WATER MANAGEMENT

NSW non-urban water metering

A best-practice guide to installing, validating and maintaining non-urban water meters in NSW

July 2019

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1. Introduction

1.1. Non-urban water metering framework

The NSW Government committed to delivering a robust new metering framework to measure and meter non-urban water take in NSW under its Water Reform Action Plan (WRAP). The WRAP was released in December 2017 in response to the *Independent investigation into NSW water management and compliance* (the Matthews Report), conducted by Ken Matthews, AO, and the Murray–Darling Basin Water Compliance Review (the MDB Compliance Review).

The new metering framework will improve the standard and coverage of non-urban water meters in NSW. It was informed by broad community consultation, economic analysis and technical expertise. The framework includes the:

- NSW Non-Urban Water Metering Policy
- metering-related provisions of the Water Management (General) Regulation 2018, updated by the Water Management (General) Amendment (Metering) Regulation 2018
- metering-related provisions of the *Water Management Act 2000*.

Under the new framework, metering equipment must be installed on works that meet the metering thresholds (see 2.4.1 below). Metering equipment is also required to meet specified standards (see 2.4.2 below).

1.2. About this guide

This guide has been prepared by the NSW Government to assist industry to:

- improve the quality of meter installations
- maintain a consistent approach to the design, installation and maintenance of metering equipment
- improve skills and knowledge, particularly in open channel systems
- ensure that metering equipment is maintained to a high standard
- build innovation and share knowledge.

It outlines the Regulation requirements and the factors that need to be considered under different situations. It also recommends best-practice methods of installing and maintaining a meter so that it conforms to the Regulation and meets the requirements of AS4747.

This guide should be read in conjunction with the following:

- the NSW Non-Urban Water Metering Policy
- the metering-related provisions of the Water Management (General) Regulation 2018
- the metering–related provisions of the *Water Management Act 2000*.

Please note that this is a guide only. Proper skill and judgement are required in each case to ensure that metering equipment complies with the new requirements. It is intended that this guide will be updated over time.

This guide summarises the requirements of the new, non-urban water metering framework. For more detail please refer to the NSW Non-Urban Water Metering Policy: industry.nsw.gov.au/__data/assets/pdf_file/0017/205442/NSW-non-urban-water-metering-policy.pdf

2. Background

2.1. Australian Standard (AS 4747.5-2013)

The Australian Standard 4747—Meters for non-urban water supply (AS 4747.5-2013) is prepared by the Standards Australia Committee. Its primary objective is to provide information such as minimum technical requirements, installation and commissioning requirements, and in-service compliance, for closed-conduit and open-channel water meters.

The pricing of standards varies from document to document. Please visit the SAI Global website for sales and pricing information to obtain a copy of AS4747 or call 131 242.

www.saiglobal.com

2.2. The National Water Initiative

The National Water Initiative (NWI) is a shared commitment by governments to increase the efficiency of Australia's water use, leading to greater certainty for investment and productivity, for rural and urban communities and for the environment. The NWI built upon the 1994 Council of Australian Governments (COAG) Water Reform Framework.

Under the NWI, governments commit to:

- prepare comprehensive water plans
- achieve sustainable water use in over-allocated or stressed water systems
- introduce registers of water rights and standards for water accounting
- expand trade in water rights
- improve pricing for water storage and delivery
- better manage urban water demands.

For further information on the National Water Initiative visit agriculture.gov.au/water/policy/nwi

2.3. Metrological Assurance Framework

The key requirements of the Metrological Assurance Framework are that non-urban meters shall comply with the following key requirements to ensure an acceptable level of confidence in meter performance. All non-urban meters shall be:

- pattern-approved by the National Measurement Institute (NMI) where available
- suited to the intended purpose
- installed in compliance with the Pattern Approval certificate and the appropriate Australian Standards
- validated by a certified validator after installation and before water is taken through the meter under an entitlement
- maintained periodically in accordance with the Pattern Approval certificate and relevant Australian Standards or Technical Specifications (for example ATS 4747)
- periodically validated by a certified validator on an ongoing basis.

For further information on the Metrological Assurance Framework -

www.agriculture.gov.au/SiteCollectionDocuments/water/national-framework-non-urban-water-metering.pdf

2.4. Summary of requirements under the new non-urban water metering framework

2.4.1. Metering thresholds

The metering framework applies to a water supply work that meets any of the metering thresholds described below.

a) **Already required to have a meter or measure threshold**—all works already required by a condition on the authority to have a meter or measuring device installed.

b) **Infrastructure size threshold**
Surface water: all authorised works (including open channels, gravity fed pipes or channels and closed pipe), except pumps authorised to be less than 100 mm.
Groundwater: all authorised works (which includes wells and spear points), except water bores less than 200 mm.

c) **Multiple works threshold**—all works linked with the same approval, licence or landholding, except those listed below.

   Surface water works with:

   - up to 2 pumps, each less than 75 mm
   - up to 3 pumps, each less than 50 mm
   - up to 4 pumps, each less than 40 mm

   Groundwater works with:

   - up to 2 bores, each less than 160 mm
   - up to 3 bores, each less than 130 mm
   - up to 4 bores, each less than 120 mm.

d) **At-risk groundwater sources threshold**—all works taking licensed water in identified at-risk groundwater sources, regardless of size. These sources are identified in Appendix B of the NSW Non-Urban Water Metering Policy, available on the department's website industry.nsw.gov.au/water-reform/metering-framework.

The metering requirements do not apply to:

- works solely used to take water under basic landholder rights
- water take that is exempt from the requirement for a water access licence or water taken under a floodplain harvesting access licence
- works granted an exemption by the minister because the take of water cannot be measured using a meter
- surface water works marked as inactive on the water supply work approval.

2.4.2. Standards for metering equipment

Table 1 summarises the standards for all new and replacement metering equipment installed on or after 1 April 2019.

Table 1. Standards for new and replacement meters

Pattern-approved	Installation to AS4747	Tamper-evident seals	Data logger	Telemetry	Maintenance
Yes Or alternative option for open channels	Yes	Yes	Yes	Yes Except surface water pumps authorised to be less than 200 mm and groundwater works	Yes

Table 2 sets out the standards for existing meters. An existing meter means a meter that was installed **before 1 April 2019**.

By the relevant roll-out date, users with works that meet the infrastructure size or multiple works thresholds must either:

- install a meter that meets the new standards, or
- ensure their existing meter is pattern-approved and validated, or confirmed as accurate, and meets the other standards for existing meters in Table 2 below.

Users with works that are below the infrastructure size and multiple works thresholds but who are still required to have a meter must ensure their existing meter operates properly. When it no longer operates properly, the meter must be replaced with one that meets the new standards. The government is also considering amendments in 2019 to require these works to also have data loggers and tamper-evident seals installed. This guide will be updated if these requirements change.

