RUM JUNGLE REHABILITATION - STAGE 2A
DETAILED ENGINEERING DESIGN

Water Treatment Facility
Technical Specification

Prepared for:

NT DPIR - Mines Division
GPO Box 4550
Darwin, NT, 0801

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BASIS OF REPORT

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DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
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1 Introduction

1.1 Scope of Work

The Contract includes the following works:

Design Development

The Contractor is responsible for the selection of all equipment so that it is both fit for the intended purpose and complies with these requirements of this specification.

The Contractor is responsible for detailed design for all electrical works, and the monitoring and control systems for operation of the plant.

Construction and Commissioning

The Contractor is responsible for supply of all equipment, construction, and commissioning of a fully functioning water treatment plant.

Operation

The Contractor will operate the Water Treatment Plant for the required Treatment Period.

Decommissioning

At completion of the treatment period the Contractor shall decommission the Water Treatment Plant, and remove all infrastructure including below ground pipes and footings, pond linings and access roads from the site.

1.2 Reference Design

The Water Treatment Plant design prepared by SLR is a 'reference design', which is not fully detailed in all aspects. The Contractor is responsible for additional detailing of elements as required to facilitate a fully functional plant which achieves the Performance Objectives.

The Contractor may enhance or modify the design only if any proposed alternative arrangements or systems are described in the Contractors Tender or agreed to by the Principal after award of Contract. The Contractor is to provide a design submission which fully details the proposed change, including purpose, technical detail, effect on performance of the Water Treatment Plant, and any changes in time and cost.

1.3 Technical Requirements

This Specification shall be read in conjunction with the Design Report and associated Drawings.

All the equipment used shall be in accordance with this Specification and shall be suitable for the function. It is essential that all chemical dosing systems offered have been demonstrated for metals contaminated water treatment on a similar scale for that proposed.

The treatment plant shall be capable of treating water at variable rates and will include flow paced chemical dosing with residual trims for pH.

Chemical storage volumes for all chemicals, except lime, are based on at least 30 days storage at peak flow and average water quality, or sufficient capacity to received full tankers of chemical deliveries plus approximately 25%, whichever is the highest volume. Lime is based on 14 days site storage volume with roadside space for a tanker or dog or both.

2 General

2.1 Chemical Pipework

The supply, installation and commissioning of all chemical pipework shall be undertaken in compliance with the requirements of this section.

2.1.1 Acceptable Dosing Line Materials

For Class 8 corrosive substances such as hydrochloric acid and hydrogen peroxide the dosing lines shall be constructed from Schedule 80 uPVC.

Dosing lines for lime shall be flexible reinforced PVC.

Dosing lines for polelectrolyte shall be uPVC Class 18 above ground and reinforced polyethylene hose below ground in ducting.

Dosing lines for carbon dioxide are to be 316SS, glass reinforced lined carbon steel, IPC steel tubing or corrosion resistant alloy tubing.

All solvents and adhesives for pipework joining shall be compatible with the chemicals being conveyed.

2.1.2 Chemical Dosing Line Arrangements

All uPVC pipework installed (except pipework in chemical trenches) shall be painted and labelled. All other pipework will be clearly labelled to requirements of AS 1345 displaying the pipework content and flow direction.

Duplicate dosing lines shall be provided for all chemicals. Each end of the pipework shall be labelled with type of chemical, hose number and be provided with isolation valves and dust caps.

Include appropriate isolation and non-return valves on the dosing pipework. A hose cock for flushing each chemical system shall be installed on the common pump suction and discharge lines.

Each chemical delivery system shall be fitted with a pressure relief valve with a return line to the suction side of the dosing pump. Whenever the pressure relief valve operates, there shall be obvious visual indication by clear tubing compatible with the chemical being dosed.

The Contractor shall ensure pipework design and installation prevents air locks and other effects that prevent effective transmission of chemicals.

Pulsation dampeners shall be connected to all delivery lines.

Loading valves shall be installed on all dosing pump delivery lines.

Support pipework in accordance with AS2032 and the manufacturers recommendations.

Support Types:

- Pipework up to 50 mm diameter - Use 316SS bolted clips or an approved alternative system.
- Larger Pipework – Use fabricated supports fabricated from 316 SS.

Clips, Shanks and Bolts: Use 316 SS, shanks and bolts throughout. Where fixing to steel work is necessary, use 316SS bolts. Where fixing to reinforced concrete is necessary use stainless steel chemical anchors, isolated from dissimilar metals.

Fixing to Horizontal Surfaces: Where supports are fixed to horizontal surfaces, fix base plates and brackets 50 to 100 mm clear of the surface and neatly grout after fixing.

All pipes/hoses shall be protected against vandalism and mechanical damage.

All dosing lines shall be contained in chemical trenches or be mechanically protected. Chemical trenches shall be easily accessible by the use of metal covers or similar approved to enable efficient change, repair and inspection of chemical pipework. The chemical trenches and covers shall be designed and installed to prevent ingress of stormwater.

Chemical trenches should only be designed to contain chemical dosing lines. Instrumentation, air, water and electrical services shall be contained in separate trenches or conduits. Trenches and pits containing both chemical and other lines will not be accepted.

Diffusers/injection lances (for all duty and standby chemical dosing lines) shall be used to ensure uniform distribution of chemical solutions into the mains as required. The diffuser/injection lances shall be capable of withdrawal from the main without stopping the water flow in the main. Use union fittings and corporation cock for this purpose.

2.1.3 Chemical Storage Bunds

Bulk chemical storage tanks and transfer pumps shall be located in a covered and secure bunded area. The bund shall be sized to contain 110% of the largest tank capacity or, where tanks are interconnected, 110% of all connected tanks. The bund floor shall drain to a collection sump to enable the bund contents to be pumped out. The bund cover shall prevent rainwater from entering the bund area. The bunded area containing the bulk storage tanks and filling points shall be fully secured to prevent unauthorised access to this area.

2.1.4 Testing of Chemical Delivery Pipes

Chemical dosing lines shall be hydrostatically tested for a 24 hour period under normal operating pressure to determine integrity of the system. Test pipelines hydrostatically to the relevant Australian Standard. Provide all equipment, temporary pipe seals, pumps and manpower required for the tests that shall be carried out in the presence of the Superintendent. Any leaks or sweating in pipe runs or fittings shall be repaired to the Superintendent's satisfaction.

2.2 Chemical Dosing Safety Equipment

Provide the following safety equipment, as a minimum, located immediately adjacent to the chemical unloading area but protected from accidental spray or spillage and with completely unobstructed access:

A deluge-type safety shower and eyewash facilities (all complying with ANSI Z 358.1) must be located within seven metres (but not closer than two metres) to any product transfer point. Water to safety equipment must come directly from the main supply and not be subject to disruption from plant maintenance or power failure.

1. A fire hose (20 mm nominal bore minimum) permanently attached to a water tap and capable of reaching all parts of the unloading pad, chemical storage and batching areas. Water to safety equipment must come directly from the main supply and not be subject to disruption from plant maintenance or power failure.
2. A fire extinguisher suitable for use in electrical/chemical fires.

3. Provide HAZCHEM signage as required by relevant legislation, Australian Dangerous Goods Code and Australian Standards. At a minimum signage should include:
    - Chemical in storage
    - UN No.
    - Hazchem Code- HAZCHEM sign will be fastened to the outer surface of the bund wall.

The following safety equipment shall be within 2m of the class 8 chemicals

- Close fitting chemical goggles with a face shield (2 sets).
- PVC jacket or impervious rubber aprons (2 sets).
- Two dust masks as to AS 1716 (Class P1).
- Elbow length rubber, or PVC gauntlet gloves (2 pairs).
- Rubber boots, worn inside the overall legs (2 pairs).
- Locker or other enclosure to store Items 5- 9 adjacent to the chemical receival or storage area(s).
- Materials Safety Data Sheets for each chemical laminated and displayed in both the bunded areas and chemical dosing rooms.
- Provide emergency positive pressure self-contained breathing apparatus that meets the requirements of AS 1716 having a service life of at least 25 minutes. The facemask shall be fitted with speech diaphragms.
- Provide appropriate gas detection equipment to allow confined space entry.
- All confined spaces shall be appropriately signed and secured.
- Where necessary make appropriate provision for davit arms and harnesses, fall arrestors, and associated anchor points to be installed for entry into tanks, reservoir, filters, valve pits and other confined space areas. The construction and installation of this equipment shall comply with relevant Australian Standards.

2.3 Chemical Systems Installation

Support all metering pumps 600mm above ground level on a 316SS, PVC or other approved stand. Spaces between and under equipment base plates shall be free draining.

Provide appropriate chemical dosing equipment including the supply and installation of base plates and holding down bolts, pipework connections.

All chemical systems shall be bunded with separate drainage systems for each chemical dosing system.

Provide adequate dust control and ventilation to any areas where dry powders are batched or stored.

Provide all documentation and signage required under applicable regulations, including Dangerous Goods manifests, Workcover guidance notes; Chemical Data Sheets, or other relevant authorities in the state.

Provide automatic change-over to stand-by units on duty unit failure.

Units shall rotate between duty and stand-by on each start.

All cabling, electrical and mechanical equipment shall be kept above the level to which the bund could flood in the event of a chemical spill.

All chemical dosing systems shall be flow paced (and residually trimmed for pre and post pH correction) to the appropriate flow meter. The set point and control loop (PID) parameters shall be capable of being set via the operator interface (SCADA).

All chemical handling systems shall be designed to eliminate manual handling. Lifts, hoists and/or other lifting equipment that are required to unload trucks shall be included in this contract.

Where chemicals have to be batched manually by weight (eg polymer), a 40 kg capacity industrial platform scale shall be supplied. If digital scales are provided they shall be powered by 240V power supply. The scale shall be accurate to 0.25 kg.

2.4 Chemical Dosing Pumps

Pump Operation:
To operate in a one duty-one standby arrangement with capability to operate two pumps in parallel.
Pump Type:
To be of the mechanical driven positive displacement diaphragm or piston/diaphragm type complete with electric drive units and all related accessories as described below and in the Technical Schedule. Other dosing pump alternatives will need to be approved by the Superintendent.
Pump Requirements:

- Drives to be suitable for use with variable frequency controllers to allow flow pacing and residual trim controllers.
- Provide manual stroke adjustment incorporating a calibrated gauge to facilitate pre-setting, and permit an output variable from zero to maximum.
- To be capable of accurate dosing with repeatability and linearity sufficient to satisfy the proof tests specified. This accuracy is to be available over the full speed turndown range.
- To be designed such as to facilitate maintenance with appropriate provisions for lubrication and access to valves and other moving parts.
- To be fitted with suction strainers of a suitable corrosion proof material with a maximum opening of 1 mm.
- Pressure relief valves shall discharge into the suction side. Whenever the pressure relief valve operates, there shall be obvious visual indication.
- Include appropriate isolation valves.
- Install pulsation dampener with visible pressure indicator on discharge side of dosing pumps.
- Install a backpressure valve on the discharge line from the metering pumps to maintain dosing accuracy at various depths in the storage tank(s). The backpressure setting shall be set externally without dismantling the valve.
- The metering pumps shall be of reliable construction and all working parts in contact with chemical solution shall be corrosion proof and compatible with the chemical contents.
- If there is a risk of gas formation in the pipework (eg Hydrogen Peroxide) the pumps shall be located at a lower level than the storage tank such that the pumps suction is always flooded, with suitable gas relief venting to the building exterior.

