

Wastewater Flow Monitoring Guide

PURPOSE

Small-scale sewerage services licensees operate wastewater collection, treatment and disposal systems that handle less than 10,000 cubic meters (m³) of wastewater per day. They can serve guest worker accommodation facilities, industrial sites, hotels and leisure facilities or small communities.

This guide aims to help small-scale sewerage services licensees understand what is required to achieve compliance with the *Wastewater Flow Monitoring Code of Practice*. The Code can be downloaded from the Bureau's website (www.rsb.gov.ae)

The guide provides information on the:

- selection and installation of flow meters;
- operation and maintenance of flow meters; &
- management and reporting of wastewater flow data.

BACKGROUND

Producing accurate flow data allows licensees to more effectively operate their wastewater systems. It also promotes confidence in flow data reported by licensees.

Producing accurate wastewater flow data is a requirement of the:

- *Recycled Water and Biosolids Regulations 2010*; and
- Incident Reporting Regulations 2008.

The *Wastewater Flow Monitoring Code of Practice* details licensee responsibilities for managing flow monitoring to ensure production of accurate flow data. It specifies the minimal technical, design and operational requirements for:

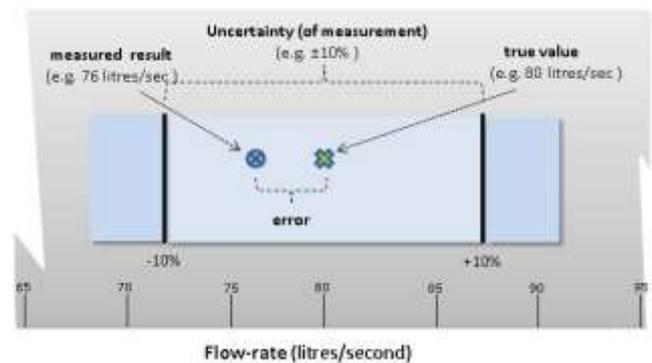
- flow metering;
- flow data collection; and
- flow data reporting.

COMPLIANCE REQUIREMENTS

GENERAL REQUIRMENTS

Licensees must report flow measurements to the Bureau that are no more than 10% higher

or lower than the actual flow values. This acceptable error range is illustrated below.



Small-scale sewerage services licensees must install a flow meter at the inlet or the outlet of their wastewater treatment plant to allow continuous flow monitoring.

SELECTION OF FLOW METERS

The Bureau believes that electromagnetic flow meters are the most suitable flow monitoring devices for measuring inlet or outlet flows at small-scale licensee wastewater treatment plants and best address the typical operating conditions at these sites.

Selecting other types of flow metering devices is acceptable, provided the licensee can demonstrate that they are better suited to the conditions at a specific site, and that they comply with the requirements of the Code.

A manufacturer's certificate must be available to confirm that the selected flow meter:

- has pattern approval (i.e. evidence that the flow meter is approved as meeting a relevant international or national standard for that type of flow meter), and
- has been calibrated by the manufacturer.

The flow meter must be sized in consultation with the flow meter supplier to ensure the flow range of the meter is able to accurately measure the maximum and minimum flow ranges at the site.

The flow meter must also have a display that provides a readable and reliable visual indication of the meter volume in m³ and instantaneous flow rate in litres/second (l/s).

Annex A provides a specification template that may assist licensees working with suppliers to procure a suitable flow meter.

INSTALLATION OF FLOW METERS

Correct installation of flow meters is critical to ensure they generate accurate flow data.

Flow meters must be installed in strict accordance with the manufacturer's instructions.

Only suitably qualified personnel may install a licensee's flow meter.

Annex A provides general information on flow meter installation requirements.

FLOW METER OPERATION AND MAINTENANCE

General

Flow meters must be checked daily to ensure they are operating suitably and that the meter and associated equipment do not require any repairs or adjustments.

Flow meters must be maintained according to manufactures' instructions, including applying preventative maintenance (e.g. regular inspections, cleaning and adjustments). Corrective actions or maintenance must be initiated if faults are detected with the meter or flow data.

Licensees may elect to engage the flow meter manufacturer or qualified agent to perform instrument testing at periods recommended by the manufacturer.

Annual dry verification

A dry verification of the flow meter and associated monitoring system must be conducted annually to confirm:

- the installation requirements specified by the manufacturer are still being met;
- the flow meter is operating within its specified flow range (from records);
- the flow data appears reasonable and reflective of the expected flow patterns at the site (from records); and
- inspections and any required preventative maintenance have been performed as required.