Table 2. Standards for existing meters

Infrastructure size	Comply with existing metering requirements	Confirm existing meter is accurate (if relying on accuracy test)	Tamper-evident seals	Data logger	Telemetry	Maintenance
Work meets the infrastructure size or multiple works threshold	Yes until roll-out date	Yes by roll-out date and at five-year intervals and every 12 months for open channel meters	Yes from roll-out date	Yes from roll-out date	Yes from roll-out date, except surface water pumps authorised to be less than 200 mm and groundwater works	Yes
Work is below the infrastructure size or multiple works threshold, but: the work is already required to have a meter or is located in an at-risk groundwater source	Yes	N/A	N/A	N/A	N/A	N/A but must ensure metering equipment is operating properly

2.4.3. When does the framework take effect?

The framework commences in a staged manner over five years:

1. 1 April 2019—new and replacement metering equipment must meet the new meter standards
2. 1 December 2019—surface water pumps 500 mm and above must comply with the new framework
3. 1 December 2020—remaining works in the Northern Inland must comply with the new framework
4. 1 December 2021—remaining works in the Southern Inland must comply with the new framework
5. 1 December 2023—remaining works on the coast must comply with the new framework

2.5. Duly qualified persons

A duly qualified person (DQP) is a person with the qualifications, skills and experience to carry out work on metering equipment as listed in clause 236 of the Regulation. Where the new metering requirements apply, a duly qualified person is required to:

- install or re-install metering equipment
- validate metering equipment on installation, at least every five years (for closed pipe) or annually (for open channels), and in any other circumstances in which validation is required under AS 4747 (for example, where maintenance activities impact on a feature assessed during a previous validation)
- carry out all maintenance required under the maintenance specifications approved by the minister and published on the department's website.

Table 3 below summarises the qualifications, skills and experience required by a duly qualified person to perform activities in relation to metering equipment, correct as at the date of publication. Please note this list will change over time. Please refer to clause 236 of the Water Management (General) Regulation 2018 for the current list.

Table 3. Duly qualified person qualifications, skills or experience

Activity	Qualification, skill and experience required to be a duly qualified person
Design Design metering equipment installed in connection with an open channel	Metering system designer Certified meter installer
Install metering equipment Install metering equipment (other than telemetry)	Certified meter installer
Telemetry Install, maintain or repair telemetry	Certified meter installer Telemetry technician Certified practising hydrographer

Activity	Qualification, skill and experience required to be a duly qualified person
Validation Validate metering equipment (except open channel)	Certified meter installer who has experience in using intrusive and non-intrusive flow measurement testing equipment
Validate metering equipment in connection with an open channel	Certified meter installer who has experience in using intrusive and non-intrusive flow measurement testing equipment Certified Practising Hydrographer who is trained in the use of testing equipment
Testing Volumetric or simulated testing (in situ accuracy testing) for metering equipment (except open channel)	Certified meter installer who has experience in using intrusive and non-intrusive flow measurement testing equipment
Volumetric testing (in situ accuracy testing) of metering equipment installed in connection with an open channel using in situ volumetric measurement procedures specified in AS4747	Certified meter installer who has experience in using intrusive and non-intrusive flow measurement testing equipment Certified practising hydrographer who has experience in using intrusive and non-intrusive flow measurement testing equipment
Maintenance Maintenance activities that are required to be carried out annually or at more frequent intervals under the maintenance specifications (except open channel)	Certified meter installer*
Maintenance activities that are required to be carried out annually or at more frequent intervals under the maintenance specifications in relation to open channels	Certified meter installer* Certified practising hydrographer*
Maintenance activities that are required to be carried out every 5 years under the maintenance specifications (except open channel)	Certified meter installer Telemetry technician
Maintenance activities that are required to be carried out every 5 years under the maintenance specifications in relation to open channels	Certified meter installer Certified practising hydrographer
Repair faulty metering equipment Repair faulty metering equipment	Certified meter installer Certified practising hydrographer

*At the date of publication, the maintenance activities listed in column 2 of schedule 1 of the Maintenance Specifications 2019 may also be carried out by the holder of the work approval, access licence or *Water Act 1912* entitlement.

3. Certificates

From 1 April 2019, duly qualified persons who carry out work on metering equipment in accordance with the Regulation must complete the approved certificate.

Duly qualified persons must give the completed certificate to the person for whom the work is done. Offences apply for duly qualified persons and water users who do not comply with the requirements.

The approved certificates can be found at industry.nsw.gov.au/water-reform/metering-framework

3.1. Validation of metering equipment

A certificate is to be completed by a duly qualified person who **validates metering equipment to confirm that the equipment complies, or does not comply, with the requirements of AS 4747**. The certificate is to be given to the person for whom the validation was done.

The department validation certificate is the approved form for the purposes of clause 237 (2) of the Water Management (General) Regulation 2018.

The authority holder must (in accordance with clause 238 of the Water Management (General) Regulation 2018):

- provide a copy of the certificate to the minister within 28 days of receiving it
- keep the certificate for five years.

Supporting photos of the metering equipment installation must be attached when providing a copy of the certificate to the minister.

3.2. Other certificates and reports

3.2.1. Design certificate for open channels

A certificate is to be completed by a duly qualified person to certify that the design of metering equipment for an open channel complies with the requirements of AS 4747. The completed certificate must be given to the person who obtained the metering equipment design.

All metering equipment installed in connection with an open channel must be of a design that is certified by a duly qualified person as complying with the requirements of AS 4747.

The approved certificate for the purposes of clause 237 (1) of the Water Management (General) Regulation 2018 is available on the department's website.

The authority holder must (in accordance with clause 238 (2) of the Water Management (General) Regulations 2018):

- provide a copy of the certificate to the minister within 28 days of receiving it, in accordance with the lodgement details provided in the certificate
- keep the certificate for five years.

3.2.2. Certificate of accuracy for existing meter (not pattern-approved)

A certificate is to be completed by a duly qualified person who checks metering equipment for accuracy to confirm whether or not the maximum permissible error of the metering equipment exceeds +/-5% in the field for both closed-conduit and open-channel meters, in accordance with clause 9 of Schedule 8 of the Water Management (General) Regulation 2018. The completed certificate is to be given to the person for whom the accuracy check is done.

The approved certificate for the purposes of clause 237 (3) of the Water Management (General) Regulation 2018 is available on the department's website.

The authority holder must (in accordance with clause 238 of the Water Management (General) Regulations 2018):

- provide a copy of the certificate to the minister within 28 days of receiving it, in accordance with the lodgement details provided in the certificate
- keep the certificate for five years.

3.2.3. Report to rely on transitional arrangements to keep existing metering equipment

A report is to be completed by the authority holder. If you are an authority holder and you intend to rely on the transitional arrangements for your existing metering equipment, you must give this report, together with any accompanying documents, to the minister before your roll-out date, in accordance with the lodgement details provided below.

If your existing metering equipment is pattern-approved and you have an existing validation, you do not have to install new metering equipment. An existing validation means a validation of your existing metering equipment that was done before the roll-out date for your work. If your existing validation meets the criteria below, you do not need to have another validation done before your roll-out date. The existing validation must:

- have been done by a duly qualified person
- have been done within 12 months before the roll-out date for your work (for open-channel metering equipment), or within five years before the roll-out date for your work (for all other metering equipment)
- confirm the metering equipment complies with the requirements for validation under AS 4747.

If your existing metering equipment is not pattern-approved and you have a meter manufacturer's certificate and an existing validation, you do not need install new metering equipment. A meter manufacturer's certificate is a certificate in writing provided by the manufacturer of the metering equipment that confirms that the maximum error of the metering equipment did not exceed +/-2.5% after manufacture. This must be done before your roll-out date.