- Pump flow shall be manually regulated with a repeatable accuracy of ±2.5 % of the set rate. The stroke adjustment shall incorporate a calibrated dial (0-1 or 0-100%) to facilitate pre-setting and shall be capable of adjustment while the pump is either running or stationary.
- If the indication is not in L/h, then a graph shall be supplied showing setting versus flow rate. Supply a copy of this graph laminated in a Perspex covered frame and mounted on the wall near the metering pumps.
- Pump controls shall be fully integrated into the water treatment plant control system.

Pump Calibration Cylinder:

- Supply a clear plastic or polycarbonate cylinder with a clearly numbered calibrated bolt-on strip for pump calibration with flanged connections and isolation valve to the suction pipe work. The top of the calibration tubes for the dosing pumps shall extend at least 500 mm above the overflow pipe of the tank. The tube shall be adequately supported/protected against mechanical damage. Locate the calibration cylinder to permit charging over the full range of bulk tank levels. Locate the calibration cylinder to allow ease of operator access and observation.
- Locate pumps or provide platforms as necessary to allow operators reasonable access to pump controls and displays.
- Provide sun shields on externally located pumps.
- Dilution water shall be provided for all chemical dosing systems/pumps with manual bypass for any solenoid valves. Rotameters shall be provided to regulate dilution water flow rate. Flow switches shall be provided for dilution water flows to alarm of low flow conditions. If low dilution water flow is detected an alarm on the SCADA system will be raised.
- All dilution water points shall have individual Reduced Pressure Zones (RPZ's) devices for each chemical dosed to prevent backflow into the water supply network.
- Provide an injection lance (for duty and standby lines) to ensure uniform distribution of chemical solutions into the centre of the receiving mains. The diffuser shall be capable of withdrawal from the main without stopping the water flow in the main. Use union fittings and corporation cock for this purpose.

2.5 Storage Tanks

The Contractor may choose to install Intermediate Bulk Containers for liquid chemicals rather than more permanent facilities.

Chemical storage tanks shall be vertical, cylindrical, conical or domed roofed storage tanks. The tanks shall be constructed in roto-moulded high-density polyethylene (HDPE) or fibreglass reinforced polymer (FRP). HDPE tanks and fittings should be rated for storage of Class 8 corrosive substance with an S.G of 1.5 and shall be guaranteed for at least 10 years.

The tanks shall be obtained from a supplier/manufacturer with proven experience in the fabrication of chemical storage tanks for corrosive chemicals. The tanks shall be designed and constructed in accordance with AS2634 and shall be hydrostatically tested for 24 hours prior to delivery to site and again for a further 24 hours after onsite installation. The cost of all testing and any repair will be borne by the Contractor.

If more than one tank is provided, then each tank shall have a separate filling line for transferral of the chemical from the road tanker. The filling lines shall project into the tank as suitable to minimise splashing.

The storage tank(s) shall be fitted with the following flanged connections

1. One (1) 50 NS top side inlet;
2. One (1) 50 NS bottom side outlet;
3. One (1) 50 NS drain;
4. One (1) 80 NS top side overflow;
5. One (1) top flange for ultrasonic level transmitter.
6. A 600 mm diameter manhole gasketted with hinged cover on the side at l m centreline above ground level (FRP tanks only);
7. A 80 NS inverted vent with protective cap and gauze mesh shall be provided in the roof;
8. Lifting lugs, as appropriate.
9. Flange backing plates shall be Grade 316 stainless steel.

Isolating valves for the tank outlet and drain lines shall be rubber lined diaphragm valves or uPVC ball lockable valves (George Fisher Series 546 or equivalent).

A visual tank level indicator covering the full height of the tank shall be designed for each system. It shall be adequately supported/protected against mechanical damage. Provide a traffolyte scale (black markings on a white background) marked with appropriate volumetric graduations mounted adjacent to the sight tube. The tank level shall have a lockable valve isolating it from the main tank.

Sight glasses are not acceptable mean of level indication for chemical storage tanks containing greater than 10 kL of Class 8 liquids. Provide filling operator visible magnetic level indicators and hydrostatic level indication reporting to the SCADA for all Class 8 storage tanks greater than 10kL.

All bulk and day tanks will have analog signal displaying the actual tank level through the SCADA. Rate of change of level for each bulk storage tank shall be recorded by PLC and a SCADA alarm raised when rate of change of tank level exceeds an operator adjustable setpoint.

All chemical storage tanks shall be fitted with independent high high and low low level detectors. These will sound an audible alarm and visible flashing light when high high level has been reached in a storage tank. The level detectors shall also indicate the high high and low low alarms on the SCADA system. Tank high high level switches to be 'latched' to the relevant GPO, such that when the high high level switch is actuated, the transfer pump GPO is shut off. Label this GPO accordingly. The alarm and flashing light shall be re-settable in the SCADA system.

Level detector outputs will be displayed on the SCADA system.

2.6 Batch / Mixing Tanks

The batch/mixing tank(s) shall be complete including inlet, outlet, overflow and drain connections and a removable lid. The drain shall be designed to allow complete draining of any sediment settling on the floor of the tank(s). Overflow and drain shall be discharged to a floor sump. All residues precipitated in the tank(s) shall be easily flushed through the drain. The drain shall be flush with the inside base of the tank. The metering pump draw-off shall be sufficiently high above the base of the tank to avoid the entry of solid material into the suction line.

The tanks shall be 316 SS, polyethylene or glass reinforced polymer (GRP) designed to AS 2638 or other approved corrosion resistant material. Valves for isolation of each tank shall be provided.

Each tank shall be fitted with a transparent polycarbonate sight/calibration tube. It shall extend to the height of the tank and be of adequate size to enable the operator to easily check the remaining volume of solution in the tanks and to carry out calibration tests on the dosing pumps. The tube shall be graduated in dual scales and shall be protected against mechanical injury. The site tube shall have a valve isolating it from the main tank.

Stirrers shall be suitable for continuous operation and shall be able to maintain a uniform mixture. The stirrers shall be mounted on separate stands (not on the mixing tanks) and shall be fabricated with 316 SS shafts and impeller(s) or other approved corrosion resistant material as appropriate to the chemical being batched. Provide baffles to enhance mixing in the batch tank, vortexing and water splashing out shall not be acceptable under any circumstances.

Stirrers shall be positioned below the low level in the tank to ensure that only well mixed solution or slurry is pumped from the tank at all times. Level switches shall be located to ensure outputs are not adversely affected by the action of the mixers.

The distance between the bottom of the impellers and the floor of the tank(s) shall not be greater than 300 mm. The low level switch shall be positioned above the bottom impeller level.

The stirrer, shaft and impellers shall be dynamically balanced to eliminate all vibrations.

2.7 Chemical Bunding

A bund wall shall be designed and constructed in accordance with the requirements of the relevant environmental authorities within the state and the following (as a minimum):

1. The bund floor and walls shall be constructed of concrete. The resulting bunded area shall be able to prevent the migration of any chemical spillage or leakage to the surrounding ground during its operational life.
2. The bund shall be designed to resist corrosion from each chemical from the respective tanks, this shall involve coating the internal faces of the bunds in order to provide adequately protected from corrosion [eg if using Ferric chloride the bund shall either be lined with U-crete or chlorinated rubber paint (Dulux Luxachlor or equivalent)] with grit added to produce an anti-slip surface.
3. The gross capacity of the bunded compound, discounting the displacement effect of each chemical storage tank, shall be at least 110% the storage capacity of the largest tank, plus the volume displaced by any foundations. Note that if tanks are interconnected below the liquid level the storage capacity will need to 110% of both tanks.
4. The bund floor shall drain towards an internal sump to be located such that the bund can be pumped out with a small portable pump. The pump and the power connection points to be provided as part of this contract. The pump discharge pipework and power connections to each bund shall be provided as part of this contract.
5. Any tanker unloading shall be carried out within a shallow bund or sloping concrete area draining to an isolated sump (road tanker bund area). This sump shall be capable of being pumped out using the same pump as that provided to pump out the chemical tank bunds. The drains adjacent to the sump pump outs shall be connected to the wastewater pipework leading to the sewerage system.
6. Pipework shall not be placed through the bund wall.
7. Any hose couplings for tanks enclosed within the bund shall be placed in a position that ensures that all leaks or spillages are contained within the bund. The male hose coupling shall be located within the bund.

8. A collection sump (or other satisfactory collection arrangement) shall be provided in the bund floor to facilitate the removal of liquids. FRP grate shall be provided for the sump.
9. Access steps with handrails shall be provided for entry and exit into each bunded compound.
10. All pipework, except the overflow lines, shall be fitted with suitable isolating valves. Isolating valves for the tank outlet and drain lines shall be rubber lined diaphragm valves with a PTFE-faced diaphragm. Other isolation valves shall be ball type with seals resistant to the various chemicals.
11. The Contractor shall fit the filling line with a 2½" "Kamlok" fitting for connection to the delivery vehicle. When not in use, a "Kamlok" twist shall be fitted. Kamlok fittings shall be of an approved corrosion resistant material. A drainage tee and valve shall be installed adjacent to the Kamlok fitting. The drain from the filling line shall discharge into a sump.
12. A hosing station shall be provided close to the chemical bunds to allow for hosing of all bunded areas including the road tanker bund area.
13. Bunds will be hydrostatically with water tested for a 24 hour period before they are deemed fit for use by the Superintendent.
14. All external bund areas shall include float switches to indicate flooding of the bund on the plant SCADA.
15. All bulk chemical bunds and storage tanks will be designed to comply with AS3780-1994 for storage and handling of corrosive substances.

2.8 Tanker Delivery

When delivery of chemicals is by road tanker, filling of the storage tanks will be by means of a polypropylene, PVC or other corrosion resistant material NATO male Kamlok fitting on the tank filling line.

The Contractor shall provide an IP56 rated combination switch and both:

1. 4-pin plug socket for 3-phase, 415 Volts, 50 Hz at 20 amp rating for semi tankers (> 8000 L) and
2. 3-pin plug socket for single-phase, 240 Volts, 50 Hz at 15 amp for rigid tankers < 7000 L: installed in accordance with AS3000 and power supply authority regulations shall be located within 7.5 metres of the filling point.

The contractor shall confirm the suitability of the above requirements with the relevant supplier in each case.

