Master Specification
Part TUN-ME-DC1

Tunnel Hydraulics Treatment and Pumping

September 2024

Government of South Australia
Department for Infrastructure and Transport

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Document Information

Document Information	
K Net Number:	
Document Version:	1
Document Date:	30/09/2024

Document Amendment Record

Version	Change Description	Date
0	Initial issue	31/08/2023
1	Updated cover page	30/09/2024

Document Management

Contents

TUN-ME-DC1 Tunnel Hydraulics Treatment and Pumping

1 General

a) This Master Specification Part sets out the requirements for the design, supply, installation and testing of the Tunnel hydraulics treatment and pumping system including:

i) the documentation requirements, as set out in section 2;

ii) the technical requirements, as set out in section 3;

iii) the control and monitoring requirements, as set out in section 4;

iv) the reliability, Design Life, and functional safety requirements, as set out in section 5;

v) the maintainability requirements, as set out in section 6;

vi) the Witness Point requirements, as set out in section 7; and

vii) the verification and testing requirements, as set out in section 8.

b) For the purposes of this Master Specification Part, the Tunnel hydraulic treatment and pumping system includes the following subsystems:

i) Tunnel sump pump systems for each of the following:

A. Tunnel portal sumps; and

B. Tunnel low point sumps;

ii) hazardous area provisions, as applicable, including:

A. hydrocarbon detection; and

B. fire foam suppression; and

iii) water treatment plant.

c) This Master Specification Part does not apply to the following:

i) drainage provisions and infrastructure required during construction;

ii) sump systems associated with the lowered motorway;

iii) the civil drainage systems, which include the gravity drainage systems;

iv) the hydraulic system for buildings and above ground facilities; or

v) ventilation systems servicing sump pump systems.

d) The design, supply, installation and testing of the Tunnel hydraulic treatment and pumping system must comply with the Reference Documents, including:

i) AS 1940 The storage and handling of flammable and combustible liquids;

ii) AS 2118.3 Automatic fire sprinkler systems, Part 3: Deluge systems;

iii) AS 2118.9 Automatic fire sprinkler systems, Part 9: Piping support and installation;

iv) AS/NZS 2280 Ductile iron pipe and fittings;

v) AS/NZS 2638 Gate valves for water work purposes;

vi) AS/NZS 3500 Plumbing and drainage;

vii) AS/NZS 4087 Metallic flanges for waterworks purposes;

viii) AS 4795 Butterfly valves for waterworks purposes;

ix) AS 4825 Tunnel fire safety;

x) AS 5612 Butterfly valves for general purposes;

xi) AS ISO 9906 Rotodynamic pumps - Hydraulic performance acceptance tests - Grades 1, 2 and 3;

xii) AS 60034 Rotating electrical machines;

xiii) AS/NZS IEC 60079 Explosive atmospheres;

xiv) National Construction Code (NCC);

xv) AGRT Part 2: Planning, Design and Commissioning;

xvi) NFPA 11 Standard for Low, Medium and High Expansion Foam; and

xvii) SA EPA Environment Protection (Water Quality) Policy;

2 Documentation

2.1 Design Documentation

In addition to the requirements of PC-EDM1 “Design Management”, the Design Documentation must include:

a) a Tunnel hydraulic strategy as required by section 3.1b);

b) records of Authority connection agreements and point of discharge details in conjunction with the civil drainage system designs, as required by section 3.2c);

c) details of the Contractor’s assessment of whether a fire foam suppression system is required for the Tunnel portal sump pump system, as required by section 3.3.1l);

d) calculations and design evidence to demonstrate coordination with the civil drainage design for:

i) Tunnel portal sump pump systems as required by section 3.3.2b); and

ii) Tunnel low point sump pump systems as required by section 3.4.2b);

e) calculations and design evidence of credible worst case combinations of inflow scenarios for:

i) Tunnel portal sump pump systems as required by section 3.3.2e); and

ii) Tunnel low point sump pump systems as required by section 3.4.2g);

f) calculations and design evidence to demonstrate the total required sump capacity for:

i) Tunnel portal sump pump systems as required by section 3.3.2h); and

ii) Tunnel low point sump pump systems as required by section 3.4.2g);

g) a hazardous area classification study report in accordance with section 3.6c);

h) computational modelling to demonstrate sump airflows in accordance with section 3.7g); and

i) a Tunnel hydraulic functionality report as required by section 4b).

