Revision Details:

<table>
<thead>
<tr>
<th>Version No.</th>
<th>Date of Revision</th>
<th>Description of Revision</th>
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<tbody>
<tr>
<td>5.0</td>
<td>20/08/11</td>
<td>Revision Details table added. References to protective coatings have been updated to refer to Principal PCS 100. References to WSAA Purchase Specifications have been updated to refer to Principal Product Specifications. Other corrections and changes have been implemented. The following clauses have been amended: M1.5, M2.2, M3.1, M4, M5, M6.1, M8, M9.1, M9.3, M9.4.1, M9.4.2, M9.5.1, M9.6.1, M9.6.5, M9.6.6, M9.6.11, M9.7.1, M9.10, M9.11.1, M9.12.1, M9.13, M9.14, M13.4.2.5, M9.14.7, M16.1, M16.4.2, M16.4.3, M16.4.4, M16.4.5, M16.4.6, M16.4.7, M16.4.9, M16.4.11, M16.4.12, M16.4.13, M16.4.14, M16.5.3, M16.5.5, M16.6.1, M16.6.2, M16.11, M18.3.4.2, M22.1, M22.2.2, M22.6, M22.9, M22.11, M23, M34.10.3, M35.1.1, M35.1.3, M35.1.4, M35.1.5, M35.1.6, M35.1.8, M35.1.9, M35.1.11, M35.1.13, M35.1.14, M37.1, M37.2, M37.3, M37.4.1, M37.5.2, M37.5.3, M37.6.2, M37.6.5.1, M37.6.5.2, M37.6.11, M37.7 and M37.10. The following clauses have been inserted: M9.14, M14.2 and M35.1.2.</td>
</tr>
<tr>
<td>6.0</td>
<td>17/10/12</td>
<td>Clauses M1.6 and M37.6.5.3 inserted. Clauses M5, M9.1, M9.3, M9.4.3, M9.5.1, M9.6.2, M9.6.9, M9.7.1, M16.1, M16.4.5, M16.4.6, M33.2, M33.5.1, M37.6.5.1, M37.8.3 and M43.3 amended.</td>
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</table>
M9 – minor editorial changes throughout, minimum pressure class added (item 6) and flange standard amended (item 7) in M9.1, operating fluid designation for buried valves added in M9.3, requirement for gearboxes amended in M9.4.4, M9.4.5 & M9.4.6 added, M9.5.1 amended, and M9.6.6 (seal-in-body butterfly valves) deleted.

M13.7 – re-written.

M16.3 & M16.4.1 – minor amendments.

New clause M16.4.3 inserted.

M16.4.9 (now M16.4.10) – re-written.

M16.4.10 & M16.4.11 (now M.16.4.11 & 12) – amended.

M22.10 – minor editorial changes.

M23 – minor editorial changes, reference to old WBS drawing deleted.

9.0 24/02/17 Minor amendments to Clauses M1.1, M1.2, M1.4, M2.2, M2.3, M2.6, M3.1, M4, M5, M6.2, M8, M9.1, M9.2, M9.3, M9.4.4, M9.4.5, M9.5.1, M9.6.1, M9.6.2, M9.6.3, M9.6.3.1, M9.6.3.2, M9.6.7, M9.6.9, M9.7.1, M9.7.2, M9.8, M9.9.4, M9.15, M13.1, M13.2, M13.3.1, M13.4.2.2, M13.4.2.7, M13.4.2.11, M13.6.3.3, M13.6.6, M13.7.1, M15.1, M15.2, M16.1, M16.3, M16.4.2, M16.4.3, M16.4.7, M16.4.8, M16.4.11, M16.5.1, M16.5.2.1, M16.5.3, M16.5.10, M16.8, M17.2, M17.3.1, M17.3.2, M17.3.3, M17.4, M17.4.1, M17.4.2, M17.4.3, M17.4.6, M17.4.6.5, M17.4.8, M18.1, M18.2.1, M18.3.1, M18.3.3, M18.3.4, M18.4.1, M18.4.2, M19.1, M20, M22.1, M22.2, M22.4, M22.6, M22.9, M23, M25.2.6, M27.2.6.2, M28.1, M32.1, M34.8, M34.10.1, M34.10.5, M35.1.1, M35.1.2, M35.1.3, M35.1.15, M35.2.3, M36.1, M38.1, M38.4, M38.7.2, M38.10.2, M38.12.8, M38.13.2, M40.5, M41.2, M41.5, M41.6, M43.2, M43.3.1, M43.3.2, M44, M45.

Major revision of Clauses M7, M13.8, M17.1, M37, M43.1, M43.3.

Deleted Clause M9.4.6.

Inserted Clauses M9.6.4, M9.15, 16.5.9, M16.7, M18.9, M18.10, M22.10, M36.4, M43.4.

10 31/08/19 Document reformatted. Title changed. Foreword and Copyright added. ‘Principal’ replaced with ‘Sydney Water’. “Approved’ replaced with ‘accepted’.

M31.7, M32.5, M33.1, M33.5.1, M33.6, M34.1, M34.2, M34.4, M34.5, M34.6, M34.7, M34.8, M34.9, M34.10.1, M34.10.2, M34.10.3, M34.10.4, 34.10.5, M34.11, M34.12.2, M34.12, M35, M35.1.1, M35.1.2, M35.1.3, M35.1.4, M35.1.5, M35.1.6, M35.1.7, M35.1.8, M35.1.10, M35.1.12, M35.1.13, M35.1.14, M35.2, M35.2.3, M35.2.4, M35.2.5, M35.2.9, M36.1, M36.3, M36.3.10, M37.1, M37.1.1, M37.1.2, M37.1.3, M37.1.4.1, M37.1.4.2, M37.1.4.3, M37.2.3, M37.2.4.1, M37.2.4.4, M37.2.5, M37.3.1, M37.3.2, M37.4.1, M37.5.2, M37.5.3, M37.5.4, M37.5.5, M37.6.1, M37.6.2, M37.6.3, M37.7.1, M37.7.2, M37.7.3, M37.7.5, M37.7.6, M37.8, M37.8.3, M37.8.8, M37.8.9, M37.8.10, M37.9.3, M37.9.4, M37.9.5 (former M37.9.6)), M37.11, M37.11.7, M37.11.8.1, M37.11.8.2, M37.11.8.6, M37.9.1, M37.9.2, M37.9.3, M37.11.8.9, M38.3.1, M38.2, M38.3.1, M38.3.3, M38.3.5, M38.5, M38.6, M38.7.2, M38.7.3, M38.7.6, M38.8, M38.10, M38.10.4, M38.12.1, M38.12.2, M38.12.3, M38.12.5, M38.12.6, M38.12.8, M38.13.1, M38.13.3, M38.14, M39.1, M39.2.1, M39.2.2, M39.2.3, M39.2.5, M39.3, M39.3.1, M40.1, M40.7, M41, M41.5, M41.6, M42, M42.1.3, M42.2, M43.1, M43.2, M43.3, M43.4, M43.5.1, M43.6 & M45.

Complete revision of Clauses M5, M17 & M25.

New Clauses M2.7, M4.2, M9.3, M9.17, M9.18, M9.19, M14, M16.6, M34.12.3, M36.4.4 & M37.11.9

Deleted Clauses M12, M35.1.13, M37.9.5, M37.11.7 & M37.11.8.

Minor editorial changes elsewhere.
Foreword
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M1. General Requirements

M1.1 Scope
This Specification covers minimum requirements for the design, supply and installation of typical mechanical equipment in sewage, water and recycled water pumping stations, sewage treatment and water filtration plants, water and recycled water reservoirs, and other Sydney Water’s assets.

M1.2 Standards
Equipment supplied and installed shall be new and in accordance with the requirements of this Specification, Needs Specifications (if supplied), Drawings and job specific Technical Specification (where supplied), and the latest editions of the relevant Australian Standards and Technical Specifications, Water Services Association of Australia Codes of Practice, Water Industry Standards and Product Specifications.

Where there is no suitable Australian Standard available, an agreed international standard and/or industry current best practice shall be adopted.

If an international standard is proposed in lieu of an Australian Standard, a detailed assessment to show that the proposed standard is equivalent or superior to the relevant Australian Standard shall be provided to Sydney Water for acceptance.

The work shall also comply with the requirements of all relevant bodies or codes, including but not limited to:

- SafeWork NSW
- NSW Environment Protection Authority (EPA),
- Power Supply Authorities,
- Australian Communications and Media Authority, and
- Local Government Authority.

In the event of any ambiguity or discrepancy Sydney Water shall be consulted as to the interpretation to be followed in carrying out the work.

M1.3 Equipment Compatibility
Where more than one item of equipment is supplied and installed to perform a particular function, all such items of equipment shall be identical and completely interchangeable.

M1.4 Equipment Design
All items of equipment shall be designed, manufactured and installed to achieve the specified performance and other requirements and perform their required functions reliably and efficiently. All equipment shall be designed so that it is safe to install, operate, maintain and decommission in accordance with Sydney Water’s Safety in Design Procedure D0000653. The safety in design shall incorporate the safety hierarchy principles (eliminate, substitute, engineering controls, administrative controls, personal protective equipment) to ensure the asset is easy to operate and maintain with a view to achieve Sydney Water’s corporate policy in safety i.e. zero harm (minimise manual handling and injuries).

All isolation devices shall comply with Sydney Water’s Energy Isolation - Lock Out Tag Out (LOTO) Procedure and be able to be locked in either closed or open position.

Particular attention shall be given to equipment installed in an adverse environment and/or exposed to weather. All equipment shall be selected, stored, handled and installed in accordance with its manufacturer’s specifications and all materials and components shall be new and unused and the best of their respective kinds.

The equipment shall be suitable for the purpose intended and shall be standard commercial equipment proven in actual service conditions in similar applications. Only manufacturers who are fully experienced, reputable
and qualified in the manufacture of such equipment shall supply the equipment specified herein. All equipment supplied shall have spare parts readily available in Australia and be serviceable for operation over its design life.

Mechanical equipment and process facilities shall be designed, selected and installed on the basis that they will generally need to provide continued service for long periods, without frequent maintenance and attention being necessary to continue operating in accordance with the design intent.

Provision is to be made for ready renewal of all wearing parts. Unless sealed for life, all gearboxes, bearing housings and other pieces of equipment shall allow for lubricant drain and fill facilities. All equipment and appurtenances (e.g. gauges) shall include isolation devices (e.g. valves) to allow for servicing without interrupting the process.

Particular attention shall be taken in the design to ensure ease of operation, inspection and maintenance, protection from corrosion and wear, cleanliness of the surrounding areas and safety of operation. All equipment shall be fit for intended purpose and shall remain so for the design life of the equipment materials, fair wear and tear expected.

The equipment shall be designed and installed to enable operation maintenance personnel to carry out their routine tasks without the need to shut down process units. Equipment service points shall be readily accessible. All indicators, instrumentation, nameplates and labels shall be at easy to read locations.

All equipment shall be appropriately designed with provisions for lifting or moving, including lifting lugs or eyebolts. Effort shall be made to design out any risk of manual handling during operation and maintenance. Where necessary, equipment shall be fitted with adequate lifting devices or have provision for use of portable lifting equipment.

For all equipment and instrumentation supplied, schedules of technical data showing all technical information, settings and calibration data shall be provided.

**M1.5 Materials**

Materials shall be selected appropriate to the application to afford a long life free from corrosion and wear and with the required strength. The quality and finish of materials shall be in accordance with the relevant Australian Standards. The strength of the parts shall be such as to provide ample margin for all possible stresses to which they may be subjected under all conditions of service.

The material grades where stated in this Specification represent the basic or minimum requirements, and materials of superior quality may be used, subject to Sydney Water’s acceptance.

Dissimilar metals that may become wet in a conductive liquid (electrolyte), which can cause galvanic corrosion shall not be in direct contact. The materials shall be selected to ensure that the galvanic potential between adjacent components does not exceed 0.3 Volts. Where necessary, components shall be electrically isolated from each other to meet this requirement.

Note: Wherever grade 304 or 316 stainless steel is specified, equivalent or superior grades of duplex stainless steel may be used.

**M1.6 Recycled and Reused Materials**

Recycled and reused materials shall not be used unless accepted by Sydney Water.

All recycled and reused materials shall be free from hazardous substances as defined in the Work Health and Safety Regulation. Carcinogenic substances such as asbestos or asbestos containing material in both friable and bonded forms shall not be present in any materials.

Prior to their use, a detailed description of the composition and origin of the recycled and reused materials shall be provided for acceptance by Sydney Water.
M2. Safety Equipment and Safety Signs

M2.1 General
All equipment shall be designed to afford maximum protection and a safe working environment for operating personnel.

Inspection covers shall be readily opened without the use of tools. Grills, bars or mesh shall be provided behind covers where moving equipment may be reached. Alternatively, interlocks shall be provided to stop equipment if covers are opened.

Warning siren and beacon light shall be installed for equipment where potential hazard may occur when equipment start automatically or fail to start.

M2.2 Guards
All couplings, pulleys, belts, chain sprockets, chains and other exposed moving parts and hot surfaces shall be adequately covered by sturdy fixed guards acceptable to SafeWork NSW and meeting the requirements of AS4024.1 Safety of machinery series. Guards shall afford maximum protection and a safe working environment for operating personnel, staff and visitors.

Guards shall be fabricated from solid, expanded metal, perforated or slotted steel plate, as specified.

Guards shall be painted yellow to AS2700, colour code Y14. The painting shall comply with WSA 201 and Sydney Water’s Supplement to WSA 201.

Guards shall be easily removable by standard tools for maintenance access. All drive guards shall be fabricated such that the guards can be removed without disturbing the sensing devices, chain or belt tensioners, field instruments and lubricators.

Where specified, the guards shall be fitted with limit switches wired into the starter circuit so that removal of a guard will prevent operation of the machinery.

M2.3 Safety Signs
Safety and warning signs shall comply with the Sydney Water’s Facilities’ Site Signage Specification SDIMS0026, AS1318, AS1319, AS2508 and AS2927, as applicable, and shall be installed where necessary.

The signs shall warn of potential hazards, assist in preventing accidents and give operational and emergency procedures for potentially hazardous situations. Signs shall provide warnings where equipment may start automatically, where equipment may move without warning and where other potential hazards may occur.

The contents of piping, conduits and ducts shall be identified as per AS1345. Arrows shall be provided to show the direction of flow.

All signs installed outdoors shall be UV resistant.

M2.4 Safety Interlocks
Necessary safety interlock devices shall be provided to facilitate protection of operating personnel, as well as to prevent damage to the mechanical portions of the equipment.

M2.5 Fail Safe
All items of equipment shall be designed for safe operation.

The machinery shall be designed to leave the plant in a safe condition in the event of any failure in part of the machinery or its associated safeguards, control circuits or its power supply.

M2.6 Protection from Vehicles
Adequate safety facilities shall be used to protect structures, equipment and personnel from moving vehicles. The safety facilities, including barriers, corner protectors, speed humps, stop signs, bollards, chains etc. shall
comply with relevant Australian Standards, including but not necessarily limited to AS1318, AS1742, AS1906, AS2890 and AS3845.

Unless specified otherwise, all bollards shall be min. Ø140mm x 1200mm high and painted yellow in accordance with AS1318, with two min. 50mm wide Class 400 ultra-high intensity self-adhesive red and white striped reflective bands to AS1906.1. First band is to be installed at the top of the bollard and the second 150mm below it.

If the works include addition of new roads or facilities (eg. buildings) to an existing plant, the traffic management plans for the site shall be updated to reflect and include the new works. The plans shall include demarcation for pedestrians and vehicles for the site at the completion of works, loading areas and parking. For new works, a traffic management plan shall be developed.

**M2.7 Work at Heights**

Effort shall be made to design out working from heights while operating and maintaining equipment.

All access covers and openings in structures that may present hazard from falling from heights shall have a safety system, such as covers, safety grilles, handrails, safety barriers etc. Where permanent anchor points are used, they shall be positioned at a safe distance to compliment fall restraint / limited free fall arrest systems.

A safe means of access to anchor points in accordance with AS1657 shall be provided. This shall consider the possibility of a fall prior to personnel connecting securely to the anchors, and after disconnection at the completion of the task. Provision shall also be made for the protection of users while transferring between fall arrest systems.

In-ground permanent anchor points shall be used in conjunction with full body harness and adjustable personal lanyard equipped with shock absorbing facility, all meeting the requirements of AS1891. Together they shall provide a fall restraint facility to the user avoiding the risk of falling from height or into an opening or penetration.

Each anchor point shall be embedded in a concrete deadman designed and constructed in accordance with Sydney Water Technical Specification - Civil.

Each anchor point shall be for single person use, rated for 1.5t, provided with a 360° swivelling type lashing point and held down by a stainless steel hexagonal bolt operable from the working surface into a M16 stainless steel DynaSet®, or equivalent, drop in anchor.

Anchor points shall be installed by qualified tradespeople using manufacturer approved tools and installation instructions.

Each anchor point shall be tested immediately after installation and then annually by axially proof loading to 50% of its ultimate strength in accordance with AS1891.4 by a NATA accredited agency.

A test tag of material suitable for external use shall be attached to the anchor point clearly showing test date/month and the agency who did the test.

Hard copy test certificates shall be provided and maintained on-site.

A colour coded laminated plan of anchor points for the whole site shall be maintained on-site. For unmanned sites such as submersible pumping station, this plan and test certificates may be stored in the RTU panel of the electrical kiosk. For manned sites these shall be stored in an appropriate place, e.g. along other quality documentation such as O&Ms and WACs.

A grade 316 stainless steel label shall be provided next to each anchor point showing its MAXIMO asset number, a short descriptor and the name of the opening it belongs to.

Any anchor point from which a person has received a fall shall be immediately quarantined until re-tested for its suitability for further use.
Location of anchor points shall meet the following requirements:

a) Each anchor points shall be located 1500mm away from the opening it will be used for.

b) Where anchor point is provided for an opening equipped with a hatch / safety grille, the anchor point shall be installed as far as practical in line with the hatch / safety grille hinges such that it allows the person attached to it freedom to move with the hatch / grille from its fully closed position to fully open position and vice versa.

c) They do not get covered by opening of other hatches / grilles / equipment at any time.

d) They allow un-hindered access to the users and their movement when attached to the anchor point.

e) Lanyard of the person attached to the anchor point does not rub against any other structure at any time of its normal use except when avoiding the lateral swing (pendulum effect) with the use of edge stops (refer AS1891.4 – fig 3.1).

f) Anchor points shall not be installed in vehicular traffic area or where they will be within the reach of lawn mower blades.

g) Anchor points shall be installed at least 100mm from the nearest concrete edge or a construction joint.

As far as practical, all anchor points are to be kept outside the main walking areas and placed in locations where they pose less of a trip hazard.
M3. Fasteners

M3.1 General

All items of equipment shall include all necessary fasteners, tightened to the torques specified by their manufacturer and, where necessary, secured from becoming lose.

All metric bolts, screws and nuts shall comply with AS1110, AS1111 and AS1112. The threads shall comply with AS1275. All unified bolts and nuts shall comply with AS2465 with threads complying with AS3635. A flat metal washer shall be fitted under each bolt head and nut. Washers shall be in accordance with AS1237.

Bolt lengths shall be such that after joints are made up, the bolts shall protrude through the nuts by a minimum of two full bolt threads, but not by more than 15mm.

Unless accepted otherwise by Sydney Water, stud bolts may only be used as tie rods in load bearing dismantling joints and similar fittings, in tapped holes, and where normal bolts cannot be used due to space constraints, eg. in short bodied valves and fittings. The stud bolts shall be of an appropriate material similar to the bolts, and with rolled threads. One end of stud bolts shall have a machined flat or square suitable for a standard size spanner.

Lock nuts, where used, shall be of full metallic construction. Nylon-insert lock nuts shall not be used.

High strength insulating washers shall be fitted under metal washers and adequate bolt stem insulating sleeves shall be used when dissimilar metals are joined in wet, humid, high condensation, outdoor or buried installations where there is a potential for galvanic corrosion between the fasteners and adjoining metals, eg. stainless steel bolts used on ductile iron pipework in wet wells, valve chambers within 1km from the sea etc. The bolt holes may have to be oversized to allow for protective coating and insulating sleeves. All interfaces of dissimilar metals shall also be insulated or fully and effectively coated.

M3.2 Stainless Steel Fasteners

Stainless steel bolts, nuts, screws, studs and washers shall be used where:

- submerged or buried in ground,
- cast or grouted into concrete, including all anchor bolts,
- in contact with raw sewage, sludge or effluent,
- exposed to corrosive environment such as sewage gas and salt loaded atmosphere (eg. in sewage pumping stations wet wells, emergency storages, maintenance holes, marine environment etc.),
- used for joining stainless steel,
- used for joining dissimilar metals,
- supplied as part of dismantling joints (stud bolts, nuts and washers),
- used in gland joints and couplings,
- for all proprietary equipment such as valves, pumps etc.

As a minimum, all bolts, nuts, screws, studs and washers shall be minimum A4-70 grade 316 stainless steel. In order to prevent seizing or galling of stainless steel fasteners the following measures shall be applied:

- Where possible, use different hardness stainless steel grades for bolts and nuts.
- Bolt and nut threads shall be rolled or buffed smooth before installation.
- Nuts shall be hand tightened at low speed to reduce the heat generated by friction.
- Nuts shall be tightened with a torque wrench to prevent over tightening.
- The threads shall be thoroughly coated with non-corrosive anti-seize compound prior to assembly. If in contact with potable water the anti-seize compound shall comply with AS4020.
M3.3 Non-Stainless Steel Fasteners

All pipe flange fasteners shall comply with the requirements of the relevant flange standards.

All structural fasteners shall be high strength steel bolts for structural engineering class 8.8, with steel nuts class 8 and associated hardened and tempered steel washers, all complying with AS1252 or AS2465. All threads shall be ISO metric coarse pitch series. Bolting category shall be 8.8/TB (full tensioning) as per AS4100.

The bolts and nuts shall be hot dipped galvanised in accordance with AS1214 and washers in accordance with AS4680.

Electro galvanising, nickel, cadmium, chrome or any other plating process shall not be used.
M4. Platforms, Walkways, Stairways, Ladders and Handrails

M4.1 General

Also refer to Technical Specification - Civil.


The spacing of ladder rungs and treads in the same ladder and the rise of stairway treads in the same stairway, and preferably throughout the whole plant, shall be uniform and within a tolerance of ±5mm.

Unless where accepted otherwise by Sydney Water, vertical rung ladders shall not be used. Stairways, inclined tread ladders or inclined rung ladders with slopes within the preferred ranges specified in AS1657, in this order of preference, shall be used instead. Stairways shall be min. 900mm wide and shall be installed where access is required on a frequent basis. Where portable ladders are to be used (e.g. access into sewage pumping station wet wells), adequate stainless steel ladder tie points are to be provided.

Handrails shall be provided around all open structures, elevated walkways and access platforms.

All stiles, stanchions and bracket surfaces shall be smooth and free from metal projections liable to cause personal injury to users.

Steps for underground maintenance holes and person entry chambers shall be in accordance with WSAA Product Specification WSA PS-314.

Step irons (individual rung ladder) installed in chambers and maintenance holes within sewage pumping stations shall be made from deformed 316 grade stainless steel and shall be minimum 400mm wide. Plastic encapsulated step irons or rungs shall not be used.

Rungs for rung ladders and steps shall be made from twisted, deformed or other slip resistant bars.

M4.2 Fixings For Floor Plates and Grating Penetration Covers

Floor plates and grating penetration covers must be fastened to their supporting structure using proprietary screws and/or clamps and shall not rely on adjacent sections for the prevention of lateral movement. They shall be fixed such that the removal of any element or panel will not affect the security of the remaining sections. Alternatively, if panels are not required to be removable they shall be permanently fixed down via welding or similar. The methods of attachment shall be capable of sustaining the imposed actions and the environment in which the fixing will be placed and shall be in accordance with AS1657 and AS1170 or other relevant regulatory requirements.

All fixings shall meet the following requirements:

- Match the design life of the grate or cover.
- Secured to structure.
- Tool required for removal.
- Quick and easy installation/removal.
- Prevent lateral movement of panel even if adjacent panels are removed.
- Be durable to wheel loads and foot traffic as required.
- Shall not create a trip hazard (be of a low profile).
- Not create dissimilar metal corrosion with relevant components including reinforcement within slabs.
- Durable and reliable.
- Suitable for the installation and the environment they will be used in.
- Installation to be in accordance with manufactures specification.
- Resistance to vibration as required.
M5. Bearings and Lubrication

M5.1 General Requirements

Bearings shall be of modern design, of rolling or plain (anti-friction) type and ample capacity for carrying all thrust and radial loads. All bearings shall be readily available metric sizes, lubricated efficiently and capable of long service without maintenance.

All rolling bearings shall be of ball or roller type, rated in accordance with AS2729 for a minimum basic rating life ($L_{10}$) of 10 billion revolutions. Bearings with non-metallic cages shall not be used.

Plain bearings shall have steel shafts running in bronze or self-lubricating graphite impregnated bushes and shall have a loading, based on projected area, of not more than 300kPa. Materials other than steel and bronze are subject to Sydney Water's acceptance.

All bearings shall be to ISO standard design dimensions and shall be readily available ex-stock from commercial bearing suppliers.

All bearing housings shall be fitted with seals and shall be grease or oil lubricated. Grease nipples with captive screw caps shall be provided for all grease lubricated bearings and, where practicable, capillary tubing shall be run from the bearings and grouped at a convenient accessible location. Where they may become in contact with potable water, all bearing materials, lubricants and painting shall comply with AS4020.

Bearings shall be adequately cooled to accommodate operation of the equipment in an ambient temperature situation of up to 45°C under most extreme loading conditions without reduction in calculated load rating or rating life. This shall be achieved without special or additional cooling arrangements, such as water-cooled heat exchangers or similar.

All bearings shall be furnished with the correct lubricants for at least one year's operation. The bearings shall also be adequately lubricated to prevent corrosion during storage and installation and for starting and commissioning the plant. Lubricants shall be as recommended by the relevant equipment manufacturer and have a minimum change period of 12 months.

Plates indicating the type of oil or grease, quantity and change period shall be fixed to the equipment items adjacent to the oil or grease lubrication points. Plates shall be engraved stainless steel grade 316, fastened with stainless steel fixings.

All bearings shall be capable of maintaining their seal for life without degradation or decrease of seal capability, eg. loss of seal element effectiveness due to higher than rated peripheral speed or due to axial shaft float. Neoprene “V” type grease and dirt seals shall be provided. Seals shall protect against ingress of water and foreign matter and from egress of lubricant for the life of the bearing. Where locking collars are required to maintain seal element tension these shall be of grade 431 stainless steel. Locking screws shall be “Loctited” at final adjustment.

To avoid damage to bearings (work hardening or “brinelling”) due to vibration during transportation, bearings shall be packed separately, or other suitable precautions taken to protect them.

M5.2 Grease Lines

Where grease lines are fitted, they shall not be attached to removable parts.

The grease lines shall be as short as possible, have sufficient radius to prevent crimping, and be adequately supported and protected from normal traffic around the machine's location.

The grease lines from the greasing point to the bearing shall be 3mm internal diameter made from Grade 316 stainless steel thin walled tubing and/or stainless steel double braided PTFE hoses. The use of nylon grease lines is not acceptable.
All connections between fittings shall be threaded connections. Grease nipples and other fittings on braided hoses shall be factory fitted. The lubrication points shall be readily accessible without removing guards and visible from normal access points to the machine and not in area or excessive dirt or moisture.

It shall be possible to grease the bearings with the machine running without danger to the operator or damage to the seals. Bearing housings shall be fitted with pressure relief devices to prevent over pressure.

The use of electrochemical and electromechanical auto greasers shall only be considered if agreed with Sydney Water. If used, these shall be installed directly on the bearing housings.

**M5.3 Oil Lubricated Bearings**

Oil lubricated bearings shall incorporate the following:

1. An integral oil circulation system. The design of the circulation system and venting arrangement shall not allow escape of oil from the bearing.
2. A large capacity adjustable constant level oil make-up system.
3. An oil level indicator.
4. A permanent marking of normal oil level on the bearing housing adjacent to the oil level indicator.
5. They should, preferably, be suitable for both mineral and synthetic lubricants.

**M5.4 Electric Motor Bearings**

For electric motor bearing requirements refer to Technical Specification - Electrical.

**M5.5 Bearing Condition Monitoring for Large Machines**

Bearings of machines larger than 600kW shall be fitted with accelerometers. Thrust and locating bearings require monitoring in all three planes, while for other bearings the accelerometers shall cover the two radial planes. The accelerometers shall be used for continuous on-line vibration monitoring, warning and shut down when vibrations exceed pre-set maximum levels. The collected data will be used by Sydney Water’s Corporate Condition Monitoring Database for monthly analysis and reporting.

Furthermore, all bearings of machines larger than 600kW shall be fitted with RTD temperature sensors wired to monitoring, warning and shut down protection system. Temperature detectors shall be 3-wire, 100-ohm resistance type PT100. All three wires from each temperature sensor shall be wired back to the associated auxiliary terminal box and from there connected to the unit’s control system.
Vibration

M6.1 General

Sydney Water employ a mixture of portable hand held and on-line permanently mounted condition monitoring equipment. Data collected from these tests is loaded into Sydney Water’s Corporate Condition Monitoring Database (Rockwell-Entek Odyssey Software). Generally, hand held condition monitoring is only carried out on equipment above 25kW unless an asset is of critical importance to the production process. Equipment over 600kW requires on-line permanently mounted condition monitoring equipment, such as the Rockwell-Entek Enwatch or XM products, which is able to download readings directly to the Sydney Water’s database.

Other equipment whose long-term operability and performance depends on severity of vibrations shall also be provided with vibration monitoring facilities.

For accurate readings to be taken by a hand-held probe a direct metal path between the bearings and the outside surfaces of the machine is required. This monitoring point must be accessible for a variety of hand held accelerometer types to be attached while the machine is operating under normal operating conditions. Examples of accelerometer types used within Sydney Water include Magnetic, Probes and Quick Connect.

Where a direct metal path accessible to the probe does not exist, a solid metal stud shall be securely fitted to the metal in contact with the bearing. This pick-up mounting shall be min. $8\text{mm}$ and be long enough to allow measurements to be taken by the conditioning equipment. Where clearance holes are required, they shall be at least 2mm greater than the stud diameter. If sealing of the hole is necessary, an elastic damping material such as soft rubber shall be used. Where it is not feasible to use this method, an alternative method is to be provided for Sydney Water’s acceptance.

Where equipment is to be inaccessible, caged/guarded or enclosed within an acoustic cover, hardwired accelerometers shall be mounted on the equipment (in a suitable position as described above) with cabling run to a termination panel mounted on the cover or in safely accessible position.

M6.2 Natural Frequencies

The lowest natural frequency of the combined industrial machines and support system, such as complete pumping units installed on their foundations, shall be at least 25% higher than the main excitation frequency, which is the machine maximum speed, when measured in any direction. The designer shall assess the combined lowest natural frequency and design the machines and foundations to meet this requirement.

For installation of pumping units, special care shall be taken to avoid resonances in the connected piping system and foundation with the impeller vane passing frequency, which may be two, three or more times the running frequency, as such resonances can cause excessive vibration.

M6.3 Vibration Severity

M6.3.1 General Industrial Machines

Vibration levels of industrial machines, other than rotodynamic pumping units, shall comply with the requirements of relevant parts of ISO 10816. Vibration severity of industrial machines not covered by ISO 10816 shall not exceed the maximum levels specified by their manufacturers.

M6.3.2 Rotodynamic Pumping Units

Vibration levels of rotodynamic pumping units, other than submersible, but including solids handling and slurry pumps when measured in situ shall comply with the requirements of ANSI/HI 9.6.4.

Vibration levels of dry and wet mounted submersible pumping units measured in situ shall comply with the requirements of ANSI/HI 11.6.

In situ vibration levels of pumps not covered by the above ANSI/HI standards shall comply with relevant ISO standards or, in their absence, with the maximum values specified by their manufacturers.
In addition, vibration levels of any pumps operating outside the preferred operating region (POR) determined as per ANSI/HI 9.6.3, but within the allowable operating region (AOR), as advised by the pump manufacturer, shall not exceed the values specified for POR plus 30%.
M7. Noise

M7.1 Introduction
The equipment, plant and systems shall be designed to:

1. Control and minimise occupational noise exposure that could lead to temporary or permanent hearing loss.

2. Minimise the likelihood that local residents and industrial premises are offended or disturbed by operation of the equipment, plant or systems.

M7.2 General
The equipment, plant and systems shall comply with the objectives, recommendations and requirements of SafeWork NSW, EPA NSW Industrial Noise Policy (INP), AS1055 Acoustics - Description and Measurement of Environmental Noise, and AS/NZS1269 Occupational Noise Measurement.

Where there is a difference between the recommendations or requirements contained in the above-mentioned documents, the more stringent recommendation or requirement shall apply.

During testing and commissioning, occupational and environmental noise tests shall be undertaken to prove compliance for final acceptance. Background noise tests, which shall be used as a basis for acceptance of the environmental noise levels, shall also be undertaken.

The plant operating under normal conditions that does not meet the following requirements for noise during site testing shall be rectified and retested.

M7.3 Occupational Noise

M7.3.1 General
In NSW the criteria used for evaluating noise exposure is based on the Code of Practice for "Noise Management and Protection of Hearing at Work". This Code of Practice provides guidance on complying with the SafeWork NSW WHS Regulation 2011.

Noise exposure resulting from the equipment, plant and systems designed, supplied and installed under the Contract shall be adequately controlled to ensure that people are not exposed to noise on site or arising from site operations which exceeds an exposure limit of:

1. 85 dB(A) for $L_{A_{eq}, 8-h}$;

2. 82 dB(A) for $L_{A_{eq}, 12-h}$; and

3. Peak shall not exceed 140 dB(C)

In addition, under normal operational conditions the maximum noise produced by new or modified equipment within the new or modified work place shall not exceed an overall A-weighted sound pressure level $L_{A_{eq}, (SPL)}$ of 85 dB(A) when measured no further than one metre from the operating unit.

M7.3.2 Noise Analysis
Definitions, test and noise evaluation methods, procedures, instrumentation and calibration as described in AS/NZ1269 shall apply. All test instruments shall be Class 1 Type 1 instruments as per AS IEC 61672 (or to available superseded AS1259).

The measured noise levels shall include room reverberation effects and any other noise associated with the supplied equipment.
M7.4 Environmental Noise - EPA Compliance

M7.4.1 General

With respect to environmental noise the operating plant supplied and installed shall comply with the EPA Industrial Noise Policy (INP), even if the occupational noise levels are within the specified limits.

The INP is primarily aimed at assessing noise from industrial noise sources scheduled under the Protection of the Environment Operations Act 1997 (NSW).

M7.4.2 Environmental Noise Criteria

The noise criteria, noise limits and noise assessments shall be determined and carried out in accordance with the INP.

Both the intrusiveness and the amenity noise criteria as per the INP shall be considered.

The noise criteria shall be met at all plant’s site boundaries.

M7.5 Noise Control

M7.5.1 General

Noise levels shall be contained by appropriate equipment design. Acoustic enclosures may only be used where agreed by Sydney Water.

Both the occupational and environmental noise impacts that would result from the works shall be covered in design report or, in the absence of the design report, in a separate document.

M7.5.2 Acoustic Enclosures

If an acoustic enclosure is provided, then the enclosure shall form an integral part of the equipment and shall not adversely affect the safety or function of equipment.

The acoustic enclosure shall not impede the flow of cooling air when fully installed.

The acoustic enclosure shall be constructed so that it can be easily removed for maintenance purposes, eg. to be wheeled across the floor. The enclosure shall have locks / latches to keep the enclosure closed when it is over the equipment.

Normal operation shall be possible without opening or removing enclosure. Hinged access doors shall be provided on all sides for easy access for routine inspection and maintenance.

The acoustic enclosure shall have double the design life of the enclosed equipment.
M8. Painting and Corrosion Protection

Painting and corrosion protection shall be in accordance with the requirements of WSAA Manual for Selection and Application of Protective Coatings WSA 201 and Sydney Water’s Supplement to WSA 201.

For all proprietary mechanical equipment such as pumps, motors, gearboxes, conveyors, etc. whether fully immersed or not, the painting shall be upgraded to be equal to or better than the requirements in the WSA 201 and Sydney Water’s Supplement to WSA 201.

Care shall be exercised to protect all instruments, bearings, and all operational parts from contamination and damage when applying the paint system.

Equipment which has been coated shall not be drilled or penetrated. Where cables, pipes, floorings and other equipment are to be fixed to structural steelwork to which protective coating, including galvanising, has already been applied, they shall be fixed using clamping systems that do not damage the protective coating.
M9. Valves

M9.1 General

Unless stated otherwise in this Specification, the valves shall satisfy the following minimum requirements:

1. The number of different types and makes of valves used shall be kept to a minimum. Valves of the same size, duty and type supplied for the same project shall be identical.

2. Valves shall be designed and manufactured in accordance with the latest editions of relevant Australian Standards and WSAA Product Specifications. In their absence suitable ISO, EN or other international standards may be considered, subject to Sydney Water’s acceptance.

3. All parts of valves shall be suitable for the worst-case operational conditions, including maximum (emergency) flows, pressures and temperatures.

4. Valve materials best suited for the service conditions and resistance to corrosion shall be selected.

5. The galvanic potential between adjacent parts of valves, including gearboxes, actuators and connecting shaft keyways, shall not exceed 0.3 Volts. Where necessary parts shall be electrically insulated from each other to achieve this requirement. Stainless steel of grade 303, 416, or other “free machining” grades shall not be used.

6. Unless specified otherwise, minimum pressure class shall be PN16.

7. Unless specified otherwise, valve flanges shall be circular and conform in dimensions and drilling to AS4087. Where sizes and pressure class exceed those contained in AS4087, valve flanges shall conform to AS4331.2 or relevant international standards as agreed with Sydney Water. Flanges shall be either raised or flat face type and faced parallel and square by machining. The backs of flanges shall be machined or spot faced to provide a satisfactory bearing for bolt heads and nuts.

8. Valves shall have proven record of reliable operation in the intended environment.

9. Valves shall be of standard and proven design to give optimum performance in meeting the specified operating conditions.

10. Unless specified otherwise, actuated valves shall be fitted with suitable manual operating elements, such as hand wheels or handles. Loss of power or failure of the actuator shall not prevent manual operation of the valve.

11. Isolating valves shall be supplied with spindle caps. Spindle caps and keys for valve operation shall be designed in accordance with the relevant Australian Standards. The colour of spindle caps for water shall be blue and for recycled water purple in accordance with Sydney Water’s Edition of Water Services Association of Australia Code WSA 03. The colour of spindle caps for valves used in sewage applications shall be black.

12. The manual operating elements, such as hand wheels or handles on isolating and control valves DN80 and larger shall close the valve in an anti-clockwise direction. Valves DN65 and smaller and all hydrant / recycle water / air valve / isolating valves (globe valves with vertical spindle installed on stand pipe) shall close in clockwise direction. However, where all existing valves within a plant open / close in opposite direction than specified in this Specification, the direction of opening / closing of any new valves shall be determined in risk workshops and in liaison with Sydney Water. The direction to turn the valve open and close shall be indicated on the valve manual operating elements or stainless steel plates fitted on or adjacent to the valve. The sign on such plates shall be laser cut through (i.e. not a weld bead).

13. The hand wheel diameter shall not exceed 600mm.
14. Isolating valves shall be capable of opening and closing against full unbalanced head and maximum flow and shall open and close smoothly without damage to any components.

15. Unless specified otherwise, all isolating and control valves shall be fitted with non-rising spindles.

16. Manually operated valves shall open and close with a maximum operator applied force of no more than 160N applied on the operating element to overcome their normal running torque, based on the maximum differential pressure, maximum flow and orientation of the valve.

17. The “cracking” torques and forces of manually operated valves required to be applied for approximately ½ to 1 turn to off-seat or on-seat the valve under maximum differential head conditions shall not be higher than as stated in the design and agreed to by Sydney Water.

18. All gate, butterfly, knife-gate, ball, globe, plug, diaphragm and piston valves shall be bi-directional, ie capable of operation with flow in both directions and pressure on either side of the valve.

19. The size, shape, strength and rating of all valve parts shall be sufficient to provide an ample factor of safety under all working conditions, taking into account corrosion and wear.

20. Valve castings shall be sound and clean. Structural defects in ductile or cast iron valve components shall not be repaired and used in valve assembly. No welding is permitted on cast components.

21. Drainage holes shall be drilled or formed in any external pockets on the valve body or associated equipment, when necessary, to prevent moisture ponding.

22. Valves DN80 and larger shall be supplied with support feet or include lugs to allow for the mounting of feet and attachment of anchor bolts or legs.

23. All internal and external fasteners shall be made of grade 316 stainless steel and shall have standard ISO thread to AS1110, AS1111 and AS1112. This includes flange fasteners on integral bypasses etc. Stainless steel bolt threads shall be coated with anti-seize lubricant.

24. Valve parts requiring grease lubrication (e.g. gearboxes) shall be fitted with grease nipples.

25. The valve leakage rates shall not exceed that specified in the relevant standard and this Specification.

26. Valve assemblies exceeding 25kg shall be provided with adequate lifting attachments. The lifting attachments shall be designed to withstand the total assembled mass of the valve, including the gearbox and actuator, if supplied. Where eyebolts are provided, they shall comply with AS2317.

27. The valve internal surfaces shall be devoid of sharp protrusions which may initiate secondary cavitation at high velocities.

28. All valve materials, coatings, lubricants etc. for drinking water application shall comply with AS/NZS4020.

29. Isolating and control valves may be electrically, hydraulically or pneumatically actuated or operated by portable actuators, as specified.

30. Valves fitted with electric actuators shall include position transmitters and torque and limit switches. Pneumatically actuated valves shall have limit switches and manual override. Where specified, manually operated valves shall also be fitted with limit switches and torque limiting devices. The position transmitters and limit switches shall comply with this Specification and Technical Specification - Electrical.

31. For valves fitted with pneumatic, electric or hydraulic actuators the gearbox and all valve components shall be designed to withstand the maximum rated torque capacity of the actuator plus 20%.
32. Unless specified otherwise, isolating valves DN450 or larger up to PN16 and DN300 or larger for PN21 and above shall be fitted with bypass arrangements, which may be integral with the valve (gate valves only) or external. The bypass arrangements and sizes shall comply with the requirements of Sydney Water’s Edition of WSAA Water Supply Code of Australia WSA 03. Subject to Sydney Water’s acceptance, reduced size integral bypasses may be used on smaller gate valves where the specified size fittings cannot be accommodated on valve body castings.

33. Manually operated gate, butterfly and knife edge gate valves larger than DN300 or valves which require more than 100 turns from fully closed to fully open position shall have an adapter on the valve spindle for use of a portable electric actuator. This spindle needs to be in the vertical position.

34. Unless specified otherwise, gate valves DN600 and above shall be fitted with gearboxes. Gearboxes shall also be fitted to smaller gate valves if the effort on their operating elements required to overcome their normal operating torque exceeds 160N.

35. Valve gearboxes shall not be buried, installed in locations where they may become submerged, or where they cannot be readily accessible for maintenance.

36. All isolating valves shall be able to be locked in either closed and open position. Where specified, valves shall be fitted with a keyed locking mechanism to prevent their unintentional operation. If the provision to lock out the isolation point directly using a hasp or lock is not available, isolation devices, such as surface box locking plates, which allow effective lockable isolation shall be utilised.

37. Where used, valve extension spindles shall be fabricated from the same material. Steel or stainless steel rods or tubes welded to ductile or cast iron valve keys or caps are not acceptable. Extension spindles in buried, submersed or aggressive environments installations shall be grade 316 stainless steel.

38. Unless specified otherwise, isolating valves DN750 and larger shall be provided with suitable actuators. Valves ≥DN450 installed on sewage pumping stations inlet lines shall also be electrically actuated.

39. Automatically operated valves shall be fitted with suitable guards to prevent injury resulting from automatic operation whilst undergoing maintenance activities.

Notes:

a) The term “isolation valve” defines a valve (such as gate, butterfly, knife-gate, plug, globe, ball, diaphragm etc.) that is in the normally fully open or fully closed position. Isolation valves are not used to control flow or pressure. They may occasionally be opened or closed under full unbalanced head or flow conditions.

b) The term “control valve” defines a valve (such as butterfly, needle, plug, globe, ball, diaphragm etc.) that may operate in a partially open or closed position to control flow or pressure.

**M9.2 Marking**

Unless specified otherwise in the relevant standards, as a minimum the following lettering shall be cast on the body of each valve equal to or greater than DN80:

- Manufacturer's name or mark
- Nominal size (DN)
- Year of manufacture
- Pressure class (PN)
- Body material designation
- Standard to which manufactured
- Serial number
- Gear ratio (if applicable)
- An arrow denoting the preferred flow direction (if applicable)
- Arrows on the face of each operating element with the words OPEN and CLOSE (if applicable). Where operating element can be removed or is not supplied, this marking shall be provided on other prominent place on or next to the valve, eg. spindle cap, surface box, valve chamber cover etc.
- Valve total mass

The lettering shall be in legible block type letters projecting not less than 3mm. The lettering shall be as large as practicable but not less than 6mm high for sizes up to DN 150, 10mm high for DN 200 to DN 300, 20mm high for DN 350 to DN 600 and 25mm high for DN 700 and above.

Where, owing to the size or any other reason (e.g. valves smaller than DN80), casting of the above lettering is not practicable, such information shall be shown on an engraved stainless steel nameplate or a permanent label. This nameplate or label shall be permanently attached to a raised pad on the body of the valve casting or to the rim of the flange using suitable adhesive and shall be positioned to be clearly visible after installation. Nameplates shall have minimum 3mm high etched or engraved letters. Labels shall be printed with minimum 8mm high letters.

Buried valves shall be provided with secondary marking in the form of an engraved stainless steel nameplate securely fixed to the underside of the surface box lid. Apart from containing the same information as above, the nameplate shall also clearly designate the valve type and seal design.

M9.3 Type of Valves

Various types of valves may be considered for water and wastewater applications. The type of valves to be used shall be in accordance with the table below. Use of other type valves shall be subject to Sydney Water’s acceptance.

<table>
<thead>
<tr>
<th>Type of Valve</th>
<th>Valve Service</th>
<th>Functionality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gate valves - metal seated</td>
<td>Clean, potable or recycled water and effluent, raw water.</td>
<td>Open or closed. Must not be used for throttling or flow control.</td>
</tr>
<tr>
<td>Gate valves - resilient seated</td>
<td>Clean, potable or recycled water and effluent, raw water, raw and screened sewage.</td>
<td>Open or closed. Must not be used for throttling or flow control.</td>
</tr>
<tr>
<td>Non-return valves - long bodied swing flex</td>
<td>Clean, potable or recycled water and effluent, raw water, raw and screened sewage.</td>
<td>Operates automatically.</td>
</tr>
<tr>
<td>Non-return valves - short bodied tilting disc</td>
<td>Clean, potable or recycled water and effluent, raw water.</td>
<td>Operates automatically.</td>
</tr>
<tr>
<td>Non-return valves - ball check</td>
<td>Clean, potable or recycled water and effluent, raw water, raw and screened sewage.</td>
<td>Operates automatically.</td>
</tr>
<tr>
<td>Type of Valve</td>
<td>Valve Service</td>
<td>Functionality</td>
</tr>
<tr>
<td>--------------</td>
<td>--------------</td>
<td>---------------</td>
</tr>
<tr>
<td>Non-return valves - flexi check (swing flex)</td>
<td>Clean, potable or recycled water and effluent, raw water, raw and screened sewage.</td>
<td>Operates automatically.</td>
</tr>
<tr>
<td>Non-return valves - double leaf (duo) check (resilient seated)</td>
<td>Clean, potable or recycled water and effluent, raw water.</td>
<td>Operates automatically.</td>
</tr>
<tr>
<td>Non-return valves - nozzle check</td>
<td>Clean, potable or recycled water and effluent, raw water.</td>
<td>Operates automatically.</td>
</tr>
<tr>
<td>Butterfly valves, seal-on-body, concentric</td>
<td>Clean, potable or recycled water and effluent, raw water, aeration and sparge air, biogas.</td>
<td>Open or closed, limited flow control (except for raw water, air and gas where a characterised positioner or SCADA function shall be applied).</td>
</tr>
<tr>
<td>Butterfly valves, seal-on-disc, double offset</td>
<td>Clean, potable or recycled water and effluent, raw water.</td>
<td>Open or closed, limited flow control (except for raw water), discharge regulating (guard valve).</td>
</tr>
<tr>
<td>Butterfly valves, metal seated, double or triple offset</td>
<td>Clean, potable or recycled water and effluent, raw water.</td>
<td>Open or closed, throttling, limited flow control (except raw water) (used as pump discharge control valve).</td>
</tr>
<tr>
<td>Knife-gate valves</td>
<td>Clean, potable or recycled water and effluent, raw water, raw and screened sewage, sludge, grit slurry, aeration and sparge air.</td>
<td>Open or closed.</td>
</tr>
<tr>
<td>Diaphragm valves - straight through type</td>
<td>Clean, potable or recycled water and effluent, raw water, raw and screened sewage, corrosive fluids.</td>
<td>Open or closed, limited throttling. Not to be used for grit slurries.</td>
</tr>
<tr>
<td>Diaphragm valves - weir type</td>
<td>Clean, potable or recycled water and effluent, slurry, corrosive fluids, chemicals.</td>
<td>Open or closed, throttling. Not to be used for grit slurries.</td>
</tr>
<tr>
<td>Plug valves - eccentric</td>
<td>Clean, potable or recycled water and effluent, raw water, raw and screened sewage, sludge, grit slurry, digester gas.</td>
<td>Open or closed, flow control.</td>
</tr>
<tr>
<td>Plug valves - lubricated</td>
<td>Gas service.</td>
<td>Open or closed.</td>
</tr>
<tr>
<td>Type of Valve</td>
<td>Valve Service</td>
<td>Functionality</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Ball valves</td>
<td>Clean, potable or recycled water and effluent, raw water, raw and screened sewage, oil, gas, chemical application, air.</td>
<td>Open or closed, limited throttling.</td>
</tr>
<tr>
<td>Air valves for water supply</td>
<td>Clean, potable or raw water, recycled water, effluent.</td>
<td>Operates automatically.</td>
</tr>
<tr>
<td>Air valves for sewage supply</td>
<td>Raw and screened sewage.</td>
<td>Operates automatically.</td>
</tr>
<tr>
<td>Reduced pressure zone valves</td>
<td>Clean, potable water.</td>
<td>Operates automatically.</td>
</tr>
<tr>
<td>Automatic control valves –</td>
<td>Clean, potable or recycled water.</td>
<td>Flow control, level control, pressure reducing, pressure sustaining.</td>
</tr>
<tr>
<td>hydraulically operated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automatic control valves - electric,</td>
<td>Clean, potable or recycled water</td>
<td>Flow control, pressure reducing, pressure sustaining, discharge regulating (guard valve).</td>
</tr>
<tr>
<td>piston (‘needle’) type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Globe valves</td>
<td>Clean, potable or recycled water and effluent, oil, gas, general purpose.</td>
<td>Open or closed, throttling, flow control.</td>
</tr>
<tr>
<td>Pressure / Vacuum relief valves (gas)</td>
<td>Compressed air or gas</td>
<td>Operates automatically.</td>
</tr>
<tr>
<td>Pressure / Vacuum relief valves</td>
<td>Water, sewage, sludge, effluent</td>
<td>Operates automatically.</td>
</tr>
<tr>
<td>valves (liquid)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pinch valves</td>
<td>Grit slurry, lime dosing (full bore pinch valves)</td>
<td>Open or closed. Must not be used for throttling or flow control. Not viable in situations where the transport media is at a high temperature. Not recommended for services that require high-pressure flow, or for use with gases.</td>
</tr>
<tr>
<td>Other DN65 and smaller valves</td>
<td>Clean, potable or recycled water and effluent, oil, gas, general purpose.</td>
<td>Open or closed.</td>
</tr>
</tbody>
</table>
M9.4 Installation

Valves shall be installed strictly in accordance with manufacturers’ instructions and this Specification. Valves may be installed in the following applications:

- Above ground / floor;
- Valve chamber with extended spindle; or
- Buried with extended spindle.

All valves shall be adequately supported. The valves, their gearboxes, actuators and operating elements shall be installed so that they are easily accessible for operation and maintenance. Adequate dismantling means, such as load bearing dismantling joints, flanged pipe elbows or threaded unions for threaded valves, shall be provided close to each valve to facilitate its dismantling and re-installation. Subject to Sydney Water’s acceptance, the dismantling means and easy access may not be provided for buried valves.

Where accepted by Sydney Water, union joint valves may be used on sizes DN50 and smaller.

Non-return and butterfly valves shall be installed such that they can be easily maintained, e.g. in suitable pits, valve chambers, pumping station buildings or above ground. They shall not be buried.

Butterfly and short bodied tilting disc non-return valves shall be installed so that they can be safely removed from the pipework even if jammed open. This may include a load bearing dismantling joint on one side and a pipe not shorter than the length of the valve disc protruding outside the valve body on the other.

Butterfly and non-return valves shall be installed with their shafts / hinge pins horizontal and the bottom of their discs shall open in the direction of flow. The valve discs shall operate freely from open to close into adjacent pipework, fitting or dismantling joint internal diameters. Disc clearance dimension shall be stated for each butterfly and non-return valve. Sufficient space must be allowed around the non-return valves to remove the hinge pins.

During installation of butterfly valves their discs shall be in partially open position.

Isolating valve operating elements, such as hand wheels, handles and removable keys shall be easily accessible. They shall preferably be positioned horizontally approx. 900mm to 1200mm or vertically with the spindle centreline approx. 1000mm to 1800mm above the operating platform level. Subject to Sydney Water’s acceptance, other positions may also be considered. Where necessary, adequate operating or “step up” platforms shall be provided.

The centreline of a horizontally installed operating element and valve spindle must not be more than 300mm from the operating platform hand railing, or edge of the operating platform where no hand railing is required. The face of the vertically installed operating elements must be within the operating platform. Operating elements must have min. 100mm clearance all around from other fixed items such as handrails, walls, pipes etc.

Valves installed at heights may be fitted with chain wheels and chains. Such installations may be considered only where suitable operating platforms cannot be provided and manual operation cannot be eliminated, eg. by installing valve actuators. Chain wheel operated valves shall be equipped with a chain guide to prevent chain from coming off the wheel and permit reasonable side pull on the chain. The chain wheel shall be keyed. The chain wheel and chain guide shall be secured to the valve or gearbox input shaft, where fitted, by means of a locking bolt which shall prevent them from becoming loose or falling off the shaft under any possible operating conditions. The locking bolt shall be prevented from becoming loose. Grub screws, retaining washers, circlips, split pins or similar shall not be used. Operating chains shall be hot dipped galvanised and shall be looped to extend within 900mm of the operating level below the valve. Suitable hooks shall be provided to tie the chain when not in use. The maximum operating effort (pull) on the chain shall not exceed 200N.
Manual operation of the valves shall be carried out with ease and without the need for any other extra equipment. All valves shall be capable of being removed from their location in a pipeline without obstruction by the pipeline or other equipment.

Where necessary, buried isolating valves and those installed under and operated from operating platforms or valve chamber covers shall be fitted with extension spindles.

The extension spindles shall comprise a rigid shaft or tube capable of transmitting the maximum torque requirement of the valve. The extension spindles for gate valves shall be manufactured, tested and supplied in accordance with WSAA Product Specification WSA PS - 262 and AS2638.2 or AS2638.1, as applicable. The extension spindles for all other valves shall comply with WSAA Product Specification WSA PS - 269.

In buried valve installations, extension spindles shall be enclosed in a rigid tube or shroud. The spindle cap shall be protected by a surface box. The surface box shall be installed in accordance with WSAA Water Supply Code of Australia WSA 03 - Sydney Water’s Edition, drawing no. WAT-1303-V and WAT-1304-V. Unless accepted otherwise, the depth of buried valves shall not exceed 3m to invert.

Buried valves shall be provided with clear and permanent marking showing their operating fluid, i.e. sewage, water or recycled water. The marking shall be provided at the surface, either next to or underside the surface box lid or on a permanent structure next to the valve spindle.

For valves installed in valve chambers or below operating platforms, their (extension) spindles shall end approximately 50mm below the platform level and the platforms shall be provided with adequate keyholes directly above the spindles to enable operation with removable keys. The extension spindles shall be fitted with supporting brackets. Valves installed with horizontal spindle (if accepted by Sydney Water) shall be fitted with bevel gearboxes and extension spindles for operation from the top of the valve chamber or operating platform.

One removable key for each valve / spindle size supplied shall be supplied for operation of buried, submersed or valves installed below operating platforms.

Where permanent hand wheels need to be fitted to valves installed below operating platforms, their extension spindles shall extend 900mm to 1200mm above the platform and provided with suitable spindle pedestals fastened to the top of the platform. In any case, the handwheel shall be position min. 50mm above the platform handrailing.

Valves not installed directly below but operated from platforms shall also be supplied with extension spindles ending above the platforms hand railing. The extension spindles shall be fitted with supporting brackets as required and be suitable for installation of operating elements. The horizontal distance from the edge of the operating platform to the centreline of the extension spindle shall not exceed 300mm.

**M9.5 Gate Valves**

**M9.5.1 Metal Seated Gate Valves**

Metal seated gate valves DN80 and larger shall be double flanged or double socketed, as specified, manufactured, tested and supplied in accordance with WSAA Product Specification WSA PS - 261 and certified compliant with AS2638.1.

The valves shall be of the required class, suitable for installation in horizontal, vertical or inclined pipelines with their spindle in vertical, horizontal or inclined position, as specified. The double flanged valves face-to-face dimensions shall comply with AS2638.1. Unless accepted by Sydney Water, no alternative face-to-face dimensions, including those specified in older versions of this Standard, will be accepted.

The gate valves shall be used for isolation purpose and shall in normal operation be either fully open or fully closed.

Gate guides shall be provided in all gate valves to ensure alignment of the gate and carry the loads imposed. Integral gate guides cast in the valve body may be used for valves up to and including DN600. Separately fitted, replaceable guide liners and gate slippers shall be provided in gate valves DN700 and above and in all
gate valves installed in vertical or inclined pipelines or with their spindle in horizontal or inclined position. The guide liners and gate slippers shall be recessed into the valve body and gate and held in position to resist loads imposed.

**M9.5.2 Resilient Seated Gate Valves**

Resilient seated gate valves DN80 and larger shall be double flanged or double socketed, as specified, manufactured, tested and supplied in accordance with WSAA Product Specification WSA PS - 260 and certified compliant with AS2638.2.

The valves shall be of the required class, suitable for installation in horizontal, vertical or inclined pipelines with their spindle in vertical, horizontal or inclined position, as specified. The double flanged valves face-to-face dimensions shall comply with AS2638.2. Unless accepted by Sydney Water, no alternative face-to-face dimensions, including those specified in older versions of this Standard, will be accepted.

The resilient seated gate valves shall be used for isolation purpose and shall normally be either fully open or fully closed.

Integral gate guides cast in the valve body shall be provided in all resilient seated gate valves to ensure alignment of the gate and carry the loads imposed.

The gates of resilient seated valves shall be fully vulcanised internally and externally to the substrate metal with no metal parts exposed to the medium. The gate nut shall preferably be integral with the gate.

**M9.5.3 Thrust Retention**

Gate valve design shall incorporate a fail-safe method of thrust retention, such as a thrust collar that is an integral part of the valve spindle, an external thrust bearing, a separate split ring, or other multiple part assembly. Unless specified otherwise, the thrust retention mechanism shall be supported off the valve body.

Gate valves fitted with external thrust retention bearing shall be fitted with a safety collar designed to support the gate, spindle and other associated parts in the fully open position should the thrust retention mechanism be removed.

Gate valves fitted with external thrust retention mechanism where the gate and spindle can fall upon its removal shall have an engraved stainless steel plate attached close to the thrust retention mechanism stating that the gate shall be in the fully closed position prior to removing the thrust retention mechanism. In addition, wherever possible such valves shall be fitted with a safety pin or bolt installed on the spindle above the valve gland to stop the spindle and gate from falling completely through the stuffing box should the thrust retention mechanism be accidentally removed. The position of the safety pin or bolt shall ensure sufficient space to allow the gland to be repacked.

**M9.5.4 Gearboxes**

Gate valve gearboxes shall be sized in accordance with Appendix D of AS2638.1 or AS2638.2, as appropriate, such that the maximum force to operate the valve applied on the operating element to overcome its normal running torque, based on the maximum differential pressure, maximum flow and orientation of the valve does not exceed 160N. The force required to be applied for approximately ½ to 1 turn to off-seat or on-seat the valve (i.e. “cracking” torque) for gearboxes with single input shaft may exceed this value.

Unless specified otherwise, for gate valves DN750 and above the gearboxes shall be supplied with two gear ratios and dual input shafts. The primary input shaft shall have a lower gear ratio and shall be used for normal operation. The secondary input shaft shall have a higher gear ration and shall be used for off-seatting and on-seatting. Unless agreed otherwise, the maximum force applied on the operating element required to off-seat or on-seat the valve using the secondary input shaft under maximum differential head shall also be no more than 160N. Both input shafts shall turn in the anti-clockwise direction to close the valve.

The gearboxes shall be capable of withstanding the forces generated by an output torque of not less than 1.5 times the minimum strength test torque given in the relevant standards.
The gearboxes shall be self-locking in all positions. Gears shall comply with AS2938 and the input and output bearings shall be of corrosion resistant materials.

The gearboxes shall be manufactured in accordance with AS60529 with an enclosure rating of IP68, suitable for 5m immersion in water for 72 hours. Mounting flanges shall comply with ISO5210 or ISO5211, as applicable, using an adaptor piece if necessary.

The gearboxes shall incorporate adjustable mechanical position stops to limit valve travel. Where valve actuators are fitted the stops will only restrict travel if the actuator travel limit stops fail.

Unless specified otherwise in the relevant standards, the gearboxes shall have the following markings:

- Manufacturer's name
- Model and series number
- Year of manufacture
- Gear ratio
- Maximum allowable gearbox input torque

The information shall be shown on an engraved stainless steel nameplate. This nameplate shall be permanently attached with a suitable adhesive. The plate shall be in a location that shall be clearly visible after installation.

