Ismail of Tyco installed new Keystone actuator for Hoffman Blower 130. Took the existing actuator for rebuild so it can be kept as a spare. Valve still not working properly in auto mode. Set up to operate on hand control.
4-Feb-06	Hoffman Blower 131	Put out of service due to tripping out on undercurrent.
4-Feb-06	Lamson Blower	Put in service.
13-Feb-06	Hoffman Blower 130	Kevin checked out signal from PLC to Hoffman Blower 130 actuator. Problem not resolved. Waiting for Unified Alloy on data for type of card.
22-Feb-06	Lamson Blower	Put on standby.
22-Feb-06	Hoffman Blower 131	Put back in service to try out.
2-Mar-06	Hoffman Blower 130	Put on standby.
2-Mar-06	Lamson Blower 133	Put in service to the Digester to try out. Set up air cycle time to 2 hours on and 1/2 hour off to try and improve the volatile reduction in the Aerobic Digester.
3-Mar-06	Lamson Blower 133	Put on standby because started going into surge mode because of the low amps.
3-Mar-06	Hoffman Blower 130	Set up in service to the Digester.

6-Mar-06	Hoffman Blower 130	Kevin George adjusted the Servo Ded Band to be less sensitive to the 4-20mA signal for Hoffman Blower 130 Keystone actuator as per Tyco instructions. Keystone valve now back in auto mode.
19-Mar-06	Blower	Set up air blower to run continuous to the Digester to improve the Digester volatile solids and the Specific Uptake Rate.
24-May-06	Lamson Blower	Not enough air going to Aerobic Digester to properly operate it. SUR numbers very high because of low DO. Set up Lamson Blower to the Digester with some air being diverted to the Oxidation Ditch to prevent Lamson Blower for surging.
6-Jun-06	Lamson Blower & one Hoffman Blower	Set up the Lamson Blower and one Hoffmn Blower for the Oxidation Ditch and the Temporary Digester. Operating the blowers continuous for overnight.
27-Jun-06	Hoffman Blower 131	Blower tripping out for no reason. Suspect capacitor for Hoffman Blower 131 failing. Isolated capacitor to test out.
4-Jul-06	Blowers	Myles Optical/Laser Alignment Services completed semi-annual maintenance for all air blowers.
15-Jul-06	Hoffman Blower 132	Failed. Put out of service.
19-Jul-06	Hoffman Blower 132	Myles Optical/Laser Alignment Services repaired Hoffman Blower 132.
29-Jul-06	Hoffman Blower 130	Set up to run continuous to the Digester.
3-Aug-06	Lamson Blower	Set up to the Aerobic Digester to run on timer at 2 hours on and 1/2 hour off.
3-Aug-06	Lamson Blower	Switched the Lamson Blower to the Oxidation and Temporary Digester Basins.
3-Aug-06	Hoffman Blower	Switched to the Digester.
13-Aug-06	Lamson Blower	Set up to the Aerobic Digester to operate at 2 hours on and 1 hour off cycle.
13-Aug-06	Hoffman Blower 132	Acutator for Blower 132 electric valve failed to work on auto. Set up to operate manually only.
31-Aug-06	Hoffman Blower 132	Actuator for Blower 132 electric valve repaired and back in auto mode.
11-Nov-06	Lamson Blower	Power bump tripped Lamson Blower. Reset.
15-Nov-06	Hoffman Blowers 131 & 132	Kept tripping due to high levels in the Oxidation Ditch creating too much resistance.
19-Nov-06	Hoffman Blowers 131 & 132	Kept tripping due to high levels in the Oxidation Ditch creating too much resistance.
21-Nov-06	Hoffman Blower 131	Tripped on low amps due to high levels in the Oxidation Ditch. Wouldn't restart.
21-Nov-06	Hoffman Blower 132	Put in service.
22-Nov-06	Hoffman Blower 132	Tripped on low amps due to high levels in the Oxidation Ditch. Wouldn't restart.
22-Nov-06	Hoffman Blower 131	Put in service.
23-Nov-06	Hoffman Blower 131	Tripped on low amps due to high levels in the Oxidation Ditch. Wouldn't restart.
23-Nov-06	Hoffman Blower 132	Put in service.
26-Nov-06	Blowers	Power failure at 10:30 am. Entire plant down. BC Hydro fuses tripped, reset at 1:00 pm.
11-Dec-06	Hoffman Blowers 131 & 132	Kept tripping due to high levels in the Oxidation Ditch creating too much resistance.
14-Dec-06	Hoffman Blower 131	Kept tripping due to high levels in the Oxidation Ditch creating too much resistance. 9:30 pm call out. Blower left off until the morning.
15-Dec-06	Hoffman Blower 132	Tripped on low ampds due to high levels in the oxidation ditch.

23-Dec-06	Hoffman Blowers 131 & 132	Kept tripping due to high levels in the Oxidation Ditch creating too much resistance.
3-Jan-07	Hoffman Blower 132	Tripped due to high levels in the Oxidation Ditch creating too much resistance. 4:50am call out.
5-Jan-07	Blowers	Myles Optical / Laser Alignment did semi-annual blower PMI's.
	Hoffman Blower 130	Outer bearing melted to shaft.
	Hoffman Blower 131	Outer bearing shot. Motor free bearing shot, motor sent to Duncan Electric for Service repair.
	Lamson Blower	Good shape.
11-Jan-07	Blowers	Myles Optical / Laser Alignment completd semi-annual blower PMI's.
	Hoffman Blower 131	Reinstalled motor.
	Hoffman Blower 132	Outer bearing shot. Shaft scored at outer bearing was patched.
8-Feb-07	Hoffman Blower 132	Motor grinding. Motor bearings shot and bent shaft. Out of service for repairs.
23-Feb-07	Hoffman Blower 132	Sent to Beaver Electrical for rebuild.
24-Feb-07	Hoffman Blower 131	Tripped out due to high flows in the Oxidation Ditch. 3:50am call out.
25-Feb-07	Hoffman Blower 131	Tripped due to high flows in the Oxidation Ditch. 6:40 pm call out.
8-Mar-07	Hoffman Blower 132	Leo Myles installed and aligned Blower 132 motor.
16-Mar-07	Hoffman Blower 131	Leo Myles removed blower 131 outboard bearing that was seized to the shaft.
10-May-07	Hoffman Blower 130	Leo Myles removed Blower 130 outer bearing housing, to be sent out for repair.
14-May-07	Hoffman Blower 130	Leo Myles replaced rebuilt bearing housing on blower 130.
10-Jul-07	Blower 2 and 3	Tripped multiple times on low current due to high ambient air temperature.
10-Jul-07	Blower 1	Tripped on high vibration. Taken out of service until Leo Myles can inspect it.
12-Jul-07	Blower 1	Leo Myles inspected and serviced Blower 1 but doesn't know what keeps causing these failures.
12-Jul-07	Blower 1	Tripped on high vibration after being put back in service. Off line until Leo Myles can come back to reservice it
13-Jul-07	Blower 3	Tripped on low current due to high ambient air temperature.
14-Jul-07	Blower 2	Low current trip call out 4:15pm
14-Jul-07	Blower 3	Low current trip call out 6:00pm
15-Jul-07	Blower 2	Low current trip 12:00 pm
15-Jul-07	Blower 3	Low current trip 1:00 pm
15-Jul-07	Blower 3	Low current trip call out 9:00pm. Left off for the night.
17-Jul-07	Blower 2	Low current trip 4:25pm. Left off for the night.

PRE-DESIGN FOR UPGRADES TO THE NORM WOOD ENVIRONMENTAL CENTRE

APPENDIX C

BUDGET QUOTES FOR MAJOR MECHANICAL EQUIPMENT

Budget Information

DATE: 12/3/08
PROJECT: Campbell River
TO: Elaine
FROM: Matt

Finescreen Monster System

The design of this project is based on the information listed below. The headloss is based on approach velocity, if the approach velocity is different than that shown below please contact your Rep or JWC.

Flow:	**16.90**	**MGD**
Channel Width:	**4.00**	**ft**
Channel Depth:	**6.00**	**ft**
Top of channel to operating floor:	**0.00**	**ft**
Discharge Height:	**4.00**	**ft**
Water level down stream:	**3.27**	**ft at peak flow**
Headloss blocked 30%	**1.42**	**ft at peak flow**
Water Level up stream:	**4.69**	**ft at peak flow**
Approach velocity:	**2.00**	**fps at peak flow**
Perforation Size:	**6**	**mm**
Material:	**304**	**stainless steel**
Weight	**4207**	**lbs**

BUDGET PRICE SCREEN	**$189,792**	**each**
BUDGET PRICE COMPACTOR (freight and service included)	**$85,500**	**each**

NOTE: Information above is preliminary only and not to be used for construction.

Andy Setiawan

From: Eric Pilger [epilger@mequipco.com]
Sent: Monday, January 19, 2009 9:48 AM
To: Andy Setiawan
Subject: Campbell River
Attachments: GRIT TYPE B grit collectgo Newberg NY r.pdf; TYPE S C&S Double strand GRITsales dwg.pdf; TYPE S TYP CONTRACT DWGS.pdf; SGritMarketingCoverWSG3107.doc; BGritMarketingCoverWSG121808.doc; 00-1GritClassifiersMarketingCoverWSG3107.doc; SW SALES DWG. NEW.pdf

Hello Andy,

As discussed please see below additional budgetary pricing for the Grit Guard (aerated) and two non –aerated designs for removing 100 mesh grit from a total flow of 20 MGD

Grit Guard

The budget price for the Grit Guard Direct system includes a blower and a screw washer at $ 128,000 each. Two would be required for the total flow of 20 MGD and removal of 100 mesh material.

This price does not include duties or field service. Field service is $1,100 US PER DIEM plus T&L expenses.

We assumed the two systems will be protected from the cold weather therefore no freeze protection is included.
Tanks and connecting piping and electrical wiring are also not included.

Non –Aerated Link Belt

Would require two units each with a capacity of 10 MGD to remove 90 % of 100 mesh grit with a SG of 2.65.

The first is a Type S Grit unit which uses chain and flights discharging into an inclined dewatering screw.

The second option is a Chain and Bucket design discharging into a screw washer.

A standard 12” inclined screw washer is being used which have a capacity of 13 cu ft/hr.
If the expected grit quantities will be greater then the screw diameters will have to be increased.

We also assumed the units will be protected from freezing.

Attached is the following:

Sales drawing Type S
Sales Drawing C&B design
Screw Washer sales drawing and descriptive information.
Typical contract drawings.

Tanks for either option would be **each** is 5 ft wide x 7 ft deep x 71 ft long.
In either design it will be necessary to supply a proportional weir located at the discharge end of the tanks to control channel velocities. Add $ 20,000 for two weirs.

Budget prices:

Two Type S units including the inclined screw----------$ 330,000

Two C&B Units with separate screw washer----------$ 360,000

The above uses materials manufactured of 304 SST, the chains will be Cast Iron. The pricing does not include duties or service which is $1,100 per day plus T&L.

I hope this will cover your options thoroughly, if you have any questions or require further info please let me know.

With regards to the On-Site Generation proposal, I have spoken with Siemens this morn, and due to the volume of proposals being requested they cannot have it to my by today as much as I have been pushing, but has promised to have it to me by tomorrow end of day the latest. I apologize for this continued delay but will continue to expedite this for you.

Regards,

Eric Pilger | Mequipco Ltd.

#225 - 11020 No. 5 Road | Richmond, BC | V7A 4E7
Tel: 604-273-0553, Ext. 142
Cell: 778-835-7687
Fax: 604-277-8302
web: www.mequipco.com

Andy Setiawan

From: Eric Pilger [epilger@mequipco.com]
Sent: Monday, December 08, 2008 11:22 AM
To: Andy Setiawan
Subject: RE: Campbell River Grit Removal
Attachments: mectan_grit_chamber.pdf; sam_grit_dewatering_screw_and_conveyor.pdf; image001.jpg

Hello Andy,

Please see below budgetary numbers for the Metcan System, attached as well are brochures and technical data for your reference.

Budget price for Grit removal equipment to handle a peak wet weather flow of 74,000 m3/h, is $110,000.00 lot net /each

This includes a Mectan vortex degritter Model JMD/6-50 ISXH, one 7.5 HP grit pump ,one grit classifier model GDS/14-12-25-CXA.
All including.: Class I div I motors, and NEMA-12 control panel
Excluding, Freight and start up service
Delivery, 18 weeks after receipt of drawings approved.

If you have any questions or require further info please let me know.

Regards,

Eric Pilger | Mequipco Ltd.

#225 - 11020 No. 5 Road | Richmond, BC | V7A 4E7
Tel: 604-273-0553, Ext. 142
Cell: 778-835-7687
Fax: 604-277-8302
web: www.mequipco.com

From: Andy Setiawan [mailto:asetiawan@dayton-knight.com]
Sent: Friday, December 05, 2008 12:11 PM
To: Eric Pilger
Subject: RE: Campbell River Grit Removal

Hi Eric,

I should have asked this from the very beginning. Can you provide me a cost estimate for the grit removal system using the Mectan vortex removal. I'm going to use the cost as a comparison. It will have the same design flow as the gravity channel one.

Thank you in advance for your help.

Regards,

Dayton & Knight Ltd.
CONSULTING ENGINEERS

Andy Setiawan
#210-889 Harbourside Drive
North Vancouver, B.C. V7P3S1
Tel: 604-990-4800*125
Fax: 604-990-4805
Email: asetiawan@dayton-knight.com
Web: www.dayton-knight.com

Please consider the environment before printing this e-mail

From: Eric Pilger [mailto:epilger@mequipco.com]
Sent: Wednesday, December 03, 2008 3:32 PM
To: Andy Setiawan
Subject: Campbell River Grit Removal

Hello Andy,

Based on your information as follows:

Max daily flow---------74,000 m3/day or 19.5 MGD

95% removal of 100 mesh material-------- = 5 minutes detention time
19.5million gallons x 5 minutes = 97.5 million gallons total.

Recommend 2 tanks each rated for 50 MGD US

Attached are: Two drawings 491Z352 and 491Z353 defining the proposed tank layout for our aerated grit system.
General marketing data on our Aerdegritter
Typical Specs
Installation list is available upon request

Budget prices for **two units** including the aeration equipment, Grit equipment and Screw washers

Grit equipment----------$ 225,000
Model 30 swings carbon steel with 1 hoist ----------$ 274,000
Above is US Funds

The above does not include escalation, special duties, service at normal rate,

Please advise if you require additional information or have questions.

Regards,

Eric Pilger | Mequipco Ltd.

#225 - 11020 No. 5 Road | Richmond, BC | V7A 4E7
Tel: 604-273-0553, Ext. 142
Cell: 778-835-7687
Fax: 604-277-8302
web: www.mequipco.com

Andy Setiawan

From: Eric Pilger [epilger@mequipco.com]
Sent: Tuesday, December 23, 2008 6:31 PM
To: Andy Setiawan
Subject: Campbell River Grit Removal

Hello Andy,

As discussed please see below budgetary pricing for just the Grit classifier, pricing is Canadian Funds.

For model GDS/14-12-25 as previously quoted with Grit chamber. The budget price, including transport to job site is 50,550.00 $can.

The price includes the GDS unit, the lamellas inside, a 304 stainless steel construction except the screw in abrasion resistant carbon steel, a Hydrocyclone for 175 USgpm. If require anything further please let me know.

Happy Holidays,

Eric Pilger | Mequipco Ltd.

#225 - 11020 No. 5 Road | Richmond, BC | V7A 4E7
Tel: 604-273-0553, Ext. 142
Cell: 778-835-7687
Fax: 604-277-8302
web: www.mequipco.com

Andy Setiawan

From: Ouyang, Hui - W&WW [Hui.Ouyang@itt.com]
Sent: Tuesday, December 23, 2008 2:49 PM
To: Andy Setiawan
Subject: FW: Campbell River WWTP
Attachments: Campbell River.pdf; Membrane_Details_2_pdf.pdf

Hello Andy,

Please see the attached design and membrane datails. We figure four grid of the same dimension and the same number of diffusers (504 diffusers) . Also please kindly note that:

1) Add provision to two grid ends to do close loops,
2) Add provision to a second purge for each grids
3) Credit for the droplegs (The price start with the manifold 200 mm and the JMC coupling 200mm included)
4) The lateral pipe supports will be different of the one show in detail M202
5) All pipes are in PVC : Manifolds are 200 mm and the air distributors are 100mm
6) All supports are in SS 316, See details
7) All diffusers (2016) are type membrane SSII 9".

The budget price will be CDN$96,500.00 FOB Jobsite with expected 2 workings days field supervision according to the current exchange rate.

Hope this will be some of assistance. If you have any question or concern, please let me know.

Merry X'mas and Happy new year!

Kind Regards

Hui (Arthur) Ouyang
Western Region Treatment Sales Manager
Tel: (403) 279-8371
Fax:(403) 279-0948
Cell:(403) 827-0103
E-mail: hui.ouyang@itt.com

From: Andy Setiawan [mailto:asetiawan@dayton-knight.com]
Sent: Monday, December 22, 2008 2:03 PM
To: Ouyang, Hui - W&WW
Subject: RE: Campbell River Diffusers

Hi Arthur,

I am assuming the unknown grid you are referring to are the ones around the top corner. Let just assume 4 grids of 13.5 m L x 5 m W, each for 504 diffusers.

I am expecting Sanitaire to provide the dropleg (200mm dia.) as well. The feeder for the droplegs can be drawn off from the 500x300x300x300 cross (south of Oxidation Ditch No. 1). The amount of air provided by the new diffuser is 1.3 SCFM per diffuser.

Hope this answer your questions.

Regards,

Andy Setiawan

From: Ouyang, Hui - W&WW [mailto:Hui.Ouyang@itt.com]
Sent: Monday, December 22, 2008 12:42 PM
To: Andy Setiawan
Subject: RE: Campbell River Diffusers

Hello Andy,

Could you verify that we have to provide 2 grids of 13.36m long X 5.027m w. each for 504 diffusers + **2 other grids with unknown number of diffusers and unknown dimensions! (see the plan)**

The dropleg (inclined 200mm SS 304) is providing air to the existing grids but:

- How the new grids will be feeded?
- What will be the amount of air provided by diffusers?
- Who will provide the dropleg (size) ? and
- where will be the feeder if we have to provide the dropleg?

Please reply at your earliest convieniece then we can give you a budget quote ASAP.

Thanks

Arthur

From: Andy Setiawan [mailto:asetiawan@dayton-knight.com]
Sent: Monday, December 22, 2008 12:48 PM
To: Ouyang, Hui - W&WW
Subject: Campbell River Diffusers

Hi Arthur,

First of all, thank you for your quick response.

The attached files are the plan drawing of the existing oxidation ditches in Campbell River WWTP (NWEC). There are 2 blocks in each oxidation ditch that are marked as "Future Diffuser Grid". Those are the area that I want you to price. The diffuser that I am looking for is Sanitaire 9", which is currently used for the other diffusers.

What I am after is a budget quote to install new Sanitaire 9" diffusers in the "Future Diffuser Grid" blocks. Hopefully you can get back to me with the cost before the holiday. If you have any question, you can give me a call at the number below.

Kind Regards,

Andy Setiawan

#210-889 Harbourside Drive

North Vancouver, B.C. V7P3S1

Tel: 604-990-4800*125

Fax: 604-990-4805

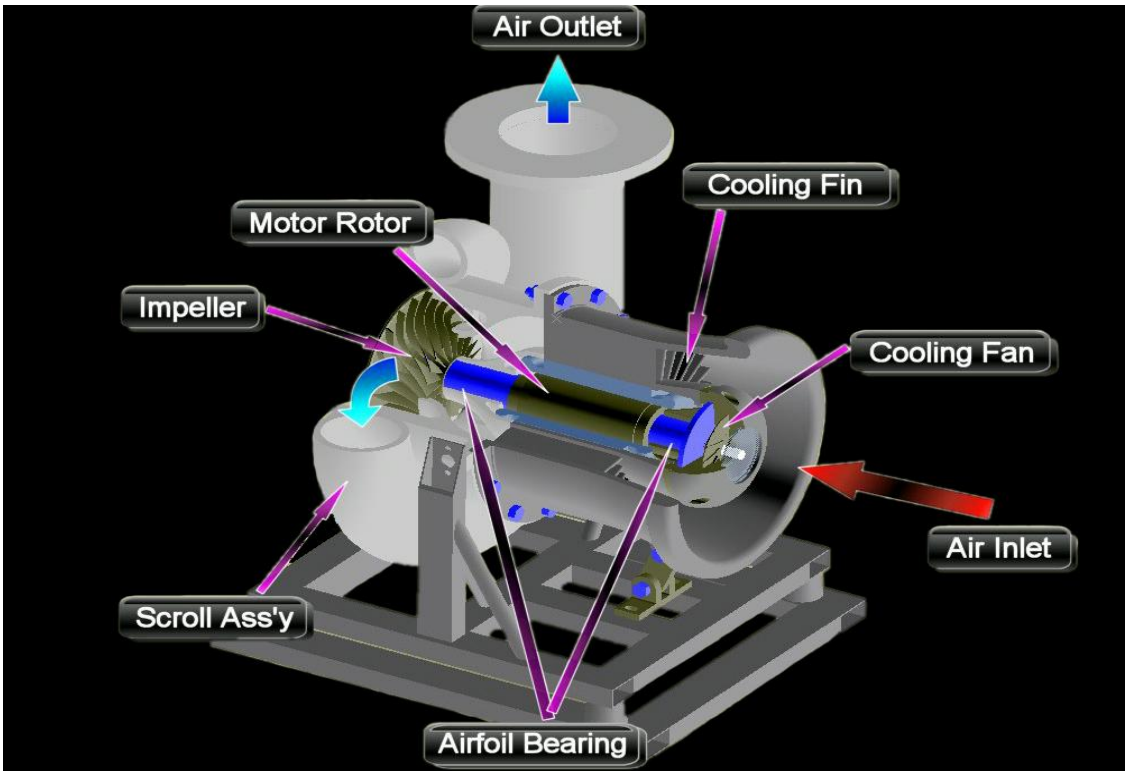
Neuros Turbo Blower Proposal

Dayton & Knight Engineering LTD.

Campbell River, B.C.

Prepared by APG-Neuros Inc.

Date: Oct. 3, 2008



Neuros Turbo Blower Core

APG-Neuros Inc.
250 Blvd. De Gaulle, Lorraine, QC, J6Z-4R3, Tel: 514 249-2724, Ohammoud@apg-neuros.com

PROJECT: Campbell River, B.C.		
Design Conditions		
Service Gas	Air	
Altitude, ASL	0	Feet
Atmospheric Pressure	14.700	PSIA
Inlet Temperature	68	Deg F
Relative Humidty	36	%
Blower Design requirements		
Flow Requirements		
Duty All Trains	3	Blower
Standby	0	Blower
Duty Air Flow, Total, Max.	9900	SCFM
Duty Air Flow, per Blower.	3300	SCFM
Duty Air Flow, Total, Min	4290	SCFM
Duty Delta Pressure	7.6	PSIG
Performance Data per Blower, at Design Conditions		
Model NX Options	**NX150-C060**	
Rated Motor Output Power	150	HP
Maximum Air Flow @ Duty Delta Press, Full Speed	3595	SCFM
Minimum Air Flow @ Duty Delta Press	1430	SCFM
Turndown Range from Max Flow to Min Flow	60%	%
@ Duty Max. Air Flow, Duty Delta Pressure	**@ 3300 SCFM**	
Blower Shaft Powe	129	BHP
Wire Power Consumption	108	KW
Discharge Temperature	161	deg F
@Min Air Flow, Duty Delta Pressure	**@ 1430 SCFM**	
Blower Shaft Powe	57	BHP
Wire Power Consumption	48	KW
Discharge Temperature	162	deg F

Notes:		
Max Noise Level; within 3 Feet	80	dBa
Dimensions per Blower, L / W / H (Excluding Disch. Cone Height)	69x30x59	Inch
Weight per unit	1675	LB
Heat Rejection inside blower room		KW
Cooling requirements		KW
Flange Size, Discharge (TBD)	12	Inch
Flange size, Inlet (optional, TBD)	16	Inch
Note: Motor output power exceeding rated motor output power shall be allowed in the limit of service factor and relevant conditions		
Toleranes: 5% on Flow and Power and 2 dBa on noise		

APG-Neuros Inc.
250 Blvd. De Gaulle, Lorraine, QC, J6Z-4R3, Tel: 514 249-2724, Ohammoud@apg-neuros.com

Scope of Supply

APG-Neuros Inc, agrees to sell to the buyer the equipment designated as Included in the scope of supply below, subject to the Seller's standard Terms and Conditions available upon request and special conditions outlined herein in this proposal.

1. Standard Neuros Turbo Blower Package INCLUDED

1. High Performance Variable Speed Drive & Inverter - Specially Tuned for High Speed Motor
2. Local Control Panel for Control and Monitoring
3. Remote Control capability via Ethernet, LAN or Hard wiring
4. Built in Sound Enclosure to below 80 dBa silence level
5. Blow off Valve to blow off air flow during start sequence
6. Blow off silencer to silence air flow during start sequence
7. Temperature sensors for motor, bearing, inlet and discharge air flow
8. Pressure sensors for discharge conditions
9. Pressure sensor and alert for air filter condition
10. Built in Flow Calculation with accuracy within +/- 0.5%
11. Built in Speed measurement within +/- 0.5% accuracy
12. Internal Expansion Joint
13. Internal vibration and dynamic effect Absorption Mounts
14. Optional built in vibration sensor, transmitter and display
15. Electric Line Reactor to reduce power factor
16. Built in air filter to within ten micron filtration
17. Discharge Duct attached to Turbo Blower

2. Optional Computers and Software (Not included)

A. Master Control Panel to operate multi-blowers

1. Complete standalone computer system, built with its own state of the art technology microprocessor in a self contained enclosure.
2. MCP operates based on input and output signals to control on line blowers and other flow equipment based on DO or other operating parameter.

3. Standard Ship Loose Accessories

1. Discharge Check Valve
2. Discharge Butterfly valve,
3. Discharge Duct Expansion Joint

4. Standard Documentation (INCLUDED)

A. Submittal Information: Five (5) Copies as required

1. Bill of Material
2. Installation Drawings
3. Electrical and Control Drawings
4. Operation and Maintenance Manual
5. Commissioning Instructions

B. Standard Tests

1. PTC-10 Factory Performance Test -non witnesed - available upon request
2. Optional Functional tests with Plant LC
2. Electrical and Control functional system test

5. Spare parts (on site)

A. One set of spares

1. One (1) sets of Air Filters

6. Quality Assurance and Control and Product certification

A. Neuros Quality Assurance program is ISO 9001 certified
B. Neuros Turbo Blower is UL and CSA certified

APG-Neuros Inc.
250 Blvd. De Gaulle, Lorraine, QC, J6Z-4R3, Tel: 514 249-2724, Ohammoud@apg-neuros.com

Scope of supply (continued)

8. Start-up and Factory Testing Service:

Unless included in the price details, start-up and operator training is available at US $1,200 per day plus travel and living expenses billed at cost, plus 10%. Advance notification of 10 working days is required for scheduling.
Factory witnessed testing or additional tests, please contact APG-Neuros for quote.

9. Proposal Validity and

The prices in this proposal are valid for ninety (90) days from the issue date on the cover page.

10. Payment Terms:

Payments shall be made as follows:
15% upon issuance of Purchase Order
75% at delivery to Jobsite
10% upon start-up
Letter of Credit listing draw of payments against above deliverables will apply for Sales outside US and Canada.
100 % of invoice amount shall be payable by bank wire transfer without deduction and to be paid Net 30 days after invoice date.
Payment shal not be dependent on the buyer being paid by any third parties or equipment acceptnace by owner.

11. Submittals or Shop Drawings:

Submittal package will be provided wthin 4 weeks after acceptance of the Purchase Order by APG-Neuros.

12. Shipment:

Shipping terms, unless otherwise stated in price details, shall be Ex-work, APG-Neuros Inc. Factory.
Shipment will be made within 16 to 20 weeks after acceptance of Purchase Order by APG-Neuros or 12 weeks after after approval of Submittals, which ever occurs last.
Add Five percent (5%) escalation to Price for each partial or full quarter that shipment is extended beyond one year after order acceptance.

13. Warranty

A. Standard Warranty (INCLUDED)

Comprehensive non pro-rated One (1) year from commissioning date or Eighteen (18) months from delivery, whichever occurs first. Warranty will begin upon successful completion of start-up and certification for full-scale operation by APG-Neuros, or Eighteen (18) months after shipment, whichever occurs first. Under no circumstances will the warranty begin upon "beneficial use", completion of the project, or acceptance of the equipment as determined by the engineer or end user.

B. Extended Warranty (OPTIONAL - Not Included)

Warranty extension available included in Maintenance Cost Guarantee program described in Item C below.

C. Maintenance Cost Guarantee (OPTIONAL - Not Included)

All inclusive maintenance and warranty cost coverage beyond first year is available at additional cost.

14. Technical and Spares Support

Technical support personnel as required to provided free of charge within 24 hours from receiving request for support

15. Items Not Included:

Installation, main starters, anchor bolts, interconnecting pipe, fittings, bolts, nuts, gaskets, wiring, valves, and taxes and duties, or any other items not specifically listed above.

APG-Neuros Inc.
250 Boulevard De Gaulle, Lorraine, QC, J6Z-4R3, Canada, Tel: (514) 249-2724, ohammoud@apg-neuros.com

Budgetary Price (CDN Dollars, 2008 Economy year)

STANDARD EQUIPMENT SCOPE OF SUPPLY PRICE:

Total Quantity,	**3**	Units
Model:	**NX150-C060**	
Capacity of each,	3595	SCFM
	(14.6, 68 Deg F, 36% RH)	
Discharge Pressure,	8	PSIG
Motor rating:	150	HP
Total Base price:	**$ 397,800.0**	CDN

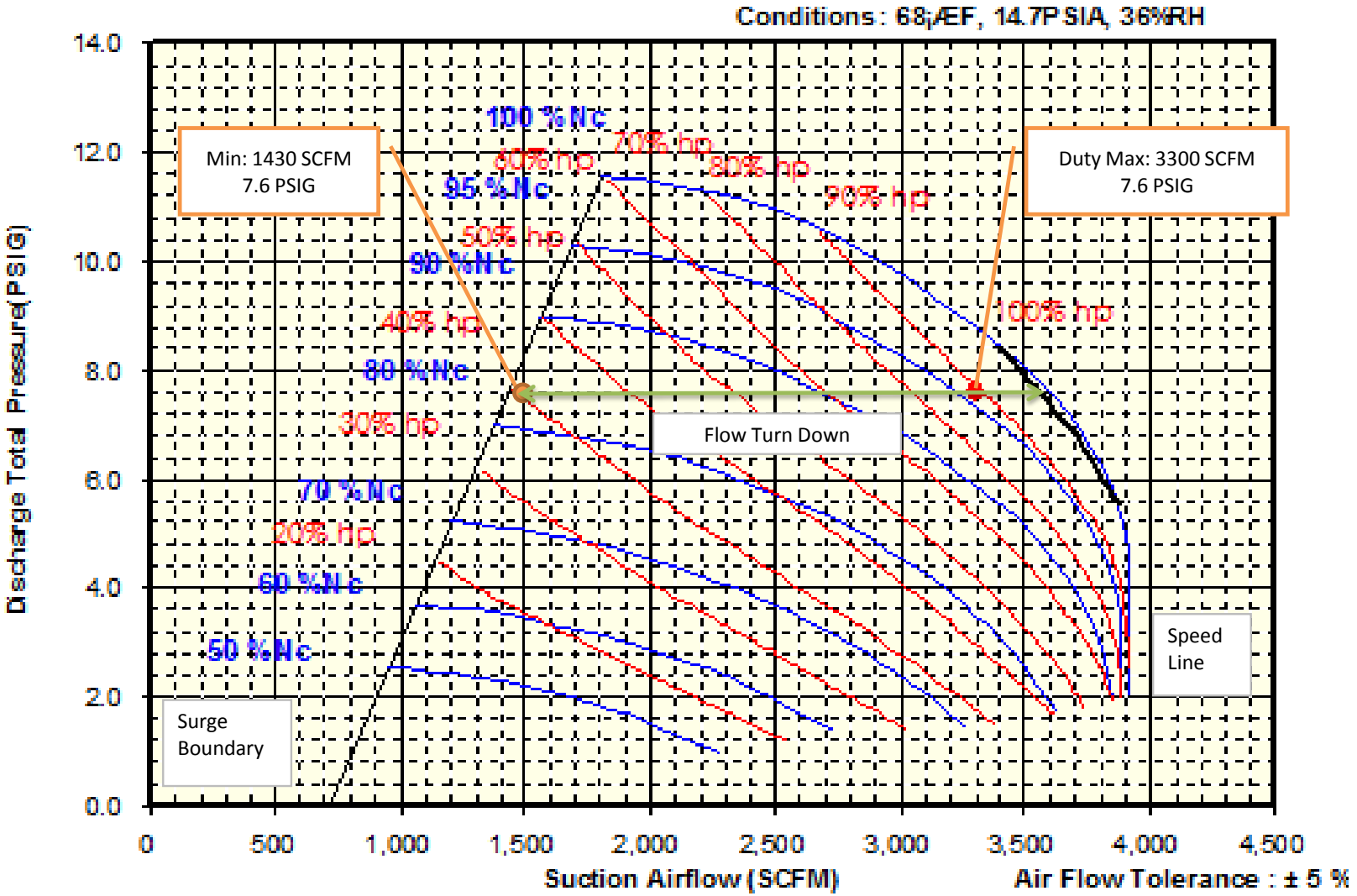
Other costs included in the price

Start-up and training:	Two (2)days		$CDN
Freight charge prepaid and included			$CDN
Taxes	Payable By Buyer		

APG-Neuros Inc.
250 Boulevard De Gaulle, Lorraine, QC, J6Z-4R3, Canada, Tel: 514 249-2724, ohammoud@apg-neuros.com

PERFORMANCE CHARACTERISTICS OF NX150N-C060

Std. Spec. V6.1



APG-Neuros Inc.

250 Boulevard De Gaulle, Lorraine, QC J6Z-4R3, Canada, ohammoud@apg-neuros.com

Andy Setiawan

From: Bocu, Marius - W&WW [Marius.Bocu@itt.com]
Sent: Monday, December 22, 2008 3:19 PM
To: Andy Setiawan
Cc: Santos, Tony - W&WW
Subject: Campbell River/4430 Banana Blade mixer budget price
Attachments: Parallel guide bar system 4410_4430_4460_Banana Blade.pdf; ParallelGBSProdSpecE.doc; Perf Specs 4410_4430.doc; ITT_email_signature.gif

Hi Andy,

Budgetary price for the SR4430, 6.2HP 600V/3 phase c/w 16M power cable, parallel guide bar system and lifting accessories @ $35,000.00/each.

Parallel guide bar system is composed of:

1. Mixer holder SS 316/PN 13-520615
2. Lower Holder SS 316/PN 13-520613
3. Upper holder SS316/PN 13-520614
4. 4" Mast Sch 40 SS 316 X 6M long/PN 13-450032

Lifting accessories composed of:
1. Spring hook SS 316/PN 845284
2. Power cable holder SS 316
3. Support cable assembly SS 316 1/4" X 12M long/PN 13-500533 (1/4" X 6M/PN 13-500532)
4. Power cable holder nylon/SS 316
5. Lifting cable holding clamp SS 316/PN 13-500513

Please note the following:

- Taxes and freight not included in above prices and are extra.
- Please note the prices provided are for budgetary purposes only and not valid for purchasing. Please advise us of the final engineering design with all the options required, for a final quotation.
- The price quoted doesn't include the controls. Controls by others.
- Site start up is not included.

- Site installation is not included.
- Our scope of supply is limited only to the items included in this email.
-All equipment offered is subject to the engineer's/customer's approval/acceptance and we reserve to right to withdraw our offer if such approval/acceptance is not granted. Should any changes have to be made regarding the quantities and/or construction of the equipment offered, extra charges will apply accordingly. Notes, comments and exceptions are part of this proposal and must be observed.

This quote is valid for: sixty (60) days.
Payment.....: Net thirty (30) days on approval of credit.
Delivery.....: 8-10 weeks after approval of drawings (Mechanical)
Prices in.....: Canadian dollars

Should you need any additional information or have any questions please do not hesitate to email or call me.

Best Regards,

Marius Bocu, BEng, AScT
Technical Sales Representative
ITT Water & Wastewater
74 Glacier Street
Coquitlam, BC V3K 5Y9
Tel: 604-941-6664 Ext.226
Fax: 604-941-3659
Cell: 778-389-2227
marius.bocu@itt.com
www.ittwww.ca

Andy Setiawan

From: Denise Gohl [dgohl@westpromachinery.com]
Sent: Tuesday, December 16, 2008 1:49 PM
To: Andy Setiawan
Subject: WSI 12819: Stainless Steel Retrofit
Attachments: image001.jpg

Please see the following:

Retrofit of only the wetted components:
C/w new center column, rakes, cage, suction header, scum skimmer assembly, overflow weir and scum baffle from SS304.
Price: 330,000* CAD
*Budgetary Offer
Delivery: 12-14 weeks after drawing approval

Please let me know if you have any further questions or comments.

Season's Greetings,

Denise Gohl
Westpro Machinery Inc.
Phone:1.250.549.6710 ext. 212
Fax: 1.250.549.6735

From: Andy Setiawan [mailto:asetiawan@dayton-knight.com]
Sent: Monday, December 15, 2008 1:09 PM
To: Denise Gohl
Subject: Stainless Steel Retrofit

Hi Denise,

I just want to check the status of my enquiry on the stainless steel retrofitting.

Regards,

Dayton & Knight Ltd.
CONSULTING ENGINEERS

Andy Setiawan
#210-889 Harbourside Drive
North Vancouver, B.C. V7P3S1
Tel: 604-990-4800*125
Fax: 604-990-4805
Email: asetiawan@dayton-knight.com
Web: www.dayton-knight.com

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promag Enviro Systems Ltd.
Water & Wastewater Treatment & Control Equipment
8042 Winston Street, Burnaby, B.C. V5A 2H5 Toll Free: 1-866-449-2781
Email: info@promagenviro.ca Phone: 604-421-6844 Fax: 604-421-6842

January 14, 2009

TO: Dayton & Knight Ltd. – Consulting Engineers

ATTN: Andy Setiawan

SUBJECT: Campbell River, BC WWTP
Spiraflo Clarifier

Andy,

We are sending you information on a 27 m (88.5-ft) diameter x 5 m (16.4-ft) sidewater depth Spiraflo Clarifier for the Campbell River, BC project as received from Lakeside Equipment Corp.

Enclosed, please find copies of the following information:

- Bulletin 1219 - Spiraflo Clarifier
- D-18345-S - Spiraflo Clarifier Layout Drawing

INTRODUCTION

The heart of any biological process is the operation and performance of the final clarifiers. This is particularly true for plants that are subject to extreme levels of infiltration and inflow (I/I) or where chemical addition is to be provided. As shown in Bulletin 1219, the Lakeside Spiraflo Clarifier has a hydraulic efficiency of 2 to 4 times that of a centerfeed clarifier. We believe that the Spiraflo Clarifier has been the key to the success of our more than 2,000 Closed Loop Reactor (CLR) Process and fixed film process (trickling filter) installations world-wide.

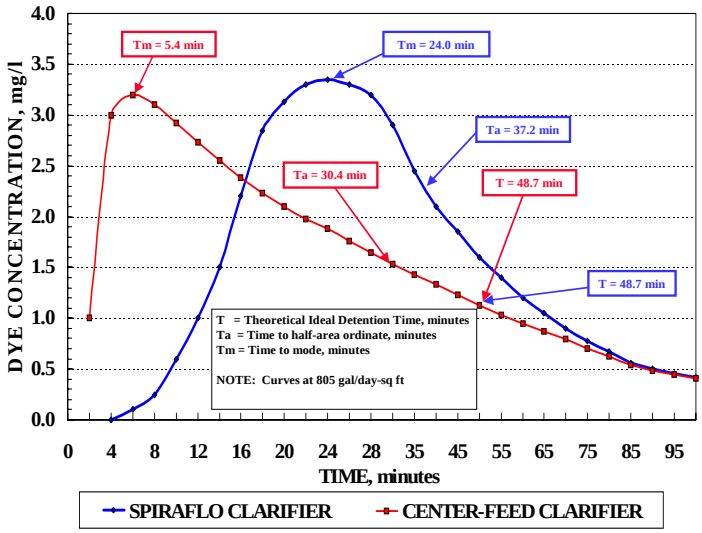
The Lakeside Spiraflo unit is a preferred choice for the following reasons.

FLOCCULATION

Incoming flows move in a downward spiraling motion around the race formed between the skirt and the tank wall. This rotational movement in the race gives the solids a chance to flocculate. This design also aids in the separation of solids from the liquid in the central section of the tank. Since no mechanical flocculators are required, operation is simple and maintenance is minimized. Only a low velocity gradient mixing tank with 30 second hydraulic detention time is required to flash mix alum and, if required, polymer.

SHORT-CIRCUITING IS PREVENTED

The flow enters the central section from the full circumference of the skirt. This distributes the flow evenly into the center section before rising to flow over the centrally located weir through. To maintain a uniform velocity in the center section, the length of the effluent weir is equal to or greater than the circumference of the skirt. This flow induction, skirt baffling, spiral downward and upward dispersement throughout the central zone, prevents any short-circuiting of the incoming flow. This provides better utilization of the total tank volume for more effective settling.



Research by Dr. E. Robert Baumann of Iowa State University clearly demonstrated that the Lakeside Spiraflo Clarifier was from 2 to 4 times more hydraulically efficient than a centerfeed clarifier.

Similar work conducted by CH2M-Hill in their study of chlorine contact tanks showed that the Spiraflo Clarifier design maintained a 90 to 100% plug flow relationship as compared to only a 38% plug flow relationship for a centerfeed clarifier. Although not related to this project, the CH2M-Hill study showed that the Spiraflo Clarifier design was as effective hydraulically as a 40-to-1 length to width ratio typical chlorine contact tank design.

DISCREET PARTICLE SETTLING

As the flow passes into the skirt, the flocculated solids and the discrete particles separate from the flow and settle to the clarifier floor. The 180% change in flow direction under the skirt enhances sedimentation of well flocculated and discrete particles in the Spiraflo Clarifier.

SLUDGE REMOVAL

Centerfeed clarifiers sometimes experience problems because sludge is moved toward the center, but the direction of flow is away from the center. With a light, fluffy floc, the flow can wash solids over the scraper blades and impair proper movement of solids to the center for withdrawal. This is not a problem in the Spiraflo Clarifier. The solids are scraped from the periphery to the center of the tank. The flow pattern is in the same direction, and actually assists in moving the sludge efficiently toward the center of the tank.

WATERFALL EFFECT

The separation of biological floc from the liquid will occur only below certain critical velocities. Activated sludge being fed to a clarifier with its high concentrations of mixed liquor suspended solids has a greater density than the liquid at the surface of the clarifier. When this denser material enters a centerfeed clarifier, it tends to follow the floor of the clarifier until it reaches a sludge blanket concentration of approximately 2,000 mg/L,

turns and moves across the floor to the outer wall, up the wall and over the effluent weirs.

In a centerfeed tank, the waterfall is a region of extremely violent agitation with considerable kinetic energy dissipated before the liquid gets to its new sense if direction and moves toward the tank periphery carrying with it eroded material. The area of disturbance in a centerfeed clarifier would be directly below the center well and at the centrally located hopper that hinders normal withdrawal of sludge. With waterfall effect hinders normal removal of settled sludge and can cause sever short-circuiting in centerfeed tank designs.

SLUDGE BLANKET

In a well-operated activated sludge system, the sludge blanket in the clarifier may be up to 4 feet or more in depth. The flow coming into the clarifier must pass below the skirt and then rise through the sludge blanket. Many of the fine colloidal solids being carried in the flow are retained within the blanket and not lost over the effluent weir. This retention of fine colloidal material within the sludge blanket is one of the more important performance features of the Spiraflo Clarifier.

As the depth of the sludge blanket increases, the concentration and compaction of sludge at the bottom of the clarifier will also increase. This reduces the total volume of sludge that must be moved from the clarifier back to the aeration process.

Because the Lakeside Spiraflo Clarifier race skirt divides the tank into a narrow outer race area (flocculation zone), and much larger inner tank area, (settling zone), it is well suited for chemical addition for phosphorus removal. The outer race area provides gentle turbulence to enhance flocculation. The hydraulic detention time for the outer race area is typically one hour at the design flow rate.

10-YEAR DRIVE WARRANTY

When you specify a Lakeside Spiraflo or Spiravac Clarifier you will not only get the superior performance of our peripheral-feed center take-off design, but you will also get the most reliable drive available. Our dedication to quality and proven reliability at more than 2,500 installations allows Lakeside to stand behind our clarifier drives with a 10-year warranty. The items covered in the 10-year warranty are as follows:

- Motor
- Worm Gear Speed Reducer
- Pinion Gear
- Spur Gear
- Guide Bearing
- Shear Pin Hub
- Thrust Bearing

SPIRAFLO CLARIFIER SELECTION

Drawing D-18345-S shows the dimensions for a 27 m (88.5-ft) diameter Spiraflo Clarifier mechanism.

