

COMMISSIONING AND HANDOVER CODE OF PRACTICE FOR COMMISSIONING

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Acronyms

Acronym	Description
ATS	Acceptance to Service
ALARP	As Low as Reasonably Practicable
CAR	Change Authority Request for control systems
CSRP	Change to System Risk Profile
CTP	Commissioning Test Procedure
DCS	Distributed Control System
ECoC	Electrical Certificate of Compliance
ERMA	Enterprise Risk Management Academy
FAT	Factory Acceptance Testing
FD	Functional Description
IP	Ingress Protection
ITP	Inspection Test Plan
ITR	Inspection Test Record
I/O	Input/output
MCC	Motor Control Centre
MoC	Management of Change
O&M	Operations and Maintenance
P&ID	Piping and Instrumentation Diagram
POD	Process Objectives and Design
PUSI	Pre-Use Startup Inspection
SAT	Site Acceptance Testing
SID	Safety in Design
SIT	Site Integration Testing
SOP	Standard Operating Procedure
QA	Quality Assurance
QC	Quality Control
WSL	Watercare Services Ltd
WSL-C	Watercare Services Ltd Commissioning Team
WSL-M	Watercare Services Ltd Maintenance Delivery Team
WSL-O	Watercare Services Ltd Operating Team
WSL-P	Watercare Services Ltd Project Team

1. Introduction

Commissioning is the process of bringing new, renewed, or modified assets into operation, and demonstrating compliance with the companies' standards, legislation, project specifications and business case objectives before handover to the operating team.

Decommissioning is the process of safely taking an asset out of service. Once decommissioned an asset can be handed over to a project team to allow modifications to take place, preserved if it is intended to be mothballed for future use, or demolished.

This code documents the process to be followed for all projects in Watercare Services Limited to demonstrate that the project has been commissioned in accordance with Watercare standards (including the Code of Practise for Disinfection of Water Systems - COP-04 where applicable) and is acceptable for operational service.

1.1 Commissioning framework

Commissioning is required for any asset that has been upgraded, replaced, or returned to service after significant downtime. The extent of commissioning/decommissioning and the team responsible depends on the project size, complexity, and criticality. Major projects require larger specialist teams while smaller, less complex projects can be commissioned by operations/maintenance as part of their normal duties.

The following framework sets out high-level stages of commissioning for a single system project. Projects can commission multiple sub-systems in parallel or series depending on the sequencing philosophy, potentially each with individual acceptance to service agreements. The methodology referred to in the commissioning plan will be project specific. The dashed boxes are a guide only and are dependent on contractual and project details.

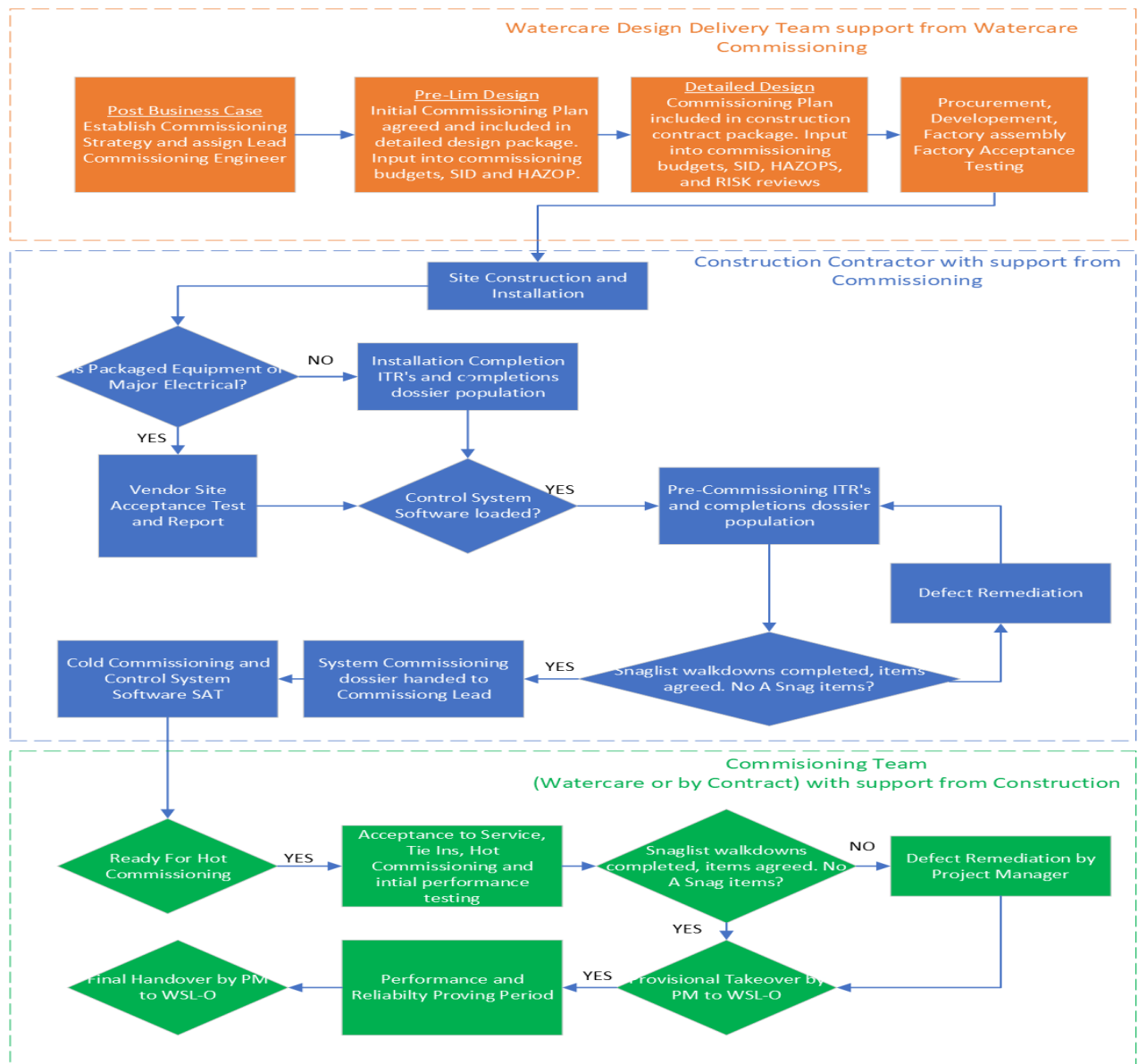


Figure 1: Watercare's commissioning framework.

2. Watercare Commissioning Process

Below is a summary of the Watercare Commissioning process. Section 6 describes each part in detail. Individual project commissioning plans will be prepared in design and execution phases to provide specific detail.

