SECTION 11

PROCESS EQUIPMENT

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FINE BAR SCREENS

1.1 GENERAL

The automatically operated mechanically fine screens shall be installed immediately adjacent to the inlet chamber. The collected screenings shall be transferred to a screening compactor then to a skip via a chute for later disposal off-site.

The relevant tender documents of this contract show the general arrangement of the equipment. One unit shall be mechanically operated screens and one shall be a hand rake screen. The manual screen is provided in case of power failure. Each unit shall include all accessories and auxiliaries necessary for the proper control, operation and maintenance of the plant.

1.2 MECHANICAL FINE SCREENS

Mechanical screens shall have a clear opening between bars of 5 mm. Top and bottom supports for the screens shall be furnished and shall be suitable for anchorage to the concrete without vibration.

The fine screens shall be capable of operating intermittently to form a mat of screenings material to provide maximum trash removal.

When operating, the fine screen shall present a clean filtration surface to the incoming wastewater at all times.

The screen shall be assembled so that the screen does not need to be removed or pivoted out from the channel for maintenance purposes.

All bearings to be externally mounted with a life expectancy of 50,000 hours

At normal operating flow conditions, approach velocities should be no less than 1.25 fps (38 cm/s), to prevent settling; and no greater than 3.0 fps (91 cm/s) to prevent forcing material through the openings.

1.3 MATERIALS

Moving part	Type 316L stainless steel
Stationary part	Type 316L stainless steel
Fasteners and hinges	Type 316L stainless steel
Side frame	Type 316L stainless steel

1.4 DESIGN CONDITIONS

A. General

Equipment furnished under this Section shall be suitable for operation in wastewater from a sanitary sewer system containing domestic and industrial wastes. The wastewater may be expected to contain gross waste solids, vegetable parts, small sections of lumber, rocks, sand, silt, petroleum products, industrial solvents, and animal fats and oils.

B. Design Requirements

The following shall apply to each bar screen furnished under this Specification:

- Ultimate peak capacity, m3/hr 3200
- Ultimate average flow, m3/hr 2100
- Channel width, m 1.5 – 2.0
- Channel depth, m 2.0
- Max. upstream water depth, m 1.0
- Min. motor horsepower, kW 3
- Bar screen openings, mm 5
- Bar size, mm - 5
- Max. screen height, m 1(above operating floor level)

C. Operation

As the solids accumulate into a mat on the screen, the unit is activated by a timer or level sensor. The motor recipricates the bars incrementally moving the materials up the bar screen steps. When the solids reach the top they fall off into a bin, washer or conveyor. The unit then stops in the home position.

The screen drive shall be protected by a torque limiting device in addition to normal starting overloads. The control panel shall include a timer and a level indicating start-stop function. The automatic start – up and shut down of the equipment shall be activated by differential level meters or on – off time timers.

A. Controls

1 General: Each bar screen shall be provided with a local control panel designed by the manufacturer. All controls and electrical components shall be suitable for a Class I, Division I, Group D environment. The control panels shall be provided with enclosures with NEMA ratings in accordance with the area designations. The CONTRACTOR shall coordinate all control power.

2 Operating Modes: Each bar screen control panel shall be provided with HAND-OFF-AUTO and REVERSE-FORWARD controls. In automatic mode, the bar screen shall be activated by timer control with a high differential level override. High differential level switches shall be located on the bubbler

panels.

3 Control Stations: Each control station shall be provided with REMOTE-LOCAL and REVERSE-OFF-FORWARD switches. REVERSE-OFF-FORWARD switch shall be lockable in the OFF position. Setting the REMOTE-LOCAL switch to the LOCAL position shall override all start controls from the control panel.

4 Timer and Head Loss Differential Control: Each mechanically cleaned bar screen shall be provided with a time controller designed for variations in operation over a 24-hour period, adjustable to 5- minute increments. When in the automatic control mode, a differential controller shall override the timer controller to initiate operation of the bar screen.

5 Alarms and Status Lights: Each bar screen shall be provided with local indicating lights for alarm and status. Status lights shall be provided to indicate run and ready conditions. Alarm lights and an alarm buzzer shall be provided to indicate the following conditions:

- Bar screen over torque.
- Motor high temperature.
- High channel water level

A status output and common trouble alarm output shall be provided for remote indication and alarm. A dry set of contacts shall be provided for each output and wired to a labeled terminal within each control panel. The trouble alarm contacts shall open when any alarm condition occurs and shall close after all alarm conditions have passed and manual alarm reset button has been depressed. Manual alarm reset buttons as well as alarm buzzers shall be surface mounted on each local control panel. Status signal contacts shall close during the run cycle, maintain closure during the entire run cycle, and open after the cycle is complete and the drive mechanism is in its normal parked position.

D. Access

The bar screen must be completely accessible for manual cleaning in the event of power outage or other emergency shut down of the mechanical screen. To allow for manual cleaning, there shall not be any mechanical cross-channel obstructions (such as support beams, shafts, etc.)

Screening areas shall be provided with stairway access, adequate lighting ,and a convenient and adequate means for removing the screenings

1.5 MATERIALS

Moving part	Type 316L stainless steel
Stationary part	Type 316L stainless steel
Fasteners and hinges	Type 316L stainless steel
Side frame	Type 316L stainless steel

1.6 CONSTRUCTION

General

The fine screen shall withstand, without deflection, damage or distortion, the loads imposed by water differential between the upstream and downstream side of the fine screen at maximum water depth in the downstream channel. The only obstructions in the channel shall be the bars of the fine screen. All structural supports and fasteners, except bar rack supports, shall be above the maximum water level to avoid interference with flow.

1.7 DRAWINGS & DOCUMENTS

The following shall be submitted:

Drawings and descriptive information in sufficient detail to show the kind, size, weight, arrangements, operation, component materials and devices; external connections, anchorages, and supports required; performance characteristics; dimensions needed for installation and correlation with the conveyor.

Electrical data including control wiring.

Information on at least one successfully performing installation of comparable size and complexity constructed in the recent past including contact name, address, and telephone number.

1.8 OWNER'S MANUAL

The following shall be included in the OWNER'S MANUAL:

1 The manufacturer shall provide a written report stating the screens have been properly installed and tested and each is ready for full-time operation.

2 Complete assembly and maintenance instructions including diagrams, drawings and parts list.

1.9 SCREENING CONVEYOR

A. An electrically driven conveyor shall be provided at the sewage treatment works for removal of screenings raked from the curved bar screens.

B. The conveyor shall be positioned so that screenings are directed onto the conveyor. The conveyor shall be fitted with troughing carrier idler rollers, return rollers, a crown faced head pulley, a crown faced tail roller and a screw type belt take-up. The pulleys and rollers shall be fabricated from a corrosion resistant material. The supporting framework shall be fabricated from hot rolled steel channel sections.

C. The conveyor rollers shall have sealed grease packed precision ball bearings and shall have a life expectancy of 80,000 hours operating life. The troughing idler roller diameter shall be selected for the duty but shall not be less than 127mm. The idler pitch shall be selected for the duty but shall not be greater than 1200mm The idler pitch at the feed position shall be no greater than 450mm The return roller pitch shall not be greater than 2400mm.

D. The conveyor shall be designed for the following condition:

- Uniformly distributed belt loading of 400 kg/m.
- Belt width of 600mm.
- Belt speed 25 m/min

If higher belt loading is required, the contractor shall change the design condition depending on higher load requirement.

E. Conveyor belting shall be solid woven, non-perishable material. It shall be fully impregnated with the selvedge reinforced and having tough, abrasion resistant synthetic rubber covers 2mm on the face and 1mm on the reverse. Joints in the conveyor belting shall be of the vulcanized type. Spillage skirts shall be fitted along both sides of the conveyor. They shall be 300mm high with abrasion resistant replaceable sealing edges to stop spillage.

F. A stainless steel discharge chute, splashguard, and positively loaded belt scraper shall be provided at the discharge end of the conveyor to ensure clean and efficient discharge of screenings.

G. The head pulley shall be driven through a fluid coupling and gear motor. The service factor of the gear motor shall not be less than 1.25 at motor full load rating.

H. A red PVC covered, stranded galvanized steel pull wire shall be fitted along the accessible side of the conveyor at a height of 600mm to adequately protect against accidental contact with moving parts. The pull wire shall actuate a latched pull switch to stop the conveyor drive motor. The latched pull switch shall have manual reset, locking and position indication features. The pull wire shall be threaded through guide rings spaced not more than 2000mm apart.

I. The mild steel conveyor frame and associated steel work shall be shot blasted and zinc sprayed to a minimum thickness of O.1mm and shall then be finished with two coats of two-pack coal tar epoxy paint. The drive unit shall be primed, undersea led and finished with three coats of alkyd enamel paint.

2 SCREENINGS COMPACTOR

2.1 GENERAL

A. Two screenings presses complete with motor, supports, and accessories for the compaction of municipal sewage screenings shall be provided, it is required that one manufacturer accept responsibility for furnishing the WORK as indicated but without altering or modifying the CONTRACTOR'S responsibilities under the Contract Documents.

B The screenings press system shall be designed to compress and transport screenings from the bar screens to the screenings bin. The press shall be the shaftless, spiral type.

2.2 DESIGN AND OPERATING

Criteria

Each press shall meet the following requirements:

Equipment identification	
Maximum cubic meter of screenings per hour, continuous	4
Rotating speed, max, rpm	35
Volume reduction, min percent	50
Obtained solids content, min percent	50
Screw diameter, nominal, mm	200-400
Screw thickness, min, mm	12-20
Inlet hopper opening length, m	1x1.5

2.3 CONSTRUCTION

A. Materials

The screenings press shall be constructed of the following materials:

1 Spiral screw and shaft -Steel, ASTM A36
2 Trough, compression zone, drainage -Stainless steel, AISI Type 304 tray, and inlet chute
3 Equipment supports -Steel or aluminum
4 Fasteners -Stainless steel, Type 304 or 316
5 Gear box housing -Cast iron, ASTM A48

B. Spiral Screw

The screw shall be a continuous, rotary spiral with a solid or hollow center shaft.

C. Compression Zone

Compression of screenings shall occur in a zone provided as an integral part of the screw press. From the compression zone, the screenings will be forced into the discharge pipe as indicated on the drawings. Liquid from the discharge pipe shall drain back to the screw area.

D. Trough

The horizontal spiral shall be supported by a U-shaped trough assembly, minimum of 3 mm thick, provided with water drain holes, countersunk from the outside. The trough shall be provided with a full length, removable, drainage tray with a 80mm NPT outlet.

E. Inlet Chute

An inlet chute for each press shall be provided to receive screenings from the screen. The chute shall be flange-bolted to the top of the press inlet. Chutes shall have removable access doors. Sidewalls shall be sloped at 60 degrees from the horizontal.

F. Washing System

A washing system shall be installed between the collecting trough and the screw housing. The washing system shall be designed to clean the trough and also prevent the accumulation of compacted material in the drain holes. It shall be controlled by a solenoid valve actuated by a timer in the control panel. In addition, the compression zone shall be provided with a manual washwater connection as indicated.

G. Supports

The equipment shall be supported and braced to the height indicated. All supports shall be fabricated of not less than 6 mm thick steel or aluminum of equivalent strength. Anchor bolts shall be provided.

H. Gear Motor

The drive motor shall be 1200 rpm, 480 V, heavy duty explosion proof motor. The gear reducer shall be the helical type with Class II service factor in accordance with AGMA 6019-E89. The gear reducer shall be provided with anti-friction bearings designed for high overhung loads with all gears.

I. Gear Head

The gear motor shall drive a gear head consisting of gears manufactured from case hardened steel and hardened to minimum 58 Rockwell C. Gear teeth shall be in accordance with AGMA 908-B89 and 2001-B88, Class II. A thrust bearing shall support the screw shaft. Gear head and bearing shall be mounted inside a totally enclosed, oil-filled gear box with a service factor of 2.0. Gear box shall be protected from contamination by two shaft seals.

J. Controls

Screw press controls shall be as indicated. The screw press shall be capable of being operated either manually or automatically. In the automatic mode, the press shall be interlocked with the bar screen [and conveyor so that the press is started when any bar screen cycle begins, and the press continues to operate for 5 minutes after the bar screen cycle is completed. High torque from a jammed screw shall stop the press and activate an alarm. The NEMA rating of local control panels shall be in accordance with the area designations of related section.

K. Discharge Chute

The screenings shall discharge into a [tube or trough] sized to match the equipment provided. It shall be angled upward to allow drainage back into the screw area. Length of the discharge [tube or trough] shall be as indicated. It shall be provided with hinged sections to allow easy access to the entire chute for manual removal of screenings if needed.

2.4 SPARE PARTS

The WORK includes the following spare parts:

1 2 bearing assemblies
2 2 shaft seal sets

2.5 MANUFACTURERS

Products of the type indicated shall be manufactured by a well known screening compactor manufacturer accepted by the Engineer.

2.6 EXECUTION

Products and equipment shall be installed in accordance with the manufacturer's installation instructions

3 GRIT AND GREASE REMOVAL CHANNELS

3.1 GENERAL

A. The aerated grit chamber is designed to remove larger, heavier particles that would cause excessive equipment wear in the other plant treatment processes.

B. The grit that settles out in this chamber is pumped through a container.

3.2 PRODUCT

3.2.1 GENERAL

A. The Grit & Grease Removal system can handle minimum to maximum peak flows with the same efficiency.

B. The design effectiveness of a grit removal system shall be commensurate with the requirements of the subsequent process units.

3.2.2 INLET

A. Inlet turbulence shall be minimized in channel type units.

B. Channels shall be provided with inlet penstocks for isolation.

3.2.3 VELOCITY AND DETENTION

Channel shall be designed to control velocities during normal variations in flow below 0.2 m/s. The detention period shall be based on the size of particle to be removed. All aerated grit removal facilities should be provided with adequate control devices to regulate air supply and agitation.

3.2.4 GRIT WASHING

The need for grit washing should be determined by the method of grit handling and final disposal.

3.2.5 DEWATERING

Provision shall be made for isolating and dewatering each unit. The design shall provide for complete draining and cleaning by means of a sloped bottom equipped with a drain sump.

3.2.6 WATER

An adequate supply of water under pressure shall be provided for cleanup.

3.2.7 GRIT HANDLING

Grit removal facilities located in deep pits should be provided with mechanical equipment for hoisting or transporting grit to ground level. Impervious, non-slip, working surfaces with adequate drainage shall be provided for grit handling areas. Grit transporting facilities shall be provided with protection against freezing and loss of material.

3.2.8 DEGRITTING AND DEGREASING TRAVELING BRIDGE

A. The bridge consists of a mobile SS316L girder in suitable section with walkway surface in SS grating, a couple of lateral trolleys in cold bent metal sheet suitably stiffened, a sand removal system, a couple of geared motors fitted on in correspondence of the bridge center line, suitable weirs, elements for collection and overflow of the oily and surface-active substances, electric control panel. The sand extraction system, which provides for the sediment suction is directly driven by the bridge and can be with air-lift or with submersible pump type.

B. Standard equipment comprises the air supply system with blowers, valves, piping, solenoid valve and accessories while.

C. The sand collection tank shall be equipped with diffusers for aeration, to facilitate the removal of the oily material and to carry out a pre-aeration of wastewater.

D. The bridge, during the going stroke of its alternate motion, collects and removes any oily floating material by means of a surface scraper, while during the return, sucks the sands collected on the channels bottom. The protection against overloads is guaranteed by the use of electronic load limiting devices.

3.2.9 BRIDGE AND PUMPS

The aerated grit chamber permits the flow to enter directly into a spiral flow rotational pattern, which is controlled by the airflow rate to submerged diffusers. The spiral rotation scours and washes the grit and then deposits the grit in a channel at the bottom of the tank. A grit pump, mounted to a discharge pipe just above the channel removes the grit and water as the traveling bridge moves down the channel. The grit is discharged into a transport trough on the side of the unit and into a grit classifier for washing and dewatering.

3.2.10 AERATION

The grease within the sewage will make contact with air bubbles that provides buoyancy. The divider wall between the grit and grease extend below the water level about 150 mm. The opening has a baffle system that permits the combiner air and grease to pass under the wall and float to the water surface. The floating grease is transported to one end of the channel air-skimming grease removal system. A small number of air lances, extending across the width of the grease channel, are spaced along the length of the channel. Nozzles mounted to each air lance direct the escaping air, which continuously transports grease to a removal screw at one end of the grease channel. Continuous removal of grease helps to eliminate build-up during peak flow events.

3.2.11 AIR MANIFOLD AND DIFUSERS

The grease and grit air supply system shall consist of a series of blower motor modules that are fitted or equipped with control valves, silencers, gauges, and other accessories. The blowers shall provide air that is piped through an air header and evenly distributed along the diffusers in the bottom of the grit aeration compartment. Automatic alternating blower controls with timers to improve life expectancy can be provided as an option.

3.2.12 FLOW CONTROL BAFFLES

System flow control baffle basin dividers promote tank roll in the grit collection section of the chamber while simultaneously producing a quiescent zone for fast and effective removal of grease and other floatables.

3.2.13 POWER SOURCE

Operating power to the bridge control panel shall be provided through use of heavy duty, self retracting cable reel that moves with the bridge.

3.2.14 ORGANICS RETURN PUMP

A. A vertically mounted pump shall be provided in the organics return chamber to induce a flow from the collecting tank through the cleaning channel and back into the collecting tank to return organic material back into the collecting tank.

B. The pump shall be of the propeller type and be driven by an electric motor through gearing or otherwise as may be appropriate.

3.2.15 SUBSIDARY OPERATIONAL PANEL

A. Operation panel shall be of the type that operates in open areas and shall be fixed on the travelling bridge. This panel contains an emergency ON/OFF switches for all equipment of the aerated grease grit removal channels. There should be an electric connection between this panel and the main control panel existing in the control building from which the equipment of the grit tank will be mainly operated.

B. All Cables connection works of the equipment of the unit, from the operation panels to the equipment, shall be executed within the works of the mechanical and electrical contractor.

C. Subsidiary operation panels and cables shall be in conformity with the electrical specification set forth in the chapter of electrical works of this contract.

3.2.16 MAINTENANCE AND OPERATION

All mechanical components shall be removable for service above the water level. Grit quality and particle size are determined by a simple adjustment of air supply. Grit settling is a continuous operation, but grit removal is intermittent, depending on the quantity of grit in the waste flow.

3.2.17 SAMPLING

Provide an online automatic sampling with the inlet works to record at least but not limited to BOD, TSS, PH and ALKALINITY.

3.2.18 FLOW MEASUREMENT AND CONTROLS

The contractor shall be responsible for supplying all necessary instruments required to monitor and control the performance of the inlet works (flow meters, pressure gauges…).

3.2.19 MANUFACTURERS

Products of the type indicated shall be manufactured by a well known grit and grease removal system manufacturer accepted by the Engineer.

3.3 EXECUTION

3.3.1 EQUIPMENT INSTALLATION

A. The equipment of the inlet work shall be installed in accordance with the manufacturer's drawings, written instructions and recommendations. The manufacturer shall provide adequate services as required for proper installation.

B. The manufacturer shall issue a certificate to the Engineer indicating that the system has been properly installed after an inspection and testing of the system.

3.3.2 MANUFACTURER'S REPRESENTATIVE

The equipment manufacturer shall furnish the services of a factory trained representative for a maximum of two trips and eight (8) - eight-hour days at the jobsite to inspect the installing contractor's equipment installation, supervise the initial operation of the equipment, instruct the plant operating personnel in proper operation and maintenance, and provide process assistance.

3.3.3 FIELD TRAINING

The manufacturer shall provide the services of a qualified representative to train contractor operation and maintenance personnel. Field training shall cover all of the items contained in the operation and maintenance.

1 GRIT CLASSIFIERS

3.4 GENERAL

3.4.1 WORK OF THIS SECTION

The WORK of this Section includes providing helical-screw type grit classifier and appurtenances as part of a combined grit separation, and classification unit including all structural frames, drive units, mounting brackets, piping transitions, controls, safety equipment, accessories, tools, and spare parts for a complete and operational system.

Two grit classifiers shall be provided, Each grit classifier shall treat 200 m3/h from the grit and grease removal channel.

3.4.2 QUALIFICATIONS

Manufacturer

Company specializing in grit classifiers with minimum one successfully performing installation of comparable size and complexity constructed in the recent past. Equipment of comparable size and complexity shall have the following characteristics:

3.5 PRODUCTS

3.5.1 EQUIPMENT REQUIREMENTS

A. Classifier Design

The classifier mechanism shall be of the helical screw type, designed to maintain necessary velocities to retain organic matter in suspension and remove the non-organic material of a size retained on a 150-mesh screen. The classifier shall be capable of removing substantially all 150-mesh grit having a specific gravity of 2.65 or greater from the underflow of the cyclone(s). Flushing water at 4-5.5 bars shall be provided to the grit classifier by means of a 1/2-inch pipe terminating in a manual isolation valve and rotameter. The helical-screw type classifier shall incorporate in its design arrangement for removal and replacement of the screw for periodic maintenance. The screw shall be equipped with easily-replaceable hardened wearing surfaces. Classifier shall have hydraulic capacity suitable for the underflow from two grit channel.

B. Drive Unit

The screw-drive unit shall be mounted on top of the screw trough. The unit shall consist of a totally-enclosed, ball-bearing, constant-speed heavy-duty motor with V-belt drive to a worm-gear type speed reducer with oil-tight housing. A belt guard shall be provided. The output shaft of the reducer shall be direct-connected to the upper end of the screw conveyor.