BUDGET PRICE

A budget price for the 27 m diameter Spiraflo Clarifier mechanism, in a concrete tank by others, is as follows:

Budget price for one (1) 27 m (88.5-ft) diameter x 5 m (16.4-ft) sidewater depth Spiraflo Clarifier mechanism:	**$218,000 US Funds**

Please note US Funds quotation for budget purposes; however at a time of imminent order we will be able to provide Canadian Funds pricing.

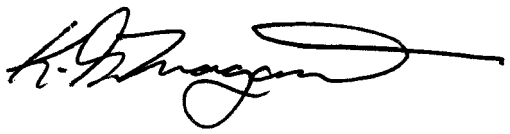
Approximate mechanism weight:	47,000 lb
Installation manhours:	250 man-hours

CONCLUSIONS

Please look over this information. If you have any questions or require additional information, please contact us.

Sincerely,

Promag Enviro Systems Ltd.



Ken Magaw, President

Andy Setiawan

From: promagkmagaw@gmail.com on behalf of Ken Magaw [kmagaw@promagenviro.ca]
Sent: Monday, December 22, 2008 11:07 AM
To: Andy Setiawan
Subject: Re: Clarifier enquiry
Attachments: image001.jpg

Andy,

A **budget price** for one (1) 32m (105-ft) diameter x 5m (16.4-ft) sidewater depth Spiraflo Clarifier is **$273,000 US FUNDS**.
This budget price includes freight to a Campbell River, B.C. site, and start-up service. No taxes included.
Provision of a concrete tank and installation is by others.
Please call if you have any questions.

Best regards,
Ken Magaw, President
Promag Enviro Systems Ltd.
Ph: 604-421-6844
Fax: 604-421-6842
Web: www.promagenviro.ca

On Fri, Dec 19, 2008 at 11:30 AM, Andy Setiawan <asetiawan@dayton-knight.com> wrote:

Greetings to you Mr. Ken Magaw,

Will you be able to provide me with a budget cost estimate for the same enquiry below. But instead of a 27 m diameter clarifier, it is a 32 m diameter. Same side water depth and weir overflow rate. I'm hoping to get the cost estimate Monday at the latest if possible.

Regards,

Andy Setiawan

From: promagkmagaw@gmail.com [mailto:promagkmagaw@gmail.com] **On Behalf Of** Ken Magaw
Sent: Thursday, November 20, 2008 2:11 PM

To: Andy Setiawan
Subject: Re: Clarifier enquiry

Andy,

We are sending you the following information on the 27 m diameter clarifier for the Campbell River, BC project;
(**please see the following attachments**):

1.) A design and budget pricing letter in a Word attachment
2.) Spiraflo Bulletin 1219, in a Pdf attachment
3.) Clarifier drawing D-18345-S, in a Pdf attachment

Please contact us if you need anything further.

Best regards,
Ken Magaw, President
Promag Enviro Systems Ltd.
Ph: 604-421-6844
Fax: 604-421-6842
Web: www.promagenviro.ca

On Mon, Nov 3, 2008 at 11:10 AM, Andy Setiawan <asetiawan@dayton-knight.com> wrote:

Hi Ken,

My answers are below in red. The plant itself is a secondary treatment plant with the following process (current):

- Headwork (screen)
- 2 Oxidation ditches with diffuser membrane (alternate operation)
- 2 Clarifiers (both running)
- Aerobic digester

A 3rd clarifier will be required when both of the oxidation ditches are in operation. As for point no. 4, instead of designing a totally new clarifier, we will design the 3rd clarifier the same the current two for now. The information of the current clarifiers is as follows:

- Diameter: 27m
- Side water depth: 5m
- Weir overflow rate: 77 m3/m/d
- Peak day flow rate: 107 m3/m/d
- Detention time: 13 hrs

Hopefully everything make sense. Let me know if it does not.

Regards,

Dayton & Knight Ltd.
CONSULTING ENGINEERS

Andy Setiawan

#210-889 Harbourside Drive

North Vancouver, B.C. V7P3S1

Tel: 604-990-4800*125

Fax: 604-990-4805

Email: asetiawan@dayton-knight.com

Web: www.dayton-knight.com

Please consider the environment before printing this e-mail

From: promagkmagaw@gmail.com [mailto:promagkmagaw@gmail.com] **On Behalf Of** Ken Magaw
Sent: Monday, November 03, 2008 10:31 AM
To: Andy Setiawan
Subject: Re: Clarifier enquiry

Hi Andy,

Thanks for your inquiry.
The information required is as follows:

- is it a primary or secondary (final) clarifier? Secondary clarifier (final)
- (assuming final clarifier) what is the TSS limit for the effluent? TSS limit = 45 mg/L
- what is the (aeration) process preceding the clarifier? Sequential On-Off air in oxidation ditch

- what is the design ave. daily flow; and what is the design peak hourly flow (or peaking factor)?

Best regards,
Ken Magaw, President
Promag Enviro Systems Ltd.
Ph: 604-421-6844
Fax: 604-421-6842
Web: www.promagenviro.ca

On Mon, Nov 3, 2008 at 9:46 AM, Andy Setiawan <asetiawan@dayton-knight.com> wrote:

Dear Mr. Ken Magaw,

I am Jonathan Knudsen's colleague which would like to get an enquiry on cost of clarifier. I was working with him on the Village of Montrose project. What sort of information do you required to come up with a figure? Note that the cost estimate is going to be for a new clarifier installation in the Campbell River WWTP (Norm Wood Env. Centre). The status of the project is at pre-design study.

Hope to hear from you soon.

Kind Regards,

Dayton & Knight Ltd.
CONSULTING ENGINEERS

Andy Setiawan

#210-889 Harbourside Drive

North Vancouver, B.C. V7P3S1

Tel: 604-990-4800*125

Fax: 604-990-4805

Email: asetiawan@dayton-knight.com

Web: www.dayton-knight.com

Please consider the environment before printing this e-mail

Andy Setiawan

From: Bocu, Marius - W&WW [Marius.Bocu@itt.com]
Sent: Friday, October 17, 2008 11:30 AM
To: Andy Setiawan
Subject: RE: Pumps enquiry
Attachments: NP3153.181LT-623_15hp.pdf; ITT_email_signature.gif; image001.jpg; image002.gif

Hi Andy,

Based on the new info supplied please find attached the N-pump selection, model NP-3153.181 LT 15HP 623impeller (222MM diameter), 600V/3 phase @ $19,000.00/each, c/w 16M power cable. The 250mm (10") discharge connection is sold separately and is $2,800.00/each.

Taxes and freight is not included.

Should you need any additional information or have any questions please do not hesitate to email or call me.

Thank you.

Best Regards,
Marius Bocu, BEng, AScT
Technical Sales Representative
ITT Water & Wastewater
74 Glacier Street
Coquitlam, BC V3K 5Y9
Tel: 604-941-6664 Ext.226
Fax: 604-941-3659
Cell: 778-389-2227
marius.bocu@itt.com
www.ittwww.ca

ITT

From: Andy Setiawan [mailto:asetiawan@dayton-knight.com]
Sent: Friday, October 17, 2008 9:17 AM
To: Bocu, Marius - W&WW
Subject: RE: Pumps enquiry

Hi Marius,

Duty point: 165 l/s, 3.6m head. This information is based on the existing duty point on the pump curve. What is the N-pump equivalent and how much will it cost?

Regards,

Dayton & Knight Ltd.
CONSULTING ENGINEERS
Andy Setiawan
#210-889 Harbourside Drive
North Vancouver, B.C. V7P3S1

Tel: 604-990-4800*125
Fax: 604-990-4805
Email: asetiawan@dayton-knight.com
Web: www.dayton-knight.com

Please consider the environment before printing this e-mail

From: Bocu, Marius - W&WW [mailto:Marius.Bocu@itt.com]
Sent: Thursday, October 16, 2008 6:04 PM
To: Andy Setiawan
Subject: RE: Pumps enquiry

Hi Andy,

Just noticed the CP3152.181 LT 250MM disch conn and 11.2KW (15HP) is no longer supplied with the 220MM impeller. Available options for the CP3152 LT 250MM discharge connection are: 244MM, 235MM and 216MM dia impeller.

The budget price for a pump with any of the above impellers c/w 16M power cable is $20,000.00/each. Taxes and freight is extra.

Should you need a N-pump equivalent please advise info requested in my previous email am I will gladly look into it.

Thank you.

Best Regards,
Marius Bocu, BEng, AScT
Technical Sales Representative
ITT Water & Wastewater
74 Glacier Street
Coquitlam, BC V3K 5Y9
Tel: 604-941-6664 Ext.226
Fax: 604-941-3659
Cell: 778-389-2227
marius.bocu@itt.com
www.ittwww.ca

ITT

From: Bocu, Marius - W&WW
Sent: Thursday, October 16, 2008 3:31 PM

To: 'Andy Setiawan'
Subject: RE: Pumps enquiry

Hi Andy,

The CP3152 is an older model. Still a valid model but, I may be able to find a N-version (N-type impeller) which is a clog free impeller with a better efficiency and a sustained efficiency. See attached info.

If you would like me to look for a N-version pump selection please advise duty point: flow, static head and TDH. Also the voltage available would be helpful as well.

Should you need any additional information or have any questions please do not hesitate to email or call me.

Thank you.

Best Regards,
Marius Bocu, BEng, AScT
Technical Sales Representative
ITT Water & Wastewater
74 Glacier Street
Coquitlam, BC V3K 5Y9
Tel: 604-941-6664 Ext.226
Fax: 604-941-3659
Cell: 778-389-2227
marius.bocu@itt.com
www.ittwww.ca

ITT

From: Andy Setiawan [mailto:asetiawan@dayton-knight.com]
Sent: Thursday, October 16, 2008 10:04 AM
To: Bocu, Marius - W&WW
Subject: Pumps enquiry

Hi Marius,

I would like to get a quote on the following pump cost:

- ITT Flygt 3152.181, outlet dia. 250mm, impeller dia. 220mm, motor power 11.2kW, rated speed 1135

This is for another part of Campbell River which might required a new pump.

Regards,

Dayton & Knight Ltd.
CONSULTING ENGINEERS

Andy Setiawan
#210-889 Harbourside Drive
North Vancouver, B.C. V7P3S1
Tel: 604-990-4800*125
Fax: 604-990-4805
Email: asetiawan@dayton-knight.com

Web: www.dayton-knight.com

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FLOWSERVE Pump Division

SMITH CAMERON PUMP SOLUTIONS

Contact: Karen Zhu
Address: #1, 13478-78 Avenue, Surrey BC, V3W 8J6
Phone: 604-596-5522

Pricing Sheet / Scope of supply

Customer: Dayton & Knight
Cust / Proj Ref: Campbell River WWT
Item Number: 1
Service:

Pump / Stg: 6MF11B FR3A / 1
Curve Number: 89116297
FPD Reference: 4618-80081
Date: Oct 20, 2008

Qty	Description	Average Unit Price	Extended Price
1	6MF11B FR3A FPD - CI "MF" Horizontal Pump No Horizontal Suction Head Discharge Nozzle- UP Viewed from Suction Channel Baseplate No Motor Mounting No Motor Pedestal Falk "T" Type Steel Prime Painted Mechanical Seals J. Crane Type 1 or Type 8-1-0 Type 1 Tung/Tung 304SS Gland Cast Iron ASTM 278 Cl 30 Casing Cast Iron ASTM 278 Cl 30 Impeller No Impeller Wearing Ring No Casing Wearing Ring ASTM A108 Gr 1045 Shaft 316L Stainless Steel Shaft Sleeve No Seal Cage Pump: Std IDP Primer and Finish Standard Balance No Bearing Housing Instrumentation Grease Lubrication No Anchor Bolts No Pressure Gauges No Hydro Test No Performance Test No Spare Parts No Boxing	Can $ 14602	Can $ 14602
1	Driver 7.50 hp 1200 RPM 254T Motor *1) 575V, TEFC, premium efficiency*	Can $ 1622	Can $ 1622

** - additional pricing to follow Feature quantities match pump quantity unless otherwise noted.

Prices may be subject to exchange rate fluctuations. Proposal is valid for 30 days.

Customer:	Dayton & Knight	Pump / Stg:	6MF11B FR3A / 1
Cust / Proj Ref:	Campbell River WWT	Curve Number:	89116297
Item Number:	1	FPD Reference:	4618-80081
Service:		Date:	Oct 20, 2008

Total: Can $ 16224 **Can $ 16224**

Options

1) Non-Witness Hydro Test — Can $ +140 each
2) Non-Witness Test — Can $ +1502 each

Comments

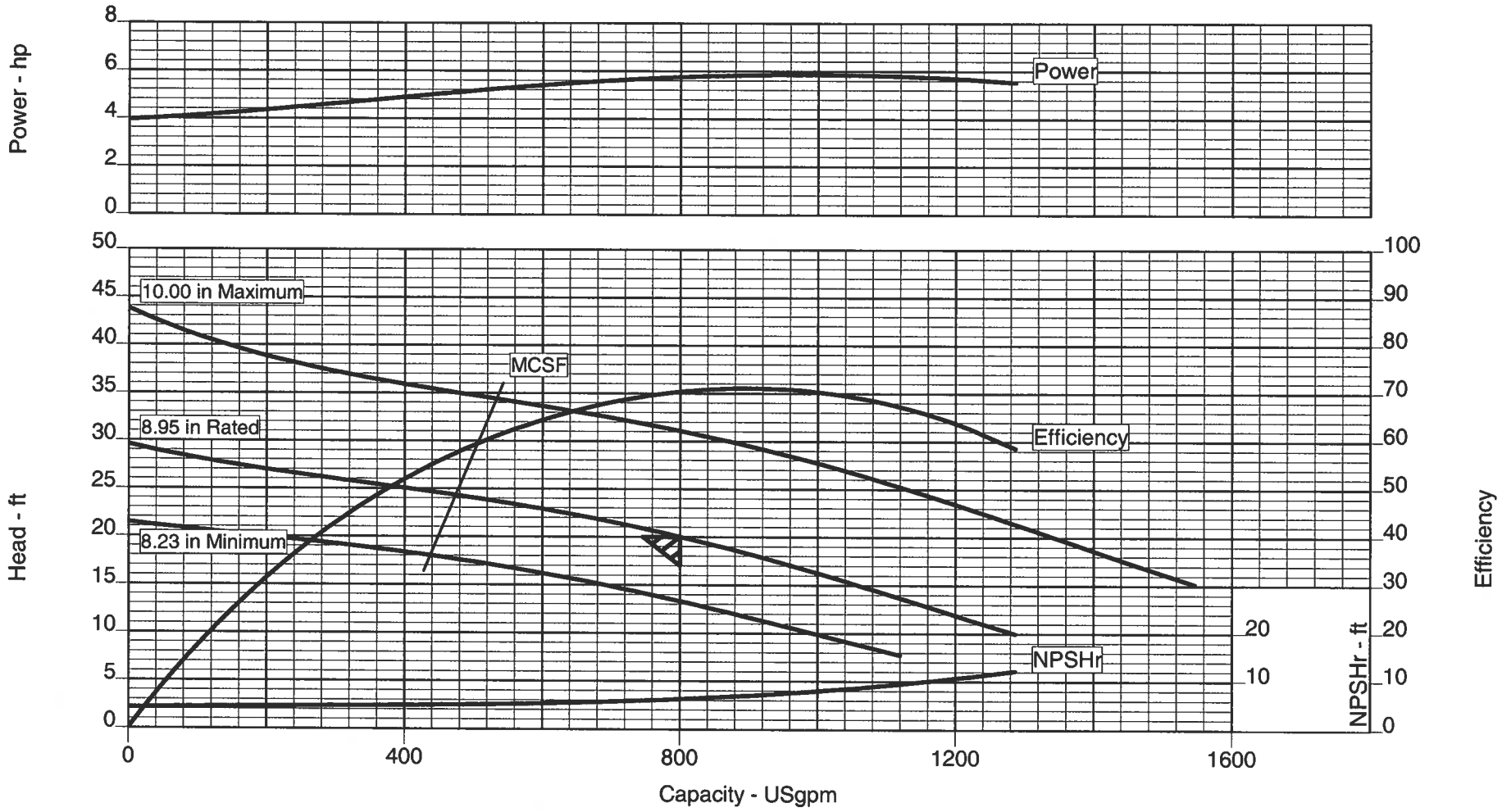
1) Shipment (after receipt of order) is 12 working weeks.

Prices may be subject to exchange rate fluctuations. Proposal is valid for 30 days.

Customer	: **Dayton & Knight**			Pump size & type	: **6MF11B FR3A**
Item number	: **1**			Based on curve no.	: **89116297**
Service	:			Number of stages	: **1**
Vendor reference	: **4618-80081**	Capacity	: **800.0 USgpm**	Specific gravity	: **1.000**
Date	: October 20, 2008	Head	: **20.00 ft**	Pump speed	: **1180 rpm**

FLOWSERVE Pump Division

CURVES ARE APPROXIMATE, PUMP IS GUARANTEED FOR ONE SET OF CONDITIONS, CAPACITY, HEAD, AND EFFICIENCY.



FLOWSERVE Pump Division

Hydraulic Datasheet

Customer	: Dayton & Knight	Pump / Stages	: 6MF11B FR3A	/ 1
Customer reference	: Campbell River WWT	Based on curve no.	: 89116297	
Item number	: 1	Vendor reference	: 4618-80081	
Service	:	Date	: October 20, 2008	

Operating Conditions

Capacity	: 800.0 USgpm
Water Capacity (CQ=1.00)	: -
Normal capacity	: -
Total Developed Head	: 20.00 ft
Water head (CH=1.00)	: -
NPSH available (NPSHa)	: Ample
NPSHa less NPSH margin	: -
Maximum suction pressure	: 0.0 psig

Liquid

Liquid type	: Sewage	
Temperature / SG	: 60 °F	/ 1.000
Solid Size - Actual / Limit	: -	/ 3.00 in
Viscosity / Vapor pressure	: 1.0 cSt	/ -

Materials / Specification

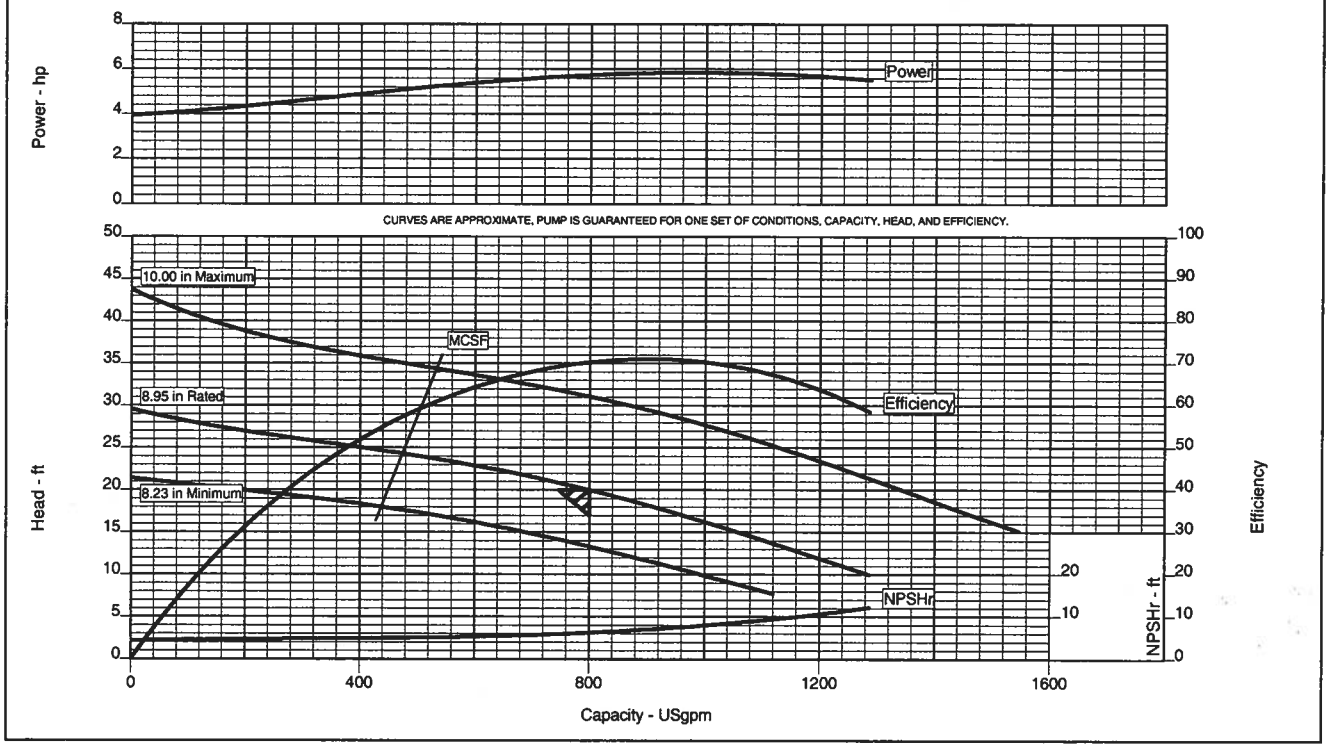
Material column code	: CI
Pump specification	:

Other Requirements

Hydraulic selection : No specification
Construction : No specification
Test tolerance : Hydraulic Institute Level A
Driver Sizing : Max Power(MCSF to EOC)with SF

Performance

Hydraulic power	: 4.04 hp	Impeller diameter	
Pump speed	: 1180 rpm	Rated	: 8.95 in
Efficiency (CE=1.00)	: 70.3 %	Maximum	: 10.00 in
		Minimum	: 8.23 in
NPSH required (NPSHr)	: 6.3 ft	Suction specific speed	: 8320 US units
Rated power	: 5.75 hp	Minimum continuous flow	: 475.6 USgpm
Maximum power	: 5.84 hp	Maximum head @ rated dia	: 29.6 ft
Driver power	: 7.50 hp / 5.59 kW	Flow at BEP	: 899.4 USgpm
Casing working pressure	: 12.8 psig	Flow as % of BEP	: 88.9 %
(based on shut off @ cut dia)		Efficiency at normal flow	: -
Maximum allowable	: 60.0 psig	Impeller dia ratio (rated/max)	: 89.5 %
Hydrostatic test pressure	: 75.0 psig	Head rise to shut off	: 47.9 %
Est. rated seal chamb. press.	: -	Total head ratio (rated/max)	: 64.4 %



FLOWSERVE Pump Division

Construction Datasheet

Customer	: Dayton & Knight	Pump / Stages	: 6MF11B FR3A / 1
Customer reference	: Campbell River WWT	Based on curve no.	: 89116297
Item number	: 1	Vendor reference	: 4618-80081
Service	:	Date	: October 20, 2008

Construction

Nozzles	Size	Rating	Face	Pos'n
Suction	-	-	-	-
Discharge	6.00 in	-	-	-

Casing mounting	: -
Casing split	: -
Impeller type	: -
Bearing Type (Rad/Thr)	: - / -
Bearing lubrication	: -
Rotation (view from cplg)	: -

Materials

Casing	: -
Impeller	: -
Case wear ring	: -
Impeller wear ring	: -
Inducer	: -
Shaft	: -
Sleeve	: -

Baseplate, Coupling and Guard

Baseplate type	: -
Baseplate material	: -
Coupling manufacturer	: -
Coupling size	: -
Coupling / Shaft guard	: -

Weights (Approx.)

Bareshaft pump(nett)	: -
Baseplate(nett)	: -
Driver(nett)	: -
Shipping gross weight/vol.	: - / -

Driver Information

Manufacturer	: Baldor
Power	: 7.50 hp / 5.59 kW
Service factor (req'st / act)	: 1.15 / 1.15
Speed	: 1200 rpm
Orientation / Mounting	: Horizontal / Foot
Driver Type	: -
Frame-size / material	: 254T / -
Enclosure	: TEFC
Hazardous area class	: -
Explosion 'T' rating	: -
Volts / Phase / Hz	: 575/0 / 3 / -
Amps-full load/locked rotor	: - / -
Motor starting	: Direct on line (DOL)
Insulation	: -
Temperature rise	: -18 ℃
Motor mounted by	: -

Seal, Gland and Piping

Arrangement	: -
Size	: -
Manufacturer / Type	: - / -
Material code (Man'f/API)	: - / -
Internal neck bushing	: -
Gland material	: -
Flush	: -
Vent	: -
Drain	: -
Auxiliary sealing device	: -
Seal flush plan	: -
Seal flush material	: -
Aux seal flush plan	: -
Aux seal flush material	: -

Endress+Hauser Canada Ltd.
PO Box 91044
W. Vancouver, BC, V7V 3N3

Project name: 14.01.2009
Project no.:
Cart: Dayton & Knight - Campbell River Sludge Level

Pos.	Qty.	Ordercode Product	MatNo.	SPK	Total net price
1	1	CUM750-1E1AA Sludge level transmitter CUM 750 SPK: CDL [1] Version: 1-channel [E] Language: English [1] Power Supply: 115VAC [A] Output: 4-20 mA + RS232 [A] Additional Option: Basic version	51503571	CDL	8310.00
2	1	CUS70-1A3A Sludge level sensor CUS 70 SPK: CDA [1] Version: Basic version [A] Cable Length: 13m [3] Cleaning System: Pump 115VAC + mounting bracket [A] Additional Option: Basic version	51503572	CDA	2860.00
		Total net price			**11170.00**

PROPOSAL

Proposal to .....DAYTON & KNIGHT

To the attention of.....ANDY SETIAWAN

Project .....NORM WOOD WWTP - Campbell River

Date 2008-10-10

Station.....SR4650 MIXER C/W JETRING & TRIPOD

No. Quotation ITT 08-70-4851

Representative .....Marius Bocu

ITT | Water & Wastewater

74 Glacier Street, Coquitlam, BC V3K 5Y9
Telephone: 604-941-6664 - Telefax: 604-941-3659

No. Quotation ITT..... 08-70-4851
Date..... 10/10/2008
Customer Ref.....
Project.....

ITT Water & WasteWater hereinafter called the Company of the Vendor, proposes to furnish the Purchaser the Equipment covered by this proposal, as follows:

SR4650 MIXER C/W JETRING & TRIPOD

Qty	Description
2	4650.410-2589 FLYGT MODEL SR-4650 SUBMERSIBLE MIXER 600 VOLT 3/60 8.3HP/6.2KW 575 RPM S/S PROP 125803SJ 16M AWG 14/7 S/S BODY C/W FLS
2	13-00 93 01 TRIPOD FOR MIXER SR4650, 4" SQUARE TUBE, 6 METER LONG MAXIMUM
1	GL-9571 FREIGHT CHARGES TO SHIP EQUIPMENT FROM OUR MONTREAL WAREHOUSE TO SITE.

Total Price CAD 42630.00

Total Price of Quotation
42630.00

Prices	**Prices in Canadian dollars.**
Taxes	**All taxes extra and not included in the above prices.**
Terms of delivery	10-11 weeks upon receipt of approved drawings. Subject to Approved Credit.
Terms of payment	30 days from invoice date
Validity	This Quote is valid for thirty (30) days.
Comments and Exceptions	This proposal is in accordance with our interpretation of the plans and specifications provided to us. All equipment offered is subject to the engineers/customers acceptance, and we reserve the right to withdraw our offer if such acceptance is not granted. Should any changes be made regarding the quantities and/or construction of the equipment offered, extra charges will apply accordingly. Comments and Exceptions are part of this proposal and must be observed. **All installations, controls, start-up, mixer and all other equipment not listed in this proposal are by others.**

ITT | Water & Wastewater

74 Glacier Street, Coquitlam, BC V3K 5Y9
Telephone: 604-941-6664 - Telefax: 604-941-3659

No. Quotation ITT..... 08-70-4851
Date..... 10/10/2008
Customer Ref.....
Project.....

Sincerely,

Ireneo Sioson
Technical Inside Sales
604-941-6664
Ireneo.Sioson@itt.com

ITT | Water & Wastewater

74 Glacier Street, Coquitlam, BC V3K 5Y9
Telephone: 604-941-6664 - Telefax: 604-941-3659

No. Quotation ITT..... 08-70-4851
Date..... 10/10/2008
Customer Ref.....
Project.....

General Conditions of Sale or Rental

1. ITT Water & Wastewater, a division of ITT Industries of Canada Ltd. ("the Company") will fill orders pursuant to the following General Conditions of Sale or Rental, which General Conditions will apply, notwithstanding all other terms and conditions, whether written or not, notwithstanding those set out on Buyer's Purchase Order.

2. Payment is due thirty (30) days following date of full or partial shipment, on approved credit. Interest on past due payments will be calculated at a rate of eighteen per cent (18%) per annum (1.5% per month) on the overdue balance. Buyer pays all taxes as well as additional charges resulting from modifications or errors in Buyer's design drawings. Shipping is FOB Company's factory. This Order is not subject to hold back.

3. Company will not be responsible for losses or delays arising from force majeure events or for consequential or indirect damages, however caused. In all cases, the liability of Company for damages arising directly from late delivery shall be limited to five percent (5%) of contract value, regardless of cause. A claim for damages arising from delay will not exist until the presentation to the Company of independently verified actual damages directly resulting from the delay.

4. Company guarantees products manufactured by Company to the original user against defects in material and workmanship under normal operating conditions which comply with written Company operating instructions. Various products are guaranteed for the following periods:

- BS, DS, CS and HS Flygt pumps are guaranteed for the lesser of six months following installation or twelve months from shipment by Company.
- All other Company products are guaranteed for the lesser of twelve (12) months following installation or eighteen (18) months from date of shipment.
- Repairs carried out by Company service personnel are guaranteed for a period of ninety (90) days following date of repair, applicable only to those parts repaired or replaced.
- Replacement parts shipped separately and not installed by Company are guaranteed for a period of thirty (30) days following shipment.

This guarantee will not apply to products or parts which have been subjected to accidents, negligence, abuse, or use, installation, service, storage, handling or treatment in a manner contrary to the written instructions of Company or to products on which the identification plates have been modified or removed. The Company must receive written notice of all claims during the guarantee period. The Company will, at its sole discretion, decide whether to repair or replace defective goods. Buyer will pay all other charges, including, but not limited to, shipping, handling and installation and removal charges. Company does not guarantee any equipment as fit for a particular purpose and does not provide any guarantee of plans and designs supplied by Buyer, or of parts or components provided by others. Company guarantees only that equipment manufactured and conforming to plans and specifications provided by the Buyer will conform to those plans and specifications and not to any particular performance standard.

This guarantee is in place and in lieu of all guarantees or warranties whether provided in law or otherwise, of merchantability and/or fitness for any particular purpose. The obligation of the Company to repair or replace all defective parts is the sole recourse of the Buyer and the value of the liability incurred thereby shall be limited to the lesser of the cost of the repair or the replacement of the part in question.

5. The Company will defend all claims or allegations that the goods violate any Canadian copyright, trademark, or other intellectual property rights, provided that the Company is promptly advised of such claims, that the Buyer assists the Company as requested in such defense (in the preparation of the necessary documentation) and goods have been paid for in full. The liability of the Company shall not extend to goods manufactured to Buyer's plans and/or specifications, for which the Buyer will indemnify the Company for all costs or damages resulting from a violation of a patent or other similar claim.

6. The cumulative liability of the Company from all causes and as set out herein shall not exceed the total value of the sale or rental.

7. In the event that any part or portion of this contract is ruled invalid or unenforceable by competent authority, such provision shall be severed from the contract without affecting the validity or enforceability of the balance.

8. The sale or rental is governed by the laws of Canada and the province to which the goods are shipped, unless the shipping destination is outside Canada in which case the laws of Quebec shall apply.

9. Company shall retain title to the goods until payment in full, Buyer shall not sell or transfer the goods to a third party before Company has received full payment for the goods in question. Buyer acknowledges receipt and agrees to these general conditions and has had the opportunity to consult counsel in connection herewith. Buyer agrees and represents that the goods sold pursuant to these General Conditions will not be installed or used in a nuclear facility.

10. The use of a variable speed drive without proper sizing, harmonics, filtering, protection etc... could result in damages to the motor or to other equipment on this system. Using variable speed drive control without the express written agreement of the Company will void all warranties.

11. Ce contrat est rédigé en Anglais à la demande expresse des parties aux présentes. This contract has been prepared in English at the specific request of the parties hereto.

This quotation is hereby accepted on _____ day of _____ 20_____.

by _____ _____

Name of the Customer | Signature of the Customer

ITT | Water & Wastewater

74 Glacier Street, Coquitlam, BC V3K 5Y9
Telephone: 604-941-6664 - Telefax: 604-941-3659

Founded
1971

ENVIRODYNE SYSTEMS INC.

75 Zimmerman Drive Camp Hill, PA 17011-6822

Fax
717 - 763-9308

Telephone
717 - 763-0500

BUDGETARY PROPOSAL

December 19, 2008

To the Contractors Bidding On:

City of Campbell River
Campbell River WWTP
Campbell River, B.C., Canada

Authorized Representative:

SANITHERM ENGINEERING LTD.
Suite 100-340 Brooksbank Avenue
North Vancouver, B.C., Canada V7J 2C1

Attn.: Richard Higgins, P.E.
Phone: (604) 986-9168
FAX: (604) 986-5377

Envirodyne Systems Inc., called the Seller, proposes to furnish to the General Contractor, called the Buyer, on the terms and conditions stated the equipment herein specified for installation in the WWTP, Campbell River, B.C., Canada.

Detailed Specifications set forth below or which may be attached hereto are a part of this Proposal.

EQUIPMENT

Ref.: ROTARY SLUDGE THICKENING SYSTEM...AND ACCESSORIES

One (1) **ROTARY DRUM THICKENER SYSTEM**, consisting of:

Item No. 1

One (1) **ALL-AMERICAN™** Thickener, Model USAT-90 with:

Main Frame, heavy-duty 304 stainless steel channels with support legs
Gravity Dewatering Drum, 304 S.S. construction, min. 92 sq.ft. filtration area, multi-compartment design with plows, monofilament polyester screen with S.S. straps & fasteners, bearings, min. $B_{10} \geq 100{,}000$ hrs., grease-lubricated pillow block type with spring-loaded lip seals
Cover Frame, 304 S.S. with S.S. cover & fabric-reinforced rubber side curtains
Wash Station with S.S. header pipe, flat recessed S.S. nozzles & handwheel-operated wire brush purging system flow regulating bail valve, pressure reducing valve, pressure gauge (0-100 PSI) with diaphragm, NEMA 4 solenoid valve & Sch. 80 PVC piping
Drain Pan, min. 16 ga. 304 S.S. with 3" long nipple outlet with 6" flange

(cont'd.)

Ref.: ROTARY SLUDGE THICKENING SYSTEM...AND ACCESSORIES (cont'd.)

Thickened Sludge Discharge Chute with transition pipe & flange to El. 751.75
Drive Unit, 1-1/2 HP TEFC NEMA 1.15 S.F., Cl. F insl., Cl. B temp. rise, severe duty package, motor for 460/3/60, AGMA Cl. II helical gear reducer with Eurodrive Varimot, variable speed, ERC & RSI for 20% - 100% range, chain & sprockets with S.S. guard & auto-lubricator
Fasteners, S.S.

Item No. 2

One (1) **Sludge Conditioning System**, consisting of

G^t Mixer™, 4" 304 S.S. constn. with adjustable counterweighted mixing device, pressure gauge (0-30 PSI) with diaphragm & UHMW polymer injection ring with PVC manifold & hoses.

Conditioning Tank, 304 S.S., nom. 160 gallon floor-mounted design with 4" flanged inlet, 6" flanged outlet & 3" drain
Drive Unit, 1/2 HP TEFC NEMA DC shunt wound C-face motor (180 volt armature & 200 volt field), AGMA-rated worm gear reducer, & channel support S.S. shaft & mixing blade
Discharge Pipe & Drum Inlet Trough, S.S.

Polymer Feed System, pre-engineered package-type designed to blend 0.2 - 4.5 GPH "neat" emulsion polymer with 120-1200 GPH potable dilution water, to include:
Frame, 304 S.S.
Inlet Water Assembly with NEMA 4X solenoid valve, rotameter, pressure gauge & control valve
Polymer Feed Pump, solenoid-operated diaphragm type with local adjustable stroke & frequency
Calibration Column
Mixing Chamber with check & needle valves, and outlet pressure gauge
NEMA 4X 304 S.S. enclosure with on/off/remote selector switch & 5.0 cord with 3-prong plug for 120/1/60 service

Item No. 3

One (1) **Control Panel**, to be NEMA 4X 304 S.S. enclosure, mounted on Thickener Frame, designed in accordance with NEC & UL standards & with UL "workmanship" label for operation on 30 amp 460/3/60 4-wire protected service, with "semi-automatic" operating logic, to include:

- Main Breaker with door-mounted disconnect
- Fuses & Control Transformer
- Starter, FVNR with overloads
- SCR Drive & Potentiometer
- PB's, Indicating Lights & Speed Indicator
- Alarm Light, Horn, Silence PB & Emergency Stop PB
- Auxiliary Contacts & Terminal Strip
- Spare Parts (as applicable) per Pg. GC-95.

(cont'd.)

Ref.: ROTARY SLUDGE THICKENING SYSTEM...AND ACCESSORIES (cont'd.)

Notes:
a. Thickener drive & servo motors, and wash station solenoid valve will be wired to Control Panel.

b. Conditioning Tank drive motor will be shop-wired to Control Panel, then disconnected for field reconnection by others.

c. All shop-installed conduit will be non-metallic, flexible & watertight per Pg. GC-58.

d. Conduit, wiring & receptacle between Thickener Control Panel & Polymer Feed System not included & to be field-installed by others.

NOTES:
(1) Demolition, installation, concrete work & grout, piping (sludge, polymer, potable & non-potable water), spool pieces, miscellaneous valves & fittings, backflow preventer, pressure gauges (except as listed above), field conduit & wiring, local disconnects if required by code, field touchup painting, lubricants & tools are NOT included.

(2) Cinch type anchors are recommended and NOT included.

(3) Field services to conduct installation checkout, startup & process performance test are included. Utilities including power, polymer & thickened sludge disposal are NOT included. Costs for independent testing laboratory are NOT included.

(4) Seller will provide specific general arrangement & isometric piping drawings showing recommended equipment layouts and piping connections.

(5) Sludge Pump & Accessories NOT included.

GENERAL

Reference may be made in this Proposal to certain Specification Sections. This is done strictly for identification purposes and is not to be construed that Envirodyne Systems Inc. proposes to furnish all items required by the referenced Sections. Only the items specifically mentioned or described in this proposal will be furnished.

Equipment and materials offered are of standard design and will comply with the general intent of the Specifications but may vary in some detail from that specified. Our tender is offered in good faith and we shall not be liable for any costs, direct or indirect, resulting from disapproval by the Owner.

Motors, speed reducers and castings will be given the manufacturer's standard paint and surface preparation and prime coat. Ferrous parts not galvanized to receive one shop coat of approved primer. Finish coats are not included except as noted herein.

DRAWINGS

Included in the price are the necessary General Arrangement and Approval Drawings, Parts Lists and Erection Drawings. Also included are detailed Erection, Maintenance and Operating Instructions.

SERVICES

Also included in the price are the services of a qualified Field Representative for inspection and checkout of the Equipment after installation by others and for initial instruction of the Owner's personnel in the care, maintenance and operation of the Equipment according to the following schedule:

Equipment	Days	Trips
Rotary Drum Thickener System	3	2

Additional service is available at a per diem rate of US$1000 plus travel and living expenses.

ESTIMATED SHIPMENT

Based upon present conditions, it is estimated shipment of the Equipment can be made within 20 to 22 weeks after receipt of approved drawings and release for manufacture.

If a delay in shipment, in excess of thirty (30) days is requested after shipment is scheduled then an additional charge of 2% per month of the total price will be added until shipment can be made.

BUDGETARY PRICE

Budgetary price for EQUIPMENT, DRAWINGS and SERVICES described in this Proposal, F.O.B. Factory with truck freight allowed to the nearest accessible point to the jobsite is .....US$***149,820.00***.

Note: (1) Above budgetary price is U.S. dollars.
(2) Budgetary price does not include G.S.T. &/or P.S.T. which may be applicable to this transaction.
(3) Budgetary price does not include brokerage fees, duties or excise taxes.

An Order in Canadian dollars is acceptable based on exchange rate of $1.00 US dollar = $1.23 Canadian dollars. If the exchange rate at the time of shipment exceeds $1.00 US dollar = $1.26 Canadian dollars (as published in the Wall Street Journal) the price will be increased by the same percentage as the rate exceeds US$1.00:CDN$1.26).

TERMS

Net thirty (30) days after date of Invoice for complete or partial shipments. The right is specifically reserved to make and invoice partial shipments.

Interest on past due accounts is charged at 1-1/2% per month. These terms are independent of and not contingent upon the time and manner in which the Buyer received its payments from the Owner.

* * * * * * *

Andritz Dewatering Technologies

Andritz Budgetary Proposal

To

Dayton & Knight Ltd.

Mr. Andy Setiawan

#210-899 Harbourside Drive
North Vancouver, BC V7P 3S1

for

Centrifuge Application

Andritz Separation Inc. Local Representative

Smith Cameron Pump Solutions
Surrey, BC
(604) 596-5522

Table of Contents

GENERAL INFORMATION FOR ANDRITZ PROPOSAL

I. Proposal being presented by:

Andritz Separation Inc.
1010 Commercial Blvd. S.
Arlington, TX 76001
(817) 465-5611

Regular business hours are 8:00 am to 5:00 pm, Monday – Friday, Central Standard Time.

Andritz Separation Inc. is an incorporated, international business, incorporated under the laws of the state of Delaware since 1978.

The Andritz Separation Inc. location stated above will be responsible for the work to supply the centrifuge dewatering equipment being proposed in this package.

This Andritz Separation Inc. Location stated above is a subsidiary of the parent company, Andritz in Graz, Austria.

II. Names of Andritz contacts authorized to make representation regarding this proposal:

John Madden – President
Bob Hill – Vice President, Sales
Todd Pratt – Regional Sales Manager

October 9, 2008

Dayton & Knight Ltd.
#210-899 Harbourside Drive
North Vancouver, BC V7P 3S1
Attn : Mr. Andy Setiawan
Phone: (604) 990-4800 ext.125
Fax: (604) 990-4805
asetiawan@dayton-knight.com

REFERENCE: Centrifuge Application

Mr. Setiawan,

As requested, Andritz is pleased to provide this information package outlining the features and benefits of the Andritz centrifuge equipment and its potential application. This proposal is submitted based on acceptance of Andritz Separation's attached Standard Terms and Conditions of Sale, payment schedule, and delivery schedule. If awarded this project, this shall form a basis for negotiation between the purchaser and Andritz Separation.

I would like to point out that all of the Andritz products are engineered for a quality competitive market. This market desires equipment with the longest life cycle time, ease of operation and lowest maintenance costs. The following outline of the features and benefits of the Andritz equipment will help to define why Andritz competes in this market area.

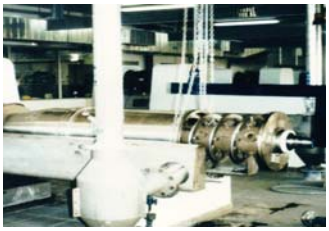
Andritz has built a reputation for manufacturing quality competitive equipment, backed by outstanding after the sale service and assistance. Should Andritz be purchased for this project, you can rest assured that the dewatering equipment need will be met with total satisfaction.

Sincerely,

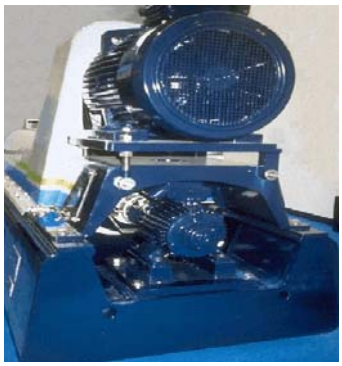
Todd R. Pratt
Regional Sales Manager
Andritz Separation Inc.

Features and Benefits of the Andritz Centrifuge Technology

Andritz offers many user-friendly features that our customers find of great benefit. These features are not limited to but certainly include the following:



- **Field Service:** The Andritz centrifuge can be maintained in the field. We are able to remove our conveyor in approximately forty-five minutes. Our bowl and conveyor are balanced independently and at full operational speeds. The benefit is elimination of re-balancing when you remove or replace the conveyor.



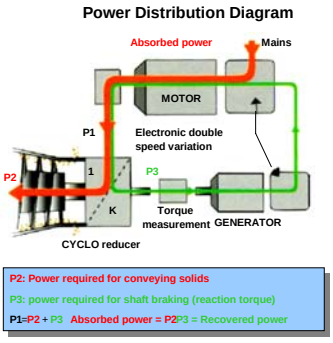
- **Electrical Control Features:** Andritz utilizes AC motors with VFD speed controllers. The benefit of which is process flexibility. This feature provides two electro-mechanical points of process optimization; bowl speed and conveyor differential speed. Both are set directly from our control panel simply by inputting the desired parameter.

  The above feature along with our standard automatic torque control and touch screen human interface permit the owner to easily identify, control and adjust the polymer dosage and cake solids. Once set points are identified and input into the PLC, the system will run unattended with ease and reliability, even as feed solids change during the dewatering cycle.