If you do not have a manufacturer's certificate or an existing validation, you may still keep your existing metering equipment if it has been checked for accuracy by a duly qualified person and the maximum error of the equipment does not exceed +/-5% in the field. The duly qualified person will provide an accuracy certificate ('Non-urban water meter—certificate of accuracy for existing meter —not pattern-approved') for your existing metering equipment that certifies that the equipment has been checked for accuracy. The accuracy certificate will specify the maximum permissible error of the equipment. This must be done before your roll-out date.

3.2.4. Compliance

Duly qualified persons should be aware that the *Water Management Act 2000* and the Regulation impose a number of obligations on them and it is an offence to not comply. It is an offence under sections 91J, H & A of the *Water Management Act 2000*, provision 237 (5) in the Regulation for a DQP to:

- make a statement or furnish any information in, or in connection with, a metering record that the person knows to be false or misleading—section 91J
- fail to notify the minister in the approved form and manner if the person knows or reasonably suspects that the metering equipment they are installing or carrying out work on has been tampered with—clause 237 of the Regulation
- fail to provide to a relevant person with any of the certificates required to be provided (including a failure to prepare the certificate in the approved form). This relates to validation

certificates, accuracy certificates and certificates with respect to the design of open channel metering equipment.

To make a confidential report on any suspicious activities, call the Natural Resources Access Regulator (NRAR) on 1800 633 362 during business hours or email nrar.enquiries@nrar.nsw.gov.au

Further information on how to report an incident can be found on the NRAR web page industry.nsw.gov.au/natural-resources-access-regulator/report-an-incident

3.3. Consumer awareness

3.3.1. Certified Meter Installer certification

Irrigation Australia Limited (IAL) provides a Certified Meter Installer & Validator (CMI) program to provide training, knowledge and compliance with meter installation and validation requirements in each Australian jurisdiction. Each DQP who is certified to install, validate and maintain meters is provided with a CMI Certification identification card. See a sample of a CMI ID Card below.

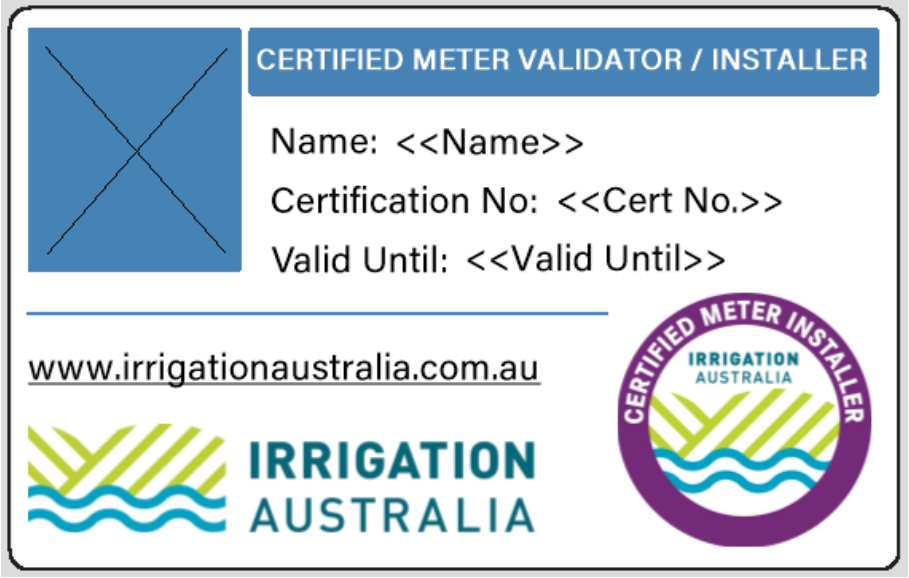

Figure 1. Sample of IAL-issued CMI Certification ID Card

3.3.2. Certified Meter Installer certification

A Certified Meter Installer and Validator must follow a code of conduct

The base principles are:

- Conduct fair and honest business practices
- Undertake all activities in a competent and professional manner at all times
- Accurately represent personal competencies, capabilities, qualifications and experience
- Maintain a current knowledge of best practice in the irrigation industry including:
    - current laws and Regulations
    - Irrigation Australia endorsed or published industry standards, benchmarks, guidelines
    - best available technologies and management practices
    - participate in the Continuing Professional Development (CPD) program
    - ensuring CMI Registration remains active and financial.

To ensure the integrity of the program it is necessary for Irrigation Australia to have a clear process by which the Certification Board can investigate any CMI whose work is alleged to have failed to meet the proper standard or procedure and decide on an appropriate outcome.

4. Types of meters

4.1. Pattern-approved meters

All new and replacement meters installed on works that meet any of the metering thresholds must be pattern-approved. An alternative to pattern-approval is available for open channel meters only (see section 4.3).

Pattern approval is the process of testing the pattern (design) of an instrument against an established standard by an independent body. Pattern approval determines the accuracy of a meter and is granted by the National Measurement Institute (NMI) in the Commonwealth Department of Industry, Innovation and Science.

Water meters for non-urban areas are assessed for pattern approval in accordance with:

- NMI M 10—meters intended for large scale, non-potable applications
- NMI M 11—meters intended for open channel flow measurement.

Further information about pattern approval is available from the National Measurement Institute website: measurement.gov.au/Industry/business/Pages/Water-Meters.aspx

The Murray–Darling Basin Authority is maintaining a list of pattern-approved meters for non-urban use on its website. This includes:

- the details of all pattern-approved meters for non-urban use
- the minimum and maximum flow rates (Q ratings) for those meters
- information from manufacturers about which models they are currently seeking pattern approval for and when the process will likely be complete.

Visit

mdba.gov.au/sites/default/files/pubs/pattern-approved-non-urban-water-meters.pdf

Importantly, only meters with pattern approval will comply with the pattern-approved requirement under the new meter standards. Meters with only ‘provisional’ pattern approval do not meet this requirement.

4.2. Manufacturer’s installation guidelines

As described in Part 2 (technical requirements for closed conduit meters fully charged) and Part 3 (technical requirements for open channel meters) of AS 4747, it is expected that meter manufacturers will provide work instructions and/or guidelines for the correct installation of their meters.

These guidelines should cover all aspects including specification, performance analysis and general installation requirements. Some manufacturers provide significant details including parts lists, while other may provide details on the electronics such as the transducers, converter and data display units. Other manufactures may not provide a lot of detail about the other components of the metering equipment.

Manufacturer’s installation guidelines should be consistent with AS 4747 and the pattern approval requirements. DQP’s must check to ensure the meter Diameter Nominal (DN) requirements of the meter meet either the AS 4747 standard or the pattern approval requirements, which includes the situation within which the meter is installed.

4.3. Overview of meter types

The types of meters that are used for irrigation measurement and are pattern-approved can be broadly divided into five types:

- mechanical meters, which includes propeller-actuated and turbine meters
- electromagnetic meters
- ultrasonic meters
- electronic automatic weir structures
- open-channel meters (not currently pattern approved).

4.3.1. Mechanical meters

Mechanical meters measure water through the operation of a propeller, turbine or paddle wheel. These devices are located within a pipe and as water passes them they rotate turning a shaft that in turn operates a number of gears that have been calibrated to measure volume in relation to the rotation of the propeller, turbine or paddle. These meters may become inaccurate when debris enters the pipe and fouls the rotating propeller, turbine or paddle.