Disposal of flow meter or wet verification

Flow meters will be replaced with a new flow meter that meets the requirements of this guideline every 5 years, or when a performance problem is detected that cannot be addressed through corrective maintenance or by a factory calibration performed by the manufacturer.

As an alternative to replacing a flow meter after 5 years of service, licensees may elect to perform a wet verification to confirm the

continuing accuracy, stability and repeatability of the flow meter.

This wet verification process must be conducted by an independence competent person by temporarily installing a flow reference meter adjacent to the existing flow meter which is able to measure to within $\pm 2\%$ accuracy.

If wet verification confirms that the existing flow monitoring system exceeds the $\pm 10\%$ limit, the flow meter shall be calibrated by a laboratory accredited to ISO 17025, or replaced with a new flow meter that meets the requirements of this guideline.

FLOW DATA COLLECTION

Small-scale licensees must collect and record cumulative daily flow for the wastewater treatment plant over each 24 hour period.

Flow data can be collected via manual readings, collection of paper charts, or electronic data logging techniques. Annex B provides an example of a daily manual flow recording template, and a graph template that can be used by licensees to track flow and identify any trends or events suggesting problems with the flow meter or the other aspects of the wastewater management system.

Flow data must be securely stored by the licensee and backed-up where possible, and be readily accessible and retrievable.

Licensees shall ensure that the collection and storage of data does not include duplications, or other errors. Where faulty or missing data is identified, these errors must be recorded on data recording sheets and any adjustments that were made to address the faulty or missing data should be explained.

FLOW DATA EXCHANGE

Licensees shall submit annual flow monitoring data to the Bureau by 31 March of the following year via the flow data fields in the Annual Information Register template.

Licensees must include details in the submitted Annual Information Register of any estimations or adjustments made to the data to address any missing or faulty data.

Annex B includes an extract from the Annual Information Register template with an example of flow data recording and details of a data estimation explanation.

Licensees shall also include in the Annual Information Register details of any wastewater or recycled water overflows or other incidents and associated volumes based on flow meter readings.

RECORDS MANAGEMENT

Licensees must maintain the following flow monitoring-related records on site:

- the flow meter manufacturer's certificate confirming pattern approval and calibration;
- flow meter installation date;
- daily flow data records and records of any data estimations or adjustments;
- dates and details of:
 - (i) dry verifications performed,
 - (ii) any wet verifications; and
 - (iii) any manufacturer factory calibrations performed; and
- records of any other maintenance (preventative or corrective) performed to

the flow meter or related equipment, including:

- (i) changes to settings,
- (ii) replacements of parts, and
- (iii) details of faults and response actions.

Records must be maintained for 10 years.

FURTHER INFORMATION

For further information contact the Regulation and Supervision Bureau's Wastewater Manager:

Tel: (02) 6543 666

Email: wastewater@rsb.gov.ae

Annex A: Flow Meter Selection

GENERAL

To ensure electromagnetic flow meters generate accurate flow data, it is essential that a suitable flow meter is selected to meet the specific conditions at a licensee's site.

SELECTION PROCESS

Licensees must work closely with their selected flow meter supplier to ensure the purchase of the most suitable flow meter for their individual application. Some suppliers offer on-line tools or other selection processes to assist licensees select the most suitable flow meter. The checklist below summarises key requirements of the Flow Monitoring Code of Practice and may be used to assist Licensees in specifying their minimum technical requirements to flow meter suppliers.

Requirement	Confirmed
Supplier confirms in writing that the flow meter complies with the requirements of the Abu Dhabi Regulation and Supervision Bureau's <i>Wastewater Flow Monitoring Code of Practice</i> .	
Complies with ISO 6817: Measurement of conductive liquid flow in closed conduits – Method using electromagnetic flowmeters.	
Suitable for raw wastewater or recycled water flow measurement.	
Meter accuracy: overall flow measurements generated are within $\pm 10\%$ of the actual flow values.	
Manufactures certificate available confirming the flow meter's pattern approval and confirming manufacture calibration details.	
Data display: Readable, reliable visual indication of the metered volume in cubic metres (m ³) and instantaneous Flow-rate in litres/second (l/s)	
Flow meter size/measuring range ensures accurate measurement for: <ul style="list-style-type: none"> Wastewater treatment process peak flow capacity _____ m³/day Wastewater treatment process minimal flow _____ m³/day Pump rate (where wastewater/ recycled water pumped through the meter) _____ litres/second 	