2.1 Feasibility, Planning and Preliminary Design

For more complex/critical projects a Lead Commissioning Engineer is assigned to the project during the feasibility phase. This Lead coordinates commissioning input into engineering design, procurement and construction contracts to help define key commissioning milestones and equipment testing requirements (factory and site).

Project systems and subsystems are defined from asset lists and P&ID's to ensure all equipment is captured and standardized throughout the project documentation.

2.2 Detailed Design

During the detailed design phase commissioning strategy and plans are further developed, and schedules and budgets prepared for the construction phase including the commissioning requirements. Key commissioning milestones and equipment testing requirements (factory and site) are defined and included in supplier contracts.

The Project level Commissioning plan is created by the design consultant, to be appended to the tender documents of the construction contract.

2.3 Factory Acceptance Testing (FAT)

All major packaged equipment including electrical boards, panels, larger pumps, and software are subjected to witnessed FATs prior to delivery to site to ensure that equipment meets project specifications, Watercare QA/QC requirements, and is ready to be installed. FAT procedures and checklists are created by the supplier and approved by WSL-P or the developer design consultant prior to testing. Outstanding issues found during the FAT are managed as a defect as agreed by the project team.

Controls Systems software and graphics will also be subject to a FAT once all design issues are resolved.

2.4 Site Installation and Site Acceptance Testing (SAT)

All vendor installed major asset packages (including software) shall be subjected to SAT to demonstrate compliance with project specifications and safe installation. SAT procedures shall be created by the supplier and approved by WSL prior to testing. The SAT report shall include the electrical certification, completed procedures and test certs, software backups, any snag lists, settings and parameters, and any software and licenses required for operation and maintenance including diagnostic software. The SAT is additional to the FAT, and includes tie-ins, transit damage and installation, and interfaces with the other aspects of the project such as control systems etc.

A full Controls System SAT testing will be completed during pre-commissioning or cold commissioning, include all I/O, graphics, logic and fault signals, trip and alarms etc and is witnessed by WSL.

2.5 Installation Completion

Inspection and testing to confirm that all equipment (civil, mechanical, electrical and instrument, controls hardware, etc) is supplied and installed undamaged, correctly as per the design, Watercare standards and vendor requirements, and is ready for the next stage of commissioning. This includes any pressure testing, cold loop testing of instruments, and ensuring all prescribed electrical work (PEW) is tested in accordance with the Electrical Safety Regulations.

Watercare 'A' ITR templates have been developed for use at this commissioning stage.

2.6 Pre-commissioning

Individual assets are powered up and tested (including leak testing). Instruments are set-up, calibrated and hot loop checks completed (device to screen); electrical circuits are livened and tested; actuated valves and gates are tested, and limits and indications set; VSD's are livened, and electrical protection settings tested; motors and pumps bump tested, and test runs completed. The process control system software must be installed under the Watercare Control Systems Change Request (CSCR) procedure.

Note: On smaller projects Installation Completion and Pre-commissioning may be combined into one phase.

2.7 Cold commissioning

Start-up of unit processes and operation in automatic mode using a safe (non-process) fluid. Confirm that trips/interlocks and control loops are operational (where possible) including control system functionality testing. Cold Commissioning will be completed on a system-by-system basis.

- ✓ Internal WSL Milestone and Hold Point – Ready for Hot Commissioning.

2.8 Hot commissioning

Start-up of unit processes and operation in automatic mode on process fluid. If applicable, unit process discharges can be integrated with the rest of the plant. Any functionality or performance checks that were unable to be undertaken as part of cold commissioning will be completed at this stage.

- ✓ Internal WSL Milestone and Hold Point – acceptance to service. (During Hot Commissioning)

Prior to presenting the Provisional Takeover the following shall be met:

- Operations and Maintenance training completed.
- Pre-Use Safety Inspection (PUSI) completed by Operations and HSE.
- Completed Completions Dossiers handed over to Operations.
- Draft Operations and Maintenance manual presented to Operations.

- ✓ Internal WSL Milestone – provisional takeover

2.9 Performance proving period

Testing of the project for defined periods to ensure specifications are met under normal operating conditions.

The period chosen will be project specific usually a minimum of 30 days continuous operation without a significant fault. If a significant fault occurs the 30 days shall restart. "Significant" describes a fault impacting resource consents or design specifications/business case requirements.

The 30 days period and test parameters can be adjusted as reasonably agreed with the Watercare Asset Owner including extensions to confirm winter/summer design specifications and high/low flow events.

- ✓ Internal WSL Milestone – final handover

3. Commissioning Documentation

3.1 Commissioning plan

The commissioning plan is a high-level project specific document describing actions, roles and responsibilities, programme and risk mitigation measures for all aspects of the execution phase.

It shall be created by the design team in the design phase, approved at the end of detailed design and included as part of the tender and contract documentation (and EPA approval for developer pump stations). The plan can be updated after contracts are awarded to reflect additional detail and changes to the planned methodology, circumstances etc.

The plan shall follow the basic format of the template, scaled to meet the project complexity. It will highlight any differences from the requirements of this code of practice and add more detail specific to the project. There are various templates for different sized projects, and additional ones can be created in conjunction with the WSL-C team.

The content of the Commissioning plan should include the following sections:

1. Introduction

- 1.1. Plant overview
- 1.2. Project overview
- 1.3. Project description

2. Commissioning process

3. Performance requirements including consent requirements and limits.

4. Commissioning Team

- 4.1. Roles and responsibilities
- 4.2. Project specific roles and RASCI
- 4.3. Major suppliers

5. Commissioning sequencing

- 5.1. Commissioning Staging
- 5.2. Tie ins
- 5.3. Performance testing

6. Communications plan

- 6.1. Onsite communications
- 6.2. Progress updates and reporting requirements

7. Health and safety

- 7.1. Transfer of safety management

7.2. Isolations

7.3. Risk register

8. Site constraints

8.1. Working hours

8.2. Parking / access

9. Training

3.1.1 Hold Points

Hold points are critical sign-off points required from Watercare before the commissioning process can continue onto the next phase.

The minimum hold points should include:

- Completion of detailed design and commissioning plan approval.
- EPA peer review (for developer projects)
- Factory acceptance testing of major equipment and software prior to site installation.
- Acceptance of “Installation Completion” activities and SATs, and handover of the completion’s dossiers to the pre-commissioning team.
- Acceptance of Pre-Commissioning activities and Handover of the completion’s dossiers to the commissioning team.
- Completion and acceptance of Cold Commissioning,
- Acceptance to Service - before integrating into any existing live systems,
- Completion and acceptance of Hot Commissioning and initial performance testing
- Pre-Use Safety Inspection (PUSI) inspection prior to provisional takeover
- Completion and acceptance of any long-term performance and reliability proving period.