  Andritz pioneered the power regeneration technology available in the centrifuge market today. Power regeneration has always been a standard feature from Andritz in the North American market place.

  Another standard feature of our control system is “one button” sequential start and stop commands. This feature automatically and in correct order energizes and de-energizes the process required ancillary equipment.

  Andritz has developed and implemented many **“New Age”** technology features. Such technology includes *Early Start, Extended Run, Pause/Resume and One Touch* operational features. These features allow for totally automatic / operator, unassisted start up, optimization, operation and shut down.



- **Controls Assembly:** Andritz designs, assembles and tests all our controls in our Arlington, Texas facility. All controls are UL listed and supplied with U.S. parts. All other centrifuge manufacturers out source this critical fabrication and assembly. Industry studies have shown that centrifuge customers consider centrifuge electronics to offer the greatest frustration. In response to the market's concern we have engineered and selected electrical components with reliability being priority number one. Andritz utilizes **"in house"** electrical engineering. We design, wire, assemble and shop test all our control panels. Andritz has proven that this provides our customers with high levels of controls reliability.

- **Conveyor Access:** The Andritz centrifuge design is a result of the feedback we have received from our existing customers. We have responded with a design that combines process and maintenance advantages. For example, the feed end is also the access end. Our customers are able to remove and inspect the conveyor and interior bowl wall in less than ninety minutes. Re-assembly requires an equal amount of time. We balance our bowls and conveyors at actual operating speeds prior to shipment. The primary benefit of balancing at full operating speeds is the ability to exchange conveyors in the field without re-balancing. **We demonstrate this on the pilot test trailer during most of our on site pilot tests.**

- **Abrasion Protection:** Andritz provides the latest field replaceable innovations concerning hard surfacing of wear areas. The complete length of the scroll flighting edge is lined with sintered tungsten tiles rated for an average service life of 20,000 operating hours. Both the feed and discharge ports are field replaceable and feature tungsten inserts. The discharge housing is lined with a field replaceable tungsten liner. When, and if the conveyor needs re-balancing, we offer a conveyor exchange program at no charge.

- **Field and Office Support:** All field replaceable wear parts; feed and discharge ports, wear tiles and drive belts can be replaced without re-balancing. We offer a 24/hr-day service phone. We are accustomed to meeting the needs of our customers and in priority situations ship parts via over night delivery. All spare parts will be available from our warehouse in Arlington, TX. Andritz believes their customers have free access to all aspects of the equipment they purchased. Naturally we provide "as built" drawings with our equipment O&M manuals.

- **Process Advice:** Processes change over time. Andritz maintains a fully staffed applications laboratory for trouble-shooting upset conditions for our customers. There is no charge, and is without restriction to all our customers. Degreed engineers with over 20 years applications experience staff our in house laboratory.

- **Summary:** In summary, we recognize that Andritz has to go the extra mile for our customers. Andritz has built a reputation for manufacturing quality competitive equipment. Andritz is also recognized for providing outstanding after the sale service and assistance. Should Andritz be purchased for this project, the consultant and customer can rest assured that their dewatering equipment needs will be met with total satisfaction.

Chronology of Andritz Decanter Centrifuge Innovations

The following brief summery highlights the effect our decanter has made on the US market since its introduction in 1994.

- 1950, known as Andritz/Guinard today, the Pompes Guinard Group is formed;
- 1963, first decanter delivered;
- 1973, Châteauroux, France factory opened and dedicated to only decanter production;
- 1990, In-line drive design launched;
- 1992, Energy recovery system introduced to the world;
- 1993, Andritz and Guinard form a marketing partnership for North America;
- 1994, Andritz begins marketing in the U.S. utilizing the AC/VFD drive package. The market place recognizes the benefits of this technology and has now become the standard in the industry;
- 1994, Andritz first introduced true power re-circulating drive packages with reduced in-rush amps utilizing VFD controllers. The industry standard was a Wye-Delta starting package, requiring specialized motors and having a six to eight times more amperage surge at start up. Now, four years later the Andritz approach is the industry standard;
- 1994, Andritz first offered the marketplace the option of bowl and scroll speed control via VFDs.;
- 1996, Andritz purchases 50% ownership of the Guinard Centrifugation Company with an agreement to purchase 100% of the company within the near future;
- 1996, Andritz introduced improved “Noise Abatement” features. All Andritz centrifuges develop 87dBA or less;
- 1998, Andritz standardizes on Allen Bradley series 1000 O.I.T eliminating the need for proprietary controls;
- 1999, Andritz includes modem in all panels as a standard;
- 2000, Andritz launches “Operators Companion” software upgrades;
- 2002, Andritz finalizes the purchase of Guinard Centrifugation;
- 2004, Andritz purchases the Bird / Humboldt Centrifuge Company which includes the R&B Plate and Frame division;
- 2005, Andritz purchases the Netzsch Filter Company.
- 2005, Andritz introduces a revolutionary new model utilizing a unique drive system combining two motors into one.

Andritz
Budgetary Proposal

To

Dayton & Knight Ltd.

October 9, 2008

A. Design Criteria

1. Type of Sludge: ..... Aerobically Digested WAS
2. Design Throughput (Current Conditions): ..... 2,800 kg/hr TS
3. Design Throughput (Future Conditions): ..... 4,000 kg/hr TS
4. Hydraulic Loading: ..... 23 – 34 cu.m/hr
5. Inlet Consistency: ..... 2.0% TS by weight
6. Operating Conditions: ..... 6 hrs/day, 5 days/week

B. Equipment Required and Expected Performance

1. Number of Units Required (Both Conditions): ..... **One (1)**
2. Model of Centrifuge (Both Conditions): ..... D5LX High Solids Centrifuge
3. Anticipated Cake Consistency: ..... 21±2%
4. Solids Capture Efficiency: ..... 95% TSS
5. Polymer Consumption (Active kg/tonne): ..... 10±2 kg/tonne

Note:

All performance values listed above are obtained from Andritz experience from similar installations and laboratory testing. Laboratory analysis and or on site pilot testing of specific sludge is required to determine actual performance capabilities for specific installations.

C. Andritz Budget Pricing

Budget Price for one (1) operating D5LX is:.....$420,000.00 USD ea.

Budget Price for one (1) redundant D5LX is: .....$420,000.00 USD ea.

The budgetary pricing above will remain valid for **60 days** from the date of this information package.

Andritz's standard delivery time is listed below.
Submittals: 30 days after receipt of order
Equipment: 24 – 28 weeks after approved submittals

Andritz's standard Terms of Payment:
Upon Approved Submittals: 15%
Upon Equipment Delivery: 85%

D. Scope of Supply

1. The Andritz D5LX Decanter Centrifuges Are Furnished Standard With:

Scroll/Bowl:	316L Stainless Steel
Wetted Parts:	316L Stainless Steel
Centrifuge Operating Panel:	NEMA 4X stainless steel panel. Terminal connection between machine and control panel to be provided by others.
Sludge Inlet:	Flanged inlet pipe header with polymer and wash water injection taps.
Control System Interface:	Fully automatic PLC with touch screen:
Drive:	75 hp main, 15 hp scroll by VFD control.
Spare Parts:	Per specification
Foundation:	Vibration Isolators.
Tools:	One (1) set
Other Services:	Field & Performance testing as specified Shop test – dry & wet operation with report
Lubrication:	High-speed grease lubricated bearings

2. Engineering and Documentation: (Includes the following)

- Arrangement drawings and dimensions for the Andritz scope (as required by specifications)
- Foundation drawings showing details needed for building work (as required by specifications)
- Motor list
- Written sequence of operation including all interlocks.
- Control panel layout
- Electrical and pneumatic schematics
- Terminal box details
- Erection, operating and maintenance manuals

3. The following items are furnished as a standard.

- Spare parts and tools
- Shop test – dry and wet demonstration with report

E. Commercial Conditions

This price proposal is based on the attached Andritz Separation Inc. "Standard Terms and Conditions of Sale" and payment terms. We draw your attention to the limitations of liability and exclusion of consequential damages set forth in paragraph 4 of these terms. Agreement to such limitations and exclusions is a requirement of our doing business and this proposal is made on the assumption that you will so agree.

The quoted price does not include any local, state or federal taxes, permits or other fees. Any taxes or fees that may apply must be added to the quoted price and paid by the buyer.

F. Scope Not Included in Andritz Price
(To be provided by others)

- Conveyors
- Diverter gates
- Polymer system
- Sludge feed pumps
- Flow meters and related field instruments
- Wash water booster pumps
- PLC or VFD spares
- Civil and structural engineering work including preparation of foundations, platforms, and channels
- Static calculations of foundations, building and building plans (Andritz will furnish load data)
- Building modifications
- All utilities required for operation and erection
- Cranes or other lifting devices
- Unloading and unpacking at site
- Process guarantees or liquidated damages
- Storage of equipment
- Flush water connections
- Oil and grease
- Electrical field wiring and connections to main and field panels or junction boxes
- Equipment installation
- Local pressure gauges and other instruments not specified in our scope of supply

ANDRITZ SEPARATION INC.
STANDARD TERMS AND CONDITIONS OF SALE

1. TERMS APPLICABLE

The Terms and Conditions of Sale listed below are the exclusive terms and conditions applicable to quotations made and orders acknowledged by Andritz Separation Inc. ("Seller") for the sales of products, equipment and parts relating thereto ("Products"). This quotation or acknowledgment is expressly made conditional upon Buyer's assent to such terms and conditions. Any of Buyer's terms and conditions which are in addition to or different from those contained herein, which are not separately agreed to by Seller in writing, are hereby objected to and shall be of no effect. Objections to any terms and conditions contained herein shall be deemed waived if Seller does not receive written notice thereof within 20 days of the date of this quotation or acknowledgment. Buyer in any event will be deemed to have assented to the terms and conditions contained herein if delivery of any Product is accepted. The term "this Agreement" as used herein means this quotation or acknowledgment or purchase order, together with any attachment hereto, any documents expressly incorporated by reference and these Standard Terms and Conditions of Sale.

2. DELIVERY

Delivery dates are good faith estimates and do not mean that "time is of the essence". Buyer's failure to promptly make advance or interim payments, supply technical information, drawings and approvals will result in a commensurate delay in delivery. Upon and after delivery, title and risk of loss or damage to the Products shall be Buyer's. Unless otherwise agreed in writing by Seller, delivery of the Products hereunder will be made F.O.B., Seller's plant (or F.O.B., point of manufacture for any Product shipped direct to Buyer from any location other than Seller's plant).

3. WARRANTY

(a) Seller warrants to Buyer that the Products manufactured by it will be delivered free from defects in material and workmanship. This warranty shall commence upon delivery of the Products and shall expire on the earlier to occur of 12 months from initial operation of the Products and 18 months from delivery thereof (the "Warranty Period"). If during the Warranty Period Buyer discovers a defect in material or workmanship and gives Seller written notice thereof within 10 days of such discovery, Seller will either deliver to Buyer, a replacement part or repair the defect in place. Seller will have no warranty obligations under this paragraph 3(a): (i) if the Products have not been operated and maintained in accordance with generally approved industry practice and with Seller's specific written instructions; (ii) if the Products are used in connection with any mixture or substance or operating condition other than that for which they were designed; (iii) if Buyer fails to give Seller such written 10 day notice; (iv) if the Products are repaired by someone other than Seller or have been intentionally or accidentally damaged, or (v) for corrosion, erosion, ordinary wear and tear or in respect of any parts which by their nature are exposed to severe wear and tear or are considered expendable.

(b) Seller further warrants to Buyer that at delivery, the Products manufactured by it will be free of any liens or encumbrances. If there are any such liens or encumbrances, Seller will cause them to be discharged promptly after notification from Buyer of their existence.

(c) THE EXPRESS WARRANTIES SELLER MAKES IN THIS PARAGRAPH 3 ARE THE ONLY WARRANTIES IT WILL MAKE. THERE ARE NO OTHER WARRANTIES, WHETHER STATUTORY, ORAL,, EXPRESS OR IMPLIED. IN PARTICULAR, THERE ARE NO IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

(d) The remedies provided in paragraphs 3(a) and 3(b) are Buyer's exclusive remedy for breach of warranty.

(e) With respect to any Product or part thereof not manufactured by Seller, Seller shall pass on to Buyer only those warranties made to Seller by the manufacturer of such Product or part which are capable of being so passed on.

4. LIMITATION OF LIABILITY

The remedies of Buyer set forth herein are exclusive and the aggregate liability of Seller and its affiliated companies or subcontractors for any claim of any kind for any loss or damage resulting from, arising out of or connected with this Agreement or from the performance or breach thereof, or from the manufacture, sale, delivery, resale, repair or use of any Product, whether based on contract, warranty, tort (including negligence), fault, strict liability, indemnity, or otherwise, shall in no event exceed the price allocable to Product which gave rise to the claim. The foregoing not withstanding, if applicable, any claims for (a) delay shall not exceed 5% and (b) breach of performance guarantees shall not exceed 20% of the order price. In no event shall Seller or its affiliated companies or subcontractors be liable to Buyer or any party for special, incidental or consequential damages of any nature or for loss of profits or revenue or business opportunity, loss by reason of shutdown of facilities or inability to operate any facility at full capacity, or for increased expenses of plant operations. All liability of Seller under this Agreement for any claim of any kind shall terminate on that date which is the third anniversary of the date of this Agreement. The provisions of this Paragraph 4 shall supersede any inconsistent provisions in any instrument forming part of this Agreement.

5. TAXES

Seller's prices do not include any sales, use, excise or other taxes. In addition to the price specified herein, the amount of any present or future sales, use, excise or other tax applicable to the sale or use of the Products shall be billed to and paid by Buyer unless Buyer provides to Seller a tax-exemption certificate acceptable to the relevant taxing authorities.

6. SECURITY INTEREST

Seller shall retain a purchase money security interest and Buyer hereby grants Seller a lien upon and security interest in the Products until all payments hereunder have been made in full. Buyer acknowledges that Seller may file a Form UCC-1 financing statement and may take all other action it deems reasonably necessary to perfect and maintain such security interest in Seller and to protect Seller's interest in the Products.

7. SET OFF

Neither Buyer nor any of its affiliates shall have any right to set off claims against Seller or any of its affiliates for amounts owed under this Agreement or otherwise.

8. PATENTS

Unless the Products or any part thereof are designed to Buyer's specifications and provided the Product or any part thereof is not used in any manner other than as specified or approved by Seller in writing, (i) Seller shall defend against any suit or proceeding brought against Buyer to the extent based on a claim that any Product, or any part thereof, infringes any United States patent; provided Seller is notified promptly in writing and given the necessary authority, information and assistance for the defense of such suit or proceeding; (ii) Seller shall satisfy any judgment for damages entered against Buyer in such suit; and (iii) if such judgment enjoins Buyer from using any product or a part thereof, then Seller shall, at its option: (a) obtain for Buyer the right to continue using such Product or part; (b) eliminate the infringement by replacing or modifying all or part of the Products; or (c) take back such Product or part and refund to Buyer all payments on the purchase price which Seller has received, in which case neither Buyer nor Seller will have any claim against the other under this Agreement or arising out of the subject matter of this Agreement. The foregoing states Seller's entire liability for patent infringement by any Product or part thereof.

9. TERMINATION

Buyer may only terminate its order upon written notice to Seller and upon payment to Seller of Seller's termination charges, which shall be specified to Buyer and shall take into account among other things expenses (direct and indirect) incurred and commitments already made by Seller and an appropriate profit; provided, that in no event shall Seller's termination charges be less than 25% of the contract price. In the event of the bankruptcy or insolvency of Buyer or in the event of any bankruptcy or insolvency proceeding brought by or against Buyer, Seller shall be entitled to terminate any order outstanding at any time during the period allowed for filing claims against the estate and shall receive reimbursement for its cancellation charges.

10. CHANGES

Seller will not make changes in the Products unless Buyer and Seller have executed a written Change Order for such change. Such Change Order will include an appropriate adjustment to price and delivery terms. If the change impairs Seller's ability to satisfy any of its obligations to Buyer, the Change Order will include appropriate modifications to this Agreement. If, after the date of this quotation or acknowledgment, new or revised governmental requirements should require a change in the Products, the change will be subject to this paragraph 10.

11. CONFIDENTIALITY

Buyer acknowledges that the information which Seller submits to Buyer in connection with this quotation or acknowledgment includes Seller's confidential and proprietary information, both of a technical and commercial nature. Buyer agrees not to disclose such information to third parties without Seller's prior written consent. Seller grants to Buyer a non-exclusive, royalty-free, perpetual license to use Seller's confidential and proprietary information for purposes of this specific order and the Products that are the subject hereof only. Buyer further agrees not to permit any third party to fabricate the Products or any parts thereof from Seller's drawings or to use the drawings other than in connection with this specific order. Buyer will defend and indemnify Seller from any claim, suit or liability based on personal injury (including death) or property damage related to any Product or part thereof which is fabricated by a third party without Seller's prior written consent and from and against related costs, charges and expenses (including attorneys fees). All copies of Seller's drawings shall remain Seller's property and may be reclaimed by Seller at any time.

12. END USER

If Buyer is not the end user of the Products sold hereunder (the "End User"), then Buyer will use its best efforts to obtain the End User's written consent to be bound to Seller by the provisions of paragraphs 3, 4, 5 and 11 hereof. If Buyer does not obtain such End User's consent, Buyer shall defend and indemnify Seller and Seller's agents, employees, subcontractors and suppliers from any action, liability, cost, loss, or expense for which Seller would not have been liable or from which Seller would have been indemnified if Buyer had obtained such End User's consent.

13. FORCE MAJEURE

(a) Force Majeure Defined. For the purpose of this Agreement "Force Majeure" will mean all unforeseeable events, beyond the reasonable control of either party which affect the performance of this Agreement, including, without limitation, acts of God, acts or advisories of governmental or quasi-governmental authorities, laws or regulations, strikes, lockouts or other industrial disturbances, acts of public enemy, wars, insurrections, riots, epidemics, pandemics, outbreaks of infectious disease or other threats to public health, lightning, earthquakes, fires, storms, severe weather, floods, sabotage, delays in transportation, rejection of main forgings and castings, lack of available shipping by land, sea or air, lack of dock lighterage or loading or unloading facilities, inability to obtain labor or materials from usual sources, serious accidents involving the work of suppliers or sub-suppliers, thefts and explosions.

(b) Suspension of Obligations. If either Buyer or Seller is unable to carry out its obligations under this Agreement due to Force Majeure, other than the obligation to make payments due hereunder, and the party affected promptly notifies the other of such delay, then all obligations that are affected by Force Majeure will be suspended or reduced for the period of Force Majeure and for such additional time as is required to resume the performance of its obligations, and the delivery schedule will be adjusted to account for the delay.

(c) Option to Terminate. If the period of suspension or reduction of operations will extend for more than four (4) consecutive months or periods of suspension or reduction total more than six (6) months in any twelve (12) month period, then either Buyer or Seller may terminate this Agreement.

14. INDEMNIFICATION AND INSURANCE

(a) Indemnification. Seller agrees to defend and indemnify Buyer from and against any third-party claim for bodily injury or physical property damage ("Loss") arising in connection with the goods provided by Seller hereunder or the Work performed by Seller hereunder, but only to the extent such Loss has been caused by the negligence, willful misconduct or other legal fault ("Fault") of Seller. Buyer shall promptly tender the defense of any such third-party claim to Seller. Seller shall be entitled to control the defense and resolution of such claim, provided that Buyer shall be entitled to be represented in the matter by counsel of its choosing at Buyer's sole expense. Where such Loss results from the Fault of both Seller and Buyer or a third party, then Seller's defense and indemnity obligation shall be limited to the proportion of the Loss that Seller's Fault bears to the total Fault.

(b) Insurance. Seller shall maintain commercial general liability insurance with limits of not less than $2,000,000 per occurrence and in the aggregate covering claims for bodily injury (including death) and physical property damage arising out of the Work. Seller shall also provide workers' compensation insurance or the like as required by the laws of the jurisdiction where the Work will be performed, and owned and non-owned auto liability insurance with limits of not less than $1,000,000 combined single limit. Buyer shall be designated as an additional insured under Seller's commercial general liability insurance and auto liability insurance coverages, and Seller will provide a Certificate of Insurance certifying the existence of such coverages upon request.

15. GENERAL

(a) Seller represents that any Products or parts thereof manufactured by Seller will be produced in compliance with all applicable Federal, State and local laws applicable to their manufacture and in accordance with Seller's engineering standards. Seller shall not be liable for failure of the Products to comply with any other specifications, standards, laws or regulations

(b) This Agreement shall inure only to the benefit of Buyer and Seller and their respective successors and assigns. Any assignment of this Agreement or any of the rights or obligations hereunder, by either party without the written consent of the other party shall be void.

(c) This Agreement contains the entire and only agreement between the parties with respect to the subject matter hereof and supersedes all prior oral and written understandings between Buyer and Seller concerning the Products, and any prior course of dealings or usage of the trade not expressly incorporated herein.

(d) This Agreement (including these standard terms and conditions of sale) may be modified, supplemented or amended only by a writing signed by an authorized representative of Seller. Seller's waiver of any breach by Buyer of any terms of this Agreement must also be in writing and any waiver by Seller or failure by Seller to enforce any of the terms and conditions of this Agreement at any time, shall not affect, limit or waive Seller's right thereafter to enforce and compel strict compliance with every term and condition thereof.

(e) This Agreement and the performance thereof will be governed by and construed according to the laws of the State of Texas. The parties hereto irrevocably submit to the jurisdiction of the Federal and State courts sitting in Tarrant County, Texas and waive any claims as to inconvenient forum. In the event this Agreement pertains to the sale of any goods outside the United States, the parties agree that the United Nations Convention for the International Sale of Goods shall not apply to this Agreement.

REV. 2/08

G.A.S. Analytical Systems Ltd.

2008-12-02

PH: 604-990-4800*125
FX: 604-990-4805
Email: asetiawan@dayton-knight.com
G.A.S. Proposal #: 2008-669

Dayton And Knight
#210-889 Harbourside Drive
North Vancouver, BC V7P3S1

Attention: Andy Setiawan

Reference: Campbell River Treatment Plant

In accordance with your request, G.A.S. Analytical Systems is pleased to submit the following quotation.

The quotation provided is based on information supplied to date. Pricing and system specifications may change upon submittal of complete stream data or modified specifications.

Prices quoted are valid for **30 days** from the date on the quotation. In the event a purchase order is received within this time frame, the quoted prices for the equipment will remain firm through the duration of the contract.

Should you have any questions or require more information please contact us at your convenience. We look forward to working with you on this project.

Sincerely,

Jason Vandergaag
Inside Sales
G.A.S. Analytical Systems (BC) Ltd

Phone: 604-279-0303
Email: jvan@gasanalytical.com

John Grinder
Outside Sales
G.A.S. Analytical Systems (BC) Ltd

Phone: 604-279-0303
Email: jgrinder@gasnalytical.com

ITEM	QTY	DESCRIPTION	UNIT PRICE	TOTAL PRICE
1.	1	Royce 9100 Dissolved Oxygen analyzer Model 9100-2-2-1-1-1-1 • Rear rail-mount kit • Sensor quick-connector • Single 4-20mA output • 115VAC power • Includes 95A-1-3-1-1-6-1-1 sensor • 15’ sensor cable • Quick-release hand rail bracket with sensor adapter	$4,094	$4,094
2.	1	Royce 9200 Dissolved Oxygen analyzer with Electro-chemical self-cleaning Model 9200-2-2-1-1-1-1 • Rear rail-mount kit • Sensor quick-connector • 4-20mA output • 115VAC power • Includes 96A-1-4-1-1-6-1-1 electrochemical self-cleaning sensor • 15’ sensor cable • Quick-release hand rail bracket with sensor adapter	$6,176	$6,176
3.	1	Royce 7011A Medium-range Suspended Solids Analyzer Model 7011A-2-2-1-1-1 • Rear rail-mount kit • Sensor quick-connector • Includes 73B-1-2-2-1 sensor • 15’ sensor cable • Quick-release handrail bracket	$6,445	$6,445
4.	1	ATI Q45 pH analyzer Model Q45P-2-1-1 • 115VAC power • Two 4-20mA outputs (one for temperature) • Includes Q25-P2-1-1 sensor	$2,038	$2,038
5.	1	ATI Q45 ORP analyzer Model Q45R-2-1-1 • 115VAC power • Two 4-20mA outputs (one for temperature) • Includes Q25-R1-1-1 platinum sensor	$2,038	$2,038

ACCESSORIES

a.	1	Royce 58060 jet head assembly To fit 95A and 96A probes	$467

G.A.S Analytical Systems Ltd. Terms and Conditions

General

G.A.S. Analytical Systems ltd. is a distributor of analytical equipment and their components (and if requested, installing of equipment and components) manufactured by various suppliers.

Warranty

Manufacturer's warranty will apply.

Delivery Schedule

Standard delivery is 6-7 weeks from acceptance of purchase order complete with all required technical and commercial information. The delivery is subject to revision at time of order due to prior sales or conditions beyond our control.

Shipping Terms

Crating, freight, Goods and Services Tax (GST), and any other applicable Federal, Provincial, or Municipal taxes are extra and are the responsibility of the purchaser.

Ex-works Calgary, Alberta, Canada, facility of G.A.S. Analytical Systems ltd.

Terms of Payment

Net 30 days in CDN Funds upon shipment or notification that the equipment is ready for shipment.
Prices do not include uncrating, placement or installation.

Cancellation/Restocking Charges

In the event, through no fault or action taken by G.A.S. Analytical Systems Ltd., the purchase order is cancelled prior to shipping of equipment; the manufacturer's cancellation charges will apply.

Liability

G.A.S. Analytical Systems ltd. is prepared to accept liability and provide indemnification for any action or claims that arise out of either its or its employees/representatives negligence, acts, or omissions, in the performance of its obligations in fulfilling the subject matter of the proposal up to the face value of the proposal.

P.O. Requirements

Upon purchasing, please make PO out to:

G.A.S. Analytical Systems (BC) Ltd.
212, 7080 River Road
Richmond, B.C.
Canada V6X 1X5

Endress+Hauser Canada Ltd.
PO Box 91044
W. Vancouver, BC, V7V 3N3

Project name: 08.01.2009
Project no.:
Cart: Dayton & Knight -Campbell River

Pos.	Qty.	Ordercode Product	MatNo.	SPK	Total net price
1	1	CUS41-A2 TURBIMAX-W CUS41 SPK: CDA [A] Cleaning System: Not used [2] Cable Length: 7m	50088375	CDA	2650.00
2	1	CUA451-A1B CLEANFIT CUA451 SPK: CDE [A] Sensor Lift: Short appr. 170mm [1] Application: CUS41 (G1, 200-220mm) [B] Process Connection: G2" internal + weld-in adapter 50mm	51512645	CDE	1661.00
3	1	CUM253-TS3505 Liquisys M CUM253 SPK: CDK [TS] Sensor Input; Software: CUS31/CUS41; plus package [3] Power Supply: 115VAC; CSA Gen.Purp. [5] Output: 1x 20mA, turbidity/SS HART [05] Additional Contact: Not selected	51500497	CDK	2314.00
		Total net price			**6625.00**

PRE-DESIGN FOR UPGRADES TO THE NORM WOOD ENVIRONMENTAL CENTRE

APPENDIX D

DETAILS OF CONSTRUCTION COST ESTIMATES

APPENDIX D
NORM WOOD ENVIRONMENTAL CENTRE COST ESTIMATION DETAILS

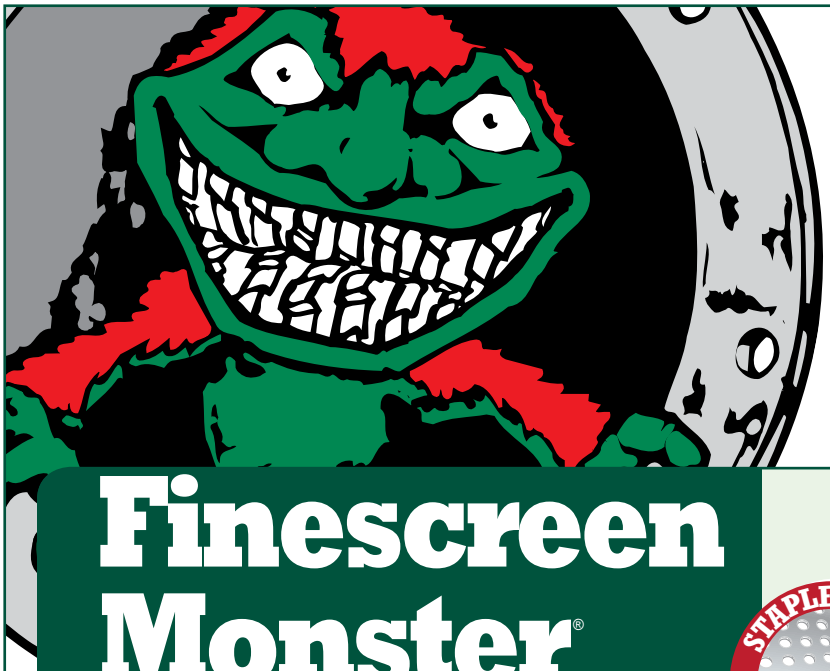
Section	Description	Quantity	Unit	Rate	Sub-Cost	Total Sub-Cost	General Contingency (25%)	Engineering, legal, construction, financial, and admin cost (25%)	Inflation (20%)	Total including contingency
4.1	**Headworks**									
4.1.1	Influent Screens					$ 420,000	$ 105,000	$ 105,000	$ 85,000	$ 715,000
	New perforated plate mechanical screen	1	LS	$ 246,730	$ 245,000					
	Washer and compactor	1	LS	$ 111,150	$ 110,000					
	Installation	1	LS	$ 40,000	$ 40,000					
	Electrical & SCADA	1	LS	$ 25,000	$ 25,000					
4.1.2	**Odour Control**									
	Replacement of Media					$ 60,000	$ 15,000	$ 15,000	$ 10,000	$ 100,000
	Replacement of the existing steel support and media	1	LS	$ 60,000	$ 60,000					
	Sol-air unit	1	LS	$ -	$ -					
	Installation	1	LS	$ -	$ -					
	Electrical & SCADA	1	LS	$ -	$ -					
	Sol-air Unit					$ 53,000	$ 15,000	$ 15,000	$ 10,000	$ 93,000
	Replacement of the existing steel support and media	1	LS	$ -	$ -					
	Sol-air unit	1	LS	$ 37,500	$ 37,500					
	Installation	1	LS	$ 5,000	$ 5,000					
	Electrical & SCADA	1	LS	$ 10,000	$ 10,000					
4.3	**Grit Removal**									
4.3.1	Gravity Channel Grit Removal					$ 795,000	$ 175,000	$ 175,000	$ 140,000	$ 1,200,000
	Concrete channel + earthwork	2	no.	$ 160,000	$ 320,000					
	Grit removal scrapper	2	no.	$ 167,500	$ 335,000					
	Grit classifier	1	no.	$ 50,000	$ 50,000					
	Parshall flume	1	LS	$ 25,000	$ 25,000					
	Installation	1	LS	$ 40,000	$ 40,000					
	Electrical & SCADA	1	LS	$ 25,000	$ 25,000					
4.3.2	Vortex Separator Grit Removal					$ 380,000	$ 95,000	$ 95,000	$ 75,000	$ 645,000
	Site dewatering	1	LS	$ 25,000	$ 25,000					
	Concrete work + earthwork	2	no.	$ 60,000	$ 120,000					
	Vortex grit separator	2	no.	$ 59,450	$ 120,000					
	Grit classifier	1	no.	$ 50,550	$ 50,000					
	Parshall flume	1	LS	$ 25,000	$ 25,000					
	Installation	1	LS	$ 13,600	$ 15,000					
	Electrical & SCADA	1	LS	$ 25,000	$ 25,000					
4.4	**Trucked Liquid Waste**	1	LS	$ 20,000	$ 20,000	$ 20,000				$ 20,000
4.5	**Oxidation Ditch Process**									
4.5.2	Aeration Needs for Oxidation Ditch Process	1000	no.	$ 55	$ 55,000	$ 55,000	$ 20,000			$ 75,000
4.5.5	Blower Selection for Oxidation Ditches									
a	Replacement of Hoffman blowers with PD blowers					$ 810,000	$ 205,000	$ 205,000	$ 160,000	$ 1,380,000
	Blowers (250HP)	3	no.	$ 75,000	$ 225,000					
	MCC VFD's (250HP)	3	no.	$ 100,000	$ 300,000					
	Piping & concrete modifications	1	LS	$ 200,000	$ 200,000					
	Installation	1	LS	$ 55,000	$ 55,000					
	Electrical & SCADA	1	LS	$ 30,000	$ 30,000					
b	Replacement of Hoffman blowers with turbo blowers					$ 675,000	$ 170,000	$ 170,000	$ 135,000	$ 1,150,000
	Blowers - (150HP) with VFD & MCC	3	no.	$ 132,600	$ 400,000					
	Piping & concrete modifications	1	LS	$ 200,000	$ 200,000					
	Installation	1	LS	$ 46,600	$ 45,000					
	Electrical & SCADA	1	LS	$ 30,000	$ 30,000					
4.5.7	3rd Oxidation Ditch vs. Primary Sedimentation									
a	3rd Oxidation Ditch					$ 1,610,000	$ 405,000	$ 405,000	$ 320,000	$ 2,740,000
	Site dewatering	1	LS	$ 150,000	$ 150,000					
	Earthwork	8300	m^3	$ 15	$ 125,000					
	Concrete work	17.5	m^3	$ 2,200	$ 40,000					
	Liner	3400	m^2	$ 30	$ 100,000					
	Diffusers (first 2,500 diffusers)	2500	no.	$ 60	$ 150,000					
	Bridge	1	LS	$ 20,000	$ 20,000					
	Treated timber wall	1	LS	$ 10,000	$ 10,000					
	Mechanical mixer	3	no.	$ 35,000	$ 105,000					
	New turbo blower complete with VFD	1	no.	$ 132,600	$ 135,000					
	Piping and valving	1	LS	$ 350,000	$ 350,000					
	Influent distribution chamber modification	1	LS	$ 250,000	$ 250,000					
	Installation	1	LS	$ 73,800	$ 75,000					
	Electrical & SCADA	1	LS	$ 100,000	$ 100,000					
b	New primary sedimentation tank					$ 2,555,000	$ 640,000	$ 640,000	$ 510,000	$ 4,345,000
	Site dewatering	1	LS	$ 100,000	$ 100,000					
	Earthwork	7200	m^3	$ 15	$ 110,000					
	Concrete Work	400	m^3	$ 2,200	$ 880,000					
	Mechanical Parts	6	no.	$ 10,000	$ 60,000					
	Scum and Primary Sludge Pumping	1	LS	$ 1,000,000	$ 1,000,000					
	Yard Piping	1	LS	$ 250,000	$ 250,000					
	Installation	1	LS	$ 130,000	$ 130,000					
	Electrical & SCADA	1	LS	$ 25,000	$ 25,000					
4.6	**Secondary Clarifiers**									
a	Refurbishment underwater metal work - Mild Steel	1	LS	$ 70,000	$ 70,000	$ 70,000	$ -			$ 70,000
b	Retrofit underwater metal work - Stainless Steel	1	LS	$ 330,000	$ 330,000	$ 330,000	$ -			$ 330,000
c	3rd 27m dia. Secondary clarifier - Mild Steel					$ 2,035,000	$ 509,000	$ 509,000	$ 407,000	$ 3,460,000
	Site dewatering	1	LS	$ 75,000	$ 75,000					
	Earthwork	5300	m^3	$ 15	$ 80,000					
	Concrete	250	m^3	$ 2,200	$ 550,000					
	Flow splitter box	1	LS	$ 250,000	$ 250,000					
	Internal clarifier - Mechanical	1	no.	$ 283,400	$ 285,000					
	RAS pumps	2	no.	$ 21,800	$ 45,000					
	WAS pumps	2	no.	$ 17,866	$ 35,000					
	Scum pump	2	no.	$ 10,000	$ 20,000					
	New RAS/WAS pump station	1	LS	$ 250,000	$ 250,000					
	Sludge level sensor	1	no.	$ 11,170	$ 10,000					
	New piping & valving (750mm)	90	m	$ 1,125	$ 100,000					
	New piping & valving (450mm)	220	m	$ 675	$ 150,000					
	New piping & valving (150mm)	120	m	$ 225	$ 25,000					
	New piping & valving (200mm)	180	m	$ 300	$ 55,000					
	Installation	1	LS	$ 72,800	$ 75,000					
	Electrical & SCADA	1	LS	$ 30,000	$ 30,000					
d	3rd 32m dia. Secondary clarifier - Mild Steel					$ 2,350,000	$ 590,000	$ 590,000	$ 470,000	$ 4,000,000
	Site dewatering	1	LS	$ 75,000	$ 75,000					
	Earthwork	6750	m^3	$ 15	$ 100,000					
	Concrete	350	m^3	$ 2,200	$ 770,000					
	Flow splitter box	1	LS	$ 250,000	$ 250,000					

	WAS pumps	2	no.	$ 17,866	$ 35,000					
	Scum pump	2	no.	$ 10,000	$ 20,000					
	New RAS/WAS pump station	1	LS	$ 250,000	$ 250,000					
	Sludge level sensor	1	no.	$ 11,170	$ 10,000					
	New piping & valving (750mm)	90	m	$ 1,125	$ 100,000					
	New piping & valving (450mm)	220	m	$ 675	$ 150,000					
	New piping & valving (150mm)	110	m	$ 225	$ 25,000					
	New piping & valving (200mm)	182	m	$ 300	$ 55,000					
	Installation	1	LS	$ 79,900	$ 80,000					
	Electrical & SCADA	1	LS	$ 30,000	$ 30,000					
e	4th 32m dia. Secondary clarifier - Mild Steel					$ 1,590,000	$ 400,000	$ 400,000	$ 320,000	$ 2,710,000
	Site dewatering	1	LS	$ 75,000	$ 75,000					
	Earthwork	6750	m^3	$ 15	$ 100,000					
	Concrete	350	m^3	$ 2,200	$ 770,000					
	Flow splitter box	0	LS	$ 250,000	$ -					
	Internal clarifier - Mechanical	1	no.	$ 354,900	$ 355,000					
	RAS pumps	0	no.	$ 21,800	$ -					
	WAS pumps	0	no.	$ 17,866	$ -					
	Scum pump	0	no.	$ 10,000	$ -					
	New RAS/WAS pump station	0	LS	$ 250,000	$ -					
	Sludge level sensor	1	no.	$ 11,170	$ 10,000					
	New piping & valving (750mm)	120	m	$ 1,125	$ 135,000					
	New piping & valving (450mm)	70	m	$ 675	$ 45,000					
	New piping & valving (150mm)	25	m	$ 225	$ 5,000					
	New piping & valving (200mm)	35	m	$ 300	$ 10,000					
	Installation	1	LS	$ 56,700	$ 55,000					
	Electrical & SCADA	1	LS	$ 30,000	$ 30,000					
4.7	**Aerobic Digester**									
4.7.5	Aerobic Digester Options									
Option 1	Digestion of Unthickened WAS					$ 2,530,000	$ 635,000	$ 635,000	$ 505,000	$ 4,305,000
	Earthwork	16,040	m^3	$ 15	$ 240,000					
	Concrete	830	m^3	$ 2,200	$ 1,825,000					
	Mechanical Mixers	2	no.	$ 21,315	$ 45,000					
	Aeration diffusers	2500	no.	$ 60	$ 150,000					
	Piping and valving	1	LS	$ 200,000	$ 200,000					
	Installation	1	LS	$ 39,500	$ 40,000					
	Electrical & SCADA	1	LS	$ 30,000	$ 30,000					
Option 2	WAS Thickening Prior to Digestion					$ 1,800,000	$ 450,000	$ 450,000	$ 360,000	$ 3,060,000
	Earthwork	5,460	m^3	$ 15	$ 80,000					
	Concrete	290	m^3	$ 2,200	$ 640,000					
	Rotating Drum Thickener	1	no.	$ 195,000	$ 195,000					
	Mechanical mixers	2	no.	$ 21,315	$ 45,000					
	Aeration diffusers	2500	no.	$ 60	$ 150,000					
	Piping and valving	1	LS	$ 200,000	$ 200,000					
	Thickener building	160	m^2	$ 2,500	$ 400,000					
	Installation	1	LS	$ 59,000	$ 60,000					
	Electrical & SCADA	1	LS	$ 30,000	$ 30,000					
4.8	**Biosolids Handling**									
	Centrifugation System					$ 1,055,000	$ 265,000	$ 265,000	$ 210,000	$ 1,795,000
	Building	110	m^2	$ 2,500	$ 275,000					
	Centrifuge	1	no.	$ 420,000	$ 420,000					
	Polymer system	1	LS	$ 50,000	$ 50,000					
	Sludge feed pumps	2	no.	$ 17,866	$ 35,000					
	Dewatered sludge pumps	2	no.	$ 17,866	$ 35,000					
	Storage bin	1	LS	$ 50,000	$ 50,000					
	Truck loading bay	1	LS	$ 20,000	$ 20,000					
	Piping and valving	1	LS	$ 80,000	$ 80,000					
	Installation	1	LS	$ 59,000	$ 60,000					
	Electrical & SCADA	1	LS	$ 30,000	$ 30,000					
4.9	**Electrical Upgrades**									
	New Genset					$ 650,000	$ 165,000	$ 165,000	$ 130,000	$ 1,110,000
	New 800 kW genset	1	no.	$ 353,661	$ 355,000					
	Genset building	1	LS	$ 125,000	$ 125,000					
	Installation	1	LS	$ 45,500	$ 45,000					
	Electrical & SCADA	1	LS	$ 25,000	$ 25,000					
	New Transfer Switch	1	no.	$ 100,000	$ 100,000					
4.10	**Administration Building**									
	Expansion of admin building					$ 210,000	$ 55,000	$ 55,000	$ 40,000	$ 360,000
	Lunch room	27	m^2	$ 2,500	$ 70,000					
	Meeting room	12	m^2	$ 2,500	$ 30,000					
	Wastewater foreman's office	9	m^2	$ 2,500	$ 25,000					
	Male lavatory	21	m^2	$ 2,500	$ 55,000					
	Corridor	12	m^2	$ 2,500	$ 30,000					
	Geotechnical investigation	1	LS	$ 40,000	$ 40,000	$ 40,000	$ -			$ 40,000
4.11	**Instrumentation Upgrade**									
	New Instrumentations									
	Oxidation Ditches					$ 45,000	$ 10,000	$ 10,000	$ 10,000	$ 75,000
	New DO meter	2	no.	$ 4,561	$ 10,000					
	New ORP meter	2	no.	$ 2,038	$ 5,000					
	New pH meter	2	no.	$ 2,038	$ 5,000					
	New Suspendid Solids meter	2	no.	$ 6,445	$ 15,000					
	Installation	1	LS	$ 5,000	$ 5,000					
	Electrical & SCADA	1	LS	$ 5,000	$ 5,000					
	Digesters					$ 60,000	$ 15,000	$ 15,000	$ 10,000	$ 100,000
	New DO meter	2	no.	$ 4,561	$ 10,000					
	New ORP meter	2	no.	$ 2,038	$ 5,000					
	New pH meter	2	no.	$ 2,038	$ 5,000					
	New Suspendid Solids meter	2	no.	$ 6,445	$ 15,000					
	Installation	1	LS	$ 20,000	$ 20,000					
	Electrical & SCADA	1	LS	$ 5,000	$ 5,000					
	WAS pumps					$ 40,000	$ 10,000	$ 10,000	$ 10,000	$ 70,000
	New solids probes for WAS pump discharges	2	no.	$ 6,625	$ 15,000					
	Installation	1	LS	$ 20,000	$ 20,000					
	Electrical & SCADA	1	LS	$ 5,000	$ 5,000					
4.12	**Potential Future Disinfection**					$ 660,000	$ 165,000	$ 165,000	$ 130,000	$ 1,120,000
	Site dewatering	1	LS	$ 50,000	$ 50,000					
	Earthwork and concrete work	1	LS	$ 85,000	$ 85,000					
	Jib crane system	1	LS	$ 5,000	$ 5,000					
	UV package system	1	LS	$ 448,500	$ 450,000					
	Installation	1	LS	$ 45,400	$ 45,000					
	Electrical & SCADA	1	LS	$ 25,000	$ 25,000					
4.12	**Parshall Flume Upgrade**					$ 130,000	$ 32,500	$ 32,500	$ 25,000	$ 220,000
	Earthwork and concrete work	1	LS	$ 85,000	$ 85,000					
	Parshall flume and level sensor	1	LS	$ 10,000	$ 10,000					
	Installation	1	LS	$ 10,000	$ 10,000					
	Electrical & SCADA	1	LS	$ 25,000	$ 25,000					

PRE-DESIGN FOR UPGRADES TO THE NORM WOOD ENVIRONMENTAL CENTRE

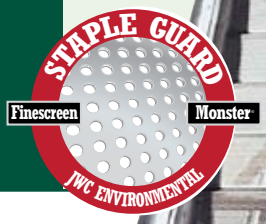
APPENDIX E

EQUIPMENT LITERATURE



Finescreen Monster®

Monster Separation Systems®



No submerged sprockets or bearings!