The lettering shall be as large as practicable but not less than 6mm nor larger than 25mm high.

**M9.5.5 Position Indicators**

Gate valves fitted with gearboxes shall have a basic position indicator for local operation attached to the gearbox or shaft or extended spindle.

Where specified, buried or submerged gate valves and those fitted with extension spindles shall be fitted with remote position indicators visible at the operating position. For buried valves the indicator shall be housed in the surface box.

The position indicator shall be sealed against ingress of moisture and contaminants and shall provide indication of the valve in the fully open, intermediate and fully closed positions. The position indicators shall be manufactured in accordance with AS60529 with an enclosure rating of IP68, suitable for 5m immersion in water for 72 hours.

**M9.5.6 Testing and Certification**

All gate valves shall be subject to full production tests and, where specified, full type tests in accordance with AS2638.1 or AS2638.2, as applicable. Test certificates shall be supplied with each valve.

Permissible seat leakages and minimum test durations for metal seated gate valves up to DN900 and resilient seated gate valves up to DN750 shall be as specified in the appropriate standard. For metal seated gate valves larger than DN900 the permissible seat leakage during valve seat tests shall not exceed 10mL/min and the minimum test duration shall be 10 minutes. For resilient seated gate valves larger than DN750 no leakage shall be allowed, and the minimum test duration shall be 10 minutes.

**M9.6 Non-return Valves**

**M9.6.1 General**

Non-return valves DN80 and larger shall be double flanged, manufactured, tested and supplied in accordance with WSAA Product Specification WSA PS - 264 and certified compliant with AS4794.

Non-return valves shall be suitable for horizontal, vertical or inclined installation, as specified. However, wherever possible non-return valves in raw sewage applications shall be installed in horizontal position to avoid solids settlement on the back of the disc. Hinge pins shall always be installed horizontally.
Tilting disc non-return valves shall be provided with a disc hinge pin extended through the valve body on one or both sides. The extended hinge pin shall be fitted with a lever arm and adjustable counterweight.

Swing check non-return valves shall be fitted with a disc hinge pin extended on one side, lever arm and adjustable counterweight.

The counterweight lever arm shall be fitted directly onto the disc hinge pin. Separate hinge pins for the disc and the counterweight lever arm shall not be accepted.

Fixed guards, fabricated from expanded metal, perforated or slotted steel plate shall be fitted to all non-return valves provided with permanent lever arms and counterweights.

The counterweights shall be fitted to the side of the non-return valves away from the area that is likely to be accessed by maintenance personnel, e.g. closer to the wall in case of valve chamber installation.

Unless it can be removed through the top flange, there should be enough space between the valve and adjacent object to enable the removal of the hinge pin.

Unless specified otherwise, non-return valves installed on discharge side of water, recycled and effluent pumps and all variable speed pumps, including sewage, shall be fitted with an adjustable proximity limit switch (also referred to as “no-flow” switch). The control system shall stop the pump if there is no flow detected through the associated non-return valve by its proximity limit switch, i.e. if the valve closes or does not open when the pump operates.

Where fitted with a damping device, the valve hinge pin / shaft and lever shall be designed to withstand the maximum torque and force that could be developed under extreme conditions of reverse flow.

M9.6.2 Other Types of Non-return Valves

Nozzle check, double-leaf (duo) check, ball check, flexi check / swing flex and other types of non-return valves may be used only where accepted by Sydney Water. Hydraulic dampers may be considered for swing check and tilting disc non-return valves in special circumstances, e.g. where water hammer or valve slamming may be an issue.

Flexi check valves with elastomeric encapsulated discs and grade 316 stainless steel hinge pin shall have the elastomeric material made of EPDM. The discs shall have a ductile iron or steel insert and nylon reinforcement in the rubber hinge. The valve seat shall be slanted to reduce disc closing time. The valves shall be designed with provision to accommodate a position indicator and an adjustable proximity limit (“no-flow”) switch and a backflow actuator and, where required, supplied with these appurtenances. They shall be manufactured by companies with extensive experience and supported by test data to prove the valve performance. The valves face-to-face dimensions shall comply with AS4794 and shall be type and production tested in accordance with AS4794.

The double-leaf check non-return valves shall be used for aeration services. Unless specified otherwise, they may also be used in small booster water pumping sets and shall be resilient seated.

For low head drainage applications non-return valves with elastomeric flaps or “bills” may be used, subject to Sydney Water’s acceptance. The valves shall be of a proven design with the flap or bill and liner of elastomeric material. If a clamp ring is required it shall be made of grade 316 stainless steel. The valve shall not incorporate any metal or mechanical hinges or fasteners to secure the flap or bill to the body of the valve.

M9.6.3 Damping Devices

If required or specified, the damping devices shall employ hydraulic damping in operation and shall facilitate fast, but soft closing of non-return valves, preventing disc slamming under reverse flow conditions and minimising vibration and water hammer. The device shall allow free and rapid disc opening and movement over the normal operating range and become active only within the damping zone which shall extend to 5-15° (adjustable) off the fully closed position.
The hydraulic damping devices shall be of a simple, reliable and compact design, generally consisting of hydraulic cylinders, pressure tubing and flow control valves. No power pack or similar device is to be employed. The damping device may be installed externally to the disc and activated via the valve shaft, or inserted into the flow way (in clean water application only) and acting directly on the disc. In either case the device shall be supported off the valve and require no external support or mounting separate to the valve. It shall be possible to undertake routine and preventative maintenance of the device without dewatering or accessing the pipeline. The device shall be designed to withstand the maximum inertia that could be developed under extreme conditions of reverse flow.

The damping device shall be single acting i.e. it shall only be effective in the closing direction. The damping zone and time shall be externally adjustable by simple means, such as by operating a flow control valve installed on the damping cylinder. The closing time shall not be significantly affected by the varying ambient temperature and fluid viscosity. Once set the closing time shall not be readily adjustable, and the adjustment device locked or permanently tagged.

M9.6.4 Testing and Certification

All non-return valves shall be subject to full production tests and, where specified, full type tests in accordance with AS4794, using clean water at ambient temperature. Test certificates shall be supplied with each valve. Valves that do not comply with AS4794 shall also be type tested in accordance with this standard and supplied with type test certificates.

The duration of the valve body and seat hydrostatic tests for valves up to DN750 shall comply with AS4794. For larger valves the tests duration shall be min. 10 minutes.

Permissible seat leakage for valves up to DN750 shall be as specified in AS4794. For larger valves the leakage shall not exceed 30mL/hr for each 25mm of valve diameter.

M9.7 Butterfly Valves

M9.7.1 General

Unless specified otherwise, butterfly valves DN80 and larger shall be resilient seated double flanged type, manufactured, tested and supplied in accordance with WSAA Product Specification WSA PS - 263 and certified compliant with AS4795.2.

Lugged type butterfly valves may be used only where accepted by Sydney Water. Lugged type butterfly valves shall comply with WSAA Product Specification WSA PS - 263 and certified compliant with AS4795.1. Wafer body butterfly valves shall not be used.

The valves shall be bi-directional, of the required class and suitable for horizontal or vertical pipeline installation, as specified.

In order to avoid galvanic corrosion, all wetted surfaces and interfaces of dissimilar metals shall be insulated or fully and effectively coated.

The shaft bearings shall be secured in the body of the valve and shall not rotate.

The butterfly valves shall be capable of opening and closing against full unbalanced head and design emergency velocity as specified. The design emergency velocity associated with maximum flow rate in case of burst water main downstream of the valve shall be calculated for each valve but shall not be less than 7.5m/s. When requested by Sydney Water, details showing the derivation of the maximum generated torque under emergency velocity conditions shall be supplied.

Butterfly valves shall not be used for unscreened sewage, slurries, sludge or process streams which may contain suspended solids, screenings or grit.
M9.7.2 Application

Butterfly valves should normally be used for isolation purposes where they are either fully open or fully closed. They may also be used for flow control providing that the design flows and pressures are within their cavitation-free operating range.

Unless specified otherwise, valves used for flow control shall be double offset (double eccentric) to increase their seal/seat life.

M9.7.3 Resilient Seated Butterfly Valves

Resilient seated butterfly valves shall be either concentric seal-on-body or double offset seal-on-disc, as specified. Seal-on-body valves may be used for waterworks purposes in normal applications (e.g. small to medium trunk mains), low emergency velocities (up to 7.5m/s) and up to PN16. Seal-on-disc valves shall generally be used for strategic assets (e.g. dam outlets, large trunk mains), high emergency velocities (above 7.5m/s) and above PN16. Resilient seated butterfly valves shall provide drop tight sealing from both sides when closed.

M9.7.3.1 Seal-on-body butterfly valves

Seal-on-body type butterfly valves shall be provided with solid synthetic resilient seal, vulcanized to the body. The valve seal shall extend over the flanges forming integral flange gaskets so that separate gaskets or O-rings are not required. Their shaft shall be positioned concentric to the valve bore. The valve disc shall be manufactured from stainless steel or aluminium bronze.

M9.7.3.2 Seal-on-disc butterfly valves

Seal-on-disc type butterfly valves shall be provided with solid synthetic resilient seal fixed on the valve disc. The seal for valves DN750 and above shall be readily replaceable in situ without requiring the removal of the valve from the pipeline. The seal shall be of a low profile, resistant to high velocities and cavitation damage.

The seat ring and seal clamp shall be manufactured from stainless steel grade 316 or other suitable corrosion and cavitation resistant material.

The seat ring shall be secured to the body to provide a corrosion resistant seating surface and prevent the valve from leaking past the seat. The seat ring shall not be secured to the body by welding.

Fasteners securing the seal clamp and seat ring in ductile or cast iron components shall be protected against the ingress of water with a sealant or thread seal.

All wetted ductile iron or carbon steel surfaces and interfaces shall be fully coated and sealed respectively to eliminate contact with moisture.

The shaft of seal-on-disc butterfly valves shall be positioned eccentrically to the valve body and valve centreline to minimise the seal to seat contact when closing and opening and to achieve better sealing properties.

M9.7.4 Metal Seated Butterfly Valves

Metal seated butterfly valves shall be of double or triple offset design, seal-on-disc / seat-in-body type, complying with WSAA Product Specification WSA PS - 263, AS4795.2 and this Specification as far as practicable, as well as with EN593 or API609, as agreed.

The valves shall be designed and selected such that they can operate over the required range of flow and pressures without damage to any components.

Metal seated butterfly valves shall be used as pump delivery control valves to assist pump starting and stopping and control water hammer surges in the pipework. They shall open and close against full pump shut off head over an extended period of time. Due to the arduous operating conditions, they shall be of a simple and sturdy design, with minimum number of internal components that may get damaged or become dislodged. The valve seal and body seat shall be fabricated as single pieces, adequately secured to the valve disc or
body and made from cavitation and corrosion resistant materials. Segmented seals and seating rings are not acceptable.

The valves shall be bi-directional, inspected and tested in accordance with EN12266.1 or API598, as appropriate. In addition to the tests specified in these standards, the valve free end test, disc strength test, shaft strength test and operation test shall be undertaken in accordance with the relevant clauses of AS4795.2.

**M9.7.5 Position Indicators**

Butterfly valves shall have a basic position indicator for local operation attached to the gearbox or shaft. Buried or submerged butterfly valves and those fitted with extension spindles shall be fitted with remote position indicators visible at the operating position. For buried valves the indicator shall be housed in the surface box. The position indicator shall be sealed against ingress of moisture and contaminants and shall provide indication of the valve disc in the fully open, intermediate and fully closed positions.

**M9.7.6 Locking Devices**

Butterfly valves shall have a locking device which shall enable locking of the valve disc in either the open or closed position, to facilitate safe pipeline inspection and allow repair work to the gearbox or actuator when the pipeline is under pressure. The locking device shall be manually fitted. It shall be capable of withstanding the full stall torque of the actuator or twice the rated input torque of the valve or the gearbox.

Where access is not available (e.g. in buried installations) and where specified, the butterfly valve spindle shall be fitted with a keyed locking mechanism to prevent its unintentional operation.

**M9.7.7 Torque Limiting Devices**

Manually operated butterfly valves shall be fitted with torque-limiting devices.

The torque limiting device shall be incorporated in the input shaft to the gearbox. It shall be fully enclosed, adjustable and set by manufacturer to the nominated torque.

The torque limiting device shall be of sturdy and corrosion resistant metal construction, tamper proof and the set torque shall be permanently marked on a stainless steel plate attached to the torque limiting device with a suitable adhesive.

The torque limiting device shall require no maintenance and shall be lubricated for life. Wherever possible, the device shall be located in a position where it cannot become submerged or affected by groundwater.

**M9.7.8 Gearboxes**

Butterfly valves DN300 and larger shall be provided with suitably sized gearboxes. The valve gearbox shall be self-locking in any position of the valve disc. Butterfly valves smaller than DN300 shall have facility to lock valve disc at selected positions.

Unless specified otherwise, the valves shall be installed with gear boxes, input shafts and actuators on the left hand side with the input shaft vertically upward, when viewed from the upstream face.

The gearboxes shall be capable of withstanding the maximum hydrodynamic torque generated by the valve under maximum velocity for the application.

Valve gearboxes shall be sized such that the required force applied on the operating element to operate the valve under the worst conditions of differential head, unseating force, or emergency flow shall be maximum 160N.

The gearboxes shall be capable of withstanding the forces generated by an output torque of not less than 1.5 times the minimum strength test torque given in the relevant standards. Where the minimum strength test torque is not specified, the gearboxes shall be capable of withstand the forces generated by an output torque of not less than 1.5 times the published maximum operating torque required to operate the valve under the worst conditions, including maximum or emergency flow, maximum differential head and seating and unseating torque.
The gearboxes shall be grease-lubricated and incorporate seals on the input and output shafts to prevent ingress of foreign matter and water.

The gearboxes shall incorporate adjustable mechanical travel stops to limit valve travel. Where valve actuators are fitted the stops shall only restrict travel if the actuator input stops fail.

The gearboxes shall be manufactured in accordance with AS60529 with an enclosure rating of IP68, suitable for 5m immersion in water for 72 hours. Mounting flanges shall comply with ISO5210 or ISO5211, as applicable, using an adaptor piece if necessary.

The gearboxes shall have the following markings, unless specified otherwise in the relevant standards:

- Manufacturer's name
- Model and series number
- Year of manufacture
- Gear ratio
- Rated input torque

The information shall be shown on an engraved stainless steel nameplate. This nameplate shall be permanently attached with a suitable adhesive. The plate shall be in a location that shall be clearly visible after installation.

The lettering shall be as large as practicable but not less than 6mm nor larger than 25mm high.

M9.7.9 Testing and Certification

All butterfly valves shall be subject to full production tests and, where specified, full type tests in accordance with AS4795.2 or AS4795.1.

Test certificates shall be supplied with each valve.

M9.8 Knife-gate Valves

M9.8.1 General

Knife-gate valves shall be either double flanged or lugged, as specified, manufactured, tested and supplied in accordance with WSAA Product Specification WSA PS-266 and AS6401, except that their pressure classification shall be PN16. Wafer type knife gate valves shall not be used.

The valves shall be of the required class and suitable for horizontal or vertical installation, as specified.

The knife gate valves will be used for isolation purpose and will normally be either fully open or fully closed. They may also be used for flow control of sludge, scum or similar materials in pipelines. The valves shall be of rugged construction with materials suitable for corrosive and abrasive sewage grit, sludge and scum slurries and operating in an aggressive environment.

All knife-gate valves shall be bi-directional, i.e. capable of operation with flow in both directions and pressure on either side of the valve.

Knife gate valves installed in dry wells, superstructures, valve chambers, machinery rooms etc. shall be bonneted. The bonnets shall be full pressure rated. Knife edge gate valves installed in wet wells of sewage pumping stations can be unbonneted.

The valve bodies shall be lugged or flanged to contain holes for the bolts to attach the valve to the pipeline. Where specified the valve spindles shall be encased in a shroud for safety and to prevent the ingress of extraneous matter.

An external packed gland for the gate shall be self-aligning.

The gate shall be adequately guided to ensure that at no stage over its full travel it can deflect enough to allow significant leakage past the seal.
The valves shall have self-cleaning features and be able to cut and dislodge stringy material that may be caught during closing. There shall be no protrusion into the flow as the raw sewage may contain rags and stringy material.

The valves shall preferably be drop tight in the closed position. In any case the maximum leakage rate shall not exceed values specified in AS6401.

**M9.8.2 Gearboxes**

The gearbox shall be sized to ensure the force applied on the operating element does not exceed 160N. The torque required to be applied for approximately ½ to 1 turn to unseat (i.e. “crack” open) or seat the valve may exceed this value.

The gearboxes shall be capable of withstanding the thrusts generated by an output torque equal to the 1.5 times the minimum strength test torque given in AS6401.

Gears should comply with AS2938 and the input and output bearings shall be of a corrosion resistant material.

Mounting flanges shall comply with ISO5210 or ISO5211, as applicable, using an adaptor piece if necessary.

The gearboxes shall be externally coated with a protective coating suitable damp environment.

The gearboxes shall have the following markings, unless specified otherwise in the relevant standards:

- Manufacturer's name
- Model and series number
- Year of manufacture
- Gear ratio
- Rated input torque

The information shall be shown on an engraved stainless steel nameplate. This nameplate shall be permanently attached with a suitable adhesive. The plate shall be in a location that shall be clearly visible after installation.

The lettering shall be as large as practicable but not less than 6mm nor larger than 25mm high.

**M9.8.3 Testing and Certification**

All knife gate valves shall be subject to full production tests and, where specified, full type tests in accordance with AS6401.

Test certificates shall be supplied with each valve.

**M9.9 Diaphragm Valves**

Diaphragm valve shall be used for flow throttling of liquids with high solids content.

Metallic diaphragm valves shall be weir or full-bore type and conform to BS:EN13397, with cast iron body and bonnet and elastomer diaphragm suitable for the specified use for valves rated up to PN16. Manual diaphragm valves shall have bonnet assemblies with a rising hand wheel design where the mild steel spindle is lubricated after each operation or the spindle is of stainless steel and shall have a distinctive visual indicator.

Diaphragm valves made of thermoplastic materials shall conform to BS:EN16138.

Lines carrying solids shall be equipped with full bore valves. Where required, larger size diaphragm valves shall be used to match the line internal diameter. Weir type valves may only be used on air or water pipelines.

Diaphragm valve pneumatic actuators shall be "air to close/spring to open" unless otherwise specified. The actuators shall be of the diaphragm type and shall be purpose designed to suit the associated valve, the maximum line pressure anticipated and the supply air pressure.

Manual override and a position indicator and transmitter shall be provided.
M9.10 Plug Valves

M9.10.1 General
Plug valves shall be of either eccentric plug type or lubricated plug type. The eccentric plug valves shall be used to modulate the flow of industrial water or recycled effluent or for flow control in wastewater applications. Where plug valves are used for modulation of air or gas flow, they shall be of lubricated plug type.
Plug valves shall be the double flanged type. Plug valve bores may be 100% or 80% of the pipe area to which the valve is fitted.

M9.10.2 Eccentric Plug Valves
Eccentric plug valves shall be of the non-lubricated eccentric type with a resilient faced plug vulcanised to the substrate metal. They shall comply with AWWA C517, except where specified otherwise.
Unless otherwise shown or specified, valves for sizes DN80 and larger shall have worm gear operators, nickel or stainless steel seats and flanged ends. Valves DN65 and smaller shall have operating handles, nickel or stainless steel seats, and screwed ends. Resilient facing shall be suitable for the intended service.
Submerged and buried valves, shall be equipped with worm-gear operators, lubricated and sealed to prevent entry of dirt and water into the operator. All shaft bearings shall be of stainless steel, furnished with permanently lubricated bearing surfaces. The operator shall clearly indicate valve position.

M9.10.3 Lubricated Plug Valves
Lubricated plug valves shall be of the tapered plug type, worm-gear operated for sizes DN80 and larger, and handle operated for sizes DN65 and smaller.
Lubricated cast iron plug valves shall conform to BS5158 for valves up to PN25 rating. Lubricated steel plug valves shall conform to BS5353.
Manually operated closed bottom taper valves shall conform to EN331.
Lubricated plug valves for digester gas service shall have grade 316 stainless steel plugs and suitable resilient seating, Buna N, Hycar, or equivalent.
The valves shall be provided with a fitting designed to provide for application of a sealant / lubricant through a check valve protected passage in the spindle, or through a stainless steel tube for worm-gear operated valves. Provision shall be made by ducts or grooves to insure the maintenance of a closed pressurized sealant / lubricant system between all contact surfaces of moving parts.
The plugs shall be held toward their seats by factory-adjusted gland assemblies set for proper sealing and operating torque. The gland assemblies shall be adjustable from the valve exteriors and shall utilize either spring washers or gland deflection to allow plug unseating when pressurized sealant / lubricant is injected.
The valve bodies and plugs shall have smoothly finished water passages free from sharp corners when the plugs are in the wide-open position. Worm-gear operators shall be completely enclosed in a watertight and dust-tight grease-packed case, with position indicator.
A manual lubricating gun shall be supplied for lubricated plug valves in sizes up to DN150, inclusive. For larger valves the a pneumatically operated lubricating gun shall be provided. The guns shall be of the same manufacturer as the valves. They shall be equipped with flexible connector, pressure gage, and safety valve, with operating instructions and shipped in a labelled toolbox.
The valves shall be leak tight. They shall be supplied with a certificate stating the body and seat test pressure and indicating that there is zero leakage at shut-off under the specified differential pressure.
M9.10.4  **Installation**

Plug valves shall be installed in strict accordance with the manufacturer’s published recommendations. Unless otherwise directed or advised by the manufacturer, the following rules shall be observed for the installation of eccentric plug valves on sewage, sludge, or other liquid systems containing solids, silt, or fine sand:

1. The valves shall be positioned with the spindle in the horizontal position.
2. In horizontal pipelines, the plug shall swing upwards when opening, to permit flushing out of solids.
3. The orientation of the valve shall prevent the valve body from filling up with solids when closed. However, where the pressure differential through the valve exceeds 150kPa, the higher pressure side for valves without worm gear, electric, or air operators, shall be through the valve, to force the plug against the seat.
4. Valves which may be closed for extended periods (stand-by, bypass, or drain lines), and valves with reversed flow (higher pressure on downstream side, forcing the plug away from its seat), shall be equipped with worm gear operators for sizes DN100 and larger.

In addition to the above, for clean water or special applications, or when in doubt, the valve shall be installed strictly in accordance with manufacturer’s instructions.

**M9.11 Ball Valves**

Metal bodied ball valves shall be two-piece type and conform to AS5830.1. Valves DN50 and larger shall have PTFE seals and long handle.

Ball valves of thermoplastic materials shall conform to AS5830.2.

Manually-operated ball valves for gas applications shall conform to EN:331 and AS4617.

**M9.12 Air Valves for Water Supply**

**M9.12.1 General**

Air release or admission valves for water supply, including large, small and double orifice and anti-slam and anti-vacuum valves, shall be automatic, flanged kinetic valves, manufactured, tested and supplied in accordance with WSAA Product Specification WSA PS 265 and AS4956.

The valves shall be of the required size and class, suitable for vertical installation.

To facilitate maintenance of the air valve an isolating valve shall be provided between the main and the air valve. For buried mains a hydrant/air valve isolator with vertical spindle, as specified by Sydney Water, shall be used. For installations where access is available a resilient seated gate valve to AS 2638.2 shall be used for isolation.

A DN20 drain valve shall be installed in large orifice air valves as per AS4956.

Air-release valves shall vent accumulating air while system is in service and under pressure. The valves shall be drip-tight from a minimum hydrostatic pressure of 10kPa to the rated operating pressure.

The body and cover of valves shall be made of either ductile iron to AS1831 grade 500-7 or 400-15 or stainless steel grade 316. Floats shall be made of stainless steel grade 316 or plastic.

**M9.12.2 Testing and Certification**

All air valves shall be subject to full production tests and, where specified, full type tests in accordance with AS4956.

Test certificates shall be supplied with each valve.
M9.13 Sewage Air Release and Vacuum Break Valves

M9.13.1 General

Air (gas) release and vacuum break valves for sewage application shall be manufactured, tested and supplied in accordance with WSAA Product Specification WSA PS-275 and AS4883. These valves shall be flanged kinetic type, anti-slam, either of a single or double orifice design. Non-kinetic and semi-kinetic air valves shall not be installed.

Sewage air valves shall be designed to provide separation of the fluid from the orifice sealing mechanism to minimise fouling. The valve body shall provide drainage outlet/s for air recharge in the case of air absorption by the waste water. The design of sewage air valve shall incorporate a manual ball valve located at the lower portion of the valve body to enable pressure release, back washing and testing of the valve operation.

Materials shall be as per basic material requirements of the standard, except where specified. The body and cover may be made of either ductile iron to AS1831 grade 500-7 or 400-15 or stainless steel grade 316.

To facilitate maintenance of the air (gas) release and vacuum break valve a separate isolating valve shall be provided between the main and the valve.

The valves shall be of the required class, suitable for vertical installation and of required size.

Sewage air release valves shall vent accumulating gases during system operation. They shall have long float stems and bodies to minimize clogging. The valves shall be drip-tight from a minimum hydrostatic pressure of 10kPa to the rated operating pressure.

M9.13.2 Testing and Certification

All sewage air (gas) release and vacuum break valves shall be subject to full production tests and, where specified, full type tests in accordance with AS4883.

Test certificates shall be supplied with each valve.

M9.14 Reduced Pressure Zone (RPZ) Valve

A backflow prevention device (Reduced Pressure Zone (RPZ)) valve with hazard rating ‘High’ shall be installed in the water supply line where necessary to prevent contamination of the water supply system. The RPZ valve shall be installed upstream of the hydrant and path tap.

The RPZ valve complying with AS2845 complete with strainer and two resilient seated stop valves shall be installed and tested in accordance with AS3500 by a licensed plumber.

A “Backflow Prevention Device - Inspection and Maintenance Report” shall be completed and a signed copy of this document shall be provided to Sydney Water as a record of compliance with the above standard.

M9.15 Hydraulically Operated Automatic Control Valves

M9.15.1 General

Hydraulically operated automatic control valves shall be double flanged, manufactured, tested and supplied in accordance with WSAA Product Specification WSA PS-268 and AS5081.

The valves shall be of the required class and suitable for horizontal or vertical installation, as specified.

M9.15.2 Testing and Certification

All hydraulically operated automatic control valves shall be subject to full production tests and, where specified, full type tests in accordance with AS5081.

Test certificates shall be supplied with each valve.
M9.16 Piston Type Control (Needle) Valves

M9.16.1 General

Piston type control valves shall be double flanged, manufactured, tested and supplied as far as possible in accordance with WSAA Product Specification WSA PS-268 and AS5081.

The valves shall be of the required class and suitable for horizontal or vertical installation, as specified.

M9.16.2 Design

Piston type control valves shall be of either vaned ring, slotted cylinder or special design, as specified. The valve body shall be of a single, two-piece or three-piece design with supporting feet. The body shall be internally streamline shaped. It shall have an annular throttling cross section in any position to ensure a linear regulating characteristic without cavitation.

The piston shall move axially in the flow direction and shall be guided on a minimum of four long guide rails. The valve shall be fitted with a precise O-ring seal in a recess to ensure that the piston seals only in the closed position. In intermediate positions, the piston seal shall be unstressed to ensure long lifetime and low operating torque. The piston shall be pressure balanced.

The vaned ring at the valve outlet shall give the flow a spiral movement to confine cavitation bubbles to the centre of pipe. Slotted cylinder shall achieve similar effect by forcing the high velocity jets to the middle.

The actuating shaft shall be easily operated and supported in maintenance-free bushes on both sides. The shaft-hub connection shall be by means of a parallel key. An internal slider crank mechanism shall turn the rotary movement of the operating shaft into the axial displacement of the piston.

Where specified, e.g. when used as a submerged outlet valve, an adequately sized air induction device shall be installed downstream of the valve for cavitation-free discharge operation.

M9.16.3 Materials

Valve main components shall be made from the following minimum acceptable standard materials. Alternative materials may be used, provided they are equivalent in performance, particularly with respect to strength, corrosion resistance, valve operation and durability.

- **Body**: Ductile Iron
- **Guide rails**: Brass
- **Piston**: Stainless Steel grade 316
- **Vane Ring**: Zinc Free Bronze
- **Air Admission Device**: Ductile Iron

M9.16.4 Valve Actuator

The piston type control valve shall be fitted with a slider crank mechanism driven by a manual, electric, hydraulic or pneumatic actuator, as specified. A position indicator shall be fitted on the actuator to indicate the degree of open/close position of the valve. The actuator shall be rated for modulating action. The actuator shall also be suitable for the specified controlled opening/closing period.

The valve body and the gearbox shall be suitable for fully submerged operation. In submerged conditions the actuator shall be weatherproof and mounted on a pedestal, connected to the gearbox by an extended shaft. The actuators other than manual shall have manual over-ride. The gearbox materials and seals shall be suitable for submerged operation.

M9.16.5 Testing and Certification

All hydraulically operated automatic control valves shall be subject to full production tests and, where specified, full type tests in accordance with AS5081 or relevant international standards.

Test certificates shall be supplied with each valve.
M9.17 Hydrant / Air Valve Isolating Valves

Hydrant / air valve isolating valves (globe valves with vertical spindle installed on stand pipe) shall be of a screw down type complying with WSAA Product Specification WSA PS-282.

M9.18 Pressure / Vacuum Relief Devices

Where required by AS1210, pressure and/or vacuum relief devices shall be used on pressure vessels and storage tanks containing compressed air or gas to prevent structural damage due to excess internal pressure or vacuum encountered during operation.

Pressure/vacuum relief valves (dual action) shall be installed on digesters to prevent structural damage due to excess internal pressure or vacuum and control tank venting to minimise emissions to the environment. They shall be suitable for biogas, made from corrosion resistant materials, and provided with grade 316 stainless steel removable seat rings that can be replaced in-situ. Integral valve seats shall not be used.

The pressure/vacuum relief valves shall comply with AS1271 and AS1210.

Refer M13.7.10 for pressure relief valves with positive displacement pumps.

M9.19 Pinch Valves

Pinch valves shall be of full cast metal body mechanical pinch type with integral flanges on body and flexible sleeve. All internal metal parts are to be isolated from the process fluid by the flexible rubber sleeve.

Valve configuration shall be full round, full port, capable of passing a sphere equal to the diameter of the mating pipe.

For all valves up to 100mm nominal diameter, the pinching mechanism shall be full round, with a single pinch bar closing the valve from the top.

For all valves 100mm and larger, the pinching mechanism shall be full round dual pinch on centreline, with two pinch bars.

M9.20 Valves DN65 and Smaller

Valves up to and including DN50 shall have threaded end connections. Larger sizes shall be flanged. Subject to Sydney Water’s acceptance, wafer type valves up to DN65 for clean water applications may be considered.

Gate, globe and non-return valves for water service up to DN65 shall be metallic complying with AS1628.

All other valves and fittings shall be metallic bodied complying with AS5200 and relevant part of ATS5200.

Globe valves shall be diaphragm-operated or piston type. Valve body and trim material shall be de-zincification resistant brass or stainless steel.

Non-return valves shall be bronze body full bore type with freely moving bronze disc. For clean water applications and where located close to pumps, short bodied tilting disc non-return valves are preferred. Otherwise, resilient seated single flap check valves are also acceptable. The single flap check valves shall be ductile iron or SS316 with springs of Hastelloy® C and EPDM seal.

Float valves shall be made from stainless steel and comply with AS1910.

Safety and liquid relief valves shall comply with AS1271.

Water pressure reducing valves shall be equipped with bronze bodies, neoprene diaphragms and discs.

Solenoid valves for water service shall be equipped with a dampening device, to prevent water hammer. All solenoid valves shall be from a single supplier. Coils shall be continuously rated 24V DC with protection to IP65 in accordance with AS60529. Solenoid valves shall be equipped with a manual override with a detent as a means of operating the valve in the case of power failure. Valve body shall be de-zincification resistant brass or stainless steel.
M10. Portable Valve Actuators

Portable actuators shall be of sturdy, metal construction with direct drive onto the valve or gearbox input spindle.

Portable actuators shall have the following features:

- A torque limiting device adjustable between approximately 130Nm and 500Nm.
- Operate at 18rpm, in both clockwise and anti-clockwise direction.
- A resettable rotation counter clearly visible from the operating position.
- A tamper-proof “dead-man” switch.
- To minimise operating effort, the distance from the operating position (“dead man” switch) to valve spindle shall not be less than 500mm.
- To limit the size of the unit the max. dimension shall not exceed 1200mm.
- Lightweight and easily handled and operated by one person. Its weight shall not exceed 16kg.
- A square drive adapter for valve spindle operation.
- Continuous rated operation for at least 60 minutes.

The actuators shall be electrically motor driven single phase (240V) with a three pin plug and min. 3 metres of power cable. The units shall be protected by an earth leakage device that can be easily tested and reset.

The motor and RCD must comply with the inspection, testing and tagging requirements of SafeWork NSW Code of Practice – Managing Electrical Risks in the Workplace and AS/NZS 3760.

Portable actuators shall be supplied with a sturdy steel lockable storage box.

An operation and maintenance manual shall be supplied with each portable actuator.
M11. Electric Valve Actuators

For electric actuators requirements refer to Technical Specification - Electrical.
M12. Pneumatic Valve Actuators

For pneumatic actuators requirements refer to Technical Specification - Electrical.
M13. Pumps

M13.1 General

Pumps shall be selected, designed and sized for the required duties, including all flow ranges, differential heads, fluids properties (including contaminants), temperatures and pressures.

The pumps shall comply with, but not be limited to, the following requirements:

1. The pumps shall be selected for lowest life cycle cost and reliable and trouble-free operation.
2. The pumps shall provide the required modes of operation within the design operating range.
3. The pumps suction and discharge piping shall be designed conservatively so that larger pumps can be installed in the future.
4. The required design capacity, including the maximum, normal, and minimum flows to be pumped, shall be considered when selecting the type and size of pumping equipment.
5. The pumps shall provide the required turndown and be capable of pumping over the complete design flow range.
6. Wherever possible larger, lower-speed pumps shall be used. The maximum pump speed should not exceed 1500 rpm for rotodynamic and 300 rpm for positive displacement pumps, unless accepted otherwise by Sydney Water.
7. The whole pumping unit shall be resistant to the corrosion and abrasive wear associated with the intended operation.
8. Pumps and driving units shall be purchased from one source (the pump manufacturer) to ensure the parts are compatible mechanically and electrically.
9. All pump casings shall withstand hydrostatic test pressure at least 1.5 times the allowable operating pressure.
10. Pump castings shall be sound and clean. Structural defects in ductile or cast iron pump casings and other components shall not be repaired and used in pump assembly.
11. All pumps shall be manifolded in such a way that they can be easily isolated, removed and replaced by a spare pump during plant operation and without disturbance to the upstream or downstream pipework.
12. Unless specified otherwise, pump flanges shall be circular and conform in dimensions and drilling to AS4087. Where sizes and pressure class exceed those contained in AS4087, pump flanges shall conform to AS4331.2 or relevant international standards as agreed with Sydney Water. Flanges shall be either raised or flat face type and faced parallel and square by machining. The backs of flanges shall be machined or spot faced to provide a satisfactory bearing for bolt heads and nuts. Bolt holes shall be off centre. Use of special adapter flanges shall be subject to the Sydney Water’s acceptance.

M13.2 Type of Pumps

Various types of rotodynamic (centrifugal, peripheral or special) and positive displacement (reciprocating or rotary) pumping units may be considered. The type of pumps to be used shall be in accordance with the table below. Use of other type pumps shall be subject to Sydney Water’s acceptance.
<table>
<thead>
<tr>
<th>Pump Service</th>
<th>Type of Pump</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean, potable or recycled water and effluent</td>
<td>Centrifugal, single or multiple stage, horizontal or vertical.</td>
<td>High efficiency, double suction split casing, end suction back pull-out, or multiple stage split casing or ring section. Comply with AS4020.</td>
</tr>
<tr>
<td>Raw sewage, screened sewage</td>
<td>Submersible (dry or wet installed) centrifugal to comply with WSA 101 and Sydney Water’s Supplement to WSA 101.</td>
<td>High efficiency, impeller with non-clogging properties capable of passing min. Ø80mm sphere. Horizontal or vertical if installed in dry well.</td>
</tr>
<tr>
<td>Raw water</td>
<td>Submersible (dry or wet installed) centrifugal to comply with WSA 101 and Sydney Water’s Supplement to WSA 101.</td>
<td>High efficiency, impeller with non-clogging properties capable of passing min. Ø80mm sphere. Horizontal or vertical if installed in dry well.</td>
</tr>
<tr>
<td>Grit slurry</td>
<td>Recessed vortex impeller, or torque flow.</td>
<td>Casing and impellers treated for abrasive and corrosive nature of grit slurry.</td>
</tr>
<tr>
<td>Mixed liquor</td>
<td>Centrifugal or mixed flow.</td>
<td>High efficiency, impeller with non-clogging properties capable of passing min. Ø80mm sphere. Horizontal or vertical.</td>
</tr>
<tr>
<td>Mixed liquor</td>
<td>Submersible (dry or wet installed) centrifugal to comply with WSA 101 and Sydney Water’s Supplement to WSA. 101.</td>
<td></td>
</tr>
<tr>
<td>RAS</td>
<td>Centrifugal recessed impeller or mixed flow pump.</td>
<td></td>
</tr>
<tr>
<td>Raw sludge, digested sludge with 1 to 3% solids content</td>
<td>Centrifugal pump with recessed vortex impeller, mixed flow or screw type impeller.</td>
<td>Impeller with non-clogging properties.</td>
</tr>
<tr>
<td></td>
<td>Progressive cavity positive displacement.</td>
<td>Macerator on pump suction.</td>
</tr>
<tr>
<td>Scum</td>
<td>Centrifugal pump with recessed vortex impeller, mixed flow or screw type impeller.</td>
<td>Arrangement for full mixing or other measures to prevent build-up of scum.</td>
</tr>
<tr>
<td>Pump Service</td>
<td>Type of Pump</td>
<td>Features</td>
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<tr>
<td>--------------------------------------------------</td>
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<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Thickened sludge or digested sludge with 3% to 7% solids content</td>
<td>Progressive cavity positive displacement.</td>
<td>Split casing to facilitate maintenance.</td>
</tr>
<tr>
<td>Reclaimed effluent</td>
<td>Centrifugal or turbine pumps.</td>
<td></td>
</tr>
<tr>
<td>Thickened sludge with greater than 7% solids content</td>
<td>Positive displacement piston pump.</td>
<td></td>
</tr>
<tr>
<td>Polymer dosing</td>
<td>Progressive cavity positive displacement.</td>
<td></td>
</tr>
<tr>
<td>Chemical dosing</td>
<td>Refer chemical storage and dosing systems clauses.</td>
<td></td>
</tr>
</tbody>
</table>

**M13.3 Centrifugal Pumps**

**M13.3.1 General**

All centrifugal (radial flow, mixed flow and axial flow) pumps shall be of a proven design, robust construction and efficient in operation under all conditions within the specified operating range.

The pumps shall be suitable for pumping clean effluent, potable water or treated recycled water.

The whole of the manufacture of the pumping unit shall be carried out in a workmanlike manner by first class labour and in accordance with best practice.

The lubrication of the pumping unit bearings shall be of a modern design and sufficient capacity to operate for long periods without attention.

All cast surfaces in contact with the pumped liquid shall be protected by non-toxic primers and finish coatings suitable for potable water application.

The pump casing shall be of ample strength to withstand all possible stresses to which it may be subjected under all conditions of service.

The pump shall be directly coupled to the drive motor. The lowest natural frequency of the combined pumping units and their concrete foundations, measured in any direction, shall be at least 25% higher than the pump maximum speed. The designer shall assess the natural frequency of the concrete foundations in combination with the pumping units and motors and make all necessary provisions to meet this requirement.

All pumps, except submersible for sewage applications, with their couplings, motors and other components shall be capable of withstanding without damage the effects of accidental reverse rotation (the reverse runaway speed) due to reverse flow through the pump under the head equal to the pump shutoff head. Submersible pumps for sewage applications shall comply with the requirements of WSAA Industry Standard for Submersible Pumps for Sewage Pumping Stations WSA 101 and Sydney Water’s Supplement to WSA 101.

The pumps shall be supplied with a guarantee and substantiating documentation that their performance is in accordance with the pump curves submitted within the tolerances specified in ISO 9906. Grade 1B tolerances shall apply for the pumps fitted with motors 50kW or larger and Grade 2B tolerances for the pumps with motors smaller than 50kW.
M13.3.2 Conditions of Pumping

Prior to ordering the pumps the designer shall obtain the following pump performance curves for the units offered which shall be superimposed over the system curves:

- Pump output (Q/H) curve;
- Pump efficiency (Q/η) curve;
- Pump net positive suction head required (Q/NPSHr) curve;
- Pump power (Q/P) curve.

The performance curves shall cover the pump operating range from zero discharge to discharge at minimum head. Where two or more units to be supplied are required to operate in parallel, the designer shall also consider output (Q/H) curves for various pump combinations in parallel operation.

Whether alone or in parallel, each unit shall be able to operate over the whole range of heads and flows.

The pumps shall have stable and cavitation free operating characteristics over the pumping range. The pumps shall be stable in operation at all heads and, in case of two or more units in parallel, under all conditions of parallel operation within the full range from the maximum head to the minimum head. Unless specified otherwise, pump shut off head shall be minimum 20% above the head where its Q/H curve intersects the maximum head system curve.

Subject to the above conditions, the pump design shall comply with the following conditions:

1. Unless specified otherwise, the continuous rated output of the motor coupled to the pump shall be at least 15% in excess of the maximum power required by the pump at 110% of the nominated duty flow rate and be non-overloading at minimum head conditions.
2. The efficiency curve shall be reasonably flat over the operating range for normal conditions, with maximum efficiency developed when pumping at average conditions.
3. The pump required net positive suction head (NPSHr) shall be at least 2.0m lower than the available net positive suction head (NPSHa). The available net positive suction head shall be calculated for the worst possible combination of fluid temperature, vapour pressure, flow rate and intake conditions.

Variable speed pumps shall be able to meet the specified duty flow and head at no more than 95% of their nominal speed at 50Hz motor supply frequency. The motor shall not be overloaded should it be required to operate at maximum speed.

Fixed speed pumps shall be able to accommodate at least one size larger impeller than required for the specified duty flow and head. The motor shall not be overloaded should the pump be fitted with a larger impeller.

One of the factors which will be used in selecting the most suitable pumping units will be economy of operation. To allow a comparison of the annual operating costs of the pumping unit, prior to ordering the pumps the supplier shall supply guaranteed figures for kilowatt hours per 1000 litres for the specified duty points.

M13.3.3 Nameplates

All pumps shall be fitted with engraved stainless steel nameplates fastened to the pump body. For submersible pumps an identical nameplate shall be provided at the top of pump sump or wet well.

Nameplate information shall include as a minimum the manufacturer's name, address (or agent's address), model number, serial number, capacity, head, impeller diameter, motor power rating, equipment identification number, contract number, fully assembled pump weight and date of manufacture.

The nameplates shall be permanently attached using stainless steel fixings and be clearly visible after installation.
M13.4 Horizontal Centrifugal Pumps

M13.4.1 General

The horizontal centrifugal pumps shall be of either of the following types, as specified:

- Double suction horizontal split casing, or
- End suction back pull-out, or
- Multiple stage horizontal split casing or ring section.

M13.4.2 Construction of Pumps

M13.4.2.1 General

The pumps shall be supplied complete with a drive motor, flexible coupling, coupling guard and other ancillary equipment, all mounted on a rigid, heavy duty baseplate.

The single and multiple stage horizontal split casing pumps shall be so designed that the top half of their casing can be dismantled and the shaft, impeller, bearings and mechanical seals easily removed without disturbing the suction and discharge pipe connections or moving the motor.

The multiple stage ring section pumps shall be made up of the required number of individual stages, each comprising an impeller, guide port and chamber. The stages shall be securely held together.

The end suction back pull-out pumps shall be designed and built in accordance with ISO 2858. Their complete rotating element / shaft assembly, including the shaft, impeller, bearings and mechanical seals, shall be capable of being removed from the back of the pump without disturbing the suction and discharge pipe connections.

M13.4.2.2 Casing

The casing shall be designed as a double or single suction smooth profiled single or double volute, fitted with replaceable wear rings. The direction of rotation shall be clearly marked on the casing.

The pump casing shall be provided with substantial footings for bolting to the baseplate and lifting lugs or eye bolts for lifting purposes. The pump mounting footings shall be machined parallel to the pump centreline. The lugs / eye bolts shall comply with the relevant standards and SafeWork NSW requirements.

For horizontal split casing pumps, the lifting lugs or eye bolts shall also allow the removal of the upper half of the casing and its inverting during maintenance.

Unless stated otherwise, the suction and discharge branches of the double suction and multiple stage pumps shall be provided on opposite sides of the pump casing, with vertical flange faces. The casing shall be able to accommodate larger impeller sizes for possible future upgrades.

Castings shall be made in accordance with the best foundry practice and shall be free from all defects. No holes or blemish shall be filled with any substance, whatsoever, without acceptance by Sydney Water. The backs of all flanges shall be machined or spot faced to provide a satisfactory bearing for bolt heads and nuts.

Wear rings shall be constructed so that they can be easily replaced when necessary. The method of sealing ring location shall prevent skewing and axial movement and shall prevent rotation of the ring in the casing.

All pockets in the casing which permit the accumulation of air shall be fitted with cocks to allow all air to be released when the pumps are being primed. The cocks shall be connected via vent lines to a manifold. The manifold shall be fitted with a normally closed cock on one end and a plug on the other. The cock shall drain to a tundish attached to the baseplate. The bottom of the tundish shall be fitted with a male end threaded 3/4" BSP for connection to a plant drainage system. The plugged end of the manifold shall be suitable for connection to a vacuum priming system where necessary.
M13.4.2.3 Impeller

The impeller shall be of a modern design, with ample thickness and strength for the duty involved and high efficiency. The fixing of the impeller to the shaft shall be by a suitable method to prevent it becoming loose or falling off the shaft under any possible operating conditions, including reversed rotation. The impellers shall be fitted with replacement inlet wear rings.

M13.4.2.4 Shaft

The pump shaft shall be of a robust construction to withstand maximum stresses, vibrations and whirling under all operating conditions. The shaft shall be fully shrouded with sleeves throughout the pumped liquid way and seal spaces and shall be stepped at each sleeve and impeller. The shaft assembly shall be such as to preclude entry of water to the bearing housing and permit axial adjustment of the impeller.

The shaft and impeller shall be dynamically balanced as an integral assembly. The rotating assembly should be designed so that its critical speeds are well beyond the speeds encountered during normal operation and pump starting and stopping in order to avoid excessive vibrations and material fatigue. This shall also include soft starting and variable speed operation speeds. The first lateral critical speed of the rotating element shall be at least 150% higher than the maximum operating speed of the pump. The first lateral critical speed shall be calculated for the maximum diameter impeller able to be fitted to the pump, without any support from wear rings.

The maximum lateral deflection of the shaft shall be determined to establish permissible internal clearances, taking into account all lateral hydraulic reactions on the impeller and any external loads. Support by the mechanical seals shall not be considered when determining shaft deflection but allowance may be made for the hydrodynamic bearing effect or running clearance.

M13.4.2.5 Shaft Seals

(a) General

The pumps shall be fitted with mechanical seals. The seals shall be of an accepted design effective for their purpose and requiring a minimum of maintenance.

The seals shall be of the balanced types, cartridge mounted, incorporating bellows or multiple helical springs of Hastelloy® C or equivalent and high nitrile synthetic rubber or ethylene propylene static "O" rings. Seal faces shall be lapped flat to within two helium light bands and the depth of interface roughness shall not exceed 0.3 microns. The pump and seal design shall be such that interface temperatures under operating conditions remain safely below the vaporisation temperature.

The seals shall be fitted with transparent splash guards to protect other equipment in case of their sudden failure.

An effective seal flushing piping system shall be fitted. It shall provide adequate flow directly to the seal faces for cooling and for flushing of minor impurities while limiting flow to avoid erosion of the seal faces or any malfunction of the seal. The seal piping system shall be made of grade 316 stainless steel tubing and shall be piped from the side of the volute or a suitable point which will minimise entrainment of small solids.

(b) Supplementary Defects Liability Period

In addition, the defects liability period provided for the pumping unit, pump mechanical seals shall carry a warranty guarantee of 8000 running hours.

M13.4.2.6 Coupling

The coupling shall be an approved flexible type, with cone rings or flexible elements, rated to suit the maximum torque output under all load conditions.
The end suction back pull-out pumps shall be fitted with spacer shaft coupling to facilitate the removal of the complete rotating element (i.e. shaft, impeller, seals and bearings) without the need to dismantle the motor or disturb the suction and discharge pipe connections.

In order to allow the removal of pump bearings and mechanical seals without the need to remove the pump top casing or motor, the coupling for larger double suction and multiple stage pumps shall also be of a spacer type.

M13.4.2.7 Guards

All couplings and exposed moving parts shall be adequately covered by sturdy, solid plate fixed guards acceptable to the SafeWork NSW, and meeting the requirements of AS4024.1.

M13.4.2.8 Bearings

The bearings throughout the pumping unit shall be of modern design, of ball and/or roller type and ample capacity for carrying all thrust and radial loads. All bearings shall be lubricated efficiently and capable of long service without maintenance.

Larger pumps bearing housings shall be either split or easily removable from the rotating element for ease of service. The bearings and mechanical seals shall be removable from each shaft end by sliding out, i.e. without the need to dismantle the pump casing or motor. For that purpose, a spacer type drive coupling shall be installed on the motor side and the pump shaft assembly may need special supporting arrangement.

M13.4.2.9 Baseplate

The pump, motor, coupling and coupling guard and all other ancillary equipment shall be mounted on a rigid baseplate, made of cast iron or fabricated from mild steel and hot dipped galvanised. The baseplate shall be substantial, suitable for installation on a concrete plinth and shall ensure the pump and motor are correctly aligned.

The baseplate shall be fitted with a minimum of three levelling screws to allow for a minimum 20mm height adjustment and levelling.

The baseplate shall be fitted with horizontal jacking screws at the motor mounting feet locations to allow the motor to be jacked horizontally during alignment.

The mounting surfaces for the pump and motor shall be machined so that the pump mounting locations are in a common plane and the motor mounting locations are in a parallel plane to the pump mounting locations. The relative dimension of the two planes shall provide adequate shimming allowance to achieve final alignment of pump and motor after allowing for manufacturers' tolerances of centreline heights.

Separate pump and motor baseplates may be considered for large pumping units.

All holding down bolts shall be of stainless steel and shall be supplied by the Contractor. Holes drilled for holding down (anchor) bolts shall not be obstructed by the equipment on the baseplate or stool.

M13.4.2.10 Bolts, Studs and Nuts

All bolts, nuts, studs and chemical anchors shall be made of stainless steel grade 316 and to AS1110, AS1111 and AS1112 metric thread and dimensions. They shall be of such size and spacing as is required to provide for the design forces with a safety factor of five and shall be suitably insulated from connecting steelwork to prevent galvanic corrosion. The threads of all stainless steel fasteners shall be thoroughly coated with anti-seize lubricant prior to assembly.
M13.4.2.11 Materials of Manufacture

The quality of materials used in the construction of the pump shall be in accordance with the table below. Material with equal or better properties for the intended application will be considered in lieu of the listed materials.

<table>
<thead>
<tr>
<th>COMPONENT</th>
<th>MATERIAL</th>
<th>AUSTRALIAN STANDARD</th>
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</thead>
<tbody>
<tr>
<td>Baseplate</td>
<td>Steel</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>AS3679.2 Gr 300</td>
</tr>
<tr>
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<td>AS3678 Gr 300</td>
</tr>
<tr>
<td></td>
<td>Cast iron</td>
<td>AS1830 Gr T-250</td>
</tr>
<tr>
<td>Casing</td>
<td>Cast iron</td>
<td>AS1830 Gr T-250</td>
</tr>
<tr>
<td></td>
<td>Ductile iron</td>
<td>AS1831</td>
</tr>
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<td>AS2074 Gr H3C</td>
</tr>
<tr>
<td>Impeller</td>
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</tr>
<tr>
<td>Impeller wear rings</td>
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<td>AS1565 Gr C90250</td>
</tr>
<tr>
<td></td>
<td>Stainless steel</td>
<td>AS2074 Gr H3B</td>
</tr>
<tr>
<td>Shaft</td>
<td>Stainless steel</td>
<td>ASTM A276M Gr 431</td>
</tr>
<tr>
<td>Shaft sleeves</td>
<td>Phosphor bronze</td>
<td>AS1565 Gr C90250</td>
</tr>
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<td>Mechanical seals:</td>
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</tr>
<tr>
<td>rotating face</td>
<td></td>
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</tr>
<tr>
<td>stationary face</td>
<td>Tungsten carbide</td>
<td></td>
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<td></td>
<td>Ductile iron</td>
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<tr>
<td>Bolts, studs and washers</td>
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<tr>
<td>Nuts</td>
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<tr>
<td>Guard</td>
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</tr>
<tr>
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</tr>
<tr>
<td></td>
<td></td>
<td>AS3678 Gr 300</td>
</tr>
</tbody>
</table>
The difference in hardness between casing and impeller wear rings shall be not less than 50HBW.

All other materials used in the construction of the pumping unit shall be the best of their respective classes and made to appropriate Australian Standards. Where international materials standards are specified, equivalent Australian Standards shall also be stated. Any difference between the international and similar Australian standards shall be clearly described.

**M13.5 Submersible Centrifugal Pumps**

All pumps shall comply with the technical requirements set out in WSAA Industry Standard for Submersible Pumps for Sewage Pumping Stations WSA101 and Sydney Water's Supplement to WSA 101.

Submersible pumps shall consist of a single stage centrifugal pump driven by an electric motor via a common rotor/impeller shaft, forming a compact, robust and completely watertight vertical pumping unit. They shall be suitable for either wet or dry well installation.

The pumps shall be capable of handling unscreened and unsettled domestic sewage, occasionally containing plastic sheeting, disposable clothing, plastic backed sanitary napkins and similar solid and fibrous material. The electric motors shall comply with the requirements of Technical Specification - Electrical.

**M13.5.1 Wet Well Installation**

In wet well type installation, the submersible pumps may operate in part or totally submerged position in raw sewage, effluent or clean water. The motors shall be cooled by the pumped liquid so that no external cooling is required. Larger motors may need to be provided with a cooling jacket with continuous circulation of a portion of the pumped liquid.

The wet well installed pumping units shall be supplied with a discharge connection (also known as “duckfoot” bend, discharge pedestal, discharge bend, etc.), a lifting chain, double guide rails and guide rail brackets. The lifting chain and guide rails shall be of a suitable length to reach the access opening at the top of the wet well or pump sump.

The complete pumping unit shall be readily removed from the wet well by means of a simple lifting device, without the necessity of either de-watering the wet well or disturbing the permanent connection to the discharge pipework, and without the need to descend into the wet well. No portion of the pump shall be permanently fixed to the base of the wet well.

The wet well units shall be supported off the discharge bends which shall be of a rigid design to take the complete pumping unit loads and provide sufficient sealing. Each submersible pump shall be checked for the operation against a closed discharge (shut-off head) to prove the effectiveness of the seal between the pump and the discharge bend. Wherever possible the pump units and the discharge bends shall be interchangeable.

The pump shall have suitable stainless steel dual guide rails and lifting chain for withdrawal from and lowering into the pump location. When lowered down the guide rails the pump shall automatically connect to the discharge bend. The guide rail arrangement shall permit easy lifting of the submersible pumps in the vertical axis.

The stainless steel lifting chain shall be of sufficient length to reach from the pump to the operating platform (ground) level. All holding down bolts shall be of grade 316 stainless steel. Where davit type lifting facilities are specified, the pump shall be fitted with wire rope and winch.

Electrical cables for each pump shall be suitably protected and supplied in place so as to prevent any damages.

Unless specified otherwise, at least one of the submersible pumps shall be fitted with a hydraulically operated automatic flush valve for flushing of the wet well or sump. The other pumps shall have provision for the installation of a flush valve. The valve shall open at each pump start for approximately thirty seconds to stir up the sludge settled in the wet well. Preferably, the valve opening / closing operation shall be induced by the pump flow and pressure, thus eliminating the need for electrical components and cable.
M13.5.2  
**Dry Well Installation**

In dry well type installation, the submersible pumps may be installed either vertically or horizontally. The motors shall be either air cooled or provided with a cooling jacket or similar with continuous circulation of a portion of the pumped liquid.

The dry well pumping units shall be supplied with a stand, stool or baseplate and a suction bend. The suction bend shall have an inspection hole of minimum Ø150mm for removal of chokes from the pump suction. The baseplate shall be of a short profile, robust design suitable for installation onto a massive concrete plinth. Tall fabricated pump supporting frames shall not be used as they may exacerbate pump vibrations.

In vertical installation, the stand, stool or baseplate shall be designed to suit the pump suction arrangement. Access to the pump suction/suction bend flanged connection shall be provided from the pump side so that no work below the stool/baseplate is needed when installing or removing the unit.

M13.5.3  
**Seal Failure Detection**

Submersible pumps shall be fitted with seal failure probes for moisture and oil leakage.

The probe shall be fitted in the oil bath between mechanical seals and shall be arranged to detect the presence of water in the oil bath, e.g. to detect failure of the shaft seals.

A moisture detection device shall be fitted in the motor stator housing and cable termination housing.

Sensors shall be compatible with Tritronics RT1 relay.

M13.6  
**Vertical Centrifugal, Mixed Flow and Axial Flow Pumps**

M13.6.1  
**General**

Each pump shall be of a centrifugal, mixed flow or axial flow type, fitted with a vertical shaft and rotating impeller or impellers (multi stage pumps), with discharge from the pumping element coaxial with the shaft. The pumping element shall be suspended by the conductor system which encloses the shaft used to transmit power to the impeller(s). The motor shall be external to the flow stream.

The pumping units shall be complete with the baseplate or stool, drive motor, flexible coupling, coupling guards, and other ancillary equipment as appropriate and/or specified.

M13.6.2  
**Discharge Head Assembly**

The pump shall be provided with a discharge head of the surface (above floor level) type.

The discharge head shall be of ample strength to withstand the weight of the drive motor and pump and all other possible stresses to which it may be subjected under all conditions of service. For larger units the drive motor may be supported independently off a fabricated, skirt shaped support, or a separate building slab.

The discharge head shall be provided with substantial footings for bolting to the base plate or stool and lifting lugs or eye bolts for lifting purposes.

All pockets in the discharge head which permit the accumulation of air shall be connected via air vent lines to manifold(s) which will terminate in an automatic air release valve.

M13.6.3  
**Pump Column**

M13.6.3.1  
**Pump Bowl Assembly**

The pump bowl assembly shall be either a single or multi-stage centrifugal, mixed flow or axial flow vertical pump with discharge coaxial with the shaft. The assembly shall be made up of the required number of individual stages, each comprising an impeller, guide-port and chamber. The stages shall be spigoted and securely held together.

The bowl casings shall be free of blowholes, sand holes and other detrimental effects. The design of the pump bowl and accessories shall be such that external priming of the pumps is not necessary.
Where appropriate, the bowls shall be equipped with replaceable seal rings on the suction side of the enclosed impellers.

For oil lubricated pump columns, the discharge case shall have bypass parts to allow water to escape through the seal or bushing and shall have a means of minimising the leakage of water into the shaft enclosing tube.

**M13.6.3.2 Impeller**

The impeller(s) shall be of a modern design with high efficiency and ample thickness and strength, and statically balanced for the duty involved. The secure fixing of the impellers to the shaft shall prevent them from becoming loose or falling off the shaft under any possible operating conditions including reversed rotation.

The impeller shall be vertically adjustable by either a nut in the driver or an adjustable coupling between the pump and the driver.

**M13.6.3.3 Bowl Assembly Shaft**

The bowl assembly shaft shall be supported by bearings above and below each impeller. The maximum combined shear stress shall be no more than 18 per cent of the ultimate tensile strength nor more than 30 per cent of the elastic limit in tension of the shafting steel used.

**M13.6.3.4 Line Shafts**

The line shafts shall be manufactured in interchangeable sections having a nominal length not exceeding 3 metres. The shafts shall be coupled with steel couplings and to ensure accurate alignment of the shaft they shall be straight within 0.13mm total indicator reading for a 3m section.

Line shafts in water lubricated pump columns shall be provided with a non-corrosive wearing surface at the location of each guide bearing.

**M13.6.3.5 Shaft Couplings**

The coupling of the line shaft shall be with steel couplings where the maximum combined shear stress shall be no more than 12 per cent of the ultimate tensile strength nor more than 20 per cent greater than the elastic limit in tension of the shafting steel used.

**M13.6.3.6 Line Shaft Bearings**

For oil lubricated pump columns the bearings which are integral tube couplings shall readily allow oil to flow through to lubricate the bearings below via one or more oil grooves. They shall be spaced not more than 1.5m apart.

For water lubricated pump columns the bearings shall be lubricated by the liquid pumped and shall be designed for vertical turbine pump service. The bearings shall be not more than 1.5m apart and shall be mounted in bearing retainers held in position in the column couplings by the butted ends of the column pipes.

**M13.6.3.7 Shaft Enclosing Tube**

The shaft-enclosing tube (oil lubricated pump column only) shall be manufactured in sections not more than 1.5m in length. The ends of the enclosing tube shall be square with the axis and shall butt to ensure accurate alignment. The enclosing tube shall be stabilised in the column by stabilisers.

**M13.6.3.8 Discharge Column Pipe**

The friction loss of the pipe shall not exceed 50mm per metre based on the rated capacity of the pump. The pipe shall be manufactured in interchangeable sections not more than 2m nominal length and shall be connected by threaded sleeve-type couplings or flanges.
Each section of pipe shall have their ends faced parallel and machined with threads to allow appropriate butting.

**M13.6.4 Suction Pipe and Strainer**

The pump shall be supplied with a suction bell-mouth and/or a strainer. If a strainer is supplied, its inlet area shall be equal to at least three times the suction pipe area. The maximum opening shall not be more than 75 per cent of the minimum opening of the water passage through the bowl or impeller.