3.1.2 Tie-Ins

A tie-in is the point of connection between the project and any external point or existing asset including electrical, communication and pipework. All tie-ins will be risk assessed and managed so that they do not adversely impact existing operational plant. Each tie-in is identified in the Construction and/or Commissioning methodology and project programme.

Critical tie-ins require a detailed methodology and a control of work work-pack to be prepared by the contractor.

Critical tie-ins are defined as interfaces to the existing plant or network when:

- Operational risk – i.e. shutdowns required, risk to system, consents or water quality.
- A health and safety risk exists (e.g. confined space entry, construction near a live asset).

3.1.3 Commissioning Equipment, Fluids, and Chemicals

All equipment, fluids, and chemicals required for testing and commissioning shall be identified in the commissioning plan. All discharges and flushing points will need to be identified and risk assessed for compliance to trade waste and discharge consents. Any requirements to use de-chlorination chemicals for discharge of water shall be identified and the process and calculations described as per Watercare’s Code of Practice for Disinfection of Water Systems (COP-04).

Chemicals are not to be delivered to site until the site certificates for the storage and handling systems have been issued.

3.1.4 Monitoring, Testing and Measuring Devices

Temporary devices are utilised throughout the commissioning process to monitor, test and measure various plant, equipment, and process streams. These devices must be documented as fit for purpose (valid calibration certificates, unique identifiers) and used by qualified and competent people. These records will be submitted as part of the ITR's and completions dossiers. Testing of process fluids and atmospheric conditions shall be completed using the Watercare Laboratory or another approved and certified laboratory. Sampling shall be completed as per the laboratory's requirements and recommendations.

3.1.5 Recirculation Requirements

To enable the operation and testing of the plant using water a dedicated recirculation line will sometimes need to be installed. Ideally this is identified during the prelim design and included in the detailed design. The line may require valving and/or restriction orifice plates to simulate the operating pressure range and shall be correctly designed and constructed and certified, including air releases and pressure safety devices as required.

3.1.6 Commissioning Sequencing

The systems and boundaries for each project are defined during the design phase. Watercare's Asset Information and Data Standard for system numbering of Process areas shall be used for the identification of system/sub-systems. The commissioning methodology details the sequential steps to be taken to achieve final commissioning in a logical system and subsystems-based approach. The contract documents should be written to support this approach.

The Construction Contractor is responsible for providing a construction plan for key tasks and dates including handover and training. A documentation dossier will be compiled for each system / sub-system. Some activities will be dependent on supplier expertise and managing these visits in the schedule will be important.

3.2 Inspection Test Plan and Records (ITP/ITR)

An Inspection Test Plan (ITP) shall be developed by the construction contractor to describe testing of each asset within each identified system at each commissioning phase. Completed ITPs shall be included in the system completions dossier.

Inspection test records (ITR) or vendor SAT testing records will be generated at the Installation Completion and Pre-commissioning stages for each piece of equipment being commissioned. ITR check sheets will be completed by the contractor and presented in handover dossiers on a system basis.

Watercare Project and/or Operations/Maintenance/Commissioning representatives may request to witness and/or perform any of these inspections. All data generated at each phase must be recorded, included in the dossier, and used in the assessment of performance.

The WSL provided ITP and ITR templates are aligned to the Watercare construction standards and shall be used, unless the contractor has an equivalent or better system approved by the WSL Commissioning Team.

3.3 Commissioning Method

The cold and hot commissioning and performance proving period will be compiled into a method by the responsible party. Each system or sub-system shall have a procedure created to document the steps of each stage.

The plan should follow the format of the WSL ITP Template with the following sections:

- **Front page** – identify the facility, system, task summary and document revisions, and approvals.
- **Pre-Start conditions** – steps prior to starting Cold Commissioning,
 - All the components of system have been pre-commissioned or identify any components which have not been.
 - Identify prerequisite and dependant systems i.e. electrical, utilities, control system etc.
 - Confirm downstream and upstream systems are in service.
- **Cold Commissioning**
 - Identify the temporary equipment and test equipment required for the testing.
 - List the steps to be taken to complete the testing, including roles and responsibilities.
 - Record results of testing vs performance specifications.
- **Hot Commissioning**
 - As for cold commissioning above.
- **Performance Testing**
 - As for cold commissioning above.
 - Summarise acceptance of results (or otherwise with remediation plan).

3.4 Non-conformances and defects

The Watercare procedure for snag lists shall be applied and managed by the Project Engineer. Items that are non-compliant with performance requirements, specification, contracts, or other documents are raised as commissioning progresses. Defects may be contractual due to workmanship, defective product, damage or not fit for purpose. Some may be general project defects e.g. design or procurement items outside the contract. All defects will be recorded in the Project Defect Register and identified as contractual or non-contractual. All defect decisions and progress will be documented in the defects register.

3.5 Completion Dossiers

Completion dossiers compiled by the construction contractor to a WSL template and are a complete record of all installation and commissioning testing for each system. The template also defines documentation deliverables specific to each handover milestone. Collated from the start of construction, the hard copy is held on site to be reviewed and added to at any time. Both the hard copy and an electronic version are handed over to the Commissioning Lead at the end of contractor commissioning, providing the evidence required for Acceptance to Service.

The completion dossier includes the following documents:

- All inspection test records, vendor docs, QC and certification.
- All drawings and documents are as-built (red line site mark ups are sufficient).
- All data collected during each stage of testing.
- Any defects are recorded along with an action plan to remediate.

4. Roles and responsibilities

The team structure, resourcing and scope will vary according to the size and complexity of each project.

For larger, more complex projects there will be a Project Manager accountable for ensuring that the Watercare commissioning process and milestones are followed. The Project Engineer is responsible for monitoring quality as detailed in the RASCI below.

The Commissioning Team structure, roles and responsibilities and communication pathways are agreed via the design level commissioning plan prior to the construction contract being finalised. Roles and responsibilities below are a guide for the commissioning stages of a project.

There are three groups that can have responsibilities for asset commissioning at Watercare:

- The Contractor's Commissioning Team will coordinate and oversee all commissioning activities according to this document up to and including the pre-commissioning phase or as agreed in the project specific commissioning plan. For some projects this will include cold and hot commissioning. The Contractors Commissioning Team must include sufficient experienced and qualified personnel to work independently to ensure compliance with Watercare standards and specifications.
- The Watercare Operations Commissioning Team can appoint technical specialists (mechanical, instrumentation and electrical) and a Lead Commissioning Process engineer to oversee and support commissioning as agreed during the design phase. The Lead Commissioning Engineer is involved from the feasibility (planning) phase approving the commissioning plans, supporting the methodology and sequencing development, and leading or overseeing the cold and hot commissioning, performance proving and transition to operations. The Commissioning Lead Engineer can stop the process at any time if documentation, installation, or setup do not meet Watercare standards or the agreed methodology and commissioning plan.
- Minor projects may be managed and commissioned by the operating team in accordance with this code.