2.9 Local Switchboard

The electrical switchgear/control gear shall include but shall not necessarily be limited to:

1. Duty/standby arrangement for all chemical dosing pumps and dosing locations under normal operating conditions
2. Duty/standby pumps shall have the ability to be operated together under abnormal conditions
3. Duty/standby pumps shall operate in "flip-flop" mode where duty shall alternate between each pump on start up
4. One MANUAL /AUTO selector switch for each pump
5. One ON/OFF switch for each pump, operative only when manual is selected.
6. One PUMP 1/ AUTO/ PUMP 2 duty pump selector switch
7. Lamp test button.

8. One two-position MANUAL/AUTO selector switch controlling the dust extractor, as appropriate.
9. One OPEN/ CLOSE switch for the dilution water solenoid valve, operable only when the process selector switch is on MANUAL, as appropriate.
10. One three-position MANUAL/OFF/AUTO selector switch for each remaining item of equipment, including volumetric feeders and service water ejector solenoid valves, tank (eg slurry) outlet solenoid controlled pneumatically actuated diaphragm valves, tank mixers and mechanical mixers, as appropriate.
11. Adjustable timers for service water ejector solenoid valves.
12. Adjustable timers for mixing tank agitators.
13. Fault reset button.
14. Operation indication lights for each item of equipment.
15. All necessary circuit breakers, contactors, thermal overloads, variable speed controllers, etc.
16. System status on main panel and the SCADA system

The following fault indicating lights or alarms on the SCADA system shall be included (as a minimum):

1. Dosing pump failure.
2. Dilution water valve failure.
3. Storage tank low and low low level alarm.
4. Storage tank high level alarm (and audible alarm).
5. System failure.
6. Bund flood indication.

The system operation signal shall be generated from the pump motor of the duty dosing system.

Any condition (1) to (6) above shall show dose system fault for transmission to the SCADA system. When the dosing system is in automatic operation, any dosing pump fault shall automatically initiate standby unit into operation. If faults occur in both the duty and standby dosing units it shall be shown as “System Fail” on the LCP and SCADA system.

2.10 Chemical Systems Testing and Commissioning

The work required during commissioning includes but is not necessarily limited to:

- Final adjustment of equipment and control settings.
- Starting up the equipment.
- Final performance testing.
- Final commissioning.
- Making good any defects

Individual Equipment Testing:

Notwithstanding the requirements for overall plant performance, individually test the items of chemical equipment supplied under this Contract for compliance with duties specified. Run all equipment installed under the contract over its full operating range.

Cleaning:

Sweep and thoroughly flush all chemical tanks, lines and metering pumps clean off all solids, swarf, etc., before filling and testing. Avoid any metallic contamination of storage tanks.

Testing:

To be carried out in the presence of the Superintendent and to continual until the Superintendent is satisfied that the equipment is performing as specified and is installed correctly. Perform up to three test runs at the discretion of the Superintendent.

Chemicals:

The Principal will arrange for supplies of chemicals for testing and commissioning. Test chemical storage tanks to approval prior to supply of chemicals.

Faults:

Rectify any leaks, vibrations, excessive splashing, sagging of pipeworks, inaccessibility of valves, fittings and equipment, looseness of fixtures, poorly aligned pipework etc., to the entire satisfaction of the Superintendent and re-test the equipment.

Equipment Failure:

Replace or modify and re-test any equipment supplied under the contract that fails to meet the specified duty and tests.

3 Lime Storage and Feeding System

3.1 General

Provide a package lime mixer with a lime storage silo(s), day hopper, slurry mixing tank and duty/standby dosing system to dose diluted hydrated lime or quicklime slurry for pH adjustment. The indicative chemical characteristics of commercially available lime are as follows:

Table 1 Hydrated lime minimum requirements

Calcium Hydroxide	95.5%
Calcium Carbonate	1.5%
Magnesium Hydroxide	1.0%
Ferric Oxide	0.5%
Aluminium Oxide	0.5%
Silicon Dioxide	1.0%
Residue 75(m (200 mesh)	0.5%
Specific Gravity	2.3 - 2.4
Bulk Density (kg/m^3)	450 – 560

The design of the treatment process shall ensure that impurities present in commercially available lime do not adversely impact on water quality.

The lime feeding equipment shall automatically start/stop on receipt of flow signals generated from the appropriate flowmeter via the PLC. When lime is used for pH control the system shall be flow paced with residual pH trim. The pH set point will be adjustable through the SCADA system and the control setting for the residual trim will also be adjustable by the operator through the SCADA.

When lime is used for water stabilisation in the low pH stream, the system shall be flow paced with pH trim achieved by carbon dioxide dosing.

Manual adjustment of the lime feed rate shall be by means of a potentiometer on the front of the local switchboard.

The system and all equipment must be capable of satisfactorily receiving and storing 150 tonne deliveries of bulk tankered commercial grade hydrated lime. The bulk lime will be transferred from the delivery truck to the storage bin by a pneumatic conveyor system. The delivery trucks are fitted with an air blower and flexible hose terminating in a female “Camlock” coupling. Provide a 100mm male “Camlock” fitting on a lime transfer pipe to the bulk storage bin. The lime bin(s), complete with supporting steel legs, shall be located within the site and adjacent to the delivery road. The bottom part of the bin (intermediate hopper section) is to be protected from the weather.

The bulk lime storage bin is to have an effective storage capacity of 150 tonnes at the minimum bulk density specified. The bin shall be designed, fabricated and erected in accordance with AS 4100, Steel Structure Code, and AS 1554, Structural Steel Welding Code. The top of the bin shall be dome shaped to ensure free drainage of water from the top of the bin.

The design of the bin shall minimise bridging, arching and hanging-up of the lime. The slope of the bin’s conical section shall not be less than 75^{o} to the horizontal. The bin design shall minimise the number of internal projections or horizontal sections which would hinder the flow of lime. All welds shall be ground smooth. The exterior of the silo shall be painted and sealed to prevent moisture ingress. The bin exterior, dust extractor and lime unloading pipework shall be prepared and painted. An access ladder shall be provided complete with handrails. The ladder shall be hot dipped galvanised steel and designed in accordance to AS 1657 and any requirements of Workcover Authority of NSW.

The bin(s) roof shall have a galvanised steel platform with handrailing and kickplate. The platform shall have removable sections, for access to manhole and other items. Bin platform, handrails, ladders, walkways, etc., shall be of hot dipped galvanised steel and shall comply with AS 1657 and any other requirements of Workcover Authority of NSW. Galvanising of the platform, handrails and kickplate should be performed following manufacture. No welding is to be performed after galvanising.

The bin shall have, as a minimum, the following fittings:

- A 100 NS tangential flanged filling connection fitted at the side of the bin and complete with a spreading device to distribute lime evenly over the bin during the filling operation. The filling connection shall be flush with the inside surface of the bin.
- A suitably sized flanged outlet for connecting the vent pipe to the dust extractor.
- Connection for bin activator.
- A DN750 circular manhole in the roof, with the flange elevated a minimum of 100mm above the bin roof. The cover shall be complete with two (2) lifting handles. The inside shall have a 50mm locating tongue, or shall be hinged to the flange. The gasket shall be 15mm thick soft rubber, suitable for temperatures of –10^{o}C through to 100^{o}C.

- A DN150 flanged outlet fitted with a suitable device for overpressure and under pressure relief at 0.5kPa gauge. The device shall be self-sealing at other pressure conditions and shall prevent ingress of air or moisture.
- A DN50 services conduit run to the top of the silo. Note: this may not be required if the dust extractor is located near the ground

The internal surface of the bin shall be sandblasted smooth to Class 2 ½ to AS 1657. Painting of the internal surface of the bin is not necessary. Provision shall be made to prevent the entry of rainwater into the bin; water ingress into the lime bin shall not be permitted under any circumstances.

Cross-bracing or any other form of structural support for the lime bin support legs inside the building cannot extend below 2.1 m above the weatherproof lime room floor level. This is to allow easy access to equipment beneath the lime bin. Bin roof and ladder lighting must be fitted on light poles.

3.2 Hydrated Lime Unloading Pipework

All bends in the filling line must have a minimum radius of 1.5m. There must be no horizontal or near horizontal sections in the filling line which could allow lime to settle and block up the line. The filling line must be located outside the structure and fixed at least 50mm clear of the structure/steelwork and must be located clear of the fully open lime room doors (when viewed from outside). The pipework is to be DN100 to AS 1074, medium thickness (4.5mm wall) or greater. The filling point is to be 1100mm above ground level and located to suit the tanker access. The unloading pipework shall terminate in an inlet with a DN100 male "Camlock" coupling complete with dust cap.

3.3 Bulk Storage Bin Level Indicators

The lime storage bin shall be fitted with a bin weighing system. This device using load cells shall be connected to an indicator mounted on the lime LCP and shall provide high and low level alarms from the device and to the indicator. The high level alarm shall be both visual and audible, to ensure overfilling does not occur. The Low level alarm shall not shut down the lime system.

The indicator shall be capable of continuous read out (analogue or digital) of the weight of contents in the storage bin with an accuracy of $\pm$5% over the entire height of the bin, including the conical section.

The bin level indicator readout shall be clearly visible from the lime unloading point.

The weight of the lime in the bin shall be available on the SCADA system for display and recording.

A bindicator shall be provided as a separate high-level alarm for the lime bulk storage bin.

3.4 Bin Activator

The bulk storage bin shall feed into an intermediate hopper as controlled by a conical vibrating bin activator. The activator shall be driven by an electric motor and connected to the remainder of the system by a flexible sleeve(s) and/or flexible suspension system. The Contractor shall provide positive lugs at the flexible sleeve to secure all holding clips.

The activator shall operate intermittently and charge the intermediate hopper when necessary. Charging shall occur according to level sensing device(s) attached to the intermediate hopper; low level shall start the bin activator and high level shall stop the bin activator. In addition, an adjustable timer shall stop the bin activator. This timer shall be used to stop the bin activator in the event of failure of the high-level sensing device in the intermediate hopper. If the timer stops the bin activator a fault light shall be illuminated. Level controls including timer shall be independent of the PLC.

Supply and position an automatically operated bulk bin rotary valve between the bin activator and the discharge to the intermediate hopper. This valve shall open/close whenever the bin activator is given a run/stop signal. The valve shall have an end stop so that travel beyond maximum opening does not occur.

Provide a manually operated sliding gate immediately above the rotary valve. This sliding gate shall be used for isolation purposes when the rotary valve is removed for maintenance.

3.5 Intermediate Hopper

The intermediate hopper shall have a capacity of at least 1/2 days lime dosage at maximum flow and average lime dose. The minimum bulk density of lime shall be taken as 450 kg/m^3 and S.G. as 2.3 to 2.4. The hopper shall have two outlets.

The design of the hopper shall minimise bridging, arching and hanging-up of lime with either one or two feeders in operation. Provide vibrator(s), as necessary. The vibrations shall not transfer to the bin above and the volumetric feeders below; suitable dampers shall be provided. Two opposite sides shall slope not less than 70^o to the horizontal; two remaining sides not less than 80^o to the horizontal.