C. Materials

The equipment shall be fabricated with the following materials and parts:

1 Flared tank assembly -Steel, A151 1015 to 1020
2 Lower bearing assembly -Cast iron
3 Pivot beam and motor support -Steel
4 Spiral screw assembly -304 stainless steel
5 Lifting device -Steel
6 Separator support -Galvanized steel
7 Spray assembly -Steel
8 Spiral guards - Expanded metal
9 Wearing shoes -Ni-hard, ASTM A532 Brinell hardness 550 minimum

3.5.2 EQUIPMENT FEATURES

A. The settling tank shall be stainless steel 316 as a complete unit after fabrication. Minimum pool area at maximum water level shall be determined by the manufacturer.

B. The weir length shall be determined by the manufacture.

C. The screw shall operate at 10 rpm maximum.

D. Each grit dewatering unit shall be V-belt driven by a 3 HP, energy efficient, heavy duty type motor.

E. Lower bearing shall be housed in a watertight enclosure suitable for completely submerged operation in grit service. The bearing shall utilize a sealed bronze sleeve type bearing, running completely submerged in oil, and shall require only yearly inspection and oil change. Internal parts of the bearing shall be sealed from outside contamination by the use of floating stellite seals. Bearings shall have an L-10 rating life of 50,000 hours while operating at maximum load.

F. The screw assembly shall be provided with a manually operated lifting device attached to the lower bearing assembly and arranged so that the lower bearing can be raised above maximum water level.

G. The grit shall be removed from the bottom of the settling compartment and discharged by means of a 50 percent pitch helical screw conveyor. The helix shall be made up from preformed heavy steel flight sections with a minimum thickness of 3/16 inch welded to the shaft, fitted with wearing shoes. The wearing shoes shall be of 16mm minimum thickness, replaceable and shall be mounted on the flights by means of countersunk 316 stainless steel bolts and nuts.

H. At the upper end of the helical screw a minimum 10mm diameter connection shall be provided to ensure continuous flushing of one side of the unit. The connection shall be equipped with a shutoff valve.

I. Classifier slope shall not exceed 300mm per m.

J. An expanded metal guard shall be provided over the full length of the rotating screw.

3.5.3 NAMEPLATES, TOOLS, AND SPARE PARTS

A. Spare Parts

The WORK includes the following spare parts. Spare parts shall be stored in boxes, and identified with the equipment number by means of stainless steel or plastic name tags attached to the box.

- One set of drive bearings
- One set of oil seals and gaskets
- One set of screw bearing assemblies
- One upper gasket
- One drive belt
- One lock bushing
- One set of wearing shoes with 316 SS bolts and nuts

3.5.4 MANUFACTURERS

Products of the type indicated shall be manufactured by a well known grit classifier manufacturer accepted by the Engineer.

3.6 EXECUTION

3.6.1 GENERAL

Installation of the grit classifier equipment shall be in strict accordance with the requirements of the manufacturer's written instructions and shop drawings.

3.6.2 FIELD TESTING

Upon completion of the installation, each piece of equipment and each system shall be tested for proper performance and satisfactory operation without excessive noise, vibration, and overheating. All equipment must be adjusted and checked for misalignment, clearances, supports, and adherence to safety standards by the equipment manufacturer for no less than 3 days. Equipment manufacturer shall certify proper installation prior to startup.

4 AERATION TANKS

4.1 GENERAL

The extended aeration system of the treatment plant is designed to comprise ultimately a enough number of aeration tanks. Each tank Feed arrangement into each tank is via an inlet weir isolation gate and discharge controlled by an outlet weir gate arrangement.

4.2 CONSTRUCTION

The aeration tanks shall be made of a material resistant against wastewater, gas and chemical products. The air to aeration tank shall be provided by air blowers and fine bubble air diffusers.

The aeration system shall be complete with all required ancillaries and control equipment for each separate tank.

The automatic adjustable weir plate shall incorporate an electric actuator – operated drive shaft which transmits, via suitable gear units and cross shafts, vertical linear movement to the operating spindles.

Design parameters are based on typical values for Domestic Sewage Loads according to the European German Standards (ATV-DVWK-A131).

Drive to the weir shall be provided by an electric actuator suitable for the application. The actuator shall be connected to a meter gearbox with dual output shafts which then are coupled to the cross-shafts

The weir plate/gate shall be of fabricated 316 L stainless steel construction, and flanged at its extreme edge for rigidity. The outer edge shall be welded to the main tubular cross-member with sufficient plate stiffening ribs welded to both, over the weir plate length. The weir plate pivots about the main tube with the connecting spindle being located by a link bracket welded to the main tubular member. The weir plate shall be fitted with a stainless steel weir strip at its extreme edge. This weir plate shall have slotted holes permitting final adjustment on installation.

The fabricated weir plate shall be carried from the concrete aeration basin by means of stainless steel support rackets and bearing brackets. These shall be fitted with nylon bearing strips.

A flexible seal shall be provided for the full length of the weir. This shall be of rubber fixed with stainless steel clamping strips to the weir plate and to the sill of the concrete opening. End seals shall also be of rubber with clamping flats but having slotted holes to permit adjustment to the steel fixed to the wall of the aeration basin

4.3 INSTRUMEMNT & CONTROL

A. Dissolved Oxygen Analyzer/ Controller

An automatic dissolved oxygen analyzer/controller shall be installed at every aeration tank for direct, continuous indication over the range 0-20 ppm (mg/1) oxygen, with low and high alarm lights, with oxygen measuring probe & necessary cable.

The dissolved oxygen probes shall be suitable for wall mounting beside the weirs and shall be complete with folding chart recorders for mounting in the main control panel.

B. MLSS Analyzer/ Controller

An automatic MLSS analyzer/controller shall be installed at each train of aeration tank for direct, continuous indication over the range 0-5000 ppm (mg/1), with low and high alarm lights, with measuring probe & necessary cable.

C. ORP Analyzer/ Controller

An automatic ORP analyzer/controller shall be installed at each train of aeration tank for direct, continuous indication over the range (-200 to 1500) mV, with low and high alarm lights, with measuring probe & necessary cable.

D. pH Analyzer/ Controller

An automatic pH analyzer/controller shall be installed at each train of aeration tank for direct, continuous indication over the range (0 to 14), with low and high alarm lights, with measuring probe & necessary cable.

E. Logical Controller

A programmable logic controller shall be installed for the whole biological treatment including aeration tanks, clarifiers, selector tank, return and wasted sludge pumps as shown on the P&ID.
The controller shall automatically control the operation of the air blowers depending on the level of dissolved oxygen and control air blowers speed motor, and control the RAS pumps speed based on MLSS or SRT set values in aeration tanks.

For technical specifications of the controller, refer to Electrical specifications.

5 POSITIVE DISPLACEMENT AIR BLOWERS

5.1 WORK OF THIS SECTION

The WORK of this Section includes providing positive displacement blowers and all appurtenant work, complete and operable, with all necessary accessories, tools, drives, piping, fittings, valves, connectors, safety devices, controls, and spare parts to obtain a workable installation suitable for continuous operation 24 hours per day, as indicated.

5.2 AIR BLOWERS OPERATION

A. Twelve No. blowers (10 Duty + 2 Standby) shall be provided. The machines shall be located in the blower room near the aeration tanks as shown on the drawings.

B. Condition of Pressure & Discharge

The blower shall be capable of discharging 18000 m3/hr of free air at room temperature & press it against the normal working pressure of 0.9 Bar when running at its rated speed corresponding to the rated speed of its driving motor which shall not exceed 1500 R.P.M the blower shall be capable of working satisfactorily against all pressures between 0.4-0.9 Bar A tabulated statement shall be submitted by the contractor showing the guaranteed discharge of the blower against pressure ranging from 0.4-0.9 Bar & the corresponding load in B. H .P. on the driving together with the corresponding speed.

C. The air blowers shall be provided with VFD for Oxygen concentration control in aeration tanks. A pressure switch shall be supplied on the blower manifold to provide alarm annunciation at the control panel on loss of pressure.

D. The characteristics of the air blower packages shall be as shown below:

Arrangement	Horizontal Blower, top inlet, bottom outlet
Drive	V Belt with ventilated guard
Motor	TEFC foot mounted
Pressure	0.9 bars (to be verified by requirements of Aeration tank depth)
Control	Relief valve operated by pressure switch
Indication	
Inlet filter	Dry pleated type in reinforced synthetic bonded fabric.
Inlet silencer (combined w/filter)	Straight through absorption type
Discharge Silencer	Straight through absorption type w / high heat resisting fibrous acoustic packing.
Insulation hood	Acoustic enclosure for sound prevention not to exceed 73.0 DB
Manifolding	Flanged with rubber vibration damper.
Mounting	Mild steel mounting frame carrying blower, motor, filters silencers and all accessories.

E. Intake air shall be drawn from the blower room via fixed louvers mounted in exterior walls of the building.

System Equipments

Gas	:	Atmospheric air
Site Elevation from sea level (m)	:	600
Capacity (m3/hr)	:	18000
Differential Pressure (mbar)	:	900
Inlet Temperature (^oC)	:	40
Velocity / Speed (RPM)	:	TBD by Manufacturer
Motor IEC	:	180M type B3-TEFC-IP55- Isol. CI.F.
Power (KW)	:	450 (to be confirmed by Manufacturer)
Voltage (V)	:	380
Speed (RPM)	:	VFD
Frequency (Hz)	:	60

5.3 Blower Package Accessories

A Each blower set should be supplied as a complete factory assembled and tested unit and be complete with the following:

a. Blower set
b. Drive motor
c. Geared or belt drive system with guard
d. Anti-vibration mounting pads
e. Combined inlet filter/silencer
f. Safety relief valve
g. Check valve
h. Flexible rubber expansion connections
i. Discharge silencer (Inlet & outlet)
j. Common base plate
k. Acoustic enclosure (Insulation hood)

B. Blower Type

Positive displacement blowers shall be of rotary, 2-lobe or 3-lobe, in volute design suitable for continuous operation 24-hours per day, directly coupled to its driving motor through a flexible coupling or V belt drive.

C. Equipment Construction

Basic equipment construction and materials required shall be as follows:

Impellers - cast-iron, machined, permanently fastened to steel shaft, dynamically balanced.

Headplates - cast-iron, machined and ground internally to close tolerances.

Impeller case - cast-iron, machined, with heavy rib reinforcement.

Bearings - anti-friction bearings with thrust control, rated for a minimum L-10 life of 100,000 hours.

Timing gear - steel, accurately cut and bolted to timing hub.

Lubrication - oil splash lubrication from oil-tight housing. Drive-end bearings may be grease lubricated, with lip-type seals, or greased by a special pump directly driven from the motor.

Drive shaft - extended steel shaft for V-belt drive, or steel stub shaft with flexible coupling for direct drive.

Drive - V-belt or direct drive with steel safety guard.

The blowers shall have water cooling system with a large cooling surface so as to eliminate great proportion of the heat and never to let the final temperature of the air discharged rise beyond 70c. The cooling system shall be complete with all required equipment & fittings.

D. TOOLS, AND SPARE PARTS

. The WORK includes the following spare parts as a minimum:

1. 2 sets of all gaskets, washers, and O-rings
2. 2 sets of all seals
3. 2 sets of all blower and motor bearings
4. 2 sets of all [belts] [couplings]
5. 4 sets of all air filter elements
6. 1 set of all flexible connectors
7. 1 set of timing gears

E. INSTALLATION

All equipment shall be installed in accordance with the manufacturer's written instructions and approved procedures submitted with the shop drawings.

F. SERVICES OF MANUFACTURER

Inspection, Startup and Field Adjustment:

An authorized service representative shall visit the site to assist and witness the following:

1. Installation of the equipment.
2. Inspection, adjustment, startup and field testing.
3. Training of OWNER'S personnel.

G. PRODUCTS

AIR BLOWER PERFORMANCE

The Contractor shall guarantee that the air blowers installed shall deliver the required air flow/ oxygen transfer , at the prevailing site ambient conditions.

Upon installation of the air blower system, test shall be performed to verify the above results all to the satisfaction of the Engineer’s Representative.

6 FINE BUBBLE DIFFUSER SYSTEM

6.1 GENERAL

A fine bubble diffuser system for the aeration tanks shall be provided complete with all accessories, connections, supports and controls necessary for a workable system and shall conform to all applicable codes and standards. The fine bubble diffuser system shall be defined as starting from the main air header on top of the tanks, excluding the air header itself, through the individual diffusers.

The WORK also requires that one manufacturer be made responsible for the WORK of this Section including drop pipes, differential pressure measuring system, distribution pipes, bleed valves and pipes, diffusers, The manufacturer of the equipment to be supplied must have supplied at least one system of comparable size and complexity.

6.2 SHOP DRAWINGS AND SAMPLES

Prior to release for manufacture of equipment, the CONTRACTOR shall submit shop drawings of all equipment of fine bubble aeration. The submittal shall include the following:

1. A complete system description.
2. The number of complete diffuser assemblies.
3. A complete materials list and dimensions of all parts of the diffuser assemblies.
4. The number and size of the orifices in the flow control device.
5. The recommended minimum, design and maximum air flows per diffuser.
6. A curve showing head loss versus air flow rate for components of the diffuser assembly (orifice, diffuser disk, and complete diffuser assembly) over the full range of operation.
8. A complete materials list and details of the air distribution system including moisture blowoff piping, fittings, valves and pipe supports. Fabrication details shall be included.
9. A layout of the diffuser system including the baseplates, fittings, valves, pipe supports as well as the moisture blowoff piping.
10. The equipment manufacturer's recommendation including, installation procedures, level test, uniformity and leakage test, and oxygen transfer test.
11. Dimensional drawings showing the proposed method of compensation for thermal expansion and contraction in the aeration system.
12. A testing plan designed to ensure consistently good quality and uniformity of the diffuser assemblies, including a sampling plan. The plan shall specify the number of diffuser elements to be tested from each batch, quality control test procedures, and the credentials of the agency conducting the tests.
13. A curve showing the oxygen transfer efficiency of the proposed system at different air flow rates in the design range (efficiency versus air flow rate at proposed depth).
14. Information on at least one successfully performing installation of comparable size and complexity constructed in the recent past.

6.3 FACTORY TESTING

Diffusers shall be inspected and tested at the factory for the following test:

1. Permeability Tests: Diffusers shall have a design mean permeability rating of 14 scfm per 9 inch diffusers when used without flow control device, and shall be permeable over their active surface.

2. Uniformity Test: All diffusers selected for permeability testing shall be randomly sampled to ensure uniformity.

3. Strength Test: Diffusers sampled for permeability shall also be strength-tested as a part of quality control plan.

4. Dynamic Wet Pressure Test: All diffusers tested for uniformity shall also be tested for dynamic wet pressure in accordance with an approved testing procedure,

5. Defects: All diffuser elements shall be visually inspected for defects. Those with appreciable warping of surfaces or irregularity of corners, showing cracks, soft spots, chipping or other defects, or not free from adhering foreign material, dirt, oil or clogging material, shall be rejected and removed from the job site.

Witnesses: The OWNER and the CONSTRUCTION MANGER (at the option of either) reserve the right to witness factory testing.

6.4 PRODUCTS

The CONTRACTOR shall provide complete diffuser systems for the aeration basins as indicated. For all systems, there shall be provided all necessary drop pipes, header pipes, distribution pipes, supports, air diffusers, hold-downs and accessories.

A DROP PIPE AND MANIFOLD:Each drop pipe shall extend from the air main piping system at the top of the tank above the water surface to the submerged air manifold.

Expansion and Contraction**:** The submerged air manifold shall include an expansion-contraction system consisting of fixed supports, intermediate supports and expansion joints.

Welded Parts**:** All welded parts and assemblies including drop pipes, fabricated supports, flanged joints and expansion joints shall be fabricated from sheets and plates of Type 304L stainless steel conforming to AISI Type 304L and ASTM A 240.

All welding shall be completed in the factory. Field welding shall not be permitted. All welding shall be by the shielded arc, inert gas, MIG or TIG method**.**

B DISTRIBUTION SYSTEM: The distribution headers shall include header piping support stands, factory installed diffuser element holders, joints, expansion joints, drainage system and anchor bolts.

The distribution headers shall connect to the bottom centerline of the manifold at the special couplings provided for that purpose. The headers shall be fabricated in sections not to exceed 20 feet in length. Joints between sections shall be of the expansion joint type and shall permit rotation of each header section independently of adjacent header sections.

C. Supports: Each header section shall be held in place by one anchor support. Intermediate supports shall allow longitudinal and rotational movement of the header section

D. Air Distribution: Air shall enter the diffuser assembly from the distribution header through the orifice control . The orifice control shall be of a size to insure adequate air distribution throughout the system and the air release of the orifice shall be designed such that air entering the diffuser assembly shall be distributed under the surface of the diffuser element.

E. Pipe Material: Distribution headers, expansion joints, vertical purge system piping, diffuser holders and retainer rings shall be manufactured of UPVC with a minimum of 2 percent Ti02 added for ultraviolet protection. Headers shall be nominal four inch diameter Schedule 40 UPVC Type 1120 pipe and shall conform to ASTM D 1785. Expansion joints, diffuser holders, and retaining rings shall have a minimum wall thickness of 0.125 inches.

F. Diffuser Gaskets: Diffuser element gaskets shall be poly-isoprene or neoprene and shall meet the requirements of ASTM D 1869 except that elongation shall be 500 percent minimum. Water absorption shall be 5 percent maximum

G Diffuser Elements [EPDM]

Diffuser assemblies shall consist of a nominal 9-inch diameter, EPDM membrane diffuser with integral O-ring, a PVC retainer ring and a diffuser support piece. Diffusers shall be composed of EPDM elastomer and shall be resistant to attack by common municipal wastewater. EPDM material shall meet the requirements of ASTM D 573.

Diffusers shall be free of voids, tears, bubbles, or other structural defects.

Diffusers shall have a uniform distribution of air release across the entire surface area of the diffuser except for the center one inch diameter which shall not be perforated. The non-perforated center of the diffuser shall provide the necessary sealing capabilities and back flow prevention when air supply to the diffuser is interrupted.

Diffuser shall be disc-shaped with a 9-inch diameter and an integral O-ring seal molded into the diffuser assembly. The diffuser cross-section shall be thickened at the center as noted above and at the periphery near the O-ring to resist stretching.

Diffuser material shall have a durometer of 55 ± 5 Shore A, with a minimum tensile strength of 1375 psi, and a minimum elongation of 500 percent at break point.

The diffuser shall be perforated with uniform slits of a shape and size to prevent tearing or lengthening of the slits during operation.

The diffuser shall exhibit uniform distribution of air across the entire surface area when submerged and operating at 1.0 cfm per diffuser.

The retainer ring shall be made of PVC with a minimum of 1 -12% TiO2 added for ultraviolet protection**.**

The diffuser baseplates shall be factory solvent welded to the PVC diffuser lateral and shall be manufactured of PVC with 1.50% TiO2 added for ultra-violet protection. The welding contact area between the baseplate and the distribution lateral shall be a minimum of 24 square inches to provide a structurally sound connection.

H DIFFUSER ELEMENTS [CERAMIC]

Ceramic diffuser elements can be proposed as alternative to EPDM diffuser,

I. TOOLS AND SPARE PARTS

Tools: The CONTRACTOR shall supply one complete set of special wrenches or other special tools necessary for the assembly, adjustment and dismantling of the equipment. All tools shall be furnished in labeled tool boxes of suitable design.

Spare Parts: The CONTRACTOR shall provide the necessary quantity of spares (gaskets, O-rings, diffuser elements and retainer rings.) as recommended by the manufacturer.

J INSTALLATION AND CHECKOUT

The fine bubble aeration diffusion system shall be installed in accordance with approved procedures submitted with the shop drawings and as indicated, unless otherwise approved.

Inverts: The invert elevation of the submerged air manifold shall be the same throughout the tank. Changes in diameter shall be accomplished with eccentric reducers. Each end of the submerged air manifold shall have a flanged welded end cap.

Leveling: The entire system shall be designed, manufactured, and installed in such a manner that all the diffuser elements are within ±0.125-inch of a common horizontal plane. Air distribution shall be uniform throughout the entire system and shall be uniform over the entire horizontal projected surface of each diffuser element.

Pipe Connections: Connections between sections of the submerged manifold shall be flanged joints or Type 304 stainless steel band couplings. These joints shall be installed such that individual manifold sections can be rotated independently of adjacent manifold sections for alignment purposes

K FIELD TESTS

The CONTRACTOR and CONSTRUCTION MANAGER shall agree upon the actual time the tests are to be performed. The CONTRACTOR shall furnish all labor, equipment, and materials required to perform the tests.

Level Test: Each aeration tank shall be flooded with potable water to the tops of the ceramic dome diffusers. The level of the domes shall then be checked to insure that they are at the same elevation within [±0.125-inch].

Uniformity and Leakage Tests: Each aeration tank shall be flooded with potable water to a depth of approximately one foot above the tops of the ceramic dome diffusers. Process air shall be supplied evenly to all headers in each tank. The surface of the water above the diffusers shall then be visually inspected for leaks and to ensure that air flow is uniformly distributed across the tank.

Clean Water Oxygen Transfer Test: The CONTRACTOR shall arrange to run this test through an independent testing laboratory approved by the CONSTRUCTION MANAGER.