4.1 Commissioning Responsibilities Summary Table

Items/Project Phase	Installation & Pre-Commissioning (individual assets)		Cold Commissioning (systems on water/air)		Hot Commissioning (systems on process fluid)	Provisional takeover	Performance Proving Period	Final Handover		
Control of Work (LOTO, permits etc)	[Contractor] responsible					WSL-O responsible				
Operation of equipment	[Contractor] responsible to lead testing except for I/O testing where WSL Control System Engineer will lead	Handover	WSL-C responsible to lead or oversee testing (project specific). [Contractor] to complete or provide support as required.		Acceptance to Service	WSL-O responsible for routine operation &.on call alarms. WSL-C responsible to lead testing and monitor. WSL-Maint responsible for instrument calibration [Contractor] and WSL-Maintenance delivery to provide support.	Handover	WSL-O responsible for operation. WSL-C responsible for monitoring performance and support with defects troubleshooting as required. WSL-Maintenance delivery to provide first response for Pump Station faults.	Handover	WSL-O responsible for operation
Maintenance of equipment	WSL-P responsible for maintenance (via Construction Contractor)					Handover	WSL-O responsible for maintenance (Via Maintenance Delivery or approved contractor)			
Project related	ITR Documentation to be submitted and accepted by Watercare	Handover	Test records submitted for each system. Approval to introduce process fluids to specific systems.	Ready for Hot Commissioning	Ready to tie in to operational plant. If the whole site is not ready for health and safety hand over, a site delamination plan to be agreed with WSL-O.	Practical Completion	Decommissioning of existing equipment Landscaping Scheduled works snags			

4.2 Commissioning Roles and Responsibilities (RASCI)

Work Packages	Contractor			Consultant	Watercare (Client)					
	Contractor PM	Contractors	CX Team	Design	Design PM	Construction PM	Project Engineer	Ops Cx manager	CX Lead Engineer	Operations Liaison
Documentation										
Design Stage Commissioning plan	I	I	S	R	A	I		I	C	S
Construction Commissioning Plan	I	I	C		S	A		S	R	S
Installation Completion and check sheets	R	S	S		C	A	C		I	
pre-commissioning and check sheets	R	S	S		C	A	C		C	
Cold and Hot commissioning Methods	I		I		C	A			R	C
Performance proving monitoring plan and technical memorandum			I		C	A		C	R	C
Completions dossier, As-Built Drawings (red line markups), asset tagging, labels	R	S	S		S	A	S	I	C	S
Maintenance plan & schedules	R	S				A	C		C	C
O&M Documents – manuals, PODs, SOPs, MOPs		S			R	A			S	S
Water Safety Plan (if required)						A	R	I	C	S
Defects/Snag Lists					S	A	R	I	S	C
Provisional takeover requirements	I		I			A	R	C	S	C
Update registers and FDs					C	A	R		S	I
Lessons Learnt	C	C	C		I	A	R	S	S	C
Commissioning report	I	I	I			A		C	R	C
Activities										
Commissioning scope and budget					R	A		S	C	I
Form a commissioning team			C		R	A		S	C	I
Hold Commissioning workshops	I	S	C			A	S	S	R	S
Factory acceptance test	R	S	C		S	A	S		I	C
Tie-ins	C	S	C			A	R		S	C
Installation Completion testing and inspection	C	S	S			A	R	I	C	I
Pre-commissioning testing and inspection	C	S	S			A	R	I	C	
Cold and Hot commissioning testing	C	S	I			A	S	C	R	S
Snag List remediation	S	S	S			A	R		S	I
Maintenance prior to Acceptance to Service	S	S	C			A	R		S	I
Initial Performance proving	S	S	C		S	A	S		R	S
Long Term Performance proving					S	A	S	I	S	R
Review Commissioning lessons learnt		I	S		C	A		R	S	C

RASCI Legend

Acronyms	Definition	Responsibilities
A	Accountable ¹	This person typically ensures the task is completed and had ultimate accountability. A person holding this role is answerable for the success and completion of the task/project and in the decision-making process - DECISION
R	Responsible ¹	This person assigned by the accountable person to manage the task being completed, they can either complete the task or delegate it - ACTION
S	Supporting	This person is assigned (or contracted) by the responsible person to deliver input that can help achieve the task completion, often this is the person who carries out the task or part of.
C	Consulted	This person who has expert knowledge, needs to be asked for feedback, and feedback needs to be considered during decision making - TWO WAY CONVERSATION
I	Informed	This person must be kept up to date with the progress of the task - ONE WAY CONVERSATION

¹ **Note:** Only 1 party accountable or responsible for each task.

5. Watercare Commissioning Responsibilities

5.1 WSL Construction Project Manager

The Watercare (WSL) construction project manager manages project delivery to enable agreed commissioning methodology and keeps the WSL Commissioning team informed on construction progress and scheduling.

During commissioning the WSL project manager is responsible for the following:

- Ensure updating and approval of the Commissioning plan during the execution phase and prior to commissioning.
- Managing the risk register
- Managing resources to fulfil commissioning requirements and remediation of snags.
- Documentation delivery and training required to ensure WSL-O is ready to operate and maintain the assets.
- Contractual changes in scope to facilitate commissioning.
- Verifying contractors commissioning requirements as stipulated in their contract documents.
- Site specific health and safety documentation
- Acceptance to service and handover certificates with assistance from WSL-C
- Finalising the asset capitalisation register, maintenance upload sheets and equipment manuals
- Reviewing the project programme in relation to commissioning progress
- Coordinating commissioning progress meetings

5.2 Watercare Development Engineers

Developer projects are handled slightly differently to other projects in Watercare. The developer is responsible for delivering the design, construction and commissioning of the project (small pump stations, pipelines etc) and ties ins as per their agreement. Developer projects are often the infrastructure required for a land sub-division for housing or commercial.

The WSL Development Engineer is responsible for these projects by managing the contract, and ensuring WSL standards are met. While the detail of this document may not be relevant the spirit of the process should still be followed, albeit in a simplified form.

5.3 Watercare Project Engineer

The Watercare project engineer works with the Lead Commissioning Engineer throughout the commissioning process to ensure that construction related activities are prioritised to facilitate commissioning. The project engineer will also provide an additional interface between the contractor and Watercare teams with the following responsibilities:

- Liaison with the design consultant, contractor, and suppliers.
- Prioritisation and identifying snags, ensuring a record is kept, and priority items are completed.