**M13.6.5 Lubrication**

For oil lubricated pump column, a lubrication system consisting of a manually operated sight-feed drip lubricator and an oil reservoir constructed as an integral part of the head or as a separate auxiliary unit, shall be located at the surface or below-base discharge head. Provision must be made for sealing off the thread at the tube tension nut installed in the head to allow tension to be placed on the shaft-enclosing tube.

For water lubricated column pipe, a discharge head of the surface or underground type shall be provided as required with a renewable bronze bushing and a shaft packing box. The line-shaft bearings shall be adequately wet down before starting the pumps by a relubricating connection in the head. It is required that provisions are made by the manufacturer to adequately pre-lubricate line-shaft bearings on installations with a setting of more than 15m. The pre-lubrication system shall operate automatically before the pump is started.

On installations with a setting of 15m or more, a non-reverse mechanism in the motor shall be provided to protect the motor and the line shaft from reverse rotation when the power is interrupted and the water empties from the discharge column.

**M13.6.6 Materials of Manufacture**

The quality of materials used in the construction of the pump shall be in accordance with the table below. Material with equal or better properties for the intended application will be considered in lieu of the listed materials.

**Note:**

OL - Oil Lubricated Pump Column
WL - Water Lubricated Pump Column

<table>
<thead>
<tr>
<th>COMPONENT</th>
<th>MATERIAL</th>
<th>AUSTRALIAN STANDARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharge head &amp; base plate</td>
<td>Cast iron</td>
<td>AS1830-T220</td>
</tr>
<tr>
<td></td>
<td>Steel</td>
<td>AS3679 Pt 1 or Pt 2 Gr 300</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AS1163 Gr C350L0</td>
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<td></td>
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</tr>
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<td>API 5L Gr. B</td>
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<td>Cast iron</td>
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<td></td>
<td>Bronze</td>
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<td>Bronze</td>
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<td>Stuffing box - studs, nuts, capscrews</td>
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All other materials used in the construction of the pumping unit shall be of the best of their respective classes and made to appropriate Australian Standards. Where international materials standards are specified, equivalent Australian Standards shall also be stated. Any difference between the international and similar Australian standards shall be clearly described.

**M13.7 Progressive Cavity Pumps**

**M13.7.1 General**

Progressive cavity pumps shall be of a single pitch helical rotor and double pitch elastomeric stator. Progressive cavity pumps shall be heavy duty industrial low speed units with proven performance. They shall be designed for a long, maintenance-free life. The manufacturer shall provide a guaranteed life for the critical pump components - rotor, stator, flexible drive shaft and mechanical seal. The guaranteed life shall be no less than 8,000 operating hours.

The pumps shall be self-priming and provide positive displacement, low shear effects and a flow proportional to the pump speed. They shall have low NPSH characteristics and positive non-turbulent flow over the full range of operating conditions.

Unless specified otherwise, the pumps shall be suitable for pumping macerated domestic raw sewage which may contain some grit. The materials selected shall provide good abrasion resistance.
The progressive cavity pumps shall have a rotor operating speed that does not exceed 70% of the manufacturer’s rated maximum speed for clean water.

The pumps shall be capable of withstanding pressure in the pump casing of not less that the discharge pipework hydrostatic test pressure or 160m, whichever is the highest.

M13.7.2 Assembly

Each pump shall be supplied mounted on a baseplate complete with gear drive unit, electric motor and guard. The baseplate shall be fitted with lifting lugs to facilitate handling. The pump assembly shall be designed for quick and easy pump dismantling and servicing.

M13.7.3 Casing

The pump body shall be cradle mounted such that the suction chamber can be rotated to allow the suction port to accommodate any piping configuration. Two inspection ports shall be incorporated 180 degree apart in the suction housing to provide access to internal parts. A DN25 drain plug shall be provided on the bottom of the suction chamber to allow the fitting of a drain valve.

M13.7.4 Rotor

The pump rotor shall be a helix constructed, machined and polished, made of abrasion resistant material.

M13.7.5 Stator

Rotor shall revolve in a helix elastomeric stator consisting of Buna-N (Nitrile rubber) chemically bonded to a steel or cast iron tube. Different materials may be used, subject to Sydney Water’s acceptance, if considered more suited to the product being pumped.

M13.7.6 Drive shaft

The pumps shall be fitted with a flexible shaft drive to the rotor. Universal joints are not acceptable. The shaft shall be designed for infinite life under the stated operating conditions and shall be suitable for fixed and variable speed operation. The flexible shaft shall be of one-piece construction with generous fillets for fatigue resistance. The shaft may be fixed to the rotor and drive with flanged or tapered joints and locking bolts. All metal to metal joints shall be sealed from the fluids being pumped to permit easy dismantling.

M13.7.7 Seals

The pumps shall be fitted with a mechanical seal. The gland packed stuffing box type shall not be accepted. The seal shall prevent liquid from contaminating the joints, and the shields shall prevent foreign objects from damaging the seal. The seals shall be of a type which has been proven in service and is readily available. The seals shall be capable of achieving the life stated above without the need for flushing water. The seal design shall be such that interface running temperatures under operating conditions remain safely below the vapourisation temperature of the material being pumped.

M13.7.8 Bearings

All ball and roller bearings shall be rated in accordance with AS2729.

M13.7.9 Pump protection devices

The pumps shall be fitted with devices that protect them against dry running conditions, excessive pressure on discharge side and excessive vacuum on suction side. All protection devices shall be connected to IICATS or SCADA control system, as appropriate. If installed in pits or similar below or above ground structures which may become flooded, such structures shall have level controls to stop and de-energize the pumps in case of flood.
M13.7.9.1 Dry-run protection device
The dry run protection device shall be connected to stator and shall measure temperature continuously. Once the set-point temperature is reached, dry-run protection device shall activate the alarm signal in IICATS / SCADA. The dry-run protection device shall also be set to switch the pump off immediately.

M13.7.9.2 High pressure protection device
A diaphragm pressure switch shall be connected at pump discharge to monitor the pressure. At high pressure, diaphragm switch shall activate the alarm in IICATS / SCADA and switch the pump off.

M13.7.9.3 High vacuum protection device
A vacuum switch shall be connected at pump suction and shall activate alarm in IICATS / SCADA in low vacuum situation and switch the pump off.

M13.7.10 Pressure relief valve
All positive displacement pumps must be provided with a pressure relief valve installed on the pump discharge. The valve shall be sized to suit the maximum flow rate and pump discharge characteristic such that it can handle the full flow from the pump without overloading the motor. The relief valve shall be of a type suitable for the material being pumped, e.g. raw sewage.

M13.7.11 Noise
Pump noise level shall not exceed that specified in this Specification. The noise figure shall be the total of the noise contributions of the pump, gearbox and motor including an allowance for noise generated by the use of a variable speed drive.

If an acoustic enclosure is required to meet the required occupational or environmental noise levels, this shall be provided by the pump supplier. Acoustic enclosures shall be designed to provide adequate ventilation and have removable panels for inspection. The acoustic enclosures shall be fabricated from galvanised steel sheeting and the insulation enclosed in perforated sheeting. Shafts guards shall be separate to any acoustic enclosure.

M13.7.12 Materials of Manufacture
The pumps shall be constructed of materials at least equal in strength, corrosion resistance and wear resistance as appropriate as follows:

<table>
<thead>
<tr>
<th>COMPONENT</th>
<th>MATERIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pump casing</td>
<td>Cast iron grade 220 or higher</td>
</tr>
<tr>
<td>Rotor</td>
<td>Stainless steel grade 410 with Duracoat 3000 coating, or equivalent</td>
</tr>
<tr>
<td>Stator</td>
<td>Steel or cast iron with Buna-N or equivalent</td>
</tr>
<tr>
<td>Drive (flexible) shaft</td>
<td>Stainless steel of suitable proven grade</td>
</tr>
<tr>
<td>Bearing housing</td>
<td>Cast iron grade 220 or higher</td>
</tr>
<tr>
<td>Baseplate</td>
<td>Mild steel, hot dip galvanised</td>
</tr>
<tr>
<td>Guard</td>
<td>Mild steel, hot dip galvanised</td>
</tr>
<tr>
<td>Fasteners</td>
<td>Stainless steel grade 316</td>
</tr>
</tbody>
</table>
M13.7.13 Electric Motors

Motor rated power shall be at least 15% greater than the pump shaft input power over the whole pump operating range. The motor rating shall be sufficient to ensure that the motor will not overload when the pump is discharging through the pressure relief valve at all speeds down to the minimum allowed as specified by the pump supplier.

Motors for the progressive cavity pumps shall be capable of a minimum 20 evenly spaced starts per hour.

Positive temperature co-efficient thermistor protection of motors shall be provided for all motors 5.5 kW and larger. Motor anti-condensation heaters shall be provided for all motors 22kW and larger.

The motor terminal boxes on the pumps shall be oriented to suit the installation layout. Separate terminal boxes shall be provided for power cables and thermistors and heaters. Each terminal box for temperature detectors or heaters shall be identified and fitted with an external warning label to caution against damage during testing and, in the case of heaters, to caution against contact with live connections.

M13.7.14 Spare parts

The Contractor shall provide one set of spare parts for each pump size supplied. The spare parts shall include the following as a minimum:

- Stator
- Rotor
- Flexible shaft
- Mechanical seal
- Gasket kit

M13.8 Installation of Pumping Units

The installation of the pumping units and accessories shall be carried out by qualified mechanical engineering tradespeople, strictly in accordance with the information and instructions supplied by the manufacturer and Clause M43 of this Specification. Proper precautions shall be taken to prevent any damage or deterioration to items of equipment prior to putting into service. The pumping unit and parts of equipment shall be installed free of any undue stresses, strains or vibrations and be accessible for maintenance. Connecting pipework shall be independently supported so that their weight is not transferred onto the pump flanges.

The setting out details for the pumping units, equipment and pipework shall be shown on drawings. Any additional information, if required, shall be obtained from the pump manufacturer.
M14. Flame Arresters

Flame arresters must be designed for digester gas service (biogas) and shall be self-draining with provision to drain away any water in the gas.

The design of the flame arrester shall be such that it provides easy access to clean and/or replace the entire core arrester element without damaging the body, plates or sealing parts.

The core flame arrester element shall be manufactured from 316 stainless steel.

Flame arrester housing/body and core element extensible frame shall be manufactured using low copper aluminium (Aluminium 356 T6).
M15. Vacuum System

M15.1 General

Vacuum systems shall comprise vacuum pumps, vacuum pipework and ancillary equipment. The vacuum pumps shall be either of an oil recirculating rotary vane type or a liquid (water) ring type, as specified.

The oil recirculating rotary vane vacuum pumps shall be of a modular, rugged design, single stage, air cooled and direct driven. Each pump shall be fitted with an oil mist eliminator with min. 99.9% oil removal efficiency, exhaust pressure gauge, anti-suckback valve, exhaust filter, wire mesh inlet screen, vibration isolators, oil level sight glass and oil filter.

The liquid (water) ring type vacuum pumps shall be driven with close coupled motors and complete with water break tank with float valve, liquid/air separator, vacuum pressure switch, base plate and all ancillary equipment.

The whole of the manufacture of the vacuum system shall be carried out in a workmanlike manner by first class labour and in accordance with best practice.

The vacuum system shall be provided as a factory tested system complete with electric starting equipment, controls and instrumentation for automatic and manual operation.

The vacuum pumps shall have ample capacity and be of a standard and proven design, robust construction and efficient in operation under all conditions within the specified operating range. The service liquid (oil or water) shall be separated from air in the liquid/air separator and reused. The vacuum pumps shall be reasonably quiet in operation in order to comply with the noise requirements stated in this Specification.

Where used for pump priming, the vacuum system shall draw water into the main pumps prior to those pumps being operated. Each vacuum pump shall be connected to one pumping unit and operate in conjunction with that unit. The vacuum system shall be fitted with suitable vacuum priming valves, solenoid valves, isolating valves and level switches. The vacuum lines shall be interconnected via a manually operated valve.

Where used for vacuum sewerage the vacuum system shall comprise of minimum one duty and one standby vacuum pumps, each sized for the design capacity, vacuum/sewage collection tank, solenoid and isolating valves, pressure and level sensors and other ancillary equipment. The design and installation of the vacuum sewerage system shall comply with WSAA Vacuum Sewerage Code WSA 06.

For the system to work efficiently it is essential that all pipework, connections, vessels, valves etc. are free of any leaks. The tightness of the vacuum lines shall be tested in accordance with relevant Australian and industry standards.

M15.2 Requirements of Vacuum System

The vacuum system is required either to ensure that the pump suction pipework and casing are always primed with water and there is no possibility of air being pumped, or that adequate vacuum is maintained in the vacuum/sewage collection tank to enable transportation of sewage from the hydraulically most disadvantageous point to the vacuum pumping station.

The vacuum pumps shall operate in a duty-standby arrangement with automatic changeover in the event of failure of the duty pump.

Each vacuum pump would be sized to draw water or sewage into the pipelines at the required flowrate.

The operation of the vacuum pump shall be controlled by a vacuum switch positioned on the vacuum receiver or vacuum/sewage collecting tank. The vacuum pump shall start when the vacuum reaches the cut-in pressure and stop when the vacuum reaches cut-out pressure.

The pipework from the main pumps to the vacuum receiver shall incorporate an air eliminator at least 100mm above the top of the pipe connections. The vacuum receiver shall have a minimum volume of 500 litres. The
vacuum/sewage collecting tank shall be sized to limit the number of vacuum and main sewage pumps starts below the maximum allowable number specified by their supplier.

The whole system shall be resistant to the corrosion associated with water and sewage pumping stations. All surfaces in contact with the potable water shall be protected by non-toxic primers and finish coatings suitable for potable water application and in accordance with WSA 201 and Sydney Water’s Supplement to WSA 201.

The vacuum pumps shall be provided assembled on a galvanised steel frame fitted with anti-vibration mounts. All flanges shall be circular and comply with AS4087.

**M15.3 Nameplates**

All vacuum pumps shall be fitted with engraved stainless steel nameplates fastened to the pump discharge head assembly.

Nameplate information shall include as a minimum the manufacturer's name, address (or agent's address), model number, serial number, capacity, head, equipment identification number, contract number and date of manufacture.

The nameplates shall be permanently attached to the pump (using stainless steel fixings) and be clearly visible after installation.

**M15.4 Valves**

Each vacuum pump shall be fitted with delivery isolating valves and non-return valves on the suction line.
M16. Pipework

M16.1 General

Pipes and pipework design shall be in accordance with AS4041 and other standards specified in the Specification.

All pipework and associated fittings shall conform to the appropriate Australian Standards, WSAA Codes of Practice, Industry Standards and Product Specifications and, where applicable, Sydney Water’s standard specifications.

M16.2 Scope

The term “Pipework” shall include, but is not necessarily limited to, the following, as applicable:

a) pipes, valves, fittings, joints and other appurtenances
b) compliance to the required regulatory approvals, notification, etc.,
c) trench excavation,
d) supply and compaction of embedment material,
e) laying of pipelines,
f) inspection prior to backfilling,
g) backfilling and compaction of trenches,
h) restoration of surfaces,
i) testing and commissioning of all pipelines,
j) defects rectification,
k) cleaning and disinfection of potable water pipelines,
l) corrosion protection systems,
m) insulation,
n) connections to proposed mechanical equipment, including flexible connections, dismantling joints etc.,
o) connections to existing and proposed structures,
p) pipe supports, anchorage and/or thrust blocks,
q) provisions for expansion, contraction and vibration,
r) temporary diversion pipework required to construct the works,
s) pipe systems to penetrate structural elements,
t) labelling of pipework and valves,
u) backflow prevention devices, as required by Australian Standards.

M16.3 Pipework Design

All piping systems, including pipes, fittings, lining, coating, joints and seals, except water mains and pipework covered by WSA 03, shall be designed for a minimum 50-year life.

Sufficient connections, flanges, dismantling joints, flange adapters or flexible couplings shall be provided, to enable valve or equipment removal for replacement and maintenance and for servicing and maintenance of the pipeline itself.
Pipework subject to blockages shall be fitted with adequate facilities such as access holes or hand holes fitted with blank flanges or flanged pipe bends, which can be easily removed for cleaning.

The high points of all pipes routes shall have provision for venting entrapped air. Likewise, adequate provisions for complete emptying of the pipework shall be incorporated at low points.

Where pipework is exposed or subject to temperature variations, the design shall include expansion loops or other Sydney Water’s accepted devices to take account of thermal expansion.

The pipework shall be rigidly and safely supported at intervals not exceeding the lesser of the manufacturer’s recommendations or relevant standard. Pipework shall be arranged in such a way that access to all parts of the plant is not impeded. This means that pipe runs shall preferably be along walls or at a height of 2m or more above floor level, or in pipe trenches and pits in the floor. Where installed at heights less than 2m above floor level, eg. in water pumping stations, adequate stairs or ladders and platforms shall be provided to provide access over the pipes and to valves and other appurtenances. Other options shall be subject to Sydney Water’s acceptance.

Pipes shall be designed and constructed to withstand all imposed loads including, but not limited to trench/embankment fill, external hydrostatic loads, internal pressure, superimposed dead loads and superimposed live loads (e.g. vehicular traffic). Wherever possible all pipework shall be graded to have a constant slope, with no high / low points.

Maximum velocity of biogas in any new pipework shall not exceed 3.7 m/s under normal duty flows to minimise the risk of liquid and solid carry-over resulting in damage to instrumentation and equipment.

Pipework carrying chemicals shall be designed and installed in accordance with the requirements of clause M37 of this Specification.

M16.4 Pipe Material Schedule and Codes

M16.4.1 General

Pipe materials shall be as specified herein. Unless indicated otherwise, fittings materials and class shall be the same as the adjacent pipe.

Pipe materials shall be selected to suit the process application, design pressure, the fluid and associated properties being conveyed and its location, environment and installation (i.e. above ground, below ground, submerged etc.).

M16.4.2 Pipework Schedule for Wastewater Treatment and Water Filtration Plants

The minimum requirements in regard to pipe materials and grades to be used in wastewater treatment and water filtration plants are given in Tables A and B. The use of materials other than those specified shall be subject to Sydney Water’s acceptance.

**TABLE A: PIPING SYSTEM SCHEDULE FOR WASTEWATER TREATMENT AND WATER FILTRATION PLANTS**

<table>
<thead>
<tr>
<th>PIPE SERVICE</th>
<th>Exposed</th>
<th>Buried/Embedded/Encased</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Up to 50mm</td>
<td>65mm to 80mm</td>
</tr>
<tr>
<td>AER</td>
<td>A2/B1</td>
<td>B4</td>
</tr>
<tr>
<td>AA</td>
<td>B1</td>
<td>B4</td>
</tr>
<tr>
<td>AL</td>
<td>D10</td>
<td>D10</td>
</tr>
<tr>
<td>PIPE SERVICE</td>
<td>Exposed Up to 50mm</td>
<td>Exposed 65mm to 80mm</td>
</tr>
<tr>
<td>------------------------------</td>
<td>--------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>AH Ammonia Hydroxide</td>
<td>D10</td>
<td>D10</td>
</tr>
<tr>
<td>AS Anti-Scalant</td>
<td>D10</td>
<td>D10</td>
</tr>
<tr>
<td>BC Biocide</td>
<td>D10</td>
<td>D10</td>
</tr>
<tr>
<td>CG Chlorine Gas</td>
<td>B3</td>
<td>-</td>
</tr>
<tr>
<td>CLS Chlorine Solution</td>
<td>D1/D10</td>
<td>D1/D10</td>
</tr>
<tr>
<td>CLV Chlorine Gas under Vacuum</td>
<td>D1</td>
<td>-</td>
</tr>
<tr>
<td>ACA Citric Acid (Aqueous)</td>
<td>D10</td>
<td>D10</td>
</tr>
<tr>
<td>DG Digester Gas</td>
<td>-</td>
<td>B4</td>
</tr>
<tr>
<td>FLT Filtrate (U/F Filtrate)</td>
<td>D1</td>
<td>D1</td>
</tr>
<tr>
<td>HA Hydrochloric Acid</td>
<td>D6/D10</td>
<td>-</td>
</tr>
<tr>
<td>MA Medical Air</td>
<td>A2/B4</td>
<td>-</td>
</tr>
<tr>
<td>MN Methanol</td>
<td>B4</td>
<td>B4</td>
</tr>
</tbody>
</table>
### PIPE MATERIAL CODE

<table>
<thead>
<tr>
<th>PIPE SERVICE</th>
<th>Exposed</th>
<th>Buried/Embedded/Encased</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Up to 50mm</td>
<td>65mm to 80mm</td>
</tr>
<tr>
<td>OSP Off Spec Permeate</td>
<td>B4/B5/D1</td>
<td>B4/B5/D1</td>
</tr>
<tr>
<td>POL Polyelectrolyte</td>
<td>D1/D10</td>
<td>D1/D10</td>
</tr>
<tr>
<td>PD Pumped Drainage Return</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>SEW Sewage</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>SA Scour Air</td>
<td>A2/B1/B4</td>
<td>A2/B4</td>
</tr>
<tr>
<td>SB Sodium Bisulphite</td>
<td>D6</td>
<td>D6</td>
</tr>
<tr>
<td>SC Scum</td>
<td>-</td>
<td>D3</td>
</tr>
<tr>
<td>SHC Sodium Hypochlorite</td>
<td>D10</td>
<td>D10</td>
</tr>
<tr>
<td>SUL Sulphuric Acid (Note 2)</td>
<td>D10/B4/B7</td>
<td>D10/B4/B7</td>
</tr>
<tr>
<td>SW Stormwater</td>
<td>-</td>
<td>D2/D</td>
</tr>
<tr>
<td>V Vent (Note 3)</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Notes:**

1. A2 Copper shall not be used for compressed air pipes above 40 mm diameter.
2. B4 (grade 316 stainless steel) and B7 (Carbon Steel) only suitable for Sulphuric Acid of concentration > 98%.
3. For “Exposed” pipework, vents will generally be of the same material as the pipes that they vent. Special cases may require detailed design when they arise. Vents are not applicable to “Buried/Embedded/Encased” pipework.
4. Also Refer M37 for pipe material to be used for chemicals not listed in Table A.
### TABLE B: PIPING MATERIAL SCHEDULE FOR WATER AND WASTEWATER TREATMENT PLANTS

<table>
<thead>
<tr>
<th>CODE</th>
<th>PIPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>Copper, AS1432, Type B, annealed tempered.</td>
</tr>
<tr>
<td>A2</td>
<td>Copper, AS1432, Type B, as drawn tempered.</td>
</tr>
<tr>
<td>B1</td>
<td>Mild Steel, to AS1074, medium, galvanised.</td>
</tr>
<tr>
<td>B2</td>
<td>Mild Steel, to AS1579, welded and or flanged. Hot dip galvanised and/or cement lined where indicated.</td>
</tr>
<tr>
<td>B3</td>
<td>Mild Steel schedule pipe, to AS4041. Flanged or welded, hot dip galvanised.</td>
</tr>
<tr>
<td>B4</td>
<td>Stainless Steel, grade 316, seam welded, Schedule pipe to suit application.</td>
</tr>
<tr>
<td>B5</td>
<td>Stainless Steel, grade 316, spiral welded, minimum thickness = 2 mm</td>
</tr>
<tr>
<td>B6</td>
<td>Mild Steel schedule 40 welded or flanged for T≤ 45°C; Stainless steel Grade 304L or 316L Schedule 40 for T&gt; 45°C;</td>
</tr>
<tr>
<td>B7</td>
<td>Carbon Steel Schedule pipe, to AS4041. Flanged or welded, no internal surface treatment.</td>
</tr>
<tr>
<td>B8</td>
<td>Stainless Steel tube, grade 316, to AS4041</td>
</tr>
<tr>
<td>C1</td>
<td>Ductile iron, rubber ring joint to AS2280. Pressure Class Pipe &amp; Fittings (WSA PS 200 and WSA PS 201,) to suit application. Cement lined internally and bitumen coated externally.</td>
</tr>
<tr>
<td>C2</td>
<td>Ductile iron flanged to AS2280. Flange Class Pipe &amp; Fittings (WSA PS 200 and WSA PS 201) to suit application. Cement lined internally and bitumen coated externally.</td>
</tr>
<tr>
<td>C3</td>
<td>Not used.</td>
</tr>
<tr>
<td>C4</td>
<td>Ductile iron flanged joint to AS2280. Flange Class Pipe &amp; Fittings (WSA PS 200 and WSA PS 201) to suit application. Epoxy lined internally to WSA 201 coating system CER and bitumen coated externally.</td>
</tr>
<tr>
<td>D1</td>
<td>UPVC, AS1477, Class 18.</td>
</tr>
<tr>
<td>D2</td>
<td>UPVC rainwater pipe, AS1273.</td>
</tr>
<tr>
<td>D3</td>
<td>Plastic ABS, AS3518, Class to suit application.</td>
</tr>
<tr>
<td>D4</td>
<td>GRP polyester based, AS2634 &amp; AS3571, Class to suit application.</td>
</tr>
<tr>
<td>D5</td>
<td>UPVC AS1254, storm water pipes.</td>
</tr>
<tr>
<td>D6</td>
<td>PVC-C to ASTM D1784, Class 23447-B</td>
</tr>
<tr>
<td>D7</td>
<td>Polyethylene series 1 to AS4130</td>
</tr>
<tr>
<td>D8</td>
<td>UPVC to AS1260, grade SN10 for DN100 and SN8 for &gt;DN100</td>
</tr>
<tr>
<td>D10</td>
<td>PVC-U to ASTM D1785 Schedule 80</td>
</tr>
</tbody>
</table>
### M16.4.3 Pipework for Pumping Stations

Only metallic pipes and fittings shall be used in water, sewage and recycled water pumping stations, next to pumps in wastewater treatment and water filtration plants and around reservoirs, including:

- Ductile iron,
- Stainless steel,
- Mild steel, and
- Copper and bronze (minor pipes and fittings only).

For pump applications in wastewater treatment and water filtration plants, plastic pipes and fittings may be used, provided the contractor can demonstrate that design prevents direct connection of plastic pipework to the pump. This is to avoid any vibration being transmitted to plastic pipework and fittings, which may result in pipework fatigue and failure. The detail design shall be subject to Sydney Water’s acceptance.

Ductile iron and stainless steel are the preferred pipework material for water and sewage pumping stations. Subject to Sydney Water’s acceptance, mild steel pipework may be used for special fittings and sizes beyond the range covered by other materials.

Ductile iron and mild steel pipework for sewage and water pumping stations shall be internally cement mortar lined and externally coated in accordance with WSA 201 system EUH for ductile iron, and WSA 201 system FPE for mild steel.

If partially or occasionally empty, the ductile iron and mild steel pipework for sewage pumping stations shall be internally calcium aluminate cement mortar lined.

Alternatively, and subject to Sydney Water’s acceptance, the ductile iron pipework for sewage and water pumping stations may be internally lined and externally coated in accordance with WSA 201 system EUH or FBE.

Stainless steel pipes, if used in water and sewage pumping stations, shall be grade 316 or other grades with Pitting Resistance Equivalent Number (PREN) of 23.1 or greater, pickled and passivated in accordance with ASTM A380. Stainless steel pipes shall be min. Schedule 40. If a lower pipe schedule is accepted by Sydney Water, the pipe wall thickness shall be adequate for the structural loads and design pressure, but not less than 6mm. Stainless steel pipes do not require internal or external protective coatings.

Non-metallic pipes can only be used for vent lines, provided that they are buried, i.e. protected from the elements and vandalism. Exposed vent lines shall also be metallic. This, however, doesn’t apply to fibreglass vent shafts.

### M16.4.4 PVC-M, PVC-O and PVC-U Pipes and Fittings for Pressure Applications

Modified (PVC-M), Oriented (PVC-O) and Unplasticised (PVC-U) Polyvinylchloride pipes and fittings for pressure applications shall be manufactured, tested and supplied in accordance with WSAA Product Specification WSA PS-209, WSA PS-210 or WSA PS-211, as applicable. Ductile iron fittings, if used with PVC pipes, shall comply with WSA PS-212. The minimum pressure class of PVC pipes and fittings shall be PN16. Pipe material classification for PVC-O pipes shall not be less than 450. All PVC pipe shall be joined by elastomeric ring joints or solvent cement welded joints as required.
For PVC-U pipework for chemical systems and for solvent cement joints refer to M37. PVC pipework shall be installed in accordance with AS2032.

**M16.4.5 PVC-U Pipes and Fittings for Drains, Waste and Vents**

Unplasticised Polyvinyl Chloride (PVC-U) pipes and fittings for sewerage service shall be manufactured, tested and supplied in accordance with WSAA Product Specification WSA PS-230.

Pipework installation shall be carried out in accordance with AS3500 and the manufacturer's specification and requirements. Method of joining shall be rubber ring or solvent cement.

All PVC-U pipework and valves exposed to sunlight and external weather shall be externally painted to ACL coating system as specified in WSA 201 and Sydney Water’s Supplement to WSA 101.

**M16.4.6 PVC-C Pipes, Fittings and Valves**

All Poly Vinyl Chloride post-chlorinated (PVC-C) pipes, fittings and valves shall meet the requirements of Class 23447-B, as defined in ASTM Specification D1784.

As the working temperature increases, pressure rating for pipe, fittings and valves shall be reduced in accordance with table below. Maximum working temperature shall not exceed 80°C.

<table>
<thead>
<tr>
<th>Temperature, °C</th>
<th>PN16</th>
<th>PN10</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>16</td>
<td>10</td>
</tr>
<tr>
<td>20</td>
<td>16</td>
<td>10</td>
</tr>
<tr>
<td>30</td>
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</tr>
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<td>40</td>
<td>14.5</td>
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<td>50</td>
<td>12</td>
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<td>9</td>
<td>5.6</td>
</tr>
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<td>70</td>
<td>6</td>
<td>3.8</td>
</tr>
<tr>
<td>80</td>
<td>3</td>
<td>2.0</td>
</tr>
</tbody>
</table>

Pipework jointing and installation shall be carried out in accordance with the manufacturer's specification and requirements. Method of jointing for PVC-C pipe shall be solvent cement.

All PVC-C pipework shall be installed in accordance with AS 2032.

All PVC-C pipework and valves exposed to sunlight and external weather shall be externally painted to ACL coating system as specified in WSA 201 and Sydney Water’s Supplement to WSA 201.

**M16.4.7 PVC-U Pipes, Fittings and Valves to ASTM D1785 Schedule 80**

Where used, PVC-U ASTM D1785 schedule 80 pipe, fittings and valve body material shall meet the requirements of ASTM Class 12454-B (PVC Type 1 Grey) as defined in ASTM Specification D1785.

Method of joining shall be solvent cement in accordance with pipe manufacturer’s recommendation to suit the application. Pipework jointing and installation shall be carried out in accordance with the manufacturer's specification and requirements.

All PVC-U ASTM D1785 schedule 80 pipework shall be installed in accordance with AS 2032.
For PVC-U pipework for chemical systems and for solvent cement joints refer to Clause M37 of this Specification. PVC pipework shall be installed in accordance with AS2032.

All PVC-U pipework exposed to sunlight and external weather shall be painted to ACL coating system as specified in WSA 201 and Sydney Water’s Supplement to WSA 201.

**M16.4.8 PE Pipes and Fittings for Pressure Applications**

PE pipes and fittings for pressure applications shall be high density polyethylene with minimum required strength of 10MPa (HDPE 100). The pipes and fittings shall be manufactured, tested and supplied in accordance with WSAA Product Specifications WSA PS-207 and WSA PS-208. Fabricated PE fittings for pressure applications shall comply with WSA PS-216.

Pipework installation, in particular the requirements for supporting exposed pipe and for penetrating structures, shall be carried out in accordance with AS2033 and the manufacturer’s specification and requirements.

The minimum pressure class of PE pipes and fittings shall be PN16 and dimensions shall be Series 1. PE pipes and fittings shall be joined by butt fusion or electro fusion welding in accordance with WSAA Polyethylene Code WSA 01.

**M16.4.9 Copper and Bronze Pipes and Fittings**

Seamless copper tube shall comply with AS1432 type B.

All soldered, threaded, compression and similar copper and bronze fittings and connectors shall comply with AS3688. Threaded fittings shall not be used on sizes larger than DN50. Pipes over DN50 shall have brass or gunmetal flanges. All flanges shall be silver soldered to the pipes. Compressions joints shall not be used near pumps and other machinery where vibrations are present.

Installation, commissioning and testing of cooper pipes and fittings shall comply with AS4809.

Wherever a copper pipe is connected to a steel or cast iron pipe, insulating dielectric unions of an acceptable type shall be installed. Wherever copper pipe is supported from hangers, it shall be suitably insulated from the hangers.

All above ground copper pipes shall be protected against corrosion.

**M16.4.10 Steel Pipes and Fittings**

All steel pipes and fittings for water and wastewater applications shall be manufactured, tested, supplied and installed in accordance with WSAA Product Specification WSA PS-203 and WSA PS-204, AS1579 and AS1646. For compressed air applications carbon steel pressure pipes to AS4041 shall be used.

Pipes and fittings shall be cement mortar or calcium aluminate mortar lined internally in accordance with WSA 201 system CML or CAC, as specified. Other internal lining systems are subject to Sydney Water's acceptance. The internal ends of cement and calcium aluminate lined pipes <DN750 having “ball and spigot” or “slip-in” joints and not cement lined shall have a factory applied thermally sprayed coating system TSZ as specified in WSA 201.

The pipework shall be externally coated system EUH, FBE or FPE, as required.

All buried steel pipes and fittings shall be provided with an external protective coating of fusion bonded polyethylene in accordance with AS4321.

Above ground steel pipes and fittings shall be externally protected using WSA 201 system PUR-A, EHB-A or Sydney Water’s accepted equivalent.

Where specified, fully welded steel pipelines shall be provided with cathodic protection.

**M16.4.11 Stainless Steel Pipes and Fittings**

Unless otherwise specified, all stainless steel pipes and fittings shall be manufactured from grade 316L or grade 316 stainless steel pipes, complying with ANSI/ASME B36.19M and B16.9, respectively.
Spiral wound stainless steel pipes, if used, shall be fabricated from grade 316 stainless steel, manufactured in accordance with the requirements set out in AS4041 for class 3 piping or other agreed manufacturers standards.

All instrumentation tubing shall be manufactured from grade 316 stainless steel Schedule 40 seamless tube and fittings suitable for use with compression fittings.

Other stainless steel grades with PREN of 23.1 or greater may be used subject to Sydney Water’s acceptance.

All welds between stainless steel components shall be in accordance with AS4041. Butt welds shall be full penetration in accordance with AS1554.6.

All stainless steel welding shall be carried out using approved welding techniques and appropriate procedures. Welds shall be chemically cleaned, pickled and fully passivated in accordance with ASTM A380.

All threaded, compression and similar stainless steel fittings and connectors shall comply with AS3688 and have a minimum pressure rating of PN16. Compressions joints shall not be used in pumping stations and near pumps and other machinery where vibrations are present.

Braided stainless steel pipes and fittings, if used, shall have minimum pressure class PN16 and be of a corrugated metal, double braided type.

**M16.4.12 Ductile Iron Pipes and Fittings**

All ductile iron pipes and fittings shall be manufactured, tested and supplied in accordance with WSAA Product Specification WSA PS-200 and WSA PS-201, AS/NZS2280 and AS1646. The pipes and fittings shall be internally cement mortar lined in accordance with WSA 201 system CML, calcium aluminate cement mortar lined to system CAC, thermally bonded to system FBE or epoxy coated to system EUH, as required. Flanged pipes and fittings shall be Flange Class pipe. Spigot and socket pipes and fittings shall be PN35.

Bare ductile iron pipes and fittings cast into concrete shall be power-tool cleaned to AS1627 Class 2. Pipes and fittings with clean and sound factory applied coating do not need additional surface preparation prior to concrete casting.

**M16.4.13 ABS Piping**

ABS piping and fittings shall be solvent welded and installed in accordance with the manufacturer's instructions and in accordance with AS3690 and AS3691. ABS pipe and fittings shall comply with AS3518.

All ABS pipework exposed to sunlight and external weather shall be painted to ACL coating system as specified in WSA 201 and Sydney Water’s Supplement to WSA 201.

**M16.4.14 GRP Pipes and Fittings**

Glass reinforced plastic (GRP) pressure pipes and fittings for water and wastewater applications shall be manufactured, tested and supplied in accordance with WSAA Product Specification WSA PS-205 and WSA PS-205S, as applicable.

GRP pipes and fittings for other applications shall comply with AS3571. Design and manufacture of GRP fittings shall comply with BS76269 and AS2634 respectively.

**M16.5 Connections of Pipes, Valves and Fittings**

**M16.5.1 Expansion Joints**

Where pipework is exposed or subject to temperature variations, the installation shall include expansion loops or other Sydney Water’s accepted device to take account of thermal expansion.

Expansion joints, anchors and guides shall be as recommended by the manufacturer to accommodate movement due to the thermal or operational load, but without releasing pipelines pressure forces. Rubber type expansion joints / flexible rubber couplings shall not be used in pumping stations and near pumps and other machinery where severe vibrations may be present.
M16.5.2 Flanges

M16.5.2.1 General
Unless specified otherwise, all flanges shall be circular and conform in dimensions, drilling and pressure rating to AS4087 PN16.

Where sizes and pressure ratings exceed those contained in AS4087, flanges shall conform to AS2129 or a relevant international standard, as agreed with Sydney Water. In the case of exceptions, mating pipe flanges shall be drilled to suit the specified drilling of the adjoining valve or equipment.

Flanges on all steel and ductile iron pipes shall be fully fixed to the pipes.

Flanges on GRP, PVC, ABS and PE pipes may be stub flanges with loose metal backing rings, or full face up to DN100. Unless accepted otherwise by Sydney Water, backing rings shall be grade 316 stainless steel. Full face flanges complying with relevant Australian Standards. Flanged GRP, PVC and ABS pipework, however, may only be used in water and wastewater treatment plants. They are not permitted in networks.

All flanges shall be integral with or positively attached to the pipes and fittings. Grip type flanges and joints, including those with set screws around flange neck that “bite” into the pipe material or similar shall not be used.

M16.5.2.2 Stainless Steel Flanges
The flanges shall be plate flanges to ASTM A240. The flanges shall be of the required pressure class, drilled in accordance with the relevant standard and welded in accordance with AS4041, figure 3.24.4.8 (H) Type 6.

Where flange joints are used on spiral wound stainless steel pipes, they may be joined using stainless steel stubs and stainless steel backing rings.

M16.5.2.3 Ductile Iron Flanges
Flanges for ductile iron pipes and fittings shall be integrally cast or fabricated and attached to the ductile iron pipe by screwing with mating threads filled with suitable epoxy resin.

Flange contact surfaces shall be raised face.

Flange faces are to be coated with an approved soluble lacquer.

M16.5.2.4 Steel Flanges
Unless specified otherwise, all steel flanges shall be slip-on, welded on both sides as per AS4041.

M16.5.2.5 Bolts and Nuts
All flanges shall be assembled square and true prior to bolting.

Bolts shall be tightened in a diametrically opposite sequence. Each bolt shall be initially tightened in sequence to 50% of required torque, then the sequence repeated to give 75%, 90% and finally 100%.

M16.5.3 Flange Gaskets and O-Rings
All flange gaskets and O-rings shall be manufactured, tested and supplied in accordance with WSA Product Specification WSA PS-312 and WSAA Industry Standard WSA 109.

The gasket type, material and thickness shall be suitable for the flange size and pressure rating, contact with the fluid being conveyed, the operating conditions and environment.

Pipes and fittings shall be in their correct position, alignment and grade before the joints are made and no springing of joints shall be permitted.
M16.5.4  Pipe Threads

Unless otherwise specified, all pipe threads shall conform in dimension and limits of size to AS1722 taper jointing thread.

All bolt threads shall be coated with a nickel based anti-seize compound prior to assembly.

M16.5.5  Dismantling Joints

All dismantling joints shall be thrust type with flanges for the required pressure class and complying with AS4087. Non-thrust type dismantling joints, unrestrained couplings, grip type flanges or joints shall not be used in pumping stations and valve chambers.

Dismantling joints shall be manufactured, tested and supplied in accordance with WSAA Product Specification WSA PS-201.

M16.5.6  Flexible Rubber Couplings

Flexible rubber couplings shall have integral duck and rubber flanges. They shall have individual solid steel ring reinforcement with a carcass of highest grade woven acceptable synthetic fibre. Couplings shall be single arch and shall be equipped with galvanised steel split flange retaining rings. Couplings shall be selected to match pipeline and/or equipment connections size and meet the operating conditions. They shall have filled arches on sludge pipelines.

Flexible rubber couplings installed adjacent to a wafer type or other through bolted type valves or fittings shall be equipped with a steel spacer flange to prevent distortion of the rubber coupling flange. Control units, consisting of at least two bolts shall be provided where necessary to limit extension of the coupling.

Flexible rubber couplings shall not be used in pumping stations or near pumps or other machinery where vibrations are present as a substitute for anti-vibration bellows, expansion joints or dismantling joints.

M16.5.7  Mechanical Pipe Couplings

Unless specified otherwise, mechanical pipe couplings not intended to take thrust shall be metallic type recommended by the manufacturer for the intended service.

M16.5.8  Victaulic Couplings

Victaulic couplings shall be installed so that a minimum of 3mm gap is left between adjacent pipe ends to allow for expansion. The seals shall be selected for the service required. Victaulic couplings on mild steel pipe may be of the rolled grooved type, or Sydney Water’s accepted equivalent.

M16.5.9  Anti-Vibration Bellows

Suitable anti-vibration bellows shall be used where required to reduce transmission of vibrations from operating machines, eg. diesel or gas pumps, onto the adjoining pipework. The bellows shall be of a thrust-bearing type, made of a suitable grade of stainless steel resistant to premature fatigue due to vibrations and operating conditions. Where installed, the bellows shall be fitted with compression lugs for ease of removal and installation so that they can be used in lieu of dismantling joints. Rubber bellows or flexible rubber couplings shall not be used.

M16.6  Painting and Labelling

All pipework is to be painted or coloured and permanently labelled as outlined below:

a) Labelling is the primary means of identification. Pipework colouring is a secondary means of identification.

b) All pipework shall be labelled in accordance with AS1345.

c) All pipework is to be labelled at regular intervals as per AS 1345.
d) The direction of flow shall be indicated by an arrowhead at the end of the pipeline marker as per AS1345.

e) Pipework colours used to assist in identifying pipework contents shall be as per Tables C and D below.

f) The colour identification system can be implemented by either pipework pigmentation during manufacture, painting in accordance with WSA 201 and Sydney Water’s Supplement or colour banding at regular intervals as per AS 1345.

g) SS pipework to be colour banded only (i.e. not painted).

h) Chemical pipework – All chemical carrying pipes shall be fully coloured/painted.

i) ABS pipes – All external ABS pipes (exposed to UV) shall be fully painted.

j) Other non-chemical ABS pipes within buildings shall be colour banded.

k) All other pipe material shall be colour banded.

l) Refer to Sydney Water Technical Specification– Electrical for electrical and communication conduits.

m) Buried PVC and other non-metallic pipes shall have metal tape placed in the trench above the pipe to allow for detection.

### TABLE C: COLOUR SCHEME FOR PIPEWORK

<table>
<thead>
<tr>
<th>PIPELINE CONTENT</th>
<th>COLOUR AS 2700</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Chemicals</strong></td>
<td></td>
</tr>
<tr>
<td>Acids</td>
<td>P11 Magenta (deep purple)</td>
</tr>
<tr>
<td>Alkalis</td>
<td>G25 Olive</td>
</tr>
<tr>
<td>Oxidising agents including chlorine gas</td>
<td>Y14 Golden yellow</td>
</tr>
<tr>
<td>Reducing agents and other hazardous chemicals</td>
<td>R25 Rose pink</td>
</tr>
<tr>
<td>Polymer solutions and non-hazardous chemicals</td>
<td>N52 Mid grey</td>
</tr>
<tr>
<td><strong>Water</strong></td>
<td></td>
</tr>
<tr>
<td>Potable water</td>
<td>B24 Harbour blue (dark blue)</td>
</tr>
<tr>
<td>Recycled water</td>
<td>P23 Lilac (bright purple)</td>
</tr>
<tr>
<td>Clean water (raw, backwash, cooling, heating, stormwater, RE, IW)</td>
<td>G21 Jade</td>
</tr>
<tr>
<td>Dirty water (sewage, wastewater, centrate, sludge, process drainage, DOOF WWTP FE)</td>
<td>Black</td>
</tr>
<tr>
<td>Fire services</td>
<td>R13 Signal red</td>
</tr>
<tr>
<td><strong>Oils, flammable and combustible liquids</strong></td>
<td>X53 Golden tan (brown)</td>
</tr>
</tbody>
</table>
Notes:
1. Refer to list of common pipework contents in Table D below.
2. Clean water is categorised as suitable for skin contact (but not ingestion), Dirty water is categorised as not suitable for skin contact.

<table>
<thead>
<tr>
<th>PIPELINE CONTENT</th>
<th>COLOUR AS 2700</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gases</td>
<td>Y44 Sand</td>
</tr>
<tr>
<td>Air (compressed, medical, scour)</td>
<td>B25 Aqua (light blue)</td>
</tr>
<tr>
<td>Steam</td>
<td>N24 Silver grey</td>
</tr>
</tbody>
</table>

**TABLE D: COMMON PIPEWORK CONTENTS**

<table>
<thead>
<tr>
<th>PIPELINE CONTENT</th>
<th>CONTENT TYPE</th>
<th>COLOUR AS2700</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetic acid (glacial)</td>
<td>Acid</td>
<td>P11 Magenta</td>
</tr>
<tr>
<td>Aluminium sulphate</td>
<td>Acid</td>
<td>P11 Magenta</td>
</tr>
<tr>
<td>Citric acid</td>
<td>Acid</td>
<td>P11 Magenta</td>
</tr>
<tr>
<td>Ferric chloride</td>
<td>Acid</td>
<td>P11 Magenta</td>
</tr>
<tr>
<td>Ferric sulphate</td>
<td>Acid</td>
<td>P11 Magenta</td>
</tr>
<tr>
<td>Ferrous chloride</td>
<td>Acid</td>
<td>P11 Magenta</td>
</tr>
<tr>
<td>Hydrochloric acid</td>
<td>Acid</td>
<td>P11 Magenta</td>
</tr>
<tr>
<td>Hydrofluorosilic acid &amp; sodium silicofluoride (bulk fluoride powder)</td>
<td>Acid</td>
<td>P11 Magenta</td>
</tr>
<tr>
<td>Sulphuric acid</td>
<td>Acid</td>
<td>P11 Magenta</td>
</tr>
<tr>
<td>Ammonium hydroxide (ammonia solution)</td>
<td>Alkali</td>
<td>G25 Olive</td>
</tr>
<tr>
<td>Lime (slurry or hydrated)</td>
<td>Alkali</td>
<td>G25 Olive</td>
</tr>
<tr>
<td>Magnesium hydroxide (bulk slurry)</td>
<td>Alkali</td>
<td>G25 Olive</td>
</tr>
<tr>
<td>Soda Ash</td>
<td>Alkali</td>
<td>G25 Olive</td>
</tr>
<tr>
<td>Sodium hydroxide</td>
<td>Alkali</td>
<td>G25 Olive</td>
</tr>
<tr>
<td>Calcium Nitrate</td>
<td>Oxidiser</td>
<td>Y14 Golden yellow</td>
</tr>
<tr>
<td>Chlorine (liquified Cl₂ gas)</td>
<td>Oxidising agent</td>
<td>Y14 Golden yellow</td>
</tr>
<tr>
<td>PIPELINE CONTENT</td>
<td>CONTENT TYPE</td>
<td>COLOUR AS2700</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>---------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Potassium permanganate</td>
<td>Oxidising agent</td>
<td>Y14 Golden yellow</td>
</tr>
<tr>
<td>Sodium hypochlorite</td>
<td>Oxidising agent</td>
<td>Y14 Golden yellow</td>
</tr>
<tr>
<td>Sodium bisulphite</td>
<td>Reducing agent</td>
<td>R25 Rose pink</td>
</tr>
<tr>
<td>Polyacrylamide polymers</td>
<td>Polymer solution</td>
<td>N52 Mid grey</td>
</tr>
<tr>
<td>PolyDADMAC polymers</td>
<td>Polymer solution</td>
<td>N52 Mid grey</td>
</tr>
<tr>
<td>Salt /Brine</td>
<td>Non-hazardous</td>
<td>N52 Mid grey</td>
</tr>
<tr>
<td>Raw water</td>
<td>Clean water</td>
<td>G21 Jade</td>
</tr>
<tr>
<td>Filtered water</td>
<td>Clean water</td>
<td>G21 Jade</td>
</tr>
<tr>
<td>Industrial water (IW)</td>
<td>Clean water</td>
<td>G21 Jade</td>
</tr>
<tr>
<td>Reclaimed Effluent (RE)</td>
<td>Clean water</td>
<td>G21 Jade</td>
</tr>
<tr>
<td>Filter backwash water</td>
<td>Clean water</td>
<td>G21 Jade</td>
</tr>
<tr>
<td>Supernatant return (WFPs)</td>
<td>Clean water</td>
<td>G21 Jade</td>
</tr>
<tr>
<td>Cooling water</td>
<td>Clean water</td>
<td>G21 Jade</td>
</tr>
<tr>
<td>Stormwater</td>
<td>Clean Water</td>
<td>G21 Jade</td>
</tr>
<tr>
<td>Sewage</td>
<td>Dirty Water</td>
<td>Black</td>
</tr>
<tr>
<td>DOOF WWTP Filtered Effluent (FE)</td>
<td>Dirty Water</td>
<td>Black</td>
</tr>
<tr>
<td>Grit</td>
<td>Dirty Water</td>
<td>Black</td>
</tr>
<tr>
<td>Raw Sludge</td>
<td>Dirty Water</td>
<td>Black</td>
</tr>
<tr>
<td>Digested Sludge</td>
<td>Dirty Water</td>
<td>Black</td>
</tr>
<tr>
<td>WFP Sludges</td>
<td>Dirty Water</td>
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<td>RAS</td>
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<tr>
<td>WAS</td>
<td>Dirty Water</td>
<td>Black</td>
</tr>
<tr>
<td>Centrate</td>
<td>Dirty Water</td>
<td>Black</td>
</tr>
<tr>
<td>Supernatant (WWTPs)</td>
<td>Dirty Water</td>
<td>Black</td>
</tr>
<tr>
<td>Process Drainage</td>
<td>Dirty Water</td>
<td>Black</td>
</tr>
</tbody>
</table>
**M16.7 In-Line Strainers**

In-line strainers shall be installed upstream of small, high speed (e.g. booster) water pumps and pressure reducing valves for protection from debris and objects accidentally left in the pipework.

Strainers shall be ductile iron or grade 316 stainless steel body, double flanged to AS4087. The screen shall be grade 316 stainless steel wire mesh or perforated sheet metal with a maximum aperture of 2mm for sizes up to DN150 or 3mm for sizes larger than DN150, with low headloss coefficient.

The strainer shall be fitted with a lid or blank flange that can be removed safely by one person to allow screen cleaning. Where the lid / flange weight exceeds 16kg, a support or lifting device shall be provided.

Unless specified otherwise, the strainers shall be either of a ‘Wye’ or ‘Tee’ design.

The strainer shall be installed above ground or in an underground pit with adequate clearance to remove the lid / flange and the screen. A sump shall be provided to allow drainage of the strainer to a suitable discharge point. All ‘Tee’ strainers shall have the drain connection fitted with a manual ball valve and piping directed towards the sump.

**M16.8 Pressure Gauges**

Pressure gauges shall comply with the requirements of AS1349.

Pressure gauges shall be industrial Bourdon tube gauges complete with glycerine filled diaphragm seals for applications where particles may block the Bourdon tube. The gauges shall be glycerine filled to dampen any potential pulsations.

The scale of the gauge shall be such that the nominal reading is at the middle of the scale.

Gauges shall have a nominal diameter of 100mm and shall be fitted with a DN10 BSP threaded shank and an isolating ball valve.

**M16.9 Installation**

**M16.9.1 General**

All pipes shall be installed as per relevant Australian Standards and as follows.

Pipes and fittings shall be in their correct position, grade and alignment before joints are made as no springing of joints shall be allowed. In spigot and socket joints, each spigot shall be driven well home into the socket of the preceding pipe, and the spigot shall be truly concentric with the socket.

Buried ductile iron pipes shall have anti-corrosion protective sleeving in accordance with WSAA Product Specification WSA PS-320 and AS3680. The need for sleeving for thermally sprayed metallic zinc or zinc-aluminium alloy with polymeric topcoat coating system shall be assessed in accordance with Sydney Water’s Procedure - Soil Assessment for Installation of Ductile Iron Pipes without Sleeving

Unprotected steel pipes shall have anti-corrosion protective sleeving in accordance with WSAA Product Specification WSA PS-335.
M16.9.2 Pipe Supports

Piping shall be properly supported on racks or by anchor brackets, saddle or concrete supports. In no case shall support spacing exceed that recommended by the pipe manufacturer to adequately support the pipework for the service intended.

Hangers, supports or pipe racks shall be provided in each direction and at each change in direction. All hangers, racks, saddles and supports shall be of standard manufacture for that purpose.

Pipe supports in the floor trench drain in the building shall be of stainless steel construction.

The bedding material shall extend for the full width of the excavated trench and shall be shaped to receive the pipe.

Extreme care shall be taken to ensure that every pipe bears evenly on the bedding material over its entire length. Pipes shall not rest on collars of couplings.

All pipework with joints not designed to withstand tensile forces tending to separate the joint when the pipeline is subjected to an internal gas or liquid pressure shall be fitted with thrust and anchor blocks at all intersections, branches, changes of direction, valves and dead ends.


Rubber ring joints shall be made strictly in accordance with the pipe manufacturer’s instructions for that form of joint using rings supplied by the pipe manufacturer. Only that lubricant specified by the manufacturer shall be used for a particular joint.

For pipework repair the use of mechanical coupling may be permitted. Where unrestrained mechanical couplings are used they shall comply with WSAA Product Specification WSA PS-270 and WSAA Industry Standard WSA 105. Care shall be taken to ensure that the bolts are tightened evenly and the rubber rings are correctly seated. Unrestrained couplings and joints may only be used in buried locations, providing that the buried pipework is suitably restrained. They shall not be used within pumping stations, valve chambers, above ground and other similar or accessible locations.

M16.10 Testing and Commissioning

All pipework that convey liquids (water, sewage, recycled water, reclaimed effluent, industrial water and chemicals) shall be hydrostatically tested when fully installed as per Sydney Water’s Commissioning Specification. New works in existing sewage systems may use sewage as test media if accepted by Sydney Water. Compressed air or vacuum shall not be permitted as test media.

All pressure pipework in pumping stations, including machinery rooms, dry wells and wet wells, with the exception of joints between the submersible pump pedestal and the pipe, shall be hydrostatically tested in-situ. Test pressures shall be documented in detailed design drawings.

Pipes conveying compressed air shall be tested for leaks. The test media shall be water. Test procedure shall be produced prior to testing and accepted by Sydney Water.

Temporary supports if required to conduct the tests shall be removed in full and the site made good after the test. Temporary supports shall not be welded to any part of pipe(s) under test.

M16.11 Pipework Support Brackets

Pipework shall be supported by suitable pipe support brackets. The brackets shall be manufactured from hot-dip-galvanised structural mild steel or grade 316 stainless steel or of a suitable proprietary item like “Unistrut”, which shall be hot-dipped galvanised mild steel or grade 316 stainless steel and cut to appropriate length. Exposed ends of “Unistrut” or similar brackets shall be fitted with end caps.

All pipes shall be attached to the brackets with suitable saddles, which shall be either hot dipped galvanised mild steel or grade 316 stainless steel.
M16.12  Anchorage of Pipework
Pipe anchorages shall be provided to absorb static and dynamic thrusts from pipe fittings and valves.
Buried pipe anchorage shall, generally, comply with WSAA Water Supply Code of Australia WSA 03 – Sydney Water’s Edition, drawing no. WAT-1205. All pipe anchors shall be designed to withstand the highest pressures the piping system may be subjected to, including maximum hydrostatic test pressures and water hammer.
All buried pipe joined with rubber ring couplings or other joints incapable of containing tension shall incorporate concrete thrust and anchor blocks at all valves, tees, bends, dead ends and where otherwise required to resist movement.

M16.13  Pipework Drainage
The pipework shall be fitted with a required number of adequately sized manual drains at all low points to enable full emptying of each pipe section within no more than 30 minutes. The drains shall be minimum DN25 and each shall be fitted with two stop valves for double isolation. The drains shall discharge into the drain system.
Automatic drain valves shall be provided at all low points of compressed air lines with an integral strainer or approved equivalent. The discharge shall be directed towards the drain.

M16.14  Air Valves Vents
Manual air vents shall be installed at the high points of all pipework containing any pressure, which cannot be vented through service connections or vent cocks furnished with equipment.
Manual air vents shall be installed at the high points of all liquid lines. Automatic air valves shall be provided at locations subject to frequent air accumulation.

M16.15  Pipework Penetrating Structures
Pipework penetrating structural elements shall be in accordance with relevant standards, shall ensure no leakage through the penetration and shall make adequate allowances for differential movement.
The Contractor shall ensure that pipework penetrating structural elements from soil include flexible pipe joints that allow articulation. As a guide, one flexible pipe joint shall be within 300mm of the structure and the second flexible pipe joint shall be within 2 – 3 times the pipe external diameter. The Contractor shall fully design the articulated pipe joint system.
Puddle flanges shall be provided around metallic pipes that penetrate reinforced concrete walls. The puddle flange shall be located centrally in the wall with a continuous reinforcement mat on both sides of the flange between it and the concrete surface.
Plastic pipe penetrations through concrete structures shall be sealed with hydrophilic rubber seal Hydrotite® or equivalent. The pipe external surfaces shall be roughened and/or coated with sand to form a better bond with concrete.
Where allowance for longitudinal movement, such as thermal expansion is required, any pipe penetrating a concrete structural element shall pass through a 316 stainless steel sleeve. The sleeve shall be cast into the concrete structural element by means of a puddle flange. No loads shall be transferred from the pipe to the sleeve. The annulus between the pipe and the sleeve shall be sealed with an approved flexible and water tight product, such as Link-seal® or equivalent.

M16.16  Identification of Buried Pipework
All non-metallic pipes buried underground shall be provided along their complete buried length with trace wire tape so that they can be identified with a pipe locater.
M17. Lifting Facilities

M17.1 General

Where specified, suitable permanent lifting facilities, such as jib cranes, monorail cranes, gantry cranes or other shall be provided. The lifting facilities will be used for the maintenance of mechanical and electrical equipment and may be utilised in the initial installation of equipment and construction of the plant.

The lifting facilities shall be designed, manufactured, installed and tested to the best modern practice and in accordance with the relevant Australian Standards, SafeWork NSW and other statutory requirements.

The capacity of the lifting facilities shall be at least 20% greater than the heaviest load to be installed within the plant, including the usually pre-assembled items, such as complete pumping units and similar assemblies installed on a common base frame.

Hoisting, lowering, cross travel, longitudinal travel or slew of the crane shall be either manually or electrically operated, as specified.

Lifting facilities shall be designed to allow the load to be moved and positioned with minimum effort. This should be achieved in one lift, with no need to detach and re-attach and/or temporary support of the load in the process.

Loading bays shall be provided for vehicular access for direct loading and offloading by the lifting equipment.

The lifting facilities with rated capacity greater than 2000kg or vertical lift of more than 2m shall be provided with electrically operated hoisting.

The lifting facilities with rated capacity greater than 2000kg shall also be provided with electrically operated long and cross travels or slew, as appropriate.

Where specified, frequently used lifting facilities with rated capacity equal to or less than 2000kg and/or vertical lift equal to or less than 2m shall also be electrically operated.

The electrically operated cranes shall be controlled by a push-button type pendant control station. The pendant shall house all the required equipment and push buttons to provide required two speed control in each direction. Battery operated control stations are not acceptable.

All structural welding on the crane shall be in accordance with AS1554 Part 1, weld category SP.

All safety requirements shall comply with AS1418, AS3000, AS2550 and SafeWork NSW. All maintainable parts of the lifting facilities shall be provided with suitable access for maintenance.

Where installed over or in contact with potable water, all paint, labels or other objects that may come in contact with water or become free from the lifting equipment or associated infrastructure shall meet the requirements of AS4020.

The lifting facility shall have the following markings in black lettering, visible to the crane operator from the operating level:

- Rated capacity in tonnes
- Class/classification numbers
- Serial No.
- Travel directional sign (North, South, East and West)

M17.2 Jib Cranes

Where specified, equipment such as submersible mixers, stop boards, penstocks, gates, submersible pumps etc. shall be provided with a permanently installed jib crane.

Each jib crane shall include a boom, hoist or winch, associated lifting chain or wire rope, hook and all necessary fixings. The jib crane may be post or wall mounted, as specified.
The reach and slew of the boom shall be suitable for raising and lowering the equipment from its installed position to a designated platform or floor area or onto a truck where it can be readily inspected and serviced or taken away.

The jib crane and hoist or winch shall be clearly labelled for the rated capacity.

**M17.3 Monorail Cranes**

Monorail cranes shall include a monorail beam, trolley and hoist and lifting chain or wire rope.

The monorail beam shall be manufactured from structural steel and be hot dipped galvanised after fabrication. The monorail beam shall have trolley stops on both ends which shall be bolted to the beam.

The monorail beam, trolley and hoist shall be clearly labelled for the rated capacity.

Monorail cranes shall be approved by SafeWork NSW and be complete with structural certification for both, the crane and its support structures. The Contactor shall be responsible for the certification of the structures that support new lifting equipment.

Where existing structures are modified to carry monorail crane, the appropriate structural certifications shall be obtained for the required modifications.

**M17.4 Overhead Travelling Cranes**

Overhead travelling gantry cranes complete with supporting beams and rails, bridge, trolley, hoist, lifting chain or wire rope, service platform and access ladder with self-closing gate shall be designed, manufactured, factory tested, delivered, installed, site tested, commissioned and registered in accordance with relevant parts of AS1418 and SafeWork Australia.

The Group Classification of the cranes shall be C1 and the Group Classification of the crane mechanism M2 (as per AS1418 Part 1).