The hopper shall include the following features:

- An access lid with hinged opening at the top of the hopper for manual loading and access to the inside of the hopper. This lid shall be locked or provided with an interlock to prevent opening while lime is being discharged from the storage hopper.
- Pipework (minimum diameter 100 NS) to vent the intermediate hopper. Vent pipe shall be vertical and connected to the top of the storage bin.
- It shall be totally enclosed with a sealed lid to prevent escape of dust.
- A transparent polycarbonate viewing window over the full height of the hopper with a minimum width of 100 mm.
- Three (3) sensing devices for determining high level and low level on the two trouserleg chutes of the intermediate hopper shall be provided. The high level switch shall be mounted vertically to permit high level adjustment. Low level switches may be mounted horizontally. The equipment shall be protected to IP56, AS 1939.
- Dual outlets

A platform and ladder designed in accordance with AS 1657 shall be provided for manual filling of the hopper. The platform shall be located to enable bags of lime to be poured from waist height.

The hopper shall be reinforced to prevent distortion and flexing and protected by a coating system. The bin shall be designed to minimise projections which could hinder the flow of lime. Welds shall be ground smooth.

Supply and install two pneumatic slide gates to control the discharge of lime out of either side of the intermediate hopper. The slide gates shall be fully sealed and minimise lime spillage and moisture ingress during operation.

Each of the outlets from the hopper shall be connected to a volumetric screw feeder.

3.6 Lime Volumetric Feeders

Two volumetric feeders shall be installed below the intermediate hopper. These shall be of the variable pitch screw type and of anti-plugging and anti-flooding design. The feeders shall be capable of 20:1 adjustment whilst operating and shall be fitted with a clearly legible graduated indicator. If the indicators are not in kg/h, then a laminated graph shall be supplied for each feeder showing setting versus feed rate. The feeders shall be

designed to allow for easy manual calibration using a weighing tray. Copies of the volumetric feeder calibration graphs shall be supplied in perspex covered frame and fixed on the wall adjacent to the relevant feeder.

When set to feed rates within the specified range, the feeders shall have an error of not more than ±5% of the set rate within the feed rate. Calibration or checking of feed rate shall be able to be carried out with ease by sliding a collection tray under the screw feeder. A suitable industrial electronic balance with a 240V connection shall be supplied by the contractor to check the dose rate. The lime feeding equipment shall automatically start/stop lime chemical dosing on receipt of a signal from the PLC.

The feeders shall be sealed to minimise leakage of lime dust during operation. All parts of the feeders in contact with lime shall be of 316 stainless steel, epoxy coated steel, reinforced plastic or other material resistant to corrosion.

When set to feed rates within the specified range, the feeders shall have a minimum turn down ratio of 20:1 and feed with an error of not more than 5% of the set rate within the feed rate. Provide a heating element for each feeder to control the humidity and avoid blocking of the feed screw. The design of the lime system shall minimise corrosion of the volumetric feeders by water vapour/caking of hydrated lime. Lime transfer from the feeder to the tank shall be totally enclosed.
Feeder outlets into the lime mixing tanks shall be located so as to avoid lime being deposited on top of the tank float valves.

3.7 Lime Mixing Tanks

The mixing tanks shall be constructed from 316 stainless steel and each shall have a minimum working capacity of 3kL. The mixing tanks shall be complete with water inlet, overflow, drain and outlet connections. Drain and overflow shall be piped to a sump. Each of the mixing tank outlets that supply lime slurry to the lime ejectors shall be located 100 mm above the bottom of the lime mixing tank to prevent solids from blocking the lime ejectors.

The service water line to the mixing water inlet shall be fitted with an isolating valve. Mixing water connection shall be fitted with globe type regulating valve and internally with 316 stainless steel float, valve and shaft assembly.
A rotameter shall be provided to measure the process water flow rate into each lime mixing tank. A low flow proximity switch shall be provided with an adjustable time delay relay on each rotameter. The rotameters shall be readily removable for cleaning and maintenance.

Each tank shall be equipped with an electrically driven agitator, which shall adequately agitate the slurry. The agitator shall provide a minimum G value of 500s-1. The tank, agitator and any other wetted parts shall be of 316 stainless steel. The agitator shall not be supported from the tank. Provide a separate floor mounted support frame.

Lime transfer from the feeder to the tank shall be totally enclosed.

A removable lockable lid shall be supplied for each of the lime mixing tanks to allow for regular maintenance and cleaning of the mixing tanks.

Whenever the treatment plant shuts down, the stirrer shall continue to operate if its selector switch is set on 'AUTO'.

3.8 Lime Slurry Ejectors

The Contractor shall provide two (2) ejectors, one ejector connected to each lime slurry tank. The ejectors shall operate on high pressure to entrain the lime slurry from the tank to the injection point. The ejectors shall be

made of 316 stainless steel. The total delivery flow capacity of each ejector (comprising lime slurry and motive water flow) shall be 5,000 L/h (1.4 L/s).

Water to actuate the ejectors shall be sourced from the treated water sump (S1). The water shall be supplied to the ejectors from booster pumps (duty and standby). The booster pumps shall have capacity to supply lime system water at a rate of 5,000 L/h (1.4L/s) to the ejectors and at a pressure of 500 kPa.

Provide a solenoid valve on the ejector water line to the booster pumps. This solenoid valve shall be complete with manual by-pass valve and upstream and downstream isolation valves.

3.8.1 Normal Operation

During start-up, the lime system water solenoid valve shall open, the duty booster pump shall start and the slurry mixer shall operate. The vacuum created at the ejector shall transfer hydrated lime slurry from the lime slurry tank to the dosing point via the dosing line.

The slurry level in the tank shall be maintained at a relatively constant level when the dosing plant is in operation by means of the inlet float valve.

3.8.2 Shutdown Operation

In the event that the treatment plant is shutdown (manually/ automatically), the hydrated lime feeder shall shutdown automatically, the lime mixing tank agitator shall continue to operate, and the lime mixing tank inlet and outlet solenoid valves shall close. The duty ejector booster pump and lime slurry ejector shall continue to operate for up to 30 minutes in order to flush the dosing lines clear of hydrated lime slurry. The time to flush the ejectors shall be readily adjustable between 1 and 30 minutes using a timer that is separate from the main control and located on the lime dosing systems LCP.

When the automatic flushing period is expired, the duty booster pump shall shutdown followed by the ejector process water solenoid valve.

3.9 Pipework and Valves

All valves handling lime slurry shall be full bore diaphragm type. Weir type diaphragm valves shall not be acceptable. Lime delivery pipework to the lime bin shall be Schedule 80 galvanised steel, flanged and welded or Schedule 80 UPVC.

The velocity of the lime slurry in the hose shall not be less than 3 m/s.

Duty/ standby/ standby lime slurry delivery lines shall be provided to the lime injection point. All connections and bends shall be able to be easily dismantled and cleaned. Pipe shall be flexible reinforced clear PVC hoses. Flow through diaphragm isolation valves shall be provided on the removable hoses at each end of the lime system pipework (i.e. at lime slurry tank and at dosing sparge).

Provide flow through diaphragm isolation valves at the end of each dosing hose at both the sparge end and at the injection point in order to avoid spillage when the hoses are disconnected for interchange.

Delivery lines shall be attached to ejector discharge by "Kamlock" couplings. Joins in delivery lines shall be provided at any change of direction. Route of these delivery lines shall be as short as practicable and routed to allow removal/replacement by plant operators when blocked. Lines shall, if practical, slope continuously towards inlet/outlet ends with no low point(s) in the middle.

Delivery lines shall be attached to the discharge sparge by “Camlock” couplings. The sparge shall be able to be easily removed.

Twin injection lances shall be provided for each lime dosing point.

3.10 Dust Collection Equipment

The Contractor shall provide a dust extractor that shall minimise the escape of lime dust to the atmosphere during unloading from the bulk tanker and from filling of the intermediate hopper. The dust extractor shall be located on top of the bulk storage bin. It shall be connected to the top of the bin and the filter bags from the dust extractor shall be possible to be retrieved from waist height. Provide easy access to all parts of dust extractor for maintenance.

During the transfer operation the dust extractor shall maintain a negative pressure in the bin. The filtered air shall be exhausted to outside the building via suitable pipework. The pipework shall satisfy the requirements of the Environmental Protection Authority and shall terminate at a point at least 1m above the ground level. Provide gauge mesh to the terminal point of the exhaust pipe.

Dust extraction suction branches to each hopper shall have manually operated isolating valves.

The dust extractor shall automatically return reclaimed lime into the lime bin. The dust extractor shall have sufficient capacity to filter and exhaust air displaced and supplied by the pneumatic conveyor system into the bin at a rate of at least 34 m^3/min of free air.

Filter area shall be at least 20 m^2. The filter material shall be polypropylene and shall be cleaned by pneumatic means; mechanical shaking or beating shall not be accepted. Cleaning of the filter shall occur continuously while filling. The filter shall be sectioned such that cleaning occurs over a section of the filter at any instant.

If the WTP compressed air system is not suitable, or is not to be used for this purpose, provide a complete compressed air system including pipework and control for the satisfactory operation of the dust extractor.

3.11 Lime Local Control Panel

The electrical switchgear/ control gear is to include but shall not necessarily be limited to:

- One MANUAL/OFF/AUTO selector switch for the process.
- One TEST/OFF switch fitted with a spring return from the test position to the OFF position for the operation of the bin activator. This switch shall function only when the process is selected for MANUAL.
- One OPEN/CLOSE switch each for the bulk bin rotary valve and diverter flap. Each switch shall function only when the process is selected for MANUAL.
- One two-position ON/OFF selector switch controlling the dust extractor.
- One three-position ON/OFF/AUTO selector switch for each remaining item of equipment, including volumetric feeders and lime system water solenoid valve, slurry tank mixers and ejector water booster pumps.
- Adjustable timer for bin activator.
- Adjustable timers for lime system water solenoid valve.
- Adjustable timers for mixing tank agitators.
- Fault reset button.
- Lamp test button.
- Operation indicating lights for each item of equipment.
- All necessary circuit breakers, contactors, thermal overloads, variable speed controllers, etc.

All timers shall be separate from the main control and adjustable from the front of the Lime LCP without opening the door of the panel.

The following fault indicating lights shall be included:

- High level external flashing light
- High level in the lime storage bin.
- Dust collector equipment failure.
- Low level in the lime storage bin.
- Bin activator failure.
- Bin activator stopped on timer (and not on high level sensing device in the intermediate hopper).
- Rotary valve motor failure.
- Diverter chute gate failure.
- Volumetric feeders failure.
- Mixing tank agitators failure.
- Booster pump failure.
- Lime system water solenoid valve failure.
- Lime system water low flow.
- System fail.