3 Technical requirements

3.1 General requirements

a) A Tunnel hydraulic strategy must be developed based on the:

i) specifics of the Tunnel design including interfacing motorways and catchment areas;

ii) Fire Engineering process in accordance with TUN-FIRE-DC3 “Tunnel Fire Engineering”; and

iii) philosophy for the operation of each sump pump system.

b) The Tunnel hydraulic strategy required by section 3.1a) must be submitted as part of the Design Documentation.

c) The philosophy for the operation of each sump pump system as required by section 3.1a)iii) must include, as a minimum, the following:

i) stop and start frequency of the pumps in response to level indication and switches;

ii) duty rotation of the pumps to manage wear and tear on pumps;

iii) coordination of the low, high and high-high sump levels and alarms with operations and maintenance requirements;

iv) maximise pump efficiency; and

v) minimise operations costs including energy consumption and energy tariffs.

d) The materials used for the sumps, sump lining and pumping system equipment must be selected to accommodate the physical and chemical composition of the groundwater.

e) The configuration and operation of sump pump systems must be fully coordinated with:

i) the overall Tunnel and lowered motorway civil drainage system; and

ii) the ventilation systems provided in accordance with TUN-ME-DC7 “Ventilation Design”.

f) The simultaneous fire suppression system discharge flowrates for the sump and pump sizing must be based on the requirements of:

i) TUN-FIRE-DC1 “Tunnel Fire Detection and Suppression Systems”; and

ii) the Contractor’s Fire Engineering Design derived from TUN-FIRE-DC3 “Tunnel Fire Engineering”.

3.2 Authority connections

a) Groundwater treatment and environmental discharge components of the Tunnel hydraulic treatment and pumping system must comply with:

i) applicable discharge criteria as agreed with the relevant Authority;

ii) conditions of any Approvals;

iii) the SA EPA Environment Protection (Water Quality) Policy; and

iv) any applicable environmental criteria set out in the Contract Documents.

b) Stormwater drainage connections must comply with:

i) applicable stormwater drainage connection criteria as agreed with the relevant Authority;

ii) conditions of any Approvals;

iii) the SA EPA Environment Protection (Water Quality) Policy;

iv) requirements of the relevant municipal council; and

v) any applicable environmental criteria set out in the Contract Documents.

c) The Design Documentation must include:

i) records of all Authority consultation and agreements related to the Authority connections;

ii) details of the point of discharge in conjunction with the civil drainage system designs; and

iii) demonstration that all authority requirements are satisfied.

3.3 Tunnel portal sump pump system

3.3.1 General

a) Tunnel portal sump pump systems must be located at all Tunnel portals where required to protect the Tunnel from external inflows.

b) Tunnel portal sump pump systems required by 3.3.1a) may mange inflows from coincident Tunnel portals provided these portals are at similar locations and vertical alignments.

c) The catchment demarcation point between the Tunnel portal sump and Tunnel low point sump zones of drainage must be the ultimate extent of the Tunnel deluge system and located outside of any covered structure.

d) Tunnel portal sump pump systems must include the following:

i) pumps servicing each sump;

ii) rising main from pump to discharge location; and

iii) other systems to facilitate the sump pump systems, including:

A. MCCs;

B. sensors and controls; and

C. hydrocarbon detection in accordance with section 3.7.

e) The power supply and controls for Tunnel portal sump pump systems must have sufficient diversity to ensure no single points of failure that prevent more than one pump from operating.

f) Tunnel portal sump structures must be provided in accordance with the requirements for underground structures as defined in TUN-CIV-DC1 “Tunnel Civil Requirements”.

g) Tunnel portal sumps must be:

i) designed and constructed using appropriately reinforced formed concrete; and

ii) made watertight using a waterproofing admixture or an accepted liquid membrane applied on the interior surfaces of the formed concrete sump walls.

h) The Tunnel portal sumps must maximise self-cleaning capability by:

i) the internal design and interior surface finish; and

ii) the sump pump configuration and operation.

i) The civil and structural design of Tunnel portal sumps must ensure that minimal turbulence is generated around the Tunnel portal sump pump intakes during their operation.

j) The Tunnel portal sump systems must ensure that vortexing does not occur at the pump inlets.

k) The Contractor must assess and document if a fire foam suppression system is required for the Tunnel portal sump pump system based upon:

i) the location of the sump system and if it within a fully or partially covered structure; and

ii) the risk and consequence associated with hydrocarbon fires within the sump.

l) The assessment required by section 3.3.1k) must be included with the Design Documentation.