L DIFFUSER SYSTEM EVALUATION

The CONTRACTOR shall provide a lump sum bid price to install all of the following alternate aeration systems specified as Bid Alternatives A, and B, . To be responsive, bid price for all alternate aeration systems shall be provided.

1. Ceramic Disk Diffusers
2. EPDM Disk Diffusers

The CONTRACTOR can therefore adjust the blower sizes accordingly, although the number of blowers and capacity, and size of piping from the blowers to the aeration tanks shall be adjusted. This information shall be supplied with the bid.

6.5 EXECUTION

6.5.1 INSTALLATION

General

The aeration system components shall be installed at the locations indicated in accordance with the manufacturer's written instructions.

6.5.2 FIELD TESTING

Field testing shall be performed as follows: The aeration unit(s) shall be tested in place to assure conformance with performance requirements. Equipment supplier shall certify proper installation prior to startup. During the commissioning of the equipment, the equipment manufacturer shall test the equipment to verify that the velocity requirements have been met. Average velocity shall be determined from an arithmetic average 16 points in a cross section of the channel. These points shall be gathered at four (4) equally spaced points across the width of the tank and four (4) equally spaced points from the liquid level to the tank bottom. Average of all values at the full power condition shall not be less than 0.3 m/s. The contractor shall construct a bridge spanning the middle of the oxidation ditch to allow a suitable platform for testing shall be done

7 SUBMERSIBLE MIXERS

7.1 GENERAL

7.1.1 WORK OF THIS SECTION

A. The WORK of this Section includes providing submersible mixers with electric motors and appurtenances.
B. The WORK also includes coordination of design, assembly, testing, and installation.

7.1.2 FACTORY TESTING

A. Mixers shall be witness tested at the factory to:

1 Verify that blade, motor rating, and electrical connections comply with this Section.
2 Measure for moisture content and insulation defects in motor and cable, both before and after the submergence test below.
3 Run mixer dry to verify proper rotation and alignment.
4 Run mixer submerged at least 30 minutes under at least 1.8 meters of water to check for balance, unusual noise, and overheating. Verify proper pumping capacity.
5 Test motor for no-load current at rated voltage, high potential, and locked rotor current.

B. A factory test report shall accompany the mixers in shipment.

7.1.3 FIELD TESTING

A. A functional wet test shall be conducted at plant startup. Verify operation without excessive noise, vibration, cavitation, or overheating. Document motor voltage and current draw.

7.2 PRODUCTS

7.2.1 SUBMERSIBLE MIXER

A. Service Conditions

1 Liquid Mixed: [Influent Water + Returned Activated Sludge]
2 Design Liquid Suspended Solids Concentration (mg/l.): 3600 [Design Liquid Suspended Solids Concentration Range (mg/l): [1000 to 10000]
3 Mixing Cycle: -continuous
4 Maximum Liquid Depth (m): 7

B. Performance Requirements

1 The location, number and capacity of mixers shall be advised by the contractor/ manufacturer to achieve a horizontal velocity in aeration tank not less than 0.3 m/s at any point of aeration tank channel

Mixer Type

Each mixer shall be submersible with two blade propeller and reduction gear. The mixer is intended for mixing liquid and sludge containing fibers and solids where very high flow capacity in relation to consumed power is wanted. The mixer shall be designed to operate completely immersed in the liquid.

1 Submergence

All components of the mixer, including motor, shall be capable of continuous underwater operation in both of the following conditions: (1) mixer blade completely submerged, and (2) mixer blade partly submerged in an unbalanced hydraulic loading condition. In addition, all components of the mixer, including motor, shall be capable of continuous operation in air, completely unsubmerged, for 2 hours minimum.

C. Materials

Mixer components in contact with the liquid shall be of Type 316 stainless steel with smooth surfaces devoid of blow holes and other irregularities. All exposed nuts, bolts, fasteners, and hardware shall be of Type 316 stainless steel.

D. Mating Surface Seals

All mating surfaces where watertight sealing is required shall be machined and be fitted with a double set of nitrile rubber or Viton O-rings. No other sealing mechanism will be accepted.

E. Propeller

The propeller hub shall be made of cast iron and the blades of polyurethane.

F. Gear Box

The gear box shall be designed for over 100,000 hours operation, according to relevant ISO and AGMA standards.

7.2.2 COMPACT SUBMERSIBLE MIXER

A. Service Conditions

1	Liquid Mixed: [Influent Water + Returned Activated Sludge]	
2	Design Liquid Suspended Solids Concentration (mg/l.): 3600	
3	Design Liquid Suspended Solids Concentration Range (mg/l.):	[1000to10000]
4	Mixing Cycle: -continuous	
5	Maximum Liquid Depth (m): 6.5	[5]

B. Performance Requirements

C. The location and capacity of mixers shall be confirmed by the contractor / manufacturer to achieve complete mixing of the selector tanks

D. Mixer Type

Each mixer shall be submersible with the motor closed-coupled, directly connected to the propeller. Gear box designs shall not be accepted. The propeller shall be capable of handling solids, fibrous materials, heavy sludge, and other matter found in sanitary sewage applications.

Submergence

All components of the mixer, including motor, shall be capable of continuous underwater operation in both of the following conditions: (1) mixer blade completely submerged, and (2) mixer blade partly submerged in an unbalanced hydraulic loading condition. In addition, all components of the mixer, including motor, shall be capable of continuous operation in air, completely unsubmerged, for 2 hours minimum.

E. Materials

Mixer components in contact with the liquid shall be of Type 316 stainless steel with smooth surfaces devoid of blow holes and other irregularities. All exposed nuts, bolts, fasteners, and hardware shall be of Type 316 stainless steel.

F. Mating Surface Seals

All mating surfaces where watertight sealing is required shall be machined and be fitted with a double set of nitrile rubber or Viton O-rings. No other sealing mechanism will be accepted.

G. Propeller

The propeller shall be of Type 316 stainless steel, dynamically balanced, non-clogging backward curved design. The propeller shall have three vanes and be of the diameter and of the blade angle, in degrees, as indicated. Each blade shall be laser cut and welded to the hub to ensure that the propeller is properly balanced. The propeller shall be secured to the shaft by friction clutch which shall act to prevent damage to the propeller or shaft in the event an object becomes jammed in the propeller. The shaft shall be Type 420 stainless steel.

H. Bearings

The shaft shall rotate on three permantly lubricated bearing. The outboard, propeller end, bearing shall be an angular contact bearing. The inboard, motor en, bearings, shall be an angular contact to take up the acial loads and radial bearing to tke up the radial loads. The bearings shall be pre-loaded by a bearing loading nut located on the motor end of the shaft in order to reduce shaft deflection and increase bearing and seal life. Mixers without pre-loaded bearing shall not be accepted. All bearings shall have a minimum L-10 rated life of 100,000 hours.

I. Shaft Seals

Appropriate shaft seals shall be provided.

J. Shroud

Each mixer assembly shall be provided with a Type 316 stainless steel shroud a full 360 degrees around the propeller. A maximum clearance of 4cm shall be maintained between the propeller tip and the shroud.

7.2.3 MOTOR

A. General

The motor shall be directly connected to the propeller. The motor shall be a squirrel cage, induction with thermal overload protection. The motor shall be designed for continuous duty, capable of sustaining a maximum of at least ten evenly spaced starts per hour. The motor shall be suitable for service in a Class 1, Division 2 environment and bear UL approval. The stator winding shall be insulated with moisture resistant Class H insulation which will resist a temperature of 180 ^{o}C.

B. Cable

Provide pump cable of sufficient length to connect to terminal junction box where indicated. Pump cable shall be sized according to the NEC and ICEA Standards, suitable for submersible service. The cable shall be rated for 600-volt and 90 degrees C with a 40 degrees C ambient temperature and shall be FM approved.

C. Cable Entry

Cable entry seal design shall provide a watertight submersible seal.

1 Housing

The cable entry housing shall be an integral part of the back plate. The cable entry shall have a double set of elastomer grommets in order to ensure a redundant system in the event of a cable entry failure. Single sealing systems shall not be accepted. The cable entry shall be comprised of two cylindrical elastomer grommets, each flanked by washers and a ferrule designed with a close tolerance fit against the cable outside diameter and the entry inside diameter. The assembly shall bear against a shoulder in the stator casing opening and be compressed by a gland nut threaded into it. Interaction between the gland nut and the ferrule should move the grommet along the cable axially instead of with a rotary motion. The junction chamber and motor compartment shall be separated by a terminal board which shall protect the motor interior from foreign material gaining access into the mixer top. Connection between the cable conductors and the stator leads shall be made with threaded, leak-proof compressed type binding posts, permanently affixed to the sealed terminal board.

D. Protection

Provide each motor with an over temperature and moisture protection system meeting the requirements below:

1 Provide each motor with integral resistive thermal sensitive solid-state sensors, one in each phase, and with a leakage sensor in the motor housing to detect water and/or oil intrusion.
2 Control conductors for the sensors shall be integral with the motor power cable.
3 Sensors shall be wired to a control and status relay unit.

7.2.4 MOUNTING ASSEMBLY

A. Each mixer shall be equipped with a mounting assembly and vertical support mast designed to secure the mixer while in operation. The vertical support mast shall be supported from the basin floor, the basin walkway, channel floor and channel walkway as appropriate, and at 3 meter vertical intervals along the basin wall.

B. All components of the mounting assembly including mixer mounting base plate, vertical support mast, sliding bracket, and fastening hardware shall be Type 316 stainless steel.

C. The vertical support mast section shall be a minimum of 4-inch by 4-inch by 3/16 inch. The assembly shall permit horizontal and vertical changing of the mixer axis. The assembly shall be designed and constructed to securely support the mixer, including providing adequate thrust resistance under all mixer operating conditions, including both submerged and unsubmerged operation and over the full range of mixer axis positions. The mast shall be

provided with a cable holder that prevents the electric cable from being entangled with the mixer propeller during operation. The mast shall be constructed with a position locking plate to work in conjunction with a lock pin in the upper guide holder to positively lock the mast in place at all operating positions.

7.2.5 POWER ASSISTED CRANE

Each mounting assembly shall be provided with an appropriate power crane.

7.2.6 ACCESSORIES

A. Lifting Cable

Appropriate lifting cable to lift the mixer shall be provided. The top of the cable shall end in an eye of sufficient strength to develop the strength of the cable. Provide a hook to secure the cable at the top of the mast.

B. Lifting Lugs

Equipment weighing over 40 kilograms shall be provided with lifting lugs.

C. Anchors

Appropriate anchors shall be provided. The mixer manufacturer shall determine the proper location for anchors.

7.2.7 TOOLS AND SPARE PARTS

A. Spare Parts

The WORK includes the following spare parts for each mixer:

1 One set motor shaft bearings.
2 One set seals, gaskets, and O-rings.
3 One set special tools (if required).

7.3 EXECUTION

7.3.1 INSTALLATION

Mixers shall be installed in strict accordance with manufacturer's recommendations and the installation shall be certified by the manufacturer as proper before testing.

8 CIRCULAR, CENTER FEED CLARIFIERS

8.1 GENERAL

A. Clarifiers shall be concrete circular settling tanks, used for separating the solid matters from the aerated sewage by allowing it to settle down and to be scraped to a collecting hopper. The clarified sewage effluent overflows above the peripheral weir towards the clarified water distribution chamber going to the filtration system/building.

B. The relevant tender drawings of this contract show the general arrangement of the required clarifiers.

8.2 PRODUCT

8.2.1 DESIGN CRITERIA

A. According to ATV A131, the final settling tank (FST) will be designed as a horizontal flow tanks where the ratio of the distance from inlet aperture to the water surface (vertical, hin) to the horizontal distance from the inlet to the outlet at the height of the water level (horizontal) is smaller than 1:3.

B. FST Specific hydraulic sludge loads must be evaluated to ensure good operation conditions for the FST.

Sludge.Volume.Index(SVI)	120	ml/l
t_{TH}	2	h

C. In order to keep the concentration of suspended solids concentration in the effluent of horizontal flow secondary settling tank below 20 mg/l, the sludge volume loading rate shall not exceed the following:

Sludge Volume Loading (qsv) =	500.00	$l/m^2.hr$
Surface Overflow Rate "Specific Hydraulic Load" (qa) = qsv / SV For Horizontal Flow FST <	1.60	m/hr
Supernatant Return (Filter backwash + Sludge dewatering)	13000	m^3/day
Plant incoming flow @ Average	200,000	m^3/day
Plant incoming flow @ peak	300,000	m^3/day
Clarifier Water Flow @ Average = Qaverage + Qsupernatant =	14,600	m^3/h
Clarifier Water Flow @ Peak = Qpeak +	21,875	m^3/h
Total No. Of Main Streams	2	No.
No. Of FST Per Main Stream	3	No.
Total No. of FST	6	No.
Horizontal Flow FST Diameter	48	m
Depth of FST at 2/3	4.5	m
Total Depth of FST	8.2	m

8.2.2 SCRAPER EQUIPMENT

A. The design of the scrapers shall be such that the sludge is removed from the floor of the tanks by means of scraper blades. Each scraper shall comprise essentially but not exclusively of the following items:

- Rotating full type scraper bridge complete with end carriages
- Feed pipe with terminating bell-mouth and supporting steelwork for pipe work
- Tripod support for scraper bridge and diffusion drum
- Rotating scum scraper, automatic scum draw off mechanism and scum boards
- Floor scraping blades
- Current collector and associated equipment
- V-notch weir plates

B. Each scraper shall be provided with a full tank diameter rotating bridge complete with central support and bearing assembly and peripheral wheeled drive units. Both halves of the bridge shall be fitted with echelon formation sludge scrapers to sweep settled sludge to the central floor hopper. Scum removal blades shall be provided to direct the floating scum towards the scum draw-off point.

C. A peripheral notched adjustable weir on the concrete effluent channel shall be provided with a separate scum plate together with supporting brackets for wall fixing. A central cylindrical diffuser / baffle mounted on and including a central bridge supporting assembly shall also be provided.

D. The material of weirs, scum plates and central baffle shall be fiberglass reinforced plastic.

E. The bridge shall be a double arm lattice section unit constructed of aluminum alloy sections spanning the full diameter of the tank, rotating on the central support assembly and bearing at each end on the concrete wall coping.

F. Both arms of the unit shall carry a walkway for access to the center assembly, the walkway shall be 800 mm wide and designed for a minimum loading of 390 kg/m2 in addition to the dead loads.

G. The bridge arms shall have two top and bottom booms, side bracings (vertical and diagonals) and bottom bracings with outriggers.

H. The walkway shall be open aluminum flooring, and a kicking strip shall be provided on each side of the bridge. The bridge shall be designed to withstand all structural and mechanical stresses based on the dead loads imposed by the various items of equipment mounted on or to the bridge, the operation of the tank mechanism and the superimposed load. The maximum deflection under this combination of maximum loads shall be less than 1/200th of the span.

I. The bridge drive arrangement shall comprise an outer box end assembly carried from the underside and at both ends of the rotating bridge. Each end assembly shall be substantially fabricated with 2 polyurethane tyred wheels each having cartridge type bearing to facilitate easy removal.

J. On each box end one wheel shall be driven by a torque arm triple reduction gear unit that is belt driven by suitable water and dust proofed electric motor electrically interlocked to give an automatic operation of the other motor with an alarm / fault signal at the main control room, incase of fault condition. The capacity of each motor shall be enough for easy and smooth driving of the bridge with its all expected static & dynamic loads. A suitable overload release mechanism shall be included. Driving and trailing wheels shall be carried on steel shafts. The tank drives, when operating under normal conditions shall have a standard peripheral speed of not more than 1.2 meters per minute so as not to disturb any settled particles.

K. The center bearing and electrical pick-up assembly shall comprise a mild steel fabrication, securely bolted to the top of a substantial steelwork central support assembly. Mounted on the top of this shall be a bearing designed to accept all loads and prevent any torsional moments or unbalanced forces due to undulations in the end carriage tracks from being transmitted to the center column.

L. The bearings shall be fully weatherproof, fitted with grease pipes to enable greasing to be carried out from the bridge and all bearings shall be designed for continuous operation at maximum load ratings.

M. The electric power supply cable shall rise from its conduit below the tank floor to the electrical pick-up unit or current collector which shall be a brush slip ring unit, containing 8 slip rings, each slip ring having at least two contact brushes which shall comply with B. S. 96. The slip ring assembly shall be totally enclosed and weatherproof. The starters shall be adjacent to the tank with emergency stop switch on each scraper bridge and indicator lights on the main control panel. The manufacturer shall provide electric wiring of equipment on the rotating bridge.

N. Stainless Steel frameworks, below which the scraper blades are to be arranged in echelon formation, shall be suspended from the edge of each half bridge.

O. Each blade shall be fabricated from stainless steel plate with renewable heavy duty synthetic rubber wearing edge projecting below the steel scraper blade. The scraper support arms shall be fabricated from stainless steel tubes, having sealed ends, the tubes being fixed with clamps to the bridge and to each other, to form a rigid structure.

P. A stainless steel scum sweep skimming blade shall be supported from below both the half bridge structures, the scum blade being made from stainless steel plate, and arranged to have an immersion depth to be specified by the Contractor. Scum shall be swept off the liquid face from the center diffuser drum to the peripheral scum baffle plate, then collected and discharged through stainless steel fabricated trough.The necessary pipe-work and fittings shall be provided to take the scum into the collecting scum chamber.

Q. Weir plates shall have elongated fixing holes to allow vertical plate adjustment. Weir plates shall have 90^{o} V notches set at a standard pitch, the depth of the V notch being specified by the Contractor.

R. The weir plate shall be fixed to the effluent channel with stainless steel bolts and the interface between the plates and the channel walls shall be sealed with a suitable sealing arrangement.

S. The scum baffles shall project into the liquid. The scum baffle shall be secured by stainless steel brackets cantilevered from the weir wall by self drilling anchors.

T. The central diffuser shall be fabricated from FRP and be held in position by the central support assembly. The diffuser shall have a hinged opening door at water level with easy access from the bridge for scum removal.

8.3 SCUM COLLECTION SYSTEM

Each FST shall be provided with trough and scum screw to deliver the collected scum to outside scum sump from where a submersible pump shall deliver the scum to sludge holding tank.

8.4 WALL CLEANING

The Contractor shall supply together with the rotating bridge, an automatic scraping or brushing equipment in order to avoid problems of clinging sludge and growth of algae on the effluent channel and weir walls. The equipment supplied must be easily operated and accessible from bridge for cleaning and assembly purposes.

8.5 PIPING SYSTEM

A. The feed pipe to the clarifier shall be made of Ductile Iron. It shall include the necessary duck-foot bend inside the sludge hopper, and it shall end with bell-mouth piece inside the inlet baffle.

B. Outlet pipe shall be also made of Ductile Iron.

C. Desludging pipe shall be made of Ductile Iron and it shall extend from the sludge collecting hopper of the clarifier up to the sludge collecting chamber at the outer periphery of the tank.

8.6 TELESCOPIC VALVE

A. A telescopic valve shall be used for controlling the sludge discharge from the clarifier and shall be operated by remotely and locally actuated electric motor, as well as the possibility for manual operation.

B. Valve Assembly

The telescoping valve assembly shall be of the rack and pinion type, of the size and travel range indicated. Assemblies shall consist of an offset handwheel pedestal with handwheel operator, a rising stem, slip tube with flat weir crest skimming funnels, a tube guide collar with companion flange and gasket and a mounting bracket.

C. Construction

- Slip Tube: The slip tube and skimming funnel shall be of Type 316, Schedule 40 stainless steel, with a seal to prevent leakage at the seam.
- Stem: The stem shall be minimum 20 mm brass or Type 316 stainless steel, with a travel and height indicating device calibrated in 10 mm increments. A suitable stem lock shall be provided for holding the stem at the desired level.
- Guide Collar: Guide collar shall include a neoprene gasket and cast iron companion flange for securing to the receiving pipe as indicated.
- Mounting Bracket: A cast iron bracket shall be provided for mounting the operator pedestal with stainless steel anchor bolts.
- Fastening Hardware: All nuts and bolts and other fastening hardware shall be Type 316 stainless steel.

D. Automatic Valve Travel Control

The valve travel shall be controlled by electrically actuated motor. The actuator in turn shall receive an analog signal from the sludge blanket sensor to control the output speed of the motor.

8.7 SLUDGE BLANKET SENSOR

A. The system shall consist of three components: analyzer, transceiver, and transducer. The system shall operate on the principle of reflected ultrasonic sound distance determination. The system shall not require the transducer to come in contact with the interface. The system shall be capable of monitoring interfaces continuously with a resolution of 30 mm. The system shall have "dead zones" that are programmable by the operator.

B. The analyzer shall operate from either 115 or 230 VAC. The monitor shall operate at temperatures from -10° to 50° C. Analyzer The analyzer shall be housed in a NEMA 4X lockable enclosure with brackets for standard round handrail mounting. The analyzer shall be fully microprocessor controlled. It shall have two displays, one showing the numerical value of the sludge blanket interface, and a second showing the profile of the relative density changes occurring within the tank. These displays shall both be visible from the front of the instrument without opening the enclosure. The analyzer shall not require any external switches, contacts or inputs of any kind to determine the interface location or to reposition the transducer for any reason.

The analyzer shall have the following outputs:

- 4-20 mA isolated which can be scaled to any range.
- One internal diagnostic alarm panel indicator.
- The analyzer shall have at least the following "test" capabilities:
- Lamp test of all digits and indicators.
- Constant current output for 4 and 20 milliamps.