Requirement	Confirmed
Data retention: All pre-set data, including calibration and alarm set points, and totalised volume can be retained for a minimum of 10 days after failure or disconnection of power supply.	
Operating temperatures: capable of operating within a wastewater temperature range of 0.1°C to 35°C and, without damage, up to 50°C on an intermittent basis as well as in ambient (external climatic) temperatures of 0° C to 70°C, without any degradation in performance or accuracy.	
Weathering and ultraviolet light exposure: tested in accordance with ISO 4582 and ISO 4892-3.	
Electromagnetic compatibility (EMC) - tested in accordance with IEC 61000-4, all functions shall operate as designed after the following tests: Electromagnetic susceptibility (ISO 61000-4-3) in desert and coastal environments when exposed to an electromagnetic radiation test field strength of 10 V/m, digital electronic equipment shall operate as designed without interference or distortion of signals/displays. Bursts (ISO 61000-4-4) in desert and coastal environments when exposed to a voltage transient of 2kV for a repetition rate of between 2 and 100 kHz, digital electronic equipment shall operate as designed without interference or distortion of signals/displays.	
Pressure: - capable of withstanding test pressures of 1.5 times the specified maximum operating pressure	
Damp and dry heat: all functions shall operate as designed after exposure to damp and dry heat tests in accordance with IEC 600068.2.30 and IEC 600068.2.2 respectively for at least equivalent to similar desert and coastal conditions.	

Annex B: Flow Meter Installation

OVERVIEW

Even highly accurate flow meters can produce inaccurate flow data if they are not installed correctly. It is critical that the manufacturer's installation instructions supplied with the flow meter are followed exactly, and that flow meters are installed by suitably qualified and experienced personnel.

SOURCES OF MEASUREMENT ERRORS

Measurement errors associated with incorrect installation of a flow meter can result from:

- disruptions to the wastewater flow patterns or characteristics, and
- other external factors, as detailed over.

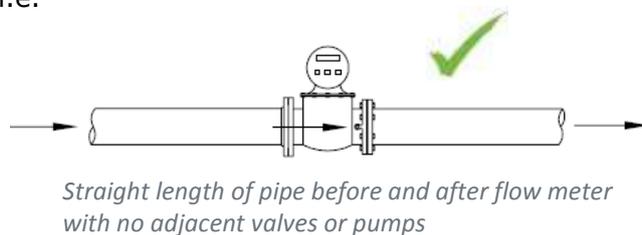
The installation instructions supplied with each flow meter will detail the specific requirements for that flow meter to avoid or minimise these errors.

The following sections overview some common installation problems, and methods to avoid them.

SWIRL EFFECTS

Installers must minimise swirl or other disruptions to the flow in pipework upstream and downstream of a flowmeter.

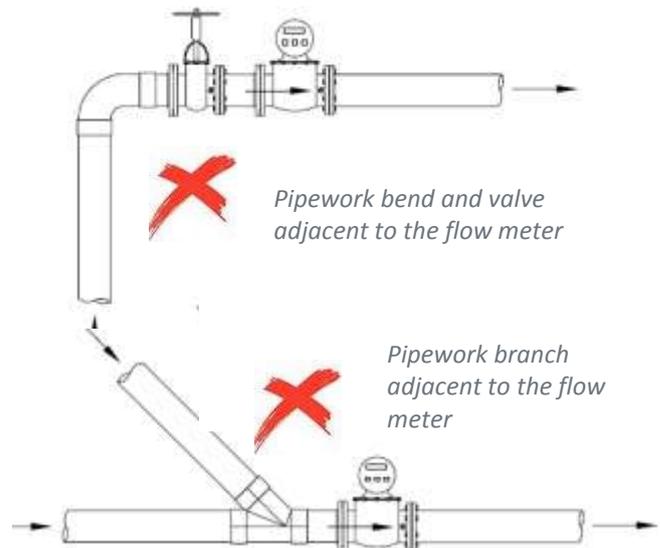
This can be achieved by providing straight lengths of pipe upstream and downstream of the flow meter (with length measurements conforming to manufacturers' instructions), i.e.



Installers must avoid the following piping arrangements near the flow meter:

- rapid changes in direction of piping runs associated with bends or