3.3.2 Tunnel portal sump capacity

a) Tunnel portal sump capacity must be coordinated with the civil drainage design including the strategy for the motorway catchment areas and motorway sump systems.

b) Evidence of compliance with section 3.3.2a) must form part of the Design Documentation.

c) Tunnel portal sump capacity (without operation of the pumps) must allow containment for the full range of credible combinations of inflows for the following events:

   i) a 1% AEP event from the catchment area;

   ii) 50,000 L liquid fuel tanker spillage;

   iii) groundwater inflows for minimum of 24 hours;

   iv) fire hydrant system discharges outside of the portal for a minimum of 4 hours; and

   v) motorway wash down, including for any cleaning and spill events.

d) The Tunnel portal sump capacity required by section 3.3.2c) must also allow for containment of the discharge of the fire foam suppression system defined by section 3.4.1e)iii)D when a fire foam suppression system is required in accordance with section 3.3.1k).

e) The calculation of credible worst case combinations of inflows for the Tunnel portal sump capacity required by section 3.3.2c) must be submitted with the Design Documentation.

f) Tunnel portal sumps must include a:

   i) hydrocarbon trap to separate hydrocarbons from the inflows;

   ii) hydrocarbon chamber that is sized for a liquid fuel tanker spill required by section 3.3.2c); and

   iii) main chamber that is sized for all other inflows determined from 3.3.2c).

g) The total Tunnel portal sump capacity must allow for:

   i) the requirements of section 3.3.2f);

   ii) dead water volume;

   iii) pump operational capacity or rating;

   iv) reserve storage capacity; and

   v) air gaps required by any subsystem (instrumentation and ventilation).

h) The calculation of the Tunnel portal sump capacity must be submitted with the Design Documentation including:

   i) the capacity sizing required by section 3.3.2g);

   ii) justification of the reserve storage capacity; and

   iii) risk of overflow of the Tunnel portal sump and impact on the Tunnel low point sump.

i) Tunnel portal sumps must have permanent extraction facilities for the connection of a vacuum truck to remove contaminated wastewater from the hydrocarbon chamber.

3.3.3 Tunnel portal sump instrumentation

a) Tunnel portal sumps must be provided with level indication including:

   i) ultrasonic level sensors; and

   ii) backup float switches.

b) The level indication required by 3.3.3a) must include:

   i) facilities to enable communication with the PMCS;

   ii) level indication from empty to overfill;

   iii) low level switch (to stop pumps);

iv) high level switch (sump at 100%); and

v) overfill level switch.

3.3.4 Tunnel portal sump pumps

a) Tunnel portal sump pumps must be certified and provided to comply with the requirements of:

i) AS ISO 9906 Rotodynamic pumps - Hydraulic performance acceptance tests - Grades 1, 2 and 3; and

ii) AS 60034 Rotating electrical machines.

b) Tunnel portal sump pumps must be submersible and self-priming.

c) Tunnel portal sump pumps must be redundantly configured in a N+1 arrangement.

d) Tunnel portal sump pumps must be capable of handling the following materials as a minimum:

i) frangible solids;

ii) hard solids;

iii) fibrous material;

iv) heavy sludge;

v) minerals and oils;

vi) ground water composition; and

vii) other matter as typically encountered in carriageway drainage applications.

e) Tunnel portal sump pumps must be selected and configured to allow the standby pump to be operated at capacity in parallel with the duty pumps in the event of higher than expected inflows.

f) The sizing and selection of the rising main and associated valves must be coordinated with the requirement of section 3.3.4e).

g) The Tunnel portal sump pump characteristics must be compatible with the sump storage volume and the maximum inflow rate.