Mechanical meters are subject to wear in bushes and shafts and as a result the rotation and turning of gears can be out of synchronisation with the design calibration of the meter. Cavitation and turbulent water can cause the propeller, turbine or paddle to spin with an irregular pattern and as a result may result in loss of flow synchronisation with the meter.

4.3.1.1. Types of mechanical meters

4.3.1.1.1. Propeller-actuated meter

A helical-shaped rotor is located on the centre of the conduit. The design of the rotor influences flow performance of the meter and the amount of unobstructed flow between the blades. This provides the opportunity for foreign objects or small aquatic life to pass through the meter. The propeller actuated meter is commonly used by river-pumpers and horticulturalists with pressurised irrigation systems.

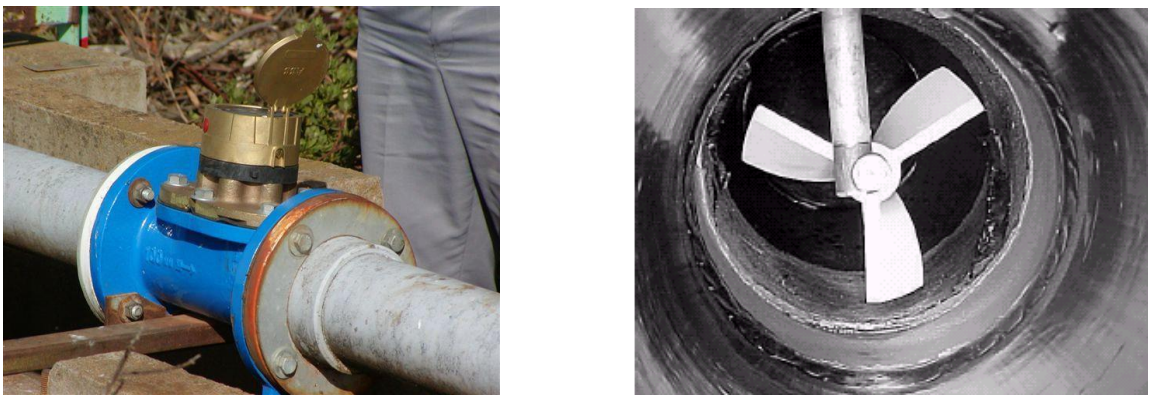

Figure 2. Examples of propeller-actuated meters

4.3.1.2. Turbine meters

The main feature of the turbine meter is the size, shape and number of blades of the impeller. The impeller takes up almost all of the water way and allows it to measure flow at a greater accuracy.

Turbine meters consist of a bladed turbine rotor installed in a flow tube. The rotor is suspended on its axis in the direction of the flow through the tube. Turbine meters are similar to propeller-actuated meters in that the movement of flowing water causes the turbine to spin.

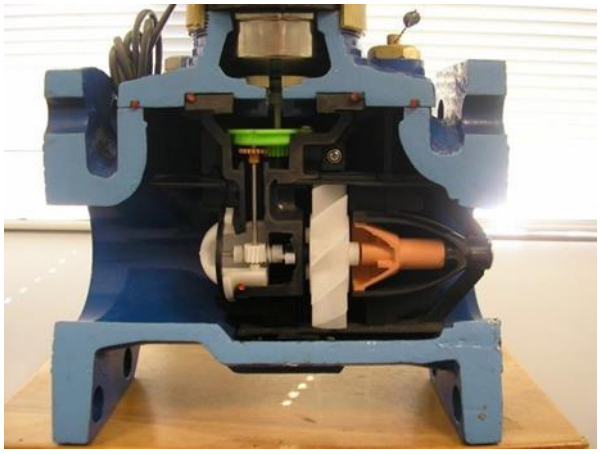

Figure 3. Example of a turbine meter

4.3.1.2.1. Paddle-wheel meter

Paddle-wheel meters generally have a small paddle wheel that extends beyond the surface of the meter body into the waterway and rotates perpendicular to the direction of the flow. The advantage of the meter is that the water way is relatively unobstructed.

Figure 4. Example of a paddle-wheel meter

4.3.1.2.2. Electromagnetic meters

The electromagnetic meter, as it suggests, involves a magnetic field. The meter has a magnetic field that surrounds the internal wall of the meter housing. The water flows through the magnetic field and generates an electrical current. This electrical current is measured and converted to flow and volume outputs.

As the flow increases, the electrical current increases, therefore the meter recognises increases in flow rate and volume. When the flows through the magnetic field reduce, the electrical charge decreases, therefore the meter records a lower flow rate and volume.

Figure 5. Example of an electromagnetic flow meter

4.3.1.2.3. Ultrasonic meters

These are sometimes referred to as acoustic meters. Ultrasonic water meters are used in rural, urban and industrial applications. The existing technology uses transducers or sensors to measure water velocity in full pipes with known cross- sectional area to calculate flow rate.

Transducers can be fixed on the outside of the pipe. These are ‘non-wetted’ types. They can also be inserted into the pipe and are known as ‘wetted’ types.

Different brands of meter use different numbers of transducers. Some use only one or one set of transducers to give a reading on a single path. Others use multiple transducers to read on more than one path. Generally, multiple paths will provide greater accuracy.

Two methods used to calculate water velocity:

1. Transit-time meter and
2. Doppler meter.

4.3.1.2.4. Transit-time meter (prefabricated)

The transit-time method calculates velocity from differences in time for an impulse to pass between two transducers located on opposite sides of the pipe and positioned along the pipe at an angle to flow direction. It uses the velocity of sound pulses travelling in the direction of flow compared to the velocity of sound pulses travelling against the direction of flow to determine the velocity of water and calculates the flow rate.

There are no obstructions or moving parts to impede the flow and the transducers can be wet or dry. These meters are usually designed for use in full flowing pipe situations and are produced in a range of standard sizes and flow capacity.

The ultrasonic principle can be extended to measure flow in partially filled pipes or open channels. This is more complex and requires additional numbers of transducers and sound paths, combined with a method to measure water depth.

Figure 6. Example of a transit-time ultrasonic meter

4.3.1.2.5. Doppler meter

The Doppler method calculates the velocity by bouncing sound pulses out into the water mass and reading the pulses that are returned after reflecting from moving particles within the water mass such as air bubbles. This is similar to how speed radar works.

Figure 7. Example of a Doppler ultrasonic meter

The method generally uses a 'wet' sensor that is installed within an existing pipe or structure. There are various ways to mount the sensors depending on the application. Some may be installed through fittings welded or clamped onto the external face of the pipe and others by strapping them inside a pipe or structure.

Ultrasonic Doppler meters can be used in a wide range of situations. For situations with open channel flow, an additional sensor can be installed to also measure the depth of flow. With known velocity and depth of flow, the flow rate can be calculated.

Depth transducers may be ultrasonic, pressure or bubbler type. The type most commonly used with ultrasonic Doppler meters is the pressure transducer, due to its high reliability.

Unlike other acoustic meters, Doppler meter performance is very dependent on the water's physical properties, such as sonic conductivity, particle density, and flow profile. This can reduce the reliability of this type of meter in some situations.

4.3.1.2.6. Automatic electronic weir structures

Automatic weir structures with incorporated metering capability are a gate-type meter that uses ultrasonic sensors to measure the upstream and downstream water level. The door position calculates the depth of water passing over an overshot weir. An algorithm (computer formula) is used to calculate the volume of water flowing over the weir.