The analyzer shall have at least the following "program" capabilities:

- Format the display as the interface depth from bottom up in meters.
- Program the time for averaging the signals in minutes. This is to give greater definition and avoid any process variations caused by rakes, skimmers, or other such devices.
- Be capable of scaling both the 4 and 20 milliamp output to any numbers within the range of the instrument, at a resolution of 30 mm.

The analyzer shall be capable of being set to understand the actual tank bottom.

The analyzer shall have built-in self-diagnostic functions and actuate an alarm indicator under any of the following conditions:

- No tank depth has been entered.
- The analyzer cannot find an interface.
- The analyzer is not receiving a signal, indicating a transducer, or transceiver failure.
- The analyzer has detected a failure in its circuitry.

C. Transceiver

The transceiver shall be located within 150 m of the analyzer and within 8 m of the transducer. It shall be housed in a weatherproof enclosure. It shall provide the required signal generation for the analyzer.

D. Transducer

The transducer shall be waterproof and include suitable cable for connection to the transceiver. It shall be mounted on a %" pipe supplied by installing contractor. It shall be supplied with a pivoting bracket so that the entire unit can pivot out of the way of the rotating skimmer. The transducer shall be of a dual headed design; one head for transmitting an ultrasonic signal, the other for receiving the signal.

8.8 EXECUTION

8.8.1 EQUIPMENT INSTALLATION

A. The clarifiers shall be installed in accordance with the manufacturer's drawings, written instructions and recommendations. The manufacturer shall provide adequate services as required for proper installation.

B. The manufacturer shall issue a certificate to the Engineer indicating that the system has been properly installed after an inspection and testing of the system.

8.8.2 MANUFACTURER'S REPRESENTATIVE

A. The manufacturer shall provide the services of a qualified field representative to perform field services including commissioning and instruction of the Owner's personnel in the operation and maintenance of equipment furnished.

B. Field Training

The manufacturer shall provide the services of a qualified representative to train operation and maintenance personnel. Training shall be provided for a total of one person day after commissioning of the system. Field training shall cover all of the items contained in the operation and maintenance manual.

8.8.3 FIELD TESTING

A. Torque Tests

The entire sludge collector mechanism shall be statically load tested by individually loading each rake arm with 150 percent of the specified design running torque. The test shall verify the torque overload control device settings for alarm and motor cutout. Each arm shall be individually anchored and the load measured to demonstrate the rake arms', cage's, and drive unit*s ability to withstand the specified torque. Sketches and calculations shall be submitted illustrating how the torque will be applied prior to the test taking place.

B. Operation Tests

The mechanism shall be operated in a dry tank for a minimum of 4 continuous hours before flow is allowed to enter the system. There shall be no binding, jerky, or unusual motion exhibited during this run in period. Motor amperage shall be checked at least hourly for any unusual or higher than normal figures. After the unit has successfully passed this initial test, flow shall be introduced into the tank and the same 4 hour observation test run. If the unit should fail under any of these conditions, the test shall be halted and the problem corrected. If, after several attempts, the unit does not successfully pass the field test, the faulty portion of the equipment shall be repaired or replaced and the test re-run.

9 SLUDGE HOLDING TANKS

9.1 GENERAL

The WORK of this Section includes providing sludge holding tanks and all appurtenant work, complete and operable, with all necessary accessories, tools, drives, piping, fittings, valves, connectors, safety devices, controls, and spare parts to obtain a workable installation suitable for continuous operation 24 hours per day, as indicated.

a. CONSTRUCTION

A. Sludge holding tanks shall be concrete circular tanks, used for storing the activated sludge., the tanks shall be provided with aeration system for mixing and keeping the sludge under oxic condition .

B. Two Sludge holding tanks shall be provided with supernatant system to return the supernatant water to activated sludge return pump stations.

C. A fixed half bridge spanning between the outer walls of the tank the center column shall be provided for access to the air distribution drop pipes. The bridge shall be with a walkway, handrails and toe plates. The bridge arms shall be supported on the central concrete column

D. The relevant tender drawings of this contract show the general arrangement of the required Sludge thickener.

1.2 AIR BLOWERS OPERATION

A. Three No. blowers (10 Duty + 2 Standby) shall be provided. The machines shall be located in the blower room near the sludge holding tanks as shown on the drawings.

B. Condition of Pressure & Discharge

The blower shall be capable of discharging 3900 m3/hr of free air at room temperature & press it against the normal working pressure of 0.7 Bar when running at its rated speed corresponding to the rated speed of its driving motor which shall not exceed 1500 R.P.M the blower shall be capable of working satisfactorily against all pressures between 0.4-0.9 Bar A tabulated statement shall be submitted by the contractor showing the guaranteed discharge of the blower against pressure ranging from 0.4-0.9 Bar & the corresponding load in B. H .P. on the driving together with the corresponding speed.

C. The air blowers shall be provided with VFD for Oxygen concentration control and mixing requirement in sludge tanks. A pressure switch shall be supplied on the blower manifold to provide alarm annunciation at the control panel on loss of pressure.

E. The characteristics of the air blower packages shall be as specified for aeration tanks air blowers.

F. The specification of air distribution system shall be as specified for the aeration tanks, contractror can suggest to use coarse bubble diffusers as alternative to fine bubble diffusers. The CONTRACTOR can therefore adjust the blower sizes accordingly, although the number of blowers and capacity, and size of piping from the blowers to the aeration tanks shall be adjusted. This information shall be supplied with the bid.

9.2 HYDROGEN SULFIDE MONITORING SYSTEM

A. General

The CONTRACTOR shall supply and install a hydrogen sulfide (H_2S) monitoring system consisting of H_2S monitors, ambient air H_2S monitors and associated piping, conduit, wiring and appurtenances.

B. System Responsibility

The CONTRACTOR shall assign to one manufacturer full responsibility for the entire H_2S monitoring system to provide all equipment indicated in this Section and factory representative services as indicated below.

C. H_2S Sensors

Five H_2S sensors shall be provided. One sensor shall be provided on each sludge holding tank, and one sensor shall be provided on each activated sludge return pump station and drainage pump station. In addition, ambient air H_2S sensors shall be mounted in the following locations: Dewatering Building. The ambient H_2S sensors shall be mounted between 2 and 2.70 meters above the floor. The sensors shall be solid-state, semi-conductor diffusion/adsorption type units. The CONTRACTOR shall furnish and install conduit and wire to the ambient H_2S sensors.

D. The sensors shall sense from 0 to 10 ppm in less than 10 seconds with 50 ppm H_2S applied. The sensors shall be 100 percent clear in less than 3 minutes. The sensors shall detect from 0 to 100 ppm of H_2S and shall exhibit no loss of sensitivity of response time due to lack of exposure or prolonged exposure to H_2S. The operating temperature range of the sensors shall be -35 ^oC to +65 ^oC.

E. The sensors shall be guaranteed to operate as specified for a period of one year after successful startup of the H_2S monitoring system.

F. H_2S Monitors

H_2S monitors shall be provided and installed in each odor control system local control panel. Each monitor shall have 2 channels for continuous readout of system influent and exhaust H_2S concentration in ppm. H_2S signals from each odor control facility and the ambient H_2S monitors shall be sent to the main control board for indication.

G. Each monitor shall indicate H_2S concentration in a range of 0 to 100 ppm. Monitors shall be equipped with channel selector switch with channel scan mode, for monitors with two or more channels, high and low level alarms and reset buttons for each channel, and malfunction alarms and reset buttons for each channel. The H_2S monitors shall have automatic calibration with no zero or pot adjustments.

H. The H_2S equipment supplier shall furnish all cable required between the H_2S sensors and H_2S monitors and the H_2S monitors and the odor control LCPs. The cable shall be installed by the CONTRACTOR.

I. Signals from H_2S sensor shall be sent to the local control board for indication and SCADA. The CONTRACTOR shall provide necessary transmitters, relays, contacts, etc., to allow for signals to be sent to these locations. All control signals shall be 4-20 mA.

J. H_2S Calibrator

The CONTRACTOR shall supply one portable H_2S calibrator for calibration of the H_2S monitors. The calibrator shall have an output range of 20 to 100 ppm and shall be equipped with a 12-volt dc rechargeable battery. An electrically driven diaphragm pump shall convey the H_2S to the instrument to be calibrated.

A. H_2S monitoring system shall be as manufactured by the following (or equal):

1 Texas Analytical Control, Inc.
2 Rexnord Gas Detection Products

10 TERTIARY FILTRATION

10.1 INTENT OF SECTION

A. This section addresses the supply, delivery, supervision of installation and commissioning of the filtration equipment as described herein.

B. The filtration system shall be supplied by a company of good reputation that is regularly engaged in the manufacture and fabrication of filtration of wastewater treatment plants. The manufacturer's experience shall include a minimum of ten installations where equipment of similar size and design has been in operation successfully in a similar process for a minimum of five years

10.2 GENERAL AND PROCESS DESCRIPTION

A) The purpose of the tertiary filtration is to reduce the BOD and suspended solids being retained in the clarified water as it flows through the voids between the filter particles.

The water entering the filter from the clarifier will have the following characteristics:

B. O. D_5	Less than 20 mg/l
S. S.	Less than 30 mg/l

After passing through the filters the improved characteristics shall be:

B. O. D_5	Less than 10 mg/l
S. S.	Less than 10 mg/l

The Tertiary Filtration Plant shall be a down flow gravity sand filtration facility designed to produce a final effluent prior to sterilization containing no more than 10 mg per liter BOD5, 10 mg per liter suspended solids.

B) The tertiary filter plant will comprise essentially of:

- 16 Nos. gravity sand filter beds each 10.0 m x 4.0 m x 1.0m media depth . These filters will be executed in one phase.
- 1 No. fully automatic sequencing combined air and water backwashing system, complete with standby equipment.
- All necessary inlet and outlet penstocks, valves and controls.
- All necessary electrical controls, cabling and wiring.
- Filtered water discharge and backwash water disposal facilities.

- 4 Nos. monorail cranes.
- Complete charge filter media.

All as detailed in the specification and shown on the drawings.

C) Flow to the filter plant will be by gravity from the clarifier tanks as shown on the drawings.

D) The flow from the clarifiers shall be discharged into the inlet feed channel and then to the filter beds via penstock controlled feed channels.

E) Filtered effluent (Filtrate) shall be discharged by gravity head to a channel leading to UV disinfection channels.

F) Backwash waters shall be collected in overflow trough within each bed and discharged to the Back wash water tank, and then part to inlet feed channel of sand filters and reaming part to the plant inlet works for treatment, or to sludge treatment units.

G) Backwashing of the filter beds shall be by a counter flow system, sequentially controlled and fully automatic using a combined water/air scour system. The backwashing system shall incorporate provision for manual backwashing of any bed as required and as indicated by increased level in the inlet chamber.

H) The backwash operations shall provide for the simultaneous application of air for a period of approximately seven (7) minutes followed by the application of wash water alone for a further period of approximately 7.5 minutes.

I) Provision of all necessary electrical works controls, cabling and wiring for the operations and control of the tertiary filter plant as detailed in the relevant sections of the specifications shall be included in the work scope.

J) The backwash water shall be taken from the filtered water tank. Therefore the backwash water will have to be dosed with chlorine from time to time to provide biological slime control within the filter beds.

10.3 DESIGN DATA

The design data for the Tertiary Filter Plant shall be as given in the table below:

Table – Filter Plant Design Data

Treatment Capacity(average flow)	200,000 m3/day
Flow Rate for Treatment (design)	200,000 m3/day
Flow Rate to Treatment (peak)	300,000 m3/day
Influent BOD (5)	Less than 20 mg/l
Influent Suspended Solids	Less than 30 mg/l
Number of Filter Beds	16
Filter Bed Dimensions per unit	15.0 m x 8.0 m
Filter Loading Rate (based on avg. flow)	4.3 m^3/m2.h
Peak Loading Rate (based on peak flow)	6.5 m3/m2.h
Filter Loading rate during backwash(Av flow) (1 bed on backwash i.e 1 bed out of service)	4.6 m3/m2.h
filter Loading rate during Backwash (Pk flow)	6.9 m3/m2.h
Backwash System	Counter flow, Combined air/water
Number of beds backwashed at one time	1 max.
Media	Silica sand, and Anthracite
Sand effective size range	0.80 mm to 1.25 mm
Sand Uniformity coefficient	Less than 1.30
Anthracite effective size range	1.4 mm to 2.5 mm
Anthracite Uniformity coefficient	Less than 1.35
Treated Effluent Quality	
BOD5	Less than 10 mg/l
Suspended Solids	Less than 10 mg/l

10.4 FILTER BED CONSTRUCTION

A) Each filter bed shall be constructed from reinforced concrete. The filter floor, which will carry the media, and through which the nozzles will protrude, shall span a series of plenum chambers.

The equipment shall be constructed to the requirements of the filter equipment manufacturer and shall be within the tolerances of level and alignment to suit the equipment specification.

B) The nozzle carriers shall be set into the filter floor in a symmetrical pattern having spacing of 200 mm at right angles to the central spine of the filter complex and 150 mm parallel to the central spine to give a minimum nozzle density of 50 nozzles/m2. The nozzles shall be of multipart construction manufactured from polypropylene and shall have facility for at least 50 mm vertical adjustment. The design of the nozzle and its carrier shall permit

pressure testing to be carried out after the floor is complete and before installation of the nozzle stems. The nozzle domes shall have slots or holes of size less than 0.2 mm that prevents leakage of the media through them.

10.5 INFLUENT FLOW CONTROL

A) The influent flow to each filter shall be controlled by means of a pneumatically actuated or motorized penstock leading to the feed channel to each bed.

B) The flow rate through each bed shall be balanced by a float operated butterfly valve or a weir on the outlet to the clear water channel which shall modulate to suit the water level in the filter bed.

C) High level shall be determined by means of ultrasonic type level detection located in the common inlet chamber.

10.6 BACKWASH

A) Backwashing of the filter beds shall be by simultaneous air and water injection through the beds via the plenum chambers.

B) Backwashing of beds shall be automatically initiated by means of an adjustable and programmable sequence controller which shall normally clean each filter bed in a prearranged sequence and during periods of low sewage flow to the sewage treatment plant management. No more than one filter shall be cleaned at any one time.

C) Provision shall be included for the ultrasonic level device, located in the filter bed inlet chamber, to override the sequence controller backwash initiation time clock and start the sequence of bed washings at a pre-set high water level in the inlet chamber. Beds shall continue to be washed in sequence until the level of water in the inlet chamber falls to a pre-set level. When the lower level is reached the backwash cycle for the bed being washed shall continue to completion and then the programmer shall automatically revert to the initial settings as described above.

D) Provision shall be included to interrupt the programme at any time to either re-wash a bed out of sequence and by manual control at the plant control panel.

E) In the event of a backwashing cycle being interrupted for any reason, the complete washing cycle shall re-start from the beginning and continue through the complete cycle.

F) Backwash water overflow channels shall be provided as shown on the drawings.

5.7 Backwash water shall be discharged to the Inlet of sand filters via pumps installed in backwash tank.

G) The timed sequence of a single backwash cycle for one of the 16 filter beds would typically be as follows:

	Time	Elapsed Time, Minutes
Normal running all filter beds on stream		
Backwash cycle starts	0	0
Filter water inlet penstock closes	30 sec	0.5
Filter bed drain down	5 min	5.5
Filter outlet valve closes	30 sec	6.0
Air valve opens and scouring proceeds	5.0 min	11.0
Backwash water inlet valve opens and backwash proceeds	8.0 min	19.0
Air valve closes backwash water continues	30sec	19.5
Backwash outlet penstock closes	30 sec	20.0
& backwash Water line valve closes	30 sec	20.5
Filter water & penstock opens	30 sec	21
Total Sequence Time	21.0 minutes	

All valve and penstock opening and closing times taken as 30 seconds.

10.7 BACKWASH WATER PUMPS

A) Six No. backwash water pump (4 duty + 2 standby) each rated at 25% of design requirements shall be provided. The pump shall be located in filtered water tank just downstream of the UV channels as shown on the drawings.

B) Backwash waters shall be taken from the filtered water tank.

C) A pressure switch shall be supplied on the pump manifold to provide alarm annunciation at the control panel on loss of pressure.

D) The characteristics of the back wash-water pumps shall be as shown below:

10.8 Filter Backwash Pumps

Number of Pumps 6 (4 Duty + 2 Standby)

Type Mixed Flow Volute

Mounting Vertical Wet-well

Flow rate Depending on Contractor's final design

Indication Suction and Discharge pressure gauges, high bearing temperature indication with alarm, running hour meter, ammeter with direct kW reading and 30 day chart recorder.

10.9 FILTER AIR SCOUR BLOWERS

A) Three No. blowers (2 Duty + 1 Standby) each rated at 50% design duty shall be provided. The machines shall be located in the filter plant blower room as shown on the drawings.

B) A pressure switch shall be supplied on the blower manifold to provide alarm annunciation at the control panel on loss of pressure.

C) The characteristics of the air blower packages shall be as shown below:

Air Blowers

Blowers Packages	3 (2Duty + 1 Standby)
Arrangement	Horizontal Blower, top inlet, bottom outlet
Drive	V Belt with ventilated guard
Motor	TEFC foot mounted

Pressure	0.5 bars (to be verified by requirements of filter bed)
Control	Relief valve operated by pressure switch
Indication	
Inlet filter	Dry pleated type in reinforced synthetic bonded fabric.
Inlet silencer (combined w/filter)	Straight through absorption type
Discharge Silencer	Straight through absorption type w / high heat resisting fibrous acoustic packing.
Insulation hood	Acoustic enclosure for sound prevention not to exceed 73.0 DB
Manifolding	Flanged with rubber vibration damper.
Mounting	Mild steel mounting frame carrying blower, motor, filters silencers and all accessories.

D) Intake air shall be drawn from the blower room via fixed louvers mounted in exterior walls of the building.

System Equipments

Gas	:	Atmospheric air
Spec.weight(Kg/m3)	:	1,11
Capacity (m3/hr)	:	4500
Differential Pressure (mbar)	:	600
Inlet Pressure (mbar a)	:	1013
Outlet Pressure (mbar a)	:	1613
Differential Temperature (^oC)	:	50
Inlet Temperature (^oC)	:	40
Dissipated Power (KW)	:	3.80
Velocity / Speed (RPM)	:	4170
Motor IEC	:	180M type B3-TEFC-IP55- Isol. CI.F.
Power (KW)	:	120
Voltage (V)	:	380
Speed (RPM)	:	3515
Poles (Nos.)	:	2
Frequency (Hz)	:	60

Each blower set should be supplied as a complete factory assembled and tested unit and be complete with the following:

a. Blower set
b. Drive motor
c. Geared or belt drive system with guard
d. Anti-vibration mounting pads
e. Combined inlet filter/silencer
f. Safety relief valve
g. Check valve
h. Flexible rubber expansion connections
i. Discharge silencer(Inlet & outlet)
j. Common base plate
k. Acoustic enclosure(Insulation hood)

E) Blower Type

Shall be of the air blower roots type directly coupled to its driving motor through a flexible coupling or V belt drive .

F) Condition of Pressure & Discharge

The blower shall be capable of discharging 4500 m3/hr of free air at room temperature & press it against the normal working pressure of 0.6 Bar when running at its rated speed corresponding to the rated speed of its driving motor which shall not exceed 1500 R.P.M the blower shall be capable of working satisfactorily against all pressures between 0.4-0.7 Bar A tabulated statement shall be submitted by the contractor showing the guaranteed discharge of the blower against pressure ranging from 0.4-0.7 Bar & the corresponding load in B. H .P. on the driving together with the corresponding speed.

G) Construction

The forging of the rotor shall be of high grade alloy steel carefully machined all over. The component parts of the rotor & the completely assembled rotor itself shall be balanced with great care.

Bearing of ball or roller type should serve support rotor and shall be arranged in such a way as to ensure self alignment. The axial thrust shall be taken by an amply dimensioned thrust bearing of an approved type.

All bearings shall be positively lubricated or greased by a special pump directly driven from the motor.

The blowers shall have water cooling system with a large cooling surface so as to eliminate great proportion of the heat and never to let the final temperature of the air discharged rise beyond 70c. The cooling system shall be complete with all required equipment & fittings.

10.10 FILTER MEDIA

Dual media (sand + anthracite) shall be used in gravity sand filters for filtration of the secondary treatment effluent.

Filter media shall be provided to fully charge the 16 Nos. filter beds.

Filter media characteristics

Anthracite Layer Thickness	0.40	m
Anthracite Density (1.35 - 1.6 kg/m3)	1.40	kg/m3
Effective Size (d10)	1.60	mm
Uniformity Coefficient	1.35	
Size Range	(1.4 - 2.5)	mm
Silica Sand Layer:		
Silica Sand Layer Thickness	0.80	m
Silica Sand Layer Density	2.60	kg/m3
Effective Size	0.8-0.9	mm
Uniformity Coefficient	1.30	
Size Range	0.8-1.25	mm
Sand will be tested using AWWA sand standards		

B) The Contractors shall detail the particular size distribution of the filter media to be provided.

C) Filter media shall be delivered in bags suitable for crane hoisting.

D) Contractors shall include for the supply of sieves for the on-site testing of delivered filter media in accordance with a programme of testing agreed between the Contractor and the Engineer. In addition the Purchaser may wish to witness media testing and laboratory analysis prior to despatch from the Contractors premises.

E) The filter media shall be provided from sources within the Kingdom.

8.6 A 10 % spare charge of filter media, in 100kg bags shall be provided as stock spares.

F) The filter media shall be carried by two layers of packing material on the filter floor.