3.4 Tunnel low point sump pump system

3.4.1 General

a) Tunnel low point sump pump systems must be located near all Tunnel longitudinal low points.

b) Tunnel low point sump pump systems required by section 3.4.1a) may manage inflows from coincident Tunnel carriageway provided the longitudinal low points are at similar locations.

c) The catchment demarcation point between the Tunnel portal sump and Tunnel low point sump zones of drainage must be the ultimate extent of the Tunnel deluge system.

d) All areas covered by the Tunnel deluge system must drain to the Tunnel low point sump system.

e) Tunnel low point sump pump systems must include the following:

i) pumps servicing each sump;

ii) rising main from pump to discharge location; and

iii) other systems to facilitate the sump pump systems, including:

A. MCCs;

B. sensors and controls;

C. hydrocarbon detection in accordance with section 3.7; and

D. fire foam suppression in accordance with section 3.8.

f) The power supply and controls for Tunnel low point sump pump systems must have sufficient diversity to ensure no single points of failure that prevent more than one pump from operating.

g) Tunnel low point sump structures must be provided in accordance with the requirements for underground structures as defined in TUN-CIV-DC1 “Tunnel Civil Requirements”.

h) Tunnel low point sumps must be:

i) designed and constructed using appropriately reinforced formed concrete; and

ii) made watertight using a waterproofing admixture or an accepted liquid membrane applied on the interior surfaces of the formed concrete sump walls.

i) The Tunnel low point sumps must maximise self-cleaning capability by:

i) the internal design and interior surface finish; and

ii) the sump pump configuration and operation.

j) The civil and structural design of Tunnel low point sumps must ensure that minimal turbulence is generated around the Tunnel low point sump pump intakes during their operation.

k) The Tunnel low point sump systems must ensure that vortexing does not occur at the pump inlets.

3.4.2 Tunnel low point sump capacity

a) Tunnel low point sump capacity must be coordinated with the civil drainage design.

b) Evidence of compliance with section 3.4.2a) must form part of the Design Documentation.

c) Tunnel low point sump capacity (without operation of the pumps) must allow containment for the full range of credible combinations of inflows for the following events:

i) 50,000 L liquid fuel tanker spillage;

ii) groundwater inflow for a minimum of 24 hrs;

iii) simultaneous deluge and hydrant discharges in accordance with section 3.1f);

iv) discharge of the fire foam suppression system required by section 3.4.1e)iii)D; and

v) overflow from Tunnel portal sump systems assessed in accordance with section 3.3.2h).

d) The calculation of credible combinations of inflows for the Tunnel low point sump capacity required by section 3.4.2a) must be submitted with the Design Documentation.

e) Tunnel low point sumps must include a:

i) hydrocarbon trap to separate hydrocarbons from the inflows;

ii) hydrocarbon chamber that is sized for a liquid fuel tanker spill required by section 3.4.2c); and

iii) main chamber that is sized for all other inflows determined from section 3.4.2c).

f) The total Tunnel low point sump capacity must allow for:

i) the requirements of section 3.4.2e);

ii) dead water volume;

iii) pump operational capacity or rating;

iv) reserve storage capacity; and

v) air gaps required by any subsystem (instrumentation, ventilation and fire foam suppression).

g) The calculation of the Tunnel low point sump capacity required by section 3.4.2f), including justification of the reserve storage capacity, must be submitted with the Design Documentation.

h) Tunnel low point sumps must have permanent extraction facilities for the connection of a vacuum truck to remove contaminated wastewater from the hydrocarbon chamber.

3.4.3 Tunnel low point sump instrumentation

a) Tunnel low point sumps must be provided with level indication including:

i) ultrasonic level sensors; and

ii) backup float switches.

b) The level indication required by 3.4.3a) must include:

i) facilities to enable communication with the PMCS;

ii) level indication from empty to overfill;

iii) low level switch (to stop pumps);

iv) high level switch (sump at 100%); and

v) overfill level switch.

3.4.4 Tunnel low point sump pumps

a) Tunnel low point sump pumps must be certified and provided to comply with the requirements of:

i) AS ISO 9906 Rotodynamic pumps - Hydraulic performance acceptance tests - Grades 1, 2 and 3; and

ii) AS 60034 Rotating electrical machines.

b) Tunnel low point sump pumps must be submersible and self-priming.

c) Tunnel low point sump pumps must be redundantly configured in a N+1 arrangement.

d) Tunnel low point pumps must be capable of handling the following materials as a minimum:

i) frangible solids;

ii) hard solids;

iii) fibrous material;

iv) heavy sludge;

v) groundwater composition;

vi) minerals and oils; and

vii) other matter as typically encountered in carriageway drainage applications.

e) Tunnel low point sump pumps must be selected and configured to allow the standby pump to be operated at capacity in parallel with the duty pumps in the event of higher than expected inflows.

f) The sizing and selection of the rising main and associated valves must be coordinated with the requirement of section 3.4.4e).

g) The Tunnel low point sump pump characteristics must be compatible with the sump storage volume and the maximum inflow rate.