The crane long travel rails shall be fixed true and securely to the crane beams. End stops shall be provided on both the longitudinal and cross travel. Electrically operated cranes shall also be fitted with limit switches to limit the motion of the crane bridge and trolley prior to hitting the end stops.

Provision shall be made for lubrication of all working parts and lubrication points shall be located such that they are readily accessible.

The design, construction and materials of the service platform(s) and access ladder(s) shall comply in every respect with the requirements of AS1657, AS1418 and SafeWork NSW.

The rated capacity of the crane, span, minimum hook height and other relevant characteristics shall be adequate to lift the heaviest part installed in the plant and place it on the centre of the tray of a truck parked in the loading bay in one lift.

Crane operating envelope shall cover all installed mechanical and electrical equipment within the plant. The direction of cardinal points (ie North, South, East and West) shall be clearly marked on the bottom of the crane in an approved manner and be visible to the crane operator at all times.

The crane shall have the following information engraved on a stainless steel nameplate visible to the crane operator from the service platform:

- Serial No.
- Manufacturer’s name
- Date of manufacture
- Standard to which designed and manufactured
**M17.5 Crane Hoists**

Cranes shall be provided either with a wire rope or chain hoist.

The hoist shall have sufficient vertical lift to lift the equipment free of all possible obstructions from the floor and place it on a designated platform or truck.

The lift height of the hoist shall be from fully lowered, hook at the floor level, to fully raised at 500mm below the monorail beam, crane bridge or boom.

Where specified, hoist shall have true vertical lift.

The hoist brake shall be fail-safe under power failure. The brake mechanisms shall be protected against rain and dust ingress.

The hoist steel wire rope shall be in accordance with AS3569 and shall be hot dipped galvanized. Where exposed to sewage or in aggressive environments the wire rope shall be made from a suitable grade of stainless steel.

The hoist rope shall be in one length. Particular attention shall be paid to anchorage to the drum, upon which the rope shall be wound tightly without kinks.

A rope and pressure ring shall be provided to ensure the rope lays correctly and actuates the upper and lower limit switches to prevent overwinding of the rope.

Hoist lifting chains shall comply with AS2321 and be hot dipped galvanized. In corrosive environment or where specified the lifting chains shall be manufactured from stainless steel and comply with AS4797.

Adequate chain buckets attached to the trolleys or hoists shall be installed to collect the hoist chains. The buckets shall be self-draining and not accumulate water.

A suitable label shall be attached near the rope drum or chain bucket, giving the gross length and particulars of the rope or chain for replacement purposes.

Wire rope and chain shall have a minimum factor of safety of ten.

For manually operated hoists and trolleys, the hand chains shall be suspended below the crane beam or boom to 500 mm above the floor.

All gears and sprockets shall be of high strength hardened and machined steel with sealed grease packed ball or roller bearings on the load shaft. Chains shall be guided onto all sprockets to ensure that under all operating conditions they will not jam.

The bottom block shall be fully guarded. The hook shall be drop forged steel. It shall have a safety catch and be supported by a thrust ball or roller bearing to allow it to swivel in any direction.

All external parts of the hoists and trolleys shall be coated in accordance with WSA 201 and Sydney Water’s Supplement to WSA 201.

The hoist and equipment shall be suitable for continuous exposure to the weather and direct sunlight.

**M17.6 Electric Hoist**

Electrically operated hoists shall be controlled by a pendant control station. The control station shall also include trolley and gantry or boom travel controls, as applicable. The station shall house all the required push buttons to provide the required two speed control in each direction.

The electric hoist shall be fitted with upper and lower limit switches.
M17.7 Crane Electrical Requirements

M17.7.1 General

Except where the specification requires a higher standard, all work shall be carried out in accordance with the latest edition of AS/NZS 3000 (SAA Wiring Rules), AS/NZS 3008.1.1, and Technical Specification– Electrical.

The electricity supply to operate electric cranes shall be 400 Volt, 3 phase, 4 wire, 50 Hz alternating current.

Electric operated cranes shall include an insulated, sliding contact power feed system and collectors (a catenary power feed system or travelling cables on pulleys) and travel limit switches.

A 3 phase isolating switch shall be installed adjacent to the unit bottom of the crane access platform ladder. "Danger" notices shall be installed on the crane and any other required “Danger” signs remote from the crane.

A Certificate of Compliance of Electrical Work (CCEW) and all associated documentation shall be completed as per the requirements in Sydney Water’s Technical Specification - Electrical. A copy of the submission shall be provided to Sydney Water at the time of submission as well as a part of the O&M Manuals.

Main Supply Isolator

A main supply isolator, capable of being padlocked in the open position shall be supplied and installed adjacent to the unit. This isolator shall be rated such that it is capable of interrupting the locked rotor current of the largest motor plus the full load current of all other motors on the crane.

A sign reading "Main Switch for Crane - Isolate Before Servicing", shall be provided for installation adjacent to the isolator. The sign shall be a minimum of 600mm wide by 500mm high.

M17.7.2 Motors

All motors shall be 400 V, 3 phase, 50 Hz alternating current, reversing, horizontal mounted squirrel cage type in accordance with AS1359 and AS 60034. Each motor shall be tested by the manufacturer at their works and certified test sheets shall be supplied before the motors are delivered.

The motors shall be designed for crane duty and be not less than one hour rated. The motors shall be class F insulation with maximum temperature of 130°C during operation.

An earthing stud shall be fitted to the frame of each motor.

A lifting eye or lug shall be fitted to the frame of each motor.

The power factor of the motor at full load shall be not less than 0.85.

The continuous rated output of each motor shall be at least 15% in excess of the maximum power required by the driven unit under all specified operating conditions.

If the motors are double wound with delta windings on one or both speeds, then one "corner" of each delta winding shall be broken, and the extra connection bought out to a fourth terminal with a removable link within the terminal box. A fourth contact in the starter shall take the place of the removable link and open the delta of the non-energised winding.

All motor bearings shall be self-lubricating ball and/or roller types of standard design, except that in motors exceeding 15 kW a roller bearing shall be fitted at the driving end.

To avoid damage to bearings (work hardening or "Brinelling") due to vibration during transport suitable precautions shall be taken to protect them.

Characteristics of all motors shall be such that acceleration and deceleration is smooth and gradual, to reduce the possibility of load swing.

At creep speed the hoisting motion shall be capable of being maintained (irrespective of the size of the load on the hook within rated capacity) for one minute continuously in both the "up" and "down" directions.
M17.7.3 Brakes
The crane shall be fitted with brakes of an approved design. The brakes shall be capable of sustaining a load 25% greater than the test load when the hoisting motor is not energised. The brake fitted to each motion shall be operated by a solenoid thruster, shall be smooth operating and of ample size to perform efficiently the operation for which they have been designed, without overheating. All brakes shall be fail-safe under power failure.

M17.7.4 Protection and Control Equipment
Control of all motions and the master cut-out contactor shall be by means of a pendant type control station. Push buttons shall be provided to control the following operations, as appropriate:

- Raise
- Raise - creep
- Lower
- Lower - creep
- Transverse forward and back
- Transverse forward and back - creep
- Longitudinal forward and back
- Longitudinal forward and back - creep
- On
- Off - master cut-out

The crane protection panel and control equipment shall include:

- Master cut-out triple pole contactor arranged for operation from the control station.
- Protection panels fitted with the necessary triple pole motor contactors, overloads, fuses, etc. mounted in an approved position on the crane, easily accessible for servicing, and to the requirements of the Lifts and Scaffolds Regulations of the SafeWork NSW.
- Fuses in each active conductor to the control circuits.
- A triple pole self-resetting time lag overload relay adjustable as to time and current and to operate in the control circuit to the main contactor. The overload relays shall be of the normally closed, circuit opening type.
- If the offered hoisting motor is a two-speed motor, protection against the simultaneous closing of "low" and "high" speed contactors shall be provided by means of electrical and mechanical interlocks.

The panels shall be housed in an enclosure with easy access to equipment and mounted in a position accepted by Sydney Water. It is preferred that the control and protective panel(s) be hinged. The dustproofing medium shall be sponge rubber or neoprene, held in place by continuous metal retainers in addition to any adhesive.

The contactors incorporated in the control equipment shall comply with utilisation category AC4, Class 1 of AS1029, Part 1.

M17.7.5 Motion Limits

a) General
Limit switches shall be heavy duty industrial type and shall be installed on the crane to limit the hoisting and long and cross travel motions.

Any additional motion limiting devices, where required, shall be provided to obviate physical damage to the crane or an object, or structure adjacent to the crane, due to movement of the crane, part of the crane, or a load being handled by the crane past its designed range of movement.
b) Working Limit Switch

Working Limit Switches shall be provided for the hoisting motions, cross travel and long travel. When operated these switches shall cause the power supply to the motor it controls to be interrupted and the brake to be applied, but it shall not prevent reversal of motion. The limit switches shall be self-resetting when the motion returns to the non-limited section of its range. These limit switches may operate in the directional contactor circuit.

c) Final Limit Switch

A Final Limit Switch shall be provided for limiting the hoisting motion. When operated this switch shall cause the power supply to the motor to be interrupted and the brake to be applied. The final limit switch shall be of whole current series type and shall prevent reversal of motion until it has been manually reset. The means to manually reset the final limit switch, shall not be readily accessible to the crane operator.

However, any additional motion limiting devices, where required, shall be provided to obviate physical damage to the crane or an object or structure adjacent to the crane, due to movement of the crane, part of the crane, or a load being handled by the crane past its designed range of movement.

M17.7.6 Lighting

Suitable lighting shall be provided on the crane structure for illumination of the hook and load. All light fittings shall have anti-vibration mountings.

Illumination shall be suitable for maintenance work and shall be to AS1670.

M17.7.7 Cables

Cables shall be PVC insulated of approved manufacture and conforming to SAA Wiring Rules AS/NZS3000 and AS/NZS3008 enclosed to accord with the specified rating.

Wiring for power circuits shall be carried out using 600/1000 volt grade PVC insulated multi-stranded cables, with minimum conductor size 2.5 mm² (7/0.67).

Wiring for control circuits shall be carried out using 600/1000 volt grade PVC insulated multi-stranded cables, with minimum conductor size 1.5 mm² (7/0.50).

All cables to and from the crane assembly shall be run in heavy gauge steel galvanised conduits. Not more than two power circuits shall be enclosed in any one conduit.

The pendant control station must be suspended in manner that will protect the electrical cables against strain.

M17.7.8 Catenary Power Feed System

The catenary system shall be of robust design, and shall be supplied with all rails, trolleys, clamps and accessories to provide a complete and safe installation.

The catenary system shall be located so as to be accessible for maintenance.

The catenary system shall be installed level, true and correctly aligned with the travel of the crane, and shall be of adequate length to allow operation of the crane over the full range of travel.

Trolleys shall be of sufficient length to prevent the impact shock between trolleys being absorbed by the catenary cable while the catenary system is being compressed.

Catenary cables shall be 600/1000 volt grade, double insulated, multi-stranded, with minimum size 2.5 mm² (50/0.25) for power circuits, and 1.5 mm² (30/0.25) for control circuits.

M17.8 Prior to Manufacture

The following drawings are required to be submitted by the manufacturer prior to fabrication:

- Crane General Arrangement (fully dimensioned) showing location of crane protection and control panel, motors, cables, main supply isolator, insulated conductor feed system, limit switches etc.
General Arrangement, (fully dimensioned) of the crane protection and control panel, listing all details and showing the location of all components and general constructional features.

Equipment List, containing a full description of all components and listing the Manufacturer, Catalogue Number, rating and quantity of each item.

Single line and control circuit diagrams of the system, showing normal current ratings, etc.

Where drawings submitted require modification, a further three copies of the modified drawings shall be submitted. This procedure shall continue until Sydney Water accepts the drawings. All work shall be in accordance with the final drawings.

M17.9 Installation and Testing

The crane shall be installed and tested under the crane manufacturer’s supervision.

Each crane shall be load tested to its safe working load. The beams and trolleys shall be tested for their full range of travel.

The installation of the crane must be inspected and passed by the electricity supply authority and SafeWork NSW.

All certificates, complete with two sets of maintenance manuals and user operational instructions shall be retained.

A maintenance schedule for the installed lifting facilities is also required.
M18. Ventilation

M18.1 General

Unless otherwise specified, ventilation ductwork, fittings and appurtenances shall be designed, supplied and installed in accordance with AS4254 or SMACNA “HVAC Duct Construction Standards, Metal and Flexible”. Where conflicting requirements arise from the use of the above standards, requirements in the Australian Standard shall have precedence.

All ventilation duct work, enclosures and covered areas shall have suitably spaced and located intake points which allow an even collection of foul or hot air from each enclosed area or piece of equipment. Intake points shall have manual dampers to allow full and proper balancing of the ventilation system.

All ductwork shall be grade 316 stainless steel, FRP or PVC (subject to a Performance Solution being in place for FRP and PVC where required). Fans, dampers and other ventilation equipment shall be grade 316 stainless steel. Spiral weld stainless steel shall not be used for ductwork containing Hydrogen Sulphide.

M18.2 Fans and Accessories

M18.2.1 Ventilation Fans

Fans shall be 3 phase, 400V, industrial quality, direct driven, axial or centrifugal type, and made from grade 316 stainless steel. The fans shall be selected to achieve the lowest practicable absorbed power at the nominated operating conditions. Grade 316 stainless steel safety guard shall be provided on the unducted entry.

Where fans are connected to common ductwork they shall have grade 316 stainless steel non-return dampers to prevent backflow of air. Where available, all fan accessories (e.g. supporting fixtures, flexible connections, anti-vibration mounts, silencers, etc.) shall be from the original fan manufacturer. Flexible connections shall be lead impregnated polyester material or equivalent.

Fan motors shall have non-overloading power characteristics. Fans and motors shall be selected such that they are capable of increasing the "as built" system flow rate by 10%. Terminal boxes external to fan casings and wired to fan motors shall be provided.

Fan bearings shall be oil or grease lubricated. Fan motors shall be provided with grease packed ball or ball-and-roller bearings. Dust seals shall be provided for all bearings.

Fan performance test curves with the operating point clearly indicated thereon, shall be provided for each of the fans and shall be incorporated in the Operation and Maintenance Manual. The performance curves shall be based on tests carried out in accordance with AS2936.

M18.2.2 Installation

Fans and accessories shall be arranged to allow service access for maintenance and removal, and for replacement of assemblies and component parts, without disturbance of other items of plant.

Flexible connections shall be provided to prevent transmission of vibration to ductwork. Where necessary, expansion pieces between fans and flexible connections shall be provided.

M18.3 Construction of Ductwork

M18.3.1 Flexible and Rigid Ductwork

All flexible and rigid ductwork, fittings, hangers, supports and duct insulation shall be selected, fabricated, supplied, tested and installed in accordance with AS4254.1, AS4254.2 and/or SMACNA "HVAC Duct Construction Standards, Metal and Flexible", with precedence given to the requirements in the Australian Standard. The ductwork shall be sized, designed, insulated and installed to reduce noise travelling along or being generated by the ducts.
The Building Code of Australia 2019, Specification C1.10 Fire hazard properties, part 5 requires rigid and flexible air-handling ductwork in a Class 2 to 9 building to comply with the fire hazard properties set out in AS4254 parts 1 and 2. AS 4254.2 Section 2.1.2 requires air-handling ductwork to achieve a Spread-of-Flame index not greater than 0 and a Smoke-Development index not greater than 3 tested as per AS/NZ1530.3. FRP and PVC ductwork do not meet the AS4254.2 requirement, specifically for the Smoke-Development index. This compliance does not apply to outdoor ductwork.

The potential hazard associated is the risk of fire and smoke spread between separate compartments from the non-compliant ductwork and the impact that this may have on the evacuation of occupants.

The use of these products internally in buildings could be justified through a fire engineering Performance Solution. There is no requirement under NSW legislation to bring already certified buildings up to current code (other than in the case of a fire order from Council or where major building refurbishment is being undertaken and the Certifying Authority deems it necessary to upgrade).

The following acceptance criteria are the minimum required under a Performance Solution to demonstrate that the use of FRP or PVC ductwork will not lead to significant fire or smoke spread between separate compartments, and that this would not impact the egress of occupants within the facilities.

The Fire Safety measures related to a Performance Solution include the following:

- Plant spaces with this type of ductwork are to be kept free of combustible storage.
- All ventilation air ductwork is operated under negative pressure and discharged to outside treatment facilities.
- Adequate evacuation signage is provided in the plant spaces meaning that on alarm, evacuees would be expected to be able to reach the fire exits provided. These exits lead either directly to outside, or into a fire isolated stair.
- Occupants of the facilities are aware of the evacuation plan, and any visitors within the facility area are accompanied by a staff member.

If any facility requires a Performance Solution as part of a formal approvals process (e.g. a construction certificate, complying development certificate or the like), then a site-specific Performance Solution would need to be prepared for submission to the approval authorities.

M18.3.2 FRP Ductwork

M18.3.2.1 General

The FRP ductwork shall be manufactured in accordance with ASME RTP-1.

All FRP duct sections shall have an identification label laminated to the exterior surface, which shall indicate manufacturer's name, address, model number, serial number, resin name and number, resin manufacturer, curing agent temperature and date of manufacture.

The FRP duct system shall provide for expansion and contraction due to temperature changes without damage to the covers.

All edges shall have a smooth finish (not rough or sharp) for safety in handling. All cut surfaces shall be resin edge sealed to prevent wicking.

The performance parameters for the ductwork are as follows:

- Temperature: +10°C to 100°C
- Positive Pressure: 200 mm water column + 8
- Negative Pressure: 100 mm water column - 4
- Flow medium and velocity: contaminated air at 10 m/s maximum*
NOTE: *  The sound pressure level at the boundary of the site shall not exceed 35 dBA under free field conditions or 5dBA above ambient levels whichever is the highest. This involves duct velocities typically not higher than 8 m/s. Duct velocities >8m/s are accepted if the noise generated does not exceed that specified above.

Ductwork shall be designed and constructed in accordance with ASME/ANSI RTP1-1989.

Ductwork shall be airtight and shall not vibrate or pulsate when the system is in operation. Joints shall be substantially airtight. Ductwork shall not come in contact with any of the ceiling construction or any other equipment in the ceiling cavity.

Calculations for wall thickness shall be based on the structural fibreglass reinforced wall only. Long term deflection shall not exceed one per cent of duct diameter or duct width for rectangular ducts. Round FRP ductwork shall be used and shall be designed using a safety factor of 10 to 1 for pressure and 5 to 1 for vacuum service. Round duct shall be designed by manufacturer to resist specified loadings.

Supports for ducts, including foundations shall be aesthetically designed. Drawings shall be submitted to Sydney Water for acceptance.

Duct insulation requirements shall as per AS4254.

### M18.3.2.2 Materials and Fabrication

FRP ductwork shall be fabricated of contact moulded or filament wound construction, or a combination of these methods, to meet design criteria.

The resin shall be a brominated vinyl ester and shall be resistant to the contaminants in the air produced by the treatment of sewage. Derakins 510A as manufactured by Dow Chemical, Hetron 992 FR as manufactured by Ashland Chemical, or Dion VR 9300 FR as manufactured by Reichold Chemical or approved equivalent shall be used. Surfacing veil shall be apertured and non-hydrophilic polyester.

The corrosion barrier resin shall be a vinyl ester Hetron 922 or approved equivalent, shall be resistant to the contaminants in the air produced by the treatment of sewage with suitable spread of flame and smoke development properties as required by AS4254.

The resin used in the structural layer shall be Iso polyester or vinyl ester (preferred) dependant on project specific requirements. Where nominated by project requirements (e.g. in bushland settings subject to bushfires) the structural resin may also need fire resistant equal to UL94 V0.

The corrosion barrier shall comprise a C Glass veil (unless the service conditions need a synthetic veil as determined by the resin manufacturer and compatible with the fire resistance requirements), backed up by a minimum of 900gsm of chopped glass. This shall comprise of two layers of 450gsm CSM mat (or equivalent) or applied by a calibrated automated chopper gun system. The glass ratio shall be between 20% and 30%, the minimum overall corrosion barrier shall be no less than 2.5mm.

Where ducts pass into, or through other vessels or are subject to the duct contents being present on the external surface, then a second corrosion barrier of the same specification shall be applied externally to the duct.

Where duct is exposed to the normal atmosphere the final layer of the duct shall comprise a C veil only. The duct shall be coated in a pigmented, paraffinated flow coat with UV inhibitors. The addition of UV inhibitors shall be compatible with the flowcoat and shall be sufficient to give a service life equal to that of the vessel. The external flowcoat where required must exhibit the same fire resistance or better than the structural resin system.

No sand or bulking fillers are permitted except for thixotropic or air release additives. Any additives shall not degrade the fire, chemical or UV resistance of the ducts.

All fittings such as elbows, laterals, trees, and reducers shall be fabricated of the same resin and reinforcement and equal or superior in strength to the adjacent duct section and shall have the same internal dimensions as the adjacent duct. Non-flanged duct joints shall be butt wrapped or bell and spigot joints. Bell and spigot joints...
shall be sealed with a standard butt joint overlay as per PS 15-69. The interior opening between the bell and spigot shall be sealed with a resin paste so that no glass fibres are exposed and all voids are filled. Field cut duct ends and exposed glass fibres shall be resin coated prior to joint assembly to maintain a continuous interior corrosion barrier. All exterior surfaces of joints shall be coated with a paraffinated resin-rich gel coat with W inhibitors.

Total width of overlay for butt-wrap joints shall be not less than 150 mm for diameters from 150 mm up to and including 750 mm for diameters of 1000 mm and larger overlay shall be not less than 250 mm.

Standard elbow centreline radius shall be equal to one and half times the duct diameter (1.5 x). Short radius bends are not acceptable.

Standard elbows up to 600mm diameter shall be smooth radius moulded elbows. Standard elbows 750mm diameter and greater may be mitred sections as specified below. 0 to 44 degree elbows shall contain one mitred joint and two sections. 45 to 80 degree elbows shall have a minimum of two mitred joints and three sections. Elbows greater than 80 degrees shall have a minimum of four mitred joints and five sections.

Fittings shall be factory manufactured to meet the specified design criteria and in accordance with approved submittals. Reinforcing ribs shall be factory installed as required to meet the specified deflection requirements and to provide a system free from pulsing, warpage, sagging and undue vibration.

Forming vanes shall be provided in all mitred rectangular elbows. Rectangular elbow turning vanes shall be of FRP construction, solid or double wall construction with an airfoil shaped profile.

Round duct and fitting reinforcing shall be factory located and installed to avoid duct hangers, support saddles, bracing, branch take offs and entries, and plenum connections. Routine field cutting and field relocations of factory installed reinforcing is not acceptable. All stiffener rings shall be moulded into the duct wall.

Out-of-roundness of duct shall be limited to plus or minus 3 mm or plus or minus one per cent of duct inside diameter, whichever is greater for duct sizes 150 mm diameter and greater.

All unflanged ducts shall be square on the ends in relation to the duct axis within plus or minus 3 mm up to and including 600 mm diameter and rectangular duct up to 1830 mm perimeter; and plus or minus 5 mm for all diameters greater than 600 mm.

The tolerance on angles of all fittings shall be plus or minus one degree, up to and including 600 mm diameter and plus or minus 1/2 degree for 750 mm diameter and above.

Flange faces shall be perpendicular to the axis of the duct within 1/2 degree. Flange faces shall be flat to within plus or minus 0.8 mm, up to and including 450 mm diameter and flat within plus or minus 1.6 mm for 500 mm diameter and larger.

All connections to expansion joints, butterfly dampers, fire dampers, tanks, or other equipment shall be flanged. Gaskets shall be chlorobutyl. Flanges shall be hand laid up to thickness specified in PS 15-69 except that minimum thickness shall be 20 mm. Each flange face shall be ground flat, and a new 2.5 mm corrosion barrier shall be applied. The flange shall be anchored to a waxed table to ensure the flatness tolerance outlined above. The face shall be textured for use with full face chlorobutyl gaskets, 3.0 mm minimum thickness. Flange drilling shall be as per PS 15-69. All bolt holes shall be back spot faced for a washer seat. All flange bolts shall be torqued to values as recommended by manufacturer.

M18.3.3 Ductwork Ancillaries

Flexible connectors shall be installed at inlet and outlet of each fan and in the duct runs where required for expansion, contraction and movement. Expansion or contraction flexible connections shall be designed to allow 25 mm movement. Working lengths or "live" length shall be as designed by the manufacturer to allow up to 25 mm of movement. Ends shall be flanged, with flanges matching duct connection flanges. Corners on rectangular expansion joints shall be moulded and free of patches or splices.
The flexible connections shall be suitable for outdoor service and temperature ranges from 10°C to 100°C and pressure to 35 kN/m². Specially fabricated split grade 316 stainless steel retaining back-up bars shall be supplied to prevent damage to the flanges when grade 316 stainless steel bolts are tightened.

The thickness of transition pieces shall be designed using a safety factor of 10 for pressure and 5 for vacuum service with the pressure classification listed herein.

Custom flanges shall be designed as required to connect to fans, dampers and ductwork. Flange sizes shall match approved equipment dimensions.

Bolted access doors of adequate size shall be installed wherever access may be required for service, maintenance and adjustment. Access doors shall be of the same material as the duct. Doors shall be equipped with gaskets and bolted. Access door fasteners and hardware shall be grade 316 stainless steel. FRP inspection ports shall also be provided as required.

Access doors and inspection ports shall be provided at the following locations (minimum requirement):

(a) Plenums - Access port.
(b) Duct mounted dampers - Inspection port.
(c) In ductwork greater than DN 600 or of equivalent cross section at nominal 12m intervals - Inspection port required for visual inspection by person looking in with a torch and/or a video inspection. As such the required size would be a minimum 300mm opening.
(d) Turning vanes - Inspection port.
(e) Spares - 2 additional inspection ports and 1 additional access manway for each odour treatment unit installed at wastewater treatment plants. (All costs shall be deemed included as part of the Ductwork Costs).
(f) For ducts less than 300mm diameter blind ends, and swept Tee “rodding points” shall be fitted every 25m or closer for complex duct geometry such that access is still maintained for remote cameras or cleaning hoses.

M18.3.4 Ductwork Installation

M18.3.4.1 General

Where the duct is supported by another structure, all necessary allowances and provisions shall be made in the installation of the ducts for the structural conditions of the supporting structure. Ducts shall be transformed or divided as may be required. Wherever ducts are divided, the cross-sectional area shall be maintained. All such changes shall be approved and installed as directed by Sydney Water.

During installation, the open ends of ducts shall be closed to prevent debris and dirt from entering. Work shall be installed in accordance with the overall approved progress schedule and in co-operation with all other trades so there will be no delay to other trades.

All ductwork, fans, outlets and other parts of the ductwork systems shall be maintained in a clean condition during installation.

Complete ductwork systems shall be cleaned prior to testing and air balancing. Cheese cloth shall be secured over all openings of the ductwork system for entrapment of dirt during the cleaning operation.

Changes in direction and offsets shall be made in a gradual manner to facilitate streamlined flow of air. All elbows shall have a centreline radius of not less than 1½ times the width of the duct in the plane of the elbow. For rectangular ductwork with greater than 450 long side where full radius elbows cannot be installed or abrupt elbows are shown, provide abrupt elbows equipped with shop-installed hollow, fibreglass or grade 316 stainless steel airfoil turning vanes. An access door shall be installed at each abrupt elbow, so located for easy access to turning vanes.
Whenever a fire-rated wall or floor is penetrated the space around the duct shall be fitted with an approved type of fireproof material.

At fire-rated walls, grade 316 stainless steel sheet metal escutcheon plates shall be installed on both faces of the wall in order to close the gap between the structure and the sides of the insulated or bare duct.

Ducts shall be sloped to shed water. All FRP ducts shall have a camber and there shall be no stagnation of water when the covers are in place.

Where ducts connect to or terminate at masonry openings or along the edges of floors where concrete curbs are not being provided, there shall be placed around the ductwork a continuous 63 mm wide by 63 mm by 4.7 mm angle of the same material as the duct which shall be bolted to the construction and made air tight to same by applying caulking compound on the angle before it is drawn down tight to construction.

Plenums connected to concrete curbs shall be fastened with 75mm by 75mm by 6mm thick continuous angle of the same material as the duct. This angle shall sit on a continuous bead of caulking compound and be anchored to the curb at 400 mm centres. The duct shall terminate at the curb and be fastened to the angle. A continuous bead of caulking compound shall seal the plenum to the curb.

Installation of all ductwork shall be neat and provide access to duct work components, which require inspection, entry, maintenance and repairs. Where possible duct runs are to be adjacent and parallel to each other and to building and plant elements. All ductwork shall be designed to prevent accumulation of materials and ensure all sections can be easily cleaned. Installed ductwork shall not prevent access to other equipment in the plant.

**M18.3.4.2 Ductwork Supports and Hangers**

Suitable supports shall be provided for all duct work to ensure that the duct work does not sag or bend. All hanger materials shall be grade 316 stainless steel. Spacing of hangers on horizontal ducts shall be in accordance with table below.

<table>
<thead>
<tr>
<th>Duct Size A (m²)</th>
<th>Spacing (mm)</th>
<th>Min. Wall Thickness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.008</td>
<td>2800</td>
<td>3</td>
</tr>
<tr>
<td>0.018</td>
<td>3000</td>
<td>3</td>
</tr>
<tr>
<td>0.030</td>
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<tr>
<td>0.070</td>
<td>3400</td>
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</tr>
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<td>0.125</td>
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</tr>
<tr>
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<td>3</td>
</tr>
<tr>
<td>0.196</td>
<td>3700</td>
<td>3</td>
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<tr>
<td>0.442</td>
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<td>0.636</td>
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<tr>
<td>0.785</td>
<td>5500</td>
<td>6</td>
</tr>
<tr>
<td>1.130</td>
<td>6000</td>
<td>6</td>
</tr>
</tbody>
</table>
Perforated band iron or wire for supporting ducts shall not be permitted. Ducts shall not be supported from non-structural building elements, any equipment items, furring, hung ceilings or from another duct or pipe. C-clamp type hangers shall be supplied with a retainer strap.

Ductwork shall be properly anchored and supported from the building or the purpose made structure as required and/or as deemed necessary. Support anchoring for horizontal ducts shall be 3m c/c maximum spacing. Each anchor shall consist of two semi-circular stainless steel bands around the duct bolted together vertically and horizontally. The structural supports or wall attachment shall be grade 316 stainless steel. All fittings, expansion joints and similar items shall be supported within 450 mm of the joint or as deemed necessary.

Concrete pedestals, grade 316 stainless steel hangers, angles and straps shall be furnished to support the ducts installed for the corrosive gases extraction systems. Anchors, inserts or clamps shall be used to secure hangers to walkway roofs, underpass or overpass structures and shall be of grade 316 stainless steel. The support system shall be designed to accommodate dead weight and dynamic analysis, including system thermal effects, pressure thrusts. All supports shall adequately secure the duct against excessive dislocation due to thermal expansion and construction.

M18.3.5 Vibration of Ductwork

Where vibration occurs in the ductwork while the system is in operation, such additional members as are necessary to overcome this vibration shall be installed. All ductwork, where vibration occurs shall be neatly and securely isolated at points of contact with the building.

The ductwork at a manually operated damper shall be reinforced to properly support the damper and prevent vibration.

M18.3.6 Maximum Duct Air Velocities

Duct velocities shall be limited to the following values:

- **Main Duct** 10 m/s
- **Branch Ducts** 8 m/s
- **Exhaust Grills** 6 m/s

*NOTE: In order to comply with the EPA environmental noise requirements, the exhaust vent shafts and duct velocities should typically be not higher than 8 m/s.

M18.4 Dampers

Dampers shall be supplied as necessary to fully balance the air flow rates from all parts of the system and to allow automatic isolation of non-working parts of the system.

Dampers shall be free of rattles, fluttering or slack movement, and capable of adjustment over the necessary range without excessive self-generated noise or the need for special tools. The dampers shall be of heavy duty construction designed to withstand 2 to 3 times the designed air flow and static pressure. Suitable access is to be provided to all dampers. The dampers shall meet the following requirements:

- Internal / external seams and body / flange joints are to be fully welded.
- Pressure tested for leaks prior to installation.
- Faulty welds (pinholes), runny (fast), or bhop (slow) or cold lap welds/joints are to be ground out and re-welded.
- Installed damper/s with faulty welds must be removed and repaired on floor. Repaired damper/s must be retested before installation.
- All welds and surrounding metal affected by welding process must be cleaned and passivated.
- Application of sealant to incomplete welds or faulty welds is not an acceptable practice.
M18.4.1 Volume Control Dampers
Dampers shall be manufactured in grade 316 stainless steel, of rugged construction and shall be free of rattles, fluttering or slack movement, and capable of adjustment over the necessary range without excessive self-generated noise or the need for special tools.

Blades shall be without sharp edges and sufficiently rigid to eliminate movement when locked. Blades minimum thickness shall be 1.6 mm.

Damper bearings shall be oil impregnated sintered bronze ball bearings or engineering plastic sleeve bearings. Where the operating temperature is expected to exceed 50°C, nylon shall not be used. Access for lubrication of bearings shall be provided.

Spindles shall be grade 316 stainless steel, securely fixed to damper blades with minimum diameter as follows:

- Blade diameter ≤ 600 mm: 10 mm
- Blade diameter > 600 mm: 12 mm

The damper shall be capable of being adjusted and locked in the following blade positions: "Open", "10° to open", "20° to open", "30° to open" and "Closed". The positions shall be clearly and permanently labelled.

M18.4.2 Non-Return Dampers
All non-return dampers assemblies shall be counterweighted so that they:

(a) Offer minimum resistance to air flow, and
(b) Close by gravity.

Where available, non-return dampers shall be manufactured and supplied by the original fan manufacturer.

M18.5 Access Panels
M18.5.1 General
Unless otherwise specified, access panels shall have the following minimum clear opening:

- Personnel access: 450 x 600 mm
- Hand access: 200 x 300 mm

The panels shall be double thick, deep formed, constructed and insulated to match the duct. Cold bridging shall be minimised. Panel frames shall be rigid, securely attached to the duct, with no part of the panel or frame protruding into the airstream.

The seals shall be silicone rubber mechanically fixed to either the panel or the frame to ensure an airtight seal when latched in the closed position. For fire rated seals, use woven ceramic fibre material. Latches shall be Wedge type sash latches and there shall be a minimum of two.

M18.5.2 Access for Cleaning
Any areas of duct work in which accumulation of materials of any kind is possible shall be provided with suitably located local access for cleaning and/or drainage. Duct work shall be designed so that any liquid which comes into the ducts can be easily and automatically drained so that there are no build-ups of liquid within the duct work. Access shall be provided to the duct work for cleaning through sealed access doors.

M18.6 Air Balancing
M18.6.1 General
Air handling systems or parts thereof shall be air balanced to give flow rates within ±10% of designated air quantities, subject to the following:
(a) Air shall be distributed to minimise duct velocities; and
(b) Air resistance at fans shall be minimised, and the fans shall be adjusted to run at lowest fan speeds and power consumption.

Balancing points shall be provided in ducts in sufficient number to facilitate the proper testing and commissioning of the air collection system, but in any case, at least one for each branch duct and each main duct. All balancing points shall be located in readily accessible positions in straight duct, at least seven "hydraulic diameters" downstream from any bend or air control device.

Where the required distance (seven “hydraulic diameters”) cannot be achieved, the design shall allow for straightening vanes or diffusing grid to achieve stable flow conditions at the balancing point. All balancing points shall be easily accessible for measurement.

M18.6.2 Procedure

Air balancing shall commence after air handling systems installation is complete. The air handling units shall be cleaned before balancing.

Where there are inter-related air handling systems, all systems shall be operated concurrently.

Final position of dampers shall be marked upon completion of balancing.

M18.6.3 Reports

The following shall be included on the air balance data sheets:

(a) Static pressure differentials.
(b) Air quantities through each sub-system or branch ducting after balancing, and
(c) Fan capacity and fan speed.

The final operating point shall be shown on the fan characteristic curve.

M18.7 Vibration

M18.7.1 General

All rotating equipment including fans and motors, shall be statically and dynamically balanced and installed on bases designed to accommodate vibration isolators.

M18.7.2 Equipment Requiring Vibration Isolation Mountings

Except for external equipment which is not connected to the structure of any building, all rotating or reciprocating equipment shall be supported on mountings as follows:

(a) For static deflections ≤ 15 mm: Single or double deflection neoprene in-shear mountings incorporating steel top and base plates and a tapped hole for bolting to equipment.
(b) For static deflections > 15 mm: Spring mountings.

M18.7.3 Selection of Vibration Isolation Mountings

Mountings shall be selected to achieve 95% isolation efficiency at the normal operating speeds of the equipment.

M18.7.4 Spring Mountings

Free-standing laterally stable springs with at least 12 mm clearance between springs and other members, such as bolts and housing, shall be used. The following shall be provided:

(a) Ratio of mean coil diameter to compressed length at the designated minimum static deflection: > 0.8:1.
(b) Minimum travel to solid of at least 150% of the designated minimum static deflection.
(c) Levelling bolts and lock nuts.

(d) 5 mm neoprene acoustic isolation pads between base plate and support.

(e) Vertical resilient limit stops to prevent spring extension when unloaded, serve as blocking during installation, and which remain out of contact during normal operation.

(f) Springs snubbing to prevent bounce at start-up.

Alternatively, spring mountings as recommended by the original equipment manufacturers will be acceptable.

**M18.7.5  Installation**

Vibration isolation mounting supports shall be set and adjusted to give adequate clearance for free movement of the supports.

**M18.8 Ventilation Air Inlet Louvres**

Weather proof and bird proof ventilation air inlet louvres and air exhaust louvres shall be installed in any rooms with ventilation fans installed.

**M18.9 Specific Ventilation Requirements for Water Pumping Stations**

Water pumping stations shall be provided with mechanical ventilation system comprising of electrically operated fans, starters, cabling, ducting, louvers etc. Minimum two equally sized single speed fans with isolators nearby shall be provided to operate in a duty + duty assist arrangement. They shall be designed to meet the maximum required duty in parallel operation. It is expected, however, that most of time only the duty fan will be required to run with the duty assist coming on line on hot and high demand days. This will provide partial redundancy if one fan fails.

The incoming cooler air shall be drawn into the building through low level intake louvres positioned approx. 300mm - 500mm above ground on one side of the building, and travel across the room and over the pump motors and electrical and control equipment before being extracted at or close to ceiling level by the exhaust air system located on the opposite side of the building. The fans shall withdraw hot air via exhaust ductwork and force it out of the building through outlet louvres. The fans are to be located inside the building at low level to facilitate their maintenance.

The ventilation louvres positioned in the building walls shall be vandal, vermin, bird and ember proof and acoustically rated. They shall incorporate a vermin proof grade 316 stainless steel mesh with max. 6.5mm aperture. The louvres shall be of a heavy duty, industrial grade made of minimum 1.5mm thick grade 316 stainless steel plate. The maximum velocity of air flow through the inlet and exhaust louvres shall comply with industry practice. The velocity shall not be excessive to cause undue noise or/and suck dust or rain into the building. All external fixings shall be vandal proof.

Each fan shall be provided with a thermostat to control its starting and stopping. Both thermostats are to be located inside the building at a location where the temperature is anticipated to be the highest.

The ventilation fans shall operate under the following conditions:

- One fan shall start when the temperature inside the building reaches 35°C.
- The fan shall stop if the inside temperature drops to 30°C.
- If the inside temperature reaches 40°C the second fan shall start and operate in parallel with the first fan.
- The second fan shall stop when the temperature drops to 35°C.
- Both fans shall stop in case of fire inside the pumping station.

The above temperature settings shall be easily adjustable.

Where specified, the control equipment shall permit auto sequencing to alternate duty fans so that a new fan will be called into operation in the new duty cycle.
Duty and control of the vent fans shall be via local hardwire. IICATS shall only monitor failure of the ventilation fans by reference to the differential pressure across each fan. If the fan fails to start, an alarm shall be sent to Sydney Water’s Systems Operations Centre (SOC).

The ventilation fans shall be capable of operating in both an automatic mode as well as a manual on/off mode.

Sizing of the ventilation system shall be based on the maximum heat load (both latent and sensible) calculations. The calculations shall consider all heat loads from the motors, electrical and control equipment, lighting, people and sun, as well as all heat losses through the pumping station pipework, concrete slab and walls out of sun. The solar heat shall be calculated for the hottest day of the year at the proposed site.

In order to minimise the heat load from variable speed drives, if installed in the building their exhausts shall be ducted out through the building wall to discharge hot air to the atmosphere. For that purpose, their internal fans may need to be upsized to cope with the increased pressure loss. Each variable speed drive should have its individual exhaust duct and outlet louvre, which shall be protected from driving rain by suitably sized steel awning.

Solar heat load shall be reduced by appropriate building design. The roof of the pumping station building shall be thermally insulated and fitted with a flat ceiling level with the top of the building walls. The roof shall have 1.2m wide eaves around the whole perimeter. The eaves shall have adequate inlet vents to provide sufficient ventilation of the roof cavity. The ridge shall be fitted with a ridge vent with a total throat area equal to the area of the eave vents. Alternatively, adequate bird and vermin proof vents may be provided in the roof gables.

M18.10  Ventilation of Small and Booster Water Pumping Stations

Ventilation requirements for small and booster water pumping stations shall be similar to those for larger water pumping stations, except that two fans are generally considered sufficient. The fans shall be installed directly onto the walls of the pumping stations at high level and no ductwork and dampers are required.

M18.11  Ventilation of Sewage Pumping Station Dry Wells

Sewage pumping stations dry well ventilation shall comply with Sydney Water’s SPS Dry Well Ventilation Design Specification.
M19. Odour and Septicity Control for Sewage Pumping Stations and Sewer Network

M19.1 Odour Control

Sewage pumping stations wet wells, emergency storage tanks, inlet maintenance holes and sewerage networks shall be provided with natural ventilation system in accordance with Sydney Water’s Editions of Water Services Association of Australia Codes WSA 04 and WSA 02. Where required, mechanical ventilation and odour control facilities shall also be provided. Odour control facilities shall comply with Sydney Water’s Technical Standard ACP0004 Odour Control Unit Standard Specification and latest IICATS standards for odour control unit (OCU).

M19.2 Septicity Control

Septicity control for sewage pumping stations and sewer network shall comply with Sydney Water Technical Standard ACP0002 Chemical Dosing Unit Standard Specification.
M20. Gearboxes

Valve and penstock gearboxes shall comply with relevant valve gearboxes sections of this Specification.

Gears and gearboxes shall comply with AS2938 and American Gear Manufacturers Association (AGMA) Standards.

Each gearbox shall be designed to operate continuously at maximum duty with a minimum service factor in accordance with AGMA Standards based on maximum operating torque. In addition, each gearbox shall be designed to withstand starting torques of up to 250% of the full load running torque of the driving motor.

Gear housings shall be in two-piece constructions with a top cover for ease of inspection and maintenance.

The direction of rotation of input and output shaft shall be permanently marked on the housing. Removable gasketed inspection covers shall be provided to permit inspection of the gears without disassembly of the gear reducer. Lifting lugs shall be provided to facilitate safe lifting of the gearbox.

The gears shall be splash lubricated from a sump. The bearings shall be either splash lubricated or grease lubricated. Where grease lubricated bearings are fitted, seals shall be installed to retain the grease in the housing. Grease nipples and grease relief devices shall be fitted to housings containing grease-lubricated bearings.

The unit shall be provided with sight glass or indicator to observe oil levels. All oil fill and drain lines shall be of sufficient size to permit efficient functioning and shall be located on the gear unit in a position, which is easily accessible from the floor. The Contractor shall supply all oil and drain piping so that a container may be placed under the drain discharge.

The gearboxes shall have the following markings, unless specified otherwise in the relevant standards:

- Manufacturer's name
- Model and series number
- Year of manufacture
- Gear ratio
- Maximum allowable gearbox input torque

The information shall be shown on an engraved stainless steel nameplate. This nameplate shall be permanently attached with a suitable adhesive. The plate shall be in a location that shall be clearly visible after installation.

The lettering shall be as large as practicable but not less than 6mm nor larger than 25mm high.
M21. Drives and Couplings

M21.1 Couplings

The pumps and equipment (except submersible mixers and pumps) shall be fitted with flexible couplings (or vee-belt or wedge or toothed belt drives). Flexible couplings shall be of the cone-ring or flexible element type, rated to suit the torque output under all loading conditions.

Care shall be taken in checking alignment of driving and driven shafts. The motor and driven equipment shall be in alignment from all aspects.

Pulleys and couplings shall be balanced before the keyway is cut to eliminate vibration caused by lack of balancing. Then the whole assemblies complete with key shall be finely balanced after assembly.

M21.2 Vee Belts, Wedge Belts and Toothed Belts Drives

Vee-belt wedge-belt drives shall comply with AS2784 (Endless Wedge belt and V belt drives). All drives shall be designed with a minimum service factor of 2 based on motor rated power. Belts shall be standard commercial items readily available locally and normally kept in stock. Pulleys and sprockets shall be keyed onto the shafts using a taper type locking bush.

The belt manufacturer's recommendations for installation and alignment shall be strictly adhered to when fitting belt drives.

M21.3 Chain Drives

Chains shall be standard roller chains comprising steel links, hardened steel pins and rollers. Chains shall comply with AS1532 "Short pitch transmission precision roller chains and chain wheels" and shall have a minimum pitch of 19 mm.

Sprockets shall be of steel with flame hardened teeth, with hardness not less than 360 Brinell.

Access covers for inspection and lubrication of the chains and sprockets shall be provided in an easily accessible location.
M22. Penstocks

M22.1 General

This Specification, in conjunction with the codes listed hereunder, sets out the requirements for the manufacture, testing, supply and installation of cast iron and fabricated stainless steel wall and channel mounted penstocks for waterworks purposes.

Cast iron penstocks shall be designed, fabricated, tested and installed in accordance with the requirements of ANSI/AWWA C560.

Fabricated stainless steel penstocks shall be designed, fabricated, tested and installed in accordance with the requirements of ANSI/AWWA C561.

Where the requirements of this Specification conflict with ANSI/AWWA C560 or ANSI/AWWA C561, this Specification shall prevail.

All penstock components made from cast iron or steel shall be coated in accordance with WSA 201 and Sydney Water’s Supplement to WSA 201. No coating of stainless steel penstocks and components made from aluminium and copper based alloys is required.

Unless specified otherwise, all penstocks shall be of a rising spindle configuration and designed for both seating and unseating heads, i.e. bi-directional.

All penstocks, including hand wheel at the gear box where fitted, shall close in anti-clockwise direction.

Penstocks shall be designed to resist all stresses which may occur during installation and operation, including overflow and 1% AEP events.

The minimum thickness of penstock gates and frames shall be 6mm. All welding of fabricated stainless steel components shall be continuous and comply with AS1554.6. No welding of cast iron parts is allowed.

All manually operated penstocks shall open and close with a maximum force of no more than 160N applied on the operating element. The “cracking” torques and forces required to be applied for approximately ½ to 1 turn to off-seat or on-seat the penstock under maximum differential head conditions shall not be higher than as stated by the Contractor and agreed to by Sydney Water.

For penstocks operated by removable key, their spindles shall be provided with removable caps. The spindle cap and key shall meet the requirements of AS2638.1.

M22.2 Materials of Construction

Penstocks shall be constructed from the materials detailed below. The stated material grades represent the basic or minimum requirements, and materials of equivalent or superior quality may be acceptable subject to Sydney Water’s acceptance.

Non-metallic materials used in the components of the penstocks shall be fit for the intended purpose and shall exhibit dimensional stability when exposed to weather, sunlight and where relevant after extended periods of immersion.

Copper alloy components subject to immersion shall be dezincification resistant complying with AS2345.

Seals shall be manufactured from an elastomeric material that is not adversely affected by the fluid, temperature or environmental conditions to which they may be subjected to in service. Seals shall comply with AS1646.

Where in contact with potable water, all materials, lubricants and painting shall comply with AS4020.

M22.2.1 Cast Iron Penstocks

<table>
<thead>
<tr>
<th>Frame:</th>
<th>Cast or ductile iron</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gate:</td>
<td>Cast or ductile iron</td>
</tr>
</tbody>
</table>
Yoke: Cast or ductile iron, steel or grade 316 or 316L stainless steel

Spindle pedestal: Cast or ductile iron or grade 316 stainless steel

Bolts and nuts: Grade 316 stainless steel

Seating (wear) faces: Bronze or grade 316 stainless steel

Guides: Cast or ductile iron

Spindle lift (thrust) nut: Gunmetal, aluminium bronze or manganese bronze

Gate top and side seals: Neoprene, polyurethane, EPDM or plasticised PVC

Gate bottom seal: Neoprene, polyurethane, EPDM or plasticised PVC

Gear housing: Cast or ductile iron

Gears and gearboxes: Refer to gate valve gearboxes clause of this Specification

Handwheel: Cast or ductile iron

Spindle, spindle couplings and spindle brackets: Grade 316 or 431 stainless steel

Spindle protection tube: Clear polycarbonate or grade 316 stainless steel

Spindle bracket bushes: Gunmetal, aluminium bronze or manganese bronze

**M22.2.2 Fabricated Stainless Steel Penstocks**

In general, the materials listed below shall be suitable for water and sewage applications.

Frame: Grade 316 or 316L stainless steel

Gate: Grade 316 or 316L stainless steel

Spindle pedestal: Grade 316 or 316L stainless steel

Yoke: Grade 316 or 316L stainless steel

Bolts and nuts: Grade 316 stainless steel

Seating (wear) faces: UV-stabilised UHMWPE (Ultra High Molecular Weight Polyethylene)

Guides: Grade 316 or 316L stainless steel

Spindle lift (thrust) nut: Gunmetal, aluminium bronze or manganese bronze

Gate top and side seals: Neoprene, polyurethane, EPDM or plasticised PVC

Gate bottom seal: Neoprene, polyurethane, EPDM or plasticised PVC

Gear housing: Cast or ductile iron

Gears and gearboxes: Refer to gate valve gearboxes clause of this Specification

Handwheel: Cast or ductile iron or grade 316 stainless steel

Limit nut: Gunmetal, aluminium bronze or manganese bronze

Spindle, spindle couplings and spindle brackets: Grade 316 or 431 stainless steel

Spindle protection tube: Clear polycarbonate or grade 316 stainless steel

Spindle bracket bushes: UV-stabilised UHMWPE, gunmetal, aluminium bronze or manganese bronze

Grade 316L stainless steel shall be used in lieu of grade 316 wherever thickness of components exceeds 6mm.
M22.3 Gate
Penstock gates shall be designed to withstand all stresses resulting from the specified operating conditions with a safety factor as specified in the relevant standard. The gates shall be of a flush-bottom closure type, unless specified otherwise, and shall clear the flow in the fully open position.

Penstocks shall be designed so that the gate can be completely removed from the frame. For that reason, the penstock gate shall be provided with a means of lifting it out of the frame for maintenance purposes or under emergency conditions. Means shall be provided for emergency lifting of the gate by a crane from surface connections. The lifting attachments shall be easily accessible for capture by lifting hooks. Where eyebolts are provided, they shall comply with AS2317.

M22.4 Frame
Penstock frames shall be designed to withstand all stresses resulting from the specified operating conditions with a safety factor as specified in the relevant standard. The frame shall incorporate a guide rail to facilitate sliding of the gate over the length of its operating travel. Guide rail length shall extend to engage at least two-thirds of the gate height in the fully open position. The guide rail shall be designed for self-cleaning with minimal clogging.

The frame shall be either the wall or channel mounted, as specified. Wall mounted frames shall be sealed against the wall using compressed elastomeric seals appropriate to the working environment. Grout shall only be used against unlined concrete wall surfaces. Channel mounted penstock frames shall not be embedded in concrete. Channel benching shall be shaped to allow penstock installation and future removal.

Frame shall be fixed to concrete structure with grade 316 stainless steel masonry anchors. Mounting bolt size/pattern shall be designed to cater for any thrust that may be exerted on the frame from force applied when the actuator reaches stall torque. When the gate is off-seating the loads on the mount bolts must not exceed the manufactures specified pull-out load and tensile strength when a force of design head hydrostatic pressure is applied. The frame shall not be subjected to undue forces during it installation which may cause its deformation or permanent damage.

M22.5 Sealing and Seating Faces
Penstock seals shall be fixed on the gate so that they can be easily removed with the gate for maintenance. Side and top seals shall remain engaged under either on-seating or off-seating heads.

The bottom seat shall be designed so as to eliminate grit traps.

Penstock guides shall be fitted with replaceable low friction and wear-resistant wear strips.

M22.6 Spindle
Penstock spindles shall be designed to withstand all stresses resulting from the specified operating conditions with a safety factor as specified in the relevant standard.

Penstock spindles shall be made of a solid stainless steel bar or a stainless steel pipe with adequate strength to withstand all perceivable loads. They shall utilise an ACME type single start thread machined to smooth finish on the bearing surface. Alternatively, a metric trapezoidal screw thread may be used instead.

Spindle brackets shall be provided where recommended by the manufacturer. The brackets shall be adjustable and spaced in accordance with the manufacturer’s recommendations. The bushings shall incorporate grease lubrication points except where they are of the self-lubricating type.

Hand wheels (where fitted) shall be installed between 900 and 1200 mm above the standing surface.

Penstocks with rising spindles shall be fitted with stainless steel or transparent polycarbonate protection tube. A position indicator shall be provided where non-transparent protection tube is used.
Limit nuts or collars shall be provided on rising spindles and set such that excessive force applied by the operator will not buckle the spindle.

Spindle couplings, where required, shall be provided where overall spindle lengths exceed 6m or where necessary to couple to actuators. Couplings shall be designed to transmit the loads from one section of the spindle to the other.

The penstock spindle shall be fitted with a keyed locking mechanism to prevent its unintentional operation when either in closed or open position.

**M22.7 Yoke**

Self-contained penstocks shall be provided with a yoke. Yoke shall be designed to withstand the thrust of the actuator for maximum static head conditions.

The actuator mounting and guide contact surfaces shall be accurately formed to ensure proper spindle alignment.

The yoke shall be designed to allow removal of the gate from the frame.

**M22.8 Pedestal**

Pedestals and their mounting brackets shall be of sufficient cross-section to withstand all thrusts resulting from the specified operating conditions. Mounting brackets shall be fixed to the yoke or concrete structure. Fixing to metal flooring is not permitted.

**M22.9 Actuators**

Electric actuators requirements shall be as per Technical Specification - Electrical.

Pneumatic actuators shall comply with the Pneumatic Valve Actuators clause of this Specification.

All actuators shall be push button operated and have a manual override.

Actuators shall be installed on pedestals and, where specified, within vandal and weather proof enclosures.

For a manually-operated penstock, the gearbox input shaft shall terminate horizontally in a keyed shaft. The shaft shall extend sufficiently to allow for operation by a portable actuator. A hand wheel suitable for mounting on the shaft shall be supplied loose.

Penstocks installed on sewage pumping stations inlet lines shall be fitted with electric actuators.

**M22.10 Installation**

All penstocks shall be installed strictly in accordance with manufacturers’ installation instructions.

**M22.11 Inspection and Testing**

Shop and field inspection and testing of penstocks shall be in accordance with the relevant ANSI/AWWA standards. Functional tests shall include penstock operation from fully open to fully closed position and vice versa over a minimum of five cycles. Unless specified otherwise, testing shall also include leakage test. The maximum allowable leakage rates for shop and field tests shall be as specified hereunder.

Test certificates shall be provided for each penstock for the tests conducted both at the manufacturer’s works and at site.

**M22.12 Maximum Leakage Rates**

The leakage rate for cast iron penstocks shall not exceed 1.2 litres per minute per metre length of the seal length for seating and 2.4 litres per minute per metre length of the seal perimeter length for unseating heads.

The leakage rate for seating or unseating design heads for fabricated stainless steel penstocks shall not exceed 0.2 litres per minute per metre length of the seal perimeter length.

Leakage tests shall be conducted with clean water at ambient temperature.
M22.13 Required Data
Prior to the commencement of fabrication, the manufacturer shall provide certified drawings and material specification of the equipment to be supplied for Sydney Water’s review and acceptance. The drawings shall show the principal dimensions, general construction and be sufficiently detailed to enable Sydney Water to determine if the proposed equipment meets this Specification.

M22.14 Marking
Each penstock shall have the following information provided on a nameplate permanently located where it can be readily viewed after installation:

a) Manufacturer’s name or mark

b) Model number

c) Serial number

d) Aperture dimensions (width x height)

e) A direction of flow arrow if penstock is unidirectional

f) Maximum input operating torque (Nm)

g) Year of manufacture

h) Maximum static head (m)
M23. Stop Boards

Stop boards shall be of a proven design and comply with all Occupational Health and Safety requirements. Stop boards shall be fabricated from 316 stainless steel or marine grade aluminium.

Design and materials used in the manufacture of the stop boards shall be suitable for a minimum 25 year service life.

The stop boards shall be fitted with a keyed locking mechanism to prevent their unintentional operation when either in closed or open position.

Stop board seals shall be neoprene or UHMW polyethylene. Sliding friction shall be taken into account when calculating lifting loads. No metal-to-metal sliding contact shall be permissible. Direct bolting of plastics or neoprene shall not be permitted.

Stop boards shall be bi-directional or clearly marked to indicate the water flow (pressure) side.

Stop boards shall have lifting handles and lifting lugs. The lifting lugs shall be rated to allow for removal under maximum differential pressure conditions.

Stop boards shall be designed to be safely lifted and fully removed or installed by one operator. Where stop boards cannot be safely manually handled by one operator, suitable lifting and handling device(s) shall be used.

Guide members for stop boards shall be designed to facilitate ease of installation and removal of the stop boards. Frame components shall provide seating or sealing faces for the stop boards as appropriate, on the sides top and bottom.

For all new works, the frames shall be embedded into the channel structure and shall be flush with the channel sides.

For new stop gates/boards to be retrofitted into existing works, subject to Sydney Water’s acceptance, some channel flow obstruction by side and bottom frames may be allowed.

All stainless steel welds shall be pickled and passivated. All parts in sliding contact shall be of dissimilar corrosion resistant materials.

For uni-directional stop boards, the edge of the bottom of the stop boards shall be chamfered to provide a narrow bearing area on the seal.

Storage racks shall be provided for stop boards when not in use in a position for easy access and out of normal access routes. The storage shall be designed to protect the boards’ seals from sunlight and physical damage.

Stop boards shall be designed to resist all stresses which may occur during installation and operation, including overflow and 1% AEP events.

The total maximum leakage rate for stop boards shall not exceed 0.5 litre per minute per metre length of the seal perimeter length. The seal length calculation shall not include the seals between the individual slide gate or stop board elements.

Leakage tests shall be conducted with clean water at ambient temperature.
M24. Weirs

Weirs shall be fabricated from stainless steel grade 316 plates and shall be a minimum of 6mm thick. The plates shall be supplied with slots for bolting the plates to the concrete wall or weir trough. Unless specified otherwise, the minimum range of adjustment that shall be provided is ± 50mm in the vertical direction. The distance between the slots shall be determined by the designer as required to support the weir plate, but not greater than 600mm.

The weir plates shall be supplied and installed complete with a suitable backing material to prevent any flow between the plate and the material to which they are fixed. The weirs shall be levelled to within ± 1mm.
M25.Screening Equipment

M25.1 General

This section covers the technical requirements for the supply of band screens, step screens and their appurtenances associated with the plant.

All screens supplied shall be of a standard and proven design.

M25.1.1 Covers

The screen shall be fully enclosed to prevent leakage and retain odour and aerosols within the channel system. Removable covers shall be provided for servicing and inspection. Covers shall be stainless steel grade 316. The covers shall be hinged, lightweight and easily removable for maintenance access. Suitably sized and spaced air intake nozzles shall be provided in the covers to allow an even collection of foul air from the sluice channels and screw conveyors.

M25.1.2 Inspection Cover

A hinged and lockable type access opening cover shall be provided for inspection and blockage clearance. As a safety measure limit switches shall be installed on all hinged access cover to prevent the screen operation in an automatic mode when the access covers are opened.

M25.1.3 Lifting Devices

The lifting devices supplied and installed shall have the capacity to lift the screen for maintenance. A monorail or gantry (preferred) crane shall be installed for below ground/covered area installations to suit for maintenance of the screen. Above ground/uncovered area installations shall use a permanent or mobile crane for maintenance. The monorail/gantry crane shall be designed to have a maximum load to swing the screen with a wet load wedged in the screen. Mobile cranes shall also be used for replacement or removal for major overhaul of the screens from below ground / covered areas. Access road and outrigger placement shall be considered where mobile cranes are used.

M25.1.4 Manual Bypass Bar Screen

The manual raking height shall not exceed 1m to avoid safety related manual handling issues.

M25.2 Band Screens

M25.2.1 General

The screens shall be either perforated plate (circular or hexagonal) or honeycomb type, self-cleaning and capable of capturing solids as per performance requirements. The effective area of the fine screen shall have a raw (no blinding) open area not less than 48% when installed.

Grid velocities (i.e. through the throat of the screen opening) shall be kept below 1.1m/s at the nominated blinding factor/s (minimum 60%) to avoid pinning through the opening.

The design of the screens and associated components such as bearings, instruments and drives shall consider the maximum possible sewage level in the channels. The screens shall be able to operate and shall be structurally designed to withstand the maximum possible differential hydrostatic head, and any possible impact from any solid object able to be passed at the maximum inlet velocity that may be present in the upstream approach channel.

Head loss profiles shall be included for both average and peak flows at the nominated blinding factor/s (minimum 60%).

Screenings shall be removed from the panel using spray wash headers incorporating nozzles that can be easily replaced or removed for cleaning.

The removed screenings shall be transferred via a sluice launder or screw conveyor to the screenings wash press units.
The drive mechanism and associated moving parts shall be mounted above the channel and shall be readily accessible for maintenance purposes. Only the mainframe and screen panels shall be submerged in sewage. Any moving parts below the water level subject to wear/frequent maintenance due to solids such as grit shall not be acceptable.

The screens shall be removable from the channels as a unit without disassembly or interruption to the flow. Lifting lugs are to be provided for this purpose. Screens shall be removable in a safe manner, without the need for personnel to enter the channels or enter any hazardous location.