The run signal shall be generated from the volumetric feeder motor of the duty dosing system.
Any condition (a) to (k) shall be lime dose fault for transmission to the SCADA. Any faults (h) to (j) on the duty unit shall be shown as “System Fail” on the LCP and “Lime Fail” on the SCADA and the water treatment plant shall shutdown automatically.

3.12 Safety Equipment

The following safety equipment shall be located adjacent to the unloading area for lime:

- Deluge type safety shower or plunge bath and eye wash facilities (complying with ANSI Z 358.1) shall be located within 7m but not closer than 2m to the unloading point.
- A hose (20 mm diameter minimum) of length suitable to reach all parts of the unloading area, permanently connected to a water tap to which water supply will not be interrupted by WTP maintenance.
- A fire extinguisher suitable for use in electrical fires.
- A safety equipment storage cabinet for dust masks.

A composite safety sign shall be provided near the lime mixing area.

The sign shall indicate the following:

1. Chemical in storage
2. UN No.

4 Hydrochloric Acid Flushing System for Lime Dosing Lines

The Contractor is to provide a Hydrochloric Acid dosing facility suitable for flushing the lime dosing lines to control scaling. The acid flushing system for the lime dosing plant is to consist of a 1000 Litre storage, a positive displacement metering pump, calibration /sight tube, dilution water, and appropriate connection to connect into the existing lime dosing lines. The equipment selected for the for the acid dosing facility shall be suitable for use with concentrated hydrochloric acid (35% w/v HCl).

The acid for the acid dosing facility shall be supplied in IBC and is to be stored in the bunded acid dosing system storage area. The acid container is to be mounted on a platform located above the dosing tank. All acid containers are to be supplied with taps. A hose is to be connected to the tap for dispensing into the dosing tank after the dosing tank has been filled with process water to the required level.

The positive displacement metering pump shall be rated at a maximum capacity of 100 L/h. The rated delivery pressure of the dosing pump shall be at least 20 metres of water (2 bar). A Start /Stop switch shall be provided for the metering pump and shall be located adjacent to the metering pump. The metering pump shall be provided with an adjustable overload motor protection and reset button.

A sight tube/ calibration tube of 30mm NS made of transparent PVC tube covering the full height of the storage tank is to be provided. The calibration tube shall be adequately supported/protected against mechanical damage and provided with graduated calibration scales. The calibration tube shall be graduated in one litre and decilitre marks for calibration of the dosing pumps. A traffolyte scale (black markings on a white background) marked in Litres, and decilitres shall be provided for the calibration tube. The top of the calibration tube shall extend above the overflow pipe of the acid storage tank and overflow from the calibration tube shall be directed back into the storage tank. The calibration tube shall be readily removable for cleaning.

Process water shall be used as process dilution water. The maximum dilution water requirement shall be 1000 L/h, which will allow greater than 10:1 dilution of as supplied hydrochloric acid (35% w/v HCl).

The acid flushing dosing plant shall be operated manually as required to maintain the lime dosing lines free of lime scaling. The acid dosing plant shall be bunded according to Australian Standard 3780. The acid dosing plant shall be located near the lime mixing area. Adequate mechanically ventilation shall be provided for the acid dosing system to remove any acid fumes which may be generated during the operation.

The following safety equipment shall be located adjacent to the acid dosing system:

- Deluge type safety shower or plunge bath, and eye wash facilities (complying with ANSI Z 358.1) is to be be located adjacent to the acid dosing system (refer drawing D846C-684).
- A hose (20 mm diameter minimum) of length suitable to reach all parts of the dosing system.
- A suitable safety mask, chemical resistant gloves, and disposable overalls.

A composite safety sign shall be provided near the lime mixing area.

The sign shall indicate the following:

1. Chemical in storage
2. UN No.

4.1 Acid Control and Alarms

The system shall be able to be operated in either test or automatic mode. SCADA alarms shall include as a minimum:

- Pump failure.
- Dilution water no flow.
- storage tank high level.
- storage tank low level.
- Bund high level.

SCADA displays shall include as a minimum:

- Bulk tank level
- Dosing pump(s) status
- Dosing pump feed rate

5 Polymer System

5.1 Flocculant

The recommended flocculant is Praestol 2540. Alternatives must have a proven track record with metal hydroxide flocculation.

5.2 Polymer Dosing System Scope

The Contractor shall include the following as a minimum the polymer dosing system:

- wetting unit (for dry powders)
- batching tank and duty tank
- water supply system
- dosing pumps
- dust control
- flow switch
- one dilution water system
- all associated pipework, valves, injectors, fittings and accessories.

Dry Praestol 2540 powder will be stored in supplied 25kg bags on a pallet. The polymer is to be loaded from the bags in which it is stored into the makeup system by vacuum loader, included under this Contract.

The Contractor is to provide a system for preparing, dosing and storing polymer, including a preparation unit for wetting and dissolving the material to a 0.25w/v % solution. The polymer preparation and dosing system shall be located between the oxidation and clarifiers.

The system to be supplied shall include a fully automatic preparation unit designed for the efficient dissolution of high molecular weight polymers. The system shall consist of:

- hopper capable of holding 30 kg of dry powdered polymer.
- vacuum loader or suitable alternative system for loading powdered polymer into the hopper from the bags in which it is supplied.
- powder feeder and wetting eductor system.
- mixing tank and mechanical mixer.
- activated polymer solution transfer system to transfer aged polymer from mixing tank to dosing tank.
- dosing tank.
- Dosing pumps.

The polymer solution is to be prepared and fed as a solution of 0.1% w/v nominal concentration, or according to manufacturer's instructions. Alternatively, a continuous package system may be installed.

5.3 Polymer Storage Hopper and Loading System

The polymer hopper shall have capacity to store 30 kg of powdered polymer. The hopper shall be constructed of 316 stainless steel. The hopper should seal from moisture ingress and be capable of sustaining routine hosing. A screen/grate shall be provided for the hopper to prevent debris from falling into the storage hopper.

A heater cone shall be supplied with the hopper to maintain moisture free conditions in the cone between the hopper screw feeder and the eductor.

A knifegate isolation valve shall be supplied to isolate the hopper from the powder feeder. A powder hopper level sensor (vibrating type) shall be provided to alarm when the powder level falls below 5 kg.

The polymer system provided shall be suitably designed to allow the operator to unload bags of polymer into the storage hopper without having to lift the bags of polymer vertically.

Supply a vacuum unloading system capable of pneumatic transfer of powdered polymer from the supplied bags at ground level into the hopper. The system shall be capable of unloading one 25 kg bag in less than 3 minutes.

The vacuum unloading system shall allow venting of the transport airflow through a filter system, which will prohibit the escape of polymer grains. Flexible suction hose sections of the system shall be smooth-walled and of abrasion resistant material. Metal tubing components of the vacuum system shall be of 316 stainless steel.

Alternatives to the vacuum unloading system will be considered, provided the proposed system both minimises polymer dust escape and does not require vertical lifting of bags by operators.

5.4 Feeding and Eductor System

The polymer feeding and eductor system shall be capable of making up a batch of 0.25% w/v Praestol 2540 into the polymer mixing tank within ½ hour with a further four (4) hours for mixing of the polymer prior to being transferred to the solution storage tank.

The system shall deliver polymer powder into the mixing tank in a manner which results in complete dissolution of the polymer and prevents the formation of polymer balls and "fish eyes".

The system components shall be constructed preferably of 316 stainless steel. Alternative corrosion resistant materials shall be considered. The feeder shall be designed to enable easy and rapid access / dismantling for cleaning of any blockages.

The polymer feeder will run at a fixed speed and shall be capable of being preset to deliver a fixed amount of chemical for a batch concentration of 0.25 % w/v. A run timer shall be provided for the polymer feeder at the local control panel to allow for optimisation batch concentrations using the polymer feeder run timer. The polymer feeder rate should deliver consistently with a repeatable accuracy of ± 5%. Easy and safe access shall be provided to the feeder exit point to enable calibration checks of the feeder rate to be performed.

5.5 Batch Mixing Tank

The batch mixing tank shall be completed with inlet, outlet, overflow and drain connections and removable lid. The tank shall have an effective volume of at least 500 litres. Safe access is to be provided to enable cleaning of the batching tank. The outlet from the mixing tank shall be located 100 mm above the bottom of the tank. Valves shall be provided to allow for isolation of the tank.

5.5.1 Mixer

Provide one (1) top entry, slow speed mixer for dissolving the polymer in the mixing tank. The mixer shall be of the propeller agitator type and shall be fabricated from 316 stainless steel shafts and impellers. The mixer shall operate at speeds not exceeding 200 rpm. The operation of the mixer shall be automatically controlled from the LCP by timer. The mixer shall be mounted on its own stand. The mixer shall be readily removable for maintenance and repairs. Vortexing or excessive air entrainment shall not be acceptable under any circumstances.

5.6 Polymer Transfer Pump

Activated (or “aged”) solution shall be transferred from the mixing tank to the dosing tank by either gravity, or using a transfer pump.

5.7 Dosing Tank

The dosing tank shall be complete with inlet, outlet, overflow and drain connections and removable lockable lid. The tank shall have an effective volume of at least 500 Litres. The inlet and outlet to the dosing tank shall be 100 mm above the bottom of the tank. Polymer transfer from the batch mixing tank may be either pumped or by gravity. Valves shall be provided for isolation of the tank.

5.8 Bunding of Polymer Make-up, Solution Storage, and Dosing System

The polymer make-up, solution storage, and dosing system shall be bunded according to Australian Standard AS 3780 – The storage and handling of Corrosive Substances, and Environmental Protection Authority (EPA) requirements.

A collection sump shall be provided, at the lowest point within the bunded area to allow for solution to drain to the residuals handling system.

Any hard ground surfaces around the polymer system is to be lined with either Parbury Nitocote EP410 or an approved chlorinated rubber paint with silicon carbide grit added to produce an anti-slip surface.

5.8.1 Level Probes and Sequencing

Supply and install a level probe (vibrating type) in the powder hopper. A hopper refill alarm will be generated when the powder level falls below the level probe (i.e. <5kg).

Supply and install conductance level electrodes in both the Mixing Tank and the Dosing Tank. The difference between the low and the high level electrodes shall form the effective volume of the Mixing Tank and Dosing tank.

A low level probe in the Dosing Tank initiates a transfer of an aged batch from the Mixing Tank. Should the transfer fail, a low low level probe in the Dosing Tank will stop the respective metering pumps and alarm this condition at the LCP. Transfer will occur until a low level probe in the Mixing Tank is reached. If the high level probe in the Dosing Tank is reached during transfer, the transfer will be terminated and an alarm will occur on the LCP.

When the low level probe in the Mixing Tank is reached a batching sequence is initiated. Process water is added to the system until a preliminary probe is reached. This probe will initiate the mixer (which should be covered) timer and start the powder feeder timer. Process water will continue until a high level probe is reached in the Mixing Tank.