3.5 Rising main and pipework

a) Rising mains, pipework, fittings and valves must be certified and provided to comply with the requirements of AS/NZS 3500 Plumbing and drainage.

b) Rising mains, pipework, fittings and valves must be provided with materials that are suitable for:

   i) the external environment in which they are installed; and

   ii) the physical and chemical composition of the pumped liquids.

c) Where ductile iron pipework and fittings are used, they must be provided and installed in accordance with the requirements of AS/NZS 2280 Ductile iron pipe and fittings.

d) Where materials other than ductile iron pipework and fittings the subject of section 3.5c) are used, the material must be non-combustible LSZH type.

e) Polyvinyl chloride (PVC) pipework must not be used within any underground or Tunnel spaces.

f) Plastic pipework must not be used where it may be exposed to fire within the Tunnel.

g) Rising mains and pipework must be sized to ensure fluid velocities of no more than 2.5 m/s.

h) Rising mains, pipework, fittings and valves must be installed with provisions to enable required maintenance and future replacement.

i) Rising mains must be provided with check valves to control discharge flows.

j) Rising mains must be provided with isolation valves that are monitored and controlled by the PMCS.

k) Rising mains must be provided with a flow meter and pressure transducer on the discharge side of the sump pumps to report flow rate and pressure to the PMCS.

l) Sump inflow pipework must be provided with isolation valves to enable safe sump access and the removal of the pumps during maintenance that are monitored and controlled by the PMCS.

m) Valves must be provided and installed in accordance with the requirements of:

   i) AS/NZS 4087 Metallic flanges for waterworks purposes;

   ii) AS 4795 Butterfly valves for waterworks purposes;

   iii) AS 5612 Butterfly valves for general purposes; and

   iv) AS/NZS 2638 Gate valves for water work purposes.

3.6 Hazardous area classification

a) A hazardous area classification study must be conducted for each sump system and adjacent areas in accordance with the requirements of AS/NZS IEC 60079 Explosive atmospheres.

b) The hazardous area classification study required by section 3.6a) must include the following:

   i) sumps and hydrocarbon chambers; and

   ii) equipment rooms connected to the sumps.

c) The hazardous area classification study required by section 3.6a) must form part of the Design Documentation.

d) All electrical installations associated with hazardous areas identified in accordance with the hazardous area classification study undertaken pursuant to section 3.6a) must be designed and installed in accordance with the requirements of AS/NZS IEC 60079 Explosive atmospheres.

3.7 Hydrocarbon detection system

a) Hydrocarbon detection systems must be provided to sump systems as set out in this Master Specification Part and as otherwise required by the Contractor's Fire Engineering design.

b) Hydrocarbon vapour detectors must be provided to enable rapid detection of hydrocarbon gas hazards within the sump pump systems.

c) Hydrocarbon vapour detectors must be redundantly configured in an N+1 arrangement.

d) Hydrocarbon vapour detectors must be installed:

i) in the exhaust outlet of the ventilation system servicing the sump;

ii) in locations readily accessible for maintenance; and

iii) in an area outside of the sump chamber.

e) The airflow being sampled by the hydrocarbon vapour detectors must be representative of the hydrocarbon vapour levels within the sump chamber.

f) To achieve the requirement of section 3.7e), the ventilation system servicing the sump pump system must be demonstrated by computational modelling to achieve an evenly distributed airflow across the sump chambers to prevent localised concentrations of hydrocarbons.

g) The computational modelling of sump airflows required by section 3.7f) must be provided in the Design Documentation.

h) Hydrocarbon vapour detectors must be:

i) suitable to monitor hydrocarbons over the range of 0-100% LEL;

ii) self-compensating for the effects of changing ambient conditions;

iii) fail safe in operation;

iv) low maintenance and immune to contamination; and

v) provided with facilities to communicate with the PMCS.