Figure 8. Example of gate-type meter in standard and large irrigation outlets

4.3.1.2.7. Open-channel meters

Currently there are no pattern-approved meters for open-channels systems. An alternative option to pattern-approval has been included in the Regulations to ensure that open-channel meters demonstrate a high level of accuracy.

An open channel is a channel or conduit used for conveying water that is not enclosed. Open channel meters do not need to be pattern-approved if:

- before the metering equipment is installed, the proposed design of the installation is certified by a duly qualified person as compliant with AS 4747, which specifies the relevant International or Australian Standard that is applicable to the metering equipment to be used or type of channel where it is to be installed
- the metering equipment is validated at least every 12 months.

5. Meter design

5.1. Design process overview

The design process of a meter installation should consider, but not be limited to the following:

- site selection
- selecting the meter equipment in conjunction with the meter owner
- work health and safety aspects
- environmental consideration
- cultural and heritage considerations
- site access for the installation and future validation
- site inductions
- the type of meter to be installed
- available sources of power
- available communication options.

Duly qualified persons will advise the landowner that in any design where meters are buried that an access pit must be made available and that in other new meter installations an inspection portal must be included to allow cameras or inspection probes for future testing.

5.2. Locating the site

The first phase of installing the meter and its infrastructure is to establish the location of the site. The duly qualified person must ensure that the meter location has been identified accurately. This will require confirmation with the authority holder that the meter location captures the following:

- the name of the landowner
- the GPS coordinates, if possible
- the identification, either name or number, of the supply channel
- the identification of existing meter or outlet
- the running distance from a known and validated point along the channel
- on-farm discharge point
- verify that the site is valid within modernisation or reconfiguration guidelines.

5.3. Accessing the site and location of the meter installation

Once the site location has been established, the next phase is to ensure that access to the meter is available. The access will allow landowners and duly qualified persons easy access to the meter facilities. In many cases, this will be across landowner property; it is expected work vehicles will be able to access the site. Unless stated in any contractual arrangements, the DQP is not responsible for the development or upgrading of access tracks. However, it is expected the installation will take the best advantage of existing access.

On a green-field site, the actual location of the meter will need to be negotiated with the landowner. Also consider the location of the intake of the meter to ensure that it does not interfere with supply flows or levels. The landowner will be interested in the discharge point to ensure that it links efficiently and effectively with existing or planned on-farm infrastructure.

On an existing site, the meter emplacement is usually placed in the same location.

5.4. Soil sampling and testing

It is essential that the duly qualified person considers the quality of the soil that they are working with. Placing a meter infrastructure within a channel bank will require the DQP to ensure the soil's permeability is sufficient to eliminate leakage and seepage.

Ideally, the soil that is used to compact the upstream and downstream sump or headwall should be of good quality clay. For effective installation, and for the structure that is built to reach its economic and functional life, the DQP needs to know the condition of the soil used for installing and backfilling.

It is highly recommended that the DQP undertakes simple sampling tests to establish the condition of the existing soil. If the soil has little clay composition, it will require some type of soil conditioning by the addition of additives such as bentonite.

Alternatively, if the soils on site are unsuitable, the DQP may need to identify and bring to the site new material for the compaction process.

Note: If the head differential between the supply level in the channel and the discharge point of the meter is high, then the potential for seepage and leakage is proportionally high. Therefore, the rule of thumb is the higher the head, the more rigorous the soil analysis

The main purpose of the soil test is to ensure the installation is protected from excessive leakage and seepage, which could cause failure. Certified Meter DQPs should aim to compact the soils to within 98% of their original compaction state.

If a design plan of the meter infrastructure has been provided, it will have considered the soil types and made allowances by recommending either an additive be used, or appropriate materials be bought in.

5.5. Water infiltration

Water can infiltrate the site from a number of sources:

- supply channel
- groundwater
- storm surface water
- on-farm infrastructure such as header or recycle dams and/or channels.

In addition to soil condition, the DQP will need to consider any infiltration. In the instance where the DQP is using a design plan developed by a DQP, it is expected the designer will have taken

infiltration into account. As part of the planning process, the DQP will need to examine the plan, as it may have included infiltration protection such as filter zones, cut off walls and drainage systems.

Infiltration can cause the infrastructure site to become saturated and influence the levels of sumps and connecting pipes, which could cause misalignment and therefore potential for flow disturbance. It may cause the channel embankment soil to become saturated, as well as creating slumps and failures.

Infiltration can be checked through inspection of the surface, toes or the lower elevations of the land surrounding the site or by undertaking test bores.

Infiltration can cause significant water logging when the DQP is backfilling the structure; it is best to know the likelihood of this occurring, so contingencies can be included, and control measures developed.

5.6. Assessment of hydraulic head and flows

As stated earlier, the important aspect of installation is to ensure there is sufficient head and flow to maintain a full pipe and create an established flow for meter accuracy. The DQP will need to know the minimum head requirements for the meter to be installed. For pattern-approved meters, there will be specifications for minimum head and flow requirements.

The DQPs should establish the flow regime for the supply channel, including the design supply level. If the DQP is installing the meter emplacement without being provided with a temporary bench mark (TBM), there will be a need to establish the true supply level, so the available head can be calculated.

It is expected when the DQP is engaged to install the meter that the meter has been selected according to the supply flows, head and on-farm requirements. Because of this, the DQP can assume there is sufficient flow within the supply channel. However, a cursory check should be taken to validate there is sufficient head to maintain a full pipe flow.

This can be done by taking a level from the supply level in the channel off a structure within the system. The level should be transferred to a TBM near the site, but far enough away to make sure the TBM will be safe from interference during installation. A check should then be made to establish the sill level of the upstream sump within the channel and then calculating the difference between the sill and supply level. This calculation will provide the head difference and therefore validate whether there is sufficient depth to place the sump to obtain the required minimum head.

In the case where a TBM has been provided, the DQP should still validate there is sufficient head, as it has been known that TBM’s have been installed at the incorrect level.

5.7. Identification of power supply

Most modern meters are operated using a DC or AC power supply and can be linked to radio or microwave communication systems. In fact, most modern meters are powered by a DC battery recharged through solar panels and can be connected to communication systems.

The DQP will need to establish the power requirements and if there is a need to connect to existing sources, the DQP will have to locate the source and make arrangements with the power supply company or electrical contractor to connect.

5.8. Identification of communication equipment to enable the meter to send data to the government data acquisition service (DAS)

The data logging and telemetry specifications 2019 set out the technical requirements that must be met by these components of metering equipment. The specifications are published in the *NSW Government Gazette* and are also available on the department's website: industry.nsw.gov.au/water-reform/metering-framework/telemetry

These specifications apply to all works required to have a data logger and/or telemetry installed (see summary of the meter standards in section 2.3 above).

5.8.1. Data acquisition service

Following a competitive procurement process, the department has engaged Eagle.io to develop a data acquisition service (DAS) to collect water data from water users with telemetry.

Data collected by the DAS will assist the Natural Resources Access Regulator, WaterNSW and the NSW Department of Planning, Industry and Environment undertake compliance and enforcement, billing and other water management activities.

The department will publish a list on its website of field solutions that are compatible with the DAS's functional and security requirements before the DAS goes live. This list will help duly qualified persons and water users identify devices that can connect to the DAS.