- Development of the POD's, SOP's etc (this may be included in the design consultants' scope of works).
- Review of commissioning methodologies.
- QA – witness and sign off contractor Installation completion and pre-commissioning testing.
- Participation in risk assessments.
- Assist with the implementation of control of work including isolations.
- Development of the defects list during commissioning.
- Review the training documentation.
- Support for the newly operational plant and equipment.

5.4 Watercare Production / Operations Area Manager

The Watercare Production Manager has overall responsibility for the assets in their assigned area and provides approval for the work to proceed, tie ins and acceptance to service, provisional takeover, and final handover once the project is complete. On simple projects this may be delegated to the site Operations Controllers.

5.5 Watercare Operations Controller

The Operations controller liaises with the Lead Commissioning Engineer to ensure operation of existing systems is not compromised by the commissioning activities. The operations controller is also responsible for making sure that Watercare controlled isolations are applied as per Watercare control of works.

The responsibilities of the operations controller include:

- Participation in control system FAT
- Review of commissioning methodologies
- Review of operational work plans
- Participation in risk assessments
- Supports development of shutdown and tie-in plans
- Implementation of isolations.
- Assist Lead Commissioning Engineer to reduce process and H&S risk during commissioning activities.
- Participation in snag walkovers

5.6 WSL Maintenance Controller

The Maintenance controller liaises with the maintenance delivery (MD) Team and supports the project team to encourage maintainability. The responsibilities of the maintenance controller include:

- Review of commissioning methodologies.
- Participation in risk assessments.
- Assisting in defining training requirements and liaising with MD.
- Assist lead commissioning engineer to troubleshoot during commissioning activities.

- Participation in snag walkovers.

5.7 WSL Operations Commissioning Manager

The WSL operations commissioning manager has overall accountability for the delivery of the project commissioning and liaises with the area WSL Project Manager, Design Manager, area Production Manager and other stakeholders e.g. Water Quality to ensure agreement with the Commissioning plan and any changes that may be required as the project progresses. This includes the following:

- Review and approval of the commissioning plan.
- Recommendation for acceptance to service and takeover
- Participation in lessons learnt.
- Provision of technical advice as required.
- Liaising with asset manager and project team to ensure the smooth running of the plant during the final stage of commissioning.

5.8 Commissioning Lead Engineer (Watercare or Contract)

The Commissioning lead Engineer is responsible for leading the Commissioning team and overseeing the commissioning process, providing an interface between the project team, contractor, consultant, suppliers, discipline leads and Watercare operations.

- Review and approve design and construction level Commissioning Plans.
- Review of commissioning methodologies.
- Ensuring the commissioning activities are undertaken in accordance with the plan.
- Liaison with the contractor, suppliers, the discipline leads and the Watercare operations teams.
- Review and acceptance of proposed ITRs. Audit signoff of inspected items and associated forms.
- Coordinate risk assessments at appropriate project milestones.
- Arrange operations controller review of any operational work plans associated with the commissioning activities.
- Coordination and direction of discipline leads for FATs, witness testing and document reviews.
- Coordination with software lead.
- Witness control system SAT.
- Provision of technical advice as required.
- Responsible for CSRPs, JSAs etc that impact Operations - Supported from Ops but led by Commissioning/Project team.
- Ensure up to date red-line mark-up documentation is available through the commissioning phases.
- Assist operations with the implementation of isolations.
- Recommendation for acceptance to service and takeover.
- Participation in lessons learnt.
- Liaising with operations and maintenance staff to ensure the smooth running of the plant during the final stage of commissioning.

- On call support for the newly operational plant and equipment.
- Preparation of commissioning sections of the Final Project report.

5.9 Commissioning Discipline Engineers (Watercare or Contract)

The discipline leads i.e. electrical, mechanical and control, work in support of the Lead Commissioning Engineer to ensure the commissioning, work and inspection and test plans are completed. The responsibilities of the discipline leads include:

- Review of the Commissioning Plan
- Review of contractor work plans including inspection and test plans and check-sheets
- Participation in risk assessments for work plan and commissioning activities
- Inspection of the works prior to testing and compilation of snag lists
- Witnessing appropriate parts of the contractors testing and accepting the successful result on Watercare's behalf
- Recommending sign-off of areas to proceed to hot commissioning.

5.10 Operations team (Watercare or Contract)

The operations team (Controllers, Operators, Maintainers, Engineers, and Scientists) shall be informed during all stages of commissioning and will be involved in several commissioning related activities that includes:

- Review and implementation of operational work plans to support commissioning activities.
- Input into commissioning methodologies.
- Participation in commissioning activity risk assessments.
- Support and implementation of isolations and tie-ins required for commissioning.
- Support of Cold and Hot Commissioning activities as agreed in the commissioning plan.
- Be available for training prior to cold Commissioning.
- Consulted by the design consultant to on the SOPs, PODs and FD's.

5.11 Control Systems team

The control systems team shall be involved in the project from the pre-liminary design onwards. Although the technical supervision of the team would be from the Watercare controls systems team, the actual project may be contracted out.

The team is responsible for the production of:

- Review and as-building of the Level 1 FD
- Attending the HAZOP and constructability reviews
- Review of the commissioning procedures (ITP)
- Creating the Level 2 FDs (If any),
- Review of the hardware design and approval of equipment
- Developing the software
- Software debugging and design review.
- Facilitating the Software FAT and associated documentation

- CSCR form
- Compiling the software SAT procedure and leading the testing

5.12 Contractor Commissioning Responsibilities

The contractor is responsible for Installation completion and pre-commissioning as per this document and the project contracts. This includes preparing the work plans covering the inspection, testing, and commissioning of all the civil, mechanical, and electrical work but may exclude software FAT and software SAT and software commissioning activities.

Loop testing and I/O commissioning is the responsibility of the contractor but requires interface with the software team. A protocol for timing, responsibilities and scope of these tests is agreed between the contractor and Watercare.

Completed testing dossiers are to be submitted electronically to the Project Engineer. Commissioning responsibilities can be expanded to include cold and hot commissioning by agreement with the Project and Commissioning teams.

5.13 Design Consultant Commissioning Responsibilities

The design consultant is required to provide technical support to ensure the project is constructed and commissioned to meet the approved design and Watercare specifications.

This will include:

- Compiling the initial commissioning plan and FD during the preliminary design and updating both documents during the detailed design and construction phases.
- Ensuring the design can be commissioned and includes all required temporary facilities such as recycle lines etc.
- Reviewing contractor work plans including inspection and test plans and check sheets.
- Reviewing (as required) the cold and hot commissioning procedures.
- Inspection of works as required prior and during testing. Answering technical queries and field design requests in a timely manner.
- Reviewing and approving the performance testing plan and analysing performance test results to compare to the design specifications and confirm compliance.
- Compiling documentation and data from all parties for the development of the performance proving report and the commissioning section of the final project closeout report.