Overview

The Monster Separation System is a complete, high-performance system that provides high capture rate of wastewater solids and more efficient washing and compacting, resulting in a discharge that is remarkably clean and ready for disposal. The more unwanted solids removed at the headworks of your treatment plant, the better the whole facility will run.

The Finescreen Monster incorporates a continuous band of stainless-steel or optional StapleGuard ultra high molecular weight (UHMW) polyethylene perforated panels attached to heavy-duty stainless steel roller chains. Panels available with 1/8" or 1/4"(3 or 6mm) openings. Stainless steel rollers track in UHMW guides at the bottom of the screen, thus eliminating the need for sprockets or bearings submerged in the wastewater flow.

Small wastewater solids, such as cigarette butts, latex, plastics and rags, are readily captured by the perforated panels and lifted to deck level where a two-stage brushing and wash water system removes them. Materials are then conveyed to the Screenings Washer Monster® for additional washing, dewatering and compacting.

***Exclusive StapleGuard panels are made of UHMW and are corrosion resistant** (optional).*

Detect screen "blinding" with the optional Monster Blind Diagnostic System.

Features & Benefits

Advanced Design

- Optional Monster Blind Diagnostic System *(patent pending)* detects and alerts operators of potential screen blinding situations
- Captures twice the trash compared to bar screens
- UHMW side seals and bottom sealing strip prevent debris from passing around the screen

StapleGuard UHMW Polyethylene Perforated Panels *(optional)*

- Reduces debris "stapling" (or hair-pinning) onto the panels
- Highly abrasion, wear and corrosion resistant

Enhanced Cleaning System

- Two-stage process with modular brushing system and wash water jets help ensure the screen remains clean and clear
- Brush tension is controlled by an easy to adjust pivot

Ease of Maintenance

- Easy to lift access covers and easy to reach assembly allows simple fine tuning
- Optional pivoting frame allows access to the entire unit from the operating floor level

Cleaner Screenings with Screenings Washer Monster

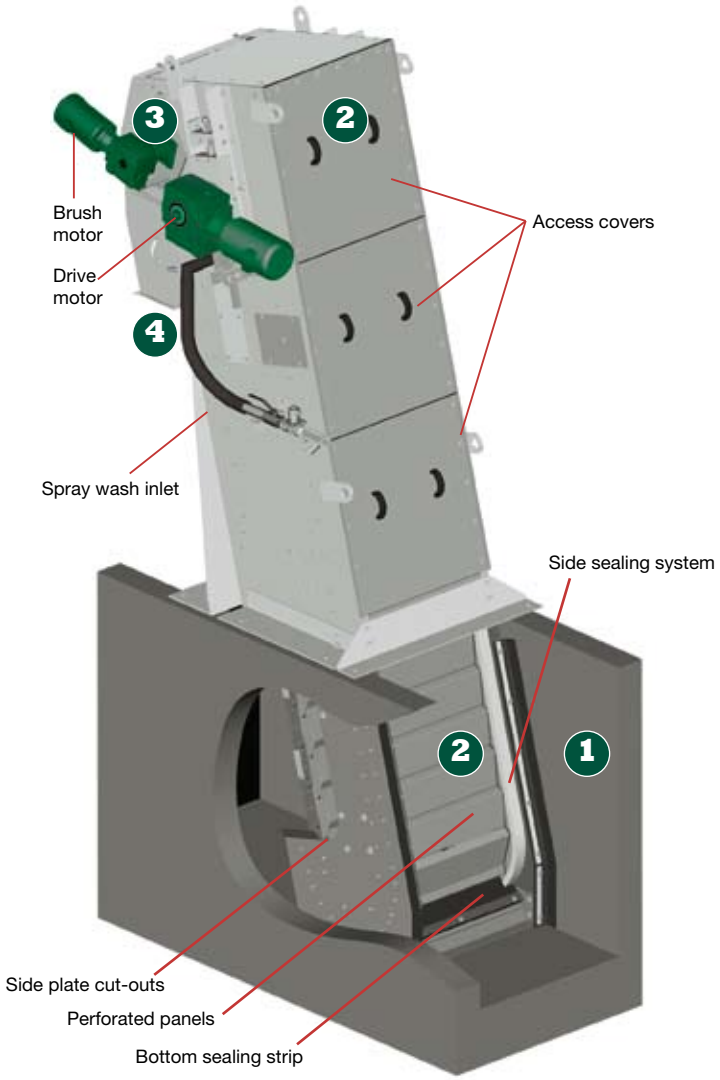
- Grinds, washes, dewaters and compacts screenings
- Dewaters screenings up to 50% or more
- Reduces volume of screenings up to 80% or more

JWC Environmental®

Trust Monster Quality™

Finescreen Monster®

Monster Separation Systems®



Equipment Sizing

Screen panel hole size: ø 3 or 6mm holes

Depth: up to 30' (9m)

Width: 1.5' to 10' (.5 to 3m)

Angle: 60° to 85° inclination; 70° standard

Minimum wash water head at spray jets: 30 PSI (2 bar)

Spray jets: 6" (150mm) centers

Wash water requirement: 1.3 GPM (0.08 l/s) per nozzle

Operation

1) Wastewater in the channel flows through the continuous band of perforated panels of the system's screening zone.

2) The drive moves panels from the screening zone, to the cleaning mechanism (during operating cycle).

3) Debris is removed from the perforated panels by the two-stage brush and wash water system.

4) Screenings are conveyed to the integrated Screenings Washer Monster® for washing and compacting.

Materials of Construction

Screen structure: 304 or 316 stainless steel

Sprockets: 304 or 316 stainless steel

Drive shafts: 17-4 stainless steel

Perforated panels: 304 or 316 stainless steel; or StapleGuard panels made from UHWM polyethylene (optional).

Heavy-duty roller chains: stainless steel

Wastewater passes through perforated panels while unwanted solids are removed.

Solids are captured on the perforated panels and conveyed to the discharge level.

The integrated Screenings Washer Monster produces very clean discharge.

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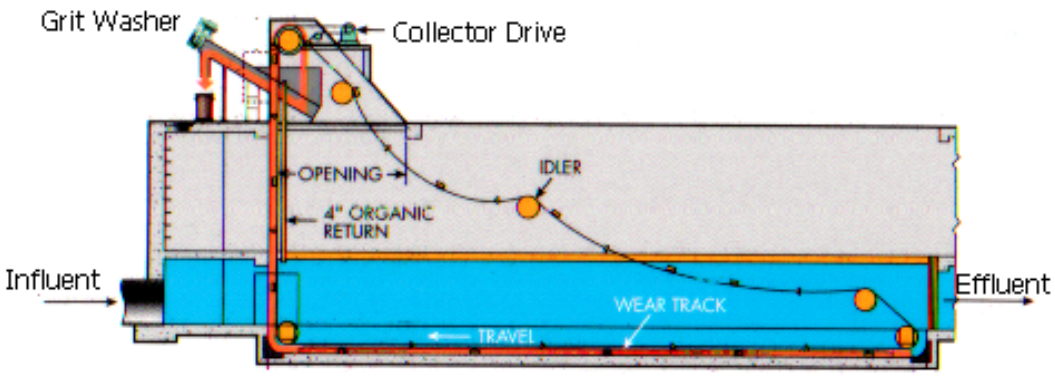
WSG & SOLUTIONS
Link-Belt®, Rex® and CSO Products

LINK-BELT® TYPE "B" GRIT COLLECTOR



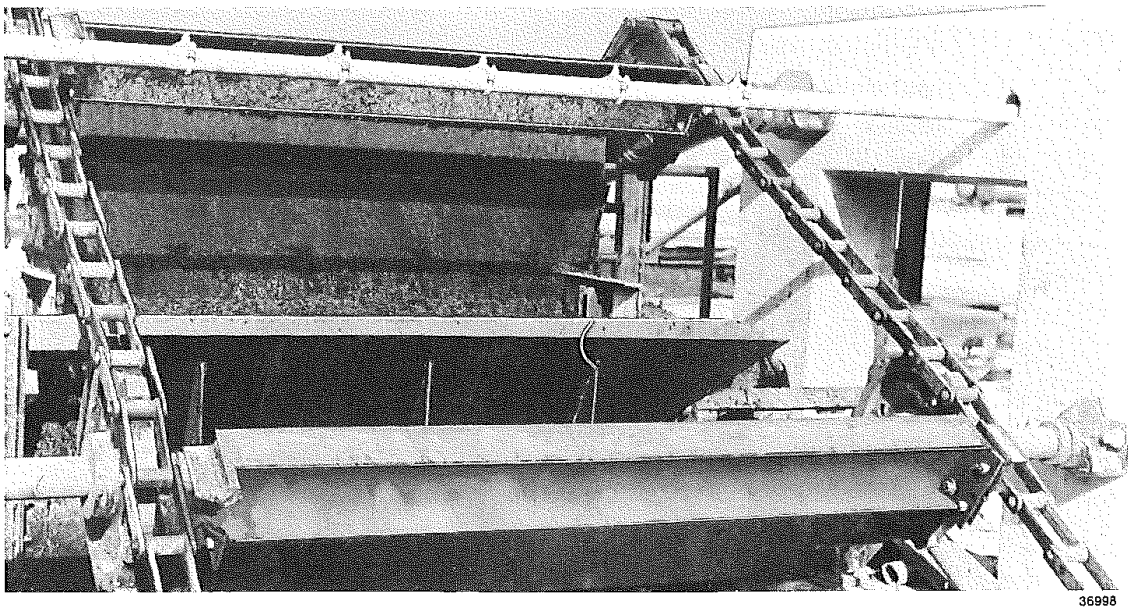
TYPE B GRIT COLLECTOR

LINK-BELT® TYPE "B" GRIT COLLECTOR

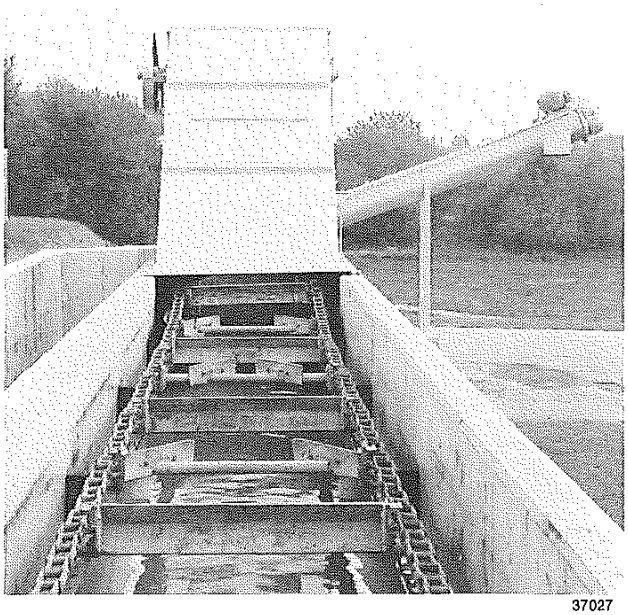
The "B" Grit Collector uses two strands of combination chain with buckets in a rectangular tank. The chain and buckets move along the floor toward the influent enc. As the buckets reach the end of the tank, the buckets are pulled vertically until they reach the top of the tank. At this point, the bucket revolves over a head shaft and discharges into a "SW" grit washer.

The "B" Chain and Bucket for flows up to 50 MGD per chamber. The Type "B" Grit Collector consists of either a single or double strand grit collector with buckets to collect and elevate the grit to a discharge point above the water level. The buckets are usually spaced every ten feet on the chain with stirring flights located mid-point between the buckets. The buckets are not perforated so that even the finest grit is elevated to the discharge point. Both the buckets and stirring flights are equipped with easily replaceable, hardened wearing shoes for easy maintenance. Complete bucket discharge does not depend on gravity, as spray water is furnished to wash out the buckets and, at the same time, wash the putrescible matter from the grit particles. The buckets discharge into a Type "SW" grit washer, which dewaters the grit, washes it, and returns the putrescible matter to the grit chamber. The "B" grit collector may be used for any depth chamber; however, it is especially adaptable to deep chambers to conserve space and reduce the cost of the structure.

LINK-BELT® TYPE “B” GRIT COLLECTOR

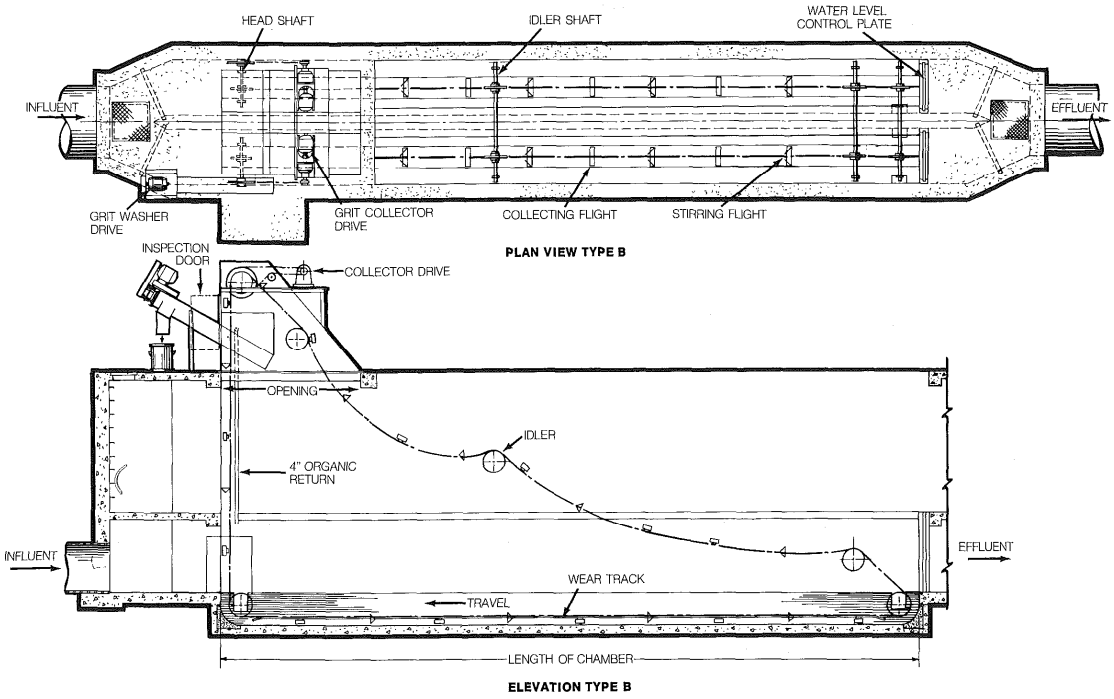


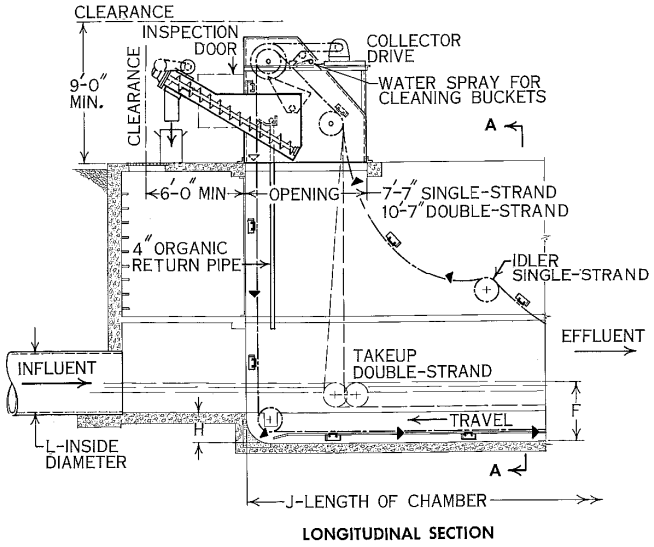
Type B chain and bucket collector removing bark from a pulpwood flume settling basin.

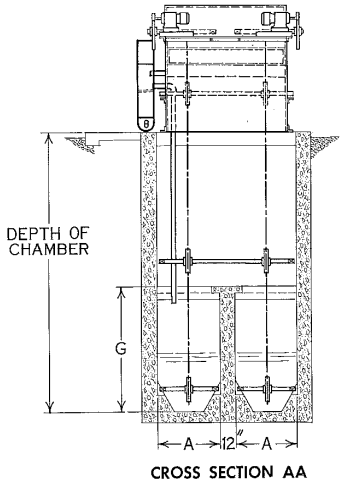


Type B Straightline grit collectors. Type SW grit washer dewaters and washes the grit prior to discharge to ground or truck.

LINK-BELT® TYPE "B" GRIT COLLECTOR







TYPE “B” GRIT COLLECTOR

DESIGN DATA SHEET

Flows	MGD
Material of construction	
Tank width	to
Tank length	to
Screw housing	thick
Screw flights	thick
Screw dia.	diameter
Capacity of screw	CFH

WASTEWATER TREATMENT

Mectan®
Grit Chamber

JOHN MEUNIER INC.

MECTAN® GRIT REMOVAL DESIGN

Cover: Denver, CO
Above: Ste-Agathe, QC

MECTAN® GRIT REMOVAL DESIGN

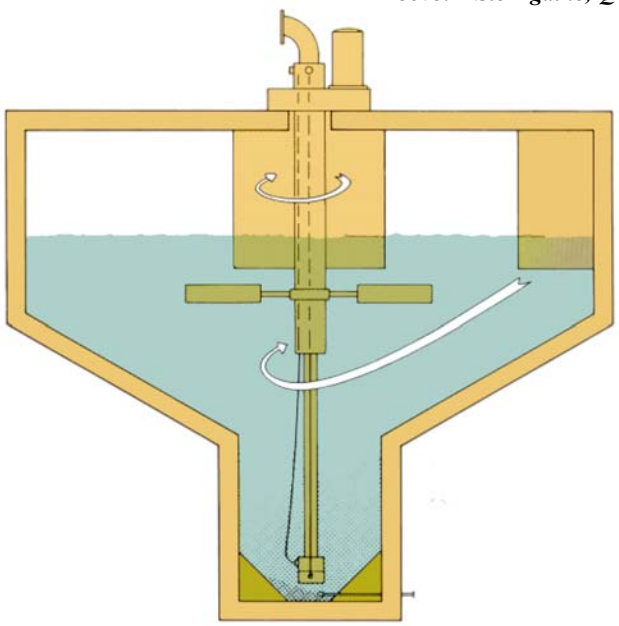
Why grit removal

Grit is a source of problems in wastewater treatment facilities, which causes wear and tear on mechanical equipment, decreases the effective treatment volume in basins, causes pipe blockages and generally increases operating costs; **John Meunier Inc**. presents the **Mectan®** vortex grit removal system as the solution.

Prior to the introduction of conical vortex grit chambers, grit removal systems were usually designed to remove 70-mesh particle size at a water velocity of 1ft./sec. This objective was met provided that the flowrate remained constant.

The **Mectan®** grit removal system operates efficiently over a *wide range of daily flowrates.*

The **Mectan®**'s circular construction sets itself apart from other systems by its *sloped transition section* between the upper chamber and the central grit collecting well. *All similar equipment on the market, at present, are modifications of our basic design. This is where we leave the others behind.*



Manufactured under license of Pista S. A.

The influent is surface fed tangentially into the upper chamber, rather than being deflected toward the bottom of the tank, resulting in additional head losses. The **Mectan®** design takes full advantage of the tangential inflow velocity along the peripheral wall of the chamber, to assist in the grit removal process. In addition, the 270-degree path the flow follows before going out of the chamber ensures that no short-circuiting will result. Because *this design combines circular and conical shapes with natural vortex and gravity forces,* turbulence is reduced considerably when compared with similar equipment. The resulting flow patterns allow for an efficient separation of grit from organic solids in the wastewater.

TOTAL EFFICIENCY SYSTEM

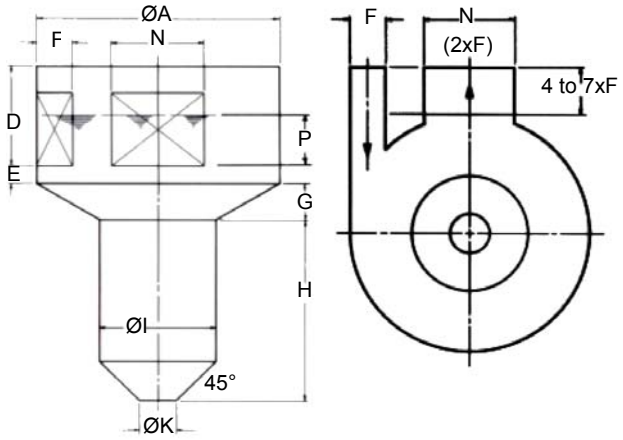
To achieve maximum efficiency over the wide range of daily flowrates, the flow velocity inside the chamber is maintained quasi-constant by adjustable rotating paddles. The energy efficient **Mectan**® design *uses only two partially submerged paddles instead of four (or more) fully submerged propellers or jets.* The constant movement of the wastewater in the tank, assisted by the sloped sides of the upper chamber, gradually move the settling solids toward the lower grit collecting well.

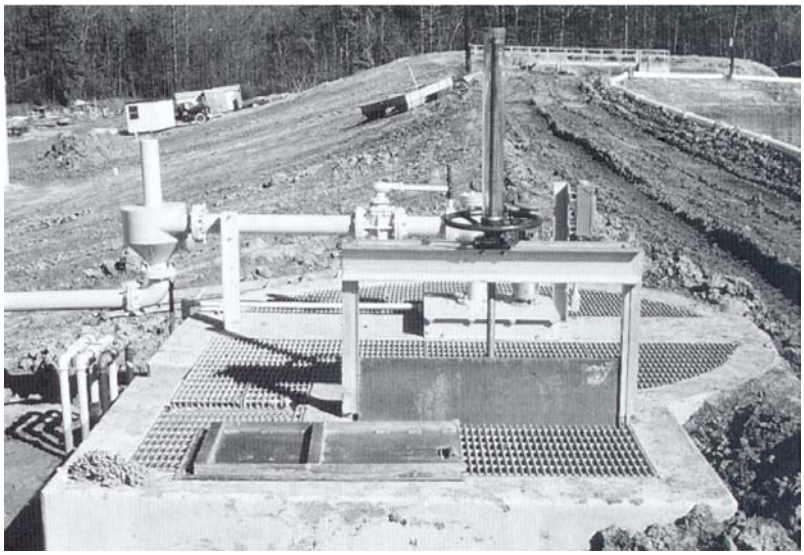
This will ensure *continuous operation without significant loss of efficiency should a power failure occur.* Flat bottom type units, or ones using submerged turbines, are not inclined to operate in this manner because their design is based strictly on the operation of the turbine. The **Mectan**® *grit collecting well is fully opened at the top for easy servicing at any time.* Limiting the access to the collecting well, by horizontal plates or submerged turbines, could result in grit accumulation and blockage in the upper chamber during power failures and complicated servicing. A good coarse screen ahead of the unit will protect the grit pump transfer system, should it be necessary, eliminating the need of throttling the opening between the two chambers.

There are many ways to remove the grit from the collecting well. *The best way to remove the grit remains the airlift pump,* because of the absence of moving parts along the transfer line, whatever the system. Also the **Mectan**® *4"airlift pump,* because of its low flow capacity characteristics compared to any 4" non-clog pump, *will create fewer disturbances* in the upper chamber during the grit transfer cycle. Air and/or water scouring is always necessary to eliminate all possibility of grit well bridging or line blockage, mainly when a motorized pump is used.

The **MECTAN**® is engineered to remove grit over a wide range of particle size.

REMOVALS	MESH SIZE
95% of grit greater than	50
85% of grit greater than	70
65% of grit greater than	100





TYPICAL DIMENSIONS

All dimensions subject to change without notice.

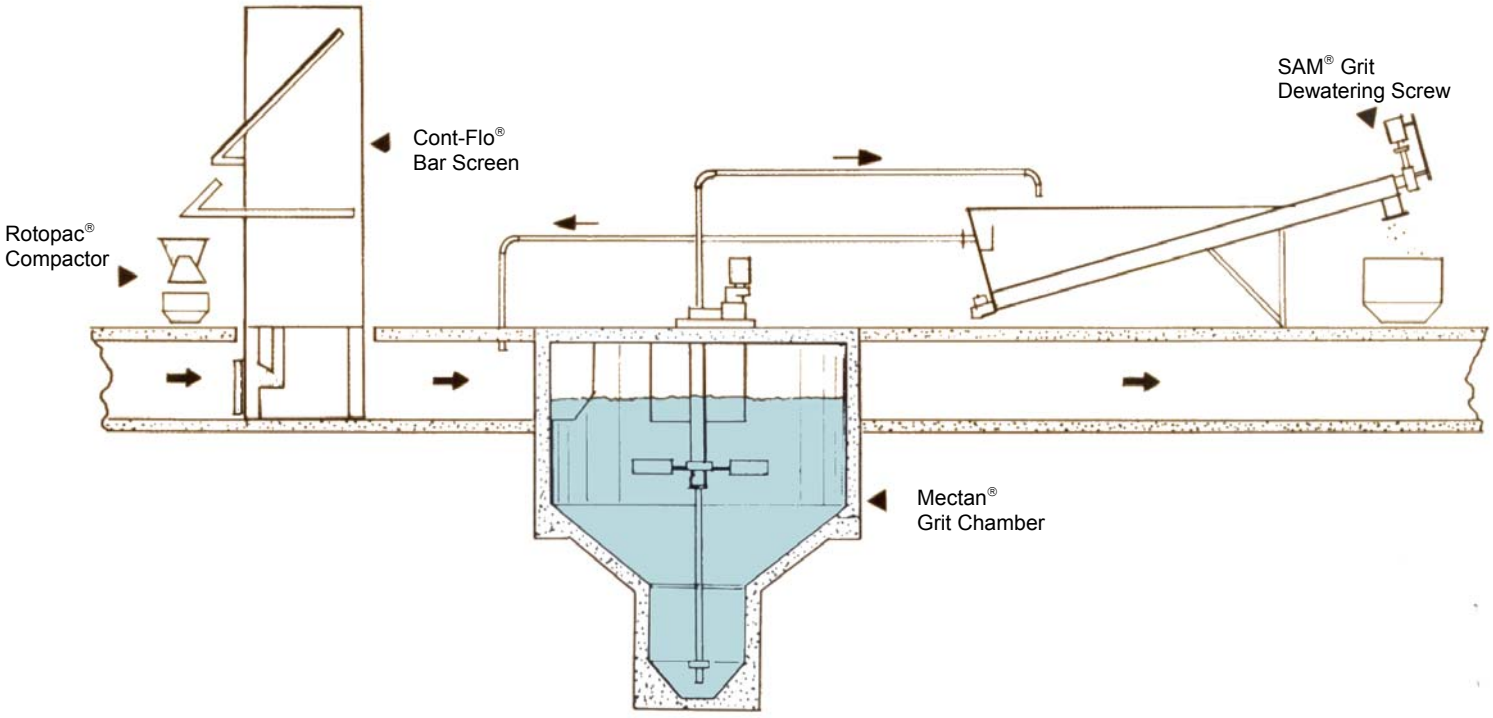
Model	Max flow (MGD)	H.P. Turbine	Dimensions								
			A	D*	E	F*	G	H*	I	K*	P(max)
JMD-0-12	0.8	0.5	4'	3'	1'6''	8''	6''	6'10''	3'	1'	1'1''
JMD-1-20	2.5	0.5	6'6''	3'	1'	1'	1'	6'	3'3''	1'	1'8''
JMD-2-25	4.3	0.5	8'6''	3'	1'2''	1'6''	1'4''	6'	3'3''	1'	1'8''
JMD-3-30	7.2	0.75	10'	3'2''	1'4''	2'	1'6''	6'	5'	1'4''	1'10''
JMD-4-35	10.7	1.0	11'6''	3'6''	1'4''	2'6''	2'	6'	5'	1'4''	2'1''
JMD-5-42	18.7	1.5	14'	4'6''	1'4''	3'	2'7''	6'6''	5'	1'4''	2'7''
JMD-6-50	30.0	2.0	16'6''	5'	1'4''	3'6''	3'3''	6'6''	5'	1'4''	3'1''
JMD-7-60	50.0	3.0	20'	5'6''	1'4''	4'6''	4'3''	6'6''	5'	1'4''	3'7''
JMD-8-73	78.0	3.0	24'	7'	1'4''	5'6''	5'6''	6'6''	5'	1'4''	3'9''

**VARIABLE*

FEATURES AND ADVANTAGES

- Compact size results in low excavation and civil works costs.
- Retrofittable into existing plants.
- Energy efficient with low cost maintenance.
- Simple mechanics and minimum mobile parts.
- No moving parts subject to wear located under water.
- Reliable simple design.
- Efficient operation on a wide range of flowrates.
- Constant velocity assisted by only two paddles.
- Low ¼" head loss.
- Sloped transition and rotating motion eliminates accumulation of grit in the chamber under all conditions.
- Full accessibility to grit collecting well.

THE PRETREATMENT SPECIALIST



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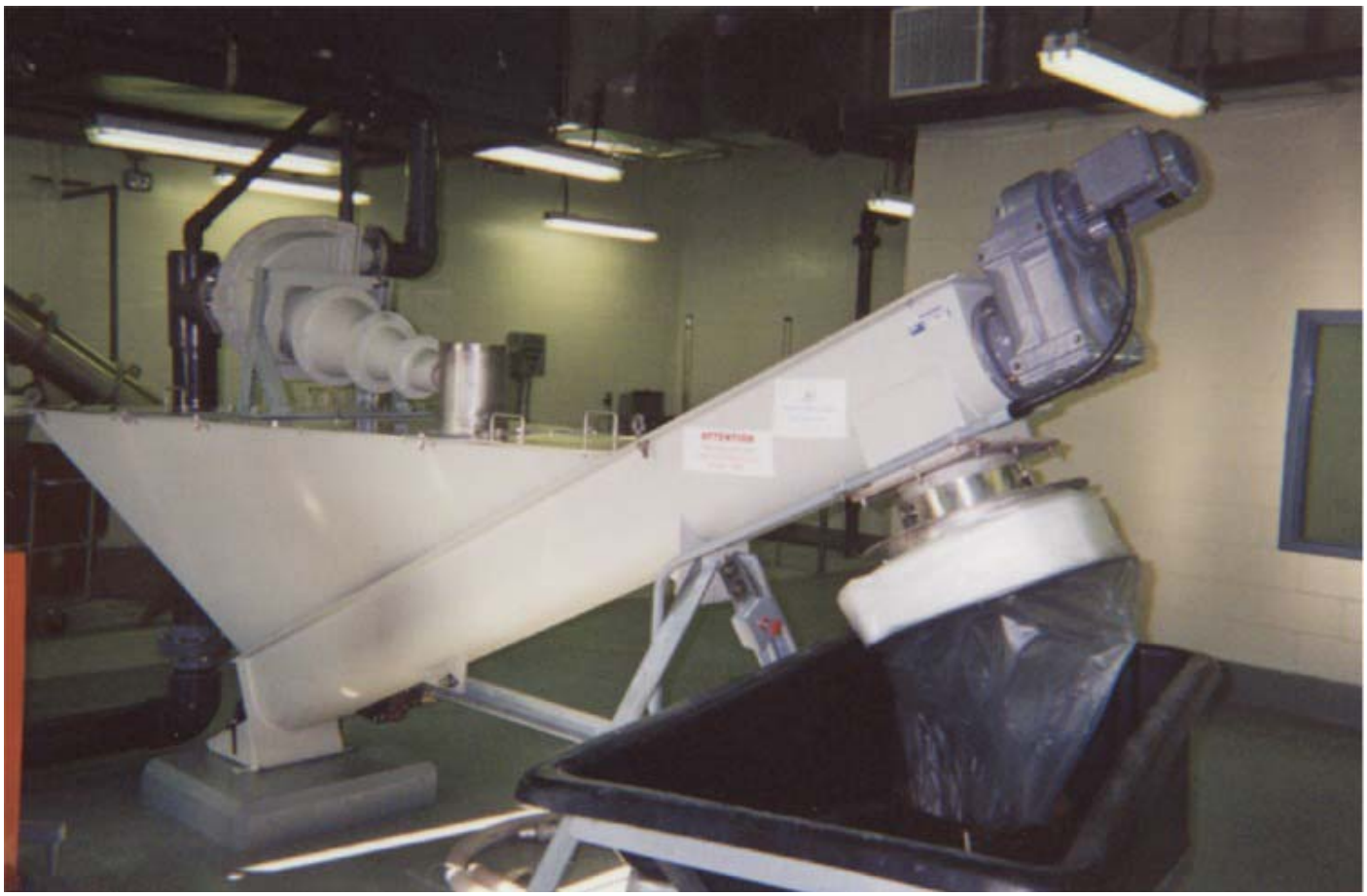
VEOLIA Environment

Revised : 2003-11-04

WASTEWATER TREATMENT

SAM®
Grit Dewatering Screw and Conveyor



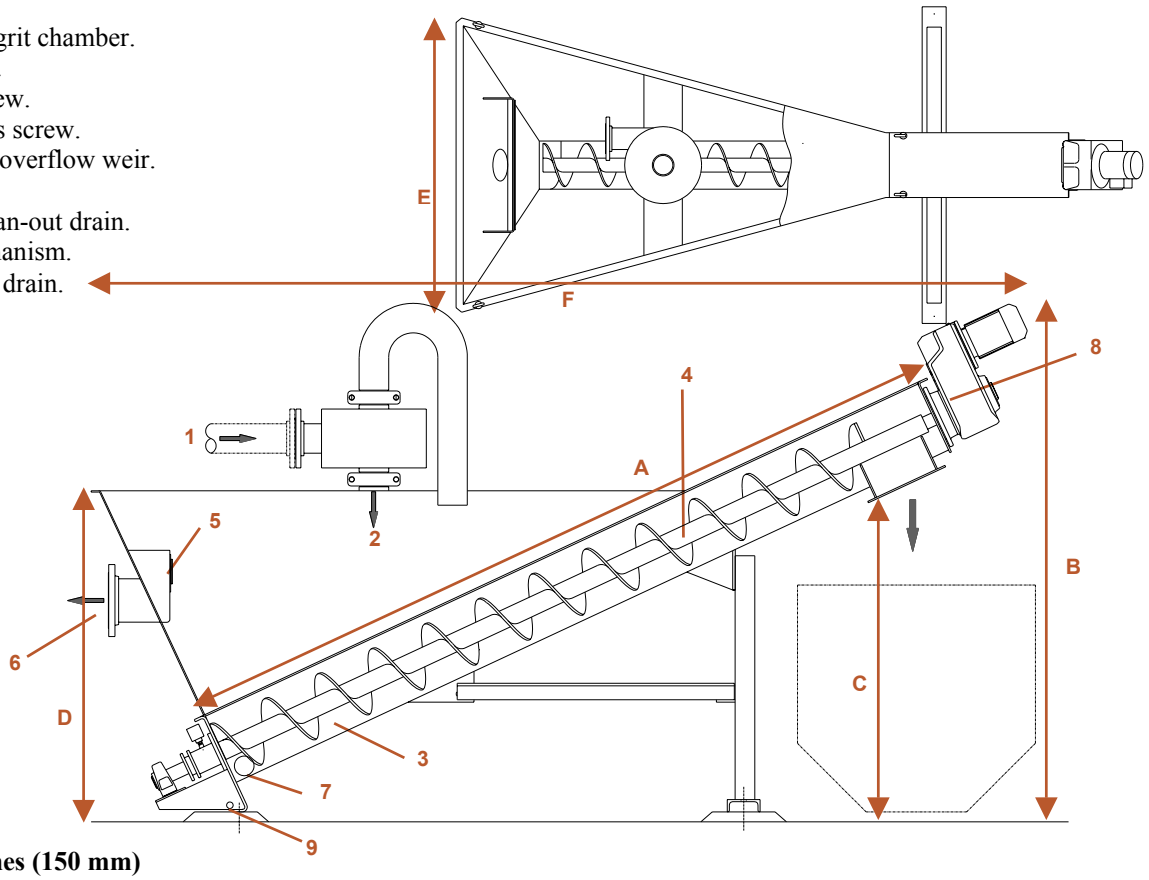
JOHN MEUNIER INC.

SAM® GRIT DEWATERING SCREW AND CONVEYOR

TECHNICAL DATA AND DIMENSIONS

The SAM® Grit Dewatering Screw is designed to provide easy and efficient separation of the grit from the liquid matrix. The grit is conveyed towards a discharge point.

1 - Feed from grit chamber.
2 - Feed outlet.
3 - Trough screw.
4 - Archimedes screw.
5 - Adjustable overflow weir.
6 - Overflow.
7 - Bottom clean-out drain.
8 - Drive mechanism.
9 - Packing by drain.



(1) Overflow: 6 inches (150 mm)

MODEL	DIMENSIONS In inches where applicable (mm)								CAPACITY		
GDS	A	B	C	D	E	F	SCREW DIA.	H.P.	FEED GAL. /MIN.	DISCHARGE CU. FT./HR.	SHIPPING WEIGHT (LBS)
09-10-25	120 (3048)	80 (2032)	46 (1168)	50 (1270)	62 (1575)	145 (3683)	9 (229)	1	165	60	2100
09-16-25	192 (4877)	110 (2794)	79 (2007)	50 (1270)	62 (1575)	208 (5283)	9 (229)	1.5	165	60	2600
14-12-25	144 (3658)	95 (2413)	54 (1372)	59 (1500)	73 (1854)	175 (4445)	14 (356)	2	240	120	3200
14-18-25	216 (5486)	125 (3175)	84 (2134)	59 (1500)	73 (1854)	236 ½ (6007)	14 (356)	3	240	120	3800

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ISO 9001 : 2000

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VEOLIA Environment

Revised : 2003-11-04

www.neuros.com

Turbo Blower

NX/VX Series

Neuros

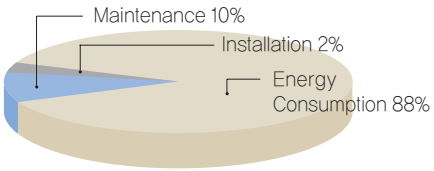
Features of NX/VX Series

| INTRODUCTION |

The NX & VX series is a high-efficiency turbo blower. Thanks to high-speed motor and air bearings, there is no need for gearbox or lubricating system. Compared with existing roots blowers, you may save considerable amount of electricity charge due to much higher efficiency. Moreover, this product will provide you with comfortable working environment thanks to much lower noise & vibration level.

1. Energy Saving

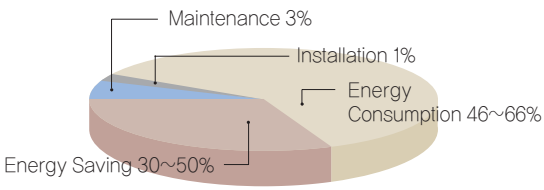
- Thanks to advanced design technology, our turbo blowers are most efficient among the same class turbo blowers.
- Compared with existing roots blowers, you may save up to 30 to 50 percent of operating cost.



[PD Blower Operating Cost]

2. Low Noise, Low Vibration

- Thanks to smart air flow path design, the noise level is less than 80 dB at one meter from the air inlet WITHOUT optional inlet silencer.
- Thanks to air bearings, no foundation work is necessary for installation.



[NX/VX Series Operating Cost]

3. Reliable, Easy to Install

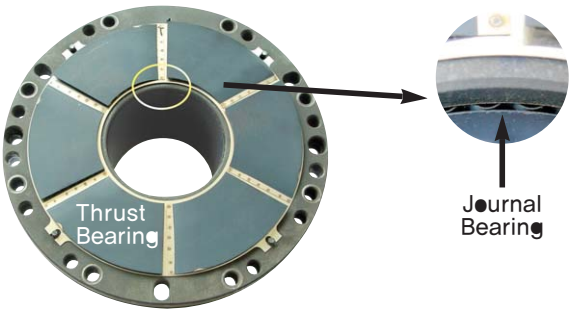
- We have secured product reliability by performing proof tests such as hot environment test, vibration environment test, air bearing endurance test and impeller spin test.
- Compact in size, easy to install in small area.

4. No Maintenance

- Thanks to air bearings, there are no liquids or oils to change, ever.
- Cleaning or replacement of inlet air filter only.
  (Just one worker can replace inlet air filter)

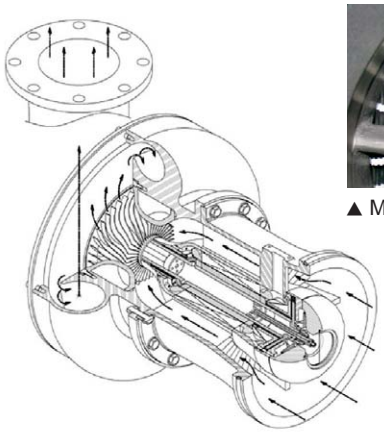
5. Oil-free, Non-contact Air Bearing

- No need for lubricating oil.
- There is little noise or vibration from bearings, since the rotating shaft does not contact air bearing during normal operation.
- Over 20,000 times of on/off endurance test.



6. Air Cooling

- High-speed motor is cooled by blower suction air itself.
- No need for additional fan or blower for motor cooling. (no additional power consumption)
- There is no adverse effect on other equipment, since the heated motor cooling air is not discharged to the surrounding air.



▲ Motor Cooling Fin

7. High-efficient Impeller

- The impeller is designed based on our over ten years' experience in aero & industrial compressor development, and it shows very high efficiency.