The weight/mass of the equipment to be lifted shall be permanently marked. This may include a percentage for blinding.

The screenings system shall be fully automatic in operation and shall operate continuously unattended. Failure detection shall be provided for all items of equipment and automatic shutdown of the plant or individual items of equipment shall be provided for as specified.

**M25.2.2 Screen Control**

The screens shall have at least two of the following operating modes:

a) **Differential Control**: Based on head loss through the screen. There shall be at least three level settings, LOW, MID and HIGH. For the LOW setting, the screens for any channel in operation will remain idle (unless completing a cleaning cycle). When the Operating Differential Level rises above the Low Differential setpoint for a period, the screens will perform a cleaning cycle, running at low speed. When the Operating Differential Level is above the Mid Differential setpoint, but below the High Differential setpoint for a period the duty band screens operate simultaneously and continuously at medium speed. Similarly, when the Operating Differential Level is above the High Differential setpoint for a period the duty band screens operate simultaneously and continuously at high speed. The HIGH setting shall be approximately 200 mm below the bypass weir level. The three level settings shall be Operator Adjustable Parameters at the PMI.

b) **Level Control**: Based on a continuous upstream or downstream water level requirement. The duty band screens shall operate simultaneously and continuously at variable speed to maintain the required water level. Standby band screens shall be brought online as needed to maintain the required water level.

c) **Timer Control**: Based on the time of day and the parameters shall be Operator Adjustable at the PMI.

A VSD shall be supplied for the screen drive motor to enable the belt speed to be adjusted according to the head loss and/or water level.

**M25.2.3 Construction**

The screens assembly including the framework and enclosure and all other wetted components shall be fabricated from grade 316 stainless steel or other accepted corrosion resistant materials (e.g. Band screen panels may also be manufactured from HDPE, Polypropylene, UHMWPE, guide links/wear strips UHMWPE, Gaskets EPDM, etc.). Fixings shall be grade 316 stainless steel. Any items not of grade 316 stainless steel material must be identified in the tender documents.

The screen design shall be such that individual panels can be removed and replaced without having to dismantle the whole screen.

**M25.2.4 Drive Assembly**

Overload and/or damage protection to be provided through a shear pin or appropriate alternate protection. During commissioning the operation of the protection mechanism shall be checked and demonstrated.
M25.3 Step Screens

Whilst no longer recommended as a technology for plants with erratic inflows, this section covers the general technical requirements for supply and installation of step screens.

M25.3.1 General

The screens shall be bar filter type, self-cleaning and capable of capturing solids as per performance requirements. The effective area of the fine screen through the channel shall not be less than 45% of the channel width.

Screenings shall be removed from the face of the screen through the interaction of the relative motion between the bars and the shape of the bars and the slope of the screen face.

The screenings shall be lifted to a height to allow them to be discharged on to the succeeding equipment (screenings conveyer) then to the screenings washing/de-watering units.

The fine screen shall be of the Step type fine screen consisting of interlaced bar racks. The bar racks shall be mounted together so that every second bar is stationary and the adjacent bars are movable.

The drive mechanism and associated moving parts (excluding movable bars) shall be mounted above the channel and shall be readily accessible for maintenance purposes. Only the mainframe and screen bars shall be submerged in sewage.

The frame shall incorporate a pivoted mounting that allows raising of the bottom of the screen from the channel.

The screen shall have a grit flap and anti-blocking feature on the channel floor. The space between the bottom of the screen and channel invert shall not exceed 3 mm.

The screen shall include side frames with pivoting mechanism, stepracking, bar racks, discharge chute, drive unit, electrical control devices and enclosure.

The screenings system shall be fully automatic in operation and shall operate continuously unattended. Failure detection shall be provided for all items of equipment and automatic shutdown of the plant or individual items of equipment shall be provided for as specified.

The design of the screen and its appurtenances, such as bearings and electrical devices, shall take into account the maximum possible sewage level in the channel under the worst conditions.

M25.3.2 Screen Control

The screens shall have two Process Operating Modes:

a) Level Control: Based on a continuous upstream water level sensor. There shall be at least three level settings, LOW, MID and HIGH. For the two lower settings, the frequency of step initiation and the number of steps after each initiation shall be Operator Adjustable Parameters at the PMI. When the depth reaches the HIGH setting, the screen shall step continuously. The HIGH setting shall be approximately 200 mm below the bypass weir level. The three level settings shall be Operator Adjustable Parameters at the PMI.

b) Timer Control: Based on the time of day initiation of screen stepping. There shall be at least three separate settings of Operator Adjustable Parameters at the PMI, for the frequency of step initiation and the number of steps after each initiation.

For both Process Operating Modes, there shall be a lag timer, to delay stepping of the follow screen by an adjustable time, after the lead screen has parked.

There shall be a float switch, set approximately 50mm above the HIGH setting, to initiate continuous stepping, if continuous stepping has not already been initiated by either of the Process Operating Modes.

The screen shall have an easily adjusted park switch on the gearbox output shaft to allow accurate parking of the moving screen steps, in line with the fixed screen steps and to count the number of steps. The park switch
will be an inductive proximity switch type or limit switch type. Accurate parking position shall be demonstrated during commissioning.

The screen shall include an electronic shear pin to protect the screen from over torque.

M25.3.3 Construction

The entire screen assembly including the screen bars, framework and enclosure and all other wetted components shall be fabricated from grade 316 stainless steel. The width and thickness of the bars shall be such as to provide ample strength to fulfil the necessary duties. The clear spacing between bars shall be 3 to 6mm. This spacing shall be maintained by intermediate spacers which are made from a replaceable bearing material.

The Screen design shall be such that individual bar element can be removed and replaced without having to dismantle the whole screen.

The construction of the side frames and bar racks assembly shall permit the assembly to be readily removed. The fine screen frame shall be supported at the top of the channel and be able to rotate completely from the pivot and drop into the channel with no anchor bolts or attachments to the channel floor.

M25.3.4 Drive Assembly

The screen shall be driven through a reduction gearbox by an electric motor. Mechanical torque protection or a proven electronic method will be provided to protect the screen element and transmission components against overload and/or damage. During commissioning the electronic shear pin operation shall be checked and demonstrated.

M25.3.5 Safety Relief Flap Gate

A step screen discharge chute shall be provided with a safety relief flap gate. In the event of discharge chute blockage, the flap will open and prevent compacting the discharge chute and overloading the step screen. An interlock shall be provided to stop the step screen operation when the emergency flap gate opens.

M25.4 Screenings Wash Press

M25.4.1 General

The screenings wash press is part of the screenings handling facility. It shall be sized to effectively convey, wash and dewater the maximum volume of screenings expected for the range of flows without blockage or failure. A substantial increase in sluice water must be accommodated in the hydraulic design of the screening wash press when the use of band screens has been specified over step screens. An allowance for backup water is required in the event the main water supply becomes unavailable e.g. If the reclaimed effluent fails then supply backup with industrial or potable water.

The screenings wash press shall be an integral unit where screenings shall be washed, dewatered, and compacted.

The screenings wash press shall be a shafted screw type complete with troughs, covers, drive units, supports and anchor bolts.

The screw conveyor trough shall have a drainage pan with slots for draining of the washed organic liquid. It shall have replaceable brushes on the screw flights.

The screenings wash press shall be supplied complete with:

- a) Purpose designed wash zone,
- b) Dewatering compaction zone,
- c) Discharge press pipe,
- d) Drain connections for organic return,
- e) Inspection hatches,
f) Wash and flush solenoid valves.
g) Drive unit.

The screenings wash press shall consist of two zones:

a) In the first zone: the screenings are washed
b) In the second zone: the washed screenings are dewatered and compacted

The screw shall be designed so that clogging and build-up on the flights shall not occur.
The screw shall have provision for movement and support bearing at the drive end which shall be capable of taking the thrust load.
The shafted screw flights shall be sized to suit the maximum screenings discharge rates.
The trough shall have a minimum two drain holes with a drain pipe.
The screw wash press shall have a suitable piped drain to drain water to a drain system, which discharges upstream of the operating screen.

M25.4.2 Screenings Wash Press Control
The operation of the screenings wash press shall be designed and supplied to be interlocked with the operation of the surrounding equipment and to prevent unwanted spillage of conveyed material when equipment is not operating.

M25.4.3 Screenings Wash Press Feed Hopper
The feed hoppers shall be designed to receive and discharge material without blockage. The feed hoppers shall be integral parts of the screenings wash press and shall be manufactured from grade 316 stainless steel.

M25.4.4 Screenings Wash Press Supports
The screenings wash press shall be supported at each end and at intermediate location where applicable. All support steelwork shall be fabricated from grade 316 stainless steel.
External support steelwork shall be fabricated from structural steel and be hot dipped galvanised after fabrication.
Connections between grade 316 stainless steel and galvanised steelwork shall be bolted using insulation between dissimilar metals.
Welding between grade 316 stainless steel and carbonised steel is not permitted.

M25.4.5 Screenings Wash Press Drive
The screw conveyor drive shall be by an electric motor with a directly mounted speed reduction unit. The motor shall be mounted in an accessible location.
The drive unit shall be fitted with an electronic shear pin to prevent excessive loading or seizure.

M25.4.6 Material of Construction
The material construction of the screenings wash press shall conform to the following:

a) The external double trough shall be grade 316 stainless steel, with minimum 5mm thickness.
b) The internal double trough shall be grade 316 stainless steel, with minimum 3mm thickness.
c) The inspection & access lids shall be grade 316 stainless steel, with minimum 2mm thickness.
d) The spiral shall be high tensile micro-alloy steel.
e) The press pipe shall be grade 316 stainless steel.
f) The chute and feed hopper shall be grade 316 stainless steel, with minimum 2mm thickness.
g) The support legs and brackets shall be grade 316 stainless steel.

**M25.4.7 Washing and Flushing**

The washing and flushing RE pipework to the screenings wash press shall each include the following:

a) Isolation valve.
b) A strainer, which shall incorporate a flush out valve and which shall be readily dismantled for cleaning, without having to remove the strainer from the pipework.
c) Separate flow switches on the pipes to the washing & flushing zone. Each flow switch shall be a low flow switch, which shall initiate an alarm during a low flow or no flow condition in the RE supply to the respective zone.
d) Separate solenoid valves shall be installed in the lines to the washing & flushing. Each solenoid valve shall open & close under the control system for the screenings facility to direct the RE supply to the respective zone.

The washwater and flush water supply to the screenings wash press shall be failsafe.

The screw wash press and its solenoid valves shall operate intermittently under the control system for the screenings handling facility.

**M25.5 Screenings Washing/Dewatering Unit**

This section covers the general technical requirements for a screenings washing/dewatering unit to enhance the product from the screenings wash press.

**M25.5.1 General**

The screenings washing/dewatering unit shall be of a proven proprietary design preferably with operation in Sydney Water plants.

The screenings washing/dewatering unit shall be capable of further enhancing the washing and dewatering of the screenings wash press to achieve dryness in excess of 35% and residual organics of 5%-7%.

The screenings washing/dewatering unit shall be sized to effectively convey the maximum volume of washed dewatered screenings from the discharge of the screw wash press to the discharge point without blockage or failure.

The screenings washing/dewatering unit shall be design designed for use with the screenings wash press unit and shall be of the counter pressure screw (CPS) unit type.

The screenings washing/dewatering unit shall be supplied complete with:

- Drive Unit,
- Integrated fully shaft screw with cutter,
- Adjustable support,
- Discharge elbow connection.

**M25.5.2 Control**

The screenings washing/dewatering unit shall operate intermittently, under the control system for the screenings facility.

The operation of the screenings washing/dewatering shall be designed and supplied to be interlocked with the operation of surrounding equipment and to prevent unwanted spillage of conveyed material when equipment is not operating.
M25.5.3 Feed Connection to Screenings Washing/Dewatering Unit

The screenings washing/dewatering unit shall be connected to the screenings wash press with an appropriately designed elbow and pipe connection. The elbow and pipe connection shall be manufactured from grade 316 stainless steel.

M25.5.4 Supports for Screenings Washing/Dewatering Unit

All support steelwork shall be fabricated from grade 316 stainless steel.

Further external support steelwork, if required, shall be fabricated from structural steel and be hot dipped galvanised after fabrication.

Connections between grade 316 stainless steel and galvanised steelwork shall be bolted using insulation between dissimilar metals.

Welding between grade 316 stainless steel and carbonised steel is not permitted.

M25.5.5 Screenings Washing/Dewatering Unit Drive

The screenings washing/dewatering drive shall be by an electronic motor with a directly mounted speed reduction unit.

The drive unit shall be controlled by the electronic shear pin fitted on the screenings wash press to prevent excessive loading or seizure.

The operation of the screenings washing/dewatering unit shall not generate excessive noise and shall preferably have a noise level not exceeding 75 dB(A) at 1 metre free field.

M25.5.6 Material of Construction

The material of construction of the screenings washing/dewatering unit shall conform to the following:

i) The cylindrical trough frame shall be grade 316 stainless steel,

j) The shafted screw spiral shall be of high tensile micro-alloy steel,

k) The support shall be grade 316 stainless steel,

l) The discharge chute shall be grade 316 stainless steel.

M25.5.7 Washing and Rinsing

The screenings washing/dewatering unit shall preferably be designed to minimise the use of RE water for washing and flushing.
M26. Grit Removal System

M26.1 General

The grit removal system shall be capable of capturing grit as per performance requirements.

The grit removal system shall consist of a flat bottom circular concrete tank having tangential inlets and radial outlets, 360 degrees rotation, and a turn down ratio of 10:1. The vortex flow shall be maintained within a range of 1.1m/s at peak flow and 0.5m/s at minimum flow. Grit capture rates to be as follows:

a) >95% of 300u
b) >85% of 200u
c) >65% of 150u

The plants that have down stream processes, such as Thermal Hydrolysis (THP), which limits the amount of incoming grit, the capture rate for the grit system shall be >95% for 150um particles.

Removed accumulated grit shall be collected in the pit centrally located in the tank. A Grit pump shall remove the accumulated grit from the centrally located hopper.

The vortex type grit removal system shall include:

d) Inlet channel to produce the Coanda effect.
e) Rotating paddle mechanism to provide spiral sewage flow to keep organic matter in suspension and allow settling of the grit into the chamber.
f) Centrifugal pumps for the removal of settled grit from the arrester.
g) Classifier for further dewatering of grit.
h) All interconnecting pipework, solenoid valves and fittings.
i) All limit switches, mechanical overload devices, interlocks, etc. necessary for the correct functioning of the equipment.

The system shall:

j) Be a proprietary system with a proven performance record.
k) Consist of a circular concrete tank with tangential inlet and radial outlet.
l) Have vortex flow maintained by a rotating paddle with accumulated grit removed from the pit by means of a pump.

m) Handle the range of flows discharged from the inlet works.

n) Be designed to prevent blockage or damage by paper, rags, etc.
o) Avoid 90-degree bends and eliminate unnecessary elbows.
p) Use dedicated suction and discharge lines.

The discharge line from the grit removal pump shall deposit the flow into a screw type grit washer classifier which elevates the grit laden slurry, allowing water to drain back into the tank, and discharge the dewatered grit into a mobile storage bin.

M26.2 Operation

The paddle mechanism shall operate continuously, while the grit pumps and classifiers operate intermittently on a predetermined cycle. The cycle and period of operation shall be determined at the time of commissioning to optimise grit removal from the chamber.

The equipment shall be designed to handle the range of flows at a minimum loss of head and shall operate under widely varying flow conditions without requiring adjustments.
M26.3 Paddle Mechanism
The paddle mechanism shall comprise two or more rotating paddles attached to a central paddle drive which revolves around a drive tube. The paddle shall be self-cleaning whereby it removes fibrous material by the incorporation of a "swept back" design.

Paddles shall have adjustable pitches and be designed to create upward thrusts in the centre of the tanks to cause sewage to spiral on a horizontal axis as it revolves. The paddle velocity shall be appropriate to detain organics in suspension and settle grit at the base of the hopper.

The paddle drive tube shall be supported axially through a main ball bearing slewing ring or turn table bearing which shall be protected against submergence.

The bearing shall have a life in excess of 100,000 hours.

The paddle drive tube shall be rotated through a large gear head, grease packed and with a direct mounted high efficiency gear reduction unit.

The paddle drive unit shall be mounted in a substantial cast iron gearbox with a base plate for bridge mounting above the tank.

M26.4 Grit Removal Pump and Pipework
One centrifugal pump shall be installed for each grit tank. The pump may be mounted above the tank with vacuum priming or remote mounted flooded suction type. The suction pipe and grit discharge pipe shall be a minimum of 100mm diameter. The suction pipe shall be grade 304 stainless steel. Vertical, direct coupled type centrifugal pumps only shall be installed (i.e. no horizontal, belt driven types).

Grit pumps shall include:
(a) Ni hardened impeller and volute.
(b) Solid stainless steel shaft.
(c) Heavy duty bearings.
(d) Mechanical seal.
(e) Recessed impeller

Additionally, the top mounted vertical pump shall:
(a) Include a sensor to detect if pump is primed.
(b) Have suction piping less than 5m in length.

The grit pump shall discharge into the classifier.

Pipework carrying grit slurries shall satisfy the following criteria:
(a) Fluid velocities shall be in the range 1 to 2.5m/s.
(b) All bends shall be radius type, moulded elbows are not acceptable.
(c) Except for flushing connections, the use of tees shall be avoided. But where this is not possible they shall be “wye” type tees are permissible.
(d) Long vertical should be avoided.
(e) Tapping points on the underside of pipes is not permitted.

M26.5 Grit Pump/Water Sparge Assembly
A grit pump/water sparge assembly shall be furnished to facilitate grit removal. The assembly shall consist of water (reclaimed) sparge and grit pump. The water sparge shall agitate the grit and then be pumped by the grit pump to the grit washing classifier. The water sparge is fed from the reclaimed effluent main and shall be
activated by a solenoid valve. The grit pump shall have a recessed torque impeller specifically designed for grit handling. The system shall also have the facility to backflush the grit pump suction line with reclaimed effluent.

**M26.6 Grit Washer Classifier**

This section covers the general technical requirements for Grit Washer Classifier.

The grit washer classifier shall be of a proven proprietary design washing classifier capable of washing and dewatering the pumped grit from the grit tank to achieve dryness in excess of 90% and residual organics less than 5%.

The classifier shall be of the inclined Archimedean screw type or similar used for separation of grit from organics. The classifier shall be fabricated from stainless steel and shall comprise of an inclined screw housed within an inclined trough and inlet hopper. Mounted on the classifier shall be a tilting launder assembly.

The grit washer classifier shall be mounted on a free standing frame bolted to a concrete plinth. The grit washer classifier shall have a successful grit operating record in sewage plants.

Interconnecting pipework and valves shall be provided to enable grit laden slurry to discharge from the grit pump to the classifier and provide overflow and drainage from the classifier back into the inlet works.
M27.Rectangular Clarifier/Primary Sedimentation Tank Equipment

This section covers the general technical requirements for the mechanical equipment for rectangular clarifier or primary sedimentation tanks.

The rectangular clarifiers shall be provided with all baffle plates, longitudinal and cross sludge scrapers, scum scrapers, effluent launders, scum baffles, drive units, launder weirs etc. and manufactured of suitable materials for operation under submerged conditions in sewage.

Clarifier tanks shall be constructed conforming to the performance requirements of this Specification.

M27.1 Scraper - Chain & Flight Type

M27.1.1 Longitudinal Sludge Scrapers

The longitudinal sludge scrapers shall be non-metallic chain, sprockets and flight type, complete with chain, flights, attachment links, wear shoes, wall brackets, return rails, floor rails and wear strips.

The longitudinal sludge scrapers shall comprise a chain and flight assembly, which:

(a) Scrapes sludge to a sludge trough or sludge hopper in the tank floor.

(b) Skims scum to a trough at the end of the tank.

Alternatively, the scum skimmer and the sludge scraper shall be two separate units.

M27.1.2 Cross Sludge Scrapers

The cross sludge scrapers shall be non-metallic chain, sprockets and flight type complete with chain, flights, attachment links, wear shoes, floor rails and wear strips.

The cross sludge scraper mechanism shall comprise a chain and flight assembly, which scrapes sludge to the sludge hopper.

M27.1.3 Scraper/Collector Chain

The scraper chain shall be non-metallic having a six-inch pitch and specifically designed for sludge scraper usage. The chain shall have a minimum rated working load of not less than 14kN based on strength, fatigue and wear consideration. The chain shall have an ultimate breaking strength of 29kN minimum. In addition, the collector chain shall be designed to withstand a working load of up to 200% of the full load running torque of driving motor. Chain links shall be manufactured from thermoplastic polyester resin. The links shall be integrally moulded with the barrel and both side bars formed in one piece to ensure squareness and strength of the links. Maximum elongation of the chains at rated working load shall not exceed 0.1 per cent at its rated working load.

Connecting pins shall be non-metallic, moulded in one piece, from acetal resin. Pins shall have a moulded T-head, which shall seat and lock inside the moulded chain link to prevent pin rotation. The pin shall positively lock when chain is assembled.

M27.1.4 Scraper/Collector Flights Assembly

M27.1.4.1 Scraper/Collector Flights

The longitudinal and cross collector scraper flights shall be minimum height of 190 and 150 nominal sizes, respectively. Flights shall be of heavy-duty channel shape or box type or an H section with wear shoes, designed to offer maximum rigidity with less than 6mm deflection in worst operating condition. Standard design of “C” channel flights, angle type flights, buoyant flights are not considered suitable, and shall not be used. The flights shall be specifically designed for sludge scraper service. Each flight shall have a scraper lip on the leading edge, plastic filler blocks for bolting to the flight attachments to match the flight attachment links. The lip shall be of a material, which will not degrade or wear significantly during contact with the tank floor. Cut or exposed edges of fibreglass material shall be coated with an epoxy resin to prevent ingress of moisture into the fibreglass structure.
M27.1.4.2 Flight Attachment Links
Rigid, non-metallic flight attachment links shall be manufactured from the same material, and shall have the same load rating, as the collector chain links. The attachment links shall extend the full depth of the flight and be integrally moulded in one piece to assure flight attachment.

M27.1.4.3 Flight Wear Shoes
The carrying wear shoes shall run on floor rails. Return wear shoes shall run on angle tracks.

Wear shoes shall be reversible providing two useable wearing surfaces. Wear shoes shall be 20mm thick high grade polyethylene Cast Nylon-6 material manufactured in compliance with ASTM D789 and shall be fastened to the flights. The main purpose of these wear shoes assembly is to protect from rubbing against the tank bottom. Four pieces of wear shoes shall be fixed in each scraper flight (two pieces of carrying wear shoes and two pieces of return wear shoes).

M27.1.5 Return Rails
The return rail shall be lightweight and supported from the tank wall with support bracket. The return rail shall be capable of supporting all combination chain and flight materials. Return rails shall be of 304 grade stainless steel or a standard fibreglass reinforced plastic angle section (minimum 50 x 75 x 6mm thick) manufactured in compliance with ASTM 4020-81 of sufficient strength to carry the conveyor distributed load. All return track hardware shall be 316 stainless steel. Return rails shall be supported at regular intervals to suit the rail strength and applied load.

Return rails shall be of sufficient strength to withstand the impact loads expected to result from the worst case tensioning of the collector system.

Return rails shall be supported by wall bracket. Wall bracket assemblies shall be of solid type construction and of Cast Nylon-6 material. Rail support shoes shall be nominally 12mm thick and of Cast Nylon-6 material.

M27.1.6 Floor Rail
The scraper chain and flight shall be supported on the floor rail, which shall be embedded in floor of the sedimentation tank. The floor rails shall be of UHMW polyethylene manufactured to ASTM4020-81. All connection hardware shall be grade 316 stainless steel. The floor rails shall be slotted to provide lateral guidance to the flights and also feature an allowance of thermal expansion and wear indicator.

M27.1.7 Wear Strips
Floor and return rail wear strips shall be 10mm thick Dotmar UHMW - PE Polystone 7000 SR Black.

Floor wear strips shall be mounted directly to tank concrete floors with chemical anchor bolts spaced at a maximum of 1.2m.

Return rail wear strips shall be attached to return rails with slotted pan head machine screws, each with a flat washer, split lock washer and hex head nut at maximum of approximately 1.2m centres.

M27.1.8 Collector Sprockets and Shafts

M27.1.8.1 Head Drive Shaft Assembly
Head drive shaft assembly shall be complete with drive sprockets, chain tensioner, idler sprockets, drive chain, electric motors, guards and loss of motion sensors.

The main longitudinal and cross scraper drive shafts shall be manufactured from stainless steel or high strength glass fibre reinforced polyester resin.
M27.1.8.2 Head Shaft Drive Sprockets
Drive sprockets shall be fastened to the drive shaft, which operates the chain sprockets. The sprockets shall have chain saver rims and shall be of a solid type construction. All sprockets shall be compatible with non-metallic chain and the drive shafts.

M27.1.8.3 Idler Stub Shaft Assemblies
Stub shafts shall be of solid one-piece construction from Cast Nylon-6 material mounting to wall. Stub shaft bearings shall be of solid type construction and of UHMW - PE material. Bearings shall be secured to stub shafts by non-metallic keys. Stub shafts shall have Cast Nylon-7 sprocket retainer plates.

M27.1.8.4 Idler Sprockets
The scraper chain idler sprockets shall be of solid type construction. Sprockets shall be 100% Cast Nylon-6.

M27.1.9 Protection Devices for Longitudinal and Cross Sludge Scrapers
The longitudinal and cross sludge scraper shall be provided with the following protection devices:
(a) A proximity type switch to detect on SCADA loss of motion of the longitudinal and cross scrapers (eg. broken chain or shaft key).
(b) An electronic torque limiter or an electronic shear pin to detect on SCADA high torque on the drive system (eg. from a lump of concrete on the floor of the sludge trough).
(c) A travel and alignment sensing system shall be provided to continuously keep track of normal operation.

Protection devices shall be operative in either field or remote equipment mode selection.

M27.1.10 Loss of Motion & Travel and Alignment Sensing System
The travel and alignment sensing system shall keep plant personnel alerted to flight misalignment or loss of motion before a failure can occur.

The travel and alignment sensing system shall be located on downstream end of the return scraper chain to detect failure of movement and or misalignment of the flights. The system shall made up of two idler sprockets, which follow the scraper chains. Metallic "targets" attached to the sprockets shall be sensed by proximity switches which report to a control panel. If the chain becomes misaligned, the control panel shall recognize a difference in the phase of the sprockets, raise an alarm and disconnect power from the drive.

If the panel recognizes a loss of motion from any of the proximity switches, the power shall be disconnected from the drive and an alarm raised. Equivalent or better alternative proprietary travel and alignment sensing systems are acceptable.

All sensors installed under water shall have IP68 rating.

M27.1.11 Drives
Longitudinal and cross scraper shall be driven by separate drive unit complete with speed reducer (i.e. one drive per tank). The base plate shall be bolted directly to the operating platform bridge. Each drive shall have ample power for starting and operating the cross scraper mechanism under normal operating conditions without overloading.

A chain tightener shall be provided to take up any unnecessary slack in the drive chain. The chain tensioner shall be mounted in a readily accessible place for easy maintenance.

The drive sprockets and chain tightener sprockets shall be plastic.
A chain tightener shall be provided to take up any unnecessary slack in the drive chain.
M27.1.11.1 Drive Motor

The longitudinal sludge collector drive units shall be equipped with a variable speed drive featuring an integrated overload protection, soft start and over torque setting. The variable speed drive shall allow the operators to adjust the scraper speed to an optimum level.

The motor for each cross sludge scraper drive shall be a fixed speed motor with ample power for starting and operating the collector mechanisms under normal operating conditions without overloading. An electronic shear pin shall be provided to protect the cross sludge scraper mechanism.

Machine drives shall be selected to be conservatively rated under all conditions of loading possible in the course of normal operation of the plant. Normal operation includes jamming by foreign matter for mechanical handling equipment.

The electrical over torque limiter (or shear pin) shall be set at 20% more than maximum sludge load. The electrical over torque limiter shall fail before the mechanical shear pin (or mechanical torque limiter).

M27.1.11.2 Mechanical Torque Limiter

The drive unit shall be provided with a torque limiting type gearbox to protect the sludge scraper assembly from overloading. The torque limiter shall be set to the maximum allowable torque required to drive the sludge scraper. This shall protect all mechanical components of the scraper system and minimize the damage due to possible overloads.

As an alternative to over torque limit type gearbox slipping clutch type mechanical shear pins shall be provided on drive chain sprockets assembly with load rated for 30% more than maximum sludge load.

The mechanical shear pin shall be designed to safeguard and prevent failure from slipping or breaking or damaging of the following equipment:

- Flight and attachment links.
- Collector chain.
- Drive chain.

Proximity switches shall be installed for detection of Collector Drive failure.

M27.1.11.3 Drive Chain

The drive chains that are submerged in water shall be of heavy duty, non-metallic glass reinforced.

The drive chain shall have a load rated 50% more than maximum sludge loads. Chain shall have a minimum working load of 7kN. The ultimate breaking strength of drive chain shall be 25% lower than the breaking strength of collector chain.

M27.1.12 Scum Troughs

The scum troughs at each end of each clarifier shall receive the scum collected from the scum skimmers and discharge scum into scum pumping station.

The scum trough shall have rotating painted hot dip galvanised steel pipes with slot openings at the top and running across the entire width of the tank.

The collector pipe shall operate automatically to turn and immerse the slot below the top water level to let the scum flow into the collector pipe for scum harvesting.

When scum is decanted from the tank, appropriate indication shall be given on the SCADA.

M27.1.12.1 Collecting Pipe

The collecting pipe shall have an opening at the top and run across the entire width of the tank. The collecting pipe shall be a rotating type and collect the floating scum when it is rotated through up to 90º. The troughs
shall be fitted with a motorised or pneumatically operated system to tilt the open top pipe through 90° angles. When the operation is completed, the scum trough will return to its parked position.

When the pipe opening is at the top position the scum trough acts as a baffle to trap the scum. The pipe shall be grade 316 stainless steel with minimum of 305mm diameter and 8mm thickness. The opening shall be 60° slots along the pipe.

M27.1.12.2 Collar
Each scum collection pipe shall be supplied with two collars. The collar shall be made of grade 316 stainless steel pipe plate to support the scum collection pipe on either end.

M27.1.12.3 Seal
Greased bearings are not preferred, but where used the collar shall be supplied with rubber ring seal to minimise friction and to avoid leakage.

M27.1.12.4 Effluent Launder
Effluent launders shall be provided at the end of the clarifier for removal of clarified effluent. The material of the effluent launder shall be either concrete or grade 316L stainless steel. An adjustable weir shall be provided as an integral part of the launder. The weirs shall have at least 20 mm of adjustment up and 20 mm down.

The weir plate shall have minimum 3mm thickness and 100mm (minimum) deep grade 316L stainless steel plate. The weir section shall be V notched and fastened to the launder wall for vertical adjustment.

M27.1.13 Materials
The scum troughs shall be made from the following materials:

<table>
<thead>
<tr>
<th>Component</th>
<th>Material Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scraper flights</td>
<td>ASTM 3917-80 Fibreglass reinforced polyester</td>
</tr>
<tr>
<td>Drive chain</td>
<td>ANSI-B29.16 Reinforced nylon resin NH78 pattern</td>
</tr>
<tr>
<td>Scraper chain</td>
<td>ANSI-B29.13 Thermoplastic polyester resin NCS 720 pattern</td>
</tr>
<tr>
<td>Flight attachment links</td>
<td>ANSI-B29.13 Thermoplastic polyester resin NCS 720 pattern</td>
</tr>
<tr>
<td>Flight wear shoes</td>
<td>ASTM D789 Cast nylon 6</td>
</tr>
<tr>
<td>Floor rail and wear strip</td>
<td>ASTM 4020-81 UHMW-PE (Ultra high molecular weight polyethylene - Virgin Grade) or stainless steel grade 316</td>
</tr>
<tr>
<td>Wall brackets</td>
<td>ASTM D789 Cast Nylon 6</td>
</tr>
<tr>
<td>Return rails</td>
<td>ASTM 3917-80 Fibreglass reinforced polyester or stainless steel gr. 316</td>
</tr>
<tr>
<td>Wear strips</td>
<td>ASTM 4020-81 UHMW-PE</td>
</tr>
<tr>
<td>Headshaft drive sprockets</td>
<td>ASTM D789 Cast Nylon 6</td>
</tr>
<tr>
<td>Idler sprockets</td>
<td>ASTM D789 Cast Nylon 6</td>
</tr>
</tbody>
</table>
M27.2 Scraper - Travelling Bridge Type

M27.2.1 General
The travelling bridge collector shall be a complete bridge assembly supported on AS1085 Rails. The bridge assembly shall consist of a travelling bridge with walkway, bridge drive, sludge removal system, support rail and anchorage parts and electrical control panel with necessary controls for the operation of the mechanism. The drive train shall be designed to withstand maximum horizontal loads placed on the bridge and sludge removal system. All parts of each mechanism shall be proportioned for stresses that may occur during fabrication, installation and operation.

The sludge collector shall meet following operational conditions:

1. The collector shall have enough capacity that channelling of over lying liquid through sludge will not result.
2. The mechanism shall be sufficiently rugged to transport and remove sludge up to 4% TSR that could accumulate in settling tank during periods of mechanical breakdown or power failure.

M27.2.2 Bridge construction
The bridge shall be designed to span the entire width of the tank. Bridge construction shall be as per requirements in Sydney Water’s Technical Specification – Civil. The walkway shall be covered with floor plate/grating and shall be in accordance with AS1657.

M27.2.3 Bridge Drive
The drive assembly shall consist of variable speed drive, gear reducer, drive chain, and drive and driven sprockets. All gearing shall be fully enclosed in an oil tight housing with the gears running in oil. Bearing shall be anti-friction type. Drive chain shall be roller chain type. The motor shall comply with IP 56 standards.

Drive shaft shall be of sufficient size to adequately and safely withstand all loads of starting and operating. The drive shaft shall be supported by multiple, grease-lubricated bearings.

M27.2.4 Scraper sludge removal, Blades and supports
The scraper blade assembly shall be positioned and guided by two or more rigid structural steel support assemblies attached to the bridge. The scraper assembly shall retract above the water surface for maintenance and inspection.

M27.2.5 Power supply system
The following systems shall be used.

M27.2.5.1 Power supply stretch cable system
A stretch cable system shall be provided with number of pulleys, which support the electrical cable used to power the collector. The electrical cable shall be looped in coils with each coil being attached to a separate pulley.

M27.2.5.2 Power supply trolley track system
A trolley track system, which allows the electrical cable to uncoil and retract as the bridge moves, shall be provided.

M27.2.5.3 Power supply cable reel system.
A cable reel system capable of unwinding and rewinding the power cable while maintaining a constant tension on the cable shall be provided. A strain relief device shall be provided to protect the fixed end of the cable.

M27.2.6 Scraper sludge removal cross collector
A cross collector shall be Helical screw type or chain and flight type.
M27.2.6.1 Helical screw type cross collector
A screw cross collector consisting of a drive unit with an overload alarm, vertical drive shaft, underwater gearbox, helical screw, bearings and anchors shall be provided. The drive unit shall consist of a motor and gear reducer connected to a vertical drive shaft through a flexible coupling.
Underwater gearbox shall be pressure lubricated and shall have bearings and seals designed for submerged operation. Grease lubrication lines shall be provided from each submerged bearing to an accessible location. The motor shall comply with IP 56 standards.

M27.2.6.2 Chain and flight type cross collector
The chain and flight type cross collector shall comply with standards specified in this Specification.

M27.3 Sludge Blanket Detector
The sludge blanket level detector shall be used in each clarifier sludge trough or hopper to detect the level of sludge blanket and for control of the sludge withdrawal.

M27.4 Drainage
Provision shall be made to drain clarifiers via the sludge withdrawal system.

M27.5 Safety
Each clarifier shall have at least one rescue float and lifeline. Double barrier protection shall be provided in all hydraulic connections to the clarifier.

M27.6 Sprays
Sprays shall be installed within the clarifier tanks to assist in moving the scum and prevent scum build up on the clarifier wall.

M27.7 Pre-commissioning
M27.7.1 Load Test
The entire sludge collector mechanism shall be load-tested. The test shall verify the operation of mechanical and electrical torque limiter (or shear pin). Initially electrical torque limiter (or shear pin) shall be set above the mechanical torque limiter settings to verify the mechanical torque limiter. Methodology shall be submitted illustrating how the torque shall be applied prior to the test taking place.

M27.7.2 Operational Test
The mechanism shall be operated in a dry tank for a minimum of 6 continuous hours before the system integrated commissioning. There shall be no binding, jerking, or unusual motion exhibited during this run in period. Motor amperage shall be checked at least hourly for any unusual or higher than normal figures. After the unit has successfully passed this initial test, flow shall be introduced into the tank and the same 6 hour observation test run.
M28. Circular Clarifiers/Sedimentation Tank

This section covers the general technical requirements for circular clarifier or sedimentation tank.

M28.1 General

The circular clarifier/sedimentation tank shall be equipped with an influent well, feed well, sludge collector, skimmers, scum baffles, drive units, launders weirs etc, and manufactured of suitable materials for operation under submerged conditions in sewage.

Minimum side water depth shall be 4 metres.

M28.2 Clarifier Inlets

The inlet arrangement shall be designed to dissipate influent velocities, distribute flows evenly, prevent short-circuiting and minimise density currents. The feed well shall be supported outside the centre cage to diffuse the liquid into the tank without disturbance. Baffled openings shall be provided near the water surface to allow scum to exit the feed well. The feed well shall be made of 5mm thick steel plate with necessary alignment angles. A double concentric feed-well shall be used for energy dissipation and final flocculation.

M28.3 Sludge Scraper Assembly

Sludge scraper blade shall be arranged to effectively sweep the whole of the tank floor and induce sufficient motion of the settled sludge to ensure its efficient passage by gravity into the central sludge collection well.

Each scraper blade assembly shall be supported from the rotating bridge and fabricated in stainless steel grade 316. Support chains incorporating stainless steel turnbuckles and rods for adjustment of tension and the support of the scraper blades shall be provided. Provision shall be made for the blade to be lifted off for inspection, adjustment and replacement.

Scraper blades shall be provided with adjustable neoprene squeegee projecting 40mm below the bottom of the blade and secured by stainless steel bolts, nuts and washers in grade 316. Each squeegee shall have a minimum thickness of 6mm and have 40mm vertical adjustment.

M28.4 Skimmer

The clarifier shall have a skimming mechanism to sweep the surface of clarifiers, automatically removing scum and floating material to a scum box at the periphery of the tank.

Skimmer blade shall be a minimum thickness of 5mm.

M28.5 Effluent Launder

A rectangular effluent launder shall be provided around the perimeter of the tank. The material of the effluent launder shall be either concrete or grade 316L stainless steel. The launders shall be an integral part of the clarifier wall.

M28.6 Weirs

An adjustable weir shall be provided around the periphery of the tank at the water surface for removal of clarified effluent. The weirs shall have at least 20 mm of adjustment up and 20 mm down.

The weir plate shall consist of minimum 4mm thickness and 200mm deep grade 316L stainless steel plate. The weir section shall be curved and fastened to the launder wall with special anchor bolts and hexagonal nuts for vertical adjustment.

Installed weir plates shall be sealed against the effluent launder wall with a continuous strip of non-degradable neoprene having a minimum width 100 mm. The neoprene strip shall be compressed between the wall and the weir plates as the plates are fixed. The neoprene strip shall be located centrally about the bolts.

The weirs shall be set to within plus or minus 2mm of their design level.
M28.7 Scum Baffle
Peripheral scum baffles shall be a minimum thickness of 5mm and shall have no less than 230mm immersion and 150mm freeboard. The baffle section shall be curved and fastened to the wall.

M28.8 Scum Box
A stainless steel grade 316 spray bar with corrosion resistant replaceable nozzles producing flared sprays shall be installed along the scum box. The spray bars shall be mechanically activated and isolated by the bridge traversing the boxes at each cycle of rotation to wash the residual scum effectively from the scum box. A typical arrangement could include a level operated ball valve and a flow control valve.

Scum box provided shall be the maximum possible size box that can fit in the clarifier to avoid scum recirculating in the clarifier.

The scum box shall be made of 5mm (minimum) stainless steel plate and serve as an integral section of the tanks scum baffle.

The scum box shall incorporate a ramp entry with a mechanical activated flushing trap type device which shall be activated by the bridge traversing the box at each cycle of rotation.

M28.9 Bridge Support Column
The bridge structure shall be supported at the tank centre by a robust support column with pivot bearings. The support column shall be designed to rigidly support the bridge structure with due allowance for all anticipated loads. The support column shall be bolted to the floor of the tank. The bridge support column shall be fabricated from grade 316L stainless steel.

Access walkway(s) shall be provided to any bearing equipment installed on the centre support column.

All bearing assemblies requiring lubrication shall have the lubricating points piped to locations accessible from the access walkway or bearing assemblies shall be sealed for life with seals that prevent the ingress of dirt or water.

M28.10 Walkways
Access walkways with handrails shall be provided around the perimeter of the circular tanks to facilitate hose down operations and maintenance. A bridge walkway of minimum width 900mm shall be provided. Walkways shall have slip-resistant surfaces. The 900mm wide walkway and platform with handrails shall be supported by the influent column at the centre and the tank wall at the outer ends.

M28.11 Centre Drive Platform
A centre drive platform shall be provided with centre driven rakes and fixed half diameter bridge for access to the centre and to drive components. It shall be provided with necessary support and connection to the walkway.

M28.12 Clarifier Bridge Motion Sensors
Every clarifier shall have one motion sensor installed to detect that the outside edge of each clarifier bridge is rotating.

M28.13 Clarifier Bridge Drive Variable Speed Units
The drive units shall be periphery or centre drive. The drive units shall be equipped with a variable speed drive featuring an integrated overload protection, soft start and over torque setting. The variable speed drive shall allow the operators to adjust the scraper speed to an optimum level. The over torque limit shall be set to the maximum sludge loads.

Motor and gearbox shall be direct coupled. The drive unit shall be suitable for mounting outdoors in a sewage environment.
The wheels shall remain in contact with the clarifier wall, on course with smooth operation, i.e. no start/stop motion.

Machine drives shall be selected to be conservatively rated under all conditions of loading possible in the course of normal operation of the plant. Normal operation includes jamming by foreign matter for mechanical handling equipment.

The electrical over torque limiter (or shear pin) shall be set at 20% more than maximum sludge load.

M28.14 Sludge Blanket Detector
The sludge blanket level detector shall be used in each primary and secondary clarifier to detect the level of sludge blanket and control the speed of the sludge withdrawal.

M28.15 Drainage
Provision shall be made to drain clarifiers via the sludge withdrawal system.

M28.16 Safety
Each clarifier shall have at least one rescue float and lifeline. Double barrier protection shall be provided in all hydraulic connections to the clarifier.

M28.17 Sprays
Sprays or small bore pipes installed within or near the tanks shall be grade 316 stainless steel.

M28.18 Testing
M28.18.1 Torque Test
The entire sludge collector mechanism shall be statically load tested by individually loading each rake arm with 150 per cent of the specified designed running torque. The test shall verify the torque overload control device settings for alarm and motor cut out. Each arm shall be individually anchored and load measured to demonstrate the rake arm, cages and drive units ability to withstand the specified torque.

Methodology shall be submitted illustrating how the torque shall be applied prior to the test taking place.

M28.18.2 Operational Test
The mechanism shall be operated in a dry tank for a minimum of 6 continuous hours before flow is allowed to enter the system. There shall be no binding, jerking, or unusual motion exhibited during this run in period. Motor amperage shall be checked at least hourly for any unusual or higher than normal figures. After the unit has successfully passed this initial test, flow shall be introduced into the tank and the same 6 hour observation test run.
M29. Decanter Equipment

This section covers the general technical requirements for the decanter equipment for IDEAT (Intermittently Decanted Extended Aerated Tank) and IDAL (Intermittently Decanted Aerated Lagoon).

M29.1 Decanting Equipment Requirements

The IDEAT / IDAL treats sewage in large tanks by a cyclic process involving aeration, settlement, decanting. After each aeration and settling phase of a cycle, clear surface liquor is decanted from IDEAT / IDAL by strategically placed decanters which are lowered below the surface.

Decanters floating on the liquid surface during aeration and settling with their weirs or entry ports submerged below the surface are not acceptable.

Decanters shall be designed to avoid air entrainment during decanting.

During aeration and settling phases the decanters shall be in their "parked" or reference position which ensures that the decanter overflow weir trough is above design maximum top water level.

In the park position, decanters shall be capable of discharging the maximum design flow for the IDEAT/IDAL and maintain the specified freeboard.

The Contractor shall provide the following information to check the design of decant weir:

- Trough travel.
- Decant trough and weir type.
- Decant time (storm cycle).
- Maximum weir overflow rate.
- Design raising speed of trough.
- Design lowering speed of trough.
- Trough park position.
- Trough bottom position.
- Drive unit.

M29.2 Side Wall Decanter

The trough shall be installed between the walls of the aeration tank and guided vertically while maintaining the weirs in a horizontal position.

The trough shall have guide rails to prevent trough misalignment. The guide rails shall have bottom stops to support the full weight of the trough. The stops shall be positioned to protect the slip joint from over travel of the trough. The guides shall also allow the trough to be supported in the park position for maintenance.

Scum baffles shall be attached to both sides of the trough. These baffles shall prevent scum and other floating material from being drawn off with clear effluent.

To connect the moving troughs to the fixed outlet piping flexible seal boots shall be provided.

M29.2.1 General

The decanter unit shall be supplied and installed complete with:

- Decant trough complete with weir.
- Scum baffles.
- Outlet pipe.
Flexible seal boot.
Trough park position switch.
Maximum water level switch.
Water level detection switch.
Trough bottom stop.
Supporting structure.
Drive unit.
Platform for access and maintenance.

**M29.2.2 Drive Mechanism**

The decanter overflow weir shall be positively driven into and out of the liquid by up and down lifting mechanism.

Raising and lowering of the trough shall be supported by stainless steel wire ropes or by chain. Alternatively raising and lowering shall be by combination of a screw jack electric actuator for drive. Adjustment of the horizontal level of the trough shall be by means of turnbuckles on the wire ropes or adjustment nut.

The speed of each decanter shall be controlled via a variable speed drive.

To compensate for variations in sewage flow into the wastewater treatment plant the decanter weirs are arranged to travel vertically up more than the maximum water level.

**M29.3 End Wall Decanter**

**M29.3.1 General**

Decanters shall be designed to avoid air entrainment during decanting.

During aeration and settling phases the decanters shall be in their "parked" or reference position which ensures that the decanter overflow weir trough is above design maximum top water level.

In the park position, decanters shall be capable of discharging the maximum design flow for the IDEAT/IDAL and maintaining the specified freeboard.

The Contractor shall provide the following information to check the design of decant weir:

- Trough travel.
- Decant trough and weir type.
- Decant time (storm cycle).
- Maximum weir overflow rate.
- Design raising speed of trough.
- Design lowering speed of trough.
- Trough park position.
- Trough bottom position.
- Drive unit.

The end-wall, rotating-arm type decant systems shall have the following attributes.

The decanter weir and trough shall always be visible from the basin side wall thereby providing the operator with a visual check of the effluent quality during the decant phase of the cycle.
The decanter shall be parked above the design top water level during aeration and settling phases, thereby eliminating any possibility of solids carryover during these phases.

At top park position, the decanter shall provide “fail safe” overflow protection in the event of a power failure. Settled supernatant will flow via gravity, under the scum guard, over the weir, and into the decanters.

The decanter shall be designed with a scum guard mechanism to prevent the discharge of scum and floatables during decanter or overflow operation.

All in-basin seals and bearings shall be maintenance free.

The trough shall be provided with support brackets at the low level position to prevent over travel of the trough. The trough shall be provided with supports when in the park position to allow maintenance of arm.

**M29.3.2 Drive Mechanism**

The drive mechanism or actuator shall be mounted on the walkway to provide easy access for maintenance and service purposes.

The drive mechanism or actuator shall be designed for a continuous duty, variable speed mode of operation thereby producing a uniform effluent flow rate throughout the decant phase. The decanter drive system shall be configured such that the decanter weir reaches bottom water level at the end of the decant phase thereby maximizing settling time.

Actuator limit switches and motor shall be integrated with process control system to prevent blower operation during the decant phase of the cycle.

**M29.4 Materials Requirement**

The material construction of side wall and end wall decanters shall conform to the following:

- Trough and scum baffle: grade 316 with minimum 3mm thickness.
- Trough outlet pipe: grade 316 stainless steel with minimum 3mm thickness.
- Guide and support brackets: stainless steel grade 316.
- Access platform and supporting structure: hot dip galvanised.

**M29.5 Decant Trough Control**

All decanter operational functions side wall and end wall shall be arranged for full automatic operation and are governed by SCADA system to enable lowering speed, decanting speed, raising speed, safety interlocks and etc. The decanter speed shall be set in the SCADA.

SCADA terminology shall be standardised as UP/DOWN or RAISE/LOWER (rather than forward/reverse) to remove any ambiguity regarding the direction of decanter operation.

Once the plant is operating it shall be capable of unattended operation. It shall be the Contractor's responsibility to arrange the equipment in the best engineering manner to fulfil the full automatic operation.

If the aeration tank suffers a Fatal Alarm fault or is RESET by the Operator at any time during the cycle the decanter shall return to its parked position.
M30. Diffused Air Aeration System

This section of the Specification sets out the minimum requirements for the design and selection of diffused air aeration system equipment.

The pipework, instrumentation and the diffusers shall be correctly sized to deliver the required quantity of air at the available pressure to meet all operating conditions.

The pipework to the tank shall be sized for 150% of the required oxygen transfer capacity to cater for the higher loadings.

M30.1 Aeration diffusers

M30.1.1 General

The three basic diffuser types are cylindrical, circular and flat blade diffusers. Expected operational life time is 8-10 years for cylindrical and circular diffusers and 18-20 years for flat blade diffusers and all diffusers will require automatic purging to remove condensate.

For continuous aeration the process shall comprise either rubber (high grade EPDM with low oil content/Polyurethane/Silicone) membrane or ceramic. For an intermittent aeration process the diffusers shall be rubber membrane discs.

The diffusers shall not clog and shall be suitable for use in the selected aeration process. The mixing capacity shall also be sufficient to re-suspend any solids that have settled on the floor of the tank if the diffusers are stopped.

The aeration rate shall be below that which will shear the flocculated microbiological bacteria.

Performance data for the diffusers shall be provided by Tenderers in the Schedule of Guarantees of Performance Data for the offered aeration system showing air flow rates versus the following:

- Oxygenation capacity in kgO₂/hr (clean water).
- Oxygenation efficiency (clean water).

The diffusers shall be securely fixed to distribution assembly pipework which shall be positioned on the tank floor to give an even distribution of diffused air over the tank floor. Note that an area shall be left clear of diffusers around mixers, the suction of the mixed liquor recycle pumps, RAS pumps and WAS pumps.

The air flow rate through individual diffusers shall not differ by more than plus or minus 5%. The diffusers shall be capable of completely mixing the tank contents and keeping the solids in suspension for all design air flow rates, including the required turndown in oxygen transfer.

M30.1.2 Fine Bubble Diffusers

The aeration diffusers for the bioreactor/IDAL shall be of the type which will produce a fine and even distribution of bubbles. The design of pores shall be such that the bubbles are prevented from coalescing into larger bubbles.

M30.1.3 Membrane Diffusers

The membrane diffusers shall comprise a flexible moulded perforated rubber membrane fitted over a supporting disc.

The diffusers shall be designed to give clog-free operation under continuous air supply and after infrequent air failures or shutdowns. The diffuser membrane shall seal against the supporting member to prevent the ingress of mixed liquor into the air pipework on air supply shut down.

The design of the retaining ring shall ensure seal between the diffuser element and the O-ring. The diffuser system shall be easily replaceable and interchangeable with a rubber membrane diffuser system. The modularity of piping and mounting systems shall allow quick dismantling and installation of diffusers.
Control orifices shall be incorporated into each individual diffuser and into each header of the air distribution pipework to prevent excessive air losses in the event of membrane rupture.

**M30.2 Air Pipework**

**M30.2.1 General Design Criteria**

Many factors need to be incorporated in the design of the air distribution pipework to minimise the potential of noise problems occurring.

Factors to be considered in the design of the air pipework to minimise vibration/noise level shall include:

- (a) The diameter of the pipework, to keep velocities low whilst considering flowmeter accuracy.
- (b) The connection of the blower discharge pipes to the manifold shall be "wye", not at right angles.
- (c) No blind flange at the end of the manifold.
- (d) The manifold shall be designed to ensure air travels in one direction.
- (e) The air pipework shall be designed to minimise changes of direction and use of large radius bends.
- (f) Flexible connections shall be provided between the diffuser assembly units and the main air supply pipework to allow for any differential movements.
- (g) Expansion and contraction shall be fully allowed for in the design and installation of the air distribution pipework.
- (h) Drain taps shall be provided on the air pipework to allow draining of moisture.
- (i) Pipework shall have inbuilt flexibility such as packer flanges for reasonable construction tolerances on the structures to which it is attached.
- (j) Pipe shall be designed to ensure the efficient operation of the aeration system and compliance with the noise limitations.

Aeration main headers and droppers shall be SS316 (schedule to suit application) seam welded pipes. Spiral welded pipe work is not acceptable.

Insulation shall be provided for pipework exposed to high temperature weather conditions to protect from heat effects where required.

Lagging/Insulation shall be provided for the pipework at a level and location where people are likely to come in contact.

All valves in the air delivery system shall be correctly selected for the duty. The Contractor shall submit calculations of Cv (head loss coefficient) values for the range of flows and pressure losses across each valve to demonstrate to Sydney Water that each valve has adequate range of controllability for the duty.

**M30.2.2 Diffuser Assembly Pipework**

The pipework system to which the diffusers are attached shall be fixed to the floor of the tanks. The underwater pipe work shall be UPVC class 12 or higher.

The diffuser assembly pipe work shall be provided with suitable support arrangements to allow ready installation of the pipes. Provisions shall be made in the supports for the distribution assembly pipe work to adjust the level of the diffuser.

The pipework support system shall be capable of withstanding all in service forces (buoyancy etc.) while allowing movement due to thermal expansion. The support system shall allow level adjustment as detailed below and not be susceptible to working loose in service.

Diffuser assembly pipework supports within the tank shall be fabricated of grade 304 stainless steel and they shall be fixed to the tank with chemical anchors.
Provision shall be made in the supports for the distribution headers to be adjusted for level such that the diffusers can be levelled to ±5mm.

Diffuser pipework systems shall be provided with facilities to purge water.

**M30.2.3 Downcomers**

Downcomer pipe shall be fitted for each diffuser assembly pipework to supply air to diffuser assembly pipework. The downcomer pipes to the diffuser assembly pipework shall not be less than 75mm in diameter. Expansion and contraction shall be fully allowed for in the design and installation of the diffuser system pipework.

Each downcomer shall be provided with a valve for airflow regulation and isolation of the unit. The valves shall be positioned so that they are readily accessible from the walkway without requiring the operator to lean out. These valves will be used for adjustment of airflow and shall be designed for throttling capability.

The valves shall be fitted with a device, which will lock the valve in the required position and ensure that the setting will not be easily tampered with. A graduated position indicator shall be provided to ensure that the required reproducible valve setting can be attained.

The pipework shall be stainless steel. All piping brackets and support to install the pipes shall be stainless steel below water or just above water and galvanised steel above water.

Anchors shall be supplied where necessary to restrain the pipes and prevent forces being applied to mechanical components.

**M30.2.4 Air Supply Headers**

The air supply headers run from the main air distribution pipework to the downcomers. Pipework shall have inbuilt flexibility such as packer flanges for future modifications and to allow for reasonable construction tolerances on the structures to which it is attached. An isolation valve for each main air supply pipe shall be installed at the point of connection to the main distribution pipework. Modulation valves and flowmeter for flow measurement and control of each air supply header pipe shall be provided.

The design of the main air supply header shall incorporate all components necessary to enable the easy connection of the main distribution pipework to the main air supply header.

**M30.2.5 Blower Discharge Pipework**

Discharge pipework from each blower shall be connected to a common manifold. Flexible connections shall be provided between the blower assembly units and the discharge pipework to allow for any differential movements.

The design of the manifold pipework shall incorporate all components necessary to enable easy connection to the main distribution pipework.

**M30.2.6 Actuated Modulating Valves**

To maintain the required air distribution for each zone/tank automatic actuated modulating valves shall be used. The purpose of the modulating valves shall be to control the flow of air into the main air supply headers and thus to the diffuser headers. During normal operation of the plant the valves shall be automatically operated.

The valves shall be electrically or pneumatically actuated, butterfly or ball valves. The valves shall be capable of stopping and remaining at any position of travel. The valves shall be provided with travel limit switches to sense the open position, fully open and closed position of the valve.

**M30.2.7 Air Flow Measurement**

The amount of air being supplied to each air supply header shall be measured by the installation of flow measuring devices. The flow measuring devices shall be suitable for the intended application. The sensor assembly shall be supplied with suitable fitting which enables easy removal during maintenance. The accuracy
of the flowmeter shall be within 5% of the minimum design flowrate. The installation shall provide adequate
distance of straight pipe upstream and downstream of the flowmeter to ensure the accuracy of the meter is
attained.
Pressure and temperature sensors shall be provided to measure the pressure and temperature of the air in
the pipe, upstream of the flow measurement device to record air flow under standard conditions of 20°C and
1 atmosphere.

M30.2.8 Pressure Gauges
Pressure gauges of an accepted type shall be installed on each main distribution pipework and main header.

M30.2.9 Lagging Requirements
Lagging shall be installed to blower pipework to give protection to personnel from pipework where the
temperature rise is above 65°C. Lagging shall also be provided for all aeration pipework in the blower building
or room to minimise the heating load within the room.
Pipe lagging requirement shall be as follows:
(a) The lagging shall form an integral part of the equipment and shall not affect the safety or function
of equipment.
(b) The lagging shall not hinder access for operation and maintenance.
(c) All lagging materials shall be non-combustible type. It shall be rockwool type with stainless steel
sheet metal outer cladding.

M30.2.10 Sound Attenuation of Pipework
Secondary sound attenuation shall be provided as agreed with Sydney Water to eliminate harmonics caused
by the operation of single or multiple blowers at all design speeds. No perceptible noise shall be heard at 50m
or more from any blower pipeline/header/sub-header.

M30.3 Purge Pipework
An automatic/manual purge system shall be provided so that in the event of condensation build up within the
laterals, the system can be purged. The automatic purge system shall be based on timer control.
The system shall have enough head to purge the collected water in the diffuser assembly pipework. Purging
of the pipework shall not cause damage to diffusers and shall not rely on pushing water through the diffusers.
The purge valve should be accessible from outside the tank.

M30.4 On-line Diffuser Cleaning
An on-line cleaning system shall be provided to allow for cleaning of diffusers without taking aeration system
off-line. The cleaning shall be able to be carried out without interruption to the treatment process.
The cleaning system may entail addition of formic acid (or other chemicals which are not detrimental to the
biological process) through a tapping point in the downcomers. All necessary tapping points, access and
portable chemical mixing and injection equipment shall be provided.
The recommended chemicals shall be able to permeate the pores of the diffusers where it shall dissolve the
minerals and eliminate microorganisms present in the deposited material. This combined action shall be
sufficient for full restoration of the original quality of the diffuser. The material of construction of pipework,
 fittings, valves and diffusers shall be chosen to withstand the exposure of applied chemicals.

M30.5 Leak and Pattern Testing Diffuser System
The diffuser system shall be visually tested by filling the tanks with clean water (the quality of water shall allow
a visual assessment can be carried out) to a level 1m above the top of the diffuser assembly units. Air shall
then be passed through the diffusers and a visual assessment of the diffuser operation shall be made.
The visual assessment shall include the following minimum inspection:

(a) Checking all diffusers have been installed in level within the required tolerances.
(b) Checking that all joints along the diffuser headers have been made airtight.
(c) Checking the required air distribution of diffused air is achieved across the entire tank floor.
M31. Blowers

The blower equipment specified herein is standard equipment for blowers handling ambient air for use in aeration tank diffusers.

M31.1 General Design Requirements

The air blowers shall be of such design as to achieve energy efficient operation continuously over the range of design air flow rates at the discharge pressure which shall remain practically constant.

The sizing of the blower units shall ensure that the peak air flow demand can be met by duty blowers. The blower system shall be capable of supplying air to meet flow variations in the plant. Each blower shall have turndown of 40% of its maximum output.

The discharge pressure shall be calculated dependent on the final design layout of the aeration system and of the delivery manifold.

The blowers shall also be capable of supplying the design "mass flow" rate at maximum ambient inlet temperature of 50°C.

Each of the blowers shall be capable of operating without surge in parallel with all the other duty blowers at the air mass flow rate 5% greater than its maximum design air mass flow rate against designed maximum gauge pressure at the outlet plenum. This shall be demonstrated during testing and commissioning.

Standard certified factory test sheets showing the results of each test shall be supplied in triplicate to Sydney Water prior to delivery of the blowers.

The blower unit shall be capable to operate at maximum duty for continuous operation.

Centrifugal blower technology referred to in this Specification is high-speed turbo with variable speed drive or geared turbo blowers.

Positive Displacement (PD) blower technology referred to in this Specification is the screw type blower with variable speed drive.

Either centrifugal or PD blowers can be used for aeration applications.

M31.2 Blower General Arrangement

The Blower arrangement shall have the following features:

(a) The arrangement shall be such that all blowers are accessible for operation and maintenance.

(b) The blowers shall be neatly arranged and housed in a sound attenuated room.

(c) The blower building shall be designed to have ready accessibility for maintenance and installation work of future work of which the Contractor was made aware.

(d) All room penetrations shall have acoustically treated louvres complete with easily maintainable filters to prevent noise emanating from the room and dust ingress. No perceivable noise shall be heard at 50m or more from any blower house.

(e) The inlet air to the blower house shall be filtered to suit the blowers and aeration diffusers selected.

(f) An overhead travelling crane system shall be provided so that any one blower can be removed as a single unit and loaded onto a truck.

The blower building shall be acoustically designed to minimise both noise inside the building and noise breaking out of the building. The building ventilation system shall be designed to limit the temperature rise not more than 3°C above ambient temperature.