5.14 Design PM Commissioning Responsibilities

The design PM is required to ensure that the design and deliverables have been reviewed and comply with Watercare standards and processes.

5.15 Specialist supplier Commissioning Responsibilities

Specialist product suppliers must be identified in the Commissioning Plan and are responsible for supervising the installation, orientation, testing and commissioning of their equipment as detailed

in the commissioning plan. The supplier representative will liaise with the Watercare commissioning engineer on all commissioning matters.

The suppliers are also expected to provide training as identified in the commissioning plan.

6. Stages of Commissioning

6.1 Factory acceptance testing

All prefabricated software and mechanical systems, pumping units, blowers, electrical panels, cabinets, and kiosks must be factory inspected and tested (FAT) at the factory before shipping. Test certificates and performance curves must be provided for each test. Other FAT testing requirements may be specified in the contract. Testing can be witnessed by the WSL-C, WSL-P and WSL-O.

The FAT checks as far as possible that:

- Equipment and components are in accordance with the specification, relevant regulations, drawings, and approved design.
- Inspection and testing of welding and castings.
- Trip points, alarms, diagnostic outputs are tested.
- Hydrostatic pressure and leakage testing of all parts which may be subject to internal pressure.
- Bearing, vibration and noise tests.
- Equipment is calibrated and certified.

Functional testing of the control system is to be conducted during the Software Factory Acceptance Test (SFAT) to ensure that the operation is in accordance with the FD. Simulated I/O is acceptable during this test.

The FAT is NOT a design review. All software and hardware are expected to be fully complete and ready for delivery at the time of the FAT. Robust FAT testing will save commissioning time later in the project.

6.2 Site installation and Site Acceptance Testing (SAT)

Site Acceptance testing is a critical step to ensure that the entire installation and/or individual subgroups are installed on site in accordance with the design requirements. All packaged or containerised equipment and control software shall be expected to undergo a SAT.

- Any defects identified in the FAT have been rectified.
- Equipment has not been damaged or modified since the FAT.
- Equipment and components are installed in accordance with the project and supplier specification, including earthing and mounting arrangements.
- Interface points are correctly connected and as per project drawings and specifications.
- Labelling and tag numbering is as per project specifications.
- Equipment is calibrated and functioning correctly.

- Trip points, alarms and diagnostic outputs as per FD.
- Documentation is available at site, including calibration certificates, as-built drawings, operation, and maintenance manuals.
- Snag lists are used to identify issues and concern and agree remediation steps and timelines.

SAT procedures shall be created by the supplier and approved by WSL prior to testing and shall include checklists and witness points as required. Watercare's general civil, mechanical, and electrical construction standards list several minimum quality control checks and tests during construction. These quality checks may be used during the SAT.

6.3 Installation Completion

Each individual asset must be verified as constructed, installed and mechanically complete to the approved design specifications, safe and ready for energisation or the introduction of test fluids. Inspections are carried out without the presence of a test media (dry).

Watercare has a set of approved dry-commissioning checklists (ITR's) which have been aligned to the ESF construction standards and QC checks, to be used for Installation Completion, however a contractor may use their own checklists if they are a suitable equivalent or better and pre-approved by Watercare Commissioning. The testing shall be witnessed by WSL-P. WSL-C may elect to be present. ITRs are collated in the commissioning completions dossiers along with the other relevant documentation such as calibration certificates, vendor manuals, pressure tests certs, load certs, weld records, etc and presented to the commissioning team lead. All defects must be added to the project defects register and closed out prior to progression to pre-commissioning unless approval is granted by WSL-P.

The following are typical Installation completion inspections and tests:

- Site walkover to verify plant is installed in accordance with P&IDs and relevant drawings and meets the specification.
- Visually inspect. Ensure equipment is undamaged and correctly assembled including bolts and gaskets. Joints and flanges are correctly assembled and torqued. Pipe supports installed.
- Ensure safe operational and maintenance access to plant and equipment.
- Confirm all chambers, tanks, channels, and sumps have been cleaned out to the required standard.
- Pipe and tank hydrostatic pressure testing complete.
- Ensure all physical adjustments, settings, lubrication, safety devices (including guards and warning notices) are in place.
- Valve, actuator and limit switch configuration.
- Ensure all pump and motor checks and adjustments are complete (dry alignment checks, pressure testing, hand rotation, mounting, valves).
- Equipment, pipes, and cables labelled. Temporary signage is acceptable.
- Lifting devices fully operational and certified.
- Cable trays and cables installed correctly including supports, cable tray fill, bend radius etc.

- Ensure all power and control cable checks have been carried out i.e. insulation testing, continuity testing, dry loop checks.
- Ensure earthing of all devices is as per legislation and WSL standards.
- Leak and pressure test water retaining structures.
- Vendor manuals are available.
- Snags agreed and included in the Project Master Defects list.
- Final electrical inspection and issue of a Certificate of Compliance (CoC)/Electrical Safety Certificate (ESC). Minimum all tests as required by the New Zealand Electricity Safety Regulations 2010 and all amendments.

6.4 Pre-commissioning

Pre-commissioning demonstrates that individual components of subsystems have been installed, powered up and tested in accordance with the specification and manufacturer's instructions, and are "Ready for Commissioning" as required prior to cold commissioning.

Checks shall be completed by the contractor using either the Watercare Pre-Commissioning ITR templates or as approved by WSL-C. Testing to be witnessed by WSL-P as the client. The ITR's shall be collated in the commissioning completions dossiers along with the other relevant documentation such as calibration certificates, vendor manuals, pressure tests certs, load certs, weld records, etc and presented to the commissioning team lead.

It is critical that all persons on site are aware when pre-commissioning is commencing due to the increased HSE risks.

Pre-commissioning checks include:

- HV and LV switchgear and distribution boards energisation and testing.
- Power transformer testing.
- Electrical energisation of equipment and bump testing of motors and pumps.
- Pump test runs using non-process fluids.
- Standby Generator Operation.
- UPS test procedure.
- Lightning protection system.
- Testing of safety systems including pressure relief valves, overload protection devices, emergency stops, field push buttons, etc.
- Check and confirmation of pump output using water, including duty point verification.
- Check of valves for clean travel and sealing when closed.
- Mechanical interlock testing.
- Biofilter smoke testing and irrigation pattern.
- Leak testing of pipework and equipment.
- With only the control circuits energised, verify that each field device and associated relays operate correctly and that they prevent contactor closing or cause tripping etc.
- Energise general purpose outlet and lighting circuits one at a time. Check that each unit is in the correct circuit in accordance with the drawings. Check lamps. Check power outlets for voltage and correct rotation of active neutral and earth pins. Check all switches for correct function.