5.9 Pipework and Valves

Isolation valves shall be ball type with union fittings. Similar sized valves shall be of consistent manufacture (i.e. from a single supplier). Non-return valves shall be PVC with stainless steel spring check type and union fittings.

All pipes shall generally be Schedule 80 uPVC. Suitable reinforced hoses may be employed for connection from Dosing Tank to dosing pumps. Pipes shall be suitably braced against movement, supported at 1m intervals for horizontal runs, and protected against mechanical damage where at risk. Where uPVC pipe is exposed to direct sunlight, these sections shall be painted and labelled accordingly.

Unions shall be placed in the pipework to enable dismantling of critical sections.

5.10 Metering Pumps

The Contractor shall provide three positive displacement variable stroke metering pumps, i.e.:

- one (1) duty dosing pump for each process stream
- one (1) common standby pump.

The rated delivery pressure of the dosing pumps shall be at least 20 metres of water (2 bar). The change over from duty dosing system to standby dosing system in the event of duty pump failure shall be manual by a duty/standby switch at the LCP.

The pumps shall be suitable for pumping 0.25% w/v Praestol 2540 solution. Each pump shall be readily manually adjustable within the specified range with a repeatable accuracy of + 2.5% of the set rate. The stroke adjustments (20:1 turndown ratio) shall incorporate a dial rate (0-1 or 0-100%) or digital readout to facilitate pre-setting and shall be capable of adjustment while the pump is either running or stationary. If the indication is not in litres per hour, then supply a graph showing stroke setting versus flow rate. Supply a copy of the graph, which is laminated and in a perspex covered frame and mounted near the metering pumps. The dosing pumps will have either internal or external pressure relief. Safety relief valves shall discharge back to the pump suction. Pulsation dampeners and pressure regulating valves shall be provided for all dosing lines. Pump operation shall be automatically started and stopped in conjunction with the treatment operation. Include appropriate isolation and non-return valves on the dosing pipework.

Sight tubes/ calibration tubes of 30mm NS made of transparent PVC tube covering the full height of the storage tanks shall be provided for each of the Praestol 2540 metering pumps. The calibration tubes shall be adequately supported/protected against mechanical damage and provided with graduated calibration scales. A traffolyte scale (black markings on a white background) marked in Litres, and decilitres shall be provided for each of the calibration tubes. The calibration tubes shall be graduated in Litres to show the volume of activated Praestol 2540 in the dosing tank and in one Litre and decilitre marks for calibration of the dosing pumps. The total height of the graduated calibration scale for the calibration of the metering pumps shall be equal to or greater than 1000 mm. The top of the calibration tubes shall extend above the overflow pipe of the polymer storage tanks.

5.11 Polymer dosing

A dynamic inline mixer is to be installed on the gravity line between the final oxidation tank and the clarifier.

The mixer is to operate at a rotary speed of between 2000 and 3000 rpm directly in the feed line to achieve a turbulent admixture of the flocculant and limed and oxygenated water.

Dosing diffusers are to be provided at the discharge pipe into the clarifier inlet to assist in the distribution of dilute polymer if additional dosing is deemed necessary.

5.12 Flushing System

A hosecock for flushing the dosing system using process water shall be installed on each of the dosing pumps suction, and delivery lines.

5.13 Polymer Dilution

Process water (treated water) is to be used as dilution water. The Praestol 2540 dilution ratio shall be 25g/kL.

5.14 Batching Procedure

Batches of polymer are to be made up automatically as required, based on the level in the dosing tank. Polymer solution is to be made up and aged in the mixing tank. This may be performed concurrently with dosing to the treatment flow from the dosing tank. Alternatively, continuous batching will be accepted.

On receiving the low-level alarm from the Dosing Tank, or to top up the stored polymer solution when required, the following procedure shall be followed to make up a new batch of polymer solution:

Polymer make-up will be automatic at the completion of a transfer to the Dosing Tank or operator manually initiated. All drives and solenoid valves shall be able to be operated manually from the LCP.

1. The solenoid valve for makeup water shall be opened.
2. When the water level has reached an intermediate level and submerged the mixer paddles in the solution tank, an intermediate probe shall automatically start the mixer.
3. The polymer feeder is to dose the required amount of polymer via the eductor in order to make-up the preset batch concentration.
4. The makeup water is to automatically be cut off via the solenoid valve when the water level reaches high level in the mixing tank.
5. The mixer is to be switched off automatically by a pre-set adjustable timer (0-300 minutes).

6. Transfer of activated Praestol 2540 solution from the mixing to tank to the dosing tank is to be automatic. A low-level alarm from dosing tank will start the transfer, and a low level alarm from the mixing tank will stop the transfer of the activated Praestol 2540 solution.

5.15 Polymer Local Control Panel

The LCP is to house all instrumentation, switchgear and control gear for the following equipment:

- solenoid valves for makeup water
- low speed mixer
- metering pumps
- level switch assemblies in powder hopper/ mixing/ dosing tanks
- powder feeder
- vacuum unloading system

The electrical instrumentation, switchgear and control gear are to include but is not necessarily limited to:

- One three-position MANUAL/OFF/AUTO selector switch for each drive of the process.
- A duty/ standby selector switch shall be provided for each of the dosing pumps.
- One START / STOP / RESET switch for each item of equipment operative only when selected for MANUAL
- An OPEN/CLOSE selector switch for each make-up/flushing water solenoid valve, operative only when the system selector switch is on MANUAL.
- Running & Fault lights for each item of equipment
- A start push button for both the mixer timer and powder feeder.
- All necessary circuit breakers, contactors, thermal overloads etc.
- Fault reset button
- Lamp test push button
- Adjustable timers for mixer and powder feeder located inside the control panel.

The following fault indicator lights are to be included (one for each item of equipment). Any condition shall be the polymer fault signal for transmission to the SCADA:

1. Dosing pump motors failure.
2. Low Low level in dosing tank.
3. Low level in dosing tank.
4. High level in dosing tank.
5. Low level in powder hopper.
6. Mixer motor failure.
7. Screw feeder motor failure.

8. General system failure for any condition (1) – (7).

The run signal from the LCP to the SCADA will be generated from the duty dosing pump.

6 Carbon Dioxide Storage & Dosing System

Re-carbonation may be required after the high pH stream lime to lower the pH prior to entering the low pH stream. A pH sensor in the clarifier discharge pipe and low pH balance tank will control the dose rate based on a blended algorithm.

Liquid carbon dioxide shall vaporise through the vaporiser prior to entering a gas pressure regulator and carbon dioxide gas automatic flow control valve.

The carbon dioxide equipment may be hired.

6.1 Liquid Carbon Dioxide Storage Vessel and Evaporator

Provide one vertical mounted insulated storage vessel with suitable vaporiser. The vessel shall be constructed to AS 1210. The vessel shall be complete with all valves and gauges controls, safety, filling and delivery systems. It shall have an effective minimum carbon dioxide capacity which will cater for at least 30 days storage at the high pH stream of (5.3 ML/D). It shall be capable of supplying the specified flow of gaseous carbon dioxide at ambient temperature. A load cell is to be provided to indicate the mass of carbon dioxide remaining in the carbon dioxide storage tank. The indicator is to be capable on continuous read out (analogue or digital) of the weight of contents in the storage bin with an accuracy of ±5% over the entire storage capacity of the tank. The mass of carbon dioxide in the storage tank is to be displayed in kilograms.

The vaporiser shall have sufficient capacity to turn the stored liquid carbon dioxide into gaseous carbon dioxide at the required rates. Liquid carbon dioxide shall vaporise through the vaporiser prior to entering a gas pressure regulator and a carbon dioxide gas automatic flow control valve.

The carbon dioxide vessel shall be complete with enclosure fence, security lighting and appropriate signage.

A composite safety sign located on or near the CO_2 storage vessel is to indicate the following:

1. Chemical in storage
2. UN No.

6.2 Carbon Dioxide Flow Control Equipment

The carbon dioxide dosing system shall be pressure controlled.

Flow of carbon dioxide shall be controlled by automatic flow control valves.

The flow control valves shall be electrically actuated with power failure to close feature. Emergency battery power packs shall be provided if spring actuated fail-safe mechanism is not available.

Provide duty and standby carbon dioxide flow control valves. A solenoid valve with power failure to close feature installed on the carbon dioxide supply line as a common fail-safe unit for the flow control valves is acceptable if emergency power packs are not offered.

The carbon dioxide flow control equipment including pressure gauges, gas flow orifice plate, rotameter and flow control valves shall be mounted on a panel installed outdoors next to the carbon dioxide storage vessel and vaporiser.

A rotameter for measuring carbon dioxide gas flow shall have a 250 mm minimum length scale marked in increments of one kg/hr.

The flow control panel shall be fully enclosed within a floor standing cabinet of an outdoor switchboard specification.

The cabinet shall have full front window to protect all equipment and instruments. The operator can check the gas flow meter setting at eye level. The cabinet shall have a degree of protection of IP56D. All process readings including pressure, flow, weight and process water flow will be displayed on the SCADA system for monitoring and control.

6.3 Carbon Dioxide Injection Equipment

The carbon dioxide pipework shall run in a chemical trench between the storage vessel and the dosing point.

Design and install an injection facility to provide sufficient mixing of carbon dioxide with the water. Pipework may be uPVC, ABS or stainless steel. The Contractor is required to design and install the air diffuser(s). Ceramic air diffusers mounted on the distribution pipework are acceptable. The diffusers must be free flowing and be designed to avoid fouling. The diffuser is to provide a gas transfer efficiency of 95 %.

6.4 Carbon Dioxide Safety Equipment

Provide all necessary safety equipment as recommended by the carbon dioxide supplier in their published Material Safety Data Sheet.

6.5 Carbon Dioxide LCP

The carbon dioxide LCP shall be an external IP56 located next to the carbon dioxide storage vessel and associated equipment. The common control circuitry for the carbon dioxide dosing system shall be hard wired via relay logic, i.e. independent of a PLC.

Starters for the booster pumps shall be incorporated into the carbon dioxide LCP. The duty selection of these booster pumps shall be via a "1-2" duty selector switch. The common control circuitry shall be incorporated into the Carbon Dioxide LCP and shall be independent of the PLC.

Provide status, auto control interlocks and group alarms via volt free contacts brought out to terminals.

The Carbon Dioxide LCP shall include but shall not necessarily be limited to:

- One MANUAL/OFF/AUTO selector switch for the process.
- An OPEN/CLOSE selector switch for each carbon dioxide flow control valve, operative only when the system selector switch is on MANUAL.
- A duty standby selector switch for the carbon dioxide flow control valve.
- Fault reset button.
- Lamp test button.
- System operation indication light.

Alarm requirements are:

- Low carbon dioxide flow
- Low carbon dioxide temperature

- Low carbon dioxide vessel supply pressure
- Low carbon dioxide vessel level/contents
- Booster pump No. 1 fault
- Booster pump No. 2 fault
- High flow vacuum (if vacuum controlled is offered)
- Others considered by the Contractor for the satisfactory operation of the dosing plant.