M31.3 Ancillary Equipment for Blowers

The blowers shall be provided with the usual ancillary equipment for aeration duty, including:
(a) Acoustic enclosure with fan cooling.
(b) Discharge pressure transmitter.
(c) Power actuated discharge bypass valve or blow-off valve. Modulated blow off valves are preferred to reduce the risk of surge.
(d) Discharge check valve.
(e) Discharge isolation valves.
(f) Discharge silencer designed to minimise noise propagation along the pipework.
(g) Vacuum transmitter, pressure transmitter, oil level indicator and any other monitoring device shall be mounted outside the acoustic enclosure.
(h) Inlet and outlet pressure gauges shall be mounted outside the acoustic enclosure.
(i) Vibration absorbing mounting pads.

M31.4 Blower Control

An air temperature probe and gauge shall be supplied and installed on discharge pipework adjacent to the blower.
Blowers shall be provided with a control system which monitors:

(a) The condition of the blower.
(b) The control logic for starting and stopping the blower - All blowers shall be provided with standalone control systems allowing for safe starting, operation to a pressure set point, and safe shutting down.
(c) Bearing temperature.
(d) Air temperature in the discharge pipe work.
(e) Air temperature inside the acoustic enclosure.
(f) Opening and closing of the blow off valve when starting blower.

Each blower shall be fitted with a suitable pressure transmitter which will 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 valves. The pressure transmitter shall be adjustable over the range 10-100kPa.

M31.5 Blower Noise limits

Blowers shall be quiet in operation. The total sound power noise emission for the aeration system shall be broad band and free from any tonal or intermittent components.

Under any loading condition from no load to full rated the blower supplied should comply with at least one of the limits as follows:

(a) With all blowers and ancillary equipment, including associated pipework, operating, the maximum internal sound pressure level within the blower building at any point greater than 1 m from the surface of each blower and ancillary equipment shall not exceed 85dB(A).
(b) For each blower unit operating individually the combined overall A-weighted sound power level emitted from the blower casing, intake, silencer and silencer casing and associated piping and ancillary equipment shall not exceed a level of 92dB(A).
(c) For each blower unit operating individually the combined overall A-weighted sound power level emitted from the blower casing, intake, silencer and silencer casing and associated piping and ancillary equipment shall not exceed the values shown in the table below for each octave band.
<table>
<thead>
<tr>
<th>Octave Band Centre Frequency H₂-re10⁻¹² W</th>
<th>63</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>1K</th>
<th>2K</th>
<th>4K</th>
<th>8K</th>
</tr>
</thead>
<tbody>
<tr>
<td>86</td>
<td>74</td>
<td>79</td>
<td>90</td>
<td>90</td>
<td>77</td>
<td>69</td>
<td>66</td>
<td></td>
</tr>
</tbody>
</table>

The Directivity Index of the blower unit shall not exceed 6dB when measured under free field conditions over a reflective ground plane, where the Directivity Index (DI) is defined by:

\[
DI = 20 \log \frac{P}{Po} - 20 \log \frac{Pm}{Po} + 3dB
\]

Where:
- \( P \) = sound pressure level in any given direction at radius “r”
- \( Pm \) = mean sound pressure level of a hemisphere at radius “r”
- \( Po \) = 20 micro Pascals

If the Directivity Index of the blower unit is greater than 6dB then the respective measured overall weighted sound power level in dB(A) shall be increased by that number of dB by which the Directivity Index exceeds 6dB.

If the sound power level in any octave band of the blower unit exceeds the sound power level in both adjacent octave bands by more than 5dB (i.e. a pure tone is dominant) then the respective measured overall weighted sound power level in dB(A) shall be increased by 5dB(A).

**M31.6 Centrifugal Blower**

The centrifugal blowers shall be mounted on a base frame incorporating all ancillary equipment completely enclosed in an acoustic enclosure.

Blowers shall be high speed turbo, controlled by variable speed drives, or geared turbo and shall operate based on aeration cycle, flow rate and level of dissolved oxygen (DO) in the tank (on-line measurement). Blowers shall be provided with control system which shall automatically and continuously adjusts the set point during the day to maintain optimum process conditions and achieve efficient power consumption.

The Centrifugal blowers shall be provided with the usual ancillary equipment for aeration duty, including discharge silencer, designed to minimise noise propagation along the pipework.

The blowers shall be provided with control system which provides the control logic for varying suction and discharge valve for flow control.

The blowers shall start up under unloaded conditions and shall be brought on line, when correct operating status has been reached.

**M31.7 Positive Displacement Blower**

The air rotary positive displacement blowers shall consist of intermeshing screw threaded rotors designed for continuous operation at the required pressures and flows.

The blowers shall be controlled by variable speed drives. The blowers shall be able to operate over a speed range to deliver the range of air flow rates nominated above.

Rotors and shafts shall be of one-piece construction and shall be of forged steel or ductile iron on steel shaft. The rotors shall have two or more screw threads and shafts shall be geared together with timing gears so that the screw threads do not make contact during operation.

Bearing housings and rotor shafts shall be fitted with suitable oil seals to exclude dirt and moisture and to prevent oil carryover into the discharge air. Where bearings are oil lubricated the housings shall be fitted with effective oil level indicators.
The blower and motor shall be mounted on a base frame incorporating an integral silencer, non-return valve, pressure relief valve, discharge connection with flexible joint and flexible mounting pads (vibration dampers shall be placed under blower mounts).

The complete assembly including drive motor and lubrication system shall be mounted and aligned on a substantial galvanised sub-frame. Heavy duty anti vibration mountings shall be located on the underside of the sub-frame.

M31.8 Materials of Constructions

The materials of construction for the blowers shall be at least equal in quality to the following:

<table>
<thead>
<tr>
<th>Component</th>
<th>Material</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Casings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseplate</td>
<td>Steel, Galvanised</td>
<td>AS3678 Grade 300</td>
</tr>
<tr>
<td>Rotor/impeller</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shaft</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bolts and washers</td>
<td>Stainless Steel</td>
<td>Grade 316</td>
</tr>
<tr>
<td>Nuts</td>
<td>Stainless Steel</td>
<td>Grade 316</td>
</tr>
</tbody>
</table>

M31.9 Filters and Silencers

The blowers shall receive filtered air via a common plenum fitted with inlet filter and sound attenuator. The filter elements shall be housed in an air-tight housing which shall allow easy replacement of the filter elements. Replacement of elements shall be possible without the use of tools.

If the filter/silencer elements supplied are located out of doors a weatherproof cover shall protect the filter element from rain.

The filter unit shall be fitted with suitable vacuum gauges to indicate the suction pressure into each blower. The gauges shall be industrial Bourdon of Schaffer type gauges with a nominal diameter of 150 mm. The scale shall be suitably selected and shall include a red line to indicate the point at which the filter elements require renewal.

Each blower intake shall be fitted with a differential pressure switch, which shall indicate an alarm signal in the event of excessive pressure drop in the blower intake. The differential pressure switches shall be adjustable in the range 0-3000 Pa.

Alternatively, each blower intake shall be fitted with an integral unit cleanable element type filter/silencer complete with supports.

M31.10 Flexible Connections

The blower discharge shall be fitted with an approved flexible sleeve with fixing clamps and a flanged outlet spigot for connection to site pipework. If the blower inlet is via a common plenum the inlet pipe shall be also fitted with an flexible connection.

Flanges shall be drilled to Table D and shall comply with AS2129.
Sleeves shall be manufactured from an approved non-metallic material suitable for the duty and location in which the blowers are to be installed.

M31.11 Pressure Relief Valve

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. Each blower shall be fitted with a suitable pressure switch, which shall 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 valves.

The pressure relief valve shall be installed at a height above 2m from the floor and away from blower suction point. The pressure relief valve shall be fitted with a silencer.

M31.12 Non-Return Valves

A non-return valve shall be installed on the discharge pipework of each blower, upstream of the blower isolation valve.

M31.13 Isolating Valves

Isolating valves shall be installed on the delivery pipework of the blowers, such that each blower and all associated pipework and valves upstream of the common distribution manifold can be dismantled without disruption to the normal operation of the plant.

M31.14 Temperature Measurement

Temperature sensor complete with gauge of an approved type shall be supplied for each main distribution pipework and for the blower room.

M31.15 Piping Vibration

If the blower type selected produces a discharge flow with a pulsating characteristic, flow pulsation dampers shall be installed on the blower intake and discharge, as required, to eliminate excessive noise or vibration from this source.
M32. Surface Aerators

M32.1 Surface Aerators

Units shall be direct coupled low speed types with impeller tip speeds being less than 7.5m/s. High speed units will not be acceptable.

Aeration equipment shall be adjustable to facilitate variations in oxygen transfer rates with all adjustments capable of being made from the aeration maintenance platforms.

Aeration and mixing shall be effected by a vertical spindle impeller, designed specifically for surface aeration. Baffles shall be provided to prevent formation of vortices or other undesirable hydraulic conditions. These baffles shall not be attached to aerators, but shall be mounted onto the floors of aeration lagoons and shall be designed not to collect rags and grit around the baffle plates.

For floating aerators:

- Adjustment of impeller immersion by ballasting of the pontoons shall not be acceptable.
- Each floating support structure shall be moored to at least two mooring posts to allow the surface aerators to move up and down with the changes of water level in the tanks.
- Mooring posts shall be either held by bolts cast into the concrete floor or cast in situ to the tank floor in the concrete base.
- Dampening mechanisms shall be attached to all surface aerators at each mooring post and shall be located well above the sewage level to prevent disturbance of the settled sludge caused by movements of the pontoons during windy periods. The dampening mechanism shall consist of an adjustable dashpot, a spring loaded roller or similar device. The dampening mechanism shall be sufficiently robust to withstand all aerator start-ups and wind forces.

M32.2 Impellers

Impellers shall be non-ragging types and be inverted cone or open blade types with equally spaced blades extending through the periphery and constructed from steel plate of adequate thickness to ensure rigidity.

The impellers shall be dynamically balanced to ensure vibration free operation under all water levels and conditions.

Impellers shall be self-cleaning. Rags etc. that form a normal part of effluent to be treated should not accumulate on the impeller or other parts of the aerator.

M32.3 Floating Platforms

Maintenance and inspection platforms are required around each motor and gear box. Each platform shall have self-draining, non-slip decking and shall be fitted with handrails and kickboards. Platforms shall be constructed from mild steel and be hot dip galvanised.

Platforms shall have lifting lugs.

Pontoons shall be constructed from grade 316 stainless steel. Pontoons shall be capable of supporting the entire weight of aerators when the aeration lagoons are drained. Bearing pressures on the floor of the aeration tanks shall not exceed 500kPa.

The support arm assembly from the maintenance platform to each of the three pontoons shall be enclosed hollow steel sections. The torsional resistance shall be such that the maximum twist along the length of the arm shall not exceed 12mm under dynamic loading conditions.

Platform structures shall be designed to have a structural resonant frequency above 7 Hz and to exceed any forcing frequency by a minimum of 20%. An example of a forcing frequency is the impeller blade passing frequency.
Provision shall be made to allow free vertical movement of each aerator unit relative to its walkway access platform. Aerator working platform design shall be such that vertical movement of the aerator unit relative to the fixed access ladder will not allow any part of the body to become trapped between the fixed ladder and the moving platform.

The platform shall be at least one metre above the water level at all operating conditions.

**M32.4 Deflectors**

Circular mist deflectors shall be provided for each aerator to eliminate spray and splash above aerator platforms. Each deflector shall be mounted in a stationary position above the aerator impeller and supported from the underside of the platform.

Deflectors shall be constructed from galvanised steel plate of adequate thickness with reinforcing members to provide sufficient rigidity during aerator operation.

**M32.5 Aeration Noise**

The installed equipment shall be quiet in operation. The operating noise emission from the aeration system shall comply with specified noise criteria, or in the absence of specified noise criteria, with statutory noise criteria.

Necessary sound barrier walls shall be installed preventing sound intrusion on the prevailing background noise criteria.
M33. Mixers

M33.1 General

All mixers shall be of a standard and proven design.

The number, size and position (including depth and orientation) of mixers shall be designed to maintain a fully mixed homogeneous solution within the entire volume of the tank or zone being mixed. Solids shall remain in suspension in a homogenous mixture for each cell.

The design and arrangement of the mixer(s) shall be determined and verified by hydraulic and mixing performance modelling. All modelling and analysis shall be based on the specific mixer design proposed and all modelling results shall be submitted for Sydney Water’s acceptance.

The performance modelling shall verify that the velocity profile across the entire floor area of the mixing tank/zone shall be sufficiently high so as to eliminate potential “dead-spots”.

The effectiveness of the installed mixers shall be such that the % w/vol solids at any single point within the tank or zone do not vary by more than ± 10%.

The mixer shall be designed so as not to entrain air or promote surface vortices.

The mixer shall possess the necessary features to prevent any ragging in the mixer impeller.

Where there is a high probability that rags are present (such as thickened sludge storage tank or scum well) alternative means of mixing shall be used. Recirculation pumps shall be used as an alternative mixer in thickened sludge storage tanks.

The mixers shall comply with the following requirements:

- The mixers shall provide continuous operation at their calculated design duty point. All calculations and drawings shall be submitted to Sydney Water.
- The continuous rated output of the electric motor driving the pump and mixers shall be at least 10% in excess of the maximum power required by the unit under all operating conditions.
- Each submersible mixer and its motor shall withstand without damage to the mixer or any other equipment the effects of reverse rotation up to 120% of normal direction rated speed.
- Mixers and driving units shall be purchased from one source (the mixer manufacturer) to ensure the parts are compatible mechanically and electrically.

M33.2 Materials

The materials of construction for mixers shall be at least equal in quality to the following:

<table>
<thead>
<tr>
<th>COMPONENT</th>
<th>MATERIAL</th>
<th>STANDARD or Additional information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor Casing</td>
<td>Cast Iron</td>
<td>AS1830 Grade T220</td>
</tr>
<tr>
<td>Impellers</td>
<td>High-Chromium abrasion-resistant white iron</td>
<td>AS2027-Cr 27</td>
</tr>
<tr>
<td></td>
<td>Phosphor bronze</td>
<td>AS1565 C90250 (refer WSA101)</td>
</tr>
<tr>
<td>Shafts</td>
<td>Stainless Steel</td>
<td></td>
</tr>
<tr>
<td>Mechanical seals</td>
<td>Silicon Carbide</td>
<td>Only for fluids with pH &lt; 3</td>
</tr>
</tbody>
</table>
### COMPONENT

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>STANDARD or Additional information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silicon Carbide</td>
<td>Only for fluids containing particles with hardness equal or in excess of that for tungsten carbide.</td>
</tr>
<tr>
<td>Tungsten Carbide</td>
<td>Elsewhere</td>
</tr>
<tr>
<td>Bolts, Studs, Washers and Anchor Bolts:</td>
<td>Stainless Steel</td>
</tr>
<tr>
<td>Nuts</td>
<td>Stainless Steel Grade 316</td>
</tr>
<tr>
<td>Guards</td>
<td>Stainless Steel Grade 316</td>
</tr>
</tbody>
</table>

### M33.3 Submersible Mixers

Each submersible mixer shall be supplied complete with the following:

- Mounting arrangement, complete with coupling devices, guide rails and support brackets.
- Swivel mechanism for rotation of the mixer in horizontal and vertical planes.
- Placement / Removal Apparatus, including swing type lifting davit, stainless steel grade 316L lifting cable, stainless steel winch and shackles.
- Composite power and control cable length.

The mixers shall be provided with adjustment for depth and mixing direction.

Mixers shall include a motor and impeller; in a close-coupled configuration, forming a compact, and robust mixing unit.

Appropriate shroud arrangements shall be provided where necessary to prevent air entrainment and vortices. The design of the casing and propeller shall allow an uninterrupted flow across the units, allowing the mixing media not to be caught and allowing cooling of the mixer.

The mixers shall be manufactured from stainless steel materials selected by the manufacturer to suit the duty requirements, fluids and operating conditions.

The guide rail arrangement shall permit easy adjustment of the submersible mixer orientation in the vertical and horizontal planes, by an operator standing on the access platform.

Mixers shall be readily removable for inspection and maintenance using the lifting equipment, without the need for personnel to enter the tank. The lifting arrangement shall enable a single operator to easily lift each mixer from its installed location and place it on the access walkway/platform without removing the handrails. Similarly a single operator shall be able to easily replace each mixer to its installed location.

No portion of the mixer shall be permanently fixed to the base of the tank.

A stainless steel lifting chain of sufficient length to reach from the mixer to the platform level shall be provided with each mixer. All holding down bolts shall be of grade 316 stainless steel. For lifting facilities by a davit the mixer shall be fitted with stainless wire rope and brake winch.

Electrical cables for each mixer shall be suitably protected and secured in place so as to prevent any damages.
M33.4 Top Entry Mixers

The mixers shall enter tanks vertically from the top and normally operate continuously. The speed of the mixer shall be variable and easily changed over a 3:1 range and shall be capable of being changed while the mixer is in operation.

The mixer paddles and shafts shall be grade 316 stainless steel. The shafts shall be sufficiently rigid to prevent flexing. Maximum deflection shall be limited to shaft length/1000. The shafts shall be fitted to the gearboxes in a positive manner, which may take the form of keyed flanges with retaining bolts or equivalent. Mixers can be supported near the blades.

M33.5 Shaft Seals

M33.5.1 General Requirements

Mixers shall be supplied with mechanical seals.

Two independent mechanical face seals assembled in tandem shall be fitted to provide reliable and durable sealing performance.

The seals shall be designed for a minimum operating life of 5 years under normal operating condition. Spare mechanical seals shall be supplied to the extent of the life of the mixers.

The seals shall be of the balanced type, cartridge mounted, incorporating bellows or multiple helical springs of Hastelloy® C or equivalent and high nitrile synthetic rubber or ethylene propylene static "O" rings.

Seal faces shall be lapped flat to within two helium light bands and the depth of interface roughness shall not exceed 0.3 microns.

M33.5.2 Seal Failure Detection

Submersible mixers shall be fitted with seal failure probes for moisture and oil leakage.

The probe shall be fitted in the oil bath between the two mechanical seals and shall be arranged to detect the presence of water in the oil bath, eg to detect failure of the propeller seals.

A moisture detection device shall be fitted in the motor stator housing and cable termination housing.

Sensors shall be compatible with Tritronics RT1 relay.

M33.6 Motor Protection

All mixers shall be protected from overheating by a positive temperature coefficient (PTC) thermistor in each phase of each stator winding. Each thermistor shall be connected in series to terminals adjacent to the stator terminals and encapsulated and compatible with the motor selected or with Tritronics RT1 relay.

Mixers shall be fitted with seal failure probes for moisture and oil leakage. The probe shall be fitted in the oil bath between mechanical seals and shall be arranged to detect the presence of water in the oil bath, eg to detect failure of the shaft seals.
M34. Rotary Drum Thickener (RDT)

M34.1 General

Each thickener shall be designed to have a clean screening surface to the oncoming wastewater stream at all times while in operations. The unit shall be designed for minimal head loss at peak flow. Spray piping shall be arranged for both internal as well as external sparging where fitted, and for washing of the drum filter mesh. The drum thickener manufacturer shall be ISO 9001 certified with prior drum thickener installation in Australia and units operating reliably at least 3 years at the wastewater treatment plant.

Each thickener shall be manufactured for a 20 year life-cycle and made from materials suited for coastal & high corrosive environments.

Each thickener shall consist of screening element/s, flexible joined inlet entry pipe, internal spray bar with accessible nozzles for effective intermittent cleaning cycles of the filter mesh, infeed mixing valves/mixing device (optional), flocculation tank with mixer and polymer dosing port, full covers which are easily lifted by personnel, integrated solids discharge chute, sludge hopper (optional), base frame, filtrate outlet drain suited for maximum hydraulic loading rate via gravity, accessible sampling points for thickened sludge and filtrate, trunnions (if manufacturer design includes trunnions), central/accessibe greasing points for bearings and drive unit appropriately geared to reliably thicken at maximum thickness at maximum hydraulic and solids loading rates.

M34.2 Rotary Screen

Each rotary drum thickener shall be designed to thicken sludge up to 6% (Dry Solids) and capture minimum 95% solids. The feed sludge enters the flocculation tank with manufacturer recommended polymer dosing point, or via a mixing device prior to the flocculation tank, where it is distributed for maximum flocculation and then introduced tangentially into the screen surface. Liquid gravitates downward through the screen slot openings passing through the screen, which retains the thickened sludge. Spiral pattern diverter flights and other manufacturer designed aids continuously move thickened sludge along the screen, into a discharge assembly and into a sludge hopper (as supplied by the manufacturer or custom built for the site and pumping needs (depending on target thickness and site layout)).

M34.3 Drive System

A variable speed drive shall be provided for controlling the speed of the drum. The cylindrical drum shall be driven using a chain and sprocket arrangement (single chain or double chain). A manual or automatic chain oiler arrangement for the chain drive shall be provided. The drive system shall be designed to rotate the drum at maximum speed.

M34.4 Cylindrical Screen

The drum assembly shall be constructed from 316 stainless steel unless accepted otherwise by Sydney Water. The screen shall be constructed from a minimum grade 304 stainless steel Vee-wire® or polyester cloth. The Vee-wire® dimensions shall be designed to minimize the stapling effect. The manufacturer may recommend an alternative mesh to achieve the thickening requirements for specific applications, and approval for its use to be authorised by this specification’s custodian.

M34.5 Enclosure

The full enclosure shall be designed to contain aerosol emissions from the rotating drum and the wash-water system. It shall also serve to protect personnel from all the moving parts. The enclosure shall be constructed of lightweight corrosion resistant material with structural integrity to withstand environmental conditions. Inspection hatches for observation of the trunnions (if trunnion design is adopted), spray bars, discharge thickened sludge end and chain and sprocket shall be provided with adequate open stays to prevent accidental cover closure.
M34.6 Frame and Access
The drum thickener shall be installed with grade 316 stainless steel main body/frame, and the installation contractor shall provide ladders, platforms and railings. All bolts, nuts, studs and washers shall be grade 316 stainless steel and hand-rails and kick-plates made from aluminium.

M34.7 Infeed Tank
The infeed tank shall be constructed of not less than 2 mm thick grade 316 stainless steel. The infeed tank shall be designed for optimum stilling and distribution of the incoming flow onto the internal section of the screening element. A capped pipe shall be furnished at the end of the infeed tank for discharge of settled solids if the tank floor is not sloped toward the drum thickener. Penetrations in the tank lid shall be made for level transmitters and high level switches.

M34.8 Pipe Connections
Pipe connections shall comply with Pipe connection requirements stated in Clause M16 of in this Specification.

M34.9 Spray System
An Internal spray water system for periodic cleaning of the drum screen mesh shall be provided. The spray headers shall be type 316 stainless steel with BSP connection. The headers shall be furnished with a combination of type NiCr brass vee jet nozzles or as recommended by the manufacturer for the most effective cleaning of the drum mesh.

M34.10 Accessories
The following accessories shall be provided for the operation and integration of the Rotary Drum Thickener specified in the above section.

M34.10.1 Flocculation Tank
The flocculation tank with motorised mixer shall be used to condition the sludge and chemicals and shall be designed to give a minimum residence time of 90 seconds within the tank. Alternatively, if recommended by the supplier, a mixing valve or mixing device at the inlet to the flocculation tank shall be provided and be of 316 stainless steel construction with easily adapted polymer dosing points.

It shall be made from not less than 2 mm thickness grade 316 stainless steel. It shall include a single outlet that allows the conditioned sludge to flow by gravity into the inlet of the RDT.

If a mixer is required, it shall have a motor installed suitable for a VSD for control of the mixer speed.

M34.10.2 Liquid discharge tank
The liquid discharge tank shall be constructed from not less than 2 mm grade 316 stainless steel and extend the full length and width of the liquid discharge area.

The bottom shall be sloped to an appropriately sized (based on flowrate), grade 316 stainless steel flanged discharge outlet.

The outlet may be changed to recycle the filtrate through the wash water system.

M34.10.3 Liquid discharge tank stand
This stand shall be constructed in grade 316 stainless steel.

The height of the stand shall be designed to allow containers to be placed completely under the frame to eliminate spillage of discharge onto the floor.
M34.10.4 Wash water system
If the site has limited service water for the spray system, then a wash water system shall be installed and made up of a duty/standby pressure pump skid and tank with all interconnecting pipework, valves and electrical devices between the pump and tank.

An inlet and a single outlet shall be provided with a control system to ensure the manufacturer recommended pressure is maintained at all times.

M34.10.5 Chemical makeup and Delivery system
Chemical dosing systems shall be capable of automatically adjusting to changes in the treatment processes. Chemical makeup and delivery system shall comply with Requirements stated in Clause M37 of this Specification.

M34.11 Spare Parts
Equipment shall be provided with at least the following spare parts:

1. Trunnion Assemblies (Includes support blocks) if trunnion design.
2. Set of nozzles (A set shall include nozzles for both drum cleaning spray-bars if two are fitted).
3. Motor and gearbox assembly (optional)
4. Filter mesh for the drum

M34.12 Electrical devices and Controls
M34.12.1 Electrical devices
The following electrical devices shall be included as minimum to automate and enhance the operation of the screen.

1. Solenoid valves for spray bar system.
2. Level transmitter and high-level switch for flocculation tank.

M34.12.2 Control Panel
If required, the control panel shall comply with Technical Specification - Electrical, or alternatively, programmed in the SCADA PLC on site (where no control panel is required).

M34.12.3 Thickened Sludge Pumping
The Thickened Sludge is recommended to be pumped directly out of the Thickened Sludge discharge hopper and directed by a stainless steel 316 chute into a progressive cavity “cake pump” to minimise friction losses and ensure pumpability at all times and at the thickest sludge concentration (%TSR).
M35. Sludge Dewatering Equipment
Also refer to “Biosolids & Dewatering Equipment” Technical Specification.

M35.1 Centrifuge
This section covers the general technical requirements for the dewatering/thickening centrifuge.

M35.1.1 General
The centrifuge shall be a horizontal decanter type unit comprising an outer rotating bowl and an inner scroll conveyor which shall rotate in the same direction at a slightly different speed. The scroll shall be arranged to thicken/dewater sludge to the conical end of the bowl to discharge through ports in the bowl periphery via a discharge chute. Centrate shall be discharged through ports at the other end of the bowl for gravity discharge into the centrate chutes which are piped to the centrate pumping station.

All protective coatings for base-frames and non-wetted parts shall comply with environments classed as “coastal corrosive” as per WSA 201 and Sydney Water’s Supplement to WSA 201, or equivalent, to withstand corrosive environments across sewage treatment plants for a lifecycle of a minimum of 20 years.

The centrifuge will be designed to produce at least 2500 G centrifugal acceleration when running at maximum speed.

The unit shall meet the noise and vibration standards and requirements of this Specification at maximum G acceleration.

Where centrifuges are to be installed on a steel mezzanine level, the centrifuge main supports shall be isolated from the mezzanine floor to prevent harmonics, vibration and noise.

The centrifuge shall have a variable speed bowl drive and a variable speed scroll drive.

The centrifuge shall be fitted with a gearbox and a VSD drive to ensure a steady increasing load during start-up for both the bowl drive and the scroll drive. The torque of the scroll conveyor shall be continuously monitored so that the optimum speed of the scroll conveyor, for a specific duty, can be maintained.

The centrifuge shall be supplied as a completely assembled unit on its base-frame and vibration take-up feet.

The centrifuge shall be supplied complete with ancillary equipment. Ancillary equipment shall include logic controller, frequency converters for both drives, push button stations, sludge diversion gates, central grease lubrication system, vibration isolators vibration take-up joiners for feed pipe connections, polymer dosing connections, cake discharge chutes and centrate discharge chutes.

Suitable lifting facilities shall be provided for maintenance of the centrifuge.

M35.1.2 Centrifuge Design
The decanter design shall incorporate, but shall not be limited to the following:

- Facility for automatically regulating scroll drive shall be provided. The differential speed shall adapt automatically as a function of scroll torque and the solids content;
- All wetted parts shall be duplex stainless steel;
- For abrasive sludges the most abrasion resistant duplex stainless steel is required;
- All structural parts shall be centrifugally cast stainless steel;
- The linings to prevent erosion shall be provided as follows:
  - In the feed zones: Hard surfacing protection;
  - On the conveyor flights: Tungsten coating and/or sintered carbide tiles (sludge characteristic dependent);
  - At cake discharge end: Tungsten carbide, except for nozzles as recommended by the manufacturer for the sludge characteristics;
• Casing wear liner shall be urethane or rubber based;
• Bearing life shall be a minimum of 8,000 hours or for the agreed period between machine overhauls;
• Conveyor bearings shall be sealed to prevent contamination so additional lubrication is not required for the life of the bearings or between major overhaul intervals;
• Torque reducer unit and gearboxes shall have a minimum life of 40,000 hours before overhaul;
• Polymer injection points shall be provided;
• Diverter gate to divert solids discharge to drain during start up shall be of 316 stainless steel;
• Both the cake and the centrate chutes shall have air vents at the same pressure and provisions for flushing of the vents;
• The differential speed shall be adaptable automatically as a function of scroll torque and solids content in the bowl;
• Accessible safe sampling points for dewatered sludge and centrate shall be provided.
• The centrifuge units shall have flanged connections for feed and centrate and vibration take-up joiners for all fitted pipework as required by the manufacturer. These shall be supplied with the centrifuge.

**M35.1.3 Centrifuge Controls**

All centrifuge and other related equipment operational functions shall be arranged for full automatic operation, governed by SCADA Control, to enable start-up, shutdown, thickening/dewatering sequence.

The Centrifuge main and back drives shall have variable speed drives. The Centrifuge bowl speed/scroll base speed shall be capable of being set on SCADA. Once the plant is operating it shall be capable of continuous unattended operation twenty-four hours per day or as per set time duration. It shall be the Contractors responsibility to arrange the equipment in the best engineering manner to fulfil the fully automatic operation.

The control system shall control the basic functions of the centrifuge from start-up to production to shut down. This system shall communicate with the plant PLC control system to allow various auxiliary systems to start and stop and be varied. The preferred control system will allow the plant operator to adjust most of the centrifuge settings from the SCADA system without the need to attend the control panel provided with the centrifuge.

The minimum instrumentation to be supplied with each centrifuge shall include but not necessarily be limited to the following:

• Excessive vibration detectors/transmitters and auxiliary contracts for alarm and shutdown
• Decanter control unit. This unit shall be capable of interfacing with the existing plant PLC control system via bus connection allowing reads and writes to and from the decanter to the site PLC. A data map shall be provided for PLC integration, and the communication protocols to be accepted by Sydney Water (acceptance shall be sought from Sydney Water for the preferred communications protocol).
• Torque transducer if fitted (or torque monitoring based on drive torque from VSDs).
• Bowl and scroll speed measurement.
• Temperature transmitters for main bearings;
• Vibration transmitters for centrifuge bearings; and
• Interlocks for torque, motor amperage and vibration;

The control system shall provide real data from all installed instruments as well as major alarms to the SCADA PLC system.

The scroll drive shall be automatically adjustable during operation to suit the varying characteristics and flow rate of the feed sludge to ensure optimum operating conditions.
The scroll conveyor torque shall be continuously monitored and controlled so that optimum relative speeds are maintained. Should the solids loading exceed the set limit of the scroll drive torque, the drive shall raise an alarm signal and initiate the centrifuge shall shut down sequence.

Automatic type control for thickening centrifuges to vary weir levels based on TSR shall be incorporated into the design.

The centrifuge shall be provided with all necessary interlocks to sequence with sludge feed pumps, pump flushing system and polymer dosing system.

**M35.1.4 Centrifuge Bowl**

The bowl shall be of the solid bowl decanter type and shall be manufactured from duplex stainless steel. The feed end of the bowl shall be provided with circumferential discharge ports. The ports shall be replaceable and manufactured from high wear resistant material. Easily adjustable weir plates shall be provided to vary the pond depth. The discharge port for the thickened/dewatered sludge and centrate shall be designed to ensure free discharge and to avoid any build-up of material.

The complete assembly including drives, motor and lubrication system shall be mounted and aligned on a sub frame. The frame shall be a stainless steel or galvanised steel frame. The galvanised base frame shall be painted to WSA 201 and Sydney Water’s Supplement to WSA 201.

Heavy duty anti-vibration mountings shall be located on the underside of the sub frame.

The equipment shall be complete with all necessary items for efficient dewatering and thickening centrifuge operation.

**M35.1.5 Scroll Conveyor**

The scroll conveyor shall be manufactured from material which is capable of resisting the wearing and corrosive effects of the sludge. The scroll flight tips shall be designed to have a minimum life of 15,000 hours. They shall be protected by either ceramic or tungsten spray or carbide tiles.

The scroll and bowl assembly shall be statically and dynamically balanced before and after assembly.

**M35.1.6 Outer Casing**

The outer casing shall be stainless steel and shall be designed to ensure segregation of cake and centrate into their respective discharge hoppers. The casing shall be of two sections connected by a flanged joint with the upper half easily removable for inspection and servicing of the rotating assembly. The outer casing shall have insulation under cover with acoustic material for noise reduction if noise doesn’t meet =/< 85dB within 1m proximity of the decanter at full speed.

**M35.1.7 Centrate Discharge Chute and Surge Sump**

The centrifuge assembly shall be fitted with a stainless steel grade 316 centrate discharge chute which shall collect all centrate without splashing. The centrate chute shall be connected to the centrate pipe with a vibration take-up joiner and allowing for free gravity of the liquid discharge without backing up into the machine (adequately vented).

**M35.1.8 Solids Discharge Chute**

The centrifuge assembly shall be fitted with a dewatered/thickened sludge chute which shall direct all the dewatered/thickened sludge into the receiving conveyor/hopper.

The solids discharge chute shall be connected to a diverter gate manufactured from grade 316 stainless steel material and separated by a vibration take-up piece supplied by the manufacturer.

The cake discharge outlet chute (post the diverter valve), shall be sized to deliver dewatered/thickened sludge without spillage, to the receiving conveyor/hopper and shall be of 316 stainless steel construction.

A flexible connection to the centrifuge discharge flange shall be provided. The centrifuge discharge connection shall not transmit any vibration or load from the centrifuge to the discharge chute to receiving chute.
The centrifuge centrate chute shall terminate with a flange connection. The discharge pipe flange size shall be of Table E with table D flange thickness to AS2129 and vibration take-up joiners supplied as per supplier recommendations.

**M35.1.9  Maintenance Platform**

The walkways around centrifuge to provide maintenance access shall be of minimum 1000 mm width around the centrifuge and shall form part of the supporting structure platform. The access platforms shall be designed in a manner to allow maintenance and operating personnel to easily access lubricating points, bearings, inspection bowl drive, adjustment of weir plates, removal of centrifuge cover, access to instruments, access to manual and control valves of the centrifuge.

**M35.1.10  Feed Pipe**

The feed pipe shall be manufactured from 316 stainless steel.

**M35.1.11  Assembly**

The complete assembly including drive motor and lubrication system shall be mounted and aligned on a substantial galvanized sub-frame.

**M35.1.12  Bearing Temperature Monitoring**

A temperature sensor shall be fitted to the centrifuge motor bearings for motors >75kW. The sensor shall be connected to the control room to provide an alarm and trip function if the Temperature exceeds the maximum temperature limit.

**M35.1.13  Lubrication System**

A central grease lubrication system shall be provided mounted on the centrifuge base assembly. Lubrication system details and bearings served are to be set by the manufacturer to ensure that the external bearings are greased correctly (grease volume and intervals) and specified in the O&M manuals.

**M35.1.14  Testing of Centrifuge**

The Contractor shall allow for sampling and testing of the dewatering/thickening performance. The Contractor shall conduct the sampling and testing over seven working days at the settings selected by the Contractor as per the supplier's manual.

The dewatering and thickening performance testing shall be carried out in two phases. Two days initial testing shall be carried out at the maximum capacity of the centrifuge. The second phase of testing shall be carried out over five days at the design capacity.

During the testing of the centrifuge, the following parameters shall be monitored, calculated and recorded:

- a) Bowl speed (rpm)
- b) Centrifugal force (g)
- c) Pool depth (mm)
- d) Differential speed (rpm)
- e) Scroll torque (% or kNm) (in the case of variable speed scroll drive)
- f) Sludge feed (m³/hr)
- g) Solids loading (kg/hr)
- h) Feed solids concentration in sludge feed (%)
- i) Solids concentration in dewatered/thickened sludge (%)
- j) Polymer used (kg/dry ton)
- k) Centrate solids concentration (NFR mg/L)
- l) Solids Capture Rate (% : Target =/> 95%)
The test will consist of four samples per day. Samples, which will establish the solids concentrations of feed sludge, dewatered sludge and centrate, shall be collected at the rate of one per every two hours for each centrifuge.

For dewatering centrifuge, the samples taken for each centrifuge shall be tested for total solids concentration in the case of dewatered sludge cake and sludge feed, and suspended solids/Non-Filterable Residue (NFR mg/L) concentration for the centrate.

For thickening centrifuge, the samples taken for each centrifuge shall be tested for total solids concentration in the case of thickened WAS and total suspended solids/NFR (mg/L) concentration in the case of the centrate and WAS feed.

**M35.2 Rotary Screw Press**

This section covers the general technical requirements for the Rotary Screw Press dewatering equipment.

**M35.2.1 Rotary Screw Press (RSP) Process Description**

The Screw Press is a continuous dewatering device. A screw is installed between the two bearing housings, which are situated in the main frame. The rotating screw is surrounded by the filter screen which is attached to the main frame of the Screw Press.

Sludge enters the Screw Press, between the screw and the screen, where the solid matter is separated from the filtrate water. The filtrate water flows through the perforated screen and is collected by the drip tray. The solid matter is slowly conveyed through the press with the internal rotating screw, driven by a gear motor. Additionally, the screw is also equipped with a replaceable or adjustable scraper which cleans the inner surface of the filter screen.

A set of spray bars also allow for cleaning of the screen perforation to allow for clear pressate to free-flow the perforated screen.

The screw and filter screen are enclosed to contain odours and aerosols, as well as sprays and prevent spills. Access hatches on the sides of the filter cover allows for access, maintenance and viewing.

A washing device, which includes multiple washing nozzles, is contained in the enclosure to rinse the filter screen and the inside of the cover regularly, or on demand, using service water. The washing nozzles are installed on spray-bar tube/s. During the washing of the filter screen, the dewatering process is not interrupted.

The Screw Press filter screen is split into several sections for dismantling and screen panel section replacements.

When the sludge reaches the end of the rotary screw press, squeezing of the cake occurs, as the sludge is squeezed via a controlled pressure-plate/disc at the cake discharge end. The sludge cake is discharged at the end of the Screw Press, where a pressure-plate or cone is situated. This presser is used to push against the discharge, achieved by pneumatic cylinders or manually set, to remove further filtrate and obtain a dryer cake.

Preparing the sludge to the correct degree of flocculation is important. This is aided by the conditioning/flocculation tank which allows the flocs to grow and develop accordingly. Variable agitation in the conditioning tank assists the development of the flocculation of the suspended solids. The slurry enters the tank at the base and exits the tank via the top directly into the Screw Press.

The efficiency of the dewatering is determined by the composition of sludge, the degree of flocculation, the speed of the screw and finally the pressure on the presser at the end of the unit.
M35.2.2 Rotary Screw Press (RSP) Equipment Design-Life

The RSP equipment must have a minimum design service life of 20 years.

To achieve this service life, the Contractor’s designs must include the selection of appropriate materials to withstand the corrosive and highly abrasive environments typically found in Municipal Sewerage treatment plant equipment.

M35.2.3 Manual Handling & Safe Access

The design and installation of all RSP equipment must adequately consider the management of all potential manual handling risks associated with Sydney Water’s ongoing operation, servicing and inspection of the equipment. This design must meet the requirements of the relevant Australian standards.

All machine covers and safety barriers must be designed to enable safe removal by an operator, without the aid of an overhead crane where possible. Nb. Designs may require the inclusion of mechanical assistance. Eg spring or pneumatic devices

The design and installation of the RSP equipment must include the provision of safe access for personnel involved in operation, inspection, cleaning and maintenance duties.

All access platforms (if standard supply inclusive) must comply with the relevant Australian standards.

M35.2.4 Rotary Screw Press Assembly

The RSP unit is to be supplied mounted on a standard OEM subframe which can be secured to either concrete or steel structural beams.

Nb. For machines prone to high vibration levels, any equipment that is susceptible to damage can be mounted remotely from the assembled unit. Eg. electrical controls modules / main control systems.

Each RSP unit and sub assembly, must be provided with designated lifting points to enable safe installation and ongoing maintenance.

Details of any specialised lifting frames or attachments required for installation or ongoing maintenance, must be provided with the equipment.

The operating environment of Sydney Water’s WWTP’s is harsh. Particularly on machine components subjected to wetted areas, including but not limited to; rotating drums, pressate and sludge discharge chutes.

The drum/filter shall be of minimum 304 stainless steel construction and the rotating screw shall be of 316 stainless steel.

Machine covers shall be of 316 stainless steel material of construction, and alike for the pressure plate or cone, unless the manufacturer recommends otherwise.

Base frame shall be 316 stainless steel.

M35.2.5 Protective Coatings

All non-stainless steel, ferrous components must have protective coatings applied to WSA 201 and Sydney Water’s supplement, or equivalent for a 20-year lifecycle in coastal corrosive environments.

- Non-wetted structural components and bearing housings to be coated to withstand coastal corrosive environments.
- Gearbox & Electric Motors to be coated to withstand coastal corrosive environments.

M35.2.6 Fasteners

All fasteners shall be of 316 stainless steel.
M35.2.7 Rotary Screw Press – Cake Discharge Chutes
The design of all discharge chutes (Sludge and Centrate/Filtrate) must be sized and utilise materials to ensure free discharge of materials, prevent material build up / blockages and prevent splashing.

The RSP shall have provision for sampling points that are safely accessible during operation utilising 316 stainless steel components.

M35.2.8 Flocculation Tank
The flocculation tank shall be fixed to the floor using 316 Stainless Steel anchors, and the tank and components shall be of 316 stainless steel construction.

M35.2.9 Rotary Screw Press Functional Requirements
The following electrical devices are to be supplied by Sydney Water or the manufacturer as a minimum to automate and enhance the operation of the screw press:

- Solenoid valves for spray systems, or motorised stainless steel 316 ball valves with digital limit switches.
- Rotary screw speed sensor if required.
- Electronic shear pin if required.
- Level Transmitters (for flocculation/header tanks). Reliable level indication is critical, thus must be provided of hydrostatic type.
- Flow Switches or flow transmitters for spray system/s (adjustable)
- Pressure Transmitter for Back-Pressure Control (pressure measuring instrument as supplier recommendation)
- Mixer for flocculation tank to be easily sourced, accessible and maintained.

M35.2.10 Rotary Screw Press Polymer Dosing
The manufacturer shall supply a polymer dosing point to either or both, the feed pipe to the flocculation tank (via a mixing valve or inline mixer) or into the flocculation tank as recommended by the manufacturer.

The dosing points shall be of 316 stainless steel.

M35.2.11 Testing of Rotary Screw Press
The Contractor shall allow for sampling and testing of the dewatering performance. The Contractor shall conduct the sampling and testing over seven working days at the settings selected by the Contractor as per the supplier's manual.

The dewatering performance testing shall be carried out in two phases. Two days initial testing shall be carried out at the maximum capacity of the RSP. The second phase of testing shall be carried out over five days at the design capacity.

During the testing of the RSP, the following parameters shall be monitored, calculated and recorded:

(a) Screw speed (rpm)
(b) Spray Timers (ON & OFF timers)
(c) Pressure Plate or Cone Pressure (kPa)
(d) Flocculator Mixer speed (rpm)
(e) Sludge feed (m³/hr)
(f) Solids loading (kg/hr)
(g) Feed solids concentration in sludge feed (%TSR)
(h) Solids concentration in dewatered sludge (%TSR)
(i) Polymer used (kg/dry ton)
(j) Pressate solids concentration (NFR mg/L)
(k) Solids Capture Rate (%: Target => 95%); recovery (%)

The test will consist of four samples per day.

Samples, which will establish the solids concentrations of feed sludge, dewatered sludge and pressate, shall be collected at the rate of one per every two hours for each RSP.
M36. Conveyors

M36.1 General

This section covers the technical requirements for the supply of screw conveyors, belt conveyors and their appurtenances associated with the plant.

Permanent access platforms, ladders and walkways shall be provided as required for the operation and regular maintenance of the installed conveyors.

Minimum safety requirements shall be in accordance with AS/NZS 4024.3610.

All conveyors shall be designed for both automatic and manual operation and all the necessary instrumentation and controls shall be supplied and installed.

All other safety requirements in accordance with AS1755 shall be supplied and installed.

All discharge chutes from conveyors shall be vertical or pyramid type to prevent build-up of material. Inverted pyramid type chute will not be accepted.

The continuous rated output of the electric motor driving the conveyors shall be at least 50% more than the maximum power required by the unit under all operating conditions.

M36.2 Motion Detectors

Conveyors shall be provided with proximity sensor type motion detectors on a driven element (e.g. conveyor screw element) to initiate a failure alarm and/or machine shutdown.

The motion detector shall detect rotation or movement of the item and a suitable metal “target” shall be supplied and fitted to operate the motion detector. The motion detector contacts shall be wired to the SCADA system to give an alarm if the equipment is running but the motion detector indicates driven elements are not rotating.

M36.3 Screw Conveyors

M36.3.1 Screw Conveyor Construction

The following requirements apply when screw conveyors are used to convey materials. The screw conveyor shall be a shaftless type comprising of a helical screw with flights having abrasion resistant surfaces. No supports or bearings shall be provided for the screw within conveyor trough casings. The conveyor screw shall have a support bearing at the drive end, which shall be capable of taking all the thrust loadings.

The conveyor shall be designed so that clogging and build up on the flights shall not occur. The screw pitches shall be selected to efficiently convey material of the required moisture content. Screw, troughs and drive shafts shall be correctly aligned and free of sharp projections that might catch rags or stringy materials.

Screw conveyors for screenings shall be “push” type. For biosolids and grit “push” type screw conveyors are preferred but “pull” type can be used where acceptance from Sydney Water is obtained.

The screw conveyor shall be designed to have the following maximum parameters:

- Maximum operating speed of a horizontal screw conveyor 10 RPM, (with capability to change the reduction gear box to increase the speed up to 15 RPM).
- Maximum operating speed of an inclined screw conveyor 15 RPM, (with capability to change the reduction gear box to increase the speed up to 20 RPM).
- Maximum inclination of screw conveyor shall not exceed 30 unless specifically accepted by Sydney Water.
- No inclination above 45 degrees shall be permitted.
Screw conveyors shall only be utilised to convey dewatered sludge over as short a distance as possible. Belt conveyors are the preferred option to convey dewatered sludge.

Exceptions:

- Shorter Screw conveyors for silo feed
- Screw conveyors for truck loading where the operation of sequential outlet gates are required

Locked or bolted access opening for inspection and blockage clearance shall be provided at all intersections of the conveyor with other equipment.

Frequent inspection (twice a month) access opening shall be of hinged locked type.

Limit switches shall be installed on all hinged access openings to stop the conveyor in an automatic mode when the access covers are opened.

The normal mode of operation shall be to drive away from the motor end. The operation of the screw conveyors shall be designed and supplied to be interlocked with the operation of surrounding equipment and to prevent unwanted spillage of conveyed material when equipment is not operating.

The design of the collection / discharge points shall meet the requirements of Work Cover Authority of NSW. All other safety requirements shall be in accordance with AS1755.

**M36.3.2 Spiral**

The spiral shall have a minimum of 280mm diameter for dewatered screening and sludge handling conveyors. All free screening conveyors shall have a minimum of 250 mm diameter.

**M36.3.3 Screw Conveyor Troughs**

The screw conveyor trough shall have an easily replaceable wear resistance liner, to prevent the steel casing contacting the conveyor screw. The trough shall be fitted with wear liners which have coloured wear indicators in the liners.

Screw conveyor troughs shall be fitted with drain plugs at low ends of each trough. Drains shall be installed so that they do not create trip hazards.

**M36.3.4 Screw Conveyor Cover**

Screw conveyors shall be enclosed throughout their length by a cover, by fixed covers and by hinged access covers that can easily be locked closed.

Suitably sized and spaced air intake nozzles shall be provided in the covers to allow an even collection of foul air from the screw conveyors.

**M36.3.5 Screw Conveyor Feed Hopper(s)**

Feed hoppers shall be designed to receive and discharge material without blockages occurring. Feed hoppers shall be integral parts of the conveyor troughs and shall be manufactured from grade 316 stainless steel. The feed hopper shall be fitted with secureable airtight inspection doors.

**M36.3.6 Screw Conveyor Discharge Chute(s)**

Discharge chutes shall be integral parts of the conveyor troughs and shall be manufactured from grade 316 stainless steel. Chutes shall be fitted with a secureable and airtight inspection door.

The discharge chute may be manufactured from rubber when the material leaves the conveyor to drop into a bin etc.

**M36.3.7 Screw Conveyor Supports**

Conveyors shall be supported at each end and at intermediate locations. All support steelwork shall be fabricated from structural steel and be hot dipped galvanised after fabrication. Connections between grade
316 stainless steel and galvanised steelwork shall be bolted using insulation between the dissimilar metals. Welding between grade 316 stainless steel and galvanised steel is not permitted.

**M36.3.8 Screw Conveyor Drive**

The screw conveyor drive shall be by an electric motor with a directly mounted speed reduction unit. The motors shall be mounted at accessible locations.

Drives shall be fitted with electronic shear pins to prevent excessive loading or seizure.

**M36.3.9 Emergency Outlet**

All screw conveyors shall be provided with an emergency outlet chute or emergency relief flap gate to prevent over loading of conveyors.

**M36.3.10 Material of Construction**

The material construction of screw conveyor shall conform to the following:

- U-Trough and Lids: 2.5 or 3 mm stainless steel grade 316.
- Liner: 12 mm extra wear resistant, ultra-high molecular weight polyethylene.
- Spiral: High tensile micro-alloy steel.
- Chute and feed hopper shall be min. 2mm thick stainless steel grade 316.
- Support Brackets shall be stainless steel grade 316.

**M36.4 Belt Conveyors**

**M36.4.1 Standards**

Belt conveyor terms shall be as defined in AS 4035.

Additional safety requirements for belt conveyors shall be in accordance with AS/NZS 4024.3611.

Conveyor belts for conveyor belting made of elastomeric materials with textile reinforcement, intended for use on conveyors using flat or troughed idlers shall comply with the requirements of AS 1332.

Conveyor belting of elastomeric materials and steel cord construction in which the carcass is composed of a plane of steel cords with or without supplementary reinforcements shall comply with requirements of AS1333.

**M36.4.2 Inclination Angle**

Conveyor inclination angle shall be such that it does not result in product being conveyed moving relative to the belt.

**M36.4.3 Belt Material**

Belt carcass and reinforcement shall be of sufficient strength to provide reliable and durable belt operation under all design conditions.

Belt cover material shall have physical properties and chemical resistance with the product being conveyed to protect the carcass and to give the conveyor belt an economical life span.

**M36.4.4 Emergency**

Lanyards shall be provided along belt conveyors to stop the conveyors in an emergency.
M37. Chemical Systems

M37.1 General

This section of the Specification covers the general requirements for chemical related assets located at Sydney Water’s facilities.

Many of the chemicals used within Sydney Water’s facilities and network are classified as Dangerous Goods and are subject to specific requirements governed by both federal and state legislation.

M37.1.1 Applicability

A range of chemicals are used for different purposes at Sydney Water’s facilities. The application of the requirements of this Specification apply in principle to all chemical installations.

The table below summarises the chemicals found at various Sydney Water’s facilities.

<table>
<thead>
<tr>
<th>Common Chemicals</th>
<th>*Application Specific Chemicals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ferrous Chloride</td>
<td>Hydrochloric Acid</td>
</tr>
<tr>
<td>Ferric Chloride</td>
<td>Sulphuric Acid</td>
</tr>
<tr>
<td>Ferric Sulphate</td>
<td>Acetic Acid</td>
</tr>
<tr>
<td>Spent Pickle Liquor</td>
<td>Citric Acid</td>
</tr>
<tr>
<td>Aluminium Sulphate</td>
<td>Ammonium Hydroxide</td>
</tr>
<tr>
<td>Sodium Hydroxide</td>
<td>Biocides</td>
</tr>
<tr>
<td>Sodium Hypochlorite</td>
<td>Anti-scalants</td>
</tr>
<tr>
<td>Sodium Bisulphite</td>
<td>Powder and Liquid Polyelectrolytes</td>
</tr>
<tr>
<td>Hydrofluosilic Acid</td>
<td>Magnesium Hydroxide</td>
</tr>
<tr>
<td></td>
<td>Methanol/ Ethanol</td>
</tr>
<tr>
<td></td>
<td>Carbon Dioxide Solutions</td>
</tr>
<tr>
<td></td>
<td>Liquid Chlorine</td>
</tr>
<tr>
<td></td>
<td>Potassium Permanganate</td>
</tr>
<tr>
<td></td>
<td>Hydrated Lime</td>
</tr>
</tbody>
</table>

* Application Specific Chemicals are less commonly used, and are generally used for a specific process requirement. For these chemicals this Specification still applies, however amendments may be required to suit the specific properties of the chemical.

M37.1.2 Relevance to Other Documents

Other specifications have been produced to cover the specific requirements for the following:

a) Network Re-chlorination Dosing Systems (D0000389).

b) Network Chemical Dosing Units (ACP0002).
For those specific applications, the documents noted above take precedence over this Specification.

**M37.1.3 Innovation and Variance to this Specification**

This document provides an indicative solution for the works. The indicative solution stated within this Specification may be further developed or the designer may produce their own design that will fully comply with the Specification requirements.

Any alternative materials, designs, methods of assembly, and processes that do not comply with specific requirements of this Specification, or are not mentioned in it, but give equivalent performance outcomes to those specified, are not necessarily prohibited. Written acceptance from Sydney Water shall be sought with the design submission, prior to construction.

**M37.1.4 Relevant Regulations, Codes and Standards**

**M37.1.4.1 Legislation and Regulations**

Work Health and Safety Act 2011
Work Health and Safety Regulations 2011
Work Health and Safety (Managing Risks of Hazardous Chemicals in the Workplace) Code of Practice 2015
National Transportation Commission (NTC) – Australian Dangerous Goods Code
New South Wales Code of Practice for Fluoridation of Public Water Supplies

**M37.1.4.2 Australian and Other Standards**

ADR43/04 Vehicle Configuration and Dimensions
AS 1319 Safety signs for the occupational environment
AS 1345 Identifications of the contents of pipes, conduits and ducts
AS 1940 The storage and handling of flammable and combustible liquids
AS 2032 Installation of PVC Pipe Systems
AS 2129 Flanges for pipes, valves and fittings
AS 2700 Colour standards for general purposes
AS 2890.1 Parking facilities – Off street car parking
AS 3500 National plumbing and drainage code
AS 3735 Concrete structures retaining liquids
AS 3780 Storage and handling of corrosive substances
AS 3996 Access covers and grates
AS 4130 Polyethylene (PE) pipes for pressure applications
AS 4506 Metal finishing – Thermoset powder coatings
AS/NZS Australian Standard/New Zealand Standard
AS/NZS 3000 Electrical Installations (Australian/New Zealand Wiring Rules)
AS/NZS 4766 Polyethylene storage tanks for water and chemicals
ANSI Z358.1 Compliance requirements- Emergency shower and eye wash stations
ASTM D1784 Standard specification for Rigid PVC Compounds and cPVC Compounds
Technical Specification - Mechanical

ASTM D1785   Standard specification for PVC plastic pipe  
ASTM D2467   Standard specification for PVC Plastic Fittings, Schedule 80  
EN 13121   GRP Tanks and Vessels For Use Above Ground  
BS 4994   Specification for Design and Construction of Vessels and Tanks in Reinforced Plastics  
WSA 201   Manual for Selection and Application of Protective Coatings  
WSA 01-2004   Polyethylene Pipeline Code

M37.1.4.3  Sydney Water Standards  
Health and Safety Procedure HSP-058: Risk Assessment in Design  
Instrumentation and Control Standards TOG_TS01  
Supplement to WSA 201, ACP0166  
Technical Specification - Civil  
Technical Specification - Electrical  
SDIMS0026 Safety Signage Specification  
Commissioning Specification  
Jointing Requirements for Solvent Cement Welding Using Weldon 724 System.

M37.1.4.4  Supplier Standards  
Chemicals are supplied through contracts that are reviewed periodically. Suppliers have their own specific requirements for chemical delivery and storage. The most recent standards should be obtained from the chemical supplier prior to commencing design.

M37.2  Overall Requirements  
M37.2.1  Site Conditions  
The site is normally subjected to temperate climate conditions, with an ambient temperature range of (minus) -6°C to 50°C, and humidity of up to 100%. All equipment, unless otherwise specified, shall be designed to accommodate and operate satisfactorily within these conditions.

Additional consideration shall be given for sites that are subjected to strong wind and saltwater spray/mist, for example, marine conditions. Thus, all equipment shall be designed to accommodate and operate satisfactorily within these weather conditions.

M37.2.2  Materials  

M37.2.2.1  General  
All materials selected or adopted in the design shall be suitable for installation in the proposed environment, and suitable for use with and contact with the chemical involved. They shall be corrosion resistant and selected to match the relevant specified design life. Where required, materials shall be coated in accordance with the Water Services Association Manual for Selection and Application of Protective Coatings, WSA 201 and Sydney Water’s Supplement to WSA 201.

All components of the chemical dosing system should be from the same manufacturer (and where possible, supplier) for a specific dosing system and where possible, for any existing chemical dosing system on site. All valves of the same size, duty and type supplied under the contract shall be identical.
M37.2.2.2 Corrosion Resistance

All internal parts in contact with the chemical substances are required to be corrosion resistant against the chemical involved.

All bolts, nuts, and washers shall be made from stainless steel grade 316, or equivalent, which is deemed to be suitable for the application.

M37.2.2.3 Gaskets, “O” Rings and Rubbers

Only approved gaskets, O rings and rubber that are compatible for use with the specific chemicals shall be used. FPM and EPDM products are to be used for chemical applications as specified in the table below. For any chemicals not listed below, direction to be requested from Sydney Water.

Chemical Applications for FPM and EPDM

<table>
<thead>
<tr>
<th>FPM (Viton)</th>
<th>EPDM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ferrous Chloride</td>
<td>Ammonium Hydroxide</td>
</tr>
<tr>
<td>Ferric Chloride</td>
<td>Sodium Hydroxide</td>
</tr>
<tr>
<td>Ferric Sulphate</td>
<td>Methanol/ Ethanol</td>
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<tr>
<td>Powder and Liquid Polyelectrolytes</td>
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</tr>
<tr>
<td>Hydrochloric Acid</td>
<td></td>
</tr>
<tr>
<td>Sulphuric Acid</td>
<td></td>
</tr>
<tr>
<td>Acetic Acid</td>
<td></td>
</tr>
<tr>
<td>Citric Acid</td>
<td></td>
</tr>
<tr>
<td>Carbon Dioxide Solutions</td>
<td></td>
</tr>
</tbody>
</table>
**M1.1.1.1  Design and Selection for Temperature Effects**

Different chemicals are influenced by site ambient conditions, leading to crystallisation, off-gassing and chemical breakdown. Consideration is required during the design process to ensure appropriate controls such as shading, heat tracing and expansion/contraction loops are included to minimise the effects of these impacts.

**M37.2.3  Operability & Maintainability**

The layout of the equipment within a chemical storage or dosing bund shall be submitted to Sydney Water for acceptance prior to construction. This is to ensure that all equipment including key valving and maintenance items can be easily reached by personnel for maintenance and operation.

The general principle to follow in the design is that the area shall have adequate space to work in. There shall be no floor-mounted obstructions and working areas shall have immediate access to the point of safe egress. For adequate emergency access / egress, pathways around tanks etc. shall be a minimum of 1m wide. Permanent access for maintenance shall be provided to all maintainable equipment within a chemical dosing installation unless otherwise accepted by Sydney Water.

Access into each bunded area shall be one or two exits depending upon ease of access and maintenance of equipment. At each exit / entrance, there shall be stairs and a platform on each side of the bund wall. Access into chemical storage bunds shall comply with the requirements of AS1657 and AS3780.

**M37.2.4  Safety**

All chemical dosing and storage installations are subject to WHS legislation and all appropriate steps are to be taken to protect persons from the potential of harm. The legislation, codes and standards referenced in this Specification detail specific safety requirements and obligations. Specific requirements for chemical dosing applications are summarised within this section.

**M37.2.4.1 Safety Showers and Eyewash**

For all chemical dosing systems, deluge type safety shower and eye wash stations, conforming to AS4775 and ANSI Z358.1, shall be supplied and installed adjacent to the dosing equipment. Water to these facilities shall come from the potable water supply line. Water supply to safety showers and eyewashes shall be connected directly to the main supply and not be subject to disruption from plant maintenance.

Water pressure to the safety showers shall meet the requirements of AS4775 at all times, regardless of the demands of other equipment. Suitable backflow protection shall be considered in the potable water supply network in accordance with AS3500.

Long water lines to the safety shower and eyewash station that are exposed to sunlight shall be lagged, as water may be heated and therefore unsuitable for use. Lagging is to consist of suitable insulation with fixed/hard covering to prevent water ingress and damage. Examples of suitable covering would be aluminium sheet, or some proprietary plastic lagging systems (subject to Sydney Water’s acceptance). Aluminium foil tape type lagging covers are not acceptable.

The installation shall be complete including the necessary cut-in into the nearest potable water supply line, fittings, isolation valves, etc. The shower shall be free standing and hand operated. The eye/face wash shall be capable of being operated by both hand and foot, and include two double aerated outlets complete with dust covers. The material of construction shall be stainless steel.

**M37.2.4.2 Splashguarding and Protective Barriers**

Where chemical storage areas are located adjacent walkways and potential hazard of chemical spraying outside of a bunded area may exist, splashguarding is to be provided.

Splashguards are to be constructed from materials impervious to the chemical stored. They are to be located such that any chemical hitting the guard is directed into the storage bund or other contained location.
Guarding shall be adequately supported in consideration of any wind loads.