3.8 Fire foam suppression system

a) Fire foam suppression systems must be provided to sump systems as set out in this Master Specification Part and as otherwise required by the Contractor's Fire Engineering design.

b) Fire foam suppression systems must be provided in accordance with the requirements of:

i) AS 1940 The storage and handling of flammable and combustible liquids;

ii) AS 2118 Automatic fire sprinkler system; and

iii) NFPA 11 Standard for Low, Medium and High Expansion Foam.

c) Pipe supports and hangers for the fire foam suppression system must comply with the requirements of AS 2118 Automatic fire sprinkler system.

d) The fire foam suppression system must have a minimum application rate as required by the manufacturer's recommendation for this specific application.

e) The foam and water admixture comprising the fire foam suppression system must be proportioned at 3% foam mixture.

f) The fire foam suppression system must be provided with a water supply sourced from the Tunnel fire water distribution mains.

g) The foam type utilised must be fluorine free foam (F3) or equivalent, and readily available in South Australia.

h) The fire foam suppression system must be activated automatically by the hydrocarbon vapour detection system specified by section 3.7.

i) The fire foam suppression system must be provided with facilities to communicate with the PMCS.

3.9 Ground water monitoring and recharge

Ground water monitoring and recharge must be in accordance with the requirements with TUN-CIV-DC1 "Tunnel Civil Requirements".

3.10 Water treatment

a) The Tunnel low point sump pump systems must allow for discharge through a fully automated water treatment plant.

b) The water treatment plant must be provided to manage the water captured by the Tunnel hydraulic treatment and pumping systems as set out in this Master Specification Part.

c) The water treatment plant must be provided:

i) for unmanned operation or minimal operational interaction;

ii) in accordance with the Contract Documents;

iii) to meet the requirements of:

A. the civil drainage specifications; and

B. relevant Project environmental documents forming part of the Contract Documents, including PC-ENV1 “Environmental Management”, PC-ENV2 “Environmental Protection Requirements” and PC-ENV3 “Environmental Design”; and

iv) to minimise the whole-of-life cost.

d) The water treatment plant must be provided with instrumentation to:

i) monitor and indicate the current state of the water treatment processes;

ii) indicate any faults, warnings or alarms with the water treatment processes; and

iii) monitor all of the parameters required to determine if the quality of the discharged water meets the Project requirements for the level of treatment of the water.

e) The water treatment plant must be integrated with the PMCS to enable the PMCS to monitor:

i) the status of the water treatment plant; and

ii) the quality of the discharged water.

f) The Contractor must submit with Design Documentation for approval the following:

i) design of the water treatment plant; and

ii) analysis to demonstrate that the requirements of this section 3.10 will be met.

3.11 Local controls

a) Tunnel hydraulic treatment and pumping systems must be provided with a local GUI to enable control and monitoring of sump pump and water treatment facilities.

b) The local GUI required by section 3.11a) must:

i) be in close proximity to the systems which it is serving;

ii) be a ruggedised PC with a touch screen;

iii) be fixed in position;

iv) be connected to the PMCS; and

v) utilise the SCADA platform for monitoring and control.

c) All Tunnel sump pump systems must be provided with a local sump pump manual control and maintenance isolation station adjacent to the Tunnel sump pump maintenance access facilities located so as to be Readily Accessible during a maintenance closure (lane or Tunnel).

4 Control and monitoring requirements

a) A Tunnel hydraulic functionality report must be developed that includes the following for each Tunnel hydraulic treatment and pumping system:

   i) sufficient detail to be a standalone report that does not require reference to other documentation in order to be used for operational purposes and control system programming;

   ii) coordination of the functionality with the strategy required by section 3.1b);

   iii) narrative and schematic descriptions of the functionality for each system;

   iv) equipment interlocking methodology required for safe equipment operation;

   v) fail-safe operation of all mechanical devices;

   vi) functionality for duty sharing of duty and standby equipment;

   vii) functionality to compensate for unhealthy and unavailable equipment;

   viii) input/output lists for each instrument and sensor;

   ix) input/output lists for equipment that includes event and alarm triggers;

   x) integrated operation and functionality of each sump pump system;

   xi) integrated operation of the hydrocarbon detection, ventilation and fire foam suppression (where provided) for each Tunnel sump system; and

   xii) integrated operation and functionality of the water treatment plant.

b) The Tunnel hydraulic functionality report required by section 4a) must be submitted as part of the Design Documentation.

c) Tunnel hydraulic treatment and pumping systems must report all diagnostic and fault information associated with equipment and instrumentation to PMCS.

d) Tunnel sump pumps must provide the following statuses to PMCS:

   i) pump status (running/stopped/fault); and

   ii) pump circuit breaker (on/off/tripped).