10.11 PLACING OF FILTER MEDIA

A) Placing of the filter media in the filter beds shall not proceed until:

- The filter floor has been hydraulically tested to the satisfaction of the Engineer.
- The levels and dimensions of the concrete work have been checked for accuracy within the tolerance specified.
- The grading of the media has been accepted by the Engineer.

B) Placing of the media into the beds shall be executed in accordance with the requirements of the filter plant manufacturer who will be responsible for supervising this operation.

C) The procedure for placing the media shall include periodic backwashing during placing to remove dust and sub-grade sand.

10.12 FILTERED EFFLUENT DISPOSAL

A) Filtered effluent disposed from the tertiary filtration plant shall flow into the UV channels for disinfections.

B) Contractors shall include for all necessary pipe-works and manholes required to connect into the UV channels.

10.13 PIPEWORK AND VALVES

A) Pipe-work systems shall be constructed of materials to suit the fluids being carried and the environment through which they pass.

B) All systems shall have adequate provision for purging and draining during testing, commissioning and operation. Each system shall be capable of complete draining without dismantling of pipe-work or plant. Drains and purges shall be in accessible locations.

C) All supports shall be constructed to adequately withstand the static, dynamic and temperature induced loadings imposed during testing and working condition.

D) Connection to plant shall be constructed such that undue loadings shall not be transmitted to the plant casings.

E) Water pipe-work shall be standard ductile cast iron or approved equivalent. Flanged sections shall permit the easy removal of plant and features such as valves for maintenance and replacement purposes. Where pipes pass through concrete there shall be adequate puddle flanging.

F) Air pipe-work shall be of Galvanised steel welded fabrication with fusion bonded lining and minimal flanging.

G) Water valves shall be wedge gate type or butterfly type as shown on the drawings. Wedge gate valves shall be flanged, butterfly valves may be flanged or wafer pattern to suit requirements.

H) Air valves shall be wedge gate type for larger sizes and plug or ball valves for drains, instruments and other small valve applications.

I) Each system shall be isolated and hydraulically tested separately prior to testing and commissioning of the complete plant.

J) Power actuation of valves and penstocks shall be provided where indicated on the drawings and with the purpose to provide a completely remote control system.

10.14 MONORAIL HOISTS

A) Four Nos. Monorail hoists shall be provided to facilitate installation and maintenance of the air blowers and filter pipe work and valves. One unit shall be located in the main Backwash pump, and one shall be located in blower room and two units shall be located in the filter pipe gallery as shown on the drawings. The minimum rated capacity shall be 5 tones and 2 ton as shown in the table. The load hook shall reach ground level and the operating chain shall reach to 1 meter above operating floor level. All chains shall be hot dipped galvanized.

B) The characteristics of the monorail hoists shall be as shown below:

Table – Monorail Cranes

Location	Pump / Blower Room	Pipe Gallery
Number Units	2	2
Type	Electric Wire Rope	Manual Wire Rope
Hoist Capacity	5000kg	2000 kg
Drum	Single Layer	Single Layer
Gearbox	Oil immersed triple reduction	-
Brake	Single disc fail safe DC energized	Dry disc

Hook Block	Tested to 150% full load w/safety catch	Tested to 150% full load w/safety catch
Motor	Rated for Hoist Duty	-
Limit Switch	To cover 'Over Hoist' and 'Over Lowering' situations	-
Control	Pendant type low voltage	Hand chain travel
Mounting	Trolley mounted w/head travel trolley	Trolley mounted w/head travel trolley

10.15 ELECTRICAL WORKS

A) All high and low voltage switchgear, cables wiring, control panels, etc. required for the complete and effective installation, operation and (remote and local) control of the filter plant shall be provided. This shall also include the filter feed water pump station, the backwash water pump station,

10.16 SUBMERSIBLE SUMP PUMP

A) 1 No. fully submersible sump pumps shall be provided to transfer leakage waters collected in the drainage sump of the backwash pumping station and the pipe Gallery to the backwash water outlet channel.

B) The pump shall be sized to transfer 10 ltr/sec of drainage water at a total lift of 18meters. The pump shall be provided with guide rails, lifting chain and wall mounted local control panel.

C) The pump shall be fully automatic under the control of float type level controllers providing pump start, pump stop, and emergency high level visual and audible warning.

D) The control panel shall be mounted on the filter building wall adjacent to the pump and shall provide for automatic pump operation and manual local starting and shall include "Power On" and Running" lamps. The panel shall be weather proof to IP65 or similar.

11 ULTRAVIOLET DISINFECTION SYSTEM

11.1 Description of Work

a. The work under this section shall cover furnishing and supervision of installation of a complete and operational open channel, gravity flow, and ultraviolet (UV) disinfection system. The system shall be complete with UV modules, power distribution, system control, UV detection system, and automatic wiping system as shown on the contract drawings and specified herein.

b. The UV system shall be a "low pressure, high intensity" system with a new lamp rated output of minimum 150 watts UV-C (254 nm) per lamp, measured with lamps having been operated for 100 hours.

c. The system shall utilize active control based on the following dose parameters;
Lamp output intensity
Quartz sleeve transmittance
Water flow Based on these parameters, the system will automatically vary the UV lamp power proportionally to the dose requirement.
Systems that take only flow and water transmittance into account are not acceptable.

d. The dose delivered by the UV system shall be linearly variable within a range of 50% to 100%. If the variability differs between modes, the automatic mode of operation shall be the sole mode considered. Power variation in "steps" shall not be permitted.

e. The system shall be capable of continuous disinfection while automatically cleaning the UV lamp sleeves without reducing or shadowing the output of the lamps.

f. A single manufacturer qualified and experienced in the production of similar equipment shall provide the system. Manufacturer must have at least ten (10) years experience in manufacturing and delivering open channel, low-pressure high-intensity UV wastewater disinfection technology. The manufacturer must have a minimum of 80 installations operating worldwide using this technology.

g. The manufacturer shall have a minimum of twenty-five (25) fully operational works using technology identical in all aspects (i.e. low pressure high intensity lamps, with continuously variable power control) to that being proposed.

h. A minimum of five (5) of these installations shall be a multi channel system comprising more than 1,000 lamps.

i. The manufacturer shall have a quality management system which ensures that all UV units are fully tested in the factory prior to delivery.

11.2 Operating Criteria for the UV System

11.2.1 System Specification

Peak Disinfection Flow (Design Flow)	12,500 m³/h
Total Suspended Solids	< 5 mg/l @ average
	< 10 mg/l @ maximum
Particle size	< 30 µm
Water temperature	5...35 °C

Microbiological loads after clarification at UV inlet:

Fecal Coliforms	max. 100,000 CFU / 100 ml

This system has to comply to the following disinfection requirements:

Fecal Coliforms (after UV disinfection)	< 10 CFU / 100 ml
	@ 30 days geometric mean
	Or < 2.3 CFU / 100 ml
	@ 30 days geometric mean

Site or Contract Specific Requirement:

Minimum ultraviolet transmittance at 253.7 nm	min. 60 %
Minimum dose at design flow	min. 600 J/m^2

11.2.2 Performance Requirements

a. Dose calculation shall be in accordance with the point source summation method as described in the US EPA Design Manual (EPA/625/1-86-021), without exceptions.

b. The UV dose produced by the system shall be at a minimum of 600 J/m^2 after 12,000 hours of operation applied to an effluent of 12,500 m³/h with an UV transmittance of min. 60 %.

c. The dose calculation shall be based on the UV intensity output at a wavelength of 253.7 nm, with the lamp output at 87% (13% lamp aging) of initial level (end of life), with clean, clear quartz sleeves.

11.2.3 Design Parameters

a. The system shall consist of four (4) equal channels (3 duty + 1 Standby) with two (2) banks each.

b. The theoretical retention time shall be 4.42 seconds at the design flow rate.

c. The total power consumption of the UV lamps shall not exceed the values given below at the design conditions:

d. 311 kW @ 12,500 m³/h

e. Channel dimensions shall be as follows;

f.	Width along UV banks (mm)	1,915
g.	Width along level control (mm)	1,915
h.	Channel total depth (mm)	1,465
i.	Channel water depth (mm)	1,070
j.	Channel length (mm)	10,250

k. Channel dimension may need to be adjusted depending on manufacturer's recommendation.

l. The lamp array configuration shall be a uniform array with all lamps parallel to each other and to the flow. The lamps shall have equal centreline spacing along the horizontal and vertical axes. The single array pattern shall be continuous and symmetrical throughout the reactor.

m. The system shall be designed for complete immersion in the effluent of the UV lamps within their protective quartz sleeve in the effluent. Both electrodes and the full arc length of the lamp shall be below the water surface. Both lamp electrodes shall operate at the same temperature and be cooled by the effluent.

n. Systems designed whereby the lamps are inserted through a metallic bulkhead or which otherwise prevent uniform cooling of the lamp electrodes (e.g. vertical lamp systems) by the effluent shall not be permitted.

11.3 System Manufacture and Construction

a. All metal components in contact with the effluent shall be Type 316 stainless steel. Aluminium wetted materials shall not be used.

b. All wiring exposed to UV light shall be Teflon or Polyether-Polyurethan, VDE0250 quoted to resist UV light.

c. All materials exposed to UV light shall be 316 stainless steel, Quartz glass, Teflon, Viton, or other suitable long-term UV resistant materials.

11.3.1 UV Lamps

a. Lamps shall be low-pressure mercury amalgam "dotated", high intensity type.

b. Medium pressure or other lamp types with a polychromatic UV output, requiring a higher connected electrical load than that specified to deliver the specified total UV-C (254 nm) output wattage shall not be acceptable.

c. All lamps within the UV system shall be completely identical (type, length, diameter, power, output etc.). UV systems, which do not conform to this requirement, shall not be acceptable.

d. Lamp will be capable of producing a minimum, new lamp (100 hrs.), output of 150 watts of UV-C energy at a wavelength of 253.7 nm (254 nm)

Low pressure-low intensity or low pressure high intensity UV lamps with less than 150 watts UV-C output at 254 nm shall not be permitted due to the increase in quantity of lamps required.

e. UV output energy of the lamp shall be variable. The lamp will be capable of maintaining a UV-C output proportional to the variable power settings from the ballast.

Low pressure-low intensity or low pressure-high output lamps with no capability to automatically vary the UV power output in operation shall not be permitted.

f. Lamp life shall be guaranteed at 12,000 operating hours on a pro-rata basis. The useful lamp life shall be higher due to periodic switching and cycling of individual UV banks.

g. UV lamps shall not require a long cool down period prior to re-start should the power to the UV system fail or be interrupted for a short period of time. Systems or lamps that require long cooling periods (e.g., 10 – 30 minutes) before re-start are not acceptable.

h. The operating skin temperature of the UV lamp shall not exceed 130°C in order to minimize the possibility of quartz fouling.

i. The lamp filaments shall be the clamped design, significantly rugged to withstand shock and vibration.

j. UV lamp arc length shall depend on manufacturer standard.

k. Lamp bases shall be of a metal and ceramic construction resistant to UV and ozone.

l. The UV manufacturer shall provide a certification of lamp output measured in Watts of UV output at a wavelength of 254 nm. An independent third party shall perform certification of lamp output. The certification must be submitted with each bid for review by the consultant and owner. Bids submitted without lamp output certification shall be considered non-responsive.

11.3.2 UV Lamp Assemblies

a. Each UV lamp assembly shall consist of a UV lamp, enclosed in an individual quartz sleeve, with the ends appropriately sealed using an O-ring sealed quartz end plug.

b. Lamps shall be removable with the quartz sleeve and wiper system remaining in place

c. The quartz sleeve shall be fixed to the module frame using stainless steel clips onto the end plugs of the sleeve. The quartz sleeves shall not come in contact with the stainless steel of the module frame.

d. The UV lamp sleeve shall be a single piece of clear fused quartz circular tubing, open at both ends.

It shall be rated for a UV transmittance (254 nm, 1cm) of 92%, which shall not be subject to degradation over the life of the system.

e. A 10% reduction of the UV transmittance (254 nm, 1cm) shall be used to reflect the effect of quartz sleeve fouling.

f. All quartz sleeves within the UV system shall be completely identical (type, length, diameter, etc.). UV systems, which do not conform to this requirement, shall not be acceptable.

g. All electrical connections to the lamp assembly shall be made at one end through a four pin machined, watertight plug connector.

h. The electrical connection end of the quartz sleeve shall be sealed by means of a protective retainer plug designed with dual o-rings to seal and hold the sleeves in parallel alignment. The retainers shall remain in place to protect the quartz sleeve ends against accidental damage, without impeding the removal and replacement of the UV lamp.

i. The lamp socket shall be centred against the inside of the quartz sleeve and shall be retained by a cap nut with a ribbed exterior surface providing a positive handgrip for tightening / loosening without the need for any tools. This connection includes a self-contained o-ring, sealing the lamp and socket assembly (independently from the quartz sleeve).

j. The lamp assembly design and UV module mounting shall allow all of the following to be easily achieved by an operator for maintenance purposes:

k. Disconnection of lamp power cable only, without removing the UV lamp or the lamp assembly from the module.

l. Disconnection of lamp power cable and removal of the UV lamp without removing the lamp assembly from the module.

m. Disconnection of the lamp power cable and removal of the entire lamp assembly without removing the lamp from the assembly.

11.3.3 UV Modules

a. Each UV module shall consist of a dual (side-by-side) row configuration of UV lamp assemblies, the number of lamp per module shall depend on manufacturer design to achieve the required disinfection.

b. The module frame shall be constructed of heavy gauge, 316 stainless steel with stainless steel spring tension clips for holding the lamp assemblies in place. The top of the frame shall also serve as a UV reflector shield to prevent UV light from exiting the UV bank area.

c. The ends of the lamp sleeve shall not protrude beyond the stainless steel frame of the UV module.

d. The UV module shall be connected to IP 65 rated modular quick disconnect plugs and sockets on the junction box, for ease of removal, by means two or three separate sets of multi-conductor cables, each covered by a flexible stainless steel conduit. The plugs shall connect the power cables to the lamps in the module, interlock and sensor cables, and wiping system airlines.

e. The UV modules shall be designed such that operating personnel at the plant can change the lamps and quartz sleeves without requiring special tools.

f. Each UV module shall be equipped with an interlock switch, which will automatically disconnect power to its associated UV bank if the module is raised from the UV channel or the quick disconnect plug is removed.

g. The UV modules shall be designed for complete submergence without causing failures or damage to the system or components. They shall not contain any components, such as electronic cards, that cannot withstand complete submergence.

h. 316 stainless steel spacer / reflector panels shall be provided between the module reflectors so that no ultraviolet light is emitted from the channel when the UV modules are installed and the lamps are energized.

i. UV Module Support Frame.

The support frame shall be 316 stainless steel and be mounted in a position above the effluent level in the channel by means of slotted angles allowing precise adjustment of the module position within the channel during installation. Once correctly positioned the frame will allow for permanent fixing to prevent any movement during the life of the installation.
The frame shall be designed such that no fastening of the individual UV lamp modules is required other than a spring clip to overcome buoyancy of the module.

11.4 Wiping System

a. Each UV module shall be equipped with an automatic wiping system with selectable wiping frequency and number of strokes.

Systems without automatic mechanical wiping or systems requiring chemicals or removal of the module from the channel as the only means of cleaning will not be acceptable.

Wiper systems that require the maintenance of an integral chemical reservoir in order to function are not acceptable.

b. The automatic wiping system shall be pneumatically powered and shall use Teflon/Viton wipers to clean the quartz sleeves. Wiping frequency shall have an adjustable number of strokes and an adjustable timer interval.

Wiper systems operating hydraulically are not acceptable.

c. The total wiper holder assembly shall not shadow more than 1.9 cm of lamp length area at any time. Systems which shadow more than 1.9 cm of lamp length or arc at any given time shall have the lamp output watts de-rated by a proportional amount of wiper length to lamp arc length to account for the shadow or covering of the lamp by the wiper during operation.

d. The wiping system shall be PLC controlled and provide a fully automatic, unattended operation.

Wiping interval, the time between wiping cycles, shall be factory preset at optimum value based on water condition and shall be easily reset by the owner whenever actual conditions warrant. Interval range shall be typically 1 to 120 minutes.

The number of wiping strokes per interval shall be factory preset for optimum effect and shall be easily reset by the owner from 1 to 5 strokes per interval.

e. The cleaning system shall maintain uniform wiping tension and cleaning over complete wiping length of the quartz sleeve and the UV sensors.

The cleaning system shall maintain full efficiency throughout its life, with no deterioration in quality of cleaning.

f. The wiper blade brush or other cleaning device in contact with the quartz sleeve shall be non-metallic and shall not damage or scratch the quartz sleeve or sensor in any way.

To offset cleaning mechanism wear and to maintain positive contact and wiping efficiency with the quartz sleeve, the wiper blade brush or other cleaning device shall be self adjusting and shall automatically adjust to account for wear over it's useful life.

Systems that require manual adjustments for operation or to maintain cleaning efficiency on the sleeve are not acceptable.

g. The wiped length of the quartz sleeve shall be not less than the complete arc length.

h. The wiping system airlines shall be quick connect. Each airline connector in the quick disconnect plug and socket shall have an integrated check valve so that upon removal of a module from service, system pressure is maintained.

i. If plant air is not available a self-contained compressor package with suitable sized receiver tank and all installation and control equipment shall be furnished for the automatic wiping system.

Note: Airflow is only required during the wiping cycle(s).

11.5 UV Monitoring System

a. A submersible UV sensor shall continuously sense the UV intensity produced in each bank of UV lamp modules.

b. The sensor shall measure only the germicidal portion of the light emitted by the UV lamps as measured at 254 nm. It shall have selectivity at 254 nm of greater than 99%.Sensors whose sensitivity to other wavelengths amounts to more than 1% of the total sensitivity shall not be allowed.

c. The UV intensity monitoring system shall be factory calibrated.

d. The measured intensity shall be displayed on the operator interface as an absolute value in mW/cm^2.

e. The sensor shall be automatically cleaned at the same frequency as the lamp sleeves to prevent fouling of the sensor and hence spurious false alarms for low intensity.

f. Systems without automatic cleaning of the intensity sensor shall not be acceptable.

g. The sensor construction shall allow the counter-check with a reference sensor without having to remove the module from the channel.

h. One hand-held UV meter with a reference sensor shall be provided by the UV manufacturer.

11.6 Water Level Control with a downward opening penstock

a. Control of level in the UV channel shall be provided with downward opening gate weir, actuated with an electric motor if required

b. Each channel shall have one actuated level control weir.

c. The dimensions of the weir shall be designed in accordance with the channel geometry and the peak hydraulic flow.

d. Weir frame shall be suitable for end of channel or in channel mounting and incorporate resilient seals.

Any tensioning adjustment units shall be mounted on the downstream side of the gate to enable adjustment without draining the channel.

e. Single or duplex stainless steel rising screw stems shall terminate in the drive sleeve of a modulating actuator or pair of gearbox units with drive shaft to modulating actuator. The modulating actuator shall be mounted on a stainless steel stool fixed directly to the frame.

f. Control of the weir position by the PLC shall maintain a constant water level under all flow conditions in the channel to ensure optimum disinfection conditions are maintained.

An ultrasonic level sensor mounted onto a fixed structure above the channel shall measure the channel level continuously. The channel level shall be used by the PLC to provide modulating control of the downward opening gate utilizing a PID control algorithm.

The PID parameters and actuator run / dwell time setting shall be adjusted at commissioning of the system to suit the hydraulic characteristics of the works and minimize system hunting.

g. The moving gate of the weir shall have an ultrasonic sensor mounted to it.

The sensor shall accurately read water level over the weir and provide a flow input to the PLC, which will use this information to calculate flow in each channel as an additional flow point and to ensure uniform flow splitting between channels for multi channel systems by providing a trim signal to the level control algorithm for each channel.

h. The weir shall protect the channel from leaking in case of "No Flow" conditions. Water level control systems that cannot keep the desired water level during "No Flow" conditions shall not be acceptable.

11.7 Electrical

11.7.1 General

The electrical system shall be designed to provide:

- Maximum reliability of the UV disinfection system.
- Segregation of plant services and supplies into sensible groups to allow for safe and simple maintenance or servicing whist ensuring maximum possible disinfection capability is maintained.
- Ballast cards and other parts of the control panels shall not be exposed to direct sunlight and shall be cooled by air to avoid temperature stress resulting in a shortened working life.
- Plug and socket quick disconnect facilities enabling non-technical personnel to carry out lamp replacement, wiper insert replacement etc. without the need for any tools or specialist isolation procedures.

a. The location of sensitive electronic components, e.g. electronic ballasts, shall be chosen to ensure that a long service life can be guaranteed (Air conditioned room).

b. All heat sensitive components shall be adequately cooled with dry air utilizing forced or natural ventilation.

c. Systems or designs that subject sensitive electrical or electronic components to excess humidity or poor air quality for cooling are not acceptable.

d. Systems that lack positive mechanical heat transfer such as fans (or air conditioning) for the sensitive electronic components are not acceptable.

e. The enclosures for the UV system shall be IP 54 painted steel to be located inside a building. The maximum ambient temperature inside the building shall not exceed 30 °C.

f. The major components of the UV electrical system shall be:

- 1 No System Control Enclosure (SCE)
- 1 No Main Incomer Enclosure (MIE)
- 4 No Power Distribution Enclosures (PDE)
- 15 No Ballast Distribution Enclosures (EBE)
- 45 No Electronic Ballast Enclosures (EBE)

- 15 No Junction Boxes (JB)

g. Facilities for fully automated control and manual control independent of the PLC shall be provided.