8. Control & Operation

- High-speed motor and inverter allow you to run the blower at desired speed.
- PLC makes it possible to run the blower in either constant pressure or constant flow mode.
- You can easily check the flow, pressure, temperature, speed, etc. on the LCD display.
- Easy operation with touch screen.
- Remote control and monitoring is possible. (optional)

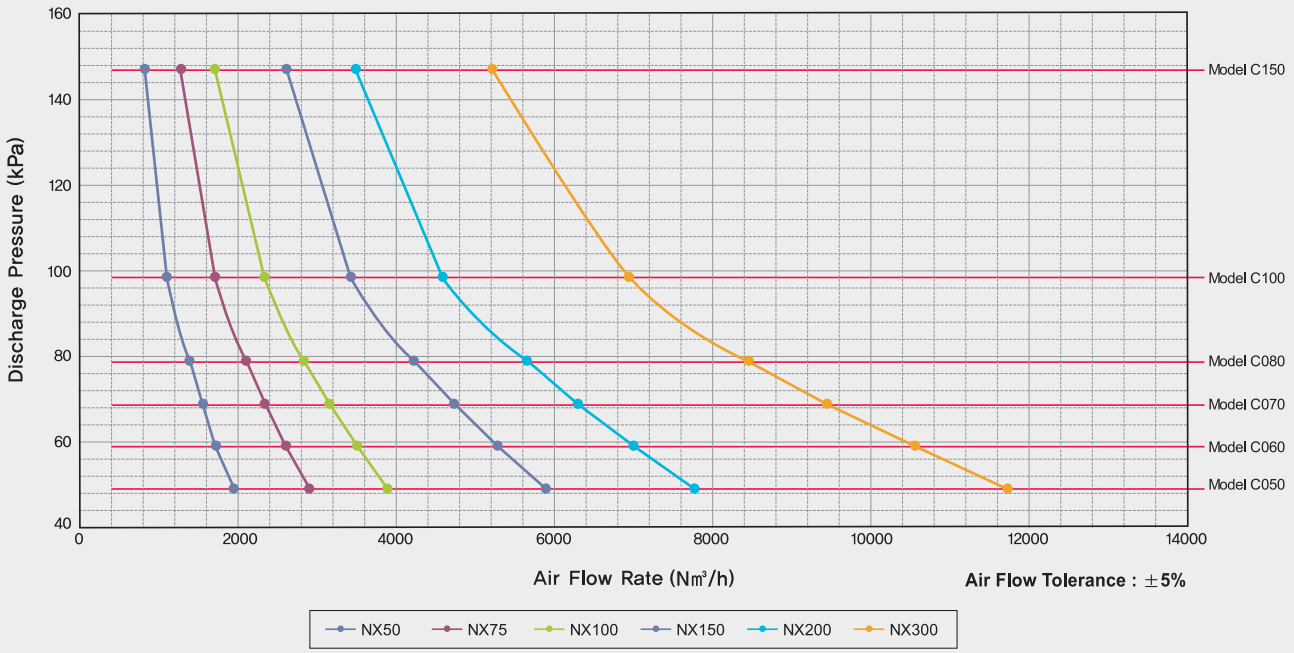
Turbo Blower

Oil-free, High-efficient

Turbo Blower

Performance Characteristics of NX Series

Nominal Air Flow Rate of NX Series Turbo Blower



Turbo Blower NX Series, Nominal Air Flow

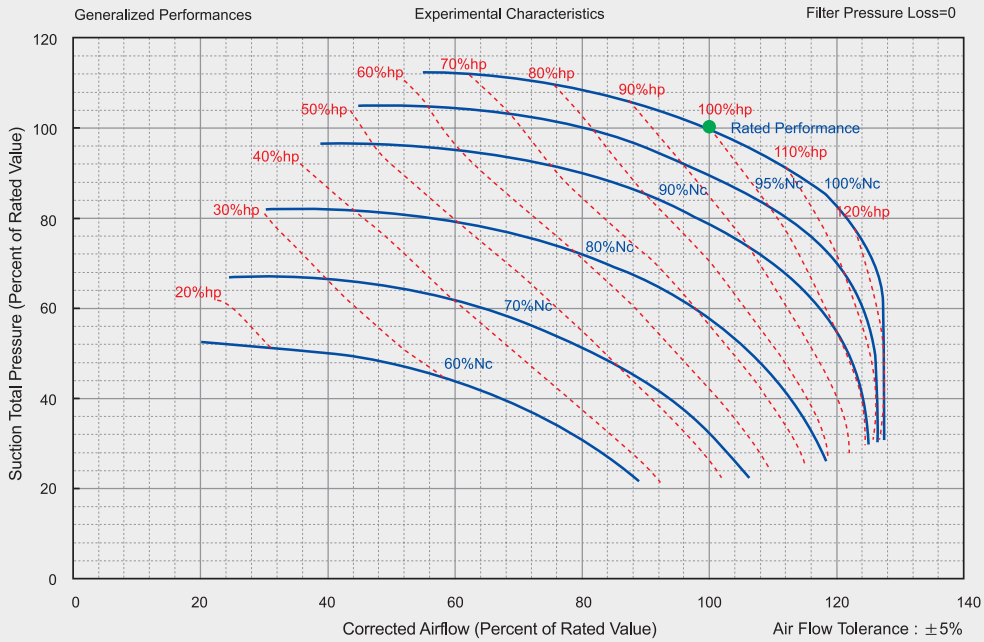
Discharge Pressure (kPa)	NX50	NX75	NX100	NX150	NX200	NX300
	50 hp	75 hp	100 hp	150 hp	200 hp	300 hp
	Air Flow Rate (Nm³/h)					
30	2860	4338	5677	8837	11127	16838
40	2292	3486	4615	7142	9046	13648
50	1930	2942	3930	6055	7703	11597
60	1677	2562	3447	5291	6755	10151
70	1489	2278	3085	4721	6046	9071
80	1344	2058	2802	4276	5492	8229
90	1227	1882	2574	3920	5045	7551
100	1132	1737	2386	3626	4676	6992
110	1052	1616	2228	3379	4366	6522
120	984	1513	2093	3168	4101	6120
130	925	1423	1975	2986	3871	5773
140	873	1345	1873	2826	3670	5469
150	828	1277	1782	2686	3492	5200

* Air Flow at 68°F, 14.7 PSI, 65% RH
(20℃, 1 atm, 65% RH)

- Single Stage Centrifugal Turbo Blower
- Direct Motor Driven System
- Flow Adjustment :
  Motor RPM Control by Inverter
- Noise Level : 75~85 dB (A)
- Flow Range : 45~100% of nominal air flow
- Tolerance of Inlet Volume : ±5%
- Obtained CSA/US Marked
- Option : Check Valve, Flexible,
  Remote Monitoring & Control
  via Internet/RS-485

Vacuum - Turbo Blower

Performance Characteristics of VX Series



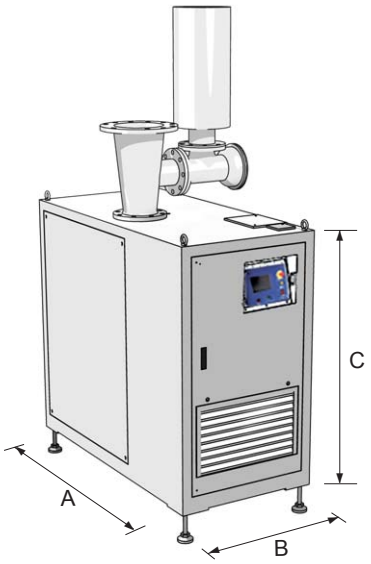
Turbo Blower VX Series, Nominal Air Flow

Model		VX75		VX100		VX150		VX200	
Shaft Power		75 hp		100 hp		150 hp		200 hp	
mmHg	inchHg	Air Flow Rate							
		(m^3/min)	(ft^3/min)	(m^3/min)	(ft^3/min)	(m^3/min)	(ft^3/min)	(m^3/min)	(ft^3/min)
200	7.874	103	3638	137	4838	206	7275	275	9712
250	9.842	88	3108	117	4132	176	6216	234	8264
300	11.811	77	2719	103	3638	155	5474	207	7311
350	13.779	70	2472	94	3320	141	4980	188	6640
400	15.748	65	2296	87	3073	131	4626	174	6145
450	17.716	63	2225	84	2967	126	4450	168	5933
500	19.685	60	2119	81	2861	121	4273	162	5721

* Air Flow at 68°F, 14.7 PSI, 65% RH
(20 , 1 atm, 65% RH)

- Noise Level : 75~85 dB
- Flow Range : 50~100% of nominal air flow
- Tolerance of Inlet Volume : ±5%
- Option : Check Valve, Flexible, RS-485 Monitoring/Control

Product Specification



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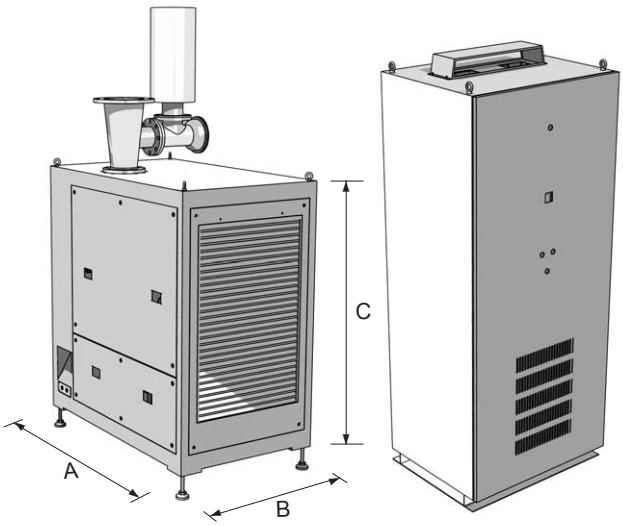

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Unit : mm

	NX50~100	NX150	NX200	NX300
A	1550	1750	2000	2100
B	770	770	900	1400
C	1350	1350	1550	2000

Unit : mm

	NX200	NX300
A	1550	1650
B	900	1000
C	1550	1720

※ The dimension of Inverter cabinet is determined at customer's request.
※ We have experience in installation of the inverter at a distance of 200 meters from the blower body at customer's request.
※ The length of the blower foot for anchor bolt or level adjustment is not included in the length of "C" above.

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ITT

Flygt

Flygt low speed mixers

Outstanding efficiency

Engineered for life

Better mixing and reduced power consumption

Allowing the mixer jet to develop leads to a good bulk flow and efficient mixing of the entire tank.

Compared to dry-mounted mixers, submersible solutions offer greater flexibility and considerable savings in energy consumption for a wide range of mixing applications, such as solids suspension, bottom erosion, blending, circulation or destratification.

How does mixing work?

All mixing applications require varying degrees of both small-scale turbulence and bulk flow. With a good bulk flow, the contents of the entire tank are put in motion so that all parts are involved in the mixing. Most mixing applications generate abundant turbulence and it is the strength of the bulk flow that controls the efficiency of the mixing. The performance of a submersible mixer is measured by the thrust (N) that it produces. So the strength of the bulk flow is in turn dependent on the total amount of installed thrust.

Submersible mixers mean more efficient bulk flow

Submersible mixers allow a great deal of flexibility in positioning and orientation, unlike their dry-mounted counterparts. The mixer jet can be positioned to develop over a long distance and adapted to the shape of the tank. This ensures the creation of a maximum level of bulk flow. The result: more efficient mixing and lower power consumption.

Fast, easy installation

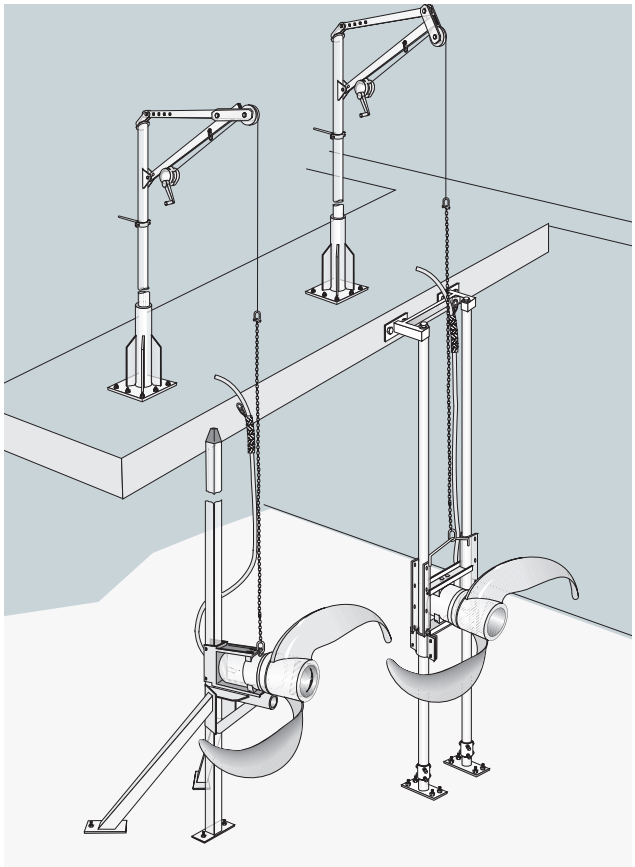
The most frequently-used installation method employed with the Flygt 4400 series mixers is the guide bar with the mixer being easily raised and lowered. This method gives easy accessibility for servicing.

The submersible route to lower capital investment

Using a submersible mixing solution presents a number of cost advantages over traditional dry-mounted mixer alternatives. The installation method is quick and easy and requires low capital investment. A minimum number of units are required to mix very large volumes, thus further reducing the costs associated with the installation.

No costly modifications

Thanks to the flexibility of the installation method, Flygt mixing equipment can be used in existing tanks without the need for expensive alterations to the site.



Single guide bar system
A frequently used solution that eliminates any risk of fatigue, yet provides a cost efficient installation.

Double guide bar system
Rigid design that also allows installation of multiple mixers at different depths.

Every detail ensures the highest reliability

Inner shaft seals
Shaft seals between stator and gear box, and between gear box and seal housing.

Outer shaft seal
Mechanical shaft seal between surrounding liquid and seal housing.

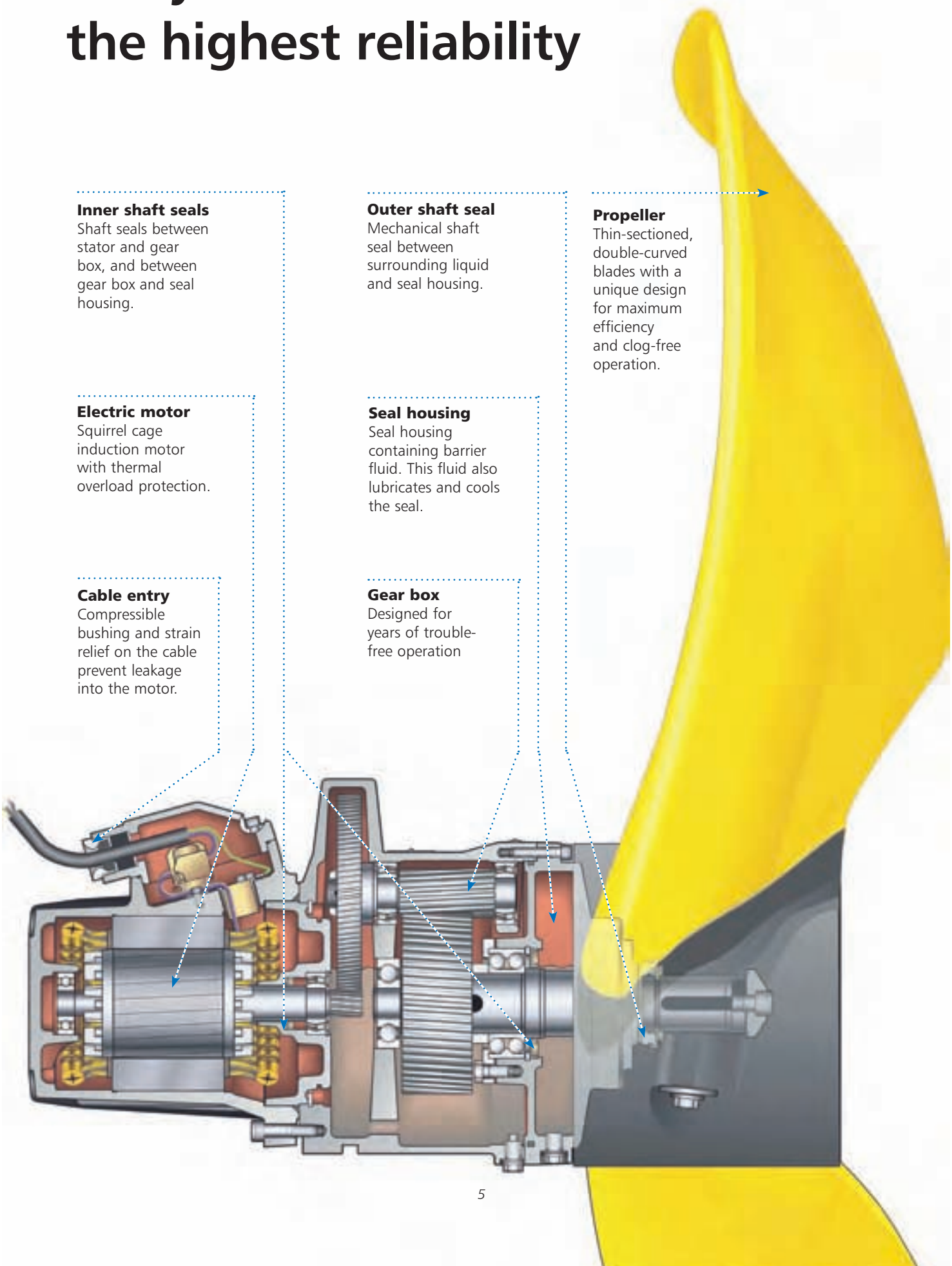
Propeller
Thin-sectioned, double-curved blades with a unique design for maximum efficiency and clog-free operation.

Electric motor
Squirrel cage induction motor with thermal overload protection.

Seal housing
Seal housing containing barrier fluid. This fluid also lubricates and cools the seal.

Cable entry
Compressible bushing and strain relief on the cable prevent leakage into the motor.

Gear box
Designed for years of trouble-free operation



Maximum efficiency from a unique design

In almost all applications, the mixing result depends on a good bulk flow being generated throughout the tank. In turn, the strength of this bulk flow depends on the thrust of the mixer. The hydraulic efficiency, speed and diameter of the propeller together determine the cost in power consumption of the generated thrust.

State-of-the-art design

ITT Flygt's low speed mixers combine excellent hydraulic design together with large diameters and low speed. The low speed mixer is therefore the optimum choice for generating the absolute maximum of thrust with the minimum of power consumption.

This efficiency also has to be maintained when operating in fibrous material, where clogging could be a problem. So the swept-back design of Flygt low speed propellers also provides exceptional self-cleaning properties.

The Flygt design solution relies on material bonding technology, employing glass fiber reinforced polyurethane. This results in maximum strength with optimum hydraulic efficiency.

Seals engineered for the job

Shaft seals are a crucial component in the reliable operation of any submersible mixer. Flygt 4400 series mixers employ our own unique mechanical shaft seal design with an intermediate barrier fluid.

Why do seals wear out?

Theoretically, the surfaces of mechanical seals should be constantly divided by a thin film of liquid. In practice, there is always some direct contact which leads to wearing of the seal surfaces. This is why the choice of material, and its sliding properties, is extremely important to the longevity of a mechanical seal.

The choice for longer life

Flygt low speed mixers are equipped with shaft seals manufactured from corrosion-resistant tungsten carbide (WCCR). Other material choices available include silicon carbide (SiC), but for the kind of applications where Flygt low speed mixers are used, WCCR provides the optimum choice.

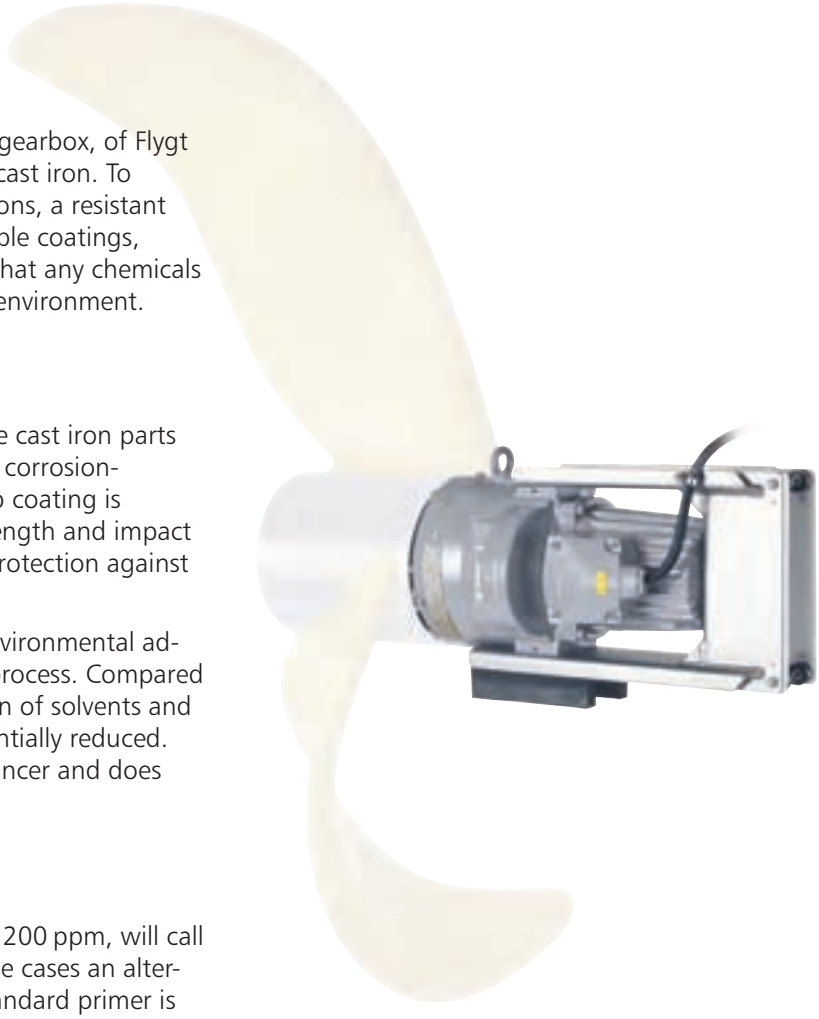
The reason can be found in WCCR's superior sliding properties. This factor results in significantly less wear between the two seal surfaces, and thus, offers a longer operational life with less risk of leakage. WCCR also offers better mechanical strength and is far less brittle or prone to handling damage. The addition of a chromium, nickel and molybdenum binder in the material also ensures excellent corrosion resistance down to a pH of 3.

	Bending strength (MPa)	Fracture toughness ($MPa^{1/2}$)
WCCR	2600	18
SiC*	390	4.5

WCCR has superior mechanical properties.
**For materials comparison only*

Tough coatings that are gentle on the environment

The drive units, including motor and gearbox, of Flygt 4400-series mixers are made of grey cast iron. To prevent corrosion in varying applications, a resistant coating is required. In choosing suitable coatings, great care has been taken to ensure that any chemicals used do not present a hazard to the environment.



Standard coating

Where a standard coating is used, the cast iron parts are first blasted and then dipped in a corrosion-preventive primer. The oxiranester top coating is characterised by high mechanical strength and impact resistance, as well as offering good protection against chemicals.

The oxiranester coating also offers environmental advantages during the manufacturing process. Compared with alternative coatings, the emission of solvents and volatile organic compounds is substantially reduced. Oxiranester does not pose a risk of cancer and does not promote allergies.

Special coating

Applications with chloride levels over 200 ppm, will call for extra corrosion protection. In these cases an alternative coating can be chosen. The standard primer is replaced with a zinc-rich epoxy primer which provides increased anodic corrosion protection. Oxiranester is still used as a top coating because of its excellent properties, but here it is applied in three layers. For further protection in these applications, the mixers may also be equipped with optional zinc anodes.

Cross section of Flygt epoxy coating

A wide performance range

ITT Flygt conceived the concept of the submersible low speed mixer for gentle mixing of large volumes. Over the years the concept has been developed and perfected, and today the Flygt range of 4410, 4430 and 4460 mixers offer highly energy-efficient solutions for a wide range of mixing applications, such as:

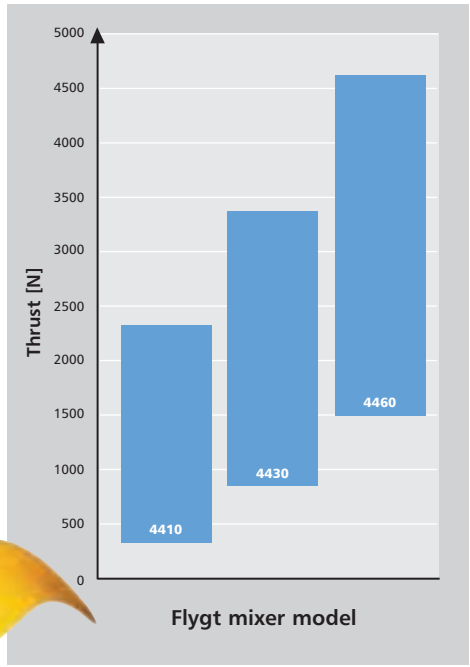
- Biological treatment tanks
- Sludge holding tanks
- Equalisation tanks
- pH stabilisation tanks
- Chemical flocculation
- Water reservoirs
- Ice prevention
- and many more.

Modular concept

The mixers are available with different motor alternatives. Eight different gear ratios are offered, and propeller diameters range from 1400 mm to 2500 mm (55 1/8" – 98 3/8").

By combining different motors, gear ratios and propeller diameters, the modular design of Flygt low speed mixers allows for a comprehensive selection of mixer performance.

Model	4410	4430	4460
Shaft power	50 Hz, 2.3 kW 60 Hz, 2.6 kW/3.5 hp	50 Hz, 4.3 kW 60 Hz, 4.6 kW/6.2 hp	50 Hz, 5.7 kW 60 Hz, 6.3 kW/8.4 hp
Max. nominal thrust	50 Hz, 2.2 kN 60 Hz, 2.4 kN/530 lb	50 Hz, 3.3 kN 60 Hz, 3.4 kN/760 lb	50 Hz, 4.6 kN 60 Hz, 4.5 kN/1000 lb
Propeller diameter	1400 mm to 2500 mm 55 1/8" to 98 3/8"	1400 mm to 2500 mm 55 1/8" to 98 3/8"	1400 mm to 2500 mm 55 1/8" to 98 3/8"



Making your equipment even easier to work with

Installation accessories should be rigid enough to withstand the weight and reaction forces exerted by the mixer throughout its operating life. Professional operators also need the equipment to be easy to work with for installation as well as inspection and service.

Well proven reliability

Strong fluctuating forces act on all large diameter mixers. So installed equipment must be capable of withstanding fatigue. Flygt's installation accessories have proven themselves in thousands and thousands of installations.

Convenient and safe lifting equipment

ITT Flygt provides equipment that enables convenient lifting and handling of mixers.

The safety is guaranteed with the CE marking, the European sign for safety approval.

The lifting davit is mounted in a holder at its lower end which enables easy turning of the davit. To raise the mixer, the davit is fitted with either a winch or a pulley block.

To reduce investment cost, one davit can be used for several mixers. Mixers can be left submerged without being suspended by the lifting wire. A Flygt patented lifting device guarantees the connection to the mixer's lifting bail.

Trouble-free operation, year after year

Local service network – worldwide

The service and maintenance of equipment is a key factor in any professional operation. At ITT Flygt we offer an unparalleled worldwide network, so that there is always a professional service centre close to your operations, with fully equipped workshops and trained service engineers.

Total service concept

Every mixer installation and system is different and so are the levels of service and support that you may require. With ITT Flygt, you can choose the level of service to suit your needs. From simply supplying mixers, to full service assistance and maintenance, ITT Flygt's total service concept means the service you require, on your terms.

Easier servicing

In the design stages of our mixers, we pay great attention to the ability of offering prompt and easy on-site service. This, in combination with the availability of service kits means minimum downtime. For customers who wish to service their own mixers, extensive Workshop and Care & Maintenance manuals are available.

15-year spare parts guarantee

We guarantee the availability of spare parts for 15 years after the production of a mixer has stopped. Just another way that ITT Flygt guarantees its long-term commitment to its customers.

ITT

What can ITT Flygt do for you?

From water supply to mining, sewage systems to construction, and process industries to emergency services, ITT Flygt solutions are helping our customers solve some of the toughest fluid-handling problems in a safe and cost-effective way.

As a leading supplier of fluid-handling solutions, we have the products and expertise to provide you with complete pumping solutions, from planning and delivery, to installation and after-sales service. With a worldwide service network, you can always get the support you need.

Flygt, a wholly owned subsidiary of ITT of White Plains, New York, is represented in more than 130 countries and has more than 40 sales companies.

www.flygt.com

Low speed mixers.02.05.Eng.06.07 893072 Trosa Tryckeri AB 60193

Lakeside's Spiraflo Clarifier

The peripheral-feed center take-off clarifier with a proven spiral flow design for superior removal of total suspended solids.

- Spiral flow pattern - provides superior solids removal
- Full utilization of tank volume - eliminates short-circuiting
- Most reliable drive available - backed by a ten year warranty

The Lakeside Spiraflo Clarifier

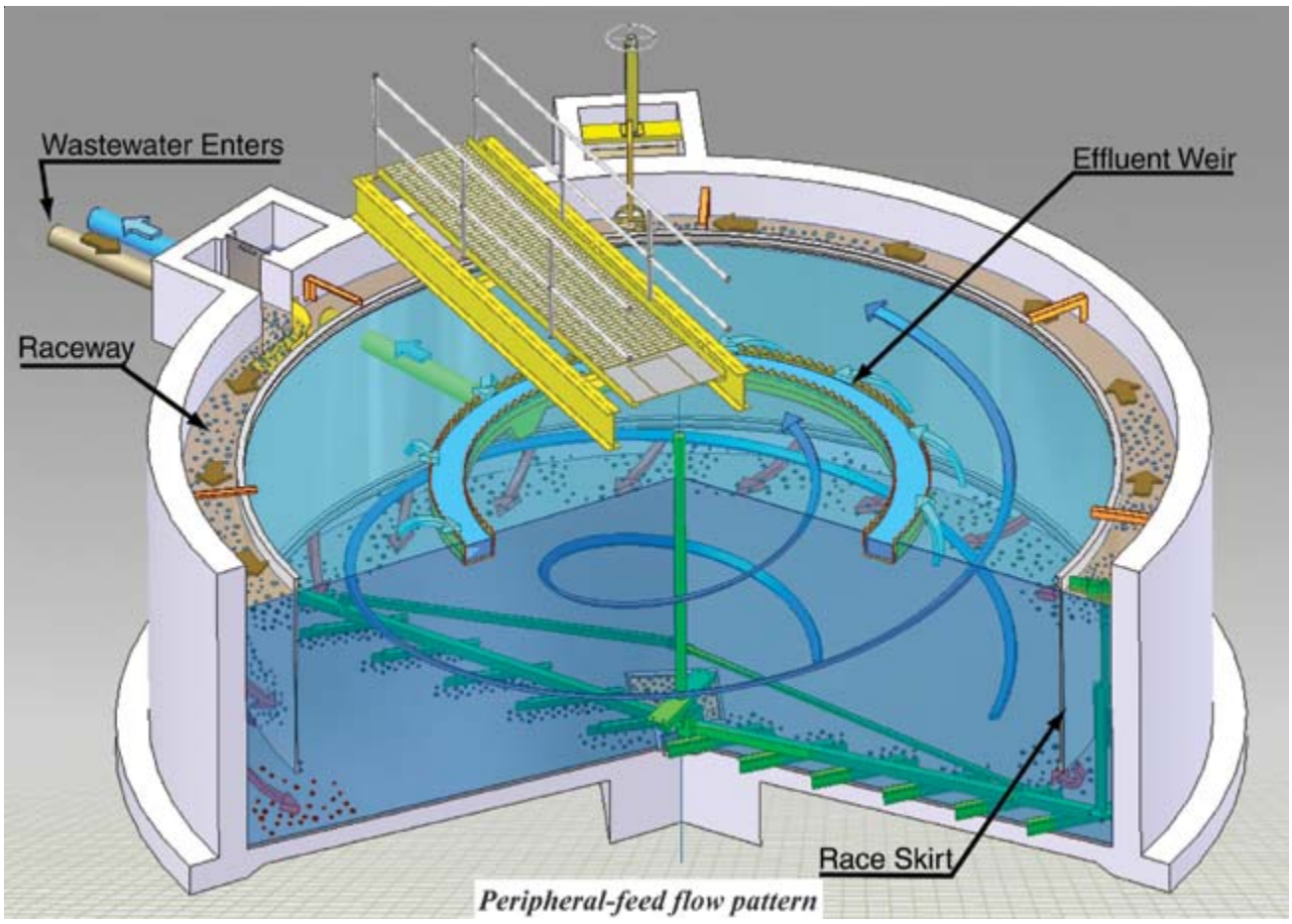
The performance of the Spiraflo Clarifier has been *extensively proven* since 1934. Lakeside has installed more than 2,000 clarifiers in sizes ranging from 8 ft to130 ft in diameter for primary, secondary and tertiary clarification.

Spiraflo Design

Peripheral-Feed Flow Pattern

Wastewater enters the Spiraflo Clarifier at the periphery of the tank and is directed along the narrow raceway formed by the skirt and the outer wall. This flow pattern dissipates the wastewater's hydraulic energy as it flows around the raceway and eventually spirals down under the skirt.

Wastewater enters the main settling area from the full circumference of the skirt and slowly rises to pass over the centrally located effluent weirs. The inflow is prevented from flowing directly to the effluent weir by the specially designed race skirt which extends down to approximately two feet above the tank floor. The spiraling flow pattern makes use of total tank volume for more effective solids settling.



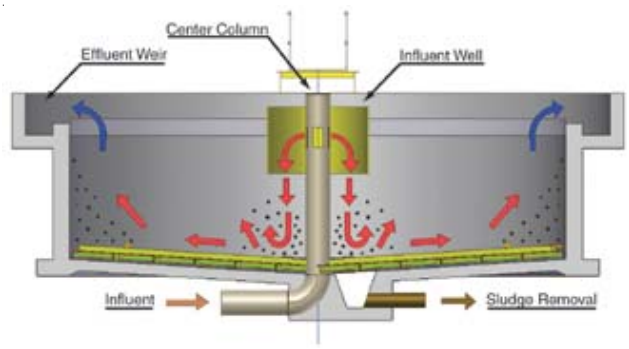
Peripheral-feed flow pattern

Spiraflo Hydraulic Advantages

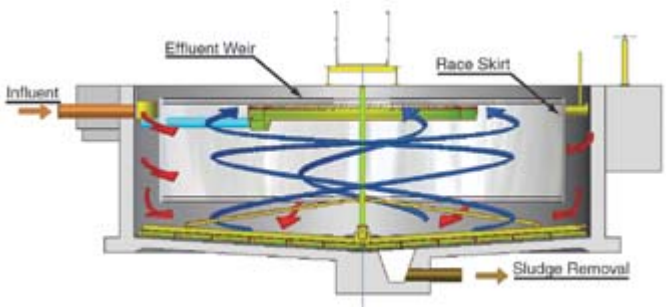
The Spiraflo's peripheral-feed design *provides the best hydraulic flow pattern* and minimizes many of the problems associated with centerfeed hydraulics.

Eliminates the Waterfall Effect

The influent well in a centerfeed clarifier deflects the high velocity inflow downward creating a waterfall effect. This velocity combined with the higher density of settling solids disturbs the sludge blanket at the bottom of the tank and interferes with proper solids removal.



Centerfeed Hydraulics



Peripheral-feed Hydraulics

Because the Spiraflo's incoming flow enters at the periphery, the flow spirals in the raceway dissipating the energy before it enters the main settling area. Any velocity remaining in the flow as it moves below the skirt is directed toward the center of the tank in a spiral pattern.

Eliminates Sludge Wall Creep

In a centerfeed clarifier, the velocity created by the waterfall effect moves solids from the center of the tank to the outer wall. This movement, known as sludge wall creep, can push solids up the outer wall and over the effluent weir and can greatly reduce effluent quality.

In the Spiraflo Clarifier, the flow travels inward from the skirt towards the center of the tank. This movement coincides with the direction of the scraper mechanism and assists in moving sludge to the central hopper.

Eliminates Short-Circuiting

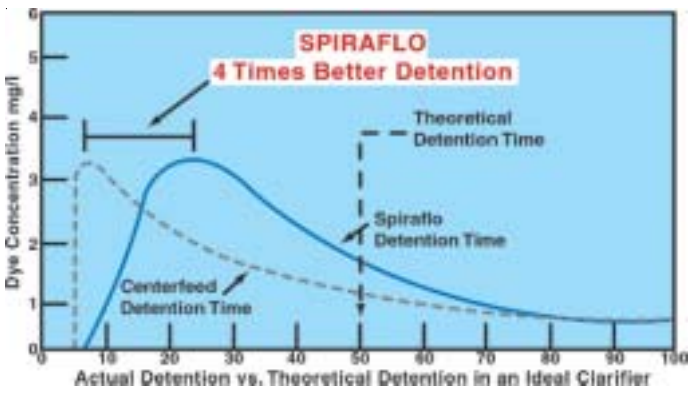
The centerfeed clarifier flow pattern, created by the waterfall effect and sludge wall creep, causes influent to flow directly to the effluent weir. This short-circuiting prevents complete use of the tank volume for the settling process.

The Spiraflo's spiraling flow pattern rolls around and under the skirt eliminating all possibility of short-circuiting and ensuring maximum use of the entire tank volume.

Spiraflo Hydraulic Theory & Results

Both full-scale and model testing at Iowa State University confirm that by dissipating the inflow current and controlling short-circuiting with the race and skirt, the Spiraflo provides superior solids removal.

Full-scale work consisted of dye studies of prototype Spiraflo and centerfeed units. Independent laboratory tests conducted on models confirmed that the peripheral feed clarifier performs two to four times better hydraulically than the centerfeed clarifier. Full-scale side-by-side testing of the Spiraflo Clarifier versus centerfeed designs has confirmed the modeling results.



Sludge Removal

Conventional Scrapers

Angled scrapers push the settled solids or sludge to the centrally located hopper for removal. The hydraulic flow in the main settling area moves in the same direction as the angled scrapers and actually helps move the sludge gently toward the center of the tank.

Conventional straight-blade angled scrapers.

Spiral Scrapers

Continuously tapered spiral-shaped scraper blades and faster operating tip speeds enable the plant operator to increase sludge transport capacity and improve return sludge concentrations.

Spiral-bladed scraper.

Spiravac Clarifier - Rapid Suction Removal

The Spiravac Clarifier uses rotating "V"-plows to direct settled solids to suction nozzles for sludge removal. Heavy, gritty material too large to be withdrawn passes through the "V" apex. Succeeding plows push this heavy material to the sludge sump located at the clarifier center for removal from the tank. The spiral flow pattern also helps direct the sludge to the central draw-off point. The Spiravac offers either controlled or direct removal of activated sludge.

Individual sludge removal pipes for Type CR design.

Common header pipe removes sludge in Type DR design.

Controlled Removal (Type CR)

The Type CR Spiravac allows the operator to vary the quality and quantity of flow from each sludge removal pipe. The smooth plastic sludge removal pipes and rotating valve construction help eliminate plugging problems and the hang-up of stringy material at the valve discharge. The controlled removal design allows removal of obstructions in the sludge piping without dewatering the tank.

Direct Removal (Type DR)

The Type DR Spiravac collects activated sludge from suction nozzles on a common header tube rotating on the clarifier floor. The sludge is suctioned off the floor and removed from the tank through a rotating manifold at the tank center.

Scum Removal and Surface Skimming

Race Skimmer

Grease, free oils and other floatable materials are separated from the flow as it slowly spirals around and down the raceway. The Spiraflo's deep skirt traps floatable material in the raceway and the depth of the skirt helps prevent floatable material from entering the main settling area.

The hydraulic energy of the influent flow then carries the floating material around the race for removal through the scum pipe. On tanks greater than 15 feet in diameter, a race skimmer is often installed to help collect scum and move it into the scum pipe. Mounted on the scraper arm, the race skimmer travels around the tank pushing scum to the removal point.

Hinged Blade Race Skimmer

Full-Surface Skimming

Although the peripheral-feed design significantly reduces floating material in the clarifier's main settling area, some processes with final settling tanks may require additional skimming.

Lakeside's Motorized Full-Surface Skimmer and Full-Surface Ducking Skimmer provide positive skimming by removing floating material over the entire surface of the main settling area.

Motorized Full-Surface Skimmer

The Motorized Full-Surface Skimmer extends the full width of the clarifier surface, from the central scum baffle to the outer race skirt. The motorized skimmer sweeps the surface of the clarifier with a hinged blade suspended from the skimmer arm. The blade maintains complete contact with the water surface while it pushes floating material to a rotating scum trough for removal.

Motorized Full-Surface Skimmer.

Full-Surface Ducking Skimmer.

Full-Surface Ducking Skimmer

In applications where skimming the clarifier surface is important but the Motorized Full-Surface Skimmer cannot be used, the non-motorized Full-Surface Ducking Skimmer is an economical alternative.

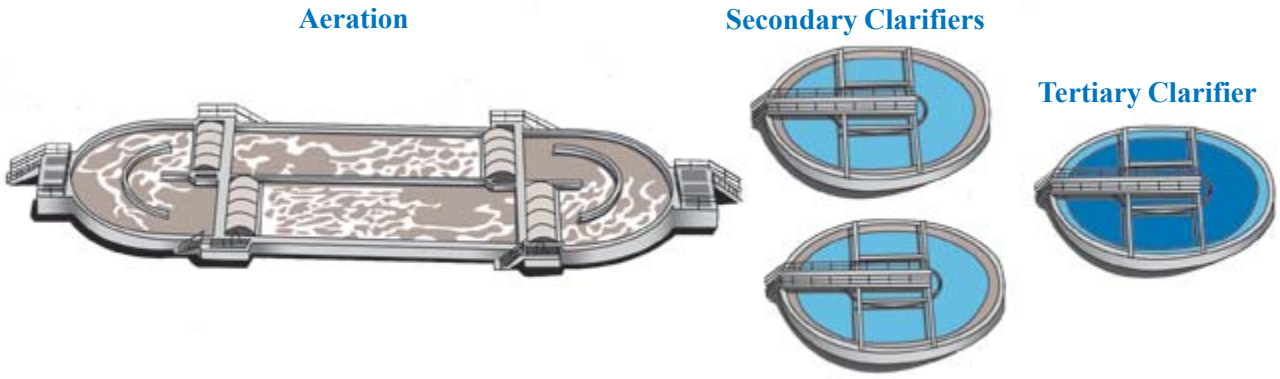
Unlike the Full-Surface Skimmer which passes over the rotating trough, the Full-Surface Ducking Skimmer pushes the floating material into the scum trough as the blade ducks under the trough.

Tertiary Treatment

Using Spiraflo Clarifiers in Series

Lakeside's established tertiary treatment process using Spiraflo Clarifiers operating in series has proven to be the simplest, most economical solution for improving the effluent quality of secondary treatment plants. Effluent qualities of 10 mg/l BOD and 10 mg/l TSS or less are being reliably achieved by adding a tertiary Spiraflo Clarifier downstream from the secondary Spiraflo Clarifier (*see process flow diagram*).

CLR Process



This diagram illustrates a typical series clarification operation.

Process Description

The Spiraflo Clarifier used for secondary treatment in the CLR Process has produced effluent qualities of 15 mg/l BOD and 15 mg/l TSS or less. However, some solids may be lost over the effluent weir because of problems such as high solids loading, sludge blanket disturbances and ashing.

To increase the solids removal capability of the plant, a tertiary Spiraflo Clarifier is added downstream. The tertiary Spiraflo Clarifier removes more solids and proportionately reduces the amount of BOD in the effluent. Using this additional Spiraflo Clarifier significantly improves the plant's effluent quality.

Tertiary treatment using Spiraflo Clarifiers in series can be added to virtually any secondary treatment process. This includes the CLR Process as well as trickling filter plants, rotating biological contactor plants, conventional activated sludge plants and extended aeration plants.

Optional Chlorination

The tertiary Spiraflo Clarifier can also function as a chlorine contact tank by simply adding chlorine to the influent. Chlorination improves solids settleability, improves effluent quality and eliminates the need for additional tanks.

The Spiraflo Clarifier makes a very effective chlorine contact tank with features such as flow direction, flow control and a race skirt to prevent short-circuiting and eliminate dead space. Independent studies have shown that one of the best shapes for chlorine contact tank design is the circular clarifier with an annular ring. The Spiraflo's race skirt forms this type of annular ring around the clarifier.

The Spiraflo Clarifier mechanically removes settled solids at a controlled rate to eliminate hydraulic shock loading, a common problem with other tertiary treatment processes using wash water. In order to remove settled solids from other types of chlorine contact tanks, plant personnel must drain the tank and shovel the solids out manually. The Spiraflo's mechanical removal of settled solids eliminates the need for this time-consuming, costly and labor-intensive step in the process.

Spiraflo vs Centerfeed Cost Comparison

Tank Excavation

Both centerfeed and Spiraflo tanks require excavation, but excavation is more expensive and time consuming for a centerfeed unit. Influent pipes for larger centerfeed clarifiers are installed under the tank floor requiring deeper excavation for gravel bedding or concrete encasement.

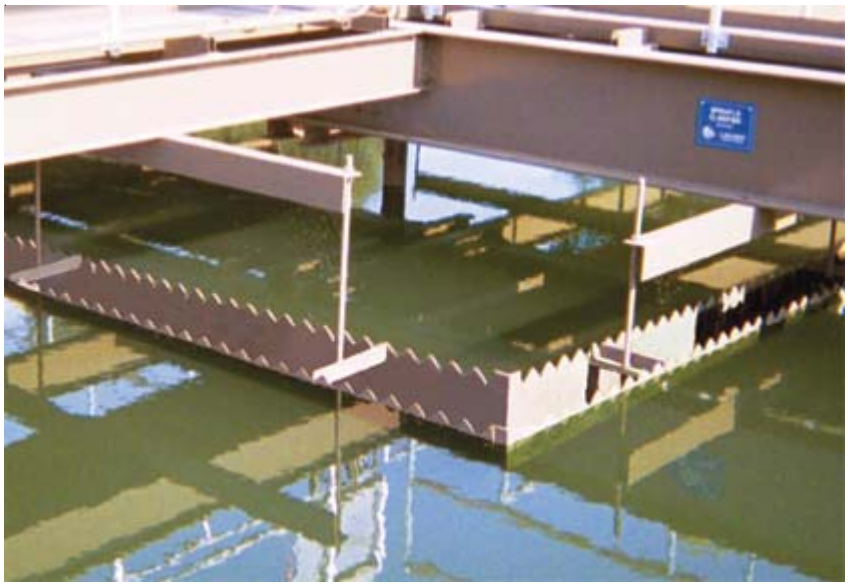
Excavation costs for a Spiraflo tank are *lower* because the tank is constructed without the below-grade influent pipe and peripheral effluent trough used for centerfeed clarifiers.

The Spiraflo's influent and effluent pipes are installed above the tank floor reducing the depth of excavation.

Tank Construction

The centerfeed's concrete peripheral effluent trough is a costly addition to tank construction. The cantilevered trough requires extra reinforcing steel to withstand design loads, special formwork to construct and extra concrete pours to complete the tank wall.

Spiraflo effluent troughs are part of the clarifier equipment provided by Lakeside. The effluent troughs are installed inside the tank and are not part of the poured concrete walls. Tank walls are straight and therefore make forming *less expensive,* steel reinforcing simpler and concrete pours easier. Less concrete is required and simple forms save time and money needed for tank construction.

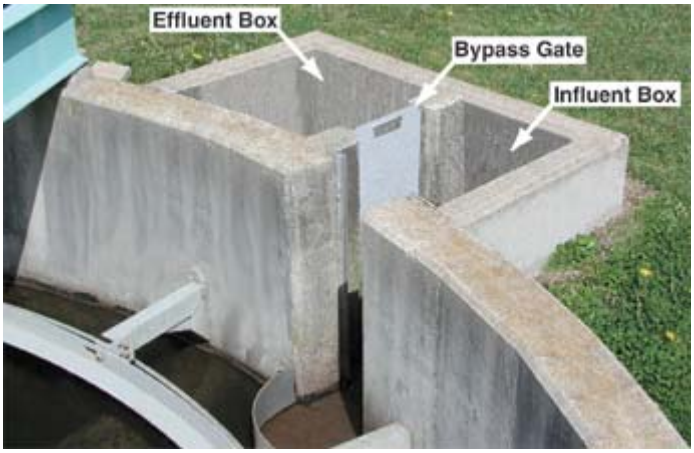


The effluent trough is suspended from adjustable supports eliminating the need for a concrete structure.

Tank Bypassing

Construction for a centerfeed clarifier bypass normally
requires additional valves, piping, valve boxes and fittings.

Materials for a Spiraflo bypass include *only* an influent and effluent box with a stop gate.



Influent and effluent boxes used for bypassing are conveniently located at the periphery of the tank.