- Instrument calibration and configuration in accordance with IO list, units, ranges etc.
- Initial configuration of operator setpoints and alarm values
- Hot loop checks i.e. simulation of process input and checking response at control system/Testing of all I/Os (Lead by WSL control systems engineer) The Contractor shall test each instrument loop separately to prove the calibration, repeatability and where appropriate the control response. These loop checks shall include the RTU I/O. Instruments shall be tested at 0, 25, 50, 75 and 100% FS with both rising and falling signals.
- Security and fire systems testing if applicable.
- Setting up flow meters
- All defects identified and recorded in the Master Project defect register. No category A snags present.

6.5 Cold Commissioning

Cold commissioning is performed on plant components and sub-systems once pre-commissioning is complete but not yet connected to existing processes. The latest working version of the process and instrumentation diagram (P&ID) and electrical drawings must be available.

Where available cold commissioning is carried out using potable/recycled water or other test media as specified in the commissioning plan. The methodology for cold commissioning will be determined at design phase to allow for consideration of delivering, storing, and recirculating the test media.

Facilities are divided into interrelated component sub-systems. This process demonstrates that each subsystem is functioning and ready for “start-up” and tests the entire control system is operating in accordance with the FD and initial control loop settings. Tests must replicate the operational range as much as possible including simulated power failure.

Cold commissioning tests include:

- Statutory approvals required prior to “Return to service”.
- Confirmation of settings and process control loops.
- Each pump/motor or combination of pumps achieve their specified flow rates and pressure at the rated discharge head over their entire range.
- The rated max power demand and consumption of pump/motor and the power/motor combined efficiency over the entire duty range.
- All the specified design features are included and are operable for the pumps and motors.
- Condition based monitoring (CBM) testing including vibration, noise and heating/cooling as specified by Watercare standards, technical specifications, or performance guarantees.
- Instrument test/calibration sheets completed verifying parameters set.
- Power factor correction and harmonic analysis.
- Operations and maintenance training.
- Maintenance plans loaded into EAM (Maintenance Controllers).
- Sterilisation of water treatment facilities.
- Systems run to waste to demonstrate compliance.

The software testing will include:

- Process functionality logic testing.
- Process parameters set points checking.
- Interlock and fault testing.
- Confirmation of alarm descriptions, set points and delays.

The Software SAT is the formal witnessed test conducted prior to the introduction of process fluids. Testing is completed by the software contractor with guidance and witnessed by the Watercare Commissioning Lead engineer.

Where possible, all snags must be rectified, and cold commissioning must be completed for all subsystems before proceeding to Hot commissioning. It is however not possible to fully test all functionality and process conditions for all plant and equipment offline. Equipment that requires screenings, grit bacterial load, sludge etc cannot be fully tested until process flows are introduced. The Commissioning plan must document this and any associated risk.

6.6 Ready for Hot Commissioning

An internal milestone approving the plant or selected subsystems for startup on process fluids including chemicals. WSL-C continues to operate the plant with the assistance of WSL-O. Control of work responsibility remains with the contractor. The plant may still be recycling or discharging to waste. Contractors may still be working on parts of the site. An updated risk assessment is required.

6.7 Hot Commissioning

At Hot Commissioning testing, the plant is placed into operation with process fluid to demonstrate that all components integrate and operate as intended. There will be a plan detailing flows and load at each stage of hot commissioning as well as a contingency plan for out of spec product. Each component must be tested over its full range of operating conditions which can be simulated/achieved at the time of the testing.

The following areas of plant must be complete, fully operational and risk assessed prior to chemicals and process fluids being introduced (where applicable):

- Odour collection/treatment and ventilation systems – to prevent hazardous atmospheres, prevent corrosion of electrical and other equipment and surfaces, and prevent nuisance odour emissions.
- Inlet works – to prevent rag/grit from entering the plant.
- Chemical dosing systems.
- Standby power systems (UPS, battery, generator).
- Emergency response procedures.

Testing can include:

- System testing that cannot be completed without process fluids.
- First fill of chemicals if applicable.
- Optimising control loops.
- Tuning of process.
- Emergency shutdowns.
- Operation under normal conditions to complete initial performance testing.

At an appropriate point during hot commissioning, the project will be ready to tie-into existing assets. A cut-over plan will be included and approved with the Commissioning plan to ensure that this crucial operation is completed safely and effectively. “Acceptance to service” is required prior to tie-in into any existing assets.

6.8 Acceptance to Service

A gateway milestone approving the plant for tie-into operational plant. The WSL Acceptance to Service template document, clearly states the status of the equipment to be entered into service, that any regulatory conditions have been met and will be adhered to, and how the next stage will be managed.

WSL-O is ready to operate the plant with the assistance of WSL-C without risk of H&S, resource consent or water quality issues.

Control of works for each defined area is transferred to WSL-O and during the periods where WSL-C is not onsite to do testing WSL-O will be responsible for the plant operation. WSL-C will also be monitoring plant performance for performance criteria and optimising the process control as required.

Any modifications to the plant, control systems, set-points, circuitry etc must be recorded in the logbook, communicated to staff and commissioning personnel, and documents updated.

6.9 Provisional Takeover Milestone

Provisional takeover can be achieved once it can be demonstrated that the plant is stable, reliable, and ready for safe operation with no critical faults or alarms, and the Operations team is ready to accept the operation and maintenance of the assets, this includes training completed.

The provisional takeover certificate (PTC) shall be completed and approved. This certificate represents the acceptance of the WSL-O to manage and WSL-M to maintain the new asset.

Documents required are identified in the PTC certificate but as a minimum shall include all red line draft documents required to safely operate and maintain the plant, such as Drawings, FD's, SOPS, O&M manuals etc. The current snag list shall also be presented and approved along with the rectification plan.

Once provisional takeover has been accepted by WSL-O and WSL-M, they will be responsible for the operation and maintenance of the assets. The start date for the performance proving period will be agreed between WSL-O, WSL-P and WSL-C. Any temporary measures which have been created upon achieving the acceptance to service milestone will need to be reviewed.

6.10 Performance Proving Period

The Performance proving can start before Provisional Takeover but would normally be the period between the Provisional Takeover and Final Project closeout or as agreed otherwise in the commissioning plan.

During this period:

- The plant is operated and maintained by WSL-O with support from the project and commissioning team. The ownership of the plant is still with the project team.
- Any defects will be attended to by the MD team with support from the Project team as required.
- All outstanding snags will be rectified by the project team and any long-term performance testing will be completed as per the commissioning or performance test plans.
- All project and operations documents will be finalised and issued as approved as-built's.