11.8 System Control Enclosure(s) (SCE)

a. The main SCE shall be separate enclosure to house the system master PLC, operator interface, control and instrumentation equipment and plant interface termination points.

b. Electrical power supply from the MIE to each SCE shall be 400/230 V, 50/60 Hz, three phases, five wires, TN-S net.

c. The SCE shall have an internal single point of isolation and house any power distribution circuits, transformers or power supplies for the UV system requirements.

d. The UV system automatic control shall be performed by a Siemens PLC type S7-300.

The PLC shall be a standard proprietary unit with no specialist hardware or firmware modifications.

Full application software will be generated using the PLC manufacturers proprietary software package.

e. The operator interface for the system shall be a Siemens Simatic Panel PC with LCD screen and fully compatible with the PLC.

The unit shall provide a graphics interface and utilize menu driven screens to allow UV system control, status monitoring, and alarm handling.

f. The operator interface will provide access to all status and control functions for operations personnel. With password access to limit change options dependant on authority.

It will also provide access to diagnostic information, e.g. I/O status, and all PID and control functions for the commissioning engineer to allow changes to be made with appropriate password without the need for a programming terminal.

g. The PLC shall include a communications port for import and export of all UV plant data from / to the main works PLC and or SCADA system.

h. The UV system shall provide a group of volt free signals to allow for hardwired alarms to be taken directly from the UV system, independent of the main works PLC or alarm annunciation:

- "UV System Power Failure". Failure of a main power supply to the UV plant.
- "Critical Instrument Failure". Failure of an instrument or communication link resulting in a control signal being lost. This condition shall instigate a default routine in the PLC control to put all available UV lamps on to ensure that disinfection will be achieved if physically possible. Personnel and plant safety must be maintained at all times.
- "Failure to Meet UV Dose". Failure to meet the minimum dose level, either due to effluent conditions or possible plant limitations, during servicing etc.
- "Low Priority Alarm". An alarm, which requires attention but is not currently putting the plant at risk of failure, i.e. requires attention at the next convenient time slot.
- "High Priority Alarm". An alarm, which requires urgent attention to stop or prevent plant from failing, i.e. requires immediate attendance.

The low and high priority alarms shall be fully configurable to allow the Engineer / Owner to determine the priority levels for individual alarms.

The PLC application software will incorporate delay times for all alarm signals, to prevent spurious false alarms from fleeting signals, and to allow for intelligent plant items, e.g. electronic ballasts, to carry out self diagnostics and corrective action before initiating external UV system alarms.

i. Low UV intensity alarms shall be provided to detect possible water quality problems or fouling of the system. Alarm set point shall be field adjustable.

j. Individual lamp status shall be monitored by the PLC and provide status information on the operator interface showing:

- Individual lamp On / Off status
- Bank running hours
- Bank On / Off cycles

Single and multiple lamp failures shall initiate appropriate alarms.

k. The PLC shall monitor the wiper system "end of travel" position switches to determine system fouling etc.

l. The PLC shall monitor hardwired protection circuits, e.g. module lifted, module unplugged, module over current, bank isolation, etc. which will shut the appropriate area of plant down directly, to aid rapid fault finding when personnel attend site.

m. All functions available on site shall be able to be remotely controlled via modem using the Tele-control module in order to reduce expenses for service purposes.

11.9 Main Incomer Enclosure (MIE)

a. Electrical power supply to the or the MIE shall be 400/230 V, 50/60 Hz, three phases, five wires, TN-S net.

b. The MIE shall provide a single point of isolation for the complete UV plant.

c. The MIE shall provide the individual power supplies to the PDEs. It reduces the number of power supplies to be delivered by the contractor to only one (1).

d. Power Distribution Enclosure (PDE)

e. Electrical power supply from the MIE to each PDE(s) shall be 400/230 V, 50/60 Hz, three phases, five wires, TN-S net.

f. The PDE shall provide a single point of isolation for a complete UV channel.

g. The PDE shall provide the individual power supplies, with appropriate circuit protection levels, required for the operation of a single channel including, each bank EBE and any auxiliary electrical plant associated with the channel.

h. Electronic Ballast Enclosure (EBE)

i. The EBE shall be a single or single multi door enclosure, which shall house all the control gear, and electronic ballasts etc. associated with a single bank of UV lamps.

j. The EBE shall have a door-interlocked isolator, which shall be the single point of isolation for the full bank of lamps, enabling simple isolation for safe working on the lamps etc. The door-interlocked isolator shall provide the facility to lock the system off with padlock.

11.10 Junction Box (JB)

a. The JB shall be a stainless steel unit, which spans over the channel and provides all service connections for the associated bank of lamps, sensor, position and safety switches, wiper system operation etc. via quick disconnect plug and socket arrangements.

b. The JB shall provide individual termination points for all field cabling and airlines entering the unit.

c. The quick disconnect plug and socket arrangement will be on one side of the JB only and will be covered by a lockable stainless steel guard that will limit unauthorized access to the plug and socket.

d. Access to the field terminations inside the JB shall be via a hinged door with weatherproof seal.

e. The construction of the JB shall provide mechanical protection for all cabling and airlines entering the JB.

11.11 The Electronic Ballasts

a. The ballasts shall be electronic microprocessor controlled, designed as slot cards fitting into a rack system with a plug connector for ease of maintenance.

b. Each ballast shall drive a pair of lamps with independent control and monitoring circuits, and providing individual lamp status information to the PLC.

c. The ballast shall produce an earth free lamp power supply operating at above supply frequency and optimized to preserve lamp life.

d. The ballast shall detect lamp failure and initiate a re-strike sequence, independently from any external influence. The ballast shall attempt three re-starts before shutting off.

e. The ballast shall incorporate a galvanic separation of the two circuits. In case of the secondary circuit operating in abnormal conditions regarding voltage and/or amperage, the ballast shall shut off the lamp concerned. Ballasts without this feature shall be equipped with one GFC per ballast.

f. The ballast shall incorporate a filament pre-heat circuit to minimize lamp failure on start up.

g. The operating power factor for the ballasts shall be above 0.98.

h. The ballast shall be capable of varying the lamp power between 50 – 100% proportional to a 4-20 mA control signal.

i. The ballasts shall be held in a standby mode when not in operation to reduce start up time and minimize stresses on electronic components induced on power up.

j. The configuration of ballast cooling shall include a minimum of two independent forced ventilation systems, to reduce risk of ballast overheating in the event of a single ventilation system failure.

k. Ballasts systems, which rely on natural ventilation, or a single forced ventilation system shall not be permitted.

l. Ballasts requiring liquid closed loop re-circulating heat exchanger systems, e.g. propylene glycol, for cooling shall not be permitted.

m. Ballasts, for which replacement a watertight seal needs to be broken, shall not be permitted.

n. Ballasts, for which replacement the removal of the module is required, shall not be permitted.

11.12 Control and Instrumentation

a. All instrumentation used in the UV disinfection system control or monitoring shall be individually fuse or circuit breaker protected to minimize the effects of any single point of failure.

b. All instrumentation shall be designed for use in the application for which the UV system is using it.

c. All instrumentation shall be installed as per manufacturer instructions.

d. All instrumentation used for on line process measurement shall be located in the medium it is measuring and not rely on transfer of medium to external reservoirs or chambers where changes in characteristics being measured could occur.

This shall apply specifically to transmittance measurement for effluent and shall preclude any straining or filtering which would clearly effect the characteristics of the medium being measured.

e. An UV disinfection management system shall control the ON / Off cycling and lamp power of the UV banks based upon a dose pacing philosophy.

The management system shall utilize an UV sensor located within the UV bank(s) to accurately sense any change in lamp power, effluent transmittance and compensate for any reduction in the UV-C output due to lamp ageing.

The UV Disinfection Management System shall receive inputs from the UV sensor and flow meter and shall automatically adjust the received UV dose to maintain the required levels under all operation conditions.

Systems, which actively monitor only flow and use independent transmittance for theoretical dose paced control, are not adequate or acceptable.

f. In addition to the UV management system for control, the UV control system shall include a facility to select simple flow pacing which operates on an assumed UV transmittance and end of lamp life power.

This alternative control principle shall be selectable via the operator interface via password protection and would normally be set at commissioning.

11.13 Spare Parts and Safety Equipment

The following spare parts and safety equipment shall be provided as a minimum:

Spares.

- 5% UV lamps based upon a guaranteed lifetime of 12,000 hrs
- 2.5% additional ballasts.
- 2.5% additional lamp sleeves.
- 2.5% additional wiper rings.

Safety

- Two (2) face shields shall be provided to block UV light wavelength between 200 and 400 nm.
- Two (2) warning signs.

11.14 Installation, commissioning and training

a. All plant and equipment must be installed in accordance with manufacturer instructions and approved drawings.

b. The UV manufacturer shall provide full submittal drawings and documentation.

The manufacturer's submittal shall state the power consumption per lamp (including ballast loss) and the system peak power consumption (including ballast loss), for both new lamps and the end of lamp life.

The submittal shall clearly state head loss through the channel with all restrictions, weirs and flow controls factored in. All system components that contribute to head loss shall be itemized. This shall be done for the design, average, minimum and maximum daily hydraulic flows.

c. The UV system manufacturer shall provide three (3) sets of operation and maintenance manuals in English language.

d. An employee of the manufacturer shall commission the UV equipment.

The start-up technician shall certify to the engineer that all equipment is properly installed, and that the plant operators have been instructed on proper operation and maintenance procedures. Local manufacturer's representatives are not acceptable to perform these tasks.

Manufacturer's field services shall be provided as follows:

- Supervision of installation 220 man-hours
- Programming 56 man-hours
- Start-up / commissioning 45 man-hours
- Operator training 40 man-hours

12 CHLORINATION SYSTEM

12.1 GENERAL

The WORK of this Section includes providing chlorine and chlorine solution handling equipment with controls, valves, piping, gages, switches, regulators, strainers, tanks, safety devices, fittings, adaptors and accessories.

12.2 PRODUCTS

12.2.1 GENERAL

A. Calcium hypochlorite dosing set shall be provided as backup to UV disinfection, in addition a separate dosing shall be provided to disinfect the raw waste water in by pass line , and to disinfect gravity sand filters during back wash when required, the dosing sets shall include the following:

- Chemical preparation tanks, equipped with makeup water unit.
- Dosing pumps.
- Chemical storage unit.
- Water supply pump and piping.
- Local Control panel.

B. The Contractor shall furnish and install all tanks and dosing pumps, wiring, piping and accessories for the complete chlorination system.

C. The equipment of the chlorination system shall be installed inside the existing chlorination building.

D. The Contractor's attention is directed to the fact that the chlorination equipment is an integrate system, and as such, shall be furnished by one manufacturer who shall provide all of the equipment and appurtenances regardless of manufacturer, and be responsible to the Contractor for satisfactory operation of the system.

E. The Contractor's attention is directed to the contractual fact, that the submission for approval shall include:

- Component manufacturing data sheets indicating pertinent data and identifying each component by item number.

- A system piping schematic and wiring schematic each on a single drawing with full description of operation. Component identification on the schematic shall be indicated.

- Component drawing showing dimensions, mounting and external connection details.

12.2.2 TRANSFER PUMPS

The transfer pumps shall be of suitable type.

12.2.3 METERING PUMPS

A. The metering pumps shall be positive displacement, hydraulically-activated diaphragm pumps. The pumps shall be of the simplex type with wetted metal parts of Type 316 stainless steel. The pumps shall be capable of pumping the solution against a head of 100 psig minimum and shall have valved bypass around the back pressure valve.

B. Unless otherwise shown, all metering pumps shall be provided with corrosion-resistant pulsation dampeners, valved calibration column, check valves, relief valves, and flush connections with check and solenoid valves, designed to stay open long enough after each pump shutdown to flush out the line sample valves, pressure gages with diaphragm seals, and shut-off valves. All pipe connections to feeders shall be firmly supported from a floor-mounted, galvanized, structural steel frame to avoid any stress on the feeder or on the piping system.

12.2.4 PREPARATION/FEED TANKS

Tanks shall be constructed of polyethylene.

12.2.5 MIXERS

Tank mixers shall be of the industrial, heavy duty, low-shear type with a maximum speed of 350 RPM. Mixers shall be of the clamp-on type to be mounted on a reinforced section of the tank wall, or they shall be flanged to match a mounting flange on top of the tank. The CONTRACTOR shall coordinate the construction of the tank to match the mixer mount. The mounting method shall provide sufficient stability to avoid excessive vibrations and fatigue of the tank wall. Vertical mixers shall be a built-together unit consisting of heavy duty electric motor, helical or spiral bevel gear reducer with oil bath, heavy-duty bearings with a minimum life of 100,000 hours, vibration mount, cast iron gear housing, with stainless steel bolts and nuts. Each drive assembly shall have ample capacity to supply the required power and torque output, shall be suitable for use out-of-doors, and shall be of weatherproof construction. The shafts, impellers, and all wetted parts of each mixer shall be of Type 316L stainless steel. Impellers shall be marine-type keyed to the drive shaft.

12.2.6 PIPING, VALVES, AND FITTINGS

A. Calcium hypochlorite solution piping, , and chlorine residual sample piping shall be normal impact unplasticized rigid polyvinyl-chloride (PVC) Type 1, Grade 1 with screwed end fittings. The pipe shall be schedule 80.

B. PVC Valves shall be made of Class 12454-B polyvinyl-chloride conforming to ASTM standard specification or rigid polyvinyl-chloride (PVC) compounds and chlorinated polyvinyl-chloride compounds, Designation D 1784-69. Valves shall be rated for at least 9 kg/cm2 (non-shock) service at 45oC. Valves shall have socket-type ends shall be of the ball, check (swing or ball acceptable), needle, angle or diaphragm type.

C. Valves shall be of all-plastic construction FRP type or equal, with seals made of Viton and seats of Teflon except that diaphragm-type valves may have metal bonnet and stem parts. Diaphragms used for chlorine solution service shall be made of reinforced rubber (neoprene is not acceptable for this service).

12.2.7 CHLORINE RESIDUAL MEASURING & CONTROL APPARATUS

A. The chlorine residual of the effluent of the treatment plant shall be indicated and recorded. It is required to supply and erect three chlorine residual sampling measuring and control units. Each unit shall be mounted with the chlorine residual recorder in one panel.

B. The chlorine residual measuring apparatus shall be of the amperometric type with suitable bi-metallic electrodes to measure free available chlorine residual in a range from 0 to 12 mg/liters.

C. The electrodes shall be continuously cleaned by suitable mechanical means. The electrodes shall be stationary and not allowed to move during the continuous cleaning operation.

D. The measuring cell shall be designed to measure "free available" chlorine. The signal generated in the measuring cell shall be fed to the recorder for recording. The measuring cell assembly contains equipment for recording. The measuring cell assembly contains equipment for regulating the pressure, flow and pH of the sample water before being passed through.

E. The instrument shall include control components to provide automatic control of chlorine residual by adjusting the feed rate of chlorinators.

F. The sampling and measuring units shall be complete with all necessary pipe-work, sampling pumps, valves and fittings.

G. The chlorine residual measuring unit shall be fed by effluent sample from the distribution chamber before the contact tanks.

12.2.8 CHLORINE RESIDUAL RECORDER

A. The measured values of chlorine residual shall be automatically recorded by chlorine residual recorder. The residual recorder shall be in one cabinet with residual measuring apparatus as mentioned before.

B. The recorder shall be servo type which accepts the chlorine residual signal from the residual measuring apparatus.

C. This signal shall be a current proportional to the chlorine residual, this current is the indicated and recorded by conventional self-balancing amperometric recorder head on a suitable diameter weekly inkless (pressure sensitive) chart.

D. The recorder shall have the same range for residual chlorine as the residual measuring apparatus.

E. The reading of residual chlorine shall be transferred to the main control panel at the control building.

12.2.9 SAFETY

A. The Chlorination Building shall be provided an emergency eyewash station and emergency shower shall be provided in the immediate vicinity.

B. The plant first-aid area shall be provided with protective clothing and breathing apparatus. and necessary safety sign post.

C. The chlorination building shall be well ventilated to the open atmosphere

12.2.10 INSTALLATION

A. General

Equipment shall be installed in accordance with safety standards.

B. Solution Diffusers

Diffusers shall be installed as indicated to feed hypochlorite solution into the water stream. Diffusers shall be supported with corrosion resistant supports of suitable material, and shall be installed for easy removal and disconnection.

12.3 EXECUTION

12.3.1 GENERAL

A. Installation of chlorination equipment shall be in strict accordance with the requirements of the manufacturer's written instructions and shop drawings.

12.3.2 FIELD TESTING

A. Upon completion of the installation, each piece of equipment and each system shall be tested for proper performance and satisfactory operation without excessive noise, vibration, and overheating. Equipment manufacturer shall certify proper installation prior to startup.

13 SLUDGE DEWATERING SYSTEM

13.1 GENERAL

13.1.1 SCOPE

A. The Contractor shall supply a complete sludge mechanical dewatering system, comprising thickened sludge pumps, centrifuges, flow control valve, polymer dosing unit, dry lime feeding unit and screw conveyors. The system shall be located inside the dewatering building which shall be a concrete structure supplied with complete air ventilation ducting and extraction fan and odor control unit.

13.1.2 PROCESS DESCRIPTION

A. The sludge dewatering process can be described as hereinafter. The thickened sludge pumps shall pump the oxidized sludge from the sludge thickener. The common feeder header of each centrifuge unit will incorporate an electromagnetic flow meter with local indication of flow and remote integration and recording at the central control panel of the dewatering plant with output to SCADA.

B. A modulating flow control valve shall be fitted downstream of the flow meter and on the feeding branch to each centrifuge, to ensure even and constant flow to centrifuges which shall be working in parallel at a time (for phase II). As for the other centrifuges their valves shall be closed to isolate them from the feeding header. The control valves shall be operated from a 5-20 mA output signal from the flow meter through a programmable logic controller / distributor.

C. A measured dose of polyelectrolyte shall be fed into the sludge feed header. The sludge flow will be split evenly towards each of the working centrifuge.

13.2 PRODUCT

13.2.1 SLUDGE – POLYMER DOSING SYSTEM

A. General

The Contractor shall supply a complete self-contained package for polymer preparation and dosing at the treatment plant.

The package shall be installed inside the Dewatering Building as shown in the relevant drawings. The polymer dose shall be added to the sludge inside the dewatering building, in the sludge distribution header to the centrifuge. This dose shall be added to improve the dewaterability of the sludge before its mechanical dewatering.

The package shall consist of one complete unit.

The complete polymer preparation unit shall consist of two fully assembled modules.

1 Batch preparation, fully automatic, batch continuous.
2 Metering and final dilution module.

Both modules shall be integrally wired and completely assembled with distinct terminal points for supply and final product to process.

The batch preparation module shall be capable of processing up to 30 kg per hour of dry polymer, with a batch volume of at least 3000 liters.

B. Description of the Batch Preparation Module

The polymer shall be of the dry powder polyelectrolyte type. It shall be added manually to the package on daily basis, while the preparation and blending of the dosage shall be automatically processed by the package.

The batch preparation tank shall contain a specifically designed mixer, the profiles, geometry and kinetics of the tank and mixer shall provide for a quick correctly prepared active concentrate to be formed, the mixer unit shall be operated by timer with variable settings.

On completion of the mixing cycle, the concentrate remains in the tank until the low level is reached and the cycle starts again.

The batch module shall be designed, if the primary water supply is interrupted during the mixing cycle, then all the sequence and time functions will be "held" until the water flow is resumed and the remainder of the cycle is automatically completed.

C. Metering Module

The system shall include multi metering and dilution modules taking suction from the batch preparation module. The metering module shall have its own integrally-mounted control panel inter-connected with the control panel on the batch preparation module. The metering pump shall be of the progressive cavity type and the rate of flow shall be variable by manual speed control inverter using a potentiometer type of control knob. Automatic speed control shall be available using a 4-20 mA signal to the inverter.

The continuously metered concentrate shall be diluted using recycled treated water.

The dilution equipment shall incorporate variable speed mixing spear, corrosion resistant equipment powered by an electrical motor. The dilution water shall be metered at a present rate to give the final concentration. Dry run protection shall be provided by low level switch with time delay in the pump tank. Should the power supply to the metering pump or dilution mixer be interrupted, both shall automatically stop. On resumption of the supply all equipment shall return to their present stage.

D. Material of Construction

The unit base frame shall be manufactured from mild steel section, epoxy coated after fabrication.

All tanks of the polymer unit shall be manufactured from HDPE.

Hydration mixer shall be made of stainless steel "SS 316L". Dispenser mixer and housing shall be made FRP.

All metering pumps shall have stainless steel rotor and Viton stator with cast iron body of the close grain type. All pipe-work shall be uPVC to SAS Class-5. All bolting shall be stainless steel.

E. Operation and Performance

All recommend dosage and concentrations of the polymer preparation and dosing system shall be complied with, timers and controls shall be adjustable to allow for better adjustment of concentration and flow rates during plant commissioning and start up periods.

The system shall be operated and automatically controlled in complete conjunction with the operation of the sludge dewatering system, by receiving an electrical DC signal from the electromagnetic flow meter at the sludge header inside the dewatering building.

The contractor shall submit before installation of the system, a complete and comprehensive technical description of the polymer system including all equipment and devices specifications as well as all necessary data and information for best operation and services of the system.