Additional Equipment

Stamford baffles, energy dissipation feedwells, flocculation wells and mid-radius baffles are often
used in an attempt to diminish the centerfeed clarifier's short-circuiting and waterfall effect.

No such additional equipment is needed with the Spiraflo peripheral-feed design.

Spiraflo Applications

Spiraflo Clarifiers can be used in water, wastewater and industrial applications to remove all types of settleable solids. The Spiraflo's proven spiral flow design provides superior removal for even the toughest applications.

Spiraflo Benefits

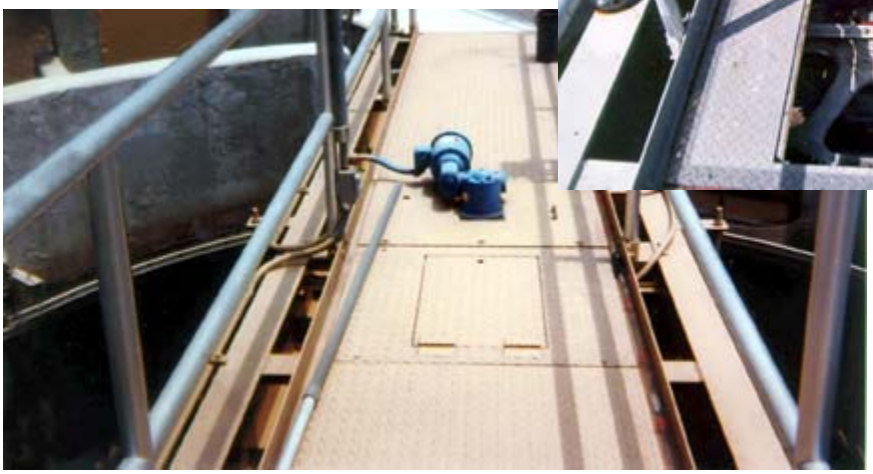
The peripheral-feed design incorporates advantages that provide *unequalled performance*.

More than 2000 installations have proven that the Lakeside Spiraflo Clarifiers:

- produce the highest quality effluent
- improve sludge collection and removal
- promote full utilization of tank volume
- eliminate short-circuiting
- handle peak flows effectively
- retain suspended solids in the sludge blanket
- eliminate sludge wall creep that is created by the waterfall effect

Ten Year Clarifier Drive Warranty

When you specify a Lakeside Spiraflo or Spiravac Clarifier you'll not only get the superior performance of a peripheral-feed clarifier, you'll also get the most reliable drive available. Our dedication to quality and proven reliability allows Lakeside to stand behind our clarifier drive with a 10 year warranty.



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Water Purification Since 1928

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E-mail: sales@lakeside-equipment.com

Technical
Information
TI 225C/07/en
51503544

CUM 750 / CUS 70

Ultrasound Measuring System for Separation Zone and Sludge Level Detection

In many instances in process engineering, suspensions are separated into their solid and liquid components by sedimentation.
To operate this process economically and efficiently in practice, it is indispensable to monitor the separation and transition zones of the clarification and settling phases continuously.
For this task, Endress+Hauser offers the CUM 750 / CUS 70 ultrasound measuring system.

Applications

- Wastewater treatment: primary clarifier, sludge thickener
- Water purification: settling basin after flocculant dosage, sludge height in contact sludge process
- Chemical industry: static separation process

Benefits at a glance

- Reliable concentration measurement using ultrasound process
- Detection of sludge concentration profile
- Also applicable in regions of low differences in density
- Multi-channel version for parallel measurement in up to four basins
- Simple configuration, calibration and adjustment via menu-assisted user interface
- Backlit multifunctional display for graphical and numerical display
- Ultrasound sensor with large measuring range at small beam angle
- Insensitive to scum
- Easy to install
- Automatic sensor cleaning with self-priming pump (optional)

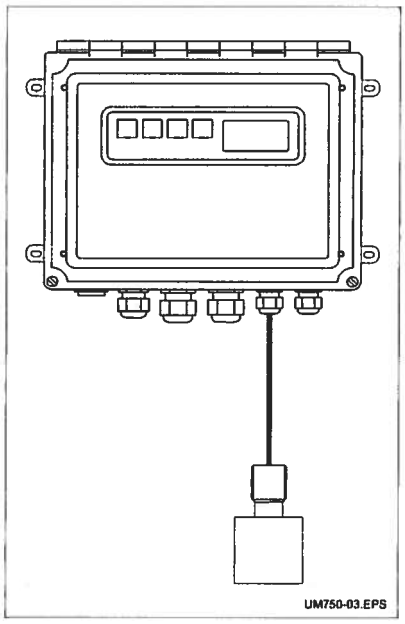
Quality made by Endress+Hauser

ISO 9001

Endress+Hauser

The Power of Know How

Measuring instrument



CUM 750 / CUS 70
measuring system

The entire measuring system consists of:
- CUM 750 measuring transmitter
- CUS 70 ultrasound sensor

The instrument is specially designed as a closed field housing for use outdoors.

Measuring principle

CUS 70 ultrasound sensor
A piezoelectric crystal is integrated in a flat cylindrical plastic housing. When the crystal is excited by an electrical voltage, it generates a sonar signal. The ultrasound waves are transmitted at a frequency at 657 kHz at an angle of 6° to scan the separation zones.

The parameter measured is the time it takes for the transmitted ultrasound signal to reach the solid particles in the separation zone and return to the receiver.

Function

The speed of sound varies according to the physical properties of the measuring medium and is affected by temperature and air pressure. The liquid zones and solids content of the medium also vary.

To obtain precise measurement results, it is therefore vital to adapt system variables to the process, e.g. pulse length and the speed of sound.

The 32-bit processor offers the following possibilities for signal evaluation:

- Mask regions where the separation zone is not expected.
- Evaluate received signal strengths differently.
- Select leading or trailing signal edges in the evaluation.
- Amplify sensor signals at different rates, e.g. for floating sludge.
- Define a region (gate) above and below the separation zone. Signal evaluation only takes place in the defined region. The gate wanders with the separation zone. This makes smoothing algorithms unnecessary.
- Arrow indicator for basin floor.

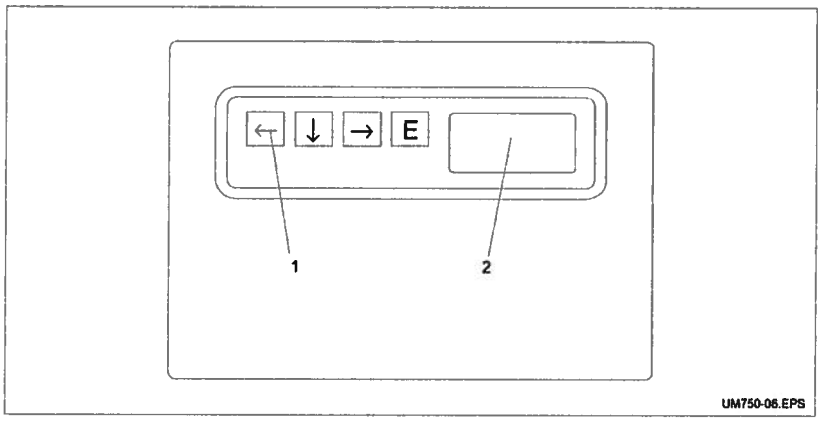
Operation

The CUM 750 can be completely set up and calibrated via the dirt-proof membrane keypad. The operator is guided interactively via the operating menu. The interface is a two-line plaintext display.

The use can selected from 3 configurations:
- 1 factory configuration
- 2 user-defined configurations

If the scraper causes interference, the signal can be smoothed and filtered. Interference from floating sludge can be eliminated by the cleaning pump.

All the calibration data and parameters are retained if there is a power failure or when the device is shut down (non-volatile RAM).

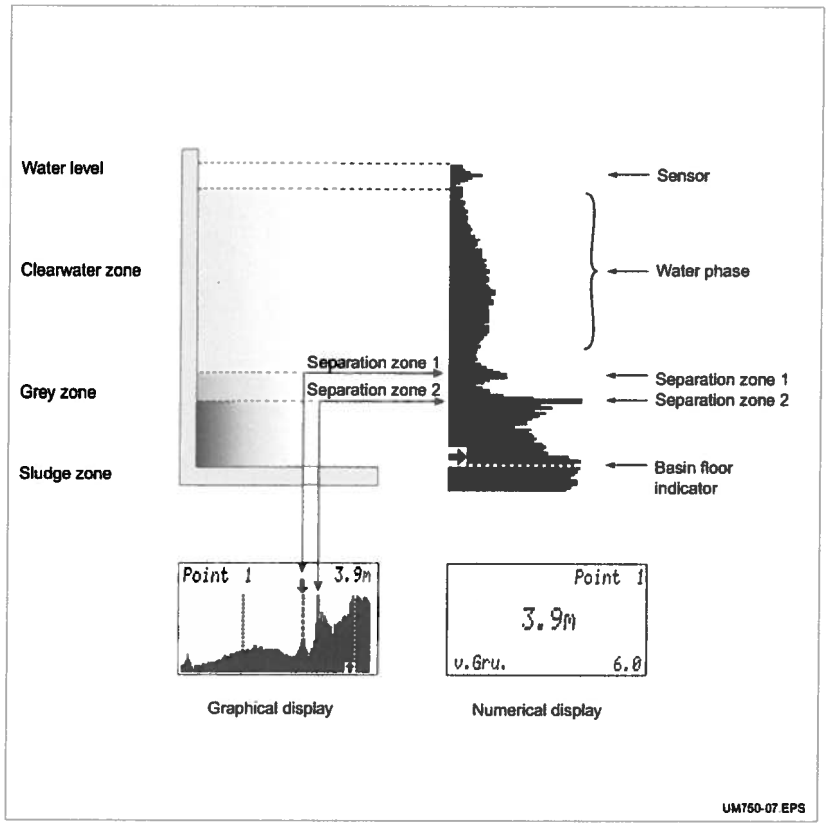


User interface

1 Membrane keypad
2 Large LC display for graphical and numerical display

Display

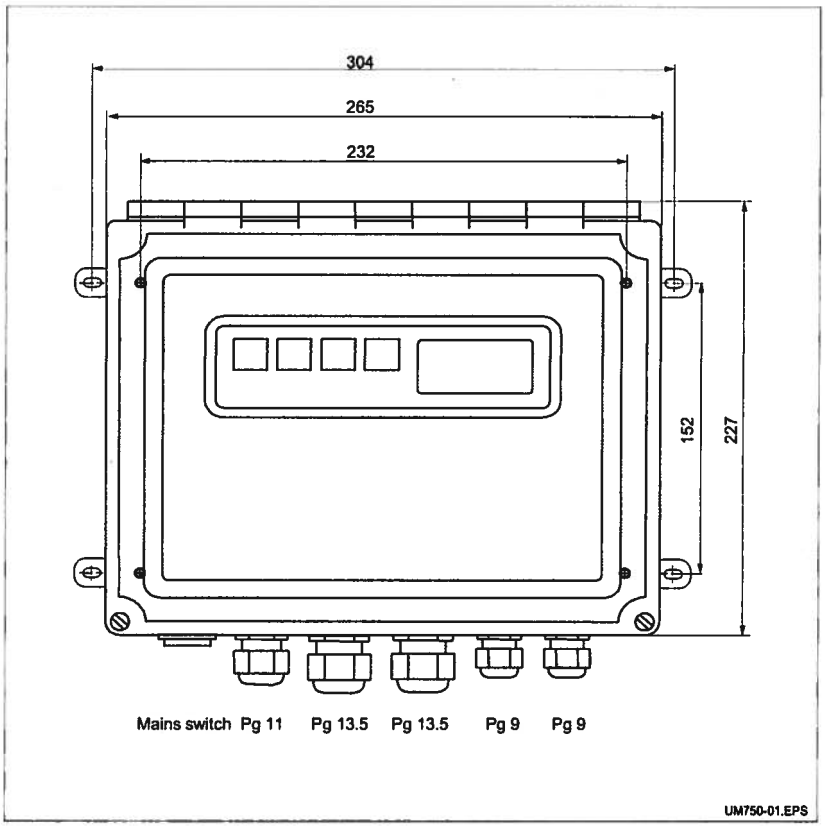
The multifunctional display has two different display modes:
- numerical display
- graphical display



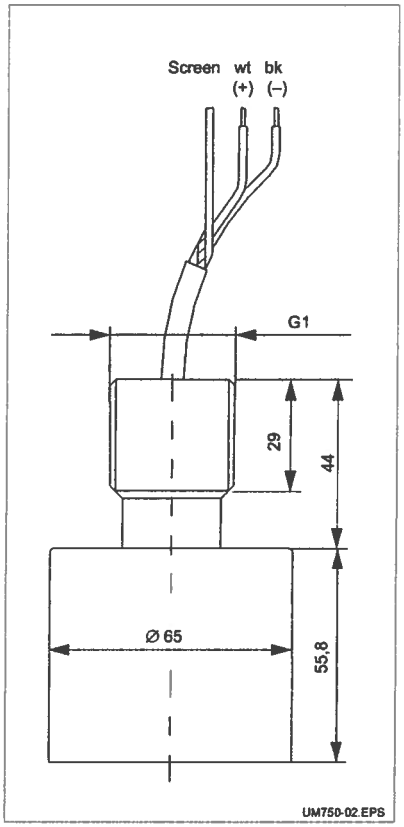
Sludge level measurement in primary clarifier

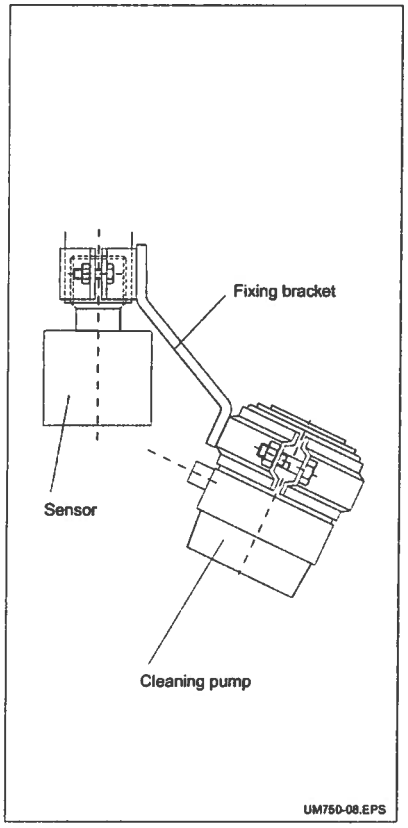
Display modes

Dimensions



Dimensions of
CUM 750 measuring
transmitter



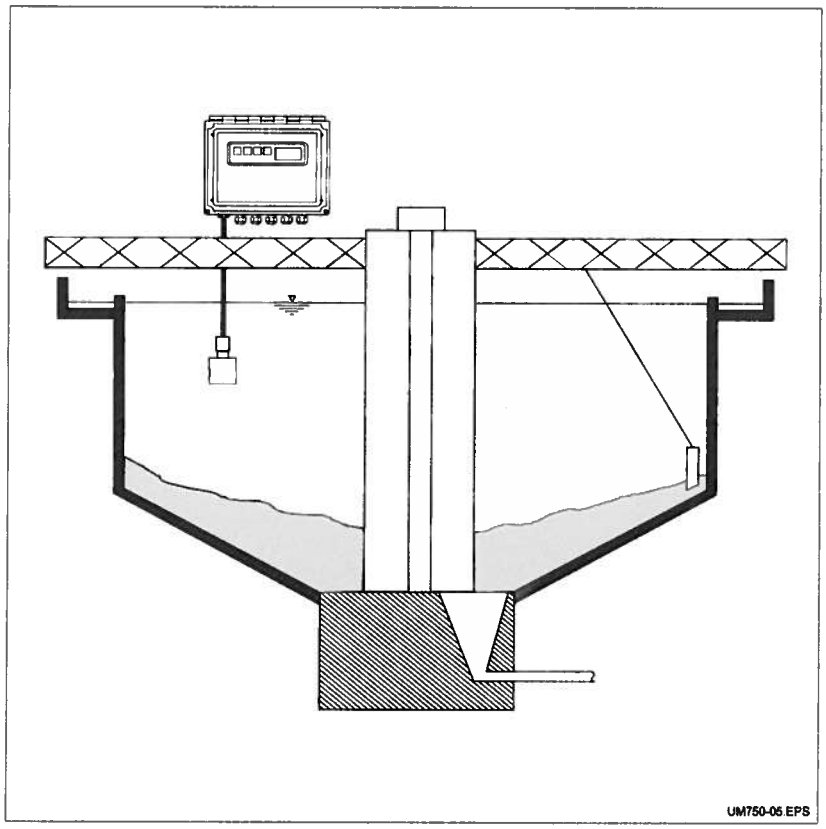


CUS 70 sensor

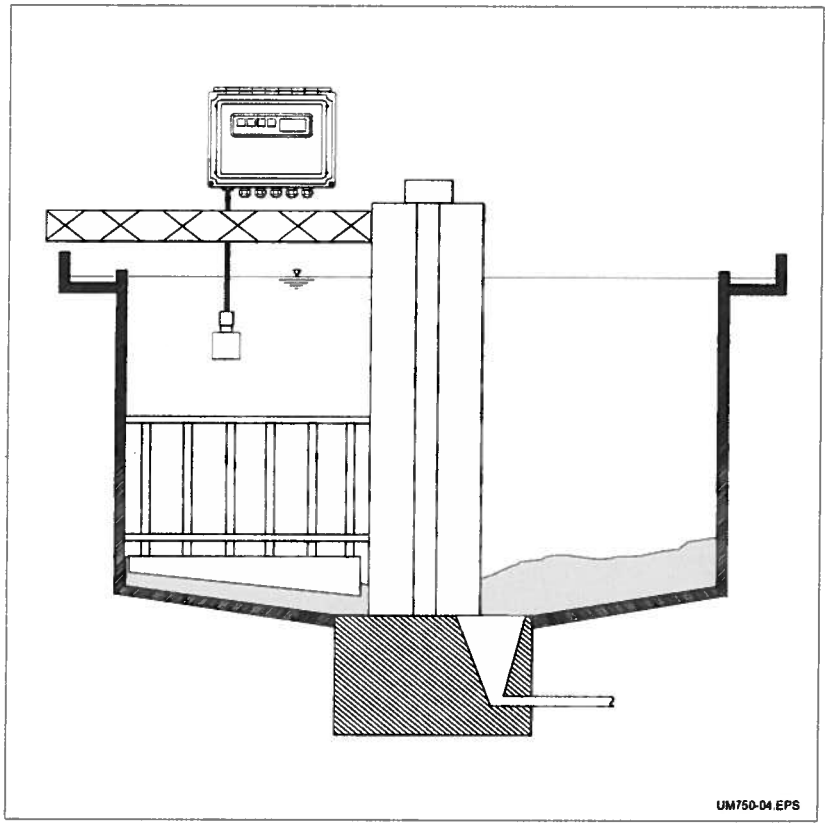
left:
Dimensions of
CUS 70 sensor

right:
CUS 70 sensor with
self-priming
cleaning pump

Installation



Continuous sludge level measurement in primary clarifier. Installation on scraper bridge



Continuous separation level measurement in sludge thickener

Technical data

CUM 750 measuring transmitter

General data

Manufacturer	Endress+Hauser
Instrument designation	CUM 750 sludge level measuring transmitter

Mechanical data

Dimensions (L x W x D)	265 x 227 x 160 mm
Weight	Approx. 4 kg
Display	LED display (14 mm) for current measured value, 2-line LC display (5 mm) for pogramming

Materials

Housing	Polycarbonate
Sight glass	Plexiglas®
Protection class	IP 65

Input

Measured variable	Height measurement
Measuring principle	Ultrasound
Frequency	657 kHz
Wavelength	0.2 cm
Measuring beam angle	6°
Dead zone	30 cm
Measuring range	0.3 ... 100 m
Signal resolution	0.03 m
Accuracy	±1 % of measuring range

Output

Signal output	0/4 ... 20 mA for height measurement
Number of signal outputs	Max. 4
Load	Max. 500 Ω
Switching outputs	Max. 4 relay contacts
Switching power	10 A at 115/230 V AC, 10 A at 30 V DC
Interfaces	RS 232, RS 485

Electrical connection

Power supply	230/115 V AC, 50/60 Hz +6 ... -10%
Power consumption	Max. 40 VA

Ambient conditions

Ambient temperature	-20 ... +50 °C

CUS 70 ultrasound sensor

General data

Manufacturer	Endress+Hauser
Instrument designation	CUS 70 ultrasound sensor

Mechanical data

Dimensions	260 x Ø 38 mm
Weight	Approx. 0.5 kg
Cable length	6 m
Max. distance between sensor and measuring transmitter	100 m
Process connection for installation pipe	Thread size G1

Materials

Sensor	epoxy resin
Sensor cable	polyurethane jacket

Operating conditions

Max. temperature	60°C
Pressure	max. 6 bar

Subject to modifications

Accessories

- Weather protection cover CYY 101
  for CUM 750
  stainless steel SS 304,
  (H x W x D) 320 x 300 x 270 mm
  Order No.: 50061258

- Stand with weather protection cover
  for CUM 750
  stainless steel SS 304
  (L x W x D) 60 x 60 x 1495 mm
  Order No.: 50064291

- Wall-mounting bracket for CUS 70
  with 300 mm distance to wall
  Order No.: 51503581

- Railing-mounting bracket for CUS 70
  with 300 mm distance from basin and
  variable length immersion tube
  Order No.: 51503582

- Railing-mounting bracket for CUS 70
  with 300 mm distance from basin,
  variable length immersion tube and
  weather protection cover
  Order No.: 51503583

Product structure

CUM 750 sludge level measuring transmitter

Version
- **1** Single-channel version
- **2** Two-cahnnel version
- **3** Three-channel version
- **4** Four-channel version
- **9** Special version

Language version
- **D** German
- **E** English
- **Y** Special version

Power supply
- **0** Power supply 230 V AC, 50/60 Hz
- **1** Power supply 115 V AC / DC, 50/60 Hz
- **9** Special version

Communication
- **A** RS 232 and 4 ... 20 mA
- **B** RS 485 and 4 ... 20 mA
- **Y** Special version

Additional equipment
- **A** Standard
- **Y** Special version

CUM 750- | | | | | | **complete order code**

CUS 70 ultrasound sensor

Version
- **1** Standard version
- **9** Special version

Cable length
- **A** 6 m cable
- **Y** Special version

Cleaning
- **1** Without cleaning
- **2** With cleaning pump 230 V AC, attachment
- **3** With cleaning pump 115 V AC, attachment
- **9** Special version

Additional equipment
- **A** Standard
- **Y** Special version

CUS 70- | | | | | **complete order code**

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Endress+Hauser
The Power of Know How

TI 225C/07/en/07.00
Printed in Germany / DT / CV5 (51503544)

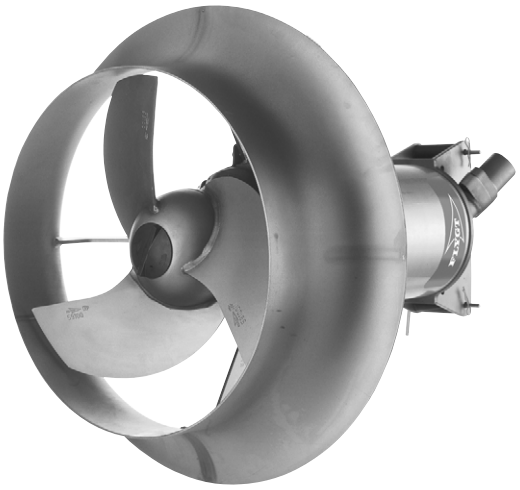
FLYGT

Technical specification

Submersible mixers S 4650, 50 Hz

Flygt

ITT Industries



S 4650

Product

Direct drive mixer with two or three blade propeller intended for mixing liquid and sludge containing fibres and solids. The mixer is designed to be operated completely immersed in the liquid.

Denomination

Product code	4650.410
Installation	Guide bar system
	Flange mounted

Process data

Liquid temperature	max +40 °C
Depth of immersion	max 20 m
The pH of the mixed liquid	pH 1 - 12
Liquid viscosity	max 5000 cp

Motor data

Frequency	50 Hz
Insulation class	H (+180 °C)
Voltage variation	
- continuously running	max ± 5%
- intermittent running	max ± 10%
Voltage imbalance between phases	max 2%
No. of starts/hour	max 30

Cable

Direct-on-line start

SUBCAB®	4G2,5+2x1,5 mm^2
	4G4+2x1,5 mm^2
	4G6+2x1,5 mm^2

Monitoring equipment

Thermal contacts opening temp.	125 °C

Material

Stator housing	Stainless steel
Shaft	Stainless steel
Oil casing	Vinyl ester based SMC

Part	ASTM 304	ASTM 316 L
Jet ring	•	•
Fixing plate	•	•
Lifting device		•

ASTM 304: general purpose stainless steel

ASTM 316 L: high grade stainless steel

Propeller

Angle	ASTM 316 L	Alloyed white iron
Two blade propeller		
5°	•	
9°	•	
Three blade propeller		
5°	•	•
7°	•	•
9°	•	•
10°	•	•
11°	•	•

Alloyed white iron (extremely abrasion-resistant alloy)

O-rings

Alternative	Material
1	Nitrile rubber
2	Fluorinated rubber

Mechanical face seals

Alternative	Inner seal	Outer seal
1	Corrosion resistant cemented carbide/ Corrosion resistant cemented carbide	Corrosion resistant cemented carbide/ Corrosion resistant cemented carbide
2	Corrosion resistant cemented carbide/ Corrosion resistant cemented carbide	Silicon carbide/ Silicon carbide
3	Carbon/ Corrosion resistant cemented carbide	Corrosion resistant cemented carbide/ Corrosion resistant cemented carbide

Surface Treatment

Stainless steel parts are blasted to a dull grey surface.

Weight

See dimensional drawing.

Mixer data chart

Propeller material ASTM 316 L

Propeller code	F_{thrust} N	P_{in} kW	F_{thrust} N	P_{in} kW
	With jet ring (J)		Without jet ring (F)	
125803SX	860	3,6	1040	4,4
125805SX	1100	4,1	1290	5,4
125807SX	1350	4,8	1530	6,5
125809SX	1620	5,6		
125811SX	1890	6,5		

Propeller material Alloyed white iron (High-Chrome)

Propeller code	F_{thrust} N	P_{in} kW	F_{thrust} N	P_{in} kW
	With jet ring (J)		Without jet ring (F)	
125805HX	560	3,00	650	3,20
125807HX	790	3,40	890	3,75
125809HX	1010	3,95	1120	4,45
125811HX	1240	4,65	1340	5,30
125813HX	1450	5,55	1540	6,20

Key to the 8-digit Propeller Code:

1:st and 2:nd digit - Motor pole No (16=16-pole)

3:rd and 4:th digit - Propeller diameter (77=766 mm)

5:th and 6:th digit - Propeller blade angle

7:th digit - Propeller material (S=ASTM 304, ASTM 316 L, H=High-Chrome)

8:th digit - Hydraulic end (J=with jet ring, F=without jet ring)

Motor rating

Rated output power, kW	Rated current, A	Starting current, A	Power factor cos φ	Ex proof version available
400 V, 50 Hz, 3 ~, 480 r/min				
5,5	17	48	0,65	•

Option

4650.490	Ex. proof version
Warm liquid version on request	
Leakage sensor in stator housing	FLS
Leakage sensor in oil housing	CLS
Seal flushing	
Seal protection	
Cutting rings	
Cable protection	
Two blade propeller	

Accessories

Stand and Single guide bar system, lifting equipment and other mechanical accessories.

Electrical accessories such as starters, alarm units.

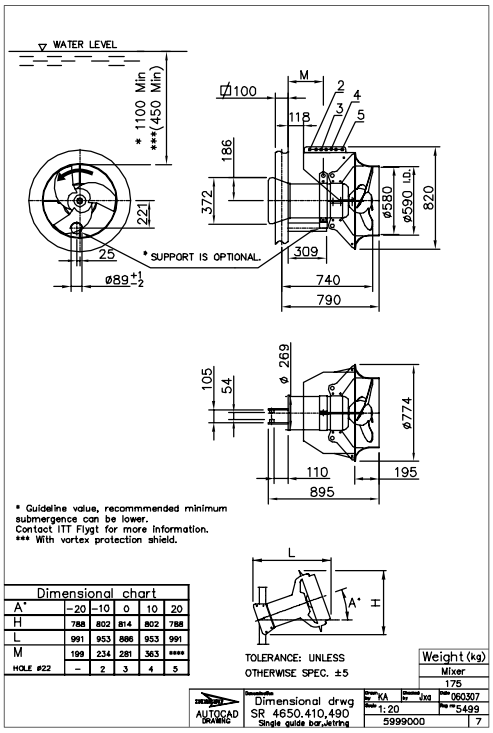
See separate booklet or int.flygt.com, for further information

Dimensional drawing

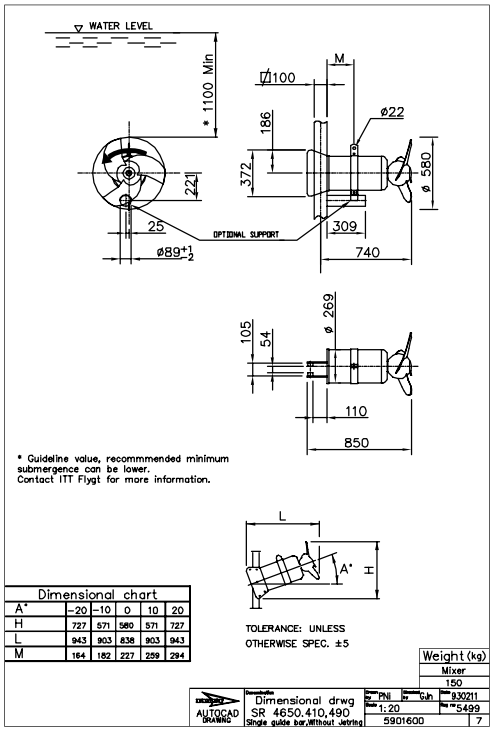
All drawings are available as Acrobat documents (.pdf) and AutoCad drawings (.dwg). Download the drawings from int.flygt.com or contact your ITT Flygt representative for more information.

All dimensions are in mm.

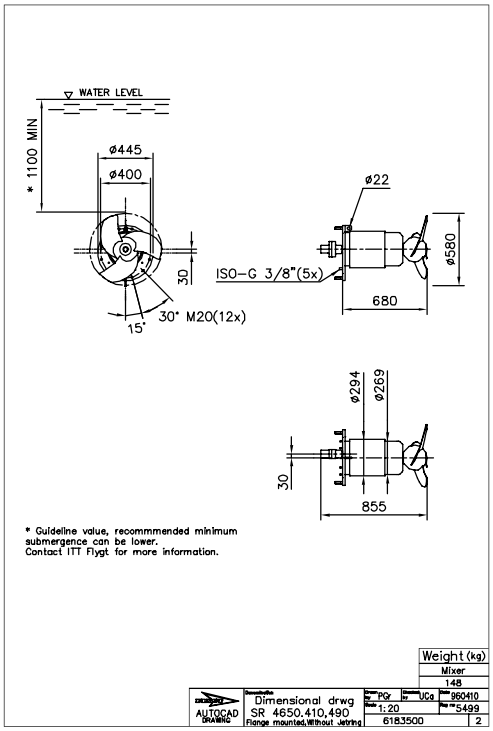
With jet ring



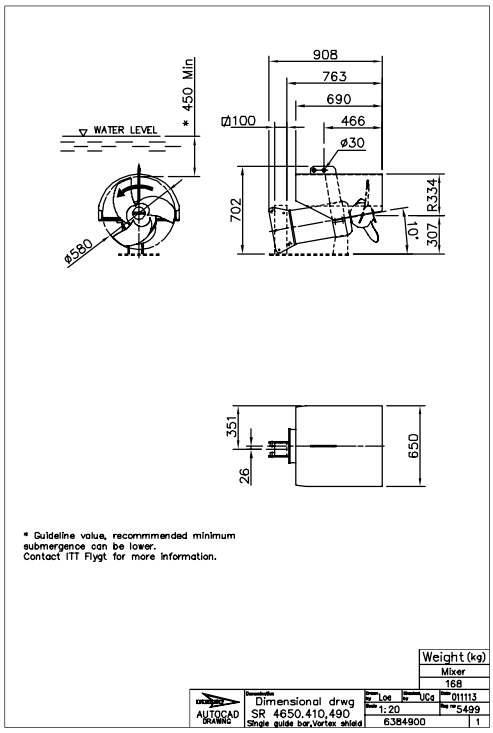
Without jet ring



Flange mounted



Vortex shield



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QUANTUM®
TRANSMITTERS

Models Q45P and Q45R

Isolated pH and ORP Monitor/Analyzer Systems

- **PEEK® Sensor Body Construction**
- **Dual-Glass Style Sensor**
- **Replaceable Sensor Saltbridge**
- **Electrode Breakage Diagnostic**
- **Universal Mounting Configurations**
- **Microprocessor Based System**
- **Loop, Line, or Battery-Powered Data Logging Options**
- **Fully Isolated Output(s)**
- **Large High-Contrast Display**
- **Superior Sensor Warranty**

Sensor Features

Sensor housings are constructed of PEEK®, a high performance thermoplastic that provides outstanding mechanical strength and chemical resistance. Multiple sealing materials are used to preserve sensor integrity over a wide range of applications.

A large volume, dual junction saltbridge is used to maximize the in-service time of the sensor. The annular junction provides a large surface area to minimize the chance of fouling. Large electrolyte volume and dual reference junctions minimize contamination of the reference solution. The replaceable saltbridge allows for easy sensor regeneration.

The reference element of the sensor is a second glass pH electrode immersed in a reference buffer solution. This glass reference system allows the sensor to be used in applications that poison conventional pH sensors.

An integral preamplifier is encapsulated in the body of the sensor. This creates a low impedance signal output which ensures stable readings in harsh environments, and maximizes the distance between sensor and analyzer. Sensor diagnostics are used to alarm the user in the event of electrode breakage, loss of sensor seal integrity, or integral temperature sensor failure.

Sensor electrodes can be user-specified to ensure measurement reliability and maximum sensor lifetime. The type of glass used in the pH electrode can be selected for optimal performance. The metal electrode used for ORP measurement can be platinum or gold, depending on chemical makeup of the process solution.

All Q25 Sensors are backed by a superior warranty (see back page).

Monitor/Analyzer Features

This line of microprocessor-based instrumentation allows easy implementation of portable, loop-powered, or line-powered analyzer capability within the **same** instrument. The standard Q45P and Q45R instruments can be rapidly converted between any of these versions with **no** requirement for software change:

- **Loop-powered (16-35 VDC) Transmitter, 4-20 mA output**
- **Line-powered (115/230 VAC) Transmitter, 4-20 mA output**
- **115/230 VAC Analyzer, dual relays, dual 4-20 mA outputs**
- **Battery-powered (9 VDC) portable version, for view-only measurement**

The large, high contrast, super-twist display provides excellent readability over a wide operating temperature range, even in low light conditions. The main display line consists of large, segmented characters with measurement units. The secondary display line utilizes easily readable dot matrix characters for clear display of calibration and diagnostic messages. Two of four measured parameters may be displayed simultaneously.

Four-button programming provides intuitive navigation through the menu driven user interface. The 4-20 mA output(s) can be configured to represent any portion of the measurement range. Output HOLD, ALARM and SIMULATION features provide the user with complete control of the system output under any condition.

Diagnostic messages provide a clear description of system condition, which eliminates confusing error codes that must be looked up in the instruction manual.

The flexible two-point and sample calibration options include auto-buffer recognition from thirteen built-in buffer tables. Manual override of the automatic buffer values allows the user to customize calibration values. To ensure high accuracy, all calibration methods include stability monitors that check temperature and main parameter stability before accepting data.

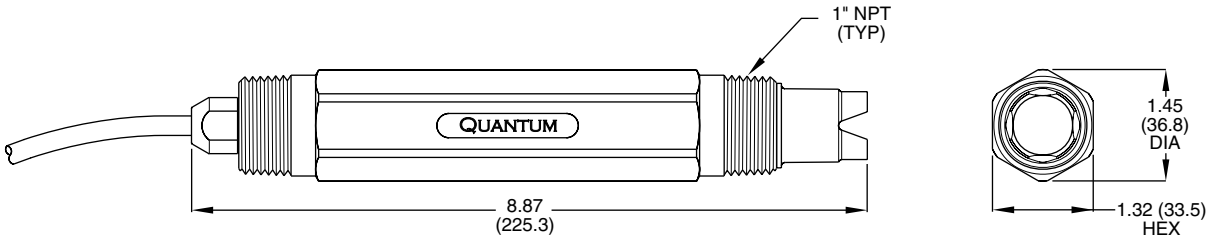
Q25 Sensor Specifications	Q25P	Q25R
Measuring Range	0 to 14.00 pH	-1000 to +2000 mV
Sensitivity	0.002 pH	0.2 mV
Stability	0.02 pH per 24 hours, non-cumulative	2 mV per 24 hours, non-cumulative
Wetted Materials	PEEK®, ceramic, titanium, glass, Viton®, EDPM (316 stainless steel with 316SS body option)	PEEK®, ceramic, titanium, glass, platinum or gold, Viton®, EDPM (316 stainless steel with 316SS body option)
Temperature Compensation	Pt1000 RTD	Pt1000 RTD
Sensor Cable	6 conductor plus 2 shields	6 conductor plus 2 shields
Temperature Range	-5 to 95° C (23 to 203° F)	-5 to 95° C (23 to 203° F)
Pressure Range	0 to 100 psig	0 to 100 psig
Maximum Flow Rate	10 feet (3 meters) per second	10 feet (3 meters) per second
Maximum Sensor to Analyzer Distance	3000 feet (914 meters)	3000 feet (914 meters)
Sensor Body Options	1" NPT convertible, 1¼" insertion, 1½" or 2" sanitary style	1" NPT convertible, 1¼" insertion, 1½" or 2" sanitary style
Weight/Shipping Weight	1 pound (0.45 kilogram)	1 pound (0.45 kilogram)

Manufacturer's Notes

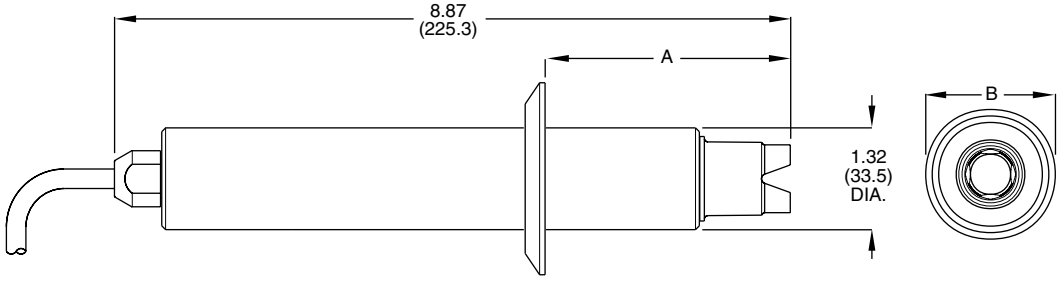
1. **CAUTION!** The type of hardware used to mount the sensor may limit the maximum temperature and pressure ratings. Please consult the hardware manufacturer's specifications to obtain the relevant temperature and pressure rating information.
2. The maximum flow rate specification should be decreased for process solutions with low ionic conductivity or high suspended solids concentration. High flow rates in low ionic conductivity processes may cause a measurement error due to static electrical discharge. High flow rates in processes with high suspended solids concentration may decrease the functional life of the sensor by eroding the pH-sensitive glass electrode.

Sensor Dimensions and Mounting Configurations

Dimensions: Inches (mm)

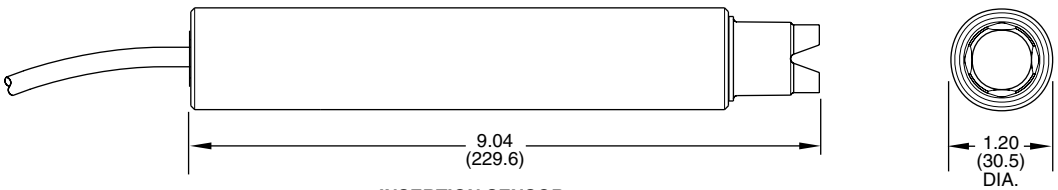


CONVERTIBLE SENSOR



SENSOR SIZE	A	B
1-1/2"	3.27 (83.1)	1.98 (50.3)
2"	4.00 (101.6)	2.50 (63.5)

SANITARY SENSOR



INSERTION SENSOR

Viton is a registered trademark of E.I. duPont de Nemours and Co.