**M37.2.4.3 Safety Equipment Cabinet**

All chemical dosing facilities shall be fitted with a lockable cabinet at the chemical storage area. The cabinet shall be used to store personal protective equipment (PPE) for use by Production Officers.

**M37.2.4.4 Signage, Labelling, Tagging and Marking**

Tags, labels, signs, and other markings shall be provided for all these systems which clearly indicate the individual system, chemical contents, hazards, warnings, and any other pertinent information in accordance with the requirements of the relevant standards, codes of practice and specifications.

Signage shall be in accordance with SDIMS0026 Safety Signage Specification.

All assets shall be labelled and identified in accordance with Sydney Water’s Commissioning Specification.

**M37.2.5 Environmental Management**

The complete chemical system, including but not limited to; storage facilities, delivery facilities, transfer pipework, dosing systems and dosing lines through to the dosing location shall be designed to provide a complete containment strategy for all aspects of the system. This ensures that any component failure or leak is captured and contained for safe disposal.

The containment shall direct any leakage or spillage to a safe location where it may be managed appropriately. This methodology is to include appropriate locations for visual identification of leaks and leak detection at any low points. The containment methodology is to be discussed and accepted by Sydney Water prior to implementation.

**M37.3 Staff Requirements and Design Deliverables**

**M37.3.1 Training Requirements**

The following specific training requirements apply to all personnel working on chemical dosing systems: All project engineers, design engineers, project managers, supervisors, leading hands and fitters specifically working on the chemical dosing systems will attend Sydney Water’s Chemical Dosing Training.

a) All personnel installing plastic pipework including uPVC, cPVC and electrofusion welded polyethylene will undertake specific supplier or industry training on installation techniques. The selected training is to be pre-approved by Sydney Water.

b) Principal: Jointing Requirements for Solvent Cement Welding Using Weldon 724 System. The use of tools, inclusive of pipe cutters, chamfering and de-burring tools detailed in this procedure shall be adhered to. Personnel carrying out the work shall be adequately trained in accordance with the requirements of this document.

c) Records / certificates for this training will be submitted with construction ITPs and checklists or produced upon request by Sydney Water.

**M37.3.2 Minimum Design Deliverables**

The following deliverables are required for all chemical dosing system designs. This list establishes the minimum requirements, and variance to these deliverables is subject to Sydney Water’s acceptance. All normal requirements for delivery and handover are also applicable to chemical dosing projects.
<table>
<thead>
<tr>
<th>ITEM</th>
<th>DELIVERABLES</th>
<th>SUB DELIVERABLES (Additional to normal design)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>50% detail design documentation</td>
<td>-3D layouts of equipment and dosing skid. These shall be provided in 3D PDF format for review.</td>
</tr>
<tr>
<td>2.</td>
<td>90% detail design documentation</td>
<td>-Equipment schedule identifying all components of the system including Supplier, Manufacturer, Model, Size, Pressure Ratings and Process Connections.</td>
</tr>
<tr>
<td>3.</td>
<td>IFC detail design documentation</td>
<td>-Schedules to include valves, pumps, fittings, pipework materials and all dosing system ancillaries.</td>
</tr>
<tr>
<td>4.</td>
<td>HIDRA – Design</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>IFC detail design documentation</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>HAZOP / CHAZOP report</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>CHAIR report</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Final Work As Constructed (WAC) drawings supplied electronically in both AutoCAD DWG and Adobe PDF formats</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Workshop and factory acceptance test (FAT)</td>
<td>-Any fabricated dosing “skid” arrangements shall require a factory based inspection prior to gluing and painting. Inspection shall be undertaken by Sydney Water.</td>
</tr>
<tr>
<td>10.</td>
<td>Construction, Commissioning and Handover</td>
<td>-This will be in accordance with the requirements of project specific specification. -Evidence of training records will be a required deliverable with ITPs and Check sheets. -Update of Documentation</td>
</tr>
</tbody>
</table>

**M37.4 Chemical System Description and Requirements**

**M37.4.1 General Description and Generic Process Diagrams**

Safe chemical receiving, storage, transfer and dosing systems are to be provided for all chemicals that are to be used. The chemical systems shall include all pipework, fittings, valves, instruments and controls, from the point of bulk delivery to the point(s) of injection into the process streams.

This Specification and supporting documentation have been developed to ensure chemical installations are designed, constructed and commissioned to ensure process security, safety, environmental protection and quality.

Sydney Water have developed a set of generic Process and Instrumentation Diagrams (P&IDs) to provide indication of the minimum standard for required equipment, instrumentation and valving on typical installations at SWC facilities. These P&IDs are provided for guidance only, and a specific P&ID shall be developed and
submitted for review for each unique chemical system being designed. Variation to the standard arrangements will be subject to acceptance by Sydney Water.

The generic P&IDs are to be requested from Sydney Water, and are outlined below:

<table>
<thead>
<tr>
<th>PID NUMBER</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>PID/1</td>
<td>Generic P&amp;ID – Chemical Dosing (w/Day Tank)</td>
</tr>
<tr>
<td>PID/2</td>
<td>Generic P&amp;ID – Chemical Dosing (Standard Arrangement)</td>
</tr>
<tr>
<td>PID/3</td>
<td>P&amp;ID – Line Legend and Instrumentation Symbols</td>
</tr>
<tr>
<td>PID/4</td>
<td>P&amp;ID – Prefixes and Piping Code</td>
</tr>
<tr>
<td>PID/5</td>
<td>P&amp;ID – Symbols</td>
</tr>
<tr>
<td>PID/6</td>
<td>Generic P&amp;ID – Magnesium Hydroxide Dosing</td>
</tr>
<tr>
<td>PID/7</td>
<td>Generic P&amp;ID – Magnesium Hydroxide Batching &amp; Dosing</td>
</tr>
<tr>
<td>PID/8</td>
<td>Generic P&amp;ID - Notes</td>
</tr>
<tr>
<td>PID/9</td>
<td>Generic P&amp;ID – Re-chlorination CDU Generic Dosing</td>
</tr>
</tbody>
</table>

M37.4.2 Key Elements of Chemical Systems

Chemical Systems are made up of a number of key elements. These elements all have specific requirements to ensure the complete chemical system is designed and constructed accordingly.

The elements are summarised below, and the requirements for each element are detailed in the following sections.

<table>
<thead>
<tr>
<th>ELEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical Delivery Bund</td>
</tr>
<tr>
<td>Chemical Storage Bund</td>
</tr>
<tr>
<td>Chemical Storage Tank</td>
</tr>
<tr>
<td>Chemical Dosing System</td>
</tr>
<tr>
<td>Chemical Pipework and Fittings (Including Dosing lines)</td>
</tr>
<tr>
<td>Dilution Water</td>
</tr>
</tbody>
</table>

M37.5 Chemical Delivery Bund

A chemical delivery bund shall be designed and constructed to provide safe arrival, parking, off-loading, turning around (if necessary), and departure of bulk chemical tanker trucks.
Where a single bund is used for delivery of multiple different chemicals, the compatibility of these chemicals will be assessed, and appropriate steps taken to prevent cross-contamination.

**M37.5.1 Location**

The delivery bund shall be located adjacent to the chemical storage facilities. Unless otherwise specified, the storage facility shall be located on the left (passenger) side of the tanker.

The unloading point shall allow the chemical delivery tanker to be fully inside the delivery bund when unloading. The unloading hose connection point shall be no more than 6m from the tanker connection point, as per the Dangerous Goods Code of Practice.

**M37.5.2 Access**

The chemical delivery bund shall be separated from the plant road where possible so that traffic moving around the plant does not have to travel through the delivery bund. The chemical delivery bund shall be designed to accommodate semi-trailers and truck and dog combinations up to 19m long to drive through. Swept path analysis shall be carried out to demonstrate vehicle accessibility during design development. The design is to avoid the possibility of the delivery truck having to pass back through a bund in which a spill has occurred.

Delivery bunds for polymer solution only may be reduced to 9m to accommodate an 8m flat-top tray truck carrying a maximum 8 off individual 1,000L intermediate bulk containers (IBCs). It shall be stated on the WAC drawings that the bund is designed for a flat top tray truck carrying a maximum of 8 off liquid polymer IBCs.

**M37.5.3 Bund**

The delivery bund shall be a concrete slab with a rounded bund wall, to provide containment for any spill or leaks. Relevant aspects of AS 3780 shall be complied with where corrosive chemicals are used.

The bund shall be designed as a water retaining structure in accordance with AS3735. It shall have a capacity of 9,000 litres or 110% capacity of the largest tanker vehicle compartment, whichever is greater.

The bunded area shall be designed with a 1 in 75 grade towards the sump drain, such that no pools of chemical or rainwater will accumulate on either side of the bund. The bund walls must also be painted yellow or marked with yellow edge strip to increase visibility and reduce the risk of tripping onsite. The step between the delivery bund low level adjacent footpaths is to be a maximum of 225mm as per AS1657 step size criteria unless accepted by Sydney Water.

Any humps in the roadway at either end of the tanker delivery bund shall be designed to allow normal passenger vehicles (Class B99) to enter and exit without scraping the bottom of the vehicle, as per the clearance requirements of ADR43/03 and AS2890.1, unless other vehicle types agreed or specified by Sydney Water.

The area between the tanker bay bund and the storage bund shall be concreted, and any spills in this area must be contained and drain into the delivery bund.

The delivery bund arrangement must ensure any stormwater from the surrounding roadway and ground shall be channelled away, and not flow into the delivery bund.

A suitable coating may be applied to the internal surfaces of the delivery bund. Where epoxy paints are used, they shall be resistant to the chemical involved. Coatings are to be selected in accordance with WSA201, and Sydney Water’s Supplement to WSA201. In applying the coatings, the manufacturer’s specific instructions on surface preparation and application requirements shall be followed. The resultant finish shall be non-slip.

**M37.5.4 Sump and Discharge**

A sump (minimum 600 mm x 600 mm x 600 mm deep), complete with a light weight lid, shall be located adjacent to the delivery bund.
The sump pit shall be located where it is not subjected to vehicle loading at one of the sides (outside) of the delivery bay bund. It shall be fitted with a grate/cover, made from lightweight materials, weighing no more than 16 kg, in accordance with AS3996, Class A. The weight limit shall be labelled where appropriate. Where the unit’s location is subject to falling debris from trees in the area, perforated sump covers with 12mm diameter holes must be used as opposed to grated covers to prevent blocking of drainage system.

A sump pump is to be provided to transfer any spills to a discharge point fitted with a 50 mm “camlock” coupling or to a point early in the overall process (e.g. the head of works, or as agreed with Sydney Water). The pump shall only be activated by a local stop/start station and include an automatic low level cut-out. The sump pump shall be manufactured from appropriate materials to withstand corrosion from the chemicals that it may be subjected to. The submersible pump shall be elevated from the floor of the sump to prevent clogging by dirt and debris. It shall be furnished with an accessible discharge union coupling, to enable removal for cleaning and servicing without the need for confined space entry permit.

A “camlock” pump out point shall be installed to allow pump out from the sump pit and bund area. The location of the “camlock” pump out point shall be such that the pump out truck does not have to enter the bunded area where possible. Isolation valves shall be installed to allow pump out from the sump pit pump or “camlock” connection.

The line from the sump pump to the point of disposal shall not include any branches where incompatible materials can mix (e.g. sodium hypochlorite with an acidic liquid).

There shall be individual lines from each tanker delivery bund sump to the point of disposal.

M37.5.5 Unloading Point

The chemical storage tank fill line shall be installed in accordance with the following requirements, or those specified by the chemical supplier.

A min. 50mm tanker fill pipe connecting from a 50mm suitable male “camlock” fitting, with lockable cover, through to the storage tank. The “camlock” shall terminate over the storage bund or other appropriate leak capture arrangement.

A ball valve is to be installed on the fill line, but is to be accessible from the delivery bund for delivery driver operation.

A drain line of smaller diameter than the fill line is to be installed between the “camlock” and fill line isolation valve. The drain line will be fitted with a ball valve that shall also be accessible from the delivery bund for delivery driver operation. The drain shall drain to a tundish that is to be visible to the delivery driver from outside the storage bund. The tundish shall subsequently have a drain line routed to the storage bund sump.

The coupling point must be positioned at least 600mm and no more than 900mm above the ground and firmly supported. Support shall be provided for the delivery hose, including clamping, to prevent damage to the coupling point during chemical delivery.

A placard containing information on chemical, tank descriptor (storage or dosing), tank capacity and safe fill volume must be placed clearly on each line at the loading point as per SDIMS0026 Service Delivery Safety Signage Specification.

Two permanently mounted electrical power outlets are required for delivery of chemical. The power outlets are 400V and 240V IP56 GPOs with RCD protection for each chemical storage tank (or tank pair in some dual tank systems) as per Sydney Water SCADA standard starter template. These will be interlocked with tank high level such that power will be cut to the outlets when high level is reached. Where multiple tanks exist in a common bund, a single GPO pair may be used (subject to Sydney Water’s acceptance), provided that the single GPO pair is interlocked with the high level of both tanks.

Power outlets shall be located between 2m and 7.5m from the tanker hose connection.

A weatherproof digital display of the tank level shall also be installed at the filling transfer point to indicate the actual level during filling. An alarm system consisting of a klaxon and beacon shall also be installed at the filling point, to alarm if tank has overflowed during filling. The digital display for tank level shall be suitable
for operation with 24V DC power supply. It shall be equipped with sunlight readable LEDs and a minimum reading range of 10m. It shall be suitable to display percentage values.

Where multiple different chemicals are delivered using a single common delivery bund, non-compatible chemicals shall not share the bund unless approved by the chemical supplier and accepted by Sydney Water, and appropriate protection is put into place to prevent any potential reactions occurring. Locked unloading points or security cages shall be used to ensure the correct delivery point is used.

A meeting must be arranged with the relevant chemical supplier for the specific chemical to confirm the tanker unloading arrangement is acceptable for delivery. Sydney Water shall be invited to attend this meeting.

M37.5.6 Safety Equipment

The following minimum safety equipment will be provided at the delivery bund:

- A safety shower and eyewash complying with the requirements of this Specification, located within 2m to 7m of the chemical delivery connection point.
- A UV resistant hose reel (20mm NB minimum) permanently attached to a water supply (reclaimed effluent at Treatment Facilities) and capable of reaching all parts of the chemical delivery bund shall be provided.
- Sufficient lighting to enable safe work beyond daylight conditions, particularly for the chemical delivery activities.
- A SDS for each chemical shall be provided in a weatherproof fixture near the respective unloading points.
- An ABE fire extinguisher for use in electrical fires shall be provided.

M37.6 Chemical Storage Bund

M37.6.1 Bund

Each chemical storage area (including polymer solution) shall include a storage bund constructed of reinforced concrete. Bunds shall meet the requirements of AS3780, and shall be designed as a water retaining structure to AS3735. The bund structure is to be hydrostatically tested after construction.

The bund shall meet the storage capacities as detailed in AS3780 (Normally 110% of the largest container in the bund). Bund flood level is to be indicated on design drawings.

The bunded area shall be designed with a 1 in 75 grade towards the sump pit such that no pools of water/chemical will accumulate on the bund floor.

A pipe chase shall be provided in the bund floor for the overflow/drain pipe from the storage tank to the sump. The pipe chase shall drain to the sump and shall be complete with FRP grating.

A suitably sized reinforced concrete plinth of min. 150mm high shall be provided for the mounting of the chemical storage tank(s). The plinth shall be appropriately designed for the maximum forces imposed on it by the tank, and any wind loads.

Access steps/stairs shall be provided on the inside and outside of the bund wall to provide safe access and egress, in accordance with AS1657. Normal working areas shall have immediate access to the point of safe egress. The width for emergency access and egress shall be no less than 1 m, unless specified otherwise.

A suitable coating shall be applied to the internal surfaces of the bunds, including any sumps or pipe chase(s). Coatings shall be resistant to the chemical involved and meet the requirements of WSA 201 and Sydney Water Supplement to WSA201. In applying the coatings, the manufacturer's specific instructions on surface preparation and application requirements shall be strictly followed. The resulting finish shall be non-slip.

Electrical components shall be installed above the bund flood level, except for the tank isolation/anti-syphon valve if it is installed below that level.
M37.6.2 Sump and Discharge

A lined concrete sump (minimum 600 mm x 600 mm x 600 mm deep), complete with a light weight lid, shall be located adjacent to the bund wall such that the sump pump may be accessed without entering a flooded bund. This may require installation of a gate in the security fencing. The sump shall be fitted with a grate suitable to accept the weight of personnel. The grate shall have handles which will allow the grate to be removed.

A sump pump is to be provided to transfer any spills to a discharge point fitted with a 50 mm “camlock” type hose coupling or to a point early in the overall process (e.g. the head of works, or as agreed with Sydney Water). The capacity of the pump shall be such that it can empty the full capacity of the bund within approximately 4 hours. The pump shall only be activated by a local stop/start station and include an automatic low level cut-out. The sump pump shall be manufactured from appropriate materials to withstand corrosion from the chemicals that it may be subjected to. The submersible pump shall be elevated from the floor of the sump to prevent clogging by dirt and debris. It shall be furnished with an accessible discharge union coupling, to enable removal for cleaning and servicing without the need for confined space entry permit.

A “camlock” pump out point shall be installed to allow pump out from the sump pit and bund area. The location of the “camlock” pump out point shall be such that the pump out truck does not have to enter the bunded area where possible. Isolation valves shall be installed to allow pump out from the sump pit pump or “camlock” connection.

The line from the sump pump to the point of disposal shall not include any branches where incompatible materials can mix (e.g. sodium hypochlorite with an acidic liquid).

The bund shall also include a level switch connected into the SCADA system to activate an alarm to warn that a high level has been reached in the bund. The level switch set point shall be agreed with Sydney Water.

M37.6.3 Storage Bund Roof Structure

Car port type roofs shall be provided over all chemical storage and dosing systems, and to extend at least 1m outside bunded areas. Car port type roofs shall have:

- Wall cladding down to approximately 2.5 m above the top of the bund walls,
- Gutters and downpipes which are in accordance with relevant section of Technical Specification - Civil, and which shall dispose roof water to the plant stormwater drainage system. Roof water shall not be directed into the bunded areas nor to the truck delivery bund.
- The roof connections are to be bolted to minimise the works involved in removing the roof if a tank replacement is required where applicable.

Equipment and instruments supplied and installed on top of each tank shall be capable of being removed without dismantling the roof. The roof shall be designed so that it does not impede access for the delivery road tanker trucks.

Structure to be designed to AS1170.0 – AS1170.4 Structural Design Actions – Set. The design shall be site specific to evaluate wind direction, topographic and shielding factors.

The roof cladding shall be “Colorbond” metal roof sheeting supported on steel columns and beams, appropriately designed and constructed.

Wall cladding shall be similar to the roof cladding.

M37.6.4 Fencing

A man proof, cyclone wire fence and single locked gate (or gates) shall surround each bunded area. Steps shall be provided at each gate over the bund wall. Supports for the man proof fence shall be separate from the columns for the storage tank covers. The fence shall be at least 2.0 m in height.
Consideration is to be given to the installation of shade protection to protect chemical tanks and equipment from heat where appropriate.

**M37.6.5 Safety Equipment**

The following minimum safety equipment will be provided at each storage bund:

- A safety shower and eyewash complying with the requirements of this Specification located within the storage bund, and directly accessible from key storage bund work areas.

- A UV resistant hose reel (20mm NB minimum) permanently attached to a water supply (reclaimed effluent at Wastewater Treatment Facilities) and capable of reaching all parts of the storage bund shall be provided. The hose shall be of sufficient length for connection from the service water tapping point to the suction flushing point at the dosing pumps. The hose shall be fitted with a female “camlock” connection on the end of the hose, and supplied with a nozzle that connects to the “camlock” (male “camlock” on the nozzle). This will enable the hose to be used for flushing chemical lines and pumps.

- Supply a secondary hose (not connected to the water supply) for use as a drain hose to direct flushing water to the storage bund sump. This hose shall be supplied with a female “camlock” fitting on each end.

- Sufficient lighting to enable safe work at night, including immediately over the dosing equipment to enable all equipment to be readily seen and be accessible.

- A carbon dioxide fire extinguisher for use in electrical fires shall be provided.

**M37.7 Chemical Storage Tank**

Chemical storage tank(s) shall be provided for safe storage of chemical and be located within the chemical storage bund. The tanks to be sized to provide four weeks of storage at nominal use.

**M37.7.1 Introduction**

The storage tank shall be manufactured from a material suitable for the chemical specified and the operating environment. Commonly used materials include high density translucent (white) polyethylene, spirally wound GRP and epoxy coated mild steel. Tank material selection is subject to the Sydney Water’s acceptance.

Storage tanks shall be cylindrical in shape with vertical walls for ease of instrument calibration. Tanks of non-uniform cross-sectional area will not be accepted.

The tanks supplied shall be fitted out with branches, fittings, labelling and identification numbers attached so they can operate as required by this Specification.

The storage tank(s) shall be designed and constructed to provide maximum draining of the tank and its connections while still maintaining the structural integrity of the tank walls and base. Equipment, such as access hatches and level sensors shall be easily accessed for ease of operation and maintenance.

There are 3 acknowledged references to tank capacity as follows:

a) Nominal Capacity – This is the tanks capacity as stated by the manufacturer. It is the tanks nominal capacity without fittings.

b) Effective capacity – This is the capacity of the tank to contain product. It is the tanks volume as determined from the floor of the tank to the invert of the tank overflow.

c) Working capacity – This is the tank capacity to deliver product. It is determined from the obvert of the discharge to the invert of the overflow.

The storage volume shall be calculated from the Working capacity.

**M37.7.2 General Requirements**

As a minimum, tanks shall be designed for and comply with the following:
Chemical storage tanks shall be fabricated in accordance with the minimum requirements of the applicable standards.

All tanks shall be furnished with at least one 600mm access hatch. All tanks, having a capacity of 5,000 litres or greater, shall be furnished with a minimum 600mm diameter opening for a side-mounted access hatch. The invert level of the access hatch opening shall be at least 1m above the floor of the bund.

All tanks shall be suitably reinforced to withstand all forces, including filling forces, without deformation when they are filled, and wind loads when they are empty.

The tanks shall be self-supporting and have a flat base. Suitable “mats” shall be supplied and installed between the tank and the plinth to prevent abrasion of the tank.

Tanks shall have appropriate mounting lugs, sized to ensure there is a minimum of 100mm cover for the hold down bolts from the edge of the plinth.

All tanks shall be fitted with lifting lugs designed so that two only can take the weight.

The tops of tanks shall be capable of supporting the weight of maintenance personnel. All necessary stairs and platforms shall be provided for maintenance access.

Where a tank requires a mixer, the mixer shall be supported on a suitably designed galvanised steel (or stainless dependent on chemical) frame independent of the tank. The frame shall also be painted with a paint, which is resistant to the chemical involved.

Furnish all manways and spare connections with the specified type of nuts, bolts and gaskets. Furnish all spare connections with suitable blind flanges.

Gaskets with full face such as Viton or Hypalon, of 50 to 60 Shore "A" Durometer shall be provided. Grade 316 stainless steel nuts and bolts are to be used.

Where practical, tanks shall be painted/coloured to reflect the chemical contained, as per the colour guide included in this Specification.

**M37.7.3 Tank Features**

Chemical storage tanks shall have the following features:

A suitable vent (breather) on the apex of the tank roof. The vent shall penetrate the tank roof and finish in a 180-degree bend with the open end facing downward. The end of the vent pipe shall be covered with a 6.5 mm mesh to prevent vermin ingress. Where chemicals stored have a corrosive vapour, vent is to be directed to a safe location away from metallic structures or equipment.

One minimum 80 mm diameter overflow branch. The overflow line diameter should be at least 1.5 times the diameter of the filling line. This shall be located 50 mm down from the roof-wall joint.

One drain branch with minimum diameter of 80 mm shall be provided as close to the tank floor level as practicable.

Two 50mm diameter branches located in the same vertical plane at appropriate levels for the installation of a level indicator.

One 50mm diameter branch on the top of the tank for the inlet from the delivery point, located on the side closest to the delivery point.

One 25mm diameter top mounted branch for the calibration cylinder vent return line. Where multiple dosing systems are fed from one tank, a separate connection is required for each calibration cylinder.

One suitably sized chemical outlet. This should be located approximately 50mm above the floor of the tank to allow suspended matter in the chemical to settle in the tank.
h) One suitably oversized (~300mm) top mounted flanged connection with blank for an ultrasonic level transmitter, or, alternatively a flanged branch at the bottom of the tank for a pressure type transmitter, complete with transmitter with local level indication, and complying isolation and drain valving to enable in service maintenance on the instrument.

i) For chemical systems with degassing, an additional 25mm diameter top mounted branch for the degassing line return to the storage tank.

j) An isolation valve on each tank outlet connection. Isolation valves shall be directly connected to the tank outlet flange to minimise risk of breakage. Where connection to the tank outlet flange is not possible, consideration shall be given to the use of appropriate metallic pipe (such as schedule 40 stainless steel, DICL and preferably concrete encased) located between the tank discharge flange and isolation valves. The design of the discharge pipe should be such that it does not constitute a trip hazard (i.e. shall be buried or have step/s or cover installed if/where access over a discharge pipe is required). No fittings (elbows etc.) are permitted between the valve and tank flanges.

k) All branches on the tank shall finish with 150 mm or more from the tank wall or roof with a Table D or E flange of AS 2129.

M37.7.4 Level Instrumentation

A high level switch shall be provided just below the overflow level of the storage tank to cut power to the tanker delivery power outlets and a low level switch shall be provided as a suction safety switch to stop the metering pumps. Installation of these switches on a magnetic indicating level is permissible.

Chemical storage tanks will be fitted with continuous level monitoring to relay the level/quantity of contents in the tank to the facility control system in accordance with the requirements of the Instrumentation and Control Standards (General) TOG_TS01. Ultrasonic level transmitters and hydrostatic pressure transmitters are acceptable.

All chemical storage tanks will be fitted with a local level indicator. The indicator shall be adjacent to the tank wall, in order to indicate actual liquid level inside the tank during filling and shall be visible from the filling point.

Level indicators shall be installed with complying isolation valves at the connections with the storage tank, and with a drain valve at the base. Construction of level indicators will be to the same requirements as all other chemical pipework. Magnetic type indicators are preferred.

M37.7.5 Tank Inspection and Testing Requirements

Chemical tank designs are to be verified by an independent third party and inspected during and after manufacture by an independent inspector (this may be the same person as the design verifier). The selection of a design verifier or inspector is subject to Sydney Water’s acceptance, and they shall be able to demonstrate relevant design verification experience across multiple fabricators and suppliers on industrial and chemical/petrochemical applications, i.e. verification of FRP tanks designed to BS4994 Category 1 requires design experience across multiple fabricators and suppliers in FRP tanks designed to BS4994 Category 1.

Inspection and testing activities are to include hold points and witness points as agreed by the independent inspector and subject to Sydney Water’s ‘s acceptance.

Tanks shall be hydrostatically tested with water to a level equivalent to the SG of the chemical, at overflow level for 24h prior to delivery to site.

Prior to installation, tank plinths are to be inspected to ensure they provide a level, even surface with no high or low points that may create high load points on the tank.

Chemical tanks are to undergo a secondary hydrostatic test (using water, then chemical) once the tanks are installed in their final location to ensure no tank damage or failure has occurred during transportation and installation.
Onsite inspections post fabrication will be required at Sydney Water’s discretion. Supplier to include detailed maintenance and inspection program with offer to ensure longevity of tank.

**M37.7.6 Glass Fibre Reinforced Plastic (GRP) Chemical Storage Tanks**

Fibreglass chemical storage tanks shall only be used where suitable for the chemical being contained. In addition to the requirements for chemical storage tanks elsewhere in this Specification, fibreglass chemical storage tanks shall also comply with Sydney Water’s Specification for FRP Chemical Tanks.

**M37.8 Chemical Dosing System and Components**

The required dosing system shall be designed to provide a reliable, continuous dosing of metered volumes of chemical. All pumps, valves, fittings and pipework necessary for the proper operation of the dosing system shall be provided. The piping shall be suitable for the chemical conveyed. The required elements in a typical chemical dosing system are detailed on the generic P&IDs.

**M37.8.1 General Requirements**

The following general requirements apply to all chemical dosing systems:

- a) All chemical systems shall be designed to allow for drop tests or individual system maintenance without a need to isolate all the other systems on the same tank.
- b) The system shall be failsafe against siphoning. Two protection devices shall be installed. A combination of a pressure retaining/anti-siphon valve and an actuated isolation valve are required.
- c) Design of chemical systems shall facilitate draining and minimise low points.
- d) Where multiple dosing systems (multiple dosing points) draw from one common storage/day tank, a manual isolation valve, an actuated isolation valve and calibration cylinder shall be provided for each dosing system. Each system should be capable of being isolated such that adjacent systems may continue to operate.
- e) Chemical dosing skids and associated pipe work shall not be painted prior to a pressure test being undertaken on site. Painting shall only be completed following a successful, final pressure test for a specific pipe section.
- f) Layout of chemical dosing system components should be logical and be oriented in direction of flow where possible.
  - a. Electrical equipment is to be installed above the flooded bund level where practicable. It is noted that this may not be possible for the actuated anti-syphon valve.

**M37.8.2 Mounting and Support of Dosing Equipment**

Where support frames are used to hold pumps, valving and equipment (dosing “skids”) materials for the support frames and pipe supports shall be selected in consideration of the chemical stored in each respective bund. The use of powder coated stainless steel in accordance with AS4506 – Metal Finishing – Thermoset Powder Coatings – (See table 2.1) Classification Application D is preferred where appropriate. Design of skid arrangements should be in consideration of their final installation location. Appropriate consideration is to be given to guarding of splashing as a result of equipment failure, such that any chemical is contained appropriately.

Pipe clips and fittings shall be suitably raised with spacers to ensure that there is sufficient space for the unions on the valving and equipment that is mounted on a backing board or supports to be unscrewed and tightened as required for maintenance activities.

Where practical to do so, a minimum distance of 2 x socket lengths shall be left between fittings so that in the event of failure of the fitting new fittings can be installed without the need to remove additional joints.
### M37.8.3 Chemical Dosing Pumps

Two identical duty and standby dosing pumps of suitable brand, type and capacity range, shall be provided for dosing. Should the duty pump fail, the switchover to the standby pump shall be automatic.

The dosing pumps shall be digital dosing type, unless process constraints (such as electrical hazardous areas) prevent their use. The pumps may incorporate internal pressure relief and automatic air bleed of the hydraulic medium. The liquid ends shall provide for easy maintenance. Orientation of the pump dosing head shall be specified when procuring to facilitate access for maintenance in situ.

Dosing pumps shall be specified such that they comply with the requirements of the current SCADA/IICATs standard. In particular the requirements of the Treatment Plant SCADA Standards are to be met unless otherwise accepted by Sydney Water.

Even if a metering pump is supplied with an internal pressure relief system, the Contractor shall provide an external pressure relief valve in the discharge pipework for each pump. This relief line shall be designed such that the inlet and discharge sides of the relief valve remain flooded to prevent the diaphragm in the valve drying out. The relief line will be piped to the vent line of the calibration cylinder. This enables a pump relieving to be visually seen in the calibration cylinder.

The dosing pumps shall be digital (10bar) with a turndown ratio of 100:1 or better.

Dosing pumps shall be specified such that they comply with the requirements of the current SCADA/IICATs standard. In particular the requirements of the Treatment Plant SCADA Standards are to be met unless otherwise accepted by Sydney Water.

Where standard motor driven piston pumps are used, turndown shall be by a variable speed drive (VSD) and motorised stroke controller. The turndown ratio shall match the process requirements regarding dose, range of process flows, and the specific gravity and concentration of the chemical. The stroke adjustment shall incorporate a calibrated dial [0 - 100%] to facilitate pre-setting and shall be capable of adjustment regardless of whether the pump is operating or not. Alternatively, the pumps shall incorporate digital indication of the set rate. The minimum stroke setting for automatic control shall be not less than 20%.

Back pressure valves shall be installed on each discharge line from the metering pumps to maintain dosing accuracy over the range of operating depths in the storage tank. The minimum back pressure setting of the valve shall be 3 bar.

Metering accuracy of the pumps shall be better than 2.5% of the minimum rate at a variable suction head. For each dosing pump supplied, the Contractor shall supply a graph showing pump setting versus flow rate in litres per hour. A copy of this graph shall be supplied in a perspex-covered frame and mounted on the wall near the metering pumps.

If the required turndown cannot be achieved using a single pump, multiple pumps shall be used.

Pumps that have no calibration below a pre-set flow will not be accepted.

Pumps shall be supplied and installed with suction strainers with a maximum opening of 1mm.

Each pump shall be provided with appropriate isolation valves.

All pumps requiring lubrication shall be lubricated as per manufacturer's recommendations. In addition, the Contractor shall supply all lubricants proposed to be used over the period of twelve months following successful commissioning of all equipment.

Pump motors shall be sized such that an additional cooling fan is not required. If motors are required to run at >50Hz, the motor manufacturer shall be consulted, and the motor shall be designed for this duty.

### M37.8.4 Transfer Pumps

Where required self-priming, centrifugal pumps are recommended for transfer of chemical from a storage tank to a day tank, particularly "seal-less" magnetic drive types. Appropriate materials of construction are:
Technical Specification - Mechanical

- Fluoro-polymer lined steel
- Titanium
- Glass Fibre Reinforced Polypropylene

Where seals are used they should have a double mechanical-seal with water flush. The seal should be constructed with wetted parts from titanium and have PTFE and ceramic seal faces.

The transfer pumps are to be designed to provide sufficient flow in the batching process in order to meet the required transfer time as specified by the facility’s operational needs.

M37.8.5 Calibration Cylinders

Each dosing system suction header shall be provided with a graduated calibration cylinder for determining the discharge rate of the pump. The measurable capacity of the cylinder shall be sized to the normal operating range of the pump (rather than maximum flow). Volume of the cylinder should enable test to be performed in 45 seconds to 1 minute. Each cylinder shall be permanently calibrated in litres and centilitres.

The calibration cylinder shall be complete with isolation valve and be capable of being easily dismantled for maintenance purposes. The calibration cylinder vent line, in rigid uPVC pipework, shall be connected to the storage/day tank. The pressure relief vent line shall also be connected to this vent line to the storage/day tank.

The top of calibration cylinders shall be below the “re-order” level in the associated storage tank.

Calibration cylinders are to be manufactured from a minimum of schedule 40 uPVC clear pipe, and solvent welded fittings. Screwed fittings are not acceptable, with the exception of standard unions upstream and downstream of the cylinder for dismantling purposes.

Isolation valving on the main suction header upstream of the calibration cylinder, and the calibration cylinder isolation valve shall be located in close proximity such that they may both be operated simultaneously by a single operator when performing a drop test.

M37.8.6 Pulsation Dampeners

Pulsation dampeners shall be provided in the discharge pipework from the dosing pump and shall be suitably sized for the displacement of the pump so that discharge pressure fluctuation does not exceed 10%. The pulsation dampeners shall have a diaphragm separating the air chamber from the liquid chamber. The air chamber shall be pressurised and be capable of re-pressurising by air pump via a Schrader valve. An air pressure gauge shall be installed.

Where possible, pulsation dampener should be located vertically at the top of the common discharge from the dosing pumps, such that discharge flow is directly into the dampener before a change of direction along the dosing line.

Pulsation dampeners shall have a bolted flange arrangement for jointing of the two halves of the diaphragm chamber.

Each pulsation dampener shall be fitted with an isolation ball valve.

Process connection is to be solvent welded type. This includes jointing to the isolation valve.

M37.8.7 Pressure Indicators

Pressure gauges shall be supplied and installed where specified. The pressure gauge shall be capable of being isolated, for maintenance purposes, by including a ball valve immediately upstream.

The pressure gauge dial size shall be 63 mm and the scale shall be calibrated in kilo Pascals. The pressure gauges shall be fitted with diaphragm seals. The seal shall be solvent welded to the dosing side of the system.

M37.8.8 Valves

Valves shall be uPVC or cPVC PN16 for all chemical applications unless not suitable to the chemical conveyed. Other valve materials will be subject to Sydney Water’s acceptance.
Valves will be rated for chemical use. Ball valves are to be used for isolation, and diaphragm valves for flow control applications.

All valves shall be full-bore type. These, along with other non-standard pipework fittings shall be double union type to minimise damage during repair and maintenance. Appropriate space is to be left around unions to enable dismantling. Utilise spacers under proprietary pipe clips where attaching directly to flat surfaces.

Union “O” Rings, seals and diaphragms will be of a material suitable to the chemical conveyed, in accordance with this Specification.

Valves shall be supplied with lockable handles where there is a safety or environmental risk from inadvertent operation. The generic P&IDs indicate the recommended minimum lockable valves.

In applications where chemicals may be subject to off-gassing, vented ball valves shall be used.

**M37.8.9 Actuated Isolation Valves**

Actuated isolation valves shall be of motorised actuation and shall include a compact electric actuator operating on 24VDC. The valve shall consist of two separate modules – the valve body and the actuator. The material of construction shall be suitable for the chemical being conveyed. The valve shall include open/close feedback and be complete with position indicator and a facility for manual control. The valve position signal shall be sent to the control system.

Actuated isolation valves shall be fail-safe and close on power failure, powered by the site/area UPS.

To protect against syphoning, any single dosing system will have at least one actuated valve that is hard wire interlocked into the dosing pump starter. I.e. one valve in the system between the storage tank and the dosing location for any chemical dosing system will have at least one hard wired actuated isolation valve. Valves for this purpose shall also meet the following requirements:

a) The hard-wired actuated valve shall not require a local hand station, as it shall be operated directly in line with the dosing pump operation (from the dosing pump field hand station). Actuated valves shall also be operated by the PLC.

b) The hard-wired actuated valve shall be equipped with open/close limit switches such that the connected dosing pump shall not start until the open limit is reached. On pump shutdown valve shall start closing immediately.

**M37.8.10 Pipework Flushing, Drain and Venting Points**

The generic P&IDs provide indication of typical requirements for drain, flush and vent points. Additional points shall be added as required to meet the requirements of each unique installation, in consideration of the following requirements.

Metering pumps shall be installed with suction and discharge flush points on the pipework according to the generic P&IDs. Flush and drain points shall include a manual isolation valve and a “camlock” fitting to suit the existing services at the plant. The “camlock” connections shall be supported as close to the “camlock” as possible to provide adequate support for the weight of a hose when connected. Installation of the flush points on an angle directed down will reduce loads on the connection. Flush and drain point “camlock” shall be 20mm.

Drain points shall be provided at low points on the entire system to ensure that all pipework can be drained safely and flushed as required for maintenance. These shall be directed to a safe, contained location.

Vent points shall be provided at high points in pipework to facilitate priming of systems for commissioning and start-up. Some chemicals will require additional venting facilities to prevent build-up of gas.

**M37.8.11 Chemical Dosing Flowmeter**

A flowmeter (magnetic and Teflon coated type preferred) shall be installed in each common dosing line (typically prior to the pressure sustaining valve). There should be sufficient upstream and downstream straight pipe run to prevent flow disturbances affecting the flowmeter. The dosing flowmeter shall be calibrated to units...
of litres per hour. The flow meter shall measure the flow and transmit the flow signal to the control system. The flow meter shall display the flow rate and any error messages. Flowmeters shall meet the requirements of the Instrumentation and Control Standards TOG_TS01. Flowmeter shall be flanged to AS2129 Table D.

M37.8.12 Diffusers and Spargers

Diffusers and spargers for chemical dosing shall be of rugged construction, easily cleanable, of the withdrawable type and shall be designed by the Contractor. Diffusers shall be for dosing into reservoirs, tanks, channels and dosing into large mains (>450 mm in diameter). Spargers shall be used when dosing into smaller mains (<450 mm in diameter).

The diffusers shall be adequately secured and supported and installed to ensure optimal diffusion of the chemical solution.

M37.9 Chemical Pipework and Fittings

M37.9.1 General Requirements

To ensure quality and fit for purpose pipework installation, the following general requirements are to be adhered to for all chemical carrying pipework:

a) All personnel undertaking pipework installation to be competent and have undertaken appropriate training in accordance with this Specification.

b) Screwed connections are not permitted, joints shall be either solvent welded (glue), electrofusion weld, or flanged. Only approved pipe glues (Weldon 724) and solvents (P70 Primer) that are designed for use with the specific chemicals and piping systems are to be used. Minimum curing times for primers and glues, as specified by the manufacturer, are to be strictly adhered to.

c) Pipe work jointing and installation shall be carried out in accordance with the manufacturer’s specification and requirements, inclusive of use of the correct tools including pipe cutters, chamfering and de-burring tools.

d) Valves, piping and fittings should be from the same supplier for a specific dosing system and where possible, for any existing chemical dosing system on site. All valves of the same size, duty and type supplied under the contract shall be identical.

e) Allowance for expansion and contraction is to be made, particularly on long pipe runs. Expansion loops are to be installed as recommended by the piping manufacturer.

f) White PVC will not be permitted to convey chemicals.

g) uPVC metric fittings will only be used with metric pipe and imperial fittings will only be used for imperial pipe.

h) All piping systems must be accepted by Sydney Water.

M37.9.2 Materials

Materials for pipe work shall be uPVC or cPVC Schedule 80 or Polyethylene (PE) to AS4130. The first preference is uPVC schedule 80, unless chemical properties make in unsuitable for use.

All PVC pipework and fittings conveying chemicals shall be uPVC or cPVC ASTM D1785 schedule 80 pipe. Polyethylene pipes conveying chemicals shall:

a) Use will be subject to Sydney Water’s acceptance;

b) Be PE100 pipe complying with AS/NZS4130 and fittings to AS/NZS4129;
c) Be a minimum pressure class PN16.

d) Have the pipe work indelibly coloured, either by stripes or jacket. Colour as per this Specification.

e) Marking of the pipe work, shall be indelibly imprinted clearly identifying the type of chemical being carried and comply with AS4130.

f) Method of jointing PE pipe work shall be electro fusion jointing. The manufacturer’s recommendations must be followed with the correct specialised tools when installation of pipe and fittings.

Pipes made of stainless steel, titanium or other metals may be used in special applications when pipes nominated above are not suitable.

M37.9.3 Support of Chemical Pipework

Support of PVC pipework and installation to be in accordance with AS2032. Supports and pipe clips are to allow for axial movement of the pipework due to expansion and contraction as well as forces associated with valve operation and hose connections. All supports shall be installed with a minimum of 25mm of grout to prevent pooling of chemical.

All fasteners and support systems to be utilised on the chemical dosing system shall be selected for compatibility with the chemical to be conveyed and shall maintain the pipework off the ground. All pipe supports are to be resistant to chemicals and provide for axial movement. In addition to this the following specific requirements apply:

a) Within chemical bunds – all anchors are to be stainless steel Grade 316. When SS316 is not compatible with the chemical the anchors are to be epoxy coated after installation to ensure contact with chemicals cannot occur. Coating must be in accordance with WSA 201 and Water’s Supplement to WSA 201.

b) External to chemical bunds - all supports, anchors and fasteners must be corrosion resistant for the application. These supports must provide sufficient structural support for the application. Hot dipped galvanised steel can be utilised in most applications unless there are corrosion concerns for example, for all seaside plants SS316 must be utilised as a minimum.

Above ground piping shall be supported and protected from mechanical damage.

Pipe trays located outside shall be supplied and installed with suitable covers.

M37.9.4 Leak Containment for Pipework Carrying Chemicals

Pipework carrying chemicals shall be designed and installed to achieve the following objectives, to prevent:

1) Leakage of chemicals to the environment;
2) Mixing of incompatible chemicals; and
3) Leakage of chemicals into processes for which the chemical is not intended.

To achieve the above objectives a leak containment strategy shall be provided for each chemical.

The leak containment system shall include at least the following elements:

a) Capture system;

b) Collection device; and

c) Detection means.

Suitable capture systems shall include:

i. “Pipe-in-Pipe” system;

ii. “Pipe-in-Culvert” system; or
iii. A leak containment system that includes the three elements a) through to c) stated above and designed and installed to achieve the above objectives 1) through to 3).

Pipework located inside bunds where the leaks are contained shall be deemed to comply with the above objectives. Pipes located over process tanks, where the leakage will not cause process upset, may also be permissible, however consideration shall be given to how spray may be directed to a safe location in the event of a pressurised leak.

Where a “pipe in pipe” arrangement is used, the following will apply:

- a) This work will be an approved manufactured product.
- b) The outer casing will be of material that is indelibly coloured and labelled. Jacketing the colour would be preferred. Painting of polyethylene pipe material will not be accepted but painting of PVC is acceptable.
- c) Be installed to the manufacturer’s requirements.

A double containment piping system should be selected based on the practicalities of the site, and provision of the highest level of safety to plant personnel and the environment. Selection should be made in consideration of site specific aspects such as:

- a) Will the pipe work be buried?
- b) Access for maintenance/emergency repair.
- c) Length and bends in pipe runs.
- d) Proximity of pipe runs to walkways, process units, vehicle operating areas etc.
- e) Can the outer containment become pressurised?
- f) Where will a leak in the pipe run be directed to?

It should be noted that all systems have mechanical limitations, with most external containment pipes being de-rated in pressure due to jointing methodologies. The supplier of the selected system should be consulted in this regard.

In case of leakage, the leaked chemical shall freely and fully drain into a collection device, which may be a bund, tank, sump or a purpose-built pit. The collection device shall have level switches to alarm to SCADA (or to the appropriate monitoring system) in case of a leak. Other instrumentation, as an alternative to the level switches, may be permitted, provided the alternative instrumentation enables the detection of the leak.

The capture system shall terminate at, and drain to a collection device, such as a bund, pit or sump provided with level switches, so that a leak can detected.

The distance between leak collection devices shall be a maximum of 100 m. Chemical dosing lines shall have a slope of at least 1 in 200, towards the leak collection devices, so that no part of the dosing line is lower than the connection of the line to the contiguous leak collection device.

Underground dosing lines shall be designed so that the pipe work can be replaced without the need for excavation. A leak detection pit is to be installed at any change of direction of the buried lines.

Where pits are used as a leak collection device, the pits shall be single piece pre-cast concrete pits at least 900mm x 900mm square and 300mm storage below the lowest dosing line connected to the pits. The pits shall protrude at least 200mm above surrounding ground. Pits are to be coated with an appropriate epoxy internally, similar to the requirements for storage bund coatings.

The pits must be accessible so that the chemical dosing pipework can be replaced when required.

Each pit shall be supplied with an aluminium cover that sits on a gasket fixed around the perimeter of the pit. The cover shall have skirts, which are at least 100 mm deep, on all four sides, to prevent ingress of rain water. The cover shall have two inspection port-holes, each at least 100mm diameter. The port-holes shall have a
rotating cover, which can be secured and sealed in the closed position, so that water does not enter the pit. Pit floors shall be graded towards one side for ease of pump out.

Where chemicals are not compatible then a separate pit system shall be used. If only two incompatible chemicals are used, then the same pit system may be used. In that case, the pits shall have segregation to prevent any mixing of these chemicals.

M37.9.5 Pipe Lagging

Pipes of less than 50mm bore and external to the building shall be suitably lagged to prevent freezing at air temperatures down to -6°C where appropriate to the chemical conveyed. Lagging shall be rigid, weather resistant and accepted by Sydney Water prior to procurement. An accepted example would be mineral wool insulation with aluminium sheet cover. Aluminium foil cover is not acceptable. Chemical compatibility shall be considered when choosing the insulation sheet cover material.

Maintenance considerations shall be included in the design. The lagging shall be easily removable (e.g. consider the use of self-tapping screws as opposed to rivets for joining cladding) and shall be easily removed from valves etc.

M37.10 Dilution Water

A dilution water (or carry water) system shall be supplied and installed to cater for each chemical provided. Dilution water shall be piped from the service water system (recycled effluent at WRPs and WWTPs) to provide a minimum dilution ratio of 10:1 of dilution water to each chemical.

Flow from the dilution water supply line shall pass through isolation ball valve, solenoid valve, diaphragm valve, rotameter, isolation ball valve and check valve. The dilution water line shall have a bypass line with manual ball valve normally closed. The rotameters shall have a minimum length of 250 mm, complete with Reed switches for low flow alarm and control purposes. Pressure indicator gauge with isolation cock shall be provided after the check valve.

M37.11 Specific Requirements for Individual Chemicals

In addition to the specified requirements, provision must be made for any other specific equipment as may be necessary for the operation, maintenance and cleaning of the particular chemical system being provided.

M37.11.1 Sodium Hypochlorite

An automatic gas vent (motorised ball valve) shall be supplied and installed in each dosing system. Any gas released from the sodium hypochlorite solution shall be automatically vented off. The vent line from this “degas” system will be run separately to the storage tank such that chemical and gas is vented to a contained location.

Pipework shall be laid, and sloped appropriately, to facilitate venting and prevent the accumulation of oxygen. The roof and wall cladding for the sodium hypochlorite storage tank shall be provided to ensure the storage tank is shielded from the sun.

Where in-line ball valves are used, the valve shall have a vented ball to prevent the build-up of gas.

M37.11.2 Sodium Hydroxide

If sodium hydroxide strength is above 30% concentration by weight, then all lines prior to dilution shall be electrically (heat) traced and lagged. This heat tracing shall have a system that indicates to SCADA that the electrical (heat) tracing is operating correctly.

cPVC in lieu of uPVC pipework shall be used in the section of pipe that is being heat traced.

Lagging of the traced pipework shall be in accordance with this Specification.

An alternative solution to prevent sodium hydroxide from freezing at low temperatures is to dilute the caustic with water immediately after the tanker is unloaded (sodium hydroxide can freeze at temperatures between...
0°C and 15°C for concentrations between 30 to 50 wt%). Typically, the sodium hydroxide concentration needs to be less than 30 wt% for freezing not to occur in most areas in Australia. Should this solution be chosen then water dilution hardware and procedures are required. Consider the need for adequate mixing etc. This may necessitate the need for a dedicated recirculation pump.

The tank shall be constructed from carbon steel with welded or flanged joints or fibreglass. The tank and its foundation shall be designed to safely contain the mass of caustic soda solution when full. A minimum corrosion allowance of 2 mm shall be added to the calculated wall thickness of steel tanks.

Valving shall be steel globe and diaphragm valves where steel tanks are used. Piping shall either be manufactured from carbon steel schedule 40 or welded PVC.

The storage tank fill line is to be manufactured from 316 stainless steel and fitted with a stainless "camlock" connector in compliance with the Orica Bulk Chemical Delivery Requirements (Liquid Caustic Soda).

**M37.11.3 Sodium Bisulphite**

Sodium bisulphite can also freeze at low temperatures (0°C or lower for the typical strength sodium metabisulphite sold in Australia). Electrical (heat) tracing and appropriate lagging may be required (particularly for small bore piping). This tracing shall have a system that indicates to SCADA that the electrical (heat) tracing is operating correctly.

Exposed sodium bisulphite pipework, from the storage tank up to the connection of the RE dilution pipework, shall be cPVC, which is capable of withstanding a working temperature up to 80°C maximum.

**M37.11.4 Acetic Acid**

The coating for the bund shall be specifically resistant to acetic acid. Should a suitable coating not be found, then a fibreglass tray, appropriately designed, shall be provided to capture and contain spills emanating from the dosing skid.

A water seal arrangement shall be provided for the tank vent to prevent corrosive gas damaging surrounding structures and equipment.

**M37.11.5 Acids**

Dilution water shall be designed carefully for acid storage and dosing systems. Particular consideration shall be given to heat generation events in the storage bund/sump and at the dilution point. Appropriate materials of construction shall be selected where heat is generated or has the potential of being generated.

**M37.11.6 Ammonium Hydroxide**

Storage tank shall be pressurised to negate the discharge of vapour to the atmosphere.

Storage tanks manufactured from FRP are not permitted.

**M37.11.7 Liquid Emulsion Polyelectrolyte Make Up and Dosing Systems**

**M37.11.7.1 General**

The system shall include all necessary equipment and controls for liquid bulk storage, mixing of the bulk storage and dosing tanks for liquid polyelectrolytes, and the dosing of the polyelectrolyte solution.

The polyelectrolyte make-up and dosing systems shall be fully automatic. The dosing rate shall be controlled by a signal from the SCADA based on kilograms of “active” polymer per dry tone of solids.

The polyelectrolyte solution shall be capable of being prepared as a solution ranging from 0.25% to 1.5% by volume (neat liquid to batched liquid).

**M37.11.7.2 Polyelectrolyte Bulk Storage Tank**

Polyelectrolyte will be delivered to the site by bulk loading tankers, parked at the truck loading bay, and pumped from IBCs into the storage tank.
The tank shall be designed to accept bulk loading from a road tanker/truck of IBCs. The storage tank/s shall be stainless steel or FRP having a tapered bottom or designed to negate stagnation on the tank floor of neat emulsion, allowing for the viscous neat liquid to naturally drain to the batching pump outlet.

The stainless steel or FRP Bulk Storage tank shall be supplied and installed. The mixing tank shall have at least 200mm freeboard above static top water level and shall be fitted with the following:

a) Flanged outlet connection to batching transfer pumps
b) Flanged drain connection for tank overflow into the bund (min DN80)
c) Flanged overflow connection
d) Support beams for mixer/ shaft
e) Platform for the accessibility of all the equipment and instruments
f) High and low tank level sensors securely mounted
g) Mixer (Slow Speed and intermittent timer from SCADA)
h) Level transmitter (hydrostatic type) with remote indicator for loader to visualise content level. The level transmitter is to be displayed on SCADA as both % Tank Volume and Litres (litres for usage calculation in litres per day and calculated kg per day once the specific gravity is entered the SCADA). The instruments should be side insertion type for ease of maintenance and limiting access needs to tops of tanks.

The bulk storage tank shall be mounted on a galvanised steel base frame suitable for installing on a concrete floor plinth using stainless steel grade 316 anchor fasteners and steel to concrete plinth separation pad.

An access platform and stairs shall be provided for maintenance of equipment on the top of the tank. The access platform shall be fabricated from mild steel and hot dip galvanised. This platform shall be connected with the bulk storage tank platform.

**M37.11.7.3 Unloading Pipework**

Unloading pipework for commercial delivery of liquid polyelectrolyte shall be provided. A filling line shall be provided with considerations of pumping into this line to prevent hardening or thickening of the emulsion between deliveries.

The loading point shall have a T-section with fill and drain valves to allow for safe connection and disconnection and minimising spills.

**M37.11.7.4 Liquid Transfer Metering System**

Liquid polymer metering shall be performed by progressive cavity pumps in a DUTY/STANDBY arrangement. The neat polymer and water shall be mixed via a purpose-designed mixing unit during a batch in progress, and flow into the polymer mixing tank.

The following liquid polymer metering equipment shall be provided/installed:

a) Progressive Cavity Pumps
b) Optional: Polymer Flow Meter (neat polymer) – Coriolis type specific for low flow polyelectrolyte.
c) Water Supply pipe with NRV to be fed into the common polymer transfer line just prior to the static mixer or mixing device.
d) Water supply manual or automatic flow regulating valve, flow transmitter and actuated valve to open and close as batching is required.
The feeder shall be of the volumetric [screw] type which shall convey the polyelectrolyte powder at a constant pre-set rate to the wetting assembly. A heater shall be supplied and installed for the discharge spout. The powder shall discharge to a venturi eductor and be transported by air to the wetting assembly through an anti-static delivery hose. An air blower shall be supplied to transport the powder. The air flow and pressure shall be capable of transporting 1.5 times the maximum powder flow from the screw feeder to the powder wetting unit.

**M37.11.7.5 Liquid Polymer Dosing Tank**

A stainless steel or FRP dosing tank shall be supplied and installed. The dosing tank shall have an active storage capacity sufficient for at least approximately 20 minutes of aging before being dosed assuming future loads under normal operating conditions and with at least 200mm freeboard above static top water level and shall be fitted with the following:

- a) Outlet connection.
- b) Drain connection.
- c) Overflow connection.
- d) Mixer (Slow Speed and intermittent timer from SCADA)
- e) Level transmitter (hydrostatic type) with remote indicator for loader to visualise content level. The level transmitter is to be displayed on SCADA as both % Tank Volume and Litres (litres for usage calculation in litres per day and calculated kg per day once the specific gravity is entered the SCADA). The instruments should be side insertion type for ease of maintenance and limiting access needs to tops of tanks.

The dosing tank shall be mounted on a galvanised steel base frame suitable for installing on a concrete floor plinth using stainless steel grade 316 anchor fasteners and steel to concrete plinth separation pad.

An access platform and stairs shall be provided for maintenance of any equipment on the top of the tank where required. The access platform shall be fabricated from mild steel and hot dip galvanised. This platform shall be connected with the dosing tank platform.

**M37.11.7.6 Metering Pumps**

Metering pumps shall comply with requirement for metering pumps specified elsewhere in this Specification.

**M37.11.7.7 In-Line Mixers**

In-line static mixers shall be supplied and installed to ensure complete mixing of the dilution water and polyelectrolyte prior to the point of injection. The mixers shall achieve complete mixing without causing excessive turbulence or destroying the polyelectrolyte flocculant chains. Specific and specialised liquid polyelectrolyte mixing devices are required.

**M37.11.8 Powder Polyelectrolyte Make Up and Dosing Systems**

**M37.11.8.1 General**

The system shall include all necessary equipment and controls for storage, mixing of powder polyelectrolytes, aging, transfer and the dosing of the polyelectrolyte solution.

The bulk storage powder capacity shall allow for a 30 days storage at future capacity.

The polyelectrolyte make-up and dosing systems shall be fully automatic. The dosing rate shall be controlled by a signal from the SCADA. The polyelectrolyte solution shall be capable of being prepared as a solution ranging from 0.25% to 0.35% by weight.
M37.11.8.2 Polyelectrolyte Bulk Storage Hopper

Polyelectrolyte will be delivered to the site by bulk loading tankers, parked at the truck loading bay, and pneumatically conveyed into the storage hopper with a 30 day capacity.

The hopper shall be designed to accept pneumatically operated bulk loading from a road tanker.

The storage hoppers shall be stainless steel having a conical bottom with a minimum slope 60 degrees to the horizontal. All internal surfaces shall be finished smooth and all internal welds finished flush. The hopper shall be complete with a supporting structure and installed on suitable footings.

Electric vibrators (hammer types are not acceptable) shall be provided and mounted to the conical portion of the hopper to facilitate free material flow and to prevent any bridging, arching and hanging-up of polyelectrolyte powder.

A knife gate type isolating valve shall be provided at the outlet of the hopper, complete with a discharge section to connect to the screw feeders.

The hopper shall be fitted with a dust separator on the outlet of the air venting frame, to filter the air exhausted.

The hopper loading hatch shall be fitted with a dustproof and moisture proof lid which shall be easily removable without hand tools.

Floor drainage shall be installed adjacent to the polyelectrolyte area to direct hose down water to the chemical hose-down sump. A non-slip floor surface shall be provided around the polyelectrolyte preparation and dosing system. The hopper shall be installed on raised concrete feet of min. 100mm height to enable clean out and hosing of spilled polymer material.

The hopper shall be fitted with a pressure relief valve.

If in a humid environment, the silo shall be fitted with a dehumidifying unit to ensure that the silo internal air is kept dry.

M37.11.8.3 Unloading Pipework

Unloading pipework for commercial delivery of polyelectrolyte shall be provided. A filling line shall be provided with no horizontal or near horizontal sections and with bends having a radius of at least 0.5 metre. The unloading pipework shall be anti- static and the pipe connections shall be located and secured at a convenient position for powder transfer.

M37.11.8.4 Weighing System

A weighing system shall be supplied and installed for the storage hopper utilising "bolt-on" strain transducers, one for each supporting leg. Alternatively, load cells may be considered. Accuracy shall be better than +/- 0.5% and resolution better than 1kg. A local display unit shall be visible to the unloader driver.

M37.11.8.5 Dust Collection Equipment

Dust collection equipment shall be supplied and installed in order to minimise escape of polyelectrolyte dust to the atmosphere during unloading from the bulk tanker. Filtered air from the dust extractor shall exhaust to outside the building or structure. Exhaust air shall comply with air quality standards, EPA regulations and any applicable Australian Standards.

The dust collection equipment shall be installed adjacent to the storage hopper and in the vicinity of the unloading area.

The separator shall include a vibrator or approved means to clear the filter cloth dust. The vibrator shall be operative whenever the hopper receives polyelectrolyte powder.
M37.11.8.6 Low Capacity Systems

For smaller systems, where usage is less than 10 kg/d, the powder storage hopper shall be designed to accommodate a minimum of 50 kg of polyelectrolyte powder.

Polyelectrolyte powder will be supplied and stored in 25 kg bags. A designated polyelectrolyte storage area shall be provided with sufficient space for a standard pallet. Access shall be provided for a forklift truck to deliver and remove pallets.

The powder loading facility shall be a vacuum transfer from 25 kg bags.

M37.11.8.7 Powder Metering Equipment

Powder metering shall be performed by a Volumetric Screw Feeder. The following powder metering equipment shall be provided:

a) Screw feeder
b) Venturi eductor
c) Air blower
d) Anti-static delivery hose
e) A high level switch (LSH) on the eductor lid

The feeder shall be of the volumetric [screw] type which shall convey the polyelectrolyte powder at a constant pre-set rate to the wetting assembly. A heater shall be supplied and installed for the discharge spout and eductor.

The powder shall discharge to a venturi eductor and be transported by air to the wetting assembly through an anti-static delivery hose.

The eductor shall have a high level switch installed to prevent poor batching and polymer powder spills.

An air blower shall be supplied to transport the powder. The air flow and pressure shall be capable of transporting 1.5 times the maximum powder flow from the screw feeder to the powder wetting unit.

M37.11.8.8 Mixing Tank

A stainless steel or FRP mixing tank shall be supplied and installed. The mixing tank shall have at least 200mm freeboard above static top water level and shall be fitted with the following:

a) Outlet connection
b) Drain connection
c) Overflow connection
d) Feed water inlet line
e) Support beams for mixer shaft and wetting unit
f) Platform for the accessibility of all the equipment and instruments
g) High and low tank level sensors securely mounted
h) Powder wetting unit
i) Mixer
j) Level transmitters (hydrostatic type) and switches to control the addition of water, polyelectrolyte mixer operation and the transfer of polyelectrolyte solution.