6.11 Final Handover

Final handover is achieved once all aspects of the project are completed, and the project is ready to be closed. This process is described in the Project management framework.

To achieve Final Handover from a commissioning view the following must be complete:

- All documents shall be issued as final as-builds including drawings, vendor manuals, O&M manual, FD, SOP, etc. Hard copies sent to site and electronic copies in ProjectWise.
- Performance testing complete and accepted by operations.
- All Snags / defects rectified or accepted as being handed over to operations to complete.
- Any outstanding design issues raised as a separate project.
- Asset Capitalisation is completed.

7. Training

Specific training on any new plant will be provided by the contractor to ensure that Watercare (WSL O and M) are competent to operate, maintain and fault find the equipment installed by the project. Training shall be completed prior to Provisional Takeover.

The training scope and plan will be created by WSL-P with support from WSL-C and WSL-O and will include:

- The names and roles of all trainees provided by WSL-O.
- The programme for the training, including the number of sessions and allowance for WSL's staff roster.
- Details of the contents of each training session.
- The logistic and administrative arrangements for the training courses.
- Identification of any off-site courses, including location, type of course, and the personnel required to attend.
- Provision of training materials (including recordings) for future needs

The timing of the training is to be agreed with WSL O and M. Most training related to plant operation and overall process will be required prior to Cold Commissioning. All remaining training shall be delivered to WSL Operations team (WSL-O) and Maintenance delivery prior to acceptance to service. WSL control system engineer and/or WSL commissioning engineer will provide any training on user interfaces and control systems if required.

Training documentation will include the draft operating manuals and Standard Operating Procedures (SOPs) which will be updated as required during the commissioning process.

8. Lessons Learnt Session

Opportunities for lessons learnt will be identified and recorded throughout commissioning. Depending on the project size and complexity WSL-C may arrange for these to be discussed collectively with WSL-P and WSL-O as they arise.

After obtaining provisional takeover, a workshop will be organised by WSL-P to summarise and collaboratively discuss all lessons learnt during execution of the project. Meeting attendees will include representatives from the WSL-O, WSL-M, WSL-C, Contractor, Design Consultant, design team and WSL-P. Comments will be recorded in the Project Implementation Review.

9. Health, Safety, Environment and Risk Management

All commissioning activities are to be carried out in accordance with Watercare Health and safety policies and procedures, specific project management plans and safety and design requirements. Hazards and controls will be identified in the Commissioning Plan and in the detailed JSA prepared for project commissioning.

For work areas that can be adequately isolated from site operations, the control of works will be signed over by the area production manager to the WSL-P. The Contractor will manage Health and Safety control of work during Installation Completion, pre-commissioning, and cold commissioning. All personnel must undertake a site-specific induction run by the Contractor unless it has been arranged that they are escorted around site by a site-inducted individual.

If the area cannot be handed over to the infrastructure team, WSL-O will manage Health and safety using the Watercare Control of Works processes.

A risk assessment shall be completed at least 10 days prior to cold commissioning and reviewed prior to hot commissioning. The risk assessment should be completed in an office environment and invite at a minimum the following persons.

- Watercare Project Manager
- Watercare (and/ or contractor) Commissioning lead(s)
- Watercare Operations liaison or area controller
- Construction Project Manager
- Construction HSE Engineer
- Design Consultant

- Other relevant persons i.e. vendors and specialist commissioning engineers

Project risks created by commissioning activities or impacting on commissioning must be identified, assessed, and managed so that risks have been reduced to ALARP and the process has been fully documented.

Work affecting any existing water treatment plant or water transmission systems must be identified and a change to system risk profile (CSRP) completed. The CSRP must be completed before the work is started.

Additional risk assessments may also be required at specific points in the project prior to hazardous activities or a due to a change in circumstances.

New hazards are likely to be introduced during commissioning which relate specifically to each phase of the project. These will be related to the following:

- Energisation and operation of equipment.
- Introduction of chemicals and process fluids.
- Interfaces with on-going/outstanding construction activities.
- Plant familiarisation especially manufacturers reps.
- Communications.
- Discharge of non-compliant product or gas.

Controls which could be considered to mitigate these hazards are:

- Watercare control of works procedures e.g. permits, LOTO etc.
- Site maps and signage identifying exclusion zones.
- Awareness signage.
- Toolbox talks.
- Safety inductions.
- Specific method statements/risk assessments.
- Inoculation programmes.
- Spill procedures and equipment.
- Emergency management plan.

10. Decommissioning of equipment

Decommissioning is the process of safely taking an asset out of service. The items to be decommissioned need to be identified prior to starting any work. The process of decommissioning is the responsibility of the asset operating team with support from the project team if required, and shall be as follows:

- Identify equipment to be decommissioned. Confirm if it is to be decommissioned for overhaul, alterations, mothballed for future use or to be demolished.
- Produce method statements and isolation plans for the isolation and making safe of the equipment, including purging, flushing, solids removal and decontamination as required.
- Complete a risk assessment and raise JSA's and isolation certificates as required.

- Apply isolations as per the Watercare HSE procedures, include inhibits or frigs required such as disabling alarms in the DCS/SCADA.
- Carry out purging, decontamination, and preservation. Including the disposal of flushing fluids.
- Confirm the equipment is safe to hand over. Use the Transfer of Premises control (TOPC) form to hand over control of an asset to the Project Manager.

If items are being de-commissioned and left “Mothballed” for potential future use, the preservation may be applied by a project team or WSL Operations depending on the scope. This is to be agreed in the commissioning plan. It shall also identify any monitoring requirements and set up maintenance routines for this.

If items are being decommissioned for demolition, all items shall be removed in a safe and systematic way and a scope of works along with a method would be expected. While the tasks are project specific the following shall be considered:

- Remove redundant software and confirm there are no unresolved references. If any software is modified to delete equipment, it shall be fully tested to confirm remaining functionality remains unaffected.
- Physical removal of the equipment to Watercare ESF requirements, and ensure the site is left in a safe and clean condition. Installation of rated blinds, capping of pipework, additional pipe supports / anchors if required, removal of cables and plugging entries on junction boxes etc. If cables cannot be safely removed, they shall have heat shrink socks applied and suitable earthing and tagging.
- While the preferred is to remove all equipment, if any are to be abandoned in situ, they must be confirmed to be free of environmental contaminants and not otherwise hazardous.
- Site remediation including landscaping.
- Removal of assets from the asset register, GIS, and EAM maintenance routines.

Demolition of redundant equipment will normally be undertaken at the end of the project except where the space is required, and sometimes as a separate project.