The department will update the list as additional solutions are identified, tested and found to be compatible with connecting with the DAS.

More information on how the DAS operates will be posted in July 2019.

5.9. Solar orientation

As stated before, in most instances, the meter emplacement will be powered by a Direct Current (DC) battery and recharged through a solar panel system.

To recharge the DC batteries, the solar panel will need to be exposed to the direct sun for significant parts of the day.

The DQP will need to check and ensure that sunlight is available on the site for sufficient times during the day to recharge the DC batteries. The location of the solar panel will need to maximise the use of available sunlight.

5.10. Environmental impacts

A DQP is expected to undertake an environmental impact study to ensure that each activity that is undertaken does not compromise the environmental integrity of the site.

The DQP will need to consider the impact of the meter installation works on the environment and consider:

- water
- air
- soil
- vegetation
- fauna
- cultural heritage.

5.11. Workplace health and Safety

The DQP will need to undertake a risk assessment associated with the site and activities involved in the meter installation process. The DQP must ensure they comply with *Work Health and Safety Act 2011* and the Work Health and Safety Regulation 2017.

The DQP will be ultimately responsible for the site and therefore all those who enter the site, including landowners.

6. Installing meters

6.1. Overview

The following points should be considered for either a closed conduit or open channel (or partially filled closed conduit):

- **Initial site and risk assessment (preparation work)**
  - WHS, access, notify authorities, utilities, protective clothing, contact the owner, manufacturer's specifications, pattern approval certificate, tools
  - Recommend that an inspection portal is installed downstream of the meter. This allows for accuracy testing and inspections without removing seals.
- **Choose appropriate location and design setup**
  - Ensure no off-takes beforehand
  - Appropriate placement of transducer or meter (all new installs, where possible are installed above ground or within a safe accessible pit)
  - Check meter is fit for purpose
  - Dismantle old system & inspect pipework
- **Install to pattern approval certificate and manufacturer's specs. Ensure appropriate diameters and lengths of straight pipe.**
  - Assess condition of existing pipe
  - Ensure meter and pipework are insulated from vibration & protected
- **Test and commission. Calibrate if necessary.**
  - Check installation—accuracy, leaks, flow rate
  - Ensure all fittings are outside require DNS
- **Seal meter and record details required for validation**
- **Restore site**
- **Provide a copy of the validation form to the owner.**

More detailed guidelines are provided in the following sections.

Note: Some activities do not apply or are required on a bore/pump set up.

6.2. Installing closed conduit meters—general

A closed conduit is defined as a pressurised or gravity pipe. In this instance, the meters are normally installed in the discharge pipe, which may be connected directly to a pump or a tank. Where these types of installations occur, the DQP must ensure:

- the meter to be installed is pattern-approved
- the investigation phase of the meter installation includes:

    - assessing the condition of any existing pipes to ensure the meter flanges can be installed as per the specifications to suit the type of pipe
- the meter is installed as per the pattern approval certificate
- the pipe must be self-supported so it does not place loading on the flowmeter. The flowmeter must not become a focus for pipeline stresses.
- pipes are cut, if necessary, and fitted with flanges to allow the meter to be retro-fitted to an existing site. Ensure that all cuts are cleaned and are smooth before mounting the flange brackets.
- all welds are cleaned and any exposed materials are protected
- the flanges align, in particular to the internal walls of the pipe
- flange gaskets do not protrude into the pipe
- flange bolts are the correct size. Small diameter bolts can cause the meter and the internal walls of the pipe to misalign.
- flange bolts are tightened to the appropriate torque provided by the manufacturer. In some cases, bolts may require protection from corrosive environments.
- if the pipe is located above the ground, the meter and the pipe must be supported to ensure there is no misalignment
- if the pipe is located above the ground, the transducers and meter display unit must be protected from any vibration through pump operation and vehicle traffic
- if the pipe and meter are above ground, they must be protected from potential damage from vehicles, pedestrians and/or stock
- if the meter is located in the ground, it must be protected by a meter box, complete with lid.

6.2.1. Installing Electromagnetic meters

The electromagnetic meters are very similar to ultrasonic transit time meters and should be installed in the same manner. If flanges are used the meters must be fitted so there is no misalignment between the internal surface of the transducer housing and the pipe; this includes protruding gaskets.

In all cases, the transducers are essential and must be placed according to the manufacturers' requirements or at least to the standard set in AS 4747.

When installing the pipework and pits, it will be necessary to keep checking levels to ensure the pipe inverts are at the required elevation in relation to the channel's supply level.

When the pipework has been installed, the final component is the sump or headwall. The DQP will need to ensure the sill level of the sump or headwall is placed according to the elevation on the plan. There may be a need to pack the sump or headwall to establish the correct elevation.

At this point in the installation, the hydraulic components should be fitted within the excavation.

6.2.2. Installing an Electronic automatic weir

Excavate the bank of the channel following similar work practices as described for the piped meters. Install the concrete emplacement in the channel bank as per plans provided for the individual gate being fitted, ensuring the supply level has been determined, TBM has been provided and excavation foundation is at the correct level.

Fit the external gate frame into the emplacement as per the manufacturer's instructions. Comprehensive work instructions are provided by the manufacturer.

Install the gate into the external frame. Comprehensive work instructions are provided by the manufacturer for this task as well.

Figure 9. Installation of gate meter

6.2.3. Installing in an open system (channel or partially filled pipe)

An open system can be defined as a gravity-fed channel system that relies on the head difference between the channel and the farm land to generate flows. Installation in this instance requires some type of structure to bring the water from the channel to the farm infrastructure, normally consisting of an upstream sump or headwall, a connecting pipe and a downstream sump or headwall, with the meter installed within the connecting pipe. Alternatively, if an electronic automatic weir is being used, it will consist of a concrete emplacement and manufactured regulating components.

6.2.4. Installing open channel transit time meters

Bulk irrigation offtakes often utilise transit time metering installations, sometimes referred to as ‘time-of-flight meters’.

These installations are complex and should only be installed by experts with experience in this area.

These meters are not pattern-approved but installation and operation should be in accordance with ISO Standard 6416:2017

These meters are designed to provide high-accuracy, real-time flow. However, the accuracy is only as good as the design and installation of the system.

The metering system consists of multi-path velocity transducers located at an angle to the channel cross-section. The difference in time taken for the ultrasonic pulse to travel upstream and downstream can be integrated to provide an accurate determination of the channel flow.

The cross-section of the metering install needs to be accurately surveyed. The cross-section is continually measured by measuring the water depth.

6.3. Final steps involved with meter installations

6.3.1. Backfill the trench

One of the key elements in ensuring the meter emplacement operates to its full economical life is the backfilling of the components. Many installations have failed immediately after the completion of the installation. The reason is poor soils and compaction.

In the investigation process, the DQP will have established the soil quality and quantity on site and developed a plan for the backfill material. Backfill material must be able to be compacted and provide a strong impermeable barrier.

The DQP must either have decided by analysis that site materials are good enough to use, or decided to bring in more material or additives to improve the quality of the soil.

6.3.2. Install the solar panel and display unit

The solar panel is a key aspect of the meter's function, as it continually recharges the DC battery. The solar panel must be orientated so that it maximises the availability of sunlight at the site.