e) Tunnel sump pump level indication must provide the following statuses to PMCS:

   i) current sump level as measured by each level instrument; and

   ii) level switch indication (low, high, overfill).

f) Tunnel pipework and rising mains must provide the following statuses to PMCS:

   i) position and state of each manual and actuated valve;

   ii) position and state of each flow control device installed (where applicable);

   iii) flowrate in rising main; and

   iv) pressure in rising main.

g) Hydrocarbon detection systems must provide the following statuses to PMCS;

   i) hydrocarbon level from each sensor; and

   ii) hydrocarbon detection sensor fault.

h) Fire foam suppression systems must provide the following statuses to PMCS:

   i) fire foam suppression release; and

   ii) fire foam suppression system fault.

5 Reliability, Design Life, and functional safety requirements

The Tunnel hydraulic treatment and pumping systems must be designed and provided:

a) to achieve its Design Life requirements, taking account of the physical and chemical composition of the pumped liquids; and

b) in accordance with the systems engineering requirements and the analysis for reliability, availability and maintainability (RAMS) in accordance with PC-EDM6 “Systems Engineering Management”.

6 Maintainability

a) The Tunnel hydraulic treatment and pumping systems must be designed to be:

   i) safely maintainable; and

   ii) replaceable at the end of the equipment life.

b) The maintenance and access strategy for the Tunnel hydraulic treatment and pumping systems must:

   i) minimise the requirements for sump and storage chamber access;

   ii) not require the pump system equipment to be dismantled to be removed and replaced;

   iii) provide access hatch and pump extraction facilities outside of the carriageways; and

   iv) be coordinated with the heights and widths of doors and corridors to allow the sump pumps to be easily removed and replaced without dismantling of equipment.

c) Where a gross pollutant trap is provided in the Contractor’s Tunnel hydraulic treatment and pumping systems design, the maintenance and access strategy must minimise access and maintenance into the traps.

d) The Tunnel hydraulic treatment and pumping systems must be arranged to minimise the accumulation of solids and reduce the maintenance cleaning in the sump.

e) Sump chambers must be designed to facilitate periodic maintenance cleaning from above using a vacuum truck.

f) The Tunnel hydraulic treatment and pumping systems must include adequate space in rooms, chambers and sumps for cleaning and maintenance of pipes, pumps and all associated equipment.

g) Provision must be made in the design of the sumps for maintenance and access of:

   i) the incoming and discharge mains pipework and spill chambers;

   ii) power supply and instrumentation cabling; and

   iii) any specific pump and instrumentation arrangements.

h) Sump pumps must be easily retrievable from the sump via permanently fixed vertical slide rails and overhead lifting beams or monorails provided complete with winches.

i) All valves must be located such that they are readily accessible from above without the need to enter the sump.

j) Subject to section 6h), sump access hatches must be provided directly above the pumps providing a clear vertical lift path for sump pump extraction purposes via the vertical slide rail.

k) All access openings must be fitted with heavy duty hot dipped galvanised steel or concrete (“Gatic” type) covers with sump access provided via permanently installed non-slip and non-corrodible access ladders and equipped with fall protection system attachment points.

l) The local control and isolation panel or MCC must be installed in a secure location for normal operation and easily accessible for maintenance purposes.

m) Sump pumps or instrumentation must be provided with electrical plug connections to facilitate the easy removal of either from the sump during maintenance or removal procedures.

7 Witness Points

Table TUN-ME-DC1 7-1 details the review period or notification period, and type (documentation or construction quality) for each Witness Point referred to in this Master Specification Part.

Table TUN-ME-DC1 7-1 Witness Points

Section reference	Witness Point	Documentation or construction quality	Review period or notification period
8b)	Hydrocarbon detection system and fire foam suppression system testing and commissioning	Construction quality	20 days notification

8 Verification requirements and records

a) Testing and commissioning procedures and documentation must be in accordance with the requirements of:

i) PC-CN1 “Testing and Commissioning”;

ii) all system component manufacturer and supplier recommendations;

iii) the Contractor’s Fire Engineering design; and

iv) the requirements of AS 4825 Tunnel fire safety.

b) The Principal and SAMFS must be invited to attend the progressive inspection, testing and approval of the hydrocarbon detection system and fire foam suppression system, which will constitute a **Witness Point.**