Status requirements:

- Booster pump No. 1 Run
- Booster pump No. 2 Run
- Post dose system running

The Carbon Dioxide Plant shall shut down the following emergency conditions:

- A booster pump failed
- Others considered by the contractor for the satisfactory operation of the dosing plant.

The above individual status and alarm indications shall be displayed on the carbon dioxide switchboard via indicating lamps.

7 Oxidation Systems

7.1 Requirements

The oxidation systems shall be coarse bubble diffused aeration. Provide aeration headers in banks. The treatment process must be able to remain in operation with one bank isolated, without damage to the remaining diffusers.

The diffused aeration shall:

- be a coarse bubble diffuser type;
- consist of diffuser elements, distribution piping, valves, air manifolds, blower assembly, and all associated equipment to provide aeration and mixing for the reactors;
- take into account the shape and the configuration of the tank;
- provide the required actual oxygen transfer rates as well as providing complete mixing over the entire tank to prevent sedimentation;
- be removable;
- comprise of a flexible perforated rubber membrane fitted over a supporting member. The diffuser membrane shall seal against the supporting member to prevent the ingress of liquid into the air pipework on air supply shut down;
- Produce an even distribution of bubbles. The air flow through individual diffusers mounted on a common header shall not differ by more than plus or minus 5%;
- Not clog and must be suitable for use in the process selected;

- The system shall supply the design oxygen transfer rate into the limed water under actual operating conditions;
- The diffused aeration system shall have a variable range from maximum to minimum requirement according to the demands for precipitation;
- Provide sufficient turndown capacity to operate over the full range of loads entering the plant over its design life. This may nominally require a 10:1 turndown ratio; and
- The aeration is to provide a normal process oxygen requirement of 100% with a maximum process oxygen requirement of 120%.

7.2 Diffuser Installation

The diffusers shall be fixed to the distribution headers which shall be positioned on the tank floor. Provision shall be made in the supports for the distribution headers to be adjusted for level such that the diffusers can be levelled to + or -5mm.

Each header and diffuser system shall be capable of being removed from the tank for maintenance without stopping the aeration system or dewatering the tank.

It shall be capable of reinstallation in the tank while the tank is full and have a means of easily locating the lifting point of each header without dewatering the tank. A mobile crane will be needed for lifting purposes. This is available from Brown's WTP next door.

7.2.1 Diffuser System Pipework

All pipework shall be Grade 304 stainless steel. The distribution pipes shall not be less than 75 mm in diameter. Expansion and contraction shall be fully allowed for in the design and installation of the diffuser system pipework. Pipework supports within the tanks shall be fabricated of Grade 304L stainless steel and they shall be fixed to the tank.

The supports shall have provision for a vertical adjustment to allow for levelling the diffusers.

Sections of pipe in the splash zone shall be flanged or quick release coupling to allow dismantling of and/or replacement of headers.

Butterfly valves shall be installed in the pipework to isolate or control the airflow rate to each individual distribution header. These control valves shall be of the lugged wafer type butterfly valves with a resilient neoprene seat which shall also act as a flange gasket. The valves shall have bodies of cast iron, stems of stainless steel Grade 304 or 316 and discs of hard chrome plated cast iron or stainless steel. Butterfly valves for control of the air flow to the diffuser banks shall be designed to allow fine adjustment of the flows. Other isolating butterfly valves may be either of the lever type or gear drive type depending on the size of valve. In all cases the force required on a lever or wheel to close or open a valve shall not exceed 120 N. Valves shall be fitted with levers and shall be fitted with a multiple (at least 10) position plate into which the lever can locate and lock.

Should a centralised blower system be installed, each reactor tank unit should be isolated from the main aeration header by an electrically actuated butterfly valve, of the lugged or wafer type with a resilient neoprene seat which shall act as a flange gasket. The actuator shall be controlled by the plant PLC

7.2.2 Aeration System Standard Oxygen Transfer

Determine oxygen transfer performance in accordance with the ASCE Standard 'Measurement of Oxygen Transfer in Clean Water', July 1984, published by the American Society of Civil Engineers, New York, USA

(abbreviated as ASCE Standard hereunder) to verify the aeration system guaranteed SOTR (kg/h) and SAE (kg/kWh). SAE (Standard Aeration Efficiency) is SOTR per unit power input.

7.2.3 Aeration System Testing Procedure

Carry out two tests in each reactor. One test for maximum SOTR duty and one test for normal SOTR duty. Operate aeration devices overnight and for at least two hours immediately prior to testing. During the pre-aeration period, check the devices to ensure that they are operating in accordance with the requirements of the ASCE Standard. Add a solution of cobalt chloride hexahydrate or cobalt sulphate hexahydrate to the test the ability of the reactor to achieve a soluble cobalt concentration between 0.10 to 0.50 mg/L on the day of testing at least one hour before testing commences. Dissolve the cobalt salt in water before adding to the test tank water. Add an equal portion of the cobalt solution to each aeration zone. Add and evenly distribute sodium sulphite in the reactor to depress the DO level below 0.5 mg/L at all points in the test water for a period of about 10 minutes. The objective is to obtain stable hydraulic conditions such as mixing or flow velocity before the dissolved oxygen concentration starts to increase and readings are taken to measure the oxygen uptake rate. Hose down the area after each test to remove any chemicals.

Measure the dissolved oxygen concentration in the test water. Site the probe location points within the area of positive influence of the aeration devices but away from areas of extreme turbulence or dead corners. Securely mount the probes so as to maintain the probes at the selected location points and also oriented as recommended by the probe manufacturers. The points shall be at least 0.6 m from walls, floor and surface.

Determine the Parameter Estimates, Standard Oxygen Transfer Rate (SOTR) and Standard Aeration Efficiency (SAE) in accordance with the methods given in the ASCE Standard. Use the non-linear regression method for parameter estimation. The theta factor (imperial correction factor) shall be taken as equal to 1.024 unless experimental data for this particular aeration system indicates conclusively that the value of that is significantly different from 1.024.

For normal oxygen transfer rate test the average SOTR shall not be less than the guaranteed figure. For maximum oxygen transfer rate test the SOTR and SAE must be equal to or greater than the guaranteed figure.

The mixing capacity of the aeration equipment shall be sufficient to resuspend any precipitated particles that have settled on the tank bottom and to evenly mix the precipitated salts in the aeration tank during aeration phase. Determine the adequacy of the mixing capacity during the aeration test.

If the above requirements are not met, carry out modifications to rectify the deficiency and retest the equipment to verify compliance with the Contract.

7.3 Air Blower

Centrifugal blowers shall be single stage, integrally geared, vertically split type with close-grained cast-iron casings. Impellers shall be open radial flow type constructed of forged aluminium alloy.

For Roots type blowers, rotors and shafts shall be of one-piece construction and shall be of forged steel or shall comprise cast iron rotors on steel shafts. The rotors shall have two or more lobes and shafts shall be geared together with timing gears so that the lobes do not make contact during operation.

All bearings shall be grease or oil lubricated ball and/or roller type and shall be rated in accordance with the latest revision of AS 2729 with factors a1, a2 and a3 equal to one to give a B10 bearing life of at least 100,000 hours at the continuous rated full load and speed of the unit.

Bearing housings and rotor shafts shall be fitted with suitable oil seals to exclude dirt and moisture and to prevent oil carry over into the discharge air. Where bearings are grease lubricated the housings shall be fitted with self-sealing grease nipples and automatic grease relief valves. Where bearings are oil lubricated the housings shall be fitted with effective oil level indicators.

The discharge side of each air blower shall be fitted with a pressure gauge to indicate discharge air pressure. The pressure gauges shall be industrial Bourdon type with nominal diameter of 100 mm. The scale shall be 0 -100 kPa. The gauges shall be fitted with "snubbers" and isolating cocks.

The blower and motor shall be mounted on a base frame incorporating an integral silencer, non-return valve, pressure relief valve, isolating valve, discharge connection with flexible joint and flexible mounting pads (vibration dampers shall be placed under blower mounts).

Stainless steel Grade 304L acoustic enclosures shall be provided for any blower systems.

The pressure relief valve shall be sized and adjusted to allow the full flow of the blower to be discharged in the event of a blockage or valve closure in the downstream pipeline, and without overloading the drive motor. In addition, each blower shall be fitted with a suitable pressure switch which shall monitor the discharge pressure of the blower and it shall be set to shut down the blower in the event of excessive discharge pressure. The pressure setting shall be lower than the set pressure of the pressure relief valve. The pressure switch shall be adjustable over the range 10 -150 kPa and shall have two sets of changeover contacts with a minimum rating of 240 V A.C., 2A. The switch housing shall be of metal with a degree of protection not less than IP56.

All items of equipment shall be fitted with engraved nameplates fastened to the casing. Name plate information shall include the manufacturer's name, Agent's name, address, item mode number, serial number, model, size, rating, equipment number and year of manufacture.

Flexible couplings shall be installed between the discharge connections of the blowers to allow for mechanical vibration and expansion and contraction. The joints shall be of the flexible rubber type and shall be suitable for the maximum temperatures which are likely to be encountered in the system and for the range of displacements which will occur due to vibration and expansion and contraction.

Install thermal covers to exposed discharge pipes.

7.4 Drive Units

The blowers shall be driven by a 4 or 6 pole electric motors. Belt drives shall consist of a Fenner Spacesaver Wedge-belt drive as manufactured by Fenner-Dodge or an approved equivalent. The belt drive shall be designed to transmit the total rated power of the motor with a service factor of 1.75. The belt drive shall be capable of transmitting the full motor rated power in the event of the failure of one belt. Pulleys and bushes shall be Fenner Taper-Lock or an approved equivalent. Guards shall be fitted over all rotating components.

7.5 Inlet Filters

Each blower shall have an independent inlet filter unit with a minimum of two levels of filtration (i.e. prefilter and final filter) and shall not be less than 86 to 90% efficient on 5 micron dust. The filters shall comprise an AAF "Amerkleen" prefilter and "Duracell" final filter, or an approved equivalent.

The filter elements shall be housed in an air-tight housing which shall allow easy replacement of the filter elements. Replacement shall be possible without the use of tools.

Each discharge filter housing shall be fitted with a pressure switch to indicate over pressure. The suction filter units shall be fitted with suitable vacuum gauges to indicate the suction pressure downstream of the filters. The

gauges shall be industrial Bourdon or Schaffer type gauges with a nominal diameter of 150mm. The scale shall be suitably selected and shall include a red line to indicate the point at which the filter elements require renewal.

7.6 Pipework and Pipe Supports

Pipework from blowers to the downcomers shall be Grade 304 stainless steel with flanged connection. All flanges shall be in accordance with AS 4087, Class 14. Flanges shall be drilled off-centre, symmetrically about horizontal and vertical centrelines. Flange gaskets shall be 3 mm thick insertion rubber.