The solar panel is attached to a pole, usually a 50 mm galvanised pipe. The pipe should be concreted at least 450 mm into the ground. The pole should not interfere with traffic or be damaged by stock. The solar panel should be attached at a height that reduces the chances of vandalism and in a way that secures it from theft.

The display unit should be attached to the solar panel support pole at a height that allows the meter reader easy access for it to be read. The display must be 1.2 m above ground level and the DQP must ensure there is a sufficient cable to allow this to occur.

In most instances, the meters will not require calibration as they are set up to plug in and start. Once the display unit has been placed on the pole, seals must be attached to ensure there is no tampering with the meter read-out.

6.3.3. Other meter types

Other types of meters are undergoing pattern approval; this guide will be updated as new meters achieve pattern approval.

6.3.4. Connect to government data acquisition service (DAS)

Telemetry is installed by a DQP, such as a certified meter installer or a licensed electrician.

DQPs will also be able to provide advice on suitable telemetry systems and telecommunications providers, and provide a sim card.

Further information will be available on the department's website in July 2019.

6.3.5. Commission and validate the meter

AS 4747 states commissioning is required to ensure the accuracy of a meter installation and to allow validation in accordance with AS 4747.8. This process shall be conducted by a duly qualified person. Steps in the commissioning process shall consist of, but not be limited to, those listed below.

The commissioning process shall be as follows:

1. Check that the meters or measurement instruments have been pattern-approved or hold other certification acceptable to the Water Management (General) Regulation 2018.
2. Check that the instruments have been installed in accordance with the requirements specified in the approval certificate and the manufacturer's installation instructions (see AS 4747).

3. Check that the installation complies with the meter design.
4. Where applicable, check that the flow computer has been programmed with any revised parameters.
5. Where applicable, check the correct version of the software has been installed.
6. Check installations of tamper-evident seals to ensure the integrity of the meter.
7. The materials and lining of the pipe shall be checked to ensure that it is in accordance with requirements of pattern approval.
8. The installation shall be checked for leaks.
9. Complete the validation certificate and provide a copy to the authority holder.
10. Ensure that the site is safe and all environmental requirements have been dealt with.

6.3.6. Restore the site

The final part of the installation process is to ensure the completed site has been restored so that it complies with all WHS requirements and is in a safe working condition. The site must also be restored so that any vegetation that has been removed or damaged during the construction phase is replaced.

7. Maintenance

7.1. Overview

Meter owners are to ensure their metering equipment is being maintained periodically in accordance with the Pattern Approval Certificate and relevant Australian Standards or Technical Specifications.

It is the responsibility of the water user to maintain their metering equipment in good working order.

Maintenance of meters is required to provide an acceptable level of confidence that they continue to operate within the maximum permissible limits of error.

Maintenance is also required to ensure that the installation of the meter still complies with the pattern approval requirements and associated limitations of the installation conditions in accordance with AS 4747. Maintenance procedures shall comply with AS 4747 and/or pattern approval certification.

7.2. Maintenance of closed conduits

All meters installed on works that meet the metering thresholds (except works that do not meet the infrastructure size and multiple works thresholds) need to be maintained in accordance with the Maintenance Specifications 2019, which are published in the *NSW Government Gazette* and on the department's website.

Maintenance Specification 2019:
industry.nsw.gov.au/__data/assets/pdf_file/0014/224033/Maintenance-Specifications-Gvt-Gazette-No-27-Friday-29-March-2019.pdf

These specifications set out the maintenance activities that need to be carried out, the frequency of maintenance, and whether the maintenance needs to be carried out by a duly qualified person or if it can be carried out by the holder of the approval or licence.

Table 4. Mandatory maintenance requirements for closed conduit meters

Column 1—Maintenance Requirements	Column 2—Frequency—At any time when necessary (by the authority holder or a duly qualified person)	Column 3—Frequency—Every 5 Years (by a duly qualified person)
1. General cleaning and housekeeping; suction clear, cleaning solar panel, clear away debris, excess soil, check for vermin issues/damage and check that site is weed free	Yes	Yes
2. Check meter, pipework and other fittings within the meter facility for structural integrity, check for leaks	Yes	Yes
3. Check that site is WHS compliant. Ensure that the site is safe for employees, contractors or visitors to inspect or perform work at the metering site	Yes	Yes
4. Check integrity of the telemetry pole, antenna and the fence around it (if required)	Yes	Yes
5.When pump has started and water is flowing, check the correct operation of totaliser	Yes	Yes
6. Verify the meter seals integrity	Yes	Yes
7. Verify batteries/solar panel and change them as required and/or specified by the manufacturer (if required)	Yes	Yes
8. Meter display is clear and readable	Yes	Yes
9. Check condition of electrical cables	Yes	Yes
10. Record of meter reading	Yes	Yes
11. Complete any other inspections and basic maintenance as per the meter manufacturer's requirements (if specified)	Yes	Yes

Column 1—Maintenance Requirements	Column 2—Frequency—At any time when necessary (by the authority holder or a duly qualified person)	Column 3—Frequency—Every 5 Years (by a duly qualified person)
12. Electronic validation: Check software version, electronic check against internal reference source that is set at the time of calibration (as per manufacturer's requirements)	N/A	Yes
13. Check Telemetry fault notification	N/A	Yes
14. Check for signal transfer between transmitter, sensor and data logger	N/A	Yes
15. Perform volumetric or simulated testing (in situ accuracy testing to ensure meter is operating within +/-5%)	N/A	Yes
16. Produce a routine maintenance report that covers all items in this Schedule	N/A	Yes
17. Complete the water meter validation certification form after completing all maintenance activities in this Schedule	N/A	Yes

7.3. Maintenance of open channels

Table 5. Mandatory maintenance requirements for open channel meters

Column 1—Maintenance Requirements	Column 2—Frequency—At any time when necessary (by the authority holder or a duly qualified person)	Column 3—Frequency—Every 12 months (by a duly qualified person)
1. General cleaning and housekeeping; cleaning solar panel, clear away debris, excess soil, check for vermin issues/damage and check that site is weed free	Yes	Yes
2. Check that site is WHS compliant. Ensure that the site is safe for employees, contractors or visitors to inspect or perform work at the metering site	Yes	Yes
3. Meter display is clear and readable	Yes	Yes
4. Check integrity of the telemetry pole, antenna and the fence around it (if applicable)	Yes	Yes
5. Record of meter reading	Yes	Yes
6. Verify the meter seals integrity	Yes	Yes
7. Verify batteries/solar panel and change them as required and/or specified by the manufacturer (if required)	Yes	Yes
8. Check condition of electrical cables	Yes	Yes
9. Remove vegetation in flow measuring section	Yes	Yes
10. Remove vegetation and silt on the sensors or sensor system	Yes	Yes
11. Complete any other inspections and basic maintenance as per the meter manufacturer's requirements (if specified)	Yes	Yes

Column 1—Maintenance Requirements	Column 2—Frequency—At any time when necessary (by the authority holder or a duly qualified person)	Column 3—Frequency—Every 12 months (by a duly qualified person)
12. When pump has started and water is flowing, check the correct operation of totaliser	Yes	Yes
13. Check for signal transfer between transmitter, sensor and data logger	N/A	Yes
14. Check software version and telemetry fault notification	N/A	Yes
15. Check in stream discharge measurement and cross section survey	N/A	Yes
16. Perform volumetric (in situ accuracy testing to ensure meter is operating within +/-5%)	N/A	Yes
17. Produce routine maintenance report that covers all items in this Schedule	N/A	Yes
18. Complete the water meter validation certification form after completing all maintenance activities in this Schedule	N/A	Yes

8. In-situ accuracy testing

8.1. Overview

The NSW Non-Urban Water Metering Policy requires that non-urban water meters should be checked to determine that the maximum permissible error of the metering equipment did not exceed +/- 5 % in the field.