The mixing tank shall be mounted on a galvanised steel base frame suitable for installing on a concrete floor plinth using stainless steel grade 316 anchor fasteners. Larger mixing tanks can be secured directly to the
concrete plinth subject to Sydney Water’s acceptance. An access platform and stairs shall be provided for maintenance of equipment on the top of the tank. The access platform shall be fabricated from mild steel and hot dip galvanised. This platform shall be connected with the bulk storage hopper platform.

The preparation unit shall completely dissolve the dry polyelectrolyte such that approximately 60 minutes aging time is achieved after batching a clear solution is produced (with no "fish eyes”).

**M37.11.8.9 Mixing Tank Accessories**

a) Mixer

The mixer shall be purpose designed and built for complete homogenous mixing of powder polymer dilution batching.

The stirrer shall be of the propeller type with grade 316 stainless steel shaft and impeller(s). The stirrer shall be automatically controlled. The mixer shall be supported on a galvanised steel or stainless-steel frame independent of the mixing tank.

b) Polyelectrolyte Wetting and Make-up Systems

A proprietary wetting system shall be provided to ensure that uniform and thorough wetting of all polyelectrolyte particles takes place. The wetting system shall be supported on a galvanised steel frame, independent of the tank. If stainless steel tanks are provided the wetting head can be supported from the tank.

The wetting and make-up systems shall use potable water.

A booster pump shall be supplied as an integral part of the batching system, should the supply pressure be inadequate for optimum operation of the batching system.

A pressure gauge shall be fitted to the polyelectrolyte preparation unit batching water piping at the top of tank level and adjacent to the service water isolation valve.

**M37.11.8.10 Dosing Tank**

A stainless steel or FRP dosing tank shall be supplied and installed. The dosing tank shall have an active storage capacity sufficient for at least 2 X batch volumes (working batch volumes made up in batching tank) under normal operating conditions and with at least 200mm freeboard above static top water level and shall be fitted with the following:

- Outlet connection.
- Drain connection.
- Overflow connection.
- High and low tank level sensors securely mounted.

**M37.11.8.11 Transfer Pumps**

The transfer pumps will transfer batched polymer to the dosing tanks.

Transfer pumps shall comply with requirement for progressive cavity pumps specified elsewhere in this Specification.

**M37.11.8.12 Metering Pumps**

Metering pumps shall dose the polymer to the receiving process and comply with requirement for progressive cavity pumps specified elsewhere in this Specification.
M37.11.8.13 In-Line Mixers
In-line static mixers shall be supplied and installed to ensure complete mixing of the dilution water and polyelectrolyte prior to the point of injection. The mixers shall achieve complete mixing without causing excessive turbulence or destroying the polyelectrolyte flocculant chains.

M37.11.9 Hydrated Lime
The dosing pipework associated with hydrated lime is susceptible to blockage due to the properties of the solution.
Lime dosing pipework shall be flexible PE pulled through double containment pipe.
The angles at which the pipework and fittings are installed shall not exceed maximum 45 degrees bends for pull through, shall use long radius bends only, shall provide quick decoupling joints to facilitate dismantling for unblocking and cleaning the lime dosing pipework. Do not use short radius bends or elbows.
A Flushing water cycle (using RE where available) during changeover and after stoppage shall be included and the valves used shall be full bore pinch valves.
Quick decoupling joints shall be used to facilitate dismantling and clearing of blockages.
Tertiary Filters

If Tertiary filters are provided, the following clauses contain the minimum requirements.

M38.1 General

The work shall include, but shall not be limited to the provision of the following:

(a) Piping to the filters inlet structure.
(b) Filter inlet structure.
(c) Filter structure including platforms, walkways, stairways, handrails, etc.
(d) Open mono or dual media gravity filters with a plenum underdrain system with nozzles for collection of filtered effluent, distribution of backwash water and scour air.
(e) Filter media and media support.
(f) Filter outlet structure to convey filter effluent
(g) Overflow structure.
(h) Bypass system, including structure, penstocks and, if required, pumps.
(i) Filter backwash system, including pumps, and a backwash storage tank.
(j) Filter air scour system, including blowers.
(k) Filter washwater transfer system, including pumps and storage tank, to temporarily store and convey washwater to the nominated tank at the head of the STP or sludge handling process for WFPs.
(l) System to prevent over-pressurisation of the filter floors during a backwash.
(m) All pipework, valves and other flow control devices, machinery, electrical power, instrumentation, controls, etc., to monitor and ensure the filtration facility performs as required under the Contract.
(n) Building(s) to house blowers, compressors, pumps and other equipment;
(o) Instrumentation to successfully and safely operate the tertiary filters.

M38.2 Type of Filters

The filters shall be either mono or dual media open gravity, down-flow, deep bed type single cell filters. The filters shall be design using equal flow splitting with effluent rate control valve to adjust the flow and level in the filter. The flow into each filter shall be equal. No other type of filters, including dual cell, or filter control will be accepted.

M38.3 Performance Requirements

M38.3.1 Filtration Rate

The filters shall be capable of filtering the flows, without exceeding maximum filtration rate of 12m³/m²/h (m/h) when one filter is off-line for backwashing and one filter is off-line for maintenance.

M38.3.2 Filter Run Time

Filter shall run a minimum of 24 hours between backwashing under normal operating conditions.

M38.3.3 Media Depth

Filter media depth shall be determined based on the required turbidity, runtime and headloss performance,
M38.3.4 Filtration Plant Arrangement

The tertiary filtration plant shall include filter observation platforms, walkways, accessways, stairways and handrails from which access, including visual and inspection, to all the filters shall be possible. The filter control panels shall be located on the observation platform so that the whole of the filters, controlled from the panel, are clearly visible from the operating position.

A Colourbond™ metal deck roofing and associated steelwork support structure shall be provided over the filter console platform and over the access stairways to the top of the filter block.

Safe access shall be provided to operate all manual valves, and any valve and item of equipment, which requires regular or periodic maintenance.

M38.3.5 Filter (Hydraulic) Control

Flow shall be distributed evenly between operating filters by means of the inlet distribution device for each filter structure.

A constant water level in each filter shall be maintained using automatically controlled modulating valves (filter outlet control valves) in the effluent lines from each filter - usually butterfly valves.

Each filter outlet control valve shall be controlled by a level control system in the associated filter cell. The level control shall be set so that the depth of water is, at all times during filtration, at least 1.2 m above the filter media surface. The filter outlet control valve and associated equipment shall maintain the operating level of the filter within a span of 300mm. That is when the filter level is at top operating water level (TWL) the filter outlet control valve is fully open and when the operating water level is 300mm below TWL the outlet control valve is closed. The available head loss across the filter shall be at least 2.5m and at most 3.5m.

This function shall be demonstrated during the testing period by checking inputs and outputs of the individual components that make up the total control loop, and observation during operation combined with the trending graphs of the filter head loss produced for each filter. Filter head loss curves for each filter shall be identical.

The outlet of the filters shall be designed so that there is a constant head downstream of the filter outlet control valve. This shall be provided by a weir, the filter control weir, located in the backwash storage tank. The depth of flow over the filter control weir shall be less than 100mm at the design flow.

At a flow, up to the maximum flow, into each filter, the inlet to each filter shall not be submerged but shall have a free fall from the inlet weir to the operating level of the filter under all conditions.

M38.4 Filter Valves and Control

The Contractor shall, for each filter, supply and install the following valves, control and associated piping:

(a) Inlet distribution device (weir or similar).
(b) Inlet isolation valve.
(c) Backwash outlet valve.
(d) Air scour inlet valve.
(e) Filter outlet / level control valve.
(f) Backwash inlet valve.
(g) Backwash rate of flow control valve.
(h) Scour air release valve.
(i) Filter (plenum) drain valve.

The valves, except for the filter drain valve, shall normally be automatically operated but each valve shall be supplied with a manual override device. The filter drain valve shall be manually operated and shall have a minimum size of 100 mm.
M38.5 Launders

Launders shall be suspended at even spacing above filter beds to provide uniform removal of washwater during back washing. Launders shall be fibreglass reinforced plastic (FRP) type, stainless steel grade 316 type or reinforced concrete type. Launders shall be properly supported both vertically and horizontally so that their weirs remain absolutely level during backwashing. Launder bottoms shall be sloped to the gullet. The invert of the launder shall be high enough above the media level to allow freeboard during backwash to accommodate media expansion of at least 20%.

M38.6 Filter Underdrains

A system employing a plenum with nozzles suitable for combined air/water backwash shall be provided. All materials in the underdrain system shall be corrosion resistant. The underdrain system shall provide even distribution of backwash water over the whole area of the filter as well as even collection of filtered effluent. The system shall also provide even distribution of scour air over the whole area of the filter for satisfactory scouring of the media bed. The design of the nozzle system shall allow for cushioning of the air inflow surge at blower start-up. Filter nozzles shall also be designed to minimise clogging by biological growth. The underside of the plenum underdrains shall be elevated by at least 900mm above the filter shell floor and permit access from one point for each filter. The underdrain support system shall provide access to all parts of the plenum from this point. A 750mm diameter manhole, as a minimum, shall be provided for this purpose.

Disparity between levels of the top of nozzle heads shall not exceed ±3mm. Centre distances between nozzles shall not vary by more than (3 mm from dimensions given on the accepted design drawings. Proprietary nozzles shall be installed in accordance with the nozzle manufacturer's installation instructions. Modifications to nozzles (which include nozzle domes, stems and bushes) without the nozzle manufacturer's authorisation will not be permitted.

Nozzles shall be threaded with a coarse thread suitable for use with plastics. BSP threads are not acceptable. Nozzles shall screw into plastic inserts cast into the plenum floor planks. The stems of the nozzles shall project a minimum of 150 mm into the plenum chamber.

Nozzle spacing shall not exceed 150 mm and the minimum number of nozzles shall be 64 per square meter of filter floor filter area. The minimum distance between end nozzles and the adjacent filter wall shall be 75 mm.

The entire underdrain system including nozzles, effluent pipework, filter and clear water tank shall be left scrupulously clean before the initial air scour and backwash.

The plenum floor components shall be provided with adequate reinforcement and anchorage to resist all possible loads.

M38.7 Filter Media

M38.7.1 General

The work includes the supply, delivery to site and unloading at the site, protection of bags of media (stored on site) from sunlight, testing, placing and washing the filter media in the filters. All details, including media type, design depth, grade, supplier, etc. for each layer of media and support gravel shall be described in the Schedule of Technical Data - Equipment - Tertiary Filters.

As a minimum, each grade of media shall be supplied to the qualities, grading and design depth stated in the Schedule of Technical Data - Equipment - Tertiary Filters, and each grade shall be placed in successive layers over the filter underdrain system.
To prevent drying and caking of media, the minimum water level shall be 80 mm above the surface area of the media.

Filter media shall be free from clay, shale and foreign materials.

**M38.7.2 Sampling**

The following shall be carried out, well in advance before placement of media into the filters, in accordance with the latest version of American Water Works Association (AWWA) Standard B100:

(a) In the presence of Sydney Water, collect a representative field sample of each size, of filter media.
(b) Reduce each sample in size to two equal portions, called Sample A and Sample B.
(c) Each sample shall be of sufficient quantity for all tests nominated in AWWA Standard B100.
(d) Forward Sample B to a registered NATA laboratory, which is not the filter media supplier itself, to carry out all tests nominated in AWWA B100.
(e) Sample A shall be held by Sydney Water.

Allowance for the above should be made in the program for the works so as not to delay placement of media and commissioning of the filters. After testing, the test results shall be submitted to Sydney Water.

Tests for quartz content of sand and gravel to meet specified minimum limits shall be carried out as follows:

(a) By counting quartz particles under a microscope
(b) By mass (based on quartz particle count) obtained in (a) above.

The minimum limit of quartz content in either sand or gravel, carried out by methods (a) and (b), shall not be less than the specified limit.

Testing for clay, dust and other impurities shall be carried out to ASTM C117. Sample of sand shall be 100g minimum. Impurities content shall not be greater than 0.1% for sand and gravel as calculated in the above Standard.

Failure of the samples to comply with the Specification shall result in the rejection of the filter media.

All costs associated with the collection, testing and retesting of the filter media shall be included in the price tendered for the works.

Filter media shall not be placed in a filter until the following certified results have been provided to and accepted by Sydney Water:

- filter media test results
- filter nozzles cleanliness check, water distribution test and air distribution test,

Any rejected filter media shall be removed from the site.

**M38.7.3 Filter Gravel**

Filter gravel shall be placed in successive layers. Each layer shall be to the depth and size nominated by the designer. The thickness of each layer of gravel shall be at least three times the maximum particle size of gravel in the layer, but not less than 80mm in any case.

Filter gravel shall be of the best quality, clean, hard, durable, non-calcareous quartz and be of rounded shape. The gravel shall contain no more than 2% of thin, flat or elongated pieces in which the largest dimension exceeds five times the smallest dimension and no more than 25% fractured or "angular pieces" in any size. Thin, flat, elongated or angular pieces shall be determined by hand picking. The material shall contain at least 95% quartz.

Not more than 8% of the weight of filter gravel shall be finer or coarser than the nominated size limits.

The specific gravity of the gravel shall not be less than 2.5.
The solubility of gravel in 10M hydrochloric acid, when tested in accordance with AWWA Standard B100 procedure, shall not exceed 5%.

Garnet can be used in lieu of gravel, where appropriate.

**M38.7.4 Filter Sand**

Filter sand shall be of the best quality quartz. At least 95% of the sand shall consist of clean, washed, single, rounded grains of quartz.

Friability tests on sand shall be carried out as per AS1141.30 Section 32. Friable materials as obtained from these tests shall not exceed 0.3%.

The solubility of sand in 10M hydrochloric acid, when tested in accordance with AWWA Standard B100 procedure, shall not exceed 1.5%.

The depth nominated shall be net after scraping of fines.

**M38.7.5 Filter Coal**

Filter coal shall be composed of hard and durable grains and shall be visibly free of shale, clay and other extraneous matter.

The coal test requirements are as follows:

<table>
<thead>
<tr>
<th>Test</th>
<th>Requirement</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific gravity</td>
<td>&gt;1.44</td>
<td>ASTM C188</td>
</tr>
<tr>
<td>Effective Size</td>
<td></td>
<td>ASTM C136</td>
</tr>
<tr>
<td>Uniformity coefficient</td>
<td>&lt; 1.35</td>
<td>AWWA B100</td>
</tr>
<tr>
<td>Acid Solubility</td>
<td>&lt;2.5%</td>
<td>AWWA B100</td>
</tr>
<tr>
<td>Hardgrove Grindability Index</td>
<td>&gt;50</td>
<td>AS1038.20</td>
</tr>
<tr>
<td>Fixed Carbon content</td>
<td>&lt; 53%</td>
<td>AS1038.3</td>
</tr>
<tr>
<td>Inherent Moisture Content</td>
<td>&lt; 3.5%</td>
<td>AS1038.3</td>
</tr>
</tbody>
</table>

**M38.7.6 Top-of-Media Plates**

In order to indicate media loss over time, a “top of media” indicator plate shall be installed in each filter. The bottom of the plate shall be installed at the design surface level, during filtration, of the filter media. The location, other than elevation, of the plates shall be the most visible position and as agreed by Sydney Water. Plate details shall be as follows:

**M38.7.6.1 Plate**

Stainless steel grade 316 plate, 2mm thick with radius corners and 6 pre-drilled 5mm diameter holes for fixing to filter wall with grade 316 stainless steel pan head type screws into Hilti HUD5 type nylon wall anchors. Length of plate depends on lettering. Depth of plate will be approximately 150mm.

**M38.7.6.2 Letters**

Letters shall be 50mm high; top of letters 30mm below top edge of plate; start and finish of print 30mm from side edges of plate.
M38.7.6.3 Arrows
Four equally spaced arrows 50mm long starting 15mm below print and ending at bottom of plate or slightly above bottom of plate. Shaft of arrow shall be approximately the same thickness as the letters.

M38.7.6.4 Method of Production
Engraving of plate - either engraving of letters and arrows or engraving area around letters and arrows - will be satisfactory. To maximise contrast the depth of engraving shall be between 0.75mm and 1mm.

M38.7.6.5 Plate Finish
To maximise contrast, each plate shall be installed in an industrial type environment rather than an architectural type environment.

M38.8 Preparation for Media Placement
Each filter shall be thoroughly cleaned and an air pattern test completed before any filter materials are placed and keep the filter clean throughout placement operations.
Before any materials are placed, the top elevation of each layer shall be clearly marked by a continuous level line on the internal wall of the filter.
Filter materials shall be kept clean and stored separately.

M38.9 Packaging
Filter media shall be delivered in ultraviolet light resistant bags, which shall contain not more than one cubic metre (1 m$^3$) of sand and gravel, and not more than 1.6 m$^3$ of filter coal.
The bags shall be suitable for lifting by crane and for ease of unloading into the filters. The bags shall be supplied with manufacturer’s instructions.
After delivery to site, all bags shall be fully covered with thick plastic sheeting (not less than 250 microns) such that all sides are completely sheltered from sunlight.

M38.10 Air Scour System
An air scour system (dedicated to filters) shall be provided for filter backwashing to enable sequential air scour followed by combined air and low flow water wash.
The air scour rate shall be as nominated by the designer, but shall not be less than 60 m/h.
Each air blower shall be supplied and installed complete with the following equipment:

- 1 isolation valve
- 1 suction filter silencer
- 1 outlet silencer
- 1 vacuum indicator
- 1 reflux valve
- 1 isolating valve
- 1 pressure gauge (anti-vibration type)
- 1 thermometer
- 1 relief valve
- 1 set anti-vibration mountings

The suction filter shall be suitable for continuous service and shall be readily cleanable.
A visual alarm indicator (400mm wg maximum vacuum) shall be placed between the air filter and its respective inlet to give warning when the filter requires cleaning.

One pressure gauge and one thermometer of at least 150mm diameter shall be supplied and fitted on the delivery side of each blower.

Each air blower shall draw air from the atmosphere through a filter-silencer and discharge it through a silencer into the scour air delivery line to the filters. The delivered air shall be completely oil-free.

**M38.10.1 Air Flow Measurement**

An air flow measuring device shall be provided in the common delivery line from a blower. Air flow rate in L/s shall be indicated on the relevant SCADA screen and locally adjacent to the blowers.

Measurement shall be by an orifice plate, in accordance with the relevant British Standard.

The flow meter shall have pressure and temperature compensation, from ambient pipe pressure and temperature, to provide air flow in standard conditions (20°C, 1 bar).

**M38.10.2 Air Scour Blowers**

At least one duty air blower of the designed capacity and one standby air blower of the same capacity as the duty blower shall be supplied and installed.

Blowers shall be of the rotary positive displacement type and shall comply with the blower requirements specified elsewhere in this Specification.

**M38.10.3 Air Pipework**

Air pipework shall be spiral wound grade 316 stainless steel of suitable wall thickness (not less than 2 mm in thickness) and flanged joints.

The air pipework shall include a high level loop rising to level 1 m above the overflow level of the filters. A check valve to prevent the accidental entry of backwash water shall be installed in this line on the filter side between the filter and the loop.

**M38.10.4 Soft Start Valve**

An air vent to atmosphere for soft start of scour air flow into the filter shall be incorporated in the air pipework located upstream of the primary measuring flow element. The soft start valve shall open on shutdown of the air scour blower and slowly close on start-up over an adjustable time period of 10 to 180 seconds. The valve shall include a discharge silencer and permit full flow venting.

The valve shall either be a Saunders diaphragm type with a pneumatic diaphragm operated spring return to open actuator or a butterfly valve with a pneumatic spring return.

A limit switch positioned on the soft start valve shall prevent the air blower from starting unless the valve is fully open.

**M38.11 Filter Scour Air Release**

An air release valve shall be provided for each filter to exhaust residual air in the underdrains at the end of the air scour operation during a backwash and thereby avoid media disturbance during the remainder of the backwash.

Each valve shall be piped to operate in conjunction with the associated filter air scour inlet valve. The release valve shall open when the air scour inlet valve is closed and vice versa.

**M38.12 Backwash System**

**M38.12.1 General**

The backwash flowrate to be used shall be as nominated by the designer. Backwash inlet valves may be arranged for slow opening if considered necessary by the designer.
Backwash flowrate shall be automatically controlled via a backwash flowmeter and modulating valves.

M38.12.2 Backwash Water Storage
The backwash shall eliminate mud ball formations, media grain coating and biological solids growth without the need of chemical cleaning systems.

The system shall be designed to achieve a maximum backwash rate up to 65m/h to achieve 20% bed expansion.

Backwash water storage shall be provided of sufficient volume equivalent to two backwashes each for a duration of ten minutes.

A storage tank shall be constructed of a material suitable for the purpose and shall be covered to prevent foreign materials getting into the water.

The tank shall have connections for inlet, outlet, overflow, drains, inspection and cleaning and other connections as required. Visual indication of the contents shall be provided on the outside of the storage.

The level and volume of the contents of the tank shall be displayed on the SCADA and appropriate high and low level alarms shall be provided.

Overflow from the storage tank shall be to the UV disinfection facility.

All valves, actuators, pipework, fittings, fixings and mountings shall be provided and backflow from the tank shall not be possible.

M38.12.3 Backwash Pumps
If backwash pumps are required there shall be at least one duty pump and one identical standby pump. The pumps shall be capable of performing to the duties as determined by the Contractor.

Pressure in the backwash delivery line shall be provided and displayed and logged on the SCADA.

To prevent high pressure in the filter underdrains a hydraulic loop shall be provided in the common backwash manifold. This loop shall relieve pressure/flow back to the backwash storage tank (where available). If a backwash storage tank is not available, then alternative forms of suitable protection from over-pressure shall be provided (pressure transmitter interlock on pumps etc.).

M38.12.4 Backwash Flow Measurement
A backwash water flow measuring device shall be provided in the common delivery line. The backwash flow rate, in L/s, shall be indicated on the relevant SCADA screen and at the filter control panel associated with the filter being backwashed. The amount of backwash water used shall be available and stored in the SCADA.

The accuracy of flow measurement shall be ±2%.

M38.12.5 Filter Head Loss Indicator
Head loss across each filter shall be measured.

Each filter shall have a turbidity meter and a head loss indicator, calibrated in metres and decimetres, shall be mounted on the filter local control console.

The head loss across each filter shall be provided and displayed and logged on the SCADA.

M38.12.6 Backwash Wastewater Disposal
Launders in the top of the filter shall collect backwash wastewater to discharge to the backwash wastewater storage. Weirs shall be adjustable with an overall tolerance of ±2 mm to ensure level overflow. Media loss during backwash shall not occur.

A filter to waste system shall be provided for WFPs and WRPs to divert the filtered water to waste handling process (for WFPs) and HOWs (for WRPs) during filter ripening stage.
Backwash wastewater shall either gravitate or be pumped to the head of the WWTP. The transfer flowrate shall be such as to have at least storage for one backwash available in the backwash wastewater storage prior to the next filter backwash and to not adversely affect the WWTP performance.

Backwash water for WFPs requires treatment before returning supernatant to the head of the WFP or discharge to environment.

### M38.12.7 Backwash Washwater Transfer Pumps

If backwash washwater transfer pumps are required there shall be at least one duty pump and one identical standby pump. The pumps shall be capable of performing to the duties as determined by the Contractor.

### M38.12.8 Control

The tertiary filter system shall be designed for automatic, manual and field operations.

Field operation of each filter shall be possible from a console located on the filter observation platform and the whole area of the filter shall be clearly visible from the operating position. One common console with controls for every two filters is acceptable.

In automatic mode the filters shall operate continuously without operator assistance. In this mode the filters perform all filtering and backwashing functions (filter, drain, backwash, etc.) automatically. A filter run continues until the backwash cycle is initiated by:

- a filter run timer (0-60 hours, adjustable).
- time of day.
- exceeding a pre-set adjustable filter head loss.
- Filtered water turbidity, or
- manual backwash initiation.

In field mode, the operators shall be able to manually set the position of each valve.

### M38.13 Filtration Sequencing

#### M38.13.1 Normal (Automatic) Operation

When a filter cell is placed on automatic, the following sequence shall occur, beginning at the start of the filtering cycle:

1. The backwash water inlet, backwash rate of flow control valve, backwash outlet and air scour inlet valves close.
2. The filter inlet valve opens completely to allow influent to the filter and the air release valve will be open.
3. Filter to waste valve opens
4. Filter to was continues until target filtered turbidity set point is reached
5. Filter to waste valve closes, and filter outlet control valve opens.
6. Filtration commences.
7. The filter outlet valve begins modulating to maintain the pre-set level in the filter.
8. Filtration continues until the backwash cycle starts

#### M38.13.2 Normal (Automatic) Backwash Sequencing

When an automatic backwash cycle is initiated, the following sequence of events shall occur:
1. Influent valve closes.
2. Backwash outlet valve opens.
3. The contents of the filter shall drain through the filter outlet valve to a set air scour level, approximately 75-100 mm above the media level. At that level the filter outlet valve shall close.
4. Air scour inlet valve opens when water drains to a set level and the air release valve closes.
5. Air blower starts and the air wash timer starts and the backwash pump delay timer starts.
6. Backwash water inlet valve opens and the backwash pump starts after the timer times out.
7. The combined air/water wash continues until sensors detect air wash mixture is at a pre-set level below the bottom of the trough.
8. The air scour inlet valve closes and the blower stops and the air release valve opens.
9. The backwash rate increases and continues until the backwash timer times out.
10. The backwash outlet valve closes.
11. The backwash pump continues until the water level in the filter reaches a pre-set level above the top of the media and then the backwash inlet valve closes and the pump stops.
12. The filter inlet valve opens and the filtration cycle commences.

All automatic sequence controls and times shall be operator adjustable.

M38.13.3 Siphon System

A siphon system shall be supplied to facilitate the filter drain down step. The siphon system shall draw from three locations and discharge into the filter gullet.

The siphon system shall be complete with automatic siphon priming/break solenoid valves. The control and operation of these primary/break solenoid valves shall form part of the backwash cycle.

M38.14 SCADA Screens

SCADA screens shall be provided to monitor and show the status of all aspects of the filtration plant. There shall be at least an overview screen, a screen for each filter, a screen for the backwash system, a screen for the air scour system and a screen for any compressed air system.

A filter statistic pop up window shall also be provided showing summary data on all filters e.g. Current filter set points (turbidity, run time, headloss trigger), current values, time since last backwash, time to next backwash, previous backwash data (e.g. run time, headloss, and turbidity at trigger etc.).
M39. UV Disinfection Equipment

M39.1 General
This section covers the technical requirements for the supply of UV disinfection equipment.
The UV system shall be capable of disinfecting the range of flows as given in this contract.
The Supplier shall provide a validation certificate based on US EPA requirements or equivalent for the UV system and a validation report to clarify the Critical Control Point (CCP) requirements for SCADA and Water/Recycled Water quality management.

Low pressure UV systems and medium pressure UV systems shall both be provided with Cleaning and Safety Equipment.

M39.2 Low Pressure UV

M39.2.1 General
The UV disinfection system shall be capable of continuous operation in ambient conditions experienced in an outdoor wastewater treatment plant. Equipment will be subject to chemicals and other conditions associated with the water and wastewater treatment plant operating environments.
The equipment and channel configuration shall be designed such that the equipment shall be capable of treating effluent with transmissivities determined by the Contractor as a result of his process design.
The UV system shall be comprised of units, which shall be fully submerged in the effluent. The system shall consist of units designed and installed with appropriate protective covers to preclude the escape of UV light. The system shall allow each unit to be readily isolated. The channel configuration shall be designed to suit the UV disinfection units, which are appropriate for the effluent standard.
The Contractor shall ensure that hydraulic conditions through the UV unit are satisfactory and that no short-circuiting of effluent can occur, and the facility shall operate at maximum flow without overflowing.
The UV system shall comprise a number of separate chambers to allow for maintenance. At times of low flow it shall be possible to isolate one chamber for maintenance whilst the flow is diverted to the remaining chambers, without loss of disinfection efficiency.
The system shall provide for efficient distribution of the effluent throughout the entire disinfection channel and be designed such that flow conditions within the channel are optimised to achieve maximum disinfection.
The system shall:
- During periods of low flow, operate only sufficient banks of lamps to disinfect the low flow.
- During periods of increasing flow, when it is apparent that the flow is about to be greater than that which can be disinfected by the operating banks, activate further banks in each channel.
- During periods of decreasing flow, when it is apparent the flow can be adequately treated by a lesser number of operating banks, deactivate a bank of lamps in each channel.
- When an isolation penstock is closed, deactivate the module in that channel.

Subject to achieving maximum economy in power consumption consistent with optimum tube life, the system shall allow for portions of the lamps to be turned on and off to cater for varying flow rates. The facility shall be controlled using data from a flow-measuring flume.
The UV disinfection system shall be supplied complete, but not limited to the following:
(a) Disinfection channel(s) or pipes/chambers.
(b) Disinfection units complete with lamps, enclosure, safety switches and other fittings suitable for installation into disinfection channel(s) or pipes/chambers.
(c) Cleaning equipment suitable for cleaning all parts, fittings, lamps and supporting structures installed within the UV channel.

(d) Any baffles required for flow straightening to ensure the robustness and efficiency of the process over the entire range of operating flows.

(e) Channel covers as necessary to protect the UV installation and personnel.

(f) Automatic lamp cleaning system.

(g) Inlet isolation penstocks or valves.

(h) A system to prevent the ingress of solid matter that could result in the catastrophic breakage of the UV lamps within the channel such as a screen.

(i) Level regulating penstock with actuator.

(j) Cleaning equipment suitable for cleaning all parts and fittings.

(k) Online UV Intensity / Dose measurement.

(l) All control system requirements fully programmed and commissioned to operate the UV system based on flow signal provided.

(m) Online UV-Transmissivity analyser to interlock and/or control UV dose to ensure UV reactors are meeting the CCPs as specified in the Validation Report and/or provide better power optimisation of the system.

(n) Lifting provisions / eyebolts.

The UV system shall disinfect the effluent in a safe, simple and automatic operation and be easily maintained. All features requiring cleaning, maintenance and adjustment shall be readily accessible.

All wetted parts of the UV units shall be grade 316 stainless steel, quartz glass, teflon or other materials not susceptible to UV or chemical degradation and shall be readily removable.

**M39.2.2  Performance Requirements**

The UV disinfection system shall be capable of achieving the required effluent quality at the end of lamp life with 10% lamp failures and up to 5% failures in any bank of lamps and uncleaned for a period of one (1) month of normal operation.

During the Proving Period weekly sampling and analysis shall be undertaken as follows:

- Final effluent before UV: faecal Coliform, SS, transmissivity Cryptosporidium
- Disinfected effluent after UV: faecal Coliform, Cryptosporidium

**M39.2.3  Lamps**

The UV lamps shall be low-pressure mercury vapour slim-line lamps of the hot cathode instant start design in which the cathodes of coiled wire are heated by the arc current.

The filament shall be the clamped design, sufficiently rugged to withstand shock and vibration.

The ultraviolet lamps shall emit UV light at a frequency of 253.7nm. Emission of light in the spectrum 310 to 410 nm and less than 230 nm shall be minimum. At least 90% of energy shall be transmitted in the 233 to 275nm band.

The lamp life shall be not less than 8,760 hours. At 8,760 hours the dosage to all effluent of 253.7 nm lights shall be not less than 30 mWs/cm². This dosage rate shall be achieved by lamps in a fouled condition, i.e. lamps shall not have to be cleaned for a one (1) month period of normal operation. The dosage rate is based on the system performance specified in this contract.
The lamp bases shall be either of a metal and ceramic construction, or of other materials resistant to UV light and ozone to ensure base integrity at the end of the lamp life.

For WFPs and WRPs the UV system supplied shall be provided with validation certification and shall be able to be operated to ensure LRV (Log Reduction Value) verification.

M39.2.4 Level Control

An adjustable automatic level controller or "finger" weir arrangement shall be placed at the discharge end of the channel, to ensure that all of the UV lamps are submerged in the effluent irrespective of flow rates.

M39.2.5 Control System

The control system shall include:

- Resettable and cumulative hours run meters for each rack of lamps.
- Indicator lights showing the operation or non-operation of all lamps.
- Intensity monitors measuring the intensity of UV light in each bank. When the intensity drops below the end of lamp life UVdosage, an alarm shall be activated. Sensors for the monitor shall measure only the germicidal portion of the light emitted by the UV lamps. The detection system shall be calibrated in the factory. Detection systems, which can be field calibrated, will not be permitted. Additional online UV-T measurement of the process water is required to interlock the process (Water and Recycled Water) against the Critical Control Point and for dose control.

Intensity shall be indicated as a percentage of that required to effect the reduction of faecal Coliform as specified in this contract and shall be continuously displayed.

A single beam UV filter photometer with 100% transmittance control adjustment shall be provided to measure UV transmittance of the effluent in the channel. The range shall be 0 to 100% transmittance of the wavelength 253.7 nm. Online monitoring is required. The photometer to be installed shall be suitable for this purpose.

The control system shall provide an alarm for the following event:

a) More than 5% of lamp failure in any one bank of lamps.

b) More than 5% of lamp failure in the complete unit.

c) On reduction of the transmittance below an operator pre-set limit between 35% and 50%.

All electrical components eg. ballast and lamp-monitoring systems shall be completely isolated from all wetted parts to ensure safe operating conditions.

The ultraviolet units and respective control boards shall have built in, the following monitoring and indicator equipment:

a) On reduction of intensity below the end of lamp limit.

b) Lamp operating/not operating indicators for each lamp.

c) Hours run meters with both not able to be reset cumulative hours run and able to be reset hours run displays for each rack.

d) Bank operating indicator.

e) Failure of lamp.

f) One UV intensity sensor per bank with meter mounted on the control panel.

g) One UV photometer per channel with meter mounted on the control panel.

h) The UV system shall be provided with a ground fault system. This shall ensure that the faulty section of UV modules will automatically be disconnected when short-circuiting to ground occurs.
system shall also be provided with an appropriate safety switch mechanism to ensure that UV lights are disconnected when any one (1) protective cover is removed.

**M39.3 Medium Pressure UV**

The UV disinfection system shall be capable of continuous operation in ambient conditions experienced in an outdoor wastewater treatment plant. Equipment will be subject to chemicals and other conditions associated with the wastewater treatment plant operating environment.

All ancillary equipment necessary for the successful operation of the UV systems, such as lifting devices for removing UV system components and hydraulic or pneumatic power packs for the operation of the self-cleaning mechanisms, shall be provided.

The UV system shall consist of medium pressure, high intensity UV modules, and these modules shall be required to be validated and certified based on the German DVGW Standard which requires the use of Computational Fluid Dynamic technology to demonstrate uniform dosing throughout the water passing through the UV system.

The UV modules shall be in mounted pipe.

The UV treatment system shall provide an ultraviolet dose of not less than 40 mJ/cm² at all times with the same dose level applied uniformly throughout the system as described above.

**M39.3.1 Performance Requirements**

The UV disinfection system shall be capable of achieving the required effluent quality at the end of lamp life with one lamp failure in any bank of lamps and uncleaned for a period of one month of normal operation.

*During the Proving Period weekly sampling and analysis shall be undertaken as follows*

- Final effluent before UV: faecal Coliform, SS, transmissivity, cryptosporidium

- Disinfected effluent after UV: faecal Coliform, Cryptosporidium

**M39.3.2 Lamp assemblies**

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

Lamps shall be removable with the quartz sleeve and wiper system remaining in place. The lamp assembly design and UV module mounting shall allow all of the following to be easily achieved by an operator for maintenance purposes:

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

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

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

**M39.3.3 Chamber**

The module chambers shall be constructed of stainless steel grade 316. All wetted parts shall be stainless steel grade 316, high purity quartz, Teflon, and/or Viton. Aluminium wetted materials shall not be used.

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

The chambers shall not allow any possibility of direct UV light exposure to the Operator.

The chamber shall incorporate the following provisions:
a) Automatic Energy Level Control.
b) UV Intensity Monitor.
c) Temperature Sensor.
d) Automatic lamp cleaning Mechanism.
e) Inspection Access Hatch with proximity switch.

M39.3.4 Inspection Access Hatch

A 200mm diameter access hatch shall be provided for each chamber to allow easy access for visual lamp/sleeve inspection.

M39.3.5 Lamps

Lamps shall be medium pressure high intensity type. Low pressure or other lamp types will not be acceptable.

The UV lamp orientation shall ensure that uniform UV dose is applied to the water passing through the chamber. The UV lamps shall not be driven at powers above their specified safety range. The lamps shall be protected from contact with water by high purity quartz sleeves of the F220 ozone free type. Each lamp shall also be equipped with an individual lamp intensity monitor. Removal of the lamps shall be achieved from one end of the chamber without the need to drain the chamber or to remove the quartz sleeves from the flow.

UV output energy of the lamp shall be variable. The lamp shall be capable of maintaining a UV-C output proportional to the variable power settings. Medium pressure-low intensity or medium pressure-high output lamps with no capability to automatically vary the UV power output in operation shall not be permitted.

The lamp lifetime at continuous operation with automatic various energy level control mode shall not be less than 8,000 hours. A minimum of ultraviolet dose of 40mJ/cm² shall be maintained at the end of lamp life and at the maximum flow rate in each module.

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

The lamps shall be capable of operating in a "No flow" condition for a minimum period of 60 minutes without causing any damage to the lamps. Systems or lamps that cannot withstand no flow conditions for a minimum period of 60 min will not be acceptable. The lamp output shall not fluctuate more than 5% due to water temperature variations between 10-30°C.

The lamps must be available from more than one supplier and the suppliers shall accept the return of used lamps for recycling.

M39.3.6 Automatic Energy Level control

The UV module shall be equipped with an automatic energy level control system that will calculate and adjust the appropriate ultraviolet dose based on flow, water transmissivity, and ultraviolet intensity.

M39.3.7 UV Intensity Monitor

Each ultraviolet chamber shall be equipped with an ultraviolet monitor for measurement of UV energy in the range of 200 to 300 nm wavelength. The monitor shall continuously monitor the water transmissivity, quartz sleeve condition, and the lamp life. The monitoring shall be transmitted as 4-20mA signals to the control panel.

One sensor per lamp with quartz windows shall be provided to satisfactorily monitor the changes in the output of the ultraviolet lamps, lamp sleeve fouling, and the transmissivity of the water being treated. The sensor viewing port(s) must be designed to allow the replacement of the on-line sensor with a reference sensor to permit routine validation of the on-line sensor calibration. The sensor(s) shall not be affected by static, electromagnetic fields, or short wave radio emissions.
The monitors shall be factory pre-calibrated and sealed before they are delivered for installation on-site. A certificate of calibration shall accompany each monitor.

The wet portion of the monitor shall have a grade 316 stainless steel housing, Viton "O" ring, and a high purity quartz probe over the monitor site hole.

**M39.4 Cleaning**

An automatic cleaning mechanism shall be provided for the ultraviolet unit to clean the quartz sleeves of the lamps, the UV intensity monitor probe, and the transmissivity monitor probe.

The cleaning mechanism shall be PLC controlled and provide for fully automatic, unattended operation. This shall be activated whenever there is a reduction in ultraviolet intensity below a pre-set level. Failure of restoring the required UV intensity level after a pre-set cleaning cycle shall send an alarm signal to the SCADA. Shutdown of a particular lamp shall also occur if the cleaning wiper stops moving or fails to return after reaching the end of the chamber.

The cleaning mechanism shall also be able to be operated by pre-set timer and manually initiated when required. Wiping interval is the time between wiping cycles and shall be easily reset by an operator whenever actual conditions warrant. The useful life of the wiper or cleaning device in contact with the quartz sleeve shall be in excess of two years.

The cleaning system shall maintain uniform wiping tension and cleaning over the complete wiping length of the quartz sleeve. The cleaning system shall maintain full efficiency throughout its life, with no deterioration in quality of cleaning.

The wiper blade brush or other cleaning device in contact with the quartz sleeve shall not damage or scratch the quartz sleeve in any way.

All equipment necessary for the operation of the wiper system shall be provided with the UV system i.e. compressor or hydraulic power pack.

No chemicals shall be used for cleaning of the lamp tubes.

**M39.5 Safety Equipment**

Notwithstanding that the equipment has been designed to prevent the escape of UV light, the Contractor shall provide safety equipment including:

- Four shields.
- Four hard hats with face shields designed to block UV light in the band of 200 to 400 nm.
M40. Compressed Air Service

This section covers the technical requirements for Equipment for Compressed Air Service.

M40.1 General

The compressed air system shall provide dry clean instrument and service air for operation and maintenance of equipment.

The compressed air system shall include a minimum of two air compressor systems (one duty and one standby). Each compressor system shall be a rotary screw compressor complete with integrated refrigerant drier and integrated oil and water separator.

The compressors will have on board controls that will allow an external SCADA system to start and stop the compressor as long as the SCADA mode relay is in AUTO position. In the event of SCADA failing, the compressor shall operate on its own pressure switches.

The compressors will be configured to restart after a power failure. Suitable on board phase sequence monitor relays will be applied if deemed necessary to achieve restarting safely.

From each compressor system air shall be discharged through a set of filtering systems for the removal of traces of oil, mist, dirt and condensation to provide clean dry air. The filtered air shall be delivered to the air delivery main and to a common air receiver.

When the compressors are not in operation, air shall be delivered from air receiver into the air delivery mains.

The air delivery main pressure shall be maintained at about 700 to 800 kPA. The pressure regulating valve shall maintain a constant system supply for instrument and service air.

If the duty compressor cannot maintain the air pressure in the receiver above 700 kPa the standby compressor shall start automatically as a backup for the duty compressor.

When the air pressure exceeds the maximum pressure (900 kPA), the control system shall generate an alarm.

The equipment shall be provided with modern techniques of vibro acoustic optimisation to reduce the overall noise level.

All pressure switches shall be adjustable with minimum range of + or - 20kPA.

M40.2 Air Compressor Requirement

The compressor system shall be provided with the following minimum requirements:

- The design capacity of each compressor shall be 300% of the peak air demand.
- Capable of rapid response to load changes so as to meet the actual demand.
- Efficient oil lubrication system complete with oil level sight glass, and oil filter.
- Each compressor air intake shall be fitted with an inlet filter and silencer.
- An unloading system shall be provided for ease of starting.

The minimum expected safety features shall include:

(i) Low suction inlet pressure
(ii) High discharge pressure
(iii) Low oil pressure
(iv) Motor overload.

M40.3 Refrigerated Dryer

Each compressor shall be fitted with an integrated refrigerated dryer with moisture separator and auto drain.
M40.4 Filters
Each compressor system shall be fitted with a set of filters to provide oil free air to the degree of 0.01 parts of residual oil per million parts of air (ppm).

The first set of filters shall be general purpose filters for removing liquid water and oil aerosol to 0.1ppm and particles down to 1 micron.

The filtered air shall pass through a second set of coalescing filters, removing liquid water and oil aerosol to 0.01 ppm and particles down to 0.01 micron to 99.99%.

The elements shall be coalescer types, providing a long life expectancy. The filters shall be complete with an element condition indicator and automatic drain.

M40.5 Air Receiver Requirement
The air receiver shall be a freestanding vertical steel tank constructed in accordance with SafeWork NSW requirement. The Air receiver shall be designed, manufactured, tested and certified to AS1210. The receiver shall be designed to withstand a maximum pressure rating of 1300 kPa.

Ample height provision shall be made between the floor and bottom of the receiver for the automatic drainage system specified here in.

The air receiver shall be fitted with the following items:
- Inlet and outlet connection.
- Spare connection.
- Pressure gauge, 100mm face and isolation cock and connection.
- Pressure relief safety valve and connection.
- Automatic condensate drains.
- Manual drain valve and connection.

The safety valve pressure setting for the receiver shall be 900 kPa.

M40.6 General Features
Each compressor and all the associated equipment, the oil separator, the integral dryer, filters, and instruments, shall be assembled in one compact size package for easy floor mounting in minimal space.

M40.7 Compressed Air Service Pipework
The main compressed air supply lines (headers) shall be copper tube or grade 316 stainless steel depending upon where the pipeline is installed. The compressed air feed lines to individual equipment like solenoids shall be polyethylene tubing, copper tubing or grade 316 stainless steel. Copper shall only be used outside of buildings in areas where H₂S is not present. All equipment shall be suitable for outside use in the sunlight. The tubing fittings shall be one touch push fittings suitable for a maximum pressure of 1000 kPa.

All compressed air lines shall be run generally parallel to building structures in a neat and ordered fashion so as not to restrict clearance to other services. Polyethylene tubing shall be run in cable tray. Grade 316 stainless steel saddles shall anchor metal pipe/tube. Plastic cable ties shall fasten polyethylene tubing.

The pipelines shall be graded in direction of flow and low points shall be fitted with valved auto drain drip legs to remove condensate. Each auto drain shall be provided with manual drain valve.

A water take off point shall be provide from beneath the pipe and an auto drain to drain the occasional condensate shall be provided at 50 metre intervals. Also every descending compressed air pipe or tube shall have an efficient auto drain at its lowest point to prevent water remaining in the tube.

Air shall be taken off from the top of the main pipe to allow occasional condensate to stay in the main pipe.
All equipment to valves and equipment shall be screwed and fitted with unions to allow removal.

A suitable air service unit shall be supplied and installed before all pneumatic control equipment like solenoids etc. to provide clean dry air. For pneumatic system components which need lubrication, the air service unit shall be provided complete with lubricator. The air service unit shall be complete with pressure regulating valve and pressure gauge.

All solenoid valves for pneumatic equipment shall be provided with speed controllers for easy and stepless adjustment of the actuator movement.

Solenoid operated valves and pneumatic equipment on compressed air lines shall be specially constructed for non-lubricated air service (unless accepted otherwise by Sydney Water).

**M40.8 Acoustic Enclosures**

Noise levels shall be contained by appropriate equipment design or with an acoustic enclosure.

The enclosures shall form an integral part of the equipment and shall not affect the safety or function of equipment. Normal operation shall be possible for continuous operation without opening or moving the enclosure. The enclosure shall not hinder access for maintenance.

The compressed air system shall have guaranteed noise levels of less than 70 dB at a distance of 1m. The agreed noise limit shall be a maximum and not be exceeded under load conditions. Noise testing shall be conducted in the factory prior to delivery to site.
M41. Pressurised Water System

This section specifies the technical requirements for pressurised water system for industrial water, reclaimed effluent or site reuse water in water and wastewater treatment plants.

M41.1 Pressurised Water System Equipment

The system shall include a packaged pressure unit consisting of:

a) Minimum two variable speed centrifugal pumps.

b) Diaphragm type pressure tank(s) or hydro pneumatic tank, pipework, valves, fittings and control and monitoring instrumentation.

M41.2 Design Requirement

Unless otherwise specified elsewhere in the Specification the pressurised water system shall maintain minimum pressure of 60 kPa in the water reticulation system at a most disadvantageous point of use under varying flow demand conditions including maximum flow demand.

M41.3 Control of the Pressurised Water System

Depending on the performance required, the pumps shall be switched on and off under full alteration. The pressure set points shall be varied according to demand and to compensate for the head loss. Control system shall be programmed to adjust for friction loss compensation. The compensation shall be distributed linearly (approximately) over the flow range.

The pressure shall automatically increase as system flow and consequent frictional losses increase. Pressure shall be monitored on the discharge manifold of the booster set using a pressure transducer, and actual pressure is compared with set point pressure. When system pressure drops below the programmed set point, initially pump number one will start and ramp up to the speed required to maintain the set pressure. As the demand continues to increase, a set point will be reached where with one pump running at full speed, set point pressure can no longer be maintained. At this point the number one pump will be running at full speed and the second pump will start to raise pressure again to above the set point.

During periods of reduced demand, once pressure rises above set point pumps speed shall be reduced to track set point pressure, down to zero flow if necessary, when all pumps shall be switched off.

M41.4 Break Tank

The industrial water (IW) shall be the potable water collected in a break tank and then pumped into a hydro pneumatic system to serve for treatment process. The break tank shall be designed as per relevant Standard requirement.

M41.5 Pumps

The design of pumps shall be as per the relevant clauses of this Specification. Also, the pumps shall:

a) Be direct coupled to a single speed three-phase 400 volt 50 Hz motor with a speed not exceeding 3000rpm.

b) Be of the vertical multi-stage type and the shut-off head plus the maximum suction head shall not exceed the pressure rating of the downstream pipework and appurtenances.

c) Have continuously falling head/flow curve and be able to be operated down to 300kPa.

d) Have cast iron suction and discharge heads with stainless steel body, stainless steel impeller and stainless steel shaft.

M41.6 Hydro Pneumatic Tank Requirement

The hydro pneumatic pressure tank shall be a freestanding vertical steel tank constructed in accordance with SafeWork NSW requirements. The pressure tank shall be designed, manufactured, tested and certified to
AS1210. The pressure tank shall be designed and be rated to withstand a maximum pressure of not less than 1600kPa.

Ample height provision shall be made between the floor and bottom of the tank for the drainage system specified here in.

The pressure tank shall be:

- Connected to the discharge manifold;
- Fitted with an isolation valve in the inlet/outlet connecting pipe;
- Bladder type, pre-charged with compressed nitrogen to the required pressure;
- Gas re-charging valve installed at a suitable height along with a dial type analogue pressure gauge;
- Inlet and outlet BSP threaded or flanged connection.
- Pressure gauge, 100mm face and isolation cock and connection.
- Pressure relief device(s) where required by AS1210.
- Differential pressure transmitter to monitor pressure as an indicator of water level.
- Manual drain valve and connection.

Certificates of compliance shall be provided to Sydney Water.
M42. Odour Control Facilities

This section of the Specification covers the general requirements for odour control related assets located at Sydney Water facilities.

Odour control facilities shall also comply with the latest Sydney Water OCU Standard Specification ACP0004 and latest IICATS and SCADA standards.

For those specific applications, the documents noted above take precedence over this Specification.

M42.1 Biofilter Systems

M42.1.1 General

Biofilter systems remove and oxidise organic gases and volatile organic compounds through the action of natural occurring microorganisms as the untreated air flows through an organic filter bed. Colonies of the microorganisms are called biomass and the media used as the filter bed to sustain this biomass varies from an engineered type media to a soil and compost bed type.

Both types of biofilter systems are required to meet the following requirements:

1. Each section of the system shall have an array of humidified foul air ducts that are designed to evenly distribute foul air within the section. Each section will also have installed a system by which excess water is collected and discharged via a collection sump and pumped or gravitate back to the plant.

2. The biofilter bed shall be designed to produce an exit odour concentration which confirms to the lowest of:
   - No more than 1000 OU, determined in accordance with Australian/New Zealand Standard 4323.3:2001, Stationary source emissions Part 3: Determination of odour concentration by dynamic olfactometry and the odour concentration values are those determined at the second, or detection threshold, and
   - As determined by dispersion modelling to not cause any predicted odour impact on any sensitive receptor in combination with all other odour sources on the plant site during normal summer operation.

The biofilter shall maintain the designed odour performance throughout the life of the unit.

M42.1.2 Engineered Media Type

Engineered media type filter bed systems shall meet the following requirements:

1. The untreated air shall pass through a pre-filter preventing fats and greases from entering the biofilter.

2. All collected air be passed through a humidification step where the relative humidity of the gas is raised to minimum 95% RH. This humidification step shall also remove particulate matter from the air stream. Industrial water shall be used for humidification.

M42.1.3 Soil and Compost Bed Type

Whilst the Soil and Compost Bed type are no longer recommended as a technology for new installations at Sydney Water’s facilities, for the purposes of maintaining existing installations, Soil and Compost Beds shall meet the following requirements:

1. The humidified air is to be split equally between 2 or more separate and isolatable treatment sections of the bed. This requirement permits repairs or renewal to be performed upon the system beds separately while maintaining foul air treatment.
2. That all collected air be passed through a humidification step where the relative humidity of the
gas is raised to minimum 90% RH. This humidification step shall also remove particulate matter
from the air stream. Industrial water shall be used for humidification.

3. The humidified air is to be split equally between 2 or more separate and isolatable treatment
sections of the bed. This requirement permits repairs or renewal to be performed upon the system
beds separately while maintaining foul air treatment.

4. The material composing the bed is to be at least 1.2 metres deep and have a surface loading of
no more than 1.5 m³/minute.m² during normal operation. This material is to be composed of
particles sized to deliver a pressure drop when new of approximately 300 Pa.

5. The moisture content of the bed is to be controlled by a timer plus either:

- Two moisture monitors installed in each section of the biofilter bed at different depths
  in the bed, or
- Two temperature sensors installed in each section of the biofilter bed at different
  depths in the bed.

These control systems shall manage the flow of irrigation water over the surface of each section
of the bed. The use of moisture monitors will require a control loop which maintains a
predetermined moisture content in the bed at each sensor. The use of temperature sensors will
control the temperature difference between the inlet humidified air and each position in each
section of the biofilter bed to be no more than one centigrade degree (1°C). These control functions
are to be programmed into the plant SCADA.
M43. Equipment Installation

M43.1 General

This clause sets out the requirements for the installation of equipment not specifically stated elsewhere in this Specification. Installation of structural steel and aluminium members shall comply with relevant sections of Technical Specification - Civil.

Equipment shall be installed on concrete plinths with a minimum height of 100 mm. The concrete plinths shall be constructed on or integrated in prepared foundations or dowelled into existing concrete. A grouting allowance of 20mm to 50mm between the concrete plinth and equipment baseplate, stand, feet or pedestal shall be provided.

M43.2 Equipment Alignment

Equipment shall be properly aligned to the prescribed centre lines and elevations and set and adjusted on stainless steel packers and shims.

To assist levelling and alignment, adjusting nuts with washers shall be installed on the anchor rods/bolts under the equipment baseplate, stand, feet or pedestal.

The equipment shall be installed free of any undue stresses, strains or vibrations and be accessible for maintenance.

All mechanical equipment shall be set, levelled, aligned and inspected with precision tools (steel straight edge, dial indicator and graduated machinist levels).

Specifically, all direct driven equipment shall be aligned by the use of a dial test indicator or laser alignment. Both the driver and the driven shafts shall be rotated simultaneously to each of the four positions at 0°, 90°, 180° and 270° at which readings shall be taken. The maximum allowable out-of-alignment tolerance shall be 50µm (0.050mm) unless specified otherwise in individual equipment installation instructions. An alignment record sheet shall be completed for each coupling aligned. This alignment procedure shall also conform to the equipment manufacturer's instructions. All alignments shall be inspected and approved by the relevant equipment supplier's representative. Inspections by the equipment supplier shall be coordinated and documented. The “as installed” alignment records shall be kept for future inclusion in the Operating and Maintenance Manuals.

M43.3 Installation of Pumping Units

This clause sets out specific requirements for the installation of pumping units in water and recycled water pumping stations, dry mounted submersible pumps in dry wells of conventional sewage pumping stations, returned activated sludge (RAS) and waste activated sludge (WAS) pumps, and pumping units whose installation is not mentioned elsewhere in this Specification.

The pumping units shall be installed using stainless steel grade 316 nuts, washers and holding down anchor rods set in chemical masonry anchors. The chemical anchors and anchor rods shall be suitable for dynamic loads, eg. “Hilti HVU” system or equivalent. Only anchor rods that are part of the chemical anchoring system provided by the manufacturer shall be used.

The holding down anchor rods shall be set into the chemical anchors in concrete base or plinth to a depth and min. distance from concrete edges as recommended by the equipment and anchor manufacturers. The depth of embedment in concrete and min. distance from edges shall be shown in detail design drawings.

The chemical anchors shall be stored and installed strictly in accordance with manufacturer's instructions using adhesive capsules for each hole and appropriate tools and equipment. The capsules shall be within the expiry period to maintain maximum anchorage strength.

The installer shall wait for the appropriate curing time, as recommended by the manufacturer of the chemical anchors before fully tightening the holding down nuts.
To assist levelling and alignment, adjusting nuts with washers shall be installed on the anchor rods under the equipment baseplate, stand, pedestal or feet. However, after the packers and shims (if required) are installed and prior to grouting, the adjusting nuts and washers where used shall be backed off all the way to the concrete plinth. The aim is that tightening the nuts above the baseplate, stand, feet or pedestal shall clamp it to the packers tightly. Correct tightening torque shall be obtained from the pump supplier.

The packers shall be located on both sides of the anchor rods along the width of the baseplate, stand, feet or pedestal. Where slots are provided in the baseplate, stand, feet or pedestal for the anchor rods, packers shall be installed along the slots and the width of the baseplate, stand, feet or pedestal. The packers shall be placed as close as possible to the holding down anchor rods such that tightening the holding down nuts will not twist, bend or misalign the baseplate, stand, feet or pedestal and the tightening force is directly applied to the packers. A square stainless steel washer of size 50x50x3mm shall be provided under the nuts above the baseplate, stand, feet or pedestal. Typically, some part if not most of the stainless steel packer would be directly under the square washer.

Packers shall be of sufficient size to sustain an effective load bearing area. They shall be of one-piece construction and rectangular in shape. Round packers and packers fabricated from multiple smaller packers are not acceptable. The combined height of a packer and shims shall not exceed the maximum grouting allowance.

Packers of dimensions 40mm (W) and 70mm (L) are generally considered adequate for most applications, however these dimensions must be checked for their suitability with the pump baseplate, stand, feet or pedestal for each installation. Height of packer shall be location specific.

Packers shall be placed on concrete surfaces that are even, rough and clear of all debris. Concrete surfaces shall be scabbled with a chipping hammer to a depth of 3 to 5mm. This scabbling shall be continued for all concrete surfaces where subsequent grout will be applied.

Shims shall be of the same width and length as the packer. The maximum number of shims at any one point shall not exceed two with maximum thickness of individual shims not exceeding 2mm. If the total thickness required is more than 4mm, the shims shall be replaced with a single machined plate.

The space between the underside of the baseplate, stand, feet or pedestal and the concrete floor / plinth shall be filled with non-shrink epoxy grout Conbextra EP65 Plus, or equivalent.

The face of pump flanges (both suction and discharge) shall be plumb and square to the direction of flow. Pump suction and discharge flanges must not be stressed due to the installation of downstream and upstream pipework and appurtenances.

**M43.4 Specific Requirements for Submersible Sewage Pumps**

Submersible sewage pumps are installed on pump pedestals, rather than on baseplates or feet. Packers shall suit the dimensions of the pump pedestal.

Packer width shall be equal or slightly larger than the dimension between the edge of the slot for hold down anchors and the edge of the pedestal (nearest edge parallel to the slot).

Packer height and length of 32mm (H) and 50mm (L) are generally considered adequate for most applications, however these dimensions must be checked for their suitability with the pump pedestal for each installation.

Packer dimensions shall be specified in the design drawings.

The space between the underside of the pedestal and the concrete floor / plinth shall be filled with non-shrink epoxy grout Conbextra EP65 Plus, or equivalent.

The face of pump pedestal shall be plumb and square to the direction of sewage flow.
M43.5 Grouting

After final alignment non-shrinking grout shall be provided under all equipment baseplates, feet and supports when mounted on a concrete base or plinth and where fastened to concrete walls, ceilings and floors. Grouting surfaces shall be graded so that there is no low points which can accumulate water or dirt and to achieve drainage to the floor drain and away from the equipment baseplate or feet so that cleaning around the equipment can be easily carried out. The grout shall be suitable for dynamic loads and permanent submergence in case of submerged installation. The installer shall follow the grout manufacturer’s instructions.

M43.5.1 Epoxy Grout

The epoxy grout shall be an epoxy resin based product designed for free-flow grouting of gaps of widths from 20 mm to 50 mm. A suitable grout shall be “Fosroc Conbextra EP65 Plus” or alternative accepted by Sydney Water. The components shall be supplied from the manufacturer in the correct mix proportions designed for whole pack mixing so that reproducible flow and mechanical properties are assured. Product packs shall be mixed near the application site to avoid product going ‘off’ prior to pouring.

The grout shall extend 30mm sideways and minimum 10mm upwards all around the baseplate, stand, feet or pedestal. All sharp edges shall be provided with a 5mm x 45 degrees bevelled edge within the formwork.

Only epoxy grout Conbextra EP 65 Plus or equivalent (with written acceptance from Sydney Water) shall be used under all pumping units.

M43.5.2 Chemical Grout

The chemical grout shall be a non-shrink, premixed, prepacked, fine graded siliceous based or non-catalysed iron aggregate cementitious grout. The grout shall be free from gas producing agents, oxidising catalysts and inorganic accelerators, including chlorides. The addition of potable water only shall be sufficient to achieve fluid consistency as specified below. A suitable grout shall be Australian Master Builders Masterflow 870A or equivalent. Such grout shall provide performance characteristics when mixed to fluid consistency of 25 to 30 seconds (flow cone method, AS1478.2 - Appendix C).

M43.6 Conformance with Regulating Authorities

It is a requirement of this specification that all equipment and plant installed, is in accordance with the regulations, ordinates, by-laws and requirements of all relevant statutory authorities. Plant and equipment inspections shall be carried out by relevant statutory authorities where required.
M44. Technical Data Labelling

This clause sets out the requirements for the labelling of equipment not specifically stated elsewhere in this Specification.

Labels shall be fixed to all items of equipment for both custom build and proprietary items. Labels shall be grade 316 stainless steel plate and fixed by oval head stainless steel screws.

The label (or nameplate) shall be suitably engraved to provide information of a descriptive and technical nature relating to the item of equipment.

The information given on the label shall include but is not limited to typical data as listed below:

a) Equipment number:
b) Name of equipment: eg. Screw Conveyor, Axial Flow Fan, Torque Flow Pump, etc
c) Name of manufacturer:
d) Model Number:
e) Serial Number: As appropriate
f) Rated Speed: If 2 speed, state both speeds. If variable speed, state upper and lower limits
g) Capacity: Depends on the equipment type, eg. pumps - litres/sec, hoppers – m³, etc.
h) Rating: kW or as appropriate

The information to be supplied depends on the equipment item, eg. for a gearbox, provide reduction ratio; for a motor, show voltage, full load current, winding connections, etc.

The labels shall replace or be in addition to nameplates of other materials, should these be supplied as part of the equipment.

The label dimensions shall be selected to be suitable for the information contained thereon.

The label shall be affixed to the specific item of equipment so that it may be conveniently read when in the installed position and shall be attached to a principal component of the equipment item so that it is not misplaced or inadvertently discarded on a replacement part during overhaul.
M45. Commissioning

Commissioning of the works shall comply with Sydney Water’s Commissioning Specification.