Provide a 25 mm stainless steel capped socket welded to each downcomer pipe in an accessible location to allow installation of a portable air flow measuring device. Locate the socket such that air flow measurements can be made whilst the aeration system is in operation.

All bolt threads shall be smeared with nickel anti-seize grease or an equivalent anti-seizing lubricant compound.

Couplings may be used in lieu of flanges. The couplings shall be of stainless steel.

All piping shall be supported and/or anchored. Anchors and flexible joints shall be provided to restrain the pipes and prevent forces being applied to mechanical components. All supports, anchors, bolting and anchor bolts shall be stainless steel Grade 304.

Provide access to all equipment in accordance with OHS & R requirements.

7.7 Noise

Supply and install equipment such that noise levels comply with the requirements of the EIS.

Test measurements shall be carried out in accordance with AS 1081-1975 "Measurement of Airborne Noise Emitted by Rotating Electrical Machinery", Sections 1 and 3. Noise from any source shall be devoid of tonal character. A tonal character would exhibit a level in analysis in which a one 1/3 octave band was more than 3 dB above the immediately adjacent 1/3 octave band.

For diffused aeration equipment the overall sound pressure measured one metre in any direction from each acoustic enclosure shall not exceed 75 dB(A). Equipment offered with sound proofing devices shall be designed so that the sound proofing devices form an integral part of the equipment. The sound proofing devices are well designed and manufactured, are neat fitting around the equipment and do not impede the flow of cooling air such that the temperature will rise to an unsafe level during normal load conditions. Where acoustic enclosures are required to reduce noise levels, provide covers that are on rollers or wheels. Access for minor maintenance functions (such as checking oil levels) should be by small panels and not require removal of the complete acoustic panel. Easy access for connection/inspection of the terminal box and for maintenance of bearings is to be provided.

7.8 Warranty

Provide an extended warranty (beyond the defects liability period) for diffusers. The extended warranty is to cover the full replacement cost of the diffusers for a period of five years from practical completion. Failure of the diffusers is defined as any one of the following having taken place:

a) a 3kPa increase in headloss across the diffusers;

b) a 15% decrease in standard oxygen transfer rate and standard aeration efficiency when tested in clean water;

c) a deterioration in the membranes which allows water into the headers;

d) a deterioration in the diffusers which changes the bubble pattern from a fine evenly distributed pattern when compared with commissioning data for the system or compared with new diffusers.

8 Clarification

The Contractor shall design, supply and install Lamella Clarifiers to meet the specified quality and quantity requirements of the treated water in this Specification. The system shall include adequately redundancy for the process equipment. The redundancy shall include but not be limited to a duty standby arrangement for the following equipment:

- High pH filtered water return pumps
- Sludge pumps

A flocculant is dosed via a dynamic mixer after the oxidation tanks. A dedicated slow speed flocculant mixer is also required in the inlet works of the clarifier to optimise polymer contact.

There shall be provision for desludging and draining of the Lamella tanks. The drain on the tank shall be sloped to the drain valve, the drain area will include a submerged pit for full removal of solids out of the tank during cleaning.

It will be necessary for the Contractor to achieve the guaranteed plant capacities and performance criteria over the temperature range of 10 to 40^{o}C as tendered.

The clarifiers must be designed to withstand the elements. Adequate access should also be provided for inspection and maintenance.

8.1 Materials

Clarifier and mix tank wetted areas are to be welded carbon steel, white sand blasted, primed, and epoxy finished. Optional stainless steel or PE construction is acceptable .

Clarifier and mix tank support structures are welded carbon steel, white sand blasted, primed, and coated with industrial enamel. Optional stainless steel construction.

Lamella plates are constructed of a special high density, flat polished finish fiberglass, stainless steel is an option.

Clarifier plate spacers are constructed of PVC plastic angle secured with nylon bolts, optional is stainless steel angle with stainless steel bolts.

Mixer blades and shafts are stainless steel.

V notch weirs of welded stainless steel, weir plates of polished fiberglass, bolts of stainless steel.

8.2 Loading Rate and Detention Time

The lamella clarifiers will be designed to operate at a maximum loading rate of 0.6 L/h/m2. The Contractor is to supply the required number of clarifiers to operate in parallel to process the following flow rates:

High pH stream = 60L/s

Neutral pH stream = 100L/s

Detention time > 1 hour

8.3 Settlement System

The clarifier plates are constructed of high density, flat hard polished fiberglass.

Clarifier plate spacers are constructed of PVC plastic angle secured with nylon bolts.

Inclined plates set at 60 degree angle to ensure self cleaning.

Lamella plates to be a maximum of 900mm in length.

Flow through unit is by gravity only.

8.4 Sludge Removal

A sludge bed is not be retained in the hopper.

Provide a slow squeegee blade to force solids into the hopper.

Provide sludge draw ports at the bottom of the sludge hopper.

9 Pre-Discharge Polishing

Hydroxide precipitation has limited capabilities to remove some metals to the required levels for discharge. A series polishing system comprising Manganese Greensand Filter in series with an Ion Exchange Resin Filter is required as a final treatment system prior to discharge. Dosing systems comprising sodium hypochlorite (chlorine) as an oxidising agent and sodium bisulphate to convert sulphites to sulphates post Greensands are required.

9.1 Manganese Greensands Filter

The Contractor shall supply a duty/ standby Package Manganese Greensands Filter with DMI-65 silica sand based catalytic water filtration media to remove remnant aqueous metals post hydroxide treatment with a maximum and constant throughput capability of 100L/s. The filter is to include a chlorine and sodium bisulphate dosing system pre and post filter respectively.

The Contractor will be required to design the filter media depth to accommodate the process requirements for treatment of Main Pit water for three years and groundwater for a period of seven to 15 years. The Contractor is directed to the 'Rum Jungle Mine Closure Remediation Water Treatment Plant Facility Design Report', for influent properties in their calculations.

The loading rate of the filter shall lie between 5kL/m^2/hour and 10kL/m^2/hour.

DMI-65 media shall have the following properties:

- Stable with satisfactory performance between a pH of 5.8 and 8.6.

- Effective size 0.3 to 0.6mm
- Specific gravity 2.4 to 2.7

The spent media can either be disposed of or regenerated on site. The Contractor will be required to install the necessary infrastructure and chemicals to perform regeneration if preferred.

9.2 Ion Exchange Filter

The Contractor shall supply a duty/ standby Package Chelating Ion Exchange Resin Filter in series and downstream of the Manganese Greensands Filter with a maximum and constant throughput capability of 100L/s.

The Contractor shall decide whether to install a non-regenerative type system and dispose of the spent resin on site or install a regeneration plant. The treated regenerant may be discharged to the Main pit for reprocessing via the normal treatment stream. This decision shall be based on providing an operational treatment system for a period of 10 to 18 years. The Contractor is directed to the 'Rum Jungle Mine Closure Remediation Water Treatment Plant Facility Design Report', for influent properties in their calculations.

10 Sodium Hypochlorite/Bisulphate Storage and Dosing Systems

10.1 Scope

Sodium hypochlorite solution (13% w/v) is to be used as an oxidising agent of treated water prior to the Manganese Greensands filter.

Sodium bisulphate is to be dosed post Manganese Greensands Filter to de-chlorinate prior to the Ion Exchange Filter.

As a minimum the following is to be included with regards to storage and dosing of each of these chemicals:

- Storage tank bunding is required to 110% of contents of largest tank, the bulk tank will be sized on a storage capacity of one month to ensure that the solutions are turned over and used within this period.
- Venting of all transfer lines to the exterior
- Calibration tube for calibration of pump flow
- Two (duty/standby) metering pumps with variable speed drives
- Isolation valves to enable removal of individual pumps while system online
- Inline strainer on the delivery line
- Pressure relief on pump discharge returning to the suction side of the dosing pump in event of blockage
- Loading valves to ensure positive check valve seating of the dosing pump
- Adjustable Pulsation dampener on the pump discharge
- Flow switch to indicate flow in dosing lines
- Dilution water system

- Flow switch to indicate flow in dilution water system
- Static mixer for dilution water solution
- All associated pipework, valves, pumps (duty/standby), injectors, fittings and accessories.

10.2 Storage Tanks

Storage tanks shall be constructed of polyethylene or other material internally lined with either PVC or polypropylene that shall then be normalised (i.e. stress relieved).

The storage tanks shall be fitted with an analog level sensor (hydrostatic or ultrasonic) to be displayed on the SCADA.

10.2.1 Cover of Storage Tanks

The Contractor must construct an enclosure with a waterproof/ UV protection covering over the storage tanks and pumps and safeguard the area from entry with security mesh. The covering is to shade the tanks from sunlight and heat and provide weather protection for the pumps.

10.3 Pipework and Valves

Pipeworks and valving shall comply with the requirements of Clause 2.1. At the filling point, a horizontally arranged male Kamlok fitting shall connect to a 40 mm tee. One branch, with valve and extension piece pointing vertically down shall be provided for draining into a sump.

Fit the filling line with a male “Kamlok” fitting for satisfactory operation during filling. When not in use, a “Kamlok” twist shall be fitted. Kamlok fittings will be of an approved corrosion resistant material.

Flanges shall be bolted with stainless steel bolts with “Never-Seez” lubricant applied to minimise corrosion and ensure ease of removal. Gaskets shall either be EPDM or Hypalon. Isolating valves for storage tank outlets and drain lines shall be cast iron rubber lined diaphragm valves with PTFE-faced diaphragms, all other valves shall be UPVC ball valves with seals suitable for use with 13% chlorine solution. Ball valves shall be arranged and operated to prevent the buildup of gas from hypochlorite trapped inside the valve. Non-return valves shall be PVC with corrosion resistant components. Alternatively, a vacuum system may be proposed.

10.3.1 Dilution

Liquid sodium hypochlorite and liquid sodium bisulphate shall each be mixed with service water to achieve dilutions up to 20:1. The dilution water system shall automatically start and stop with the starting and stopping of the chlorine and bisulphate dosing systems.

The Contractor shall provide a static in-line mixer for mixing the concentrated solutions with process dilution water. The in-line mixer shall be made of corrosion resistant material resistant to chlorine. Provide a rotameter (at least 200 mm face), associated valves and pipework. The systems shall also be designed to eliminate scaling and blockages within the chlorine dosing pipework.

10.3.2 Control and Alarms

The system shall be able to be operated in either test or automatic mode.

Include at a minimum:

- Dosing setpoint user adjustable through the SCADA
- Residual trim feedback control PID settings in SCADA

SCADA alarms shall include as a minimum:

- Low free residual.
- +/- 20% free residual setpoint
- Pump failure.
- Dilution water no flow.
- Storage tank high level.
- Storage tank low level.
- Bund high level.

SCADA displays shall include as a minimum:

- Free residual
- Bulk tank level
- Dosing pump(s) status
- Dosing pump feed rate

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