13.2.2 CENTRIFUGE

A. General

1 Description

Furnish, install, test and place in satisfactory operation centrifugal dewatering equipment and appurtenances as indicated and as specified.

2 System Description

General:

- The centrifuges shall be of the solid bowl, horizontal continuous feed, scroll type, specifically designed to dewater sludge.
- The centrifuge shall be designed and constructed to operate continuously.

- The centrifuges shall be capable of performing in accordance with the requirements set forth in these specifications. In order to be assured of meeting the required performance, the centrifuges shall be capable of operating at a speed of 3100 rpm and a G force of 3000. Speed control shall be provided by a solid-state variable frequency drive (frequency inverter).

Components and Appurtenances:

- All equipment shall be furnished by the manufacturer of the sludge dewatering units; however, all equipment need not be manufactured by a single manufacturer.
- All components, including but not limited to the following, shall be considered as part of the sludge dewatering package and become the responsibility of the sludge dewatering equipment manufacturer:

  - Centrifuge Assembly.
  - Main Drive Motor with variable frequency drive.
  - Automatic hydraulic Backdrive System.
  - Automatic Lubrication System.
  - Control Panel and Wiring.
  - Motor Starters and Appurtenant Enclosures.
  - Flexible Connectors, Dewatered Sludge, and Centrate Chutes.
  - Spare Parts and Special Tools.

All equipment, components and appurtenant items shall be furnished and installed as complete assemblies. The interconnecting wiring, conduit, piping shall be furnished by others.

3 Conditions of Service

Sludge dewatering equipment and appurtenances are to be installed in areas of a heated building specifically designed for these systems.

The equipment and its appurtenances shall be suitable for exposure to splash and spill conditions, and 100% humidity.

The equipment and its appurtenances shall be capable of receiving, conditioning and dewatering the feed sludge specified herein, and discharging the dewatered sludge into the sludge pumps, conveyors or gravity discharge chutes as the case may be. Each unit shall be capable of operating continuously and shall be suitable for dewatering the specified sludge continuously for up to 24 hours per day, 7 days per week.

The feed sludge will have the following characteristics:

Sludge Feed Characteristics	
Type of Sludge:	Activated Sludge from sludge thickener
Sludge Concentration:	3% TS
Temperature:	20-32 ^{o}C
Sludge Quantity (Excluding Polymers)	
Normal Operating	3527 kg dry solids per day
Design	3527 kg dry solids per day

4 Required Performance

Each Centrifuge shall achieve the minimum following performance while thickening the sludge having the characteristics listed under paragraph 3 above.

Dewatering Performances	
Hours per day of operation:	8
Capacity	18-26 m3/hr
Dewatered sludge minimum solids concentration:	20 %TS min.

5 Quality Assurance

Workmanship and Design:

- All parts of the equipment provided to be amply proportioned for long, continuous and uninterrupted service. All materials to be used, to be of the best quality and entirely suitable for the service required.

- Provisions to be made for easy lubrication, adjustment or replacement of all parts. A minimum clearance of three feet around all sides of the equipment shall be retained.
- Centrifuge assembly shall be designed to assure easy disassembly of the unit, including vertical removal of the centrifuge rotating assembly, within the space and headroom provided and without displacement of the centrifuge main drive and Backdrive motors.
- The corresponding parts of the multiple units shall be interchangeable.

Services of Manufacturer's Representative:

- Provide services of factory-trained Service Engineer, specifically trained on type of equipment specified. Submit qualifications of Service Engineer for approval. Man-day requirements listed are exclusive of travel time, and do not relieve Contractor of obligation to provide sufficient service to place equipment in satisfactory operation.

- Installation: to assist in location of anchor bolts; setting, leveling, field erection, etc.; coordination of piping, electrical, miscellaneous utility connections: 2 man-days.

- Start-up, testing and calibration: 2 man-days.

- Operation and maintenance instruction: 2 man-days.

Shop test

- Upon completion of manufacture of centrifuge and appurtenances to be installed on this project, conduct shop tests which shall be witnessed by the Engineer:

  - Centrifuge:

    - Running test, each machine, without sludge, with minimum of 8 hours of continuous operation at proposed design operating speed. Fluids required for testing supplied by manufacturer.

    - Demonstrate that all equipment is capable of continuous operation in satisfactory manner without mechanical defects or operational difficulties. Measure and record vibration. (maximum 4mm/sec RMS)

    - If necessary, tests repeated until satisfactory results are obtained.

    - All defects or defective equipment revealed by or noted during tests corrected or replaced promptly at no additional compensation.

  - Main Drive Motor: Each main drive motor shall be given a routine commercial test as well as additional electrical tests as outlined below. All tests shall be as required to meet NEMA and ANSI standards and shall be performed in accordance with IEEE standard 112 "Test Procedure for Polyphase Induction Motors and Generators." The additional tests, beyond commercial tests, are as follows:

    - Tests at full load, 3/4 load and 1/2 load to establish motor efficiencies and temperature rise.

    - Tests to establish starting characteristics.

    - Tests to establish noise pressure levels.

- All facilities, lubrication oil, instruments, equipment and electric power shall be supplied by the Contractor at his expense.
- Upon completion of the tests, provide six copies of the certified shop test results to the Engineer.

6 Submittals

Shop drawings, catalog cuts, and other materials required to completely describe and specify system and equipment shall be submitted to Engineer for review. These will include:

- Submission of certified shop and erection drawings, including complete motor data.
- Foundations, installations, and grouting.
- Services of manufacturer's representative.
- Operating and maintenance instructions and parts lists.
- Lubricants.
- Special tools.
- Bolts, anchor bolts, and nuts.
- Sleeves and inserts.
- Electric motors.
- Voltage rating of motors.
- Equipment drive guards.
- Vibration isolators.
- Nameplates.
- Noise level data.

Detailed shop drawings include, but not necessarily limited to:

- Detailed drawings and specifications of all items of equipment showing all dimensions, parts, and construction details and materials, and installation details and requirements.

- Performance specifications of all items of equipment.
- Instrument layout of control panels.
- Complete instrumentation and control and wiring diagrams in sufficient detail to allow installation of instrumentation and controls, and electrical components. Specifically, the following required:

    - Complete instrumentation and control schematics.
    - Complete electrical circuit schematics, including all motor control, alarms, and power to motors and accessories such as analytical instruments, etc. Schematics include termination points in various panels. Every circuit assigned circuitry number; every wire assigned wire number. In schematics, wiring is identified by numbers. Also, in schematics, every termination point assigned number, and number or identifier assigned to each terminal strip. Both termination point number (including wire number) and terminal strip identifier appear on the schematics for each wiring termination shown.
    - Complete electrical instrumentation and control schematics of control panels and field junction boxes. (Note these are to be supplied pre wired.)

Schematics to provide complete information on terminal strips and panel instruments.

- Certified shop testing results as set forth under "Quality Assurance."
- Certified acceptance test results.

7 Delivery, Storage and Handling

Ship items as complete assemblies except where partial disassembly is required by transportation regulations or for protection of components.

Spare Parts:

- Packed in containers bearing labels clearly designating contents and pieces of equipment for which intended.
- Deliver at same time as pertinent equipment.

B. Products

1 General

The Equipment specified herein shall be furnished by sludge dewatering equipment manufacturer, who shall assume complete responsibility for conformance to the design documents.

Like items of equipment shall be the product of one manufacturer to achieve standardization of operation, spare parts, maintenance and manufacturer's service.

Manufacturer's standard equipment sizes shall be used unless otherwise specified.

The equipment provided shall be complete in all respects including, but not limited to, lubricants, components, calibration, alignment, and adjustments as necessary to place the equipment in operation to perform its intended functions.

2 Manufacturers

The sludge dewatering equipment manufacturer’s shall have experience in the design and manufacture of dewatering centrifuge. The manufacturer's experience shall include a minimum of ten (10) installations where equipment of similar size and design has been in operation successfully in a similar process for a minimum of five (5) years

3 Material of Construction

Unless otherwise specified all parts of the centrifuge in contact with the sludge shall be made of 304/316 stainless steel or duplex stainless steel (A.S.T.M. A 890), except o-rings, seals or abrasion resistant materials.

The O-ring and seals shall be manufactured of the following:

- O-rings: Buna-N
- Lip Type Seals: Buna-N

All equipment guards shall be constructed with 304 stainless steel. Plexiglas, plastic or painted carbon steel shall not be allowed.

4 Centrifuge Assembly

Bowl:

- The bowl shall consist of a horizontal cylindrical-conical assembly. Solids are discharged at the small end of the conical section. The bowl shall have a minimum diameter of 560 mm I.D., and a minimum length of 2500 mm and shall be supported by spherical roller bearings mounted in pillow blocks.

  All parts of the bowl shall be centrifugally cast or forged. All centrifugally cast and forged parts shall have a certification from the casting / forging supplier that states the chemical and physical properties. All centrifugally cast / forged parts shall be LPI tested.

  The minimum acceptable thickness for the cylindrical and conical sections of the bowl wall shall be 15 mm.

  The centrifuge bowl shall be centrifugally cast or forged from duplex stainless steel A890 (1.4470) with a minimum tensile strength of 690 MPa.

- The liquid pool depth in the bowl shall be adjustable through the use of plate dams at the large diameter end of the bowl where liquid is discharged. Solids shall be discharged from the small diameter end of the bowl. The plate dams shall be manufactured from 304 stainless steel.

- The bowl wall shall be protected by, longitudinal wear strips which cause formation of a protective feed solids layer.

- The solids discharge ports shall be protected by field replaceable tungsten carbide inserts.

- Sludge feed shall be introduced into the centrifuge feed zone by means of a 50 mm diameter 316L stainless steel feed pipe. The feed shall be uniformly distributed into the centrifuge and the feed zone shall have accelerators and contact surfaces protected from abrasion by fused tungsten carbide.

Scroll Conveyor

- The centrifuge shall include a horizontal cylindrical-conical scroll conveyor. The conveyor hub shall be centrifugal cased or forged of the duplex stainless steel with a minimum tensile strength of 690 MPa. All centrifugally cast and forged parts shall have a certification from the casting / forging supplier that states the chemical and physical properties. All centrifugally cast / forged parts shall be LPI tested. The conveyor shall be supported by grease lubricated cylindrical roller and angular contact anti-thrust ball bearings. The hub shall be equipped with helical flights independently mounted concentrically within the centrifuge bowl. The conveyor flights shall be 304/316L stainless steel.

- Conveyor bearings shall be protected by seals and shall be externally lubricated by means of a forced grease lubrication system.
- The feed compartment within the conveyor shall be constructed of duplex stainless steel. It shall be protected by field replaceable tungsten carbide inserts.
- The edge and face of the conveyor flights shall be protected against abrasion with Eutalloy hard surfacing material from the feed chamber to the liquid endo, The hard surfacing shall be guaranteed against failure for minimum of 15,000 hours of operation.
- The edge and face of the conveyor flights shall be protected against abrasion field replacable TC tiles that are welded to the flight from the feed chamber to the solid end discharge, The hard surfacing shall be guaranteed against failure for minimum of 15,000 hours of operation.

Case:

- The centrifuge casing shall consist of a 304 /316 stainless enclosure. The upper half of the centrifuge case shall be manufactured as single piece. Opening the single piece centrifuge top cover will expose the entire centrifuge bowl for service and inspections. The lower half of the centrifuge case shall be manufactured as a single piece.

- The purpose of the case shall be to contain and direct the solids and liquid discharge from the centrifuge, to act as a protective guard and to provide a complete enclosure for noise reduction.
- The centrifuge case shall have fitted stainless steel wear liners in both the solids and liquid end compartments.
- A sound proof panel system will be provided as specified to limit the noise generated by the centrifuge to 88 dBA or less 1 meter from the panels.
- The centrifuge case shall be vented as recommended by the manufacturer. Lifting hooks shall be provided for lifting the casing.

- To limit splashing and air leakage, the casing shall be provided with seals where the bowl hubs intersect the casing and a gasket on the machine flanges where the upper and lower casings join.

Base:

- The centrifuge shall be supported on a fabricated carbon steel base with 304 stainless steel wetted parts. The base shall be mounted on vibration isolators.
- Machined surfaces shall be provided at all points where support loads are transferred to the base. The bottom portion of the base shall be provided with machined outlets for the attachment of the solids and centrate flexible connectors and chutes and other appurtenant connections.
- Lifting hooks or solid lifting bars shall be provided for lifting the base.

Main Bearings:

- The main bearing shall roller bearings and mounted in a one piece pillow block. The bearings shall have an L-10 life of 100,000 hours minimum.

- The bearings shall be lubricated by an automatic forced lubrication system.

5 Main Drive Motor

The main drive motor shall be designed, manufactured and tested in accordance with the latest NEMA, IEEE and ANSI standards and have the following characteristics:

- Type: Squirrel-Cage, Single-Speed
- Power: (15) kW
- Synchronous Speed: 3560 rpm
- Service Factor: 1.15
- NEMA Design: B
- Insulation Class F or H
- Code Letter: G
- Voltage: 380 volts
- Phase: 3-phase
- Ambient Temperature Rating: 40 degrees C
- Maximum Temperature Rating: 120 degrees C
- Mounting: Horizontal
- Enclosure: TEFC
- Duty Cycle: Continuous
- Starting Method: Reduced voltage
- Bearing Life: 40,000 Hrs. as defined by AFBMA B-10
- Full Load: Not less than 94 percent
- Efficiency: power factor of 0.88.
- Sound Level: Maximum 85 dBA at 1 m

The motor shall be equipped with a thermal protection system to protect the motor from temperatures damaging the stator windings resulting from motor overload, too frequent starting and locked-rotor current and a variable frequency inverter.

6 Backdrive System

A Hydraulic Backdrive system shall be supplied with each centrifuge to provide speed variation between the conveyor and the bowl.

The differential speed between the centrifuge bowl and scroll conveyor shall be produced water or air cooled hydraulic system which shall independently drive the scroll conveyor. The hydraulic scroll conveyor drive system shall be designed such that no mechanical gear reducer is required in the scroll conveyor drive train. The hydraulic drive system shall be capable of operating in either a speed or torque mode. In the speed mode it shall provide for operation at a specific, adjustable scroll differential speed with internal torque allowed to vary up to the maximum allowable scroll shaft torque.

In the torque mode it shall continuously monitor changes in internal torque created by variations in influent feed solids and automatically maintain a preset torque input to the scroll by allowing the differential speed to vary. The hydraulic drive shall operate in a manner such that, as the reactive torque of scroll shaft increases due to an increase in solids inventory in the bowl, the scroll differential speed shall gradually increase and, conversely, as the inventory of solids in the bowl and resultant reactive torque decreases, the scroll differential speed shall decrease. The net effect of this system, when operated in the torque mode, shall be to maximize the time that cake solids are under the influence of accelerated gravitational force to ensure that the driest possible dewatered cake product is produced without plugging the centrifuge.

The system shall use a hydraulic pumping group and hydraulic motor. Torque-based adjustment shall be a function of input to the driven unit. The maximum torque input and rate of change of scroll differential speed shall be adjustable.

The system shall be designed such that automatic centrifuge shutdown is initiated in the event that excessive torque is detected. Two (2) sets of contacts shall be provided being high torque and high-high torque.

In the event that torque exceeds the normal operating range, the sludge feed pump shall be automatically stopped to allow the centrifuge to clear itself and shall automatically restart when the torque drops to the normal operating range. In the event that the torque approaches the limit of the drive, the second set of contacts shall automatically initiate shutdown of both the feed pump and centrifuge. In this instance manual reset of the hydraulic drive is required before the centrifuge can be restarted.

The system shall have a Backdrive controller which is fully adjustable and programmable by the plant operations including a series of preprogrammed curves for different operating conditions. These curves are to be programmable on site and offer

an optimum centrifuge setting based upon sludge feed rates and feed solids loadings. Changes from one operating curve to another shall be done with a single button change at the centrifuge Backdrive controller.

7 Vibration Isolators

The equipment manufacturer shall furnish vibration isolators which shall be capable of dampening vibration in all directions created during normal and emergency operation of the equipment.

The vibration isolators shall be provided for the centrifuge assembly.

8 Connections

All piping and discharge chute connections to the centrifuge assembly, main drive motor and lubrication system, including but not limited to the feed sludge, wash water, polymer, drain, centrate, discharge, thickened sludge discharge and power and control connections, shall be equipped with flexible connections.

The flexible connections shall isolate the equipment from fixed rigid piping, chutes or other connections

No exterior loads are to be transferred to any of the equipment.

The centrate discharge chute shall be rectangular with a top flange matching the flange of the flexible liquid discharge connection. The chute shall include a 50 mm connection as a vent flange.

The chute shall maintain the shape of the centrifuge casing discharge connection and shall be 300 mm long. The chute shall be independently supported so as to impose no weight on the centrifuge casing flange. The chute is to be manufactured from 304 stainless steel.

The dewatered sludge discharge chute shall be rectangular with a top flange which matches the flange of the solids flexible discharge connection. The chute is to maintain the shape of the centrifuge casing discharge connection and is to have sides as straight as possible to prevent solids from bridging or hanging up. The chute is to be independently supported so as to impose no weight on the centrifuge casing flange. The chute is to be 600 mm long and shall be manufactured of 304 stainless steel.

9 Controls

A complete central system shall be furnished for each centrifuge to include all controls, instrumentation and interlocks necessary for the operation of the centrifuge and ancillary equipment.
The main control panel shall be free standing and have a NEMA 4X enclosure. The control panel shall be equipped with the following:

- 1. Main circuit breaker.
- 2. Variable frequency inverter for the main drive motor.
- 3. Motor starter for the hydraulic drive system.
- 4. Pushbuttons, H-O-A and running lights for:
    - Main Drive Motor
    - Backdrive Motor
    - Cake transportation (conveyer or pump)
    - Feed pump
    - Polymer make up systems
- 5. Ammeter and Hours-run meter for main drive motor.
- 6. Indication of the following malfunctions on the HMI.
    - High main drive motor temperature.
    - High Backdrive motor temperature.
    - High vibration in main bearings.
    - High Backdrive torque (hydraulic pressure).
    - High high Backdrive torque
    - High sludge pump discharge pressure
    - High polymer pump discharge pressure.
    - High centrate tank
    - Low polymer tank
    - Low sludge flow
    - Diverter valve malfunction
    - High Backdrive oil temperature / low level
- 7. Audible alarm with re-set.
- 8. Microprocessor
- 9. Panel view HMI

10 Painting

Shop and field painting shall be manufacturers standard.

11 Spare Parts

The following spare parts shall be furnished with the centrifuges and back drive systems.

- 1 Set of Bearings and Seals.
- 1 Set of O-Rings.
- 1 Set of Matched Drive Belts.
- 1 Set of Filters

12 Special Tools

One set of the following tools will be furnished.

- 1 Set of Wrenches.
- 1 Bowl Lifter.
- 1 Bearing Puller.

C. Execution

1 Service

The centrifuge manufacturer shall furnish the services of an authorized representative to inspect the equipment installation, check out the equipment mechanically, and instruct plant operating personnel in the operation, optimization and maintenance of the equipment. This service shall be for a period of TWO 8-hour days and shall be completed within TWO trips to the job site.

13.2.3 CONVEYORS

A. Sludge dry cakes shall be collected from the centrifuges by a inclined screw conveyor. The steel bins outside the building shall be loaded by another screw conveyor by a slewing arrangement.

B. The contractor shall supply two inclined cake conveyors and one horizontal cake conveyors for centrifuge system.

C. Horizontal cake conveyors shall have capacity of 3 m3/hr and the material is made of stainless steel including trough, cover support and spiral.

D. Inclined cake conveyors shall have capacity of 1 m3/hr and the material is made of stainless steel including trough, cover support and spiral.

E. Screw conveyors for mixing and conveying the cake with lime shall have capacity of 3 m3/hr and the material is made of stainless steel including mixing hopper, cover support and spiral.

F. Final inclined cake conveyors shall have capacity of 3 m3/hr and the material is made of stainless steel including trough, cover support and spiral.

13.2.4 THICKENED SLUDGE PUMPS (PROGRESSIVE CAVITY PUMP)

A. General

All supplied and erected thickened sludge pumps shall be suitable for pumping the thickened sludge of 2% solids or greater directly without any blockage either inside the pump or in the suction and delivery piping system.

The pump shall be of the progressive cavity type and the rate of flow shall be variable by manual speed control inverter using a potentiometer type of control knob. Automatic speed control shall be available using a 4-20 mA signal to the inverter.

B. Construction

1 Casing

Pump casing shall be made of cast iron alloy to (DIN 17006) or equally approved standard.

2 Rotor

Rotor shall be of the triple acting type suitable for sludge pumping services. It shall be made of cast iron alloy to (DIN 17006) or equal.

3 Frame

Pump and motor shall be coupled together and erected on a cast iron base frame, which shall be anchored to the concrete plinth of the pump set.

13.2.5 DRY LIME FEEDING SYSTEM

As specified in Sub-Section 11730.

13.2.6 CONTROL VALVE

A. A modulating flow control valve shall be fitted on each branch feeding the centrifuge. The valve shall be of the plug type with electric actuator and positional for modulating control. The valve shall be used in order to ensure even constant flow to the presses. It shall be operated from a 4 – 20 mA output signal from the flow meter through a controller.