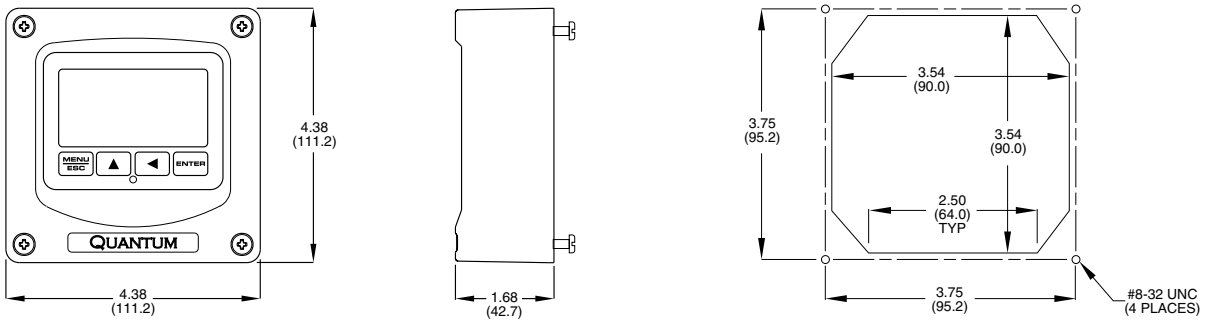
Q45P/Q45R Instrument Specifications (NOT common to all variations)

Basic 2-Wire Transmitter:	
Power	16-35 VDC (2-wire device)
DC Cable Max. Length	3000 feet (914 meters)
DC Cable Type	Belden twisted-pair, shielded
Insertion Loss	15.5 VDC
115/230 VAC Option:	
Power	115/230 VAC ±10%, 50/60 Hz 4 kV line isolation
Fuse	250 mA slow-blo on hot line, auto-reset secondary
115/230 VAC + Dual Relays Option:	
Power	115/230 VAC ±10% 50/60 Hz
Fuse	250 mA slow-blo on hot line, auto-reset secondary
Relays	**Electromechanical:** Dual SPDT, 6-amp @ 250 VAC, 5 amp @ 24 VDC contacts, resistive **Solid-State (AC):** Dual SPST (N.O.) 0.06-2.0 amp @ 12-280 VAC, RMS **Solid-State (DC):** Dual SPST (N.O.) 3 amp @ 60 VDC Software selection for setpoint, phase, delay, deadband, hi-lo alarm, and failsafe. A-B indicators on main LCD. Timer mode for auto-cleaning.
Analog Outputs	Dual 4-20 mA current loops, one for main parameter and one for temperature. Max load 500 Ohms on main and 500 Ohms on temperature.
Battery Option:	
Power	Generic 9 VDC alkaline battery
Auto-OFF Time	2 hours after no key press
Low Battery Indication	6.75 VDC
Battery Life	Normal use (2-4 hours per week), 4-6 months Continuous operation, 10-14 days
Analog Outputs	Dual isolated 0-2.5 VDC (1pH and 1 Temperature
Data Logger	Optional Internal Logger, 32,000 data point capacity, programmable storage interval

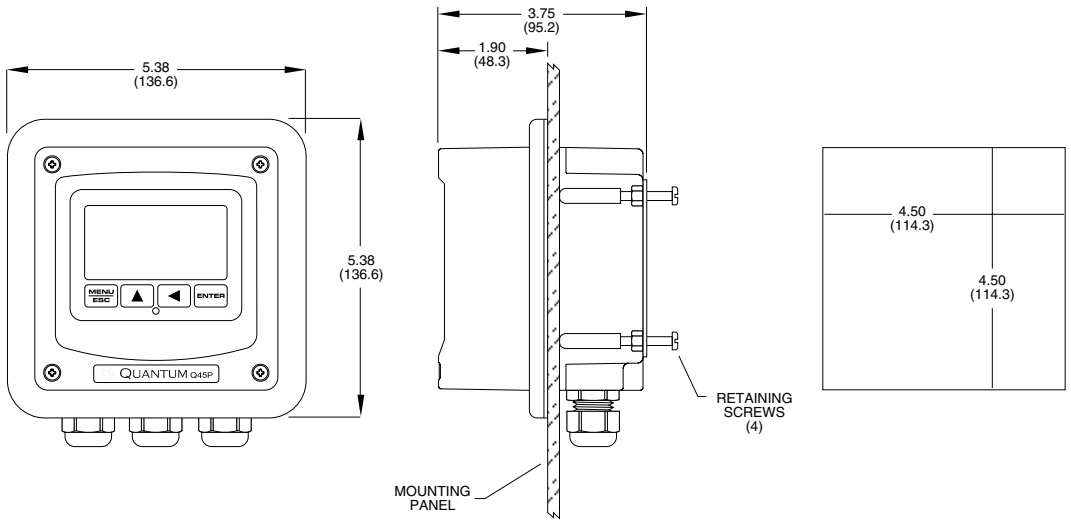
Panel Mount and Cut-Out

Dimensions: Inches (mm)

Standard

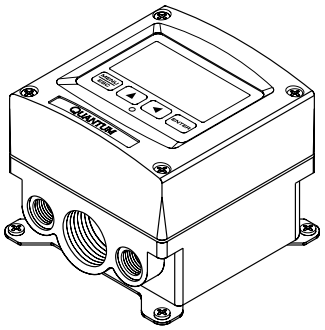


Relay Version

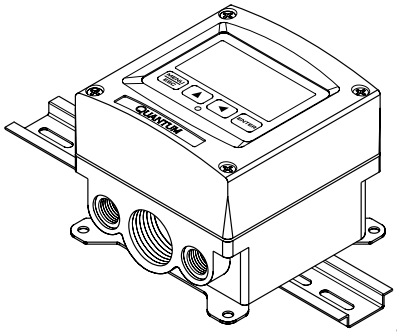


Analyzer Dimensions and Mounting Configurations

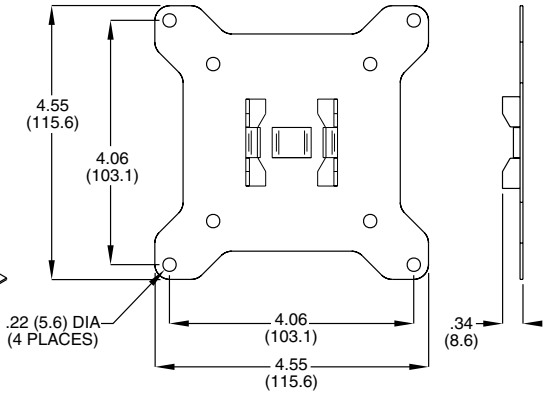
Dimensions: Inches (mm)



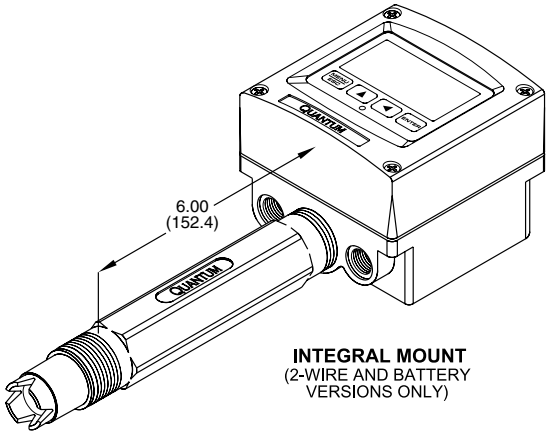
WALL MOUNT



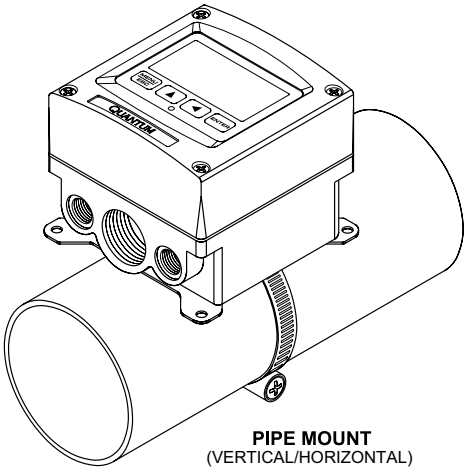
DIN RAIL MOUNT
(STANDARD 35 mm DIN)



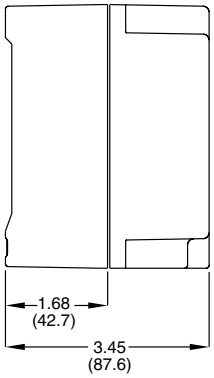
MULTI-PURPOSE BRACKET



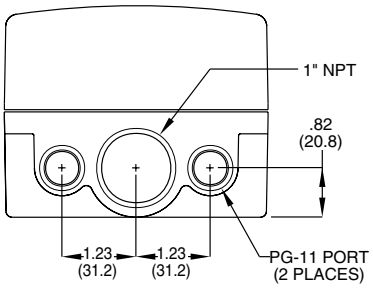
INTEGRAL MOUNT
(2-WIRE AND BATTERY VERSIONS ONLY)



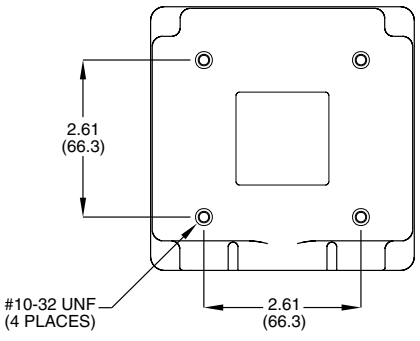
PIPE MOUNT
(VERTICAL/HORIZONTAL)



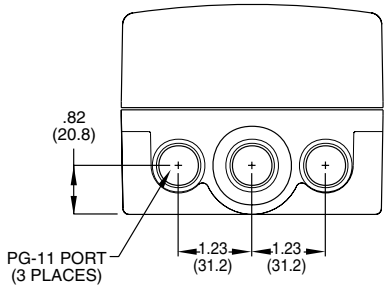
SIDE VIEW



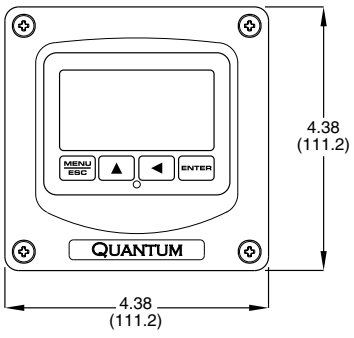
BOTTOM VIEW



BACK VIEW



BOTTOM VIEW
(RELAY VERSION)



FRONT VIEW

Performance Specifications

	Q45P	Q45R
Displayed Parameters	Main input, 0 to 14 pH Sensor voltage, ± 500 mV Loop current, 4.00 to 20.00 mA Sensor temperature, -10 to 110° C (14 to 230° F)	Main input, -1000 to +2000 mV Loop current, 4.00 to 20.00 mA Sensor temperature, -10° to 110° C (14 to 230° F)
Main Parameter Range	0 to 14.00 pH	-1000 to +2000 mV
Input Impedance	Greater than 10^{13} Ohms	Greater than 10^{13} Ohms
Repeatability	0.1% of span or better	0.1% of span or better
Sensitivity	0.05% of span	0.05% of span
Non-Linearity	0.1% of span	0.1% of span
Stability	0.05% of span per 24 hours, non-cumulative	0.05% of span per 24 hours, non-cumulative
Temperature Drift	Span or zero, 0.02% of span/° C	Span or zero, 0.02% of span/° C
Warm-Up Time	7 seconds to rated performance	7 seconds to rated performance
Instrument Response Time	6 seconds to 90% of step input at lowest setting	6 seconds to 90% of step input at lowest setting
Max. Sensor-to-Analyzer Distance	3000 feet (914 meters) w/preamp, 30 feet (9.1 meters) w/o preamp	3000 feet (914 meters) w/preamp, 30 feet (9.1 meters) w/o preamp
Sensor Types	Quantum pH w/preamp - 5-wire input or combination style pH electrode w/TC - 2-wire input	Quantum ORP w/preamp - 5-wire input or combination style ORP electrode w/TC - 2-wire input

Q45P/Q45R Instrument Specifications (common to all variations)

Enclosure	NEMA 4X, IP66, polycarbonate, stainless steel hardware, weatherproof and corrosion resistant, (HWD): 4.4" (112 mm) x 4.4" (112 mm) x 3.5" (89 mm)
Mounting Options	Wall, panel, pipe, DIN rail, or integral-sensor (DC only)
Conduit Openings	Standard: 2-PG-9 openings, 1-1" NPT center opening, cordgrips and plug included Relay option: 3-PG-11 openings, plugs included
Weight	DC transmitter configuration: 1 lb. (0.45 kg) Line-powered unit: 1.5 lb. (0.68 kg)
Display	Large, high-contrast, Super-Twist (STN) LCD 4-digit main display with sign, 0.75" (19.1 mm) seven-segment characters 12-digit secondary display, 0.3" (7.6 mm) 5 x 7 dot matrix characters
Keypad	4-key membrane type with tactile feedback, polycarbonate with UV coating, integral EMI/static shield and conductively coated window
Ambient Temperature	Service -20 to 60° C (-4 to 140° F) Storage -30 to 70° C (-22 to 158° F)
Ambient Humidity	0 to 95%, non-condensing
Location	Designed for hazardous and non-hazardous areas
EMI/RFI Influence	Designed to EN 61326-1
Output Isolation	600 V galvanic isolation
Filter	Adjustable 0-9.9 minutes additional damping to 90% step input
Temperature Input	Selectable Pt1000 or Pt100 RTD with automatic compensation

Monitor/Analyzer Ordering Information

	Parameter	Reserved	Control	Power	Housing	Approval	Tags
Q45	**P**	**N**					
	P pH	**Reserved**	**N** None **2** 2 Electromechanical Relays **3** 2 Solid-State Relays, AC **4** 2 Solid-State Relays, DC	**S** Loop **P** Portable **L** Portable w/ Data Logger **A** 115 VAC **B** 230 VAC	**S** Standard **P** Panel Mount, 115 x 115 mm **Q** Panel Mount, 1/2 DIN	**N** None **1** CSA	**N** None **1** 316SS

	Parameter	Reserved	Control	Power	Housing	Approval	Tags
Q45	**R**	**N**					
	R ORP	**Reserved**	**N** None **2** 2 Electromechanical Relays **3** 2 Solid-State Relays, AC **4** 2 Solid-State Relays, DC	**S** Loop **P** Portable **L** Portable w/ Data Logger **A** 115 VAC **B** 230 VAC	**S** Standard **P** Panel Mount, 115 x 115 mm **Q** Panel Mount, 1/2 DIN	**N** None **1** CSA	**N** None **1** 316SS

Sensor Ordering Information

	Electrode Type	Reserved	Reserved	Body Material	Mounting Style	Cable Leads	Cable Length
Q25		**N**	**N**				
	P1 Standard pH glass (industrial) **P2** Low Ω pH glass (municipal)	**Reserved**	**Reserved**	**1** PEEK® **2** 316SS	**1** Convertible **2** Insertion **3** Sanitary, 1½" **4** Sanitary, 2"	**1** Stripped (standard)	**1** 15' **2** 30' **9** Special

	Electrode Type	Reserved	Reserved	Body Material	Mounting Style	Cable Leads	Cable Length
Q25		**N**	**N**				
	R1 Platinum (standard) **R2** Gold	**Reserved**	**Reserved**	**1** PEEK® **2** 316SS	**1** Convertible **2** Insertion **3** Sanitary, 1½" **4** Sanitary, 2"	**1** Stripped (standard)	**1** 15' **2** 30' **9** Special

Q25 Sensor Warranty

In addition to a standard one-year quality warranty, ATI unconditionally warrants to the ultimate purchaser **for a period of thirty months from date of shipment from our factory, that any Q25 series sensor may be replaced, FOR ANY REASON, at 50% off the current list price.** This warranty applies to normal sensor wear, as well as accidental damage.

Accessories

07-0100	NEMA 4X junction box	**09-0034**	pH 4.00 buffer, 1000 mL
31-0057	Sensor interconnect cable per foot (custom, double-shielded, six-wire)	**09-0035**	pH 7.00 buffer, 1000 mL
		09-0045	pH 6.87 buffer, 500 mL
09-0042	200 mV ORP solution, 500 mL	**09-0036**	pH 10.00 buffer, 1000 mL
09-0043	600 mV ORP solution, 500 mL	**09-0037**	pH 9.18 buffer, 500 mL
05-0056	Quinhydrone powder, 5 grams	**05-0057**	pH/ORP sensor regeneration kit

QUANTUM® TRANSMITTERS

Analytical Technology, Inc.
6 Iron Bridge Drive, Collegeville, PA 19426
Toll-Free (U.S. & Canada): 800/959-0299
Phone: 610/917-0991
Fax: 610/917-0992

ATI (UK) Limited
Bank Chambers, 33 Stamford Street
Mossley, Aston-u-Lyne OL5 0LL
Phone: +44 (0) 1457 832800
Fax: +44 (0) 1457 83950

Web: www.quantumanalytical.com

ROYCE TECHNOLOGIES

Monitoring and Control Instrumentation for the Wastewater Treatment Industry

Measurement Technologies by ROYCE

Dissolved Oxygen Monitoring and Control
- Portable Analyzers
- Single and Multi-channel Analyzers
- Bioreactor and Lagoon Systems

Total Suspended Solids Monitoring and Control
- Portable Analyzers
- Single and Multi-channel Analyzers
- Turbidity and Solids density

DO & TSS Multi Parameter Monitors & Controllers
- Single and Dual channel

Interface Level analyzers
- Primary, Secondary and Thickener Analyzers

pH/ORP and CO_2 Monitoring and Control
- Submersion and Inline Electrode Designs

Chemical Analyzers - Multi-parameter
- 2, 3 and 5 parameter sensors
- Insitu, continuous measurements of:
  COC - TOC - BOD
  Nitrites - Nitrates - Hydrocarbons

Common Features of ROYCE Products

- Microprocessor based, self-diagnosing electronics
- Rugged, mil-spec electronic components
- One step, automatic calibration
- Analog and digital output communications, including multiple BUSS options
- Wireless communications (Optional)
- Global remote access of all data
- Programmable setpoints and solid state relays
- Space age composite sensor materials
- Polymer, unbreakable sensor optics
- Color compensating optics (TSS)
- Self cleaning sensors throughout the line of products
- Intelligent, menu driven setup and operation
- Enclosure sun screens (Optional)
- Sensor fault feedback on all controllers
- Backlit displays

Bulletin WWT
December 2005

ITT

Galvanic Parts Per Million Dissolved Oxygen Systems

Model 900 Portable Analyzers

Request Brochure PPM-9

- Reads in PPM DO, temperature, % saturation
- Waterproof, completely submersible, rugged housing
- Two choices of sensors
- Accessories for various field and lab applications
- Disposable or Rechargeable sensors

Model 9100 Series Analyzer

Request Brochure 9110/9210

- Single & Dual Channel
- One step, push button calibration
- Displays DO & temperature for each channel
- Two 4 - 20 mA per channel for DO & temperature
- Two relays per channel
- RS-485 Standard
- (Optional) Profibus PA or DP

Models 9100/9200 Analyzers

Request Brochure PPM-9

- Range 0 - 99.9 PPM & % saturation 0 - 99.9%
- One step, push button calibration
- Two methods of calibration are standard
- Automatic Temp, altitude & salinity compensation
- Isolated 4 - 20 mA or 0 - 20 mA
- Digital serial output available

Model 9300 Analyzer

Request Brochure PPM-9

- Sensor cleans automatically up to 12 Mo.
- Sensor automatically calibrates daily
- Automatic control of aerators, alarms, - up to four outputs
- Self diagnosing electronics with automatic sensor buoy test procedures
- 16 day datalogging

Optical Parts Per Million Dissolved Oxygen Systems

Model 980 Optical Portable DO Meter

Request Brochure PPM-980

- Displays DO and Temperature
- No electrolyte or membranes required
- No water movement necessary
- Data logging
- IRDA data transmission

Model 9810 Optical Analyzer

Request Brochure PPM-9810

- Patented fluorescent sensor
- 3 year sensor warranty
- No electrolyte or membranes required
- No replaceable parts for the life of the sensor
- Microprocessor based electronics

Total Suspended Solids Systems

Model 711
Portable MLSS/ILA System

Request Brochure TSS-9

- Two complete analyzers in one package (TSS & Interface Level)
- One sensor for both applications
- Microprocessor based
- Automatic Ranging
- Simple, insitu calibration
- Electronic self diagnostics
- Nine volt battery with automatic shut off
- Waterproof, completely submersible, rugged housing

Model 7100 Series
Analyzer

Request Brochure 7110/7120

- Single & Dual Channels
- Automatic, push button, insitu calibration to a known value
- Range 0 - 80,000 mg/l
- Measured range depends on sensor
- 72 Series - 0 - 1500 mg/l
- 73/75 series - 0 - 30,000 mg/l
- 74 Series - 0 - 80,000 mg/l
- 76 Series - 0 - 30,000 mg/l
- Two 4 - 20 mA per channel
- Two relays per channel
- RS-485 Standard
  (Optional) Profibus PA or DP

Model 7011A
Continuous Analyzer

Request Brochure TSS-9

- Automatic ranging
  0 - 10,000 up to 0 - 80,000 mg/l
- Phased array source for automatic color compensation (Model 73B)
- Automatic, push button, insitu calibration to a known value
- Automatic ambient light compensation on all models
- User selectable calibration curves
- Two Programmable setpoint relays
- Outputs 4 - 20 mA. 0 - 1 VDC (isolated)
- RS-485 (Standard)

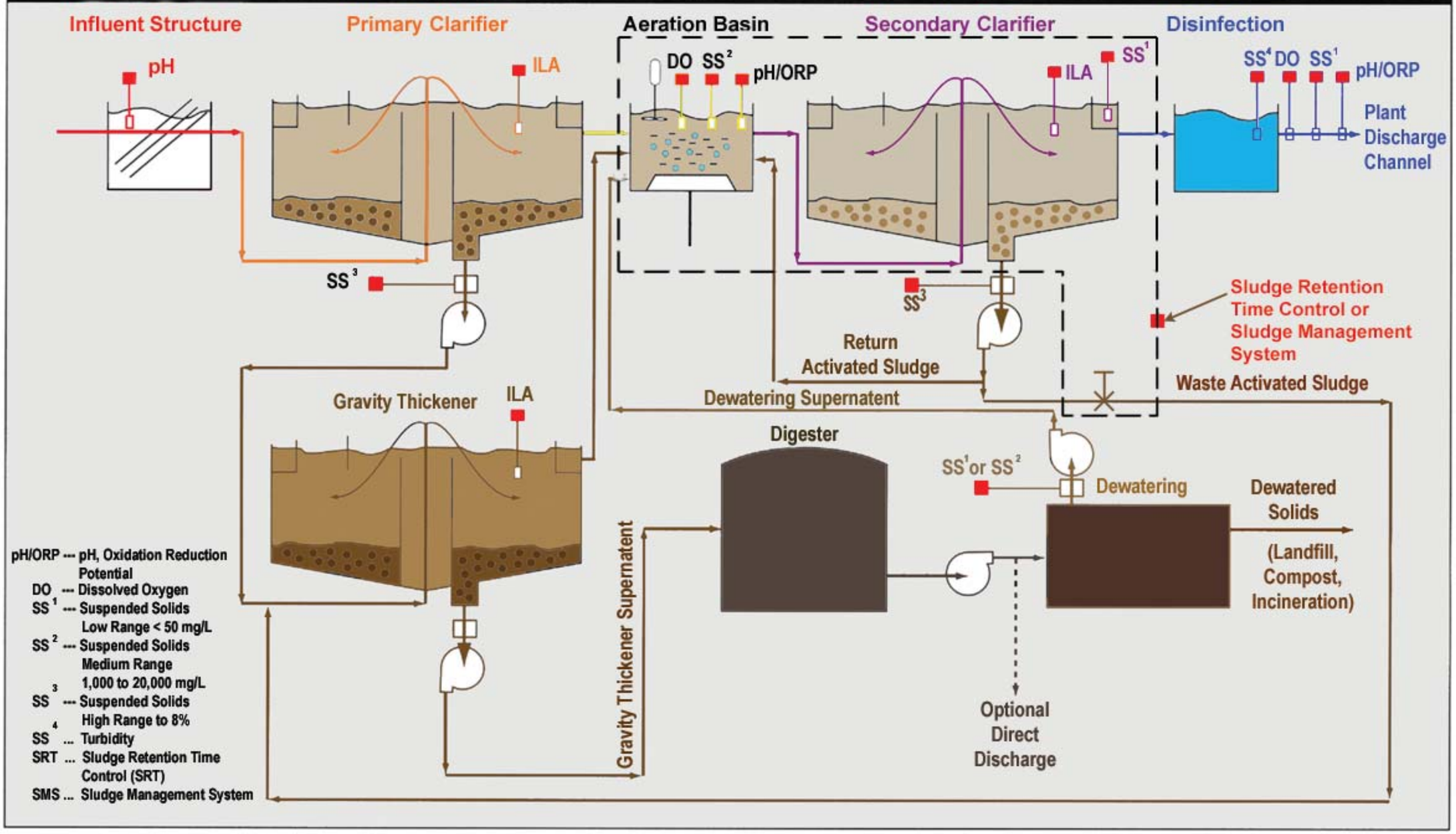
Dissolved Oxygen and Total Suspended Solids Multiparameter Systems

Model 8000 Series Analyzer

Request TSS or PPM-DO Bulletins

- Uses any Royce galvanic DO and/or total suspended solids sensor(s)
- Will utilize any Royce disposable galvanic, rechargeable galvanic, or electrochemical self-cleaning DO sensor
- Four line backlit display
- Two outputs per channel
- Two relays per channel
- Digital output available for various Bus communications systems
- Multi-parameter options include:
  - One DO and one TSS sensor (Models 8120 or 8220)
  - Two DO and one TSS sensors (Models 8130 or 8230)
  - Two TSS and one DO sensors (Models 8130 or 8230)
  - Two DO and two TSS Sensors Models 8140 or 8240)

Process Control Instrumentation at a Typical Secondary Wastewater Treatment Plant



Interface Level And Point Level Analyzers & Sensors

Models 2501A/2511A Analyzer

Request Brochure Level 1-R

- Measures both interface and Clarity
- No Moving parts, no maintenance, no recalibration required
- Surface skimmer friendly
- Microprocessor based electronics
- Backlit LCD displays
- Full featured set point relays available
- Simple user friendly menu driven programming
- Numerical and graphical displays

Model 2505 Analyzer

Request Brochure Level 1-R

- Economical for multiple tank applications
- Measures both interface and clarity
- No Moving parts, no maintenance, no recalibration required
- Surface skimmer friendly
- Back-Lit LCD displays
- Full featured set point relays are standard
- Simple user friendly menu driven programming
- Numerical and graphical displays

Model 2110/2120 Analyzer

Request Brochure Level 1-R

- Programmable Cleaning Intervals for Sensor Optics
- Push Button Sensor Calibration
- Backlit LCD displays
- Setpoint Control Relays
  - Two on Model 2110
  - Four on Model 2120
- NEMA 4X - IP65 - UL Listed Enclosure

pH/ORP & CO_2 Analyzers/Controllers

Model 5000 Continuous pH/ORP Monitor/Controller

Request Brochure pH-8

- User friendly setup
- Panel mountable
- Digital readout
- Microprocessor based electronics
- Self-diagnostic electronics
- NEMA 4 (IP65) Enclosure

Model 5300 Continuous pH/CO_2 Monitor/Controller

Request Brochure pH-8

- Measurement Ranges:
  pH: 0 to 14 pH
  CO_2: 0.0 - 999 mg/l
- Displayed Resolution:
  pH: 0.01
  CO_2: 0.1 mg/l
  Temperature: 1^{O} (C or F)
- Relays:
  (2) rated 250 VAC at 5 AMPS resistive load

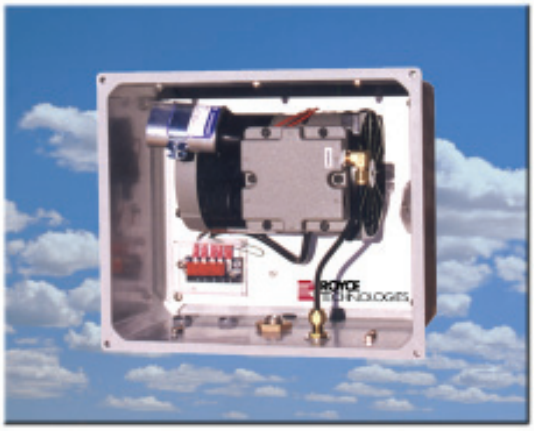
Chemical Analyzers - Multiparameter

Model 8540 Analyzer with Model 82 Sensor

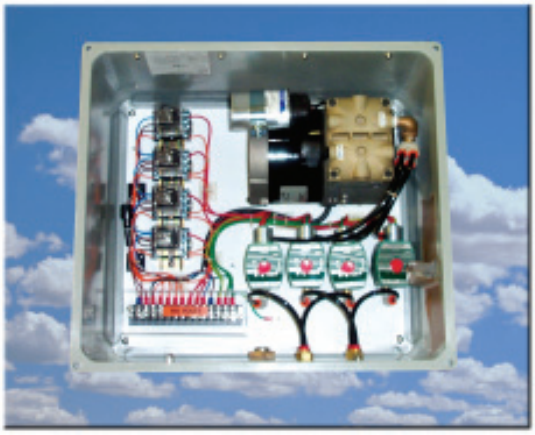
Request Brochure 8500

- Patented optical technology
- Rugged Xenon dual beam optical platform
- Utilizes Royce Jet Clean System for optics cleaning
- Low to zero maintenance required
- Factory calibrated - plug and play
- Parameters Available
  - Turbidity
  - Total Suspended Solids
  - DOD (equivalent)
  - TOC (equivalent)
  - BOD (equivalent)
  - Nitrates
  - Nitrites
  - Color
  - Hydrocarbons
- Up to five parameters can be monitored per sensor

JC Series Compressor Cleaning Systems



Model JC-1 Compressor
(Single Channel)



Model JC-4 Compressor
(Four Channel Shown)

Request Brochure JC-1

- One channel, two channel and four channel systems available
- Utilizes the highest grade compressor available
- Can be used on any Royce Sensor
- Can be controlled by a Royce analyzer or controller
- Thousands in use worldwide

Control Systems

Model 7700
SRT Control System
Request Brochure SRT System - 4

Model 7200
Sludge Management System
Request Brochure SMS System - 1

- Automatic analyzer ranging
- Electronic self-diagnostics
- NEMA 4X (IP65) enclosure
- Backlit display
- Full CE conformance
- Simple to use insitu calibration
- Phased array light source for automatic color compensation (Model 73B)
- Digital communications with isolation and surge protection
- Menu driven text “help screens”
- Relay control contacts - 3A resistive
- Optional input power - 115/230V, 50/60 Hz, Max 1/2 amp
- Modular I/O interface to allow up to 20 additional inputs for system expansion
- Optional Bi-Directional communications with plant SCADA systems

ROYCE is a member of

ISA

Instrumentation Testing Association
Promoting Reliability & Performance of Environmental Instrumentation and Automation Technologies

Water Environment Federation

WEMA

MCAA
Measurement, Control & Automation Association

ROYCE TECHNOLOGIES

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ITT

Technical
Information
TI 177C/07/en

Operating Instructions
No. 51517577

Solids Content Sensor
TurbiMax W CUS 41 / CUS 41-W

Process and immersion sensor for service water and solids content measurement based on multi-channel technology, also applying the 90° scattered light method

Areas of application
Optical solids content measurement is indispensable as a regulating variable for operation in following areas:
- Sewage treatment plants
  - Primary sludge
  - Activated sludge
  - Returned sludge
  - Putrefied sludge
  - Outlet
- Paper
  - Monitoring of sieve water
  - Water processing
- Concrete
  - Measurement of soiling
- Production
- Water processing
- Water monitoring

Benefits at a glance
- Measuring range from 0.01 FNU to 100 g/l
  - from completely clear to completely black
- Scratch-proof sapphire windows
- Compact shock-proof design
- For installations in pipes or basins
- Simple commissioning
- 3-point calibration and 1-point adjustment
- 7 calibration data records according to customer specifications can be stored
- Wiper cleaning integrated or retrofitted
- Inclined flat sensor surface uses medium flow to increase self-cleaning effect
- Permissible distance between sensor and transmitter up to 200 m

Quality made by
Endress+Hauser

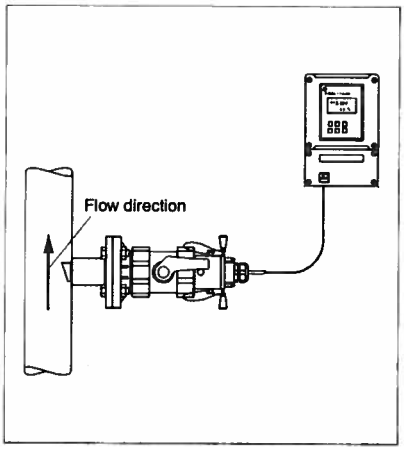
ISO 9001

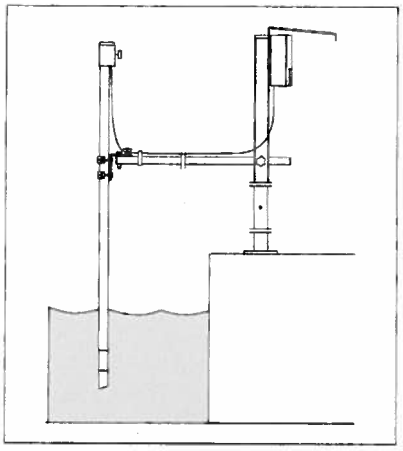
Endress+Hauser

Nothing beats know-how

Measuring system

A measuring system consists of:
- TurbiMax W CUS 41 solids content sensor
- Liquisys CUM M 223/253 transmitter





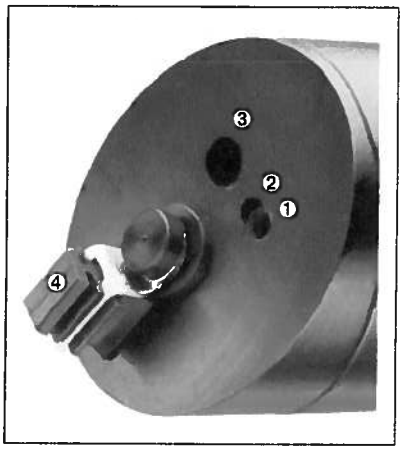
Examples of complete measuring systems

left:
CUS 41 in CUA 461 retractable assembly

right:
CUS 41 in immersion assembly

Functional principle

The 90° scattered light method with a measuring frequency in the near-infrared range of light (880 nm) according to ISO 7027 / EN 27027 guarantees a measurement of the turbidity value under standardised, comparable conditions.
The excitation radiation of an infrared transmitter strikes the medium at a defined angle of beam. The different refractive indices of the entrance window and the measuring medium (water) are taken into account. Particles in the medium generate a scattered radiation which strikes the scattered light receiver at a defined angle. The measurement in the medium is constantly adjusted with the values of a reference receiver.
Digital filter functions with an excellent interference signal suppression and sensor self-monitoring ensure additional measurement reliability.
In addition to the turbidity signal, a temperature measurement signal is detected and transmitted.



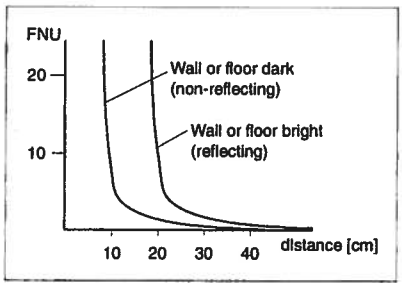
① LED
② photodiode
③ photodiode
④ wiper (optional)

Calibration

Every sensor in the "FNU field of application" is carefully factory-calibrated using standard procedures. Other customer- and substance-specific calibrations can also be stored. Depending on the different precise requirements in service or drinking water, special assemblies with the integrated calibration values are provided.

For service water measurements, standard specifications are usually sufficient. However, installing the sensor in a pipe or very close to a wall can cause backscatter resulting in a higher signal. To compensate for this, an installation adjustment must be performed.

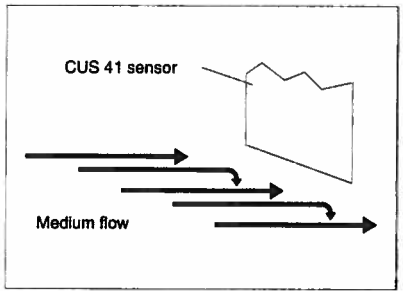
Notes on installation and application



Dependence of the measurement on the wall or floor distance

Wall distance

The effective wall or floor distance can be optimised by aligning with the flat sensor side. The opposite figure shows the influence of this distance on the measurement with bright or dark shading of wall or floor.
As a rule, the CUS 41 sensor should be immersed at least 4 cm into the medium to be measured.

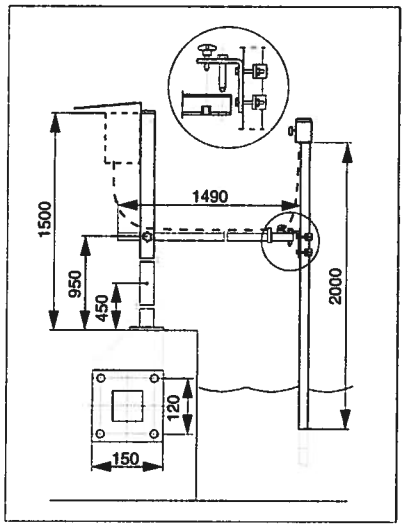


Self-cleaning by flow against the inclined sensor surface

Self-cleaning

Optimum self-cleaning and sufficient wall distance (e.g. in narrow channels) are achieved by turning the inclined sensor surface into the flow direction. Some time after initial operation, the sensor should be checked for dirt. To clean it, wipe with a soft cloth. The most favourable sensor position should be maintained. Should self-cleaning not be sufficient, then we recommend the wiper sensor CUS 41-W or the spray cleaner CUR 4 – especially for media which tend to deposit sludge films or crusts.

Installation in immersion assemblies



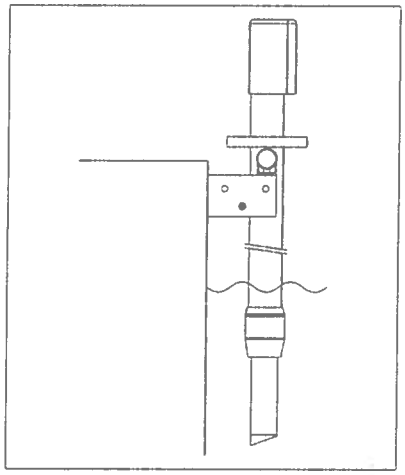
Assembly holder CYH 101 with weather protection cover CYY 101 for field transmitter

Note

When installing CUS 41 in an immersion assembly, such as CYA 611 with a pendulum frame, please note that sufficient wall distance must be maintained during the measuring process. The assembly should be installed where a minimum wall distance of 15 cm is guaranteed even with varying medium levels or changing flow conditions. Installation in a suspension assembly with chain must therefore be avoided.

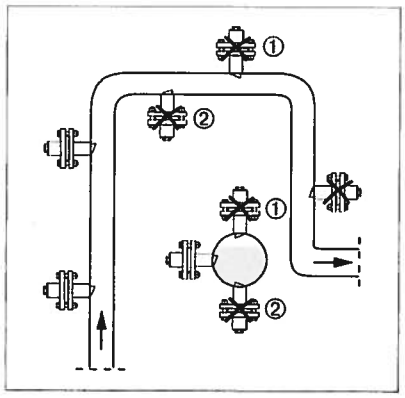
Mounting

- Remove cover from holding tube.
- Pull connection cable through holding tube without twisting it; screw in sensor and turn to the stop.
  Note:
  First undo twists in cable by reverse twisting.
- Put on cover.
- Secure sensor cable to transverse pipe and connect it to the instrument, or if used, to the junction box.



TurbiMax W CUS 41 sensor installed in CYA 611 assembly with pendulum frame

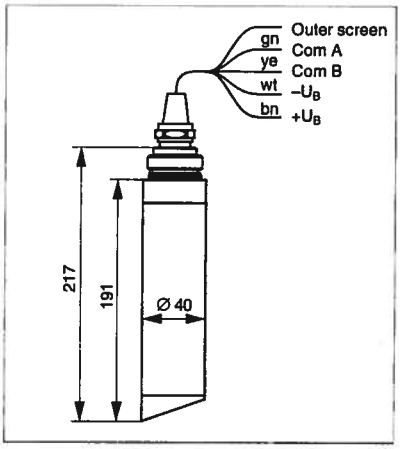
Pipe installation



Orientation and positions of CUS 41 with CUA 120-A/-B adapter or CUA 461 retractable assembly

Notes

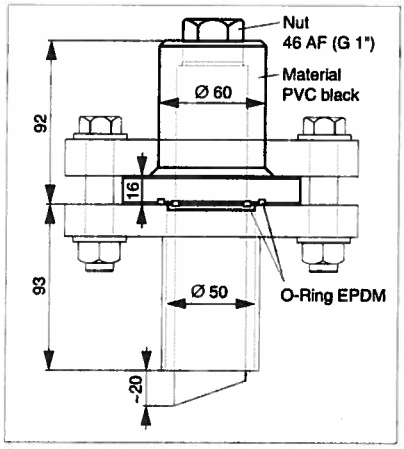
- The pipe diameter must be at least DN 100 when shiny materials (e.g. stainless steel) are used.
- Install the sensor in places with uniform flow conditions.
  Do not install it in places where air may collect, where foam bubbles are likely to form (①) or where suspended solids may settle (②).
- Install the sensor surface against the medium flow.



CUS 41 sensor

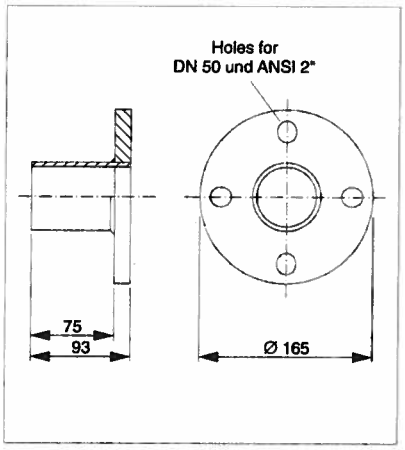
Mounting

- Lead connection cable through sleeve and hexagon coupling without twisting it.
- Insert sensor body into the sleeve so that the O-ring adjoins under the G 1" screw thread in the sleeve.
  Note marking pin and marking hole on the sleeve.
- Install CUS 41 into the adapter in such a way that the acute-angled edge of the sensor lies opposite to the marking hole and points away from it. The marking hole renders the sensor orientation clearly identifiable.



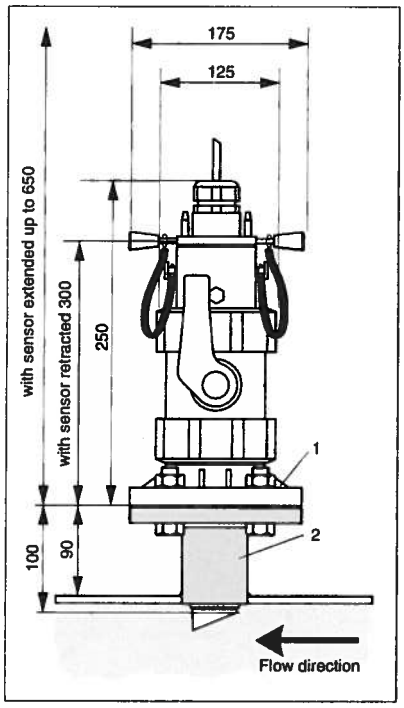
left:
CUA 120-B adapter with welding neck DN 50 / ANSI 2" (accessory) and lap joint flange DN 50 / ANSI 2" (to be provided by customer)

right:
Process connection adapter for pipe diameter greater than 80 mm



Welding neck DN 50 / ANSI 2"	
Material	Order no.
Stainless steel 1.4571 (SS 316Ti)	50080249
Polyvinyl chloride PVC	50080250
Polypropylene PP	50080251

Pipe installation (continued)



Dimensions of Probfit CUA 461 assembly
1 Process connection DIN Flange DN 50 or ANSI 2"
2 Process connection adapter (accessory, see p. 4)

For a description of the assembly, refer to Technical Information TI 134C/07/en, order no. 50073613.

Installation in flow assemblies

Notes on installation

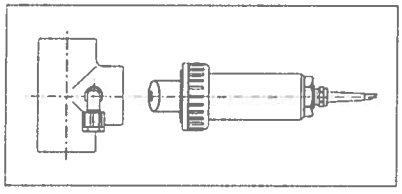
- The medium should, if possible, flow into the assembly from below. If the flow assembly must be installed in a horizontal instead of a vertical position, then install the sensor in the 3 o'clock or 9 o'clock position. This helps avoid air pockets.
- Installing the sensor parallel to the medium flow is necessary:
  - for turbidities < 5 FNU to minimise wall reflection effects. Also carry out installation adjustment!
  - in conjunction with the spray head CUR 3.
- Installing the sensor against the medium flow is used to increase self-cleaning effects:
  - in heavily soiled media with turbidities > 15 FNU, where wall reflections can in any case be neglected due to the high absorption rate.

Sensor orientation parallel to the medium flow

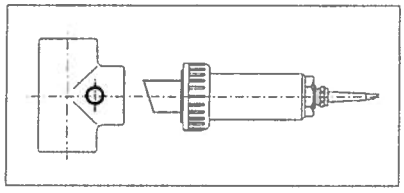
The sensor is inserted into the union nut. Loosely tighten the hexagon coupling on the G 1" thread of the sensor. When the sensor is inserted with the sleeve on, the fitting hole on the upper edge of the assembly accommodates the locking pin. Position the sensor by turning it in such a way that the sharp edge formed by inclined sensor surface and sensor cylinder lies opposite the marking pin and points away from it. The spray-head connection in the T-section of the CUA 250 is now located over the sensor surface.

Sensor orientation against the medium flow

Position the sensor by turning it until the sharp edge formed by inclined sensor surface and sensor cylinder lies turned by 90° opposite the marking pin and points in the flow direction of the medium. Hand-tighten the hexagon nut.



Installed parallel to the medium flow

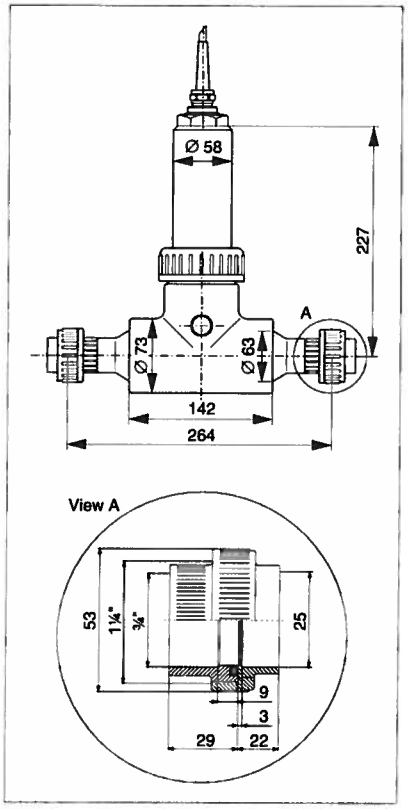


Installed against the medium flow

Installation in flow assemblies (continued)

FlowFit W CUA 250-A, CUA 250-B

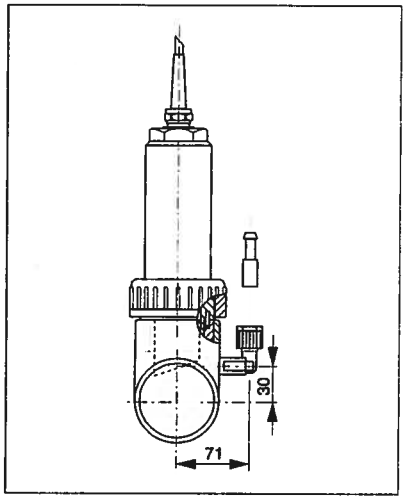
- Lead connection cable through union nut, sleeve and hexagon coupling without twisting it.
- Insert sensor body into the sleeve so that the O-ring adjoins under the G 1" screw thread in the sleeve.
  Note locking pin and marking hole on the sleeve.



Dimensions
CUA 250-A/-B

FlowFit W CUA 250-A, CUA 250-B with CUR 3-1 spray head

- Screw the CUR 3-1 spray head into the CUA 250 assembly in place of the lateral plug screw.
- Mount the CUS 41 sensor as above with parallel sensor installation to ensure optimum self-cleaning.



Dimensions
CUA 250-A/-B with
CUR 3-1 spray head

Turbidity sensor with wiper cleaning

The CUS 31/41-W sensors are both equipped with a screen wiper. The cleaning times and intervals are entered into the Liquisys M CUM 223/253 transmitter. For optimum cleaning, wiper timing is adjustable.

Checking the rest position

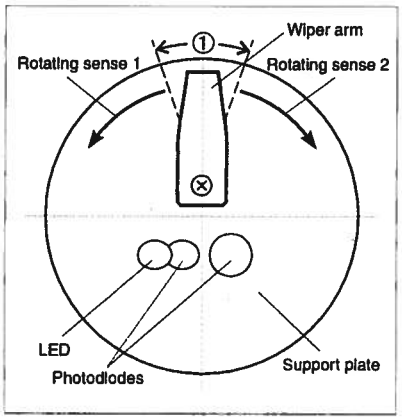
- Pull the sensor from the assembly.
- Moisten the sensor surface.
- Set type of cleaning and cleaning times on the transmitter and start the wiping cycle.
- Check the wiper movement (cycle) on the sensor. The wiper must reach the rest position (see figure).

Caution:

Do not move the wiper arm by hand!