The aim of measured, in-situ, verification (MISV) is to verify this accuracy. As a result, the verifying measuring device must have an uncertainty of at least three times and preferably five times better than 5%. The requirement for this level of accuracy precludes some methods of in-situ verification.

For further information on measured, in-situ, verification, please refer to AS4747 Part 8: In-service compliance for non-urban water meters.

Source: *Measured in-situ Verification of Meters for Non-Urban Water Supply Technical Report No. 10/08* irrigationaustralia.com.au/documents/item/220

The department is reviewing current in-situ testing approaches with the most potential to provide cost-effective, practical and reliable accuracy testing. Once completed, the results and methods will be published on the department's website.

8.2. Closed conduit meters

Figure 10 outlines the current methods in which in-situ verification can be done on closed conduit meters:

- an external ultrasonic flow meter
- a meter inserted into the pipe using either mechanical or non-mechanical technology
- a reference meter in series with the service meter
- tracer methods
- gravimetric methods
- electronic validation checks.

The methods most likely to be applicable to Australian meter installations are insertion meters and clamp on ultrasonic meters. In a few instances, it may be possible to insert a reference meter in series.

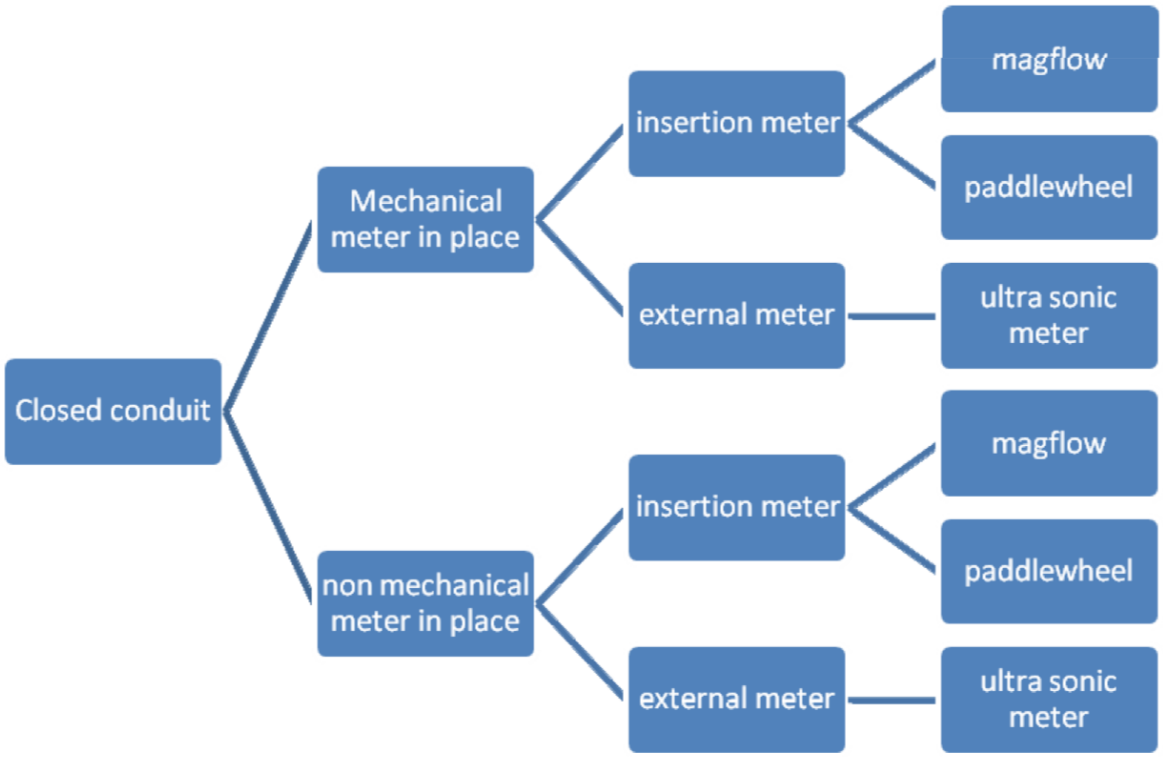

Figure 10. Close conduit MISV options most likely to be used in Australia*

*There are other methods of in-situ verification, such as gravimetric, tracer and dilution, but cost, convenience and practicality are likely to preclude their use except in some circumstances when a reference meter is installed in series with the service meter.

Source: *Measured in-situ Verification of Meters for Non-Urban Water Supply Technical Report No. 10/08* irrigationaustralia.com.au/documents/item/220

8.3. Open channel meters

When performing the accuracy testing on open channel meters, a duly qualified person should, as part of annual validation -

- record the details on the method used and why it was selected
- reference the Standard, ISO and NMI
- provide a statement that gives the metering point variances and indicates if the meter it is within the maximum permissible error margin of +/-5%
- describe the site installation in detail, including the approach channel, channel reach downstream, a list of any vegetation impacts, and a list of any structures that may affect the flow regime
- list any advice that assists with maintaining the channel system so that calibration can be maintained
- recommend the ongoing gauging frequency
- undertake an uncertainty analysis.

9. Further information

NSW Department of Planning, Industry & Environment
The department manages surface and groundwater and ensures water security for NSW. It also ensures that:

- surface and groundwater resources are shared equitably
- water entitlements and allocations are secure and tradeable.

The department manages NSW's water resources through planning, policy and regulation.

https://www.industry.nsw.gov.au/water

WaterNSW
WaterNSW is responsible for information about customer service and WaterNSW licensing, faulty meters, billing (including one- or two-part tariffs) and trading.

https://www.waternsw.com.au/

Natural Resources Access Regulator
The Natural Resources Access Regulator (NRAR) enforces water laws in NSW and ensures that people comply with them. NRAR's compliance approach to metering regulations outlines how it manages the new metering requirements.

https://www.industry.nsw.gov.au/natural-resources-access-regulator

Irrigation Australia Limited
To find a certified meter installer, visit the Irrigation Australia webpage www.irrigationaustralia.com.au

Australian Hydrographers Association
To find a certified practising hydrographer, visit the Australian Hydrographers Association webpage

https://aha.net.au/

10. Glossary

Table 6. Abbreviations used

Term	Meaning
AS	Australian Standards as applicable to materials, workmanship, design and construction guidelines
CMI	Certified Meter Installer
DAS	data acquisition service
DC	direct current battery
DN	diameter nominal
DQP	duly qualified person
GPS	global positioning system
ISO	International Organization for Standardization
MAF	Metrological Assurance Framework
ML/d	mega litre per day
ML	mega litre
m	metre
mm	millimetres
MISV	measured, in-situ, verification
NMI	National Measurement Institute
NMI M 10	Meters intended for the metering of water in full-flowing pipes
NMI M 11	Meters intended for the metering of water flowing in open channels and partially filled pipes
Q	flow rates
TBM	temporary bench mark
WHS	work health and safety