13.2.7 FLOW METER

A. The common feed header line shall be fitted with an electromagnetic flow meter with local indication of flow and remote integration and recording at the central control panel. The size of the flow-meter shall be 80 mm and the range of measuring shall be cu. m/hr. This meter shall have flanges of ANSI B 16.5 rating 150 PSI or similar. The electrical connections shall have IP 66 enclosure. It shall include indicator, chart recorder and its power supply be a single phase at 60 Hz.

13.2.8 PIPING

A. All sludge feed piping of the dewatering system is made of uPVC class 5 based on (SAS 14).

B. Connections of piping shall be either by mechanical joints or by standard flanges. However for connections between piping and equipment, meters & valves, the standard flanges shall be used in accordance with the relevant flanges of the fitting or nozzle.

13.2.9 WASHWATER SUPPLY SYSTEM

A. The sludge dewatering system shall be supplied by an effective washing water system, supplied from the plant wash water pumps in addition to all piping network and valves within the building.

B. The wash water-piping network shall be connected to all presses and reactors in addition to the house connections between presses. Its nominal diameter shall be 50 mm and made of uPVC class 5 based on (SAS 14). All valves shall be of the ball type, flanges connections with stainless steel ball and stem with plastic linings and coating. Fire hose with reels and connections shall be supplied and installed as shown on drawings of the building, each with 15 meters length hose.

13.3 EXECUTION

13.3.1 INSTALLATION

A. General

The sludge dewatering system components shall be installed at the locations indicated in accordance with the manufacturer's written instructions.

13.3.2 FIELD TESTING

A. Field testing shall be performed as follows: The sludge dewatering system shall be tested in place to assure conformance with performance requirements. Equipment supplier shall certify proper installation prior to startup.

14 PUMPS

14.1 GENERAL

14.1.1 GENERAL REQUIREMENTS

A. All supplied submersible pumps shall be suitable for pumping sewage and sludge without any blockage and shall be of the vertical type close-coupled, hermetically sealed, waterproof non-clogging impeller type and all material of construction must be suitable for corrosive and abrasive services of the sewage water and sludge. All wet hydraulic parts must be of hardened and tempered materials after final machining of the components. The pump shall be installed in a wet sump. It shall not be necessary for personnel to enter the sump during maintenance or for re-installation purposes. An automatic discharge connection shall be fitted.

B. All supplied and erected sludge pumps shall be suitable for pumping the return and waste activated sludge (of 98% liquid content) directly without any blockage either inside the pump casing or in the suction and delivery piping system.

C. The utility water pump set shall be provided to supply the sewage treatment plant with wash-water from the effluent storage tank at the required head and flow rate to cover the requirements of the plant at both emergency case and normal operation and maintenance case.

D. The treated water submersible pumps shall be provided to deliver the treated effluent of the treatment plant, under pressure, irrigation tank ,

E. The system shall feed the treated water into the fire fighting water and wash networks.

14.2 PRODUCTS

14.2.1 SEWAGE AND SLUDGE SUBMERSIBLE PUMPS

A. Impeller

The impeller shall be made of cast iron alloy suitable for services containing corrosive sewage and abrasive solids, in accordance with the standard specification (DIN - 17006) or equal. It shall be a closed vane, non-clog with a minimum free solid size of 100 mm. The power transfer of the shaft to the impeller shall be by a key while the impeller fixing shall be protected from the sewage effect.

B. Casing

Pump casing shall be made of cast iron in accordance with (DIN – 17006) or equal. The hydraulic passage shall be smooth and free from burrs or rough spots. Discharge flange shall be radial and drilled to the applicable standard.

C. Wear Ring

Wear ring shall be fixed in the pump casing bottom and the impeller and shall be made of stainless steel (DIN 17440 X5 Cr Ni 18) for the rotating ring and chromium alloyed cast iron for the casing ring.

D. Shaft

A common pump shaft for motor and impeller shall be provided with material of stainless steel in accordance with (DIN 17440 x 22 Cr Ni 17) or (ASTM 276 Gr 416). The shaft shall be designed in such a manner that the maximum torque which can arise during operation as well as during starting and stopping has been considered.

E. Mechanical Seals

The pump shall be fitted with two independent mechanical seals. An oil filled chamber shall be provided for lubrication, independently from the medium being pumped. Mechanical seals should be maintenance-free and easy to assemble, made of "SS-316".

F. Bearings

The pump shall be fitted with life-lubricated rolling contact bearings. The upper and lower bearings shall be designed and adequately selected to give a bearing life of 100.000 hours at least at the operating point.

G. Motor

The drive motor shall be fitted into an air-filled watertight housing. The motor shall be sized so that continuous operation is possible with the motor either fully submerged or full out of water. Motor shall have the appropriate insulation class for the service and be dimensioned for a maximum of 10 starts per hour.

Motor shall be fitted with suitable control and power supply cable with adequate strain relief. The cable shall be brought into the junction box which is water-tight in the longitudinal direction. The use of resin as sealing media shall not be allowed. The junction box has to be separated from the motor section and sealed completely from the surrounding liquid.

H. Thermal Protection

The motor shall be completely surrounded by a water filled cooling jacket. The cooling water shall be circulated in such a manner that the heat from the motor is passed on to the medium being pumped. Each phase of the stators winding shall be protected by all a thermal sensor.

Bearings shall have temperature monitoring contacts located in the upper and lower area. The switch-out temperature shall be chosen in such a manner that wearing or abnormal loading which causes a rise in bearing temperature gives a warning signal for switching off from the pump control center.

I. Moisture Sensors

Moisture sensors on the basis of the conductivity measuring principle shall be located in the connection chamber, motor section and oil chamber. All signals shall be separately monitored.

The adjustment of the sensors shall be so that a warning or switch-out signal is given before major damage to the motor section may occur.

J. Flush Valve

The pump shall be provided with automatic flush valve electrically operated in order to keep the sump free of sludge build-up. The valve shall be actuated periodically by the pump control system for a certain predetermined period during the pump operating cycle.

K. Installation

The pump shall seal automatically on the discharge line. A system with guide bar and discharge connection fixed to the bottom of the sump shall be used. The pump shall be easily hoisted up for inspection without any personnel having to enter the sump. The pedestal of the pump should be provided with stainless steel "SS-304" guide rails which lines up the coupling bracket and pump before the actual coupling takes place.

L. Pumps Operation

Pumps shall be operated under remote control from the plant control room. The Contractor shall prepare a proposed operation scheme for the sludge pump station.

M. Tests

Pumps shall be tested hydraulically in accordance with standard specifications (ISO 2548 Class C) at rated capacity and head with maximum efficiency.

14.2.2 TREATED WATER PUMPING SETS

A. Description

The treated water pumping station shall consist of eight pumps. The system shall comprise submersible pumps and all necessary piping, valves and control system and in-line flow meter.

The pump shall be operated sequentially (6 working, 2 standby), a level sensor shall be installed in the filtered water tank to switch off the working pumps if the water level in the tank drops to the adjusted minimum level required to back wash the sand filters.

B. Pumps

Number of Pumps 8 (6 Duty + 2 Standby)

Type Mixed Flow Volute

Mounting Vertical Wet-well

Flow rate 2100 m3/hr

Indication Suction and Discharge pressure gauges, high bearing temperature indication with alarm, running hour meter, ammeter with direct kW reading and 30 day chart recorder.

C. Subsidiary Items

The treated water pumping station shall be equipped with a monorail crane suitable for use during maintenance and repairing periods.

All piping items installed in the station system shall be made of ductile iron or FRP.

D. Pumps Operation

Pumps shall be operated under remote control from the plant control room. The Contractor shall prepare a proposed operation scheme for these pumps.

E. Tests

Pumps shall be tested in accordance with API or with ISO standards for the duty points and the Contractor shall present all certificates for the results of these tests. The Contractor shall guarantee the pumps, performance and function within the treatment process proposed.

F. General Pump Requirements

1.All bearings shall be provided in accordance with general pump manufacturer requirement with 100,000 hours life time.

2.All pumps shall be provided with pressure gauges in accordance with standard engineering practice.

3.All the necessary cast iron pipe work valves and reflux valves to accomplish the duty and standby pump arrangements shall be provided in accordance with the relevant clauses of section three.

4.All controls, programmers and timers etc., necessary for the operation of the pumps and to achieve the sequence of events detailed here under, shall be housed in the control panel detailed in electrical specifications.

5.Both manual and automatic control shall be provided for the pumps: "hand-off-remote" selector switch shall be provided in the motor control and distribution panel. A "local hand-off-auto" selector-switch shall be provided in the plant control panel.

6.Under local hand control, starting and stopping of the pumps shall be initiated from the local filter control console detailed in electrical specifications.

7.Automatic control shall result in duty and duty assist pumps stopping and starting in response to the signals from the filter wash sequence controller.

8. Failure of a duty pump shall initiate the alarm system and the standby pump shall be started automatically and manually selected for automatic operation.

9. There shall be provided the appropriate number of level regulators to carry out the following functions:

10. Automatically cut out the pumps in the event of low level in the filterd water tank.
11. Automatically cut out the pumps in the event of high level in the irrigation tank.
12. Prevent the pumps from starting if the level in the filtered water tank is below a preset level.

G. Level Control

There shall be provided the appropriate level sensors regulators in accordance with standard engineering practice and as detailed below:

The operating levels of the regulators shall be determined by the contractor prior to commissioning.

The stop level for the duty and standby pumps shall be set by the contractor as low as the equipment and arrangement will permit.

The difference between start and stop level shall be selected to prevent more than ten starts per hour, but shall not be less than 150 mm.

H. Motors

Motor shall be protected to IP67 unless otherwise specified.

I. Starters

The pump motor starters shall be housed in the motor control and distribution panel, as described in electrical specifications.

J. Stop Push Button Stations

A local "emergency stop" push button shall be provided for each motor, the 'stations' shall be located adjacent to each pump motor.

K. Cabling

All cabling shall be provided in accordance with electrical specifications.

L. Safety Notices

Safety notices shall be provided in accordance with standard engineering practice wording of the notices shall be subject to the Engineer's approval.

M. Metal Protection

All items of equipment shall be treated in accordance with paint specifications.

14.2.3 UTILITY WATER PUMP SET

A. System Construction

The wash water pump shall consist of an automatic hydro pneumatic boosting system controlled by pressure variations in the discharge. The system shall comprise booster pumps and a pneumatic water pressure tank at the discharge side of pumps.

The pump shall be of the centrifugal vertical multi-stage type, and shall be made of stainless steel casing with stainless steel impeller in accordance to DIN 1.4401 or equal. Shaft shall be made of stainless steel to (DIN 1.4460) or equal. All materials shall be strictly in accordance with DIN, ASTM or ISO standard specification. Pumps drive shall be an electric motor working at 380V., 60Hz of the drip proof / dust proof type.

The pneumatic pressure tank shall be made of galvanized mild steel sheets of minimum 6mm thickness, fitted with pressure gauge, water level gauge, safety valve, drain valve and an inspection opening with cover. The steel tank shall be tested in accordance with (BS S487) or to (DIN 50049).

Provision shall be made for supplying the hydro pneumatic tank with compressed nitrogen from bottles.

Complete metal work of the booster plant and the system control plant shall be epoxy coated, while the piping of the system made of mild steel above ground.

B. Installation and Control

All the items of the wash water pump shall be installed on a concrete pad nearby the treated effluent tank. The manufacturer shall provide all wiring between component items of the plant, while the Contractor shall supply the wiring of power and control serving the booster. An indicator light shall be provided on the main control panel at the control room of the treatment plant, for RUN-STOP-FAULT of each pump. The boosting pumps could be set to AUTOMATIC or on MANUAL duty. At Auto mode, the sets shall be controlled by pressure switches on the discharge side.

A changeover switch shall enable any pump to be selected on a duty or standby basis. The boosting pumps shall be protected from running dry on the suction side by means of pressure switches at the common suction header pipe.

15 MECHANICAL PIPING – PROCESS

15.1 GENERAL

This Section describes the technical requirements of the mechanical piping which shall be erected inside the different treatment units: inlet structure, aeration tanks, as well as the distribution chambers around the plant interconnecting piping.

15.2 PRODUCTS

15.2.1 PIPES, FITTING AND JOINTS

A. All mechanical pipes and fittings shall be made of Ductile Iron.

B. Effluent pipes from the clarifiers, UV disinfection, bypass and overflow piping shall be made of GRP.

15.2.2 VALVES

A. Gate Valves

Gate valves shall be made of ductile cast iron of the solid wedge type unless otherwise stated. The valves shall be designed for domestic sewage working pressure of 10 kg/cm^2.

Gate valves shall be made to comply with the following standards:

- AWWA C500-61 or
- DIN 3352-4A or
- B.S. 5150 or
- other equivalent accepted standard.

Valves shall be flanged ends drilled to conform to jointed pipe or fitting.

Body and bonnet shall be made of ductile cast iron and protected internally and externally against corrosion by enamel glass or by epoxy resin thermosetting plastic. Wedge, stem nut, stuffing box casing and gland shall be made of ductile cast iron, seat ring or body and wedge shall be made of stainless steel. Stem also shall be made of stainless steel and of the inside-screw / non-rising type. Connecting bolts shall be made of steel.

Valve shall be of the type suitable for being repacked under line pressure. Hand wheel, if required shall be made of cast iron. It shall be opened in the anticlockwise direction and have an arrow indicating the direction of opening and closing.

Gate valve whenever required in valve chamber shall be capable of manual operation of the valve from floor level or grade elevation level.

Valve may be provided with a bypass connection complete with valve in order to facilitate the opening and closing operation of the valve by pressure compensation on both sides of the valve wedge.
Gate valve shall be hydrotested after assembling at the manufacturer site and the test pressure at gate closure (Differential Pressure) shall not be less than 10kg/cm^2.

Supplier of valves shall certify that the operation of the gate valve shall not require more than 5 kilogram meter of torque. Wherever this figure will not be satisfied, the supplier shall provide the valve with a reduction-gear operating mechanism, connecting the valve stem to the hand-wheel or the surface box driving nut.

B. Check Valve

Cast iron check valve at each pump discharge line shall be of cast iron body and valve disk. It shall be of the full opening swing type with bolted over and flanged ends. The valve shall be equipped with outside lever and adjustable counter weight.

The check valves shall be designed for working pressure of 10 kg/cm^2. The internal an external parts of the valve shall be protected against corrosion by enamel glass or by epoxy resin thermosetting plastic.

C. Automatic Air Valve

The automatic air valve to be installed at the pump deliveries, shall be of the dual large orifice type suitable for air admission and evacuation of the sewage pipes. It shall be made of cast iron body and cover while the float and all other parts of the valve shall be made of non-corrodible materials.

The nominal working pressure of the valve shall be 10 kg/cm^2. The air valve shall be installed combined with an isolating gate valve of the same diameter and a washout gate valve. Gate valves shall be so arranged that they can be opened and closed by using valve keys.

D. Flap Valve

The valve shall be of the flexible type and suitable for mounting on head walls. The valve shall require very low operating water head and consequently quiet operation.

E. Flushing Tap with Hose Bipp

The Contractor shall supply a 25 mm diameter flushing tap and hose bib. The whole unit shall be suitable for a working pressure of 10 kg/cm^2.

F. Penstocks

All the components of the penstocks shall be made of 304L SS material suitable for corrosive services at sewage treatment plants.

The frame shall be made of welded stainless steel sections in accordance to American standard ASTM-A-276 type 304L or equivalent approved standard.

The frame guides must be of sufficient length to support the slide fully in the open position. All fasteners of the frame shall be made of stainless steel type SS 304.

The sliding door of the penstock shall be made of stainless steel type SS 304L reinforced sheet to ASTM-A-276 or equal. The sliding door shall not deflect more than 1 to 1000 of the gate span under maximum hydraulic head.

The operating stem of the penstock shall be made of stainless steel type SS 304 with ample cross section to prevent distortion and shall be capable to withstand twice the rated output of a sudden manual operation force of 20 kg. pull. The stem shall be supported by stainless steel brackets at maximum 2.5 m interval distance.

The fixed sealing and sliding faces of the penstock shall be made of ultra high molecular weight polyethylene and shall provide a low coefficient of friction between the sliding surfaces.

The penstock shall be fixed to concrete by stainless steel anchor bolts type SS 304 to ASTM-A-276.

The penstock shall be of the rising spindle / stem type. It shall be suitable to withstand hydraulic differential head of 10 m.

Whenever required, the penstock shall be equipped with pillars, foot brackets and stem / spindle guides and brackets as well as wall thimbles . The gate shall be provided with geared lifting devices, crank operated, with two speed lift ratios 4:1 and 2:1. The lifting device shall include thrust ball bearing above and bellow the lifting nut. The bevel and spur gears shall be driven by steel pinion shaft with needle bearings. The fully enclosed housing of the lifting device shall be made of cast iron and pedestal bases are cast iron. The crank shall be removable with fitted handgrip. Lubrication nipples shall be fitted to the device. Stem cover of clear plastic type shall be supplied with each device along with a locking device.

Unless otherwise indicated, channel penstocks shall have flush bottom rails and sealing strips.

Hand-lifting penstocks and disk valves shall be as above described except that, instead of being operated through spindles, they shall be operated by lifting handles complete with easing-off devices and self-sustaining device.

Where penstocks are to be of laminated construction they shall be constructed in a form similar to those manufactured of stainless steel but the frame and door shall be constructed of steel with

nylon, cellular polymer and rigid compressed composite plastic laminar sheets enclosing a steel matrix completely sealed against water and against corrosion. The seals may then incorporate low friction plastic and expanded neoprene strip. All fasteners used shall be manufacture in stainless steel.

G. Hand Stops and Stop Logs

Hand-stops and stop-logs shall be easily hand operated and shall be controlling the flow of sewage at the inlet structure channel. They shall be made mainly or light weight material with high strength value with non-corrosive characteristic.

Hand-stop shall be made of light weight high strength door, stainless steel frame, stainless steel fasteners and sealing arrangement that will provide no leaking and no corrodible surfaces. Two stainless steel lifting handles shall be bolted to the door for lifting purposes.

Stop-logs isolators shall be made of light-weight high strength materials logs, of stainless steel frame and sealing arrangement that will provide no-leak, no-corrosion. Also two log lifting tool shall be provided with each unit.

15.2.3 MOTORIZED VALVES AND PENSTOCKS

A. Electric motor actuator shall be provided for those valves, weirs or penstocks needing remote or automatic operation.

B. Gate valves and penstock shall be manufactured as previously specified. Indicators shall be provided to show the position of valves. The drive units shall be of the best geared crank type actuators, with simple manual-auto selection facility (manually in the event of power failure).

C. The electric drive motors shall be squirrel cage stator built integrally with the actuator and with operating speed compatible with the type of valve and generally less than 50 r. p. m.

D. The construction shall allow quick and easy removal of the motor stator and / or rotor for replacement.

E. There shall also be provision for the motor to reach maximum speed before taking up drive so as to give hammer blow for unseating stuck valves.

F. Proper lubrication shall be provided for all gears and shaft bearing. The entire unit shall be watertight and flame proof construction. The actuators shall be fitted with a mechanical position indicator with graduated dial showing the position of the valve door.

G. The operation of the motorized valves and penstocks shall be by manual switching of the motor starters situated adjacent to the valve (locally) and from the main control panel at the control building. A selector switch shall be fitted near the valve for local/remote operation selection.

H. Also indicating lamps for all motor operated valves at the main control panel showing the status and valve door shall be provided.

I. The whole of the equipment comprising the motorized valves and weirs shall be suitable for the

duties described or required and for the site climatic conditions.

15.3 EXECUTION

15.3.1 VALVES INSTALLATION AND APPURTENANCES

A. The Contractor shall install valves as nearly as possible in the positions indicted on the Drawings in consistent with the convenience of operating the crank or wrench. Valves shall be erected in their positions free from all distortion and strain during handling and installation.

B. All valves items shall be carefully inspected for defects in workmanship and material. All debris and foreign material to be cleaned out of valve openings and seats. All operating mechanisms shall be operated to check their proper functioning and all nuts bolts to be checked for tightness. Valves and other equipment which do not operated easily or are otherwise defective shall be repaired or replaced at the Contractor's expense.

C. Valve shall be supported adequately matching the manufacturer's instructions. A permanent type gasket of uniform and adequate standard thickness shall be provided between flanges of valves and between penstocks and their wall thimble.

D. Valve floor stand shall be crank-operated as required or as suitable for applicable. Floor stands with crank-operator or hand wheel operating type shall have single or double gear reduction depending on the lifting capacity so that the maximum pull on the crank-operator or hand wheel (or T-Wrench) should not exceed 15 kg.

E. Gears, where required shall be steel with mechanical cut teeth designed for smooth operation. The pinion shafts on crank-operated floor stands, either single or double ratio, shall be supported on tapered roller bearings or other approved bearings. All components shall be totally enclosed in a cast-iron case. All components shall be totally enclosed in a cast-iron case. Lubricating nipples to be provided for the lubrication of all gears and bearings.

F. Floor stands shall include a cast-iron pedestal with the input shaft or hand wheel centerline at 90 cm approximately above the operating floor. An arrow with the word open shall be cast on the floor stand indicating the direction of rotation to open. Cranks on crank-operated floor stands shall be removable. It is necessary that floor stands shall be provided by the valve manufacturer wherever the valve shall require a floor stand.

G. T-handle operating wrenches shall be provided in the number of lengths necessary for operation of all valves in the chambers by operators of average height, working at normal positions.

H. Also in valve chambers, floor boxes (ceiling drive) made of cast iron shall be installed, and shall be suitable for installation in a concrete floor. The top of the cover shall be flush with the top of the box cover to indicate the direction of turning to open the valve.