Note:

If the wiper comes to rest over the measuring windows, then measuring errors will result.



① Rest position of the wiper arm
Tolerance range: ±20°

Maintenance and cleaning

Deposits on the sensor optics may result in inaccurate measurement. Therefore the sensor must be cleaned at regular intervals. The intervals are specific to each installation and must be determined during operation.
Clean the optics with the following agents depending on the type of soiling:

- Clean the sensor mechanically using a soft brush. Then rinse thoroughly with water.

Type of soiling	Cleaning agent
Limestone deposits	Short treatment with commercial deliming agent
Oily and greasy soiling	Cleaning agents based on water-soluble surfactants (e.g. household dish detergents)
Other types of soiling	With water and brush

Warning:

- Do not touch the optics with sharp-edged objects.
- Do not scratch the optics.

Technical data

Measuring principle	nephelometric 90° NIR scattered light according to EN 27027
Measuring ranges	0.00 ... 9999 FNU, 0.00 ... 9999 ppm, 0.0 ... 300 g/l, 0.0 ... 200.0% (depending on the type of sample)
Wavelength	880 nm
Optical reference compensation	by reference photodiodes
Factory calibration	formazine standard and SiO_2
Temperature / pressure	25 °C / 6 bar ... 50 °C / 1 bar
Connecting cable	4-core with terminal bushes
Max. cable length	200 m
Temperature sensor	NTC
Nominal operating range	-5 ... +50 °C
Storage temperature range	-20 ... +60 °C
Ingress protection	IP 68

Materials

Sensor support plate, shaft, cable	PVC
Optical windows	sapphire
Flow assemblies	PVC

How to order

Solids content sensor TurbiMax W CUS 41

Sensor

A Sensor in standard version
W Sensor with integrated wiper

Cable length

2 Connecting cable 7 m
4 Connecting cable 15 m
9 Connection cable according to customer specifications

CUS 41- [ ][ ] **complete order code**

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Technical
Information
TI 200C/07/en
No. 51500283

Turbidity/Suspended Solids Measurement
Liquisys M CUM 223 / 253

Turbidity and Suspended Solids Transmitter

Liquisys M CUM 253

Liquisys M CUM 223

Due to the modularity of its design, the Liquisys M CUM 223 / 253 transmitter can be adapted to a wide range of customer needs. The basic version, which provides simple measuring and alarm signalling functions, can be equipped with additional software and hardware modules to match specific applications. Retrofitting of expansion modules is also possible.

Areas of application
- Sewage treatment plants, suspended solids measurement
- Effluent treatment
- Water treatment and monitoring
- Drinking water
- Surface water: rivers, lakes, ocean
- Service water
- Indirect discharge
- Water recycling

Benefits at a glance
- Measuring transmitter in field or panel-mounted housing
- Universal application
  - One instrument for turbidity and suspended solids
  - Units: FNU (formazine standard), ppm, g/l, % or % SS
- Simple handling
  - Logically arranged menu structure with plain text in 6 languages facilitates instrument configuration
  - Large, two-line display indicates measured value and temperature at the same time
  - Ultrasimple calibration with user samples and alarm signalling for calibration errors
- Safe operation
  - Overvoltage (lightning) protection according to EN 61000-4-5
  - Direct access for manual contact control
  - User-defined alarm configuration for alarm contact and error current
  - Sensors are factory-calibrated with formazine standard and SiO_2
  - Automatic sensor self-recognition with calibration data transfer

The basic unit can be extended with:

- 2 or 4 contacts for use as:
  - Limit contacts (also for temperature)
  - P(ID) controller
  - Timer for simple rinse processes
  - Complete cleaning with Chemoclean
- Plus package:
  - Any current output configuration via table
  - Automatic initiation of cleaning in case of alarm or limit violation
  - Display in customer units (e.g. density) via table assignment
  - Live check of sensor
- HART® or PROFIBUS-PA
- 2nd current output for temperature

Quality made by Endress+Hauser

ISO 9001

Endress+Hauser

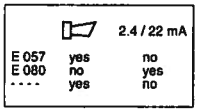
Nothing beats know-how

Details

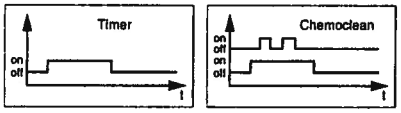
Liquisys M CUM 223 / 253 provides a solution for all drinking water processing, process water and sewage treatment applications.

Features of the **basic version (TU):**

Measurement of turbidity or suspended solids
This is selected via the menu. During measurement, the value measured can be displayed in the other measuring mode. The **temperature** is displayed at the same time if desired.



Different alarms are required depending on application and operator. Therefore the Liquisys M CUM 223 / 253 permits independent **configuration of the alarm contact and error current** for each individual error. Unnecessary or undesirable alarms can be suppressed in this manner.

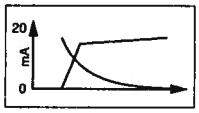


Up to four contacts can be used as limit contacts (also for temperature), to implement a P(ID) controller or for cleaning functions.

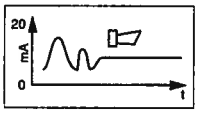
Direct **manual operation of the contacts** (bypassing the menu) provides quick access to limit, control or cleaning contacts, permitting speedy correction of deviations.

The **serial numbers** of the instrument and modules and the order code can be called up on the display.

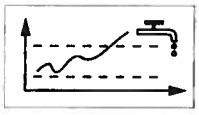
The **TS version** version provides **additional functions:**



In order to display wide measuring ranges while still achieving a high resolution in specific ranges, the **current output** can be configured as required via a table. This permits **bilinear** or **quasi-logarithmic** curves, etc.



The **live check** issues an alarm when the sensor signal does not change over a defined period of time. This may be caused by blocking, passivation, separation from the process, etc.



Soiling quickly results in excessive measured values. **Automatic cleaning** prevents alarms and inaccuracy caused by soiling.

In addition to concentration (ppm / % SS), **the display can also show other units** (e.g. density). A table is used for conversion (calibration in %).

Basic version and plus package

	Basic version	With plus package (TS version)
Alarm signalling	MEASUREMENT CALIBRATION (3-pt. / 1-pt. / reflection) Read instrument DATA Linear CURRENT OUTPUT CURRENT OUTPUT simulation 1 programmable ALARM CONTACT (contact and error current)	 LIVE CHECK of sensor CURRENT OUTPUT programmable (table)
	Additional features	*Additional features*
Controlling	2 CHANGEOVER CONTACTS for – Measuring parameter limit – Temperature limit – P(ID) controller – Timer for cleaning	Concentration measurement with assignment to other units Automatic cleaning triggered by alarm or limit violation
	Additional features	*Additional features*
Cleaning	2 more CHANGEOVER CONTACTS (total of 4) for – Measuring parameter limit – Temperature limit – P(ID) controller – Chemoclean cleaning (water and cleaning agent)	 Cleaning triggered externally or automatically by alarm or limit violation

Measuring and control system

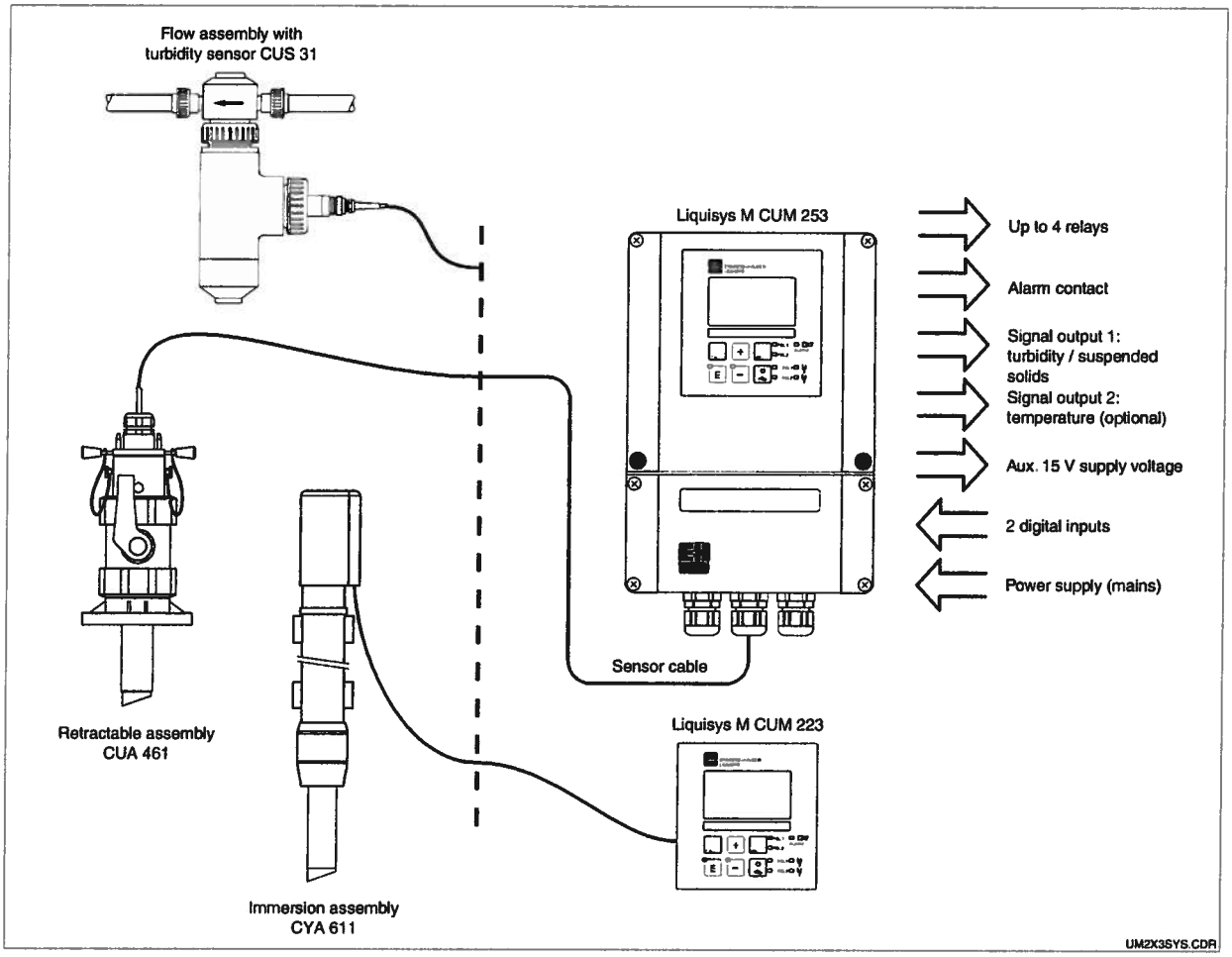
A complete measuring system comprises:

- the turbidity/suspended solids transmitter Liquisys M CUM 223 or CUM 253
- a turbidity sensor CUS 31 or suspended solids sensor CUS 41, and
- an immersion, flow or retractable assembly

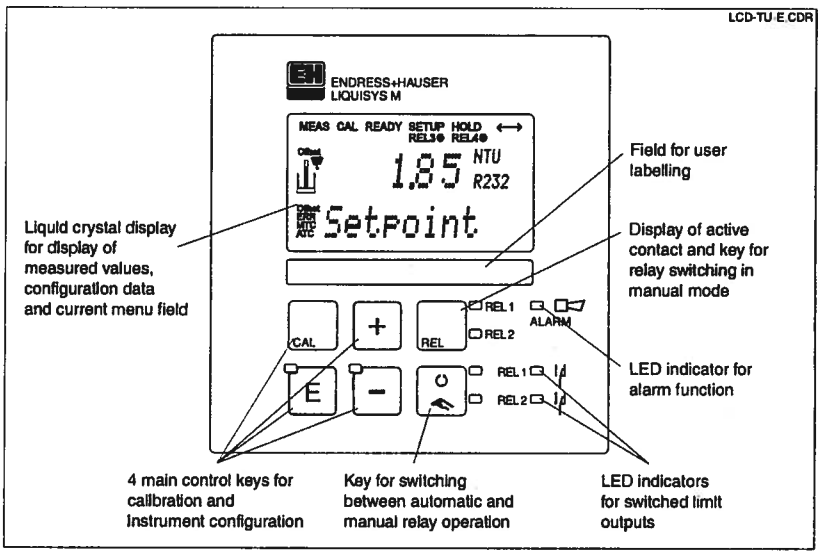
Options:

- extension cable CYK 8, and
- junction box VBM.

Complete measuring systems with Liquisys M CUM 223 / 253



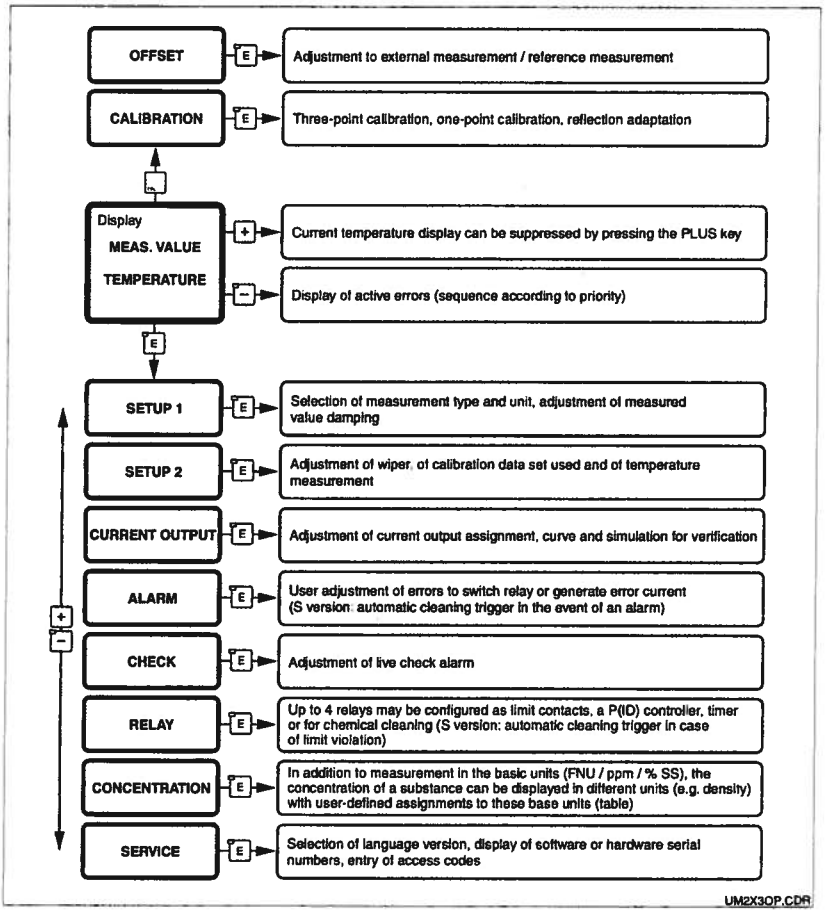
Operation



User interface: Display and keys

Everything at a glance
The display simultaneously shows the current measured value and the temperature – the essential process data. Brief informational texts in the configuration menu provide assistance with parameter configuration.

Intelligent and simple
All instrument control functions are arranged in a logical menu structure. Following access code entry, the individual parameters can be easily selected and modified as needed.

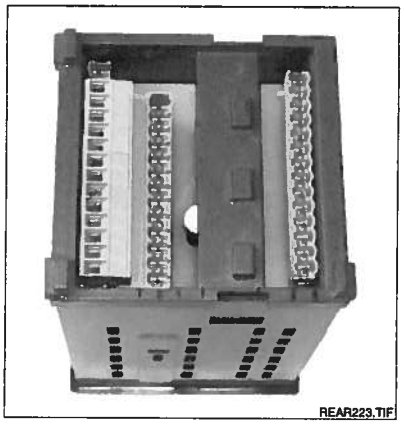


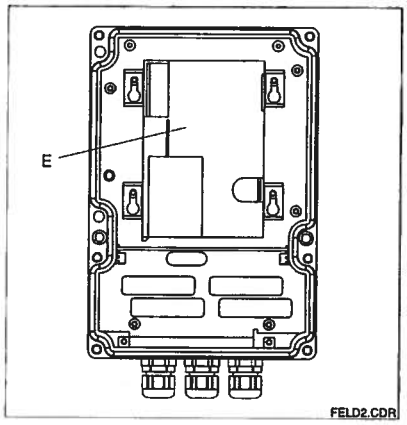
Overview of Liquisys M CUM 223 / 253 menu. This overview covers all the options that can be installed (see page 2 Details).

Electrical connection

All connections to the panel-mounted instrument CUM 223 are established via the terminal strips on the rear.
In the case of the field instrument CUM 253, all wires (including the sensor cable) are connected to terminals in a separate wiring compartment.

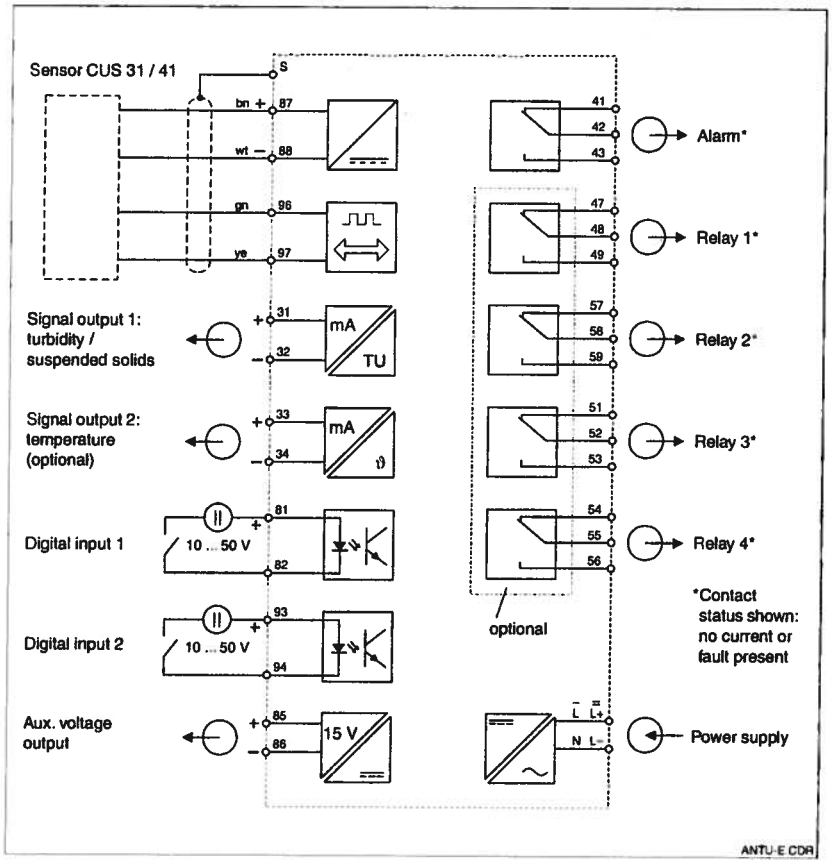
All the wiring can remain in place if the instrument needs repair because all possible repairs are limited to assembly replacement. So, Dismantling the instrument and rewiring are no longer necessary.





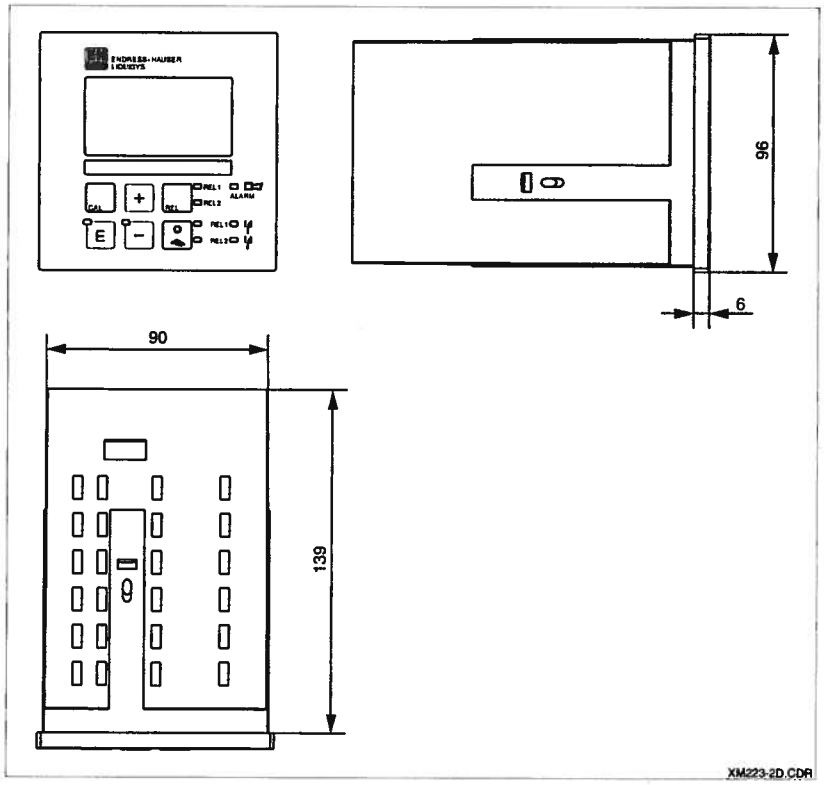
Left:
Liquisys M CUM 223, connections on the rear of the instrument

Right:
Liquisys M CUM 253, rear of instrument with replaceable electronics box (E)

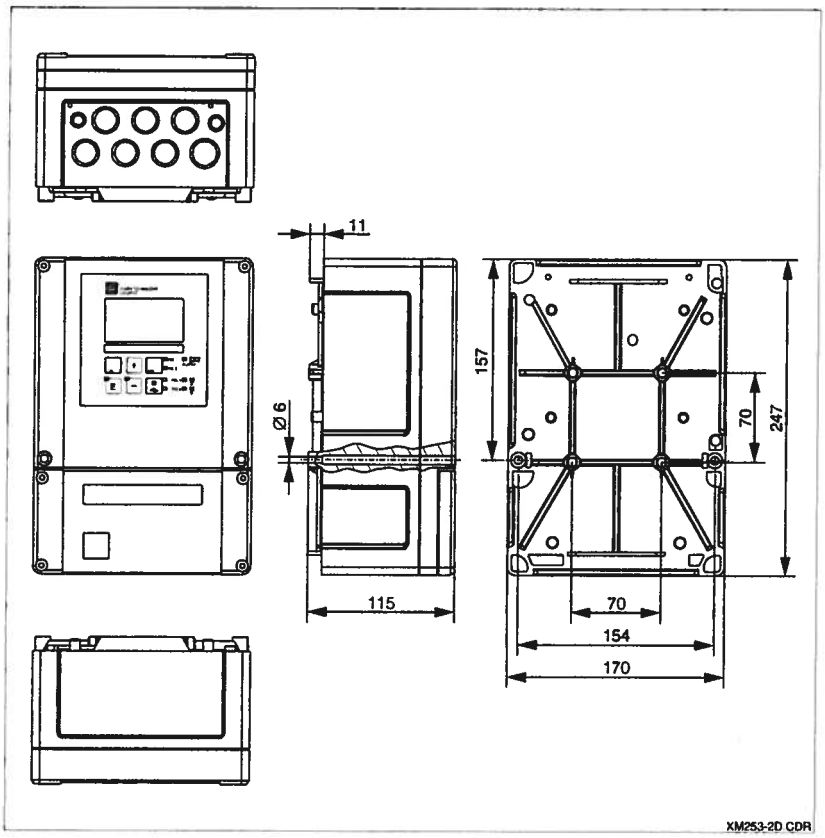


Electrical connection of Liquisys M CUM 223 / 253

Dimensions



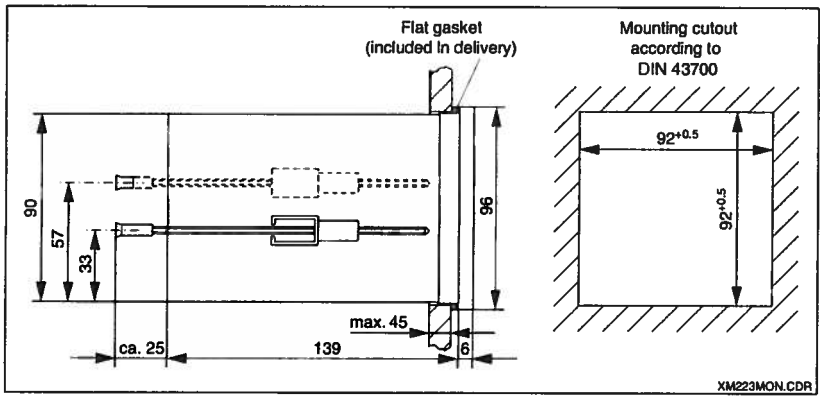
Dimensions of
Liquisys M CUM 223



Dimensions of
Liquisys M CUM 253

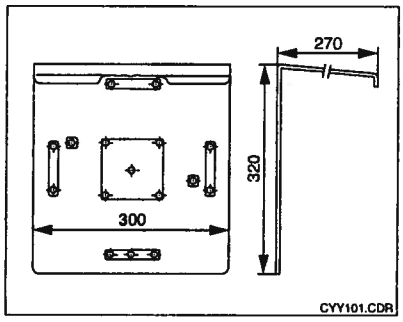
Mounting of Liquisys M CUM 223

The panel-mounted version is mounted using the supplied tensioning screws. The required overall mounting depth is approx. 165 mm.



Installation of panel-mounted housing

Mounting of Liquisys M CUM 253

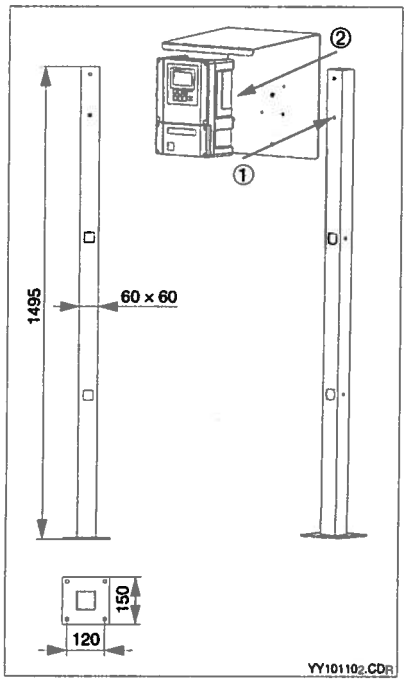


Weather protection cover CYY 101 (see Accessories)

There are several mounting options for the field instrument:

- Mounting on a square-tube mounting post
- Mounting on cylindrical pipes
- Wall mounting with fastening screws

Weather protection cover CYY 101 is required for outdoor installation. This cover is compatible with all field instrument mounting options.



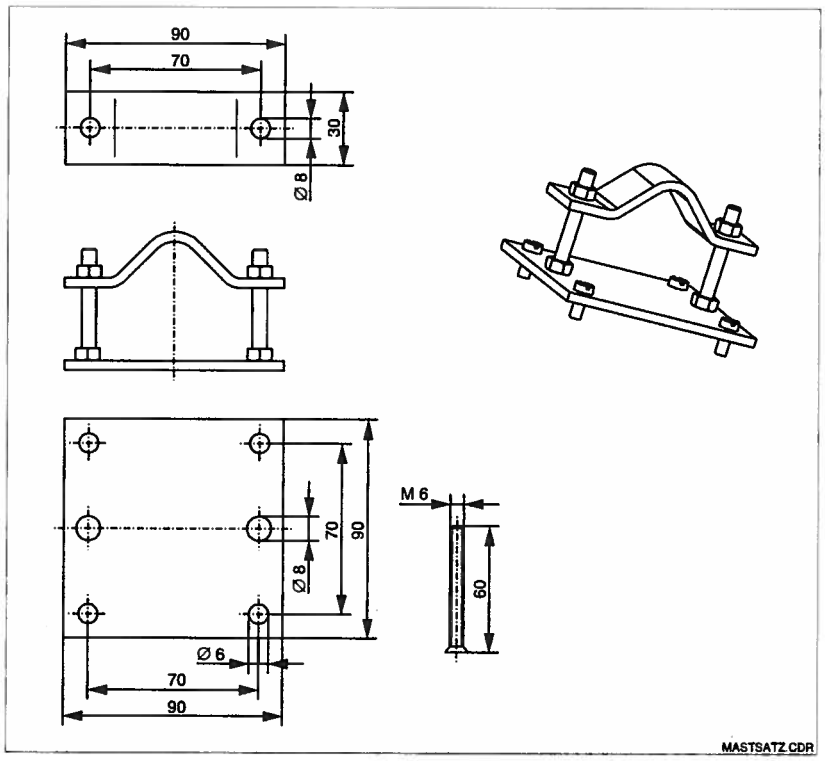
Universal upright post CYY 102 or identical upright post of suspension assembly holder CYH 101 (square tube, see Accessories); mounting of weather protection cover and field instrument

Proceed as follows to install the instrument on a square-tube mounting post (universal upright post CYY 102 or upright post of suspension assembly holder CYH 101):

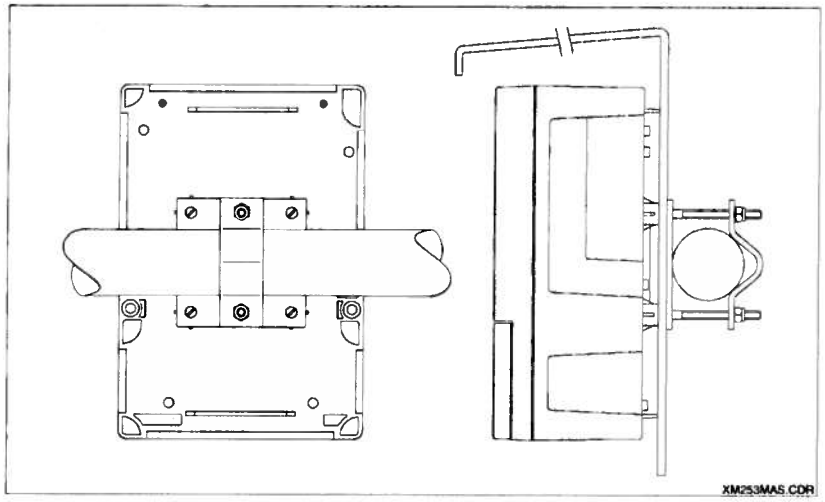
① Install the weather protection cover on the upright post first.

② Attach the field instrument to the weather protection cover from the rear.

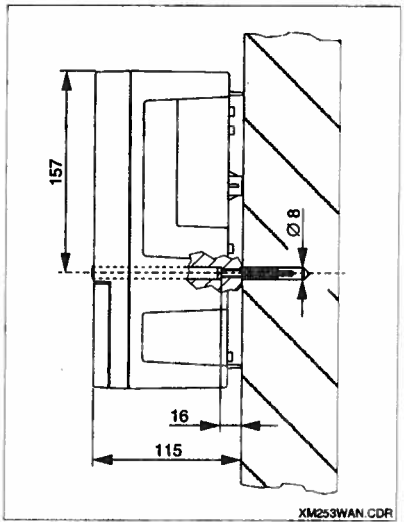
Mounting of Liquisys M CUM 253 (continued)



Post mounting kit for installation of field housing on cylindrical pipes (horizontal or vertical, max. Ø 60 mm; see Accessories)



Mounting on cylindrical pipes (shown with weather protection cover installed on right)



Wall mounting
Screws: Ø 6 mm
Anchors: Ø 8 mm

Technical data

General specifications

Manulacturer	Endress+Hauser
Product designation	Liquisys M CUM 223 Liquisys M CUM 253

Operating mode and system design

Measuring principle	A CUS 31 or CUS 41 sensor is connected to the digital sensor interface on the Liquisys M CUM 223 / 253. The sensors supply a standardised signal for turbidity and temperature.

Input

Measured quantities	turbidity, suspended solids, temperature

Turbidity measurement with CUS 31

Measuring range	0.000 ... 9999 FNU, 0.00 ... 3000 ppm, 0.0 ... 3.0 g/l, 0.0 ... 200.0%
Turbidity offset range	±99.99 FNU, ±99.99 ppm, ±99.9 g/l, ±99.9%

Suspended solids measurement with CUS 41

Measuring range	0.00 ... 9999 FNU, 0.00 ... 9999 ppm, 0.0 ... 300.0 g/l, 0.0 ... 200.0%
Suspended solids offset range	±99.99 FNU, ±99.99 ppm, ±99.9 g/l, ±99.9%

Temperature measurement

Temperature sensor	NTC, 30 kΩ at 25 °C
Measuring range	-5.0 ... +70.0 °C
Temperature offset range	±5 °C

Signal input for turbidity / suspended solids / temperature

Sensor interface	digital
Max. length of cable to sensor	200 m

Digital inputs 1 and 2

Voltage	10 ... 50 V
Current consumption	max. 10 mA

Output

Signal output for turbidity / suspended solids

Current range	0 / 4 ... 20 mA, galvanically separated; error current 2.4 / 22 mA
Load	max. 500 Ω
Max. resolution	700 digits/mA
Output range	adjustable, min. Δ 0.1 FNU, Δ 1 ppm, Δ 1 g/l, Δ 0.1%
Separation voltage	max. 350 V_{rms} / 500 V DC
Overvoltage (lightning) protection	according to EN 61000-4-5:1995

Signal output for temperature (optional)

Current range	0 / 4 ... 20 mA, galvanically separated
Load	max. 500 Ω
Max. resolution	700 digits/mA
Output range	adjustable, Δ 10 ... Δ 100% of upper range value
Separation voltage	max. 350 V_{rms} / 500 V DC
Overvoltage (lightning) protection	acc. to EN 61000-4-5:1995

Auxiliary voltage output

Output voltage	15 V ± 0.6 V
Output current	max. 10 mA

Contact outputs (potential-free changeover contacts)

Switching current with ohmic load (cos φ = 1)	max. 2 A
Switching current with inductive load (cos φ = 0.4)	max. 2 A
Switching voltage	max. 250 V AC, 30 V DC
Switching power with ohmic load (cos φ = 1)	max. 1250 VA AC, 150 W DC
Switching power with inductive load (cos φ = 0.4)	max. 500 VA AC, 90 W DC

Limit contactor

Pickup / droput delay	0 .. 7200 s

Technical data (continued)

Output (continued)

Controller

Function (adjustable)	pulse length / pulse frequency controller
Controller response	P, PI, PD, PID
Control gain K_p	0.01 ... 20.00
Integral action time T_n	0.0 ... 999.9 min
Derivative action time T_v	0.0 ... 999.9 min
Period for pulse length controller	0.5 ... 999.9 s
Frequency for pulse frequency controller	60 ... 180 min^{-1}

Alarm

Function (switchable)	steady / fleeting contact
Alarm threshold adjustment range	turbidity / suspended solids / temperature: complete measuring range
Alarm delay	0 ... 2000 s (min)

Accuracy

Turbidity measurement with CUS 31

Resolution	0.001 FNU, 0.01 ppm, 0.1 g/l, 0.1%
Deviation of indication[1]	±2% of meas. value (min. 0.02 FNU)
Reproducibility[1]	±1% of meas. value (min. 0.01 FNU)
Measurement deviation[1], turbidity signal output	1% of current output range (min. 0.02 FNU)

Suspended solids measurement with CUS 41

Resolution	0.01 FNU, 0.01 ppm, 0.1 g/l, 0.1%
Deviation of indication[1]	±2% of meas. value (min. 0.02 FNU)
Reproducibility[1]	±1% of meas. value (min. 0.01 FNU)
Measurement deviation[1], suspended solids signal output	1% of current output range (min. 0.02 FNU)

Temperature measurement

Resolution	0.1 °C
Deviation of indication[1]	max. 1.0% of measuring range
Measurement deviation[1], temperature signal output	max. 1.25% of current output range

Ambient conditions

Ambient temperature (nominal operating conditions)	–10 ... +55 °C
Ambient temperature (limit operating conditions)	–20 ... +60 °C
Storage and transport temperature	–25 ... +65 °C
Relative humidity (nominal operating conditions)	10 ... 95%, non-condensing
Protection class of panel-mounted unit	IP 54 (front), IP 30 (housing)
Protection class of field housing	IP 65
Electromagnetic compatibility	interference emission and interference immunity acc. to EN 61326-1:1998

Physical data / design

Dimensions of panel-mounted unit (H × W × D)	96 × 96 × 145 mm
Mounting depth	approx. 165 mm
Dimensions of field housing (H × W × D)	247 × 170 × 115 mm
Weight of panel-mounted unit	max. 0.7 kg
Weight with field housing	max. 2.3 kg
Display	LC display, two lines, five and nine digits, with status indicators

Materials

Housing of panel-mounted unit	polycarbonate
Front membrane	polyester, UV-resistant
Field housing	ABS PC Fr

Power requirements

Supply voltage	100 / 115 / 230 V AC +10 / –15%, 48 ... 62 Hz 24 V AC/DC +20 / –15%
Power consumption	max. 7.5 VA
Fuse protection	fine-wire fuse, medium time-lag, 250 V / 3.15 A

[1]acc. to IEC 746-1, for nominal operating conditions

Subject to modifications.

Accessories

Mounting accessories

Type	Features	Order number
Weather protection cover CYY 101	For mounting on field housing, for outdoor installation Dimensions (H x W x D): 320 x 300 x 270 mm Material: stainless steel 1.4301	CYY 101-A
Universal upright post CYY 102	Square tube for mounting of field housing Dimensions (H x W x D): 1495 x 60 x 60 mm Material: stainless steel 1.4301	CYY 102-A
Suspension assembly holder CYH 101	For installation on basin or channel rim Materials: stainless steel 1.4301 / PE	CYH 101-D
Pendulum frame	For pendulum suspension of assemblies, e.g. CYA 611 Material: stainless steel 1.4301	50080196
Post mounting kit	Kit for mounting of field housing on horizontal or vertical pipes (Ø max. 60 mm) Material: stainless steel 1.4301	50086842

Assemblies

Type	Features	Applications
DipFit W CYA 611	Immersion assembly with G 1, G ¾ or NPT ¾" thread	Basins and channels
FlowFit W CUA 250	Flow assembly (pressure-resistant up to 6 bar / 20 °C)	Pipelines
CUA 461	Retractable assembly for sensor installation and removal without process interruption (max. 2 bar)	Pipelines

Sensors

Type	Features	Applications
TurbiMax W CUS 31	Turbidity sensor for drinking water and service water applications	Drinking water, filter monitoring, phase separation, surface water
TurbiMax W CUS 41	Sensor for measurement of suspended solids	Sedimentation, sewage treatment plants, industrial service water, phase separation

Cable / junction box

Type	Features	Order number
CYK 8	Data cable (unassembled) for extension of CUS 31 / CUS 41 sensor connection cables	50089633
VBM	Junction box	50003987

Product structure

Turbidity/suspended solids transmitter Liquisys M CUM 223 / CUM 253

Version

TU Turbidity/suspended solids measurement
TS Turbidity/suspended solids measurement with additional functions

Power supply

0 230 V AC
1 115 V AC
5 100 V AC
8 24 V AC/DC

Measurement output

0 Turbidity / SS
1 Turbidity / SS and temperature
3 Profibus PA
5 Turbidity / SS with HART
6 Turbidity / SS with HART and temperature

Contacts

05 No additional contacts
10 2 contacts (limit / P(ID) / timer)
15 4 contacts (limit / P(ID) / timer / Chemoclean)
16 4 contacts (limit / P(ID) / timer)

CUM 223-					**complete order code for CUM 223**
CUM 253-					**complete order code for CUM 253**

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- Instruments International -
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Fax (0 76 21) 97 53 45

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City of Campbell River

PRE-DESIGN FOR UPGRADES TO THE NORM WOOD ENVIRONMENTAL CENTRE

APPENDIX F

REFERENCE FACILITIES

Andy Setiawan

From: Lucas, Allen [ALucas@utilitieskingston.com]
Sent: Thursday, November 27, 2008 1:18 PM
To: Andy Setiawan
Subject: RE: Performance information
Attachments: image001.jpg

Yes, we have designed an upgrade to our second plant to include 4 NX150's, the same as Ravensview. I learned today they are fabricated and ready to ship, so now we need to get them put in.

Omar and his team have been very helpful on the Ravensview installation. There was a different configuration that was tried, but when it caused more problems than it solved, Neuros changed and set everything up to vent on start-up into the room. Fantastic service from them and very willing to ensure the installation will work seamlessly. Operations are really pleased and are eager to get the others installed.

Will get together something tomorrow for you.

Allen K. Lucas, P.Eng.
Utilities Engineer

tel (613) 546-1181 ext. 2250
fax (613) 542-1463

From: Andy Setiawan [mailto:asetiawan@dayton-knight.com]
Sent: Thursday, November 27, 2008 4:14 PM
To: Lucas, Allen
Subject: RE: Performance information

Hi Allen,

Yes, I am still interested on getting the information from you. I heard through Omar that City of Kingston is ordering a few more units?

Regards,

Dayton & Knight Ltd.
CONSULTING ENGINEERS

Andy Setiawan
#210-889 Harbourside Drive
North Vancouver, B.C. V7P3S1
Tel: 604-990-4800*125
Fax: 604-990-4805
Email: asetiawan@dayton-knight.com
Web: www.dayton-knight.com

****

From: Lucas, Allen [mailto:ALucas@utilitieskingston.com]
Sent: Thursday, November 27, 2008 12:07 PM
To: Andy Setiawan
Subject: RE: Performance information

Andy,

I am just reviewing some past notes and realized I never got any information back to you. Are you still interested in receiving information?

Allen K. Lucas, P.Eng.
Utilities Engineer

tel (613) 546-1181 ext. 2250
fax (613) 542-1463

From: Andy Setiawan [mailto:asetiawan@dayton-knight.com]
Sent: Tuesday, October 07, 2008 2:30 PM
To: Lucas, Allen
Subject: Performance information

Dear Mr. Allen Lucas,

My name is Andy Setiawan and I am working with Dayton & Knight Consultant here in Vancouver, Canada. Currently, we are doing a blower-study upgrade on a wastewater treatment plant at Campbell River.

We are interested on replacing the centrifugal blowers that are currently running with turbo blowers by Neuros. Upon consultation with the supplier (Omar Hammoud at APG-Neuros) we got your name as a reference at City of Kingston.

I am specifically interested on the performance of the NX150 units, such as operating and maintenance issues and actual power efficiency. To fairly review the turbo blowers performance, I would also like to find out about the following on your treatment plant:

1. The schematic of your treatment plant
2. Location of blowers usage
3. Design Service population
4. Average annual flow
5. Maximum day flow
6. Maximum month flow
7. Design air requirement
8. Discharge pressure

Your time and assistance on this is appreciated.

Kind Regards,

Dayton & Knight Ltd.
CONSULTING ENGINEERS

Andy Setiawan
#210-889 Harbourside Drive
North Vancouver, B.C. V7P3S1

Tel: 604-990-4800*125
Fax: 604-990-4805
Email: asetiawan@dayton-knight.com
Web: www.dayton-knight.com

Please consider the environment before printing this e-mail

Andy Setiawan

From: Mike Jensen [mjensen@hydroscience.com]
Sent: Tuesday, October 07, 2008 11:18 AM
To: Andy Setiawan
Subject: RE: Performance information
Attachments: image001.jpg

Andy-

The Neuros NX-150 blowers have been in operation for about 3 months. To date they are operating to our satisfaction. Neuros has been responsive to any problems. Note that most of our problems have been with our control system – not with the blowers. Neuros helped trouble shoot & worked to help solve the control issues. The only problems we had were discovered during commissioning – there was one bad VFD which was replaced promptly and one bad temperature probe. See other answers below.

We intend on using these types of turbo blowers on future projects.

Mike Jensen
Chief Engineer
HydroScience Engineers, Inc.
10569 Old Placerville Road
Sacramento, CA 95827

Ph: 916.364.1490
Fx: 916.364.1491

www.hydroscience.com

From: Andy Setiawan [mailto:asetiawan@dayton-knight.com]
Sent: Tuesday, October 07, 2008 11:00 AM
To: Mike Jensen
Subject: Performance information

Dear Mr. Michael Jensen,

My name is Andy Setiawan and I am working with Dayton & Knight Consultant here in Vancouver, Canada. Currently, we are doing a blower-study upgrade on a wastewater treatment plant at Campbell River.

We are interested on replacing the centrifugal blowers that are currently running with turbo blowers by Neuros. Upon consultation with the supplier (Omar Hammoud at APG-Neuros) we got your name as a reference at City of Hollister.

I am specifically interested on the performance of the NX150 units, such as operating and maintenance issues and actual power efficiency. To fairly review the turbo blowers performance, I would also like to find out about the following on your treatment plant:

1. The schematic of your treatment plant MBR treatment plant with Pre-Anoxic, Aerobic, Post-Anoxic followed by membrane tanks.
2. Location of blowers usage Used for process air (NX150, 4 ea.) and membrane scour air (NX100, 5 ea.)
3. Design Service population ~33,000

4. Average annual flow Design flow 5 mgd
5. Maximum day flow 8 mgd
6. Maximum month flow 6.7 mgd
7. Design air requirement 7900 scfm total (2630 scfm per blower)
8. Discharge pressure 11 psig

Your time and assistance on this is appreciated.

Kind Regards,

Dayton & Knight Ltd.
CONSULTING ENGINEERS

Andy Setiawan
#210-889 Harbourside Drive
North Vancouver, B.C. V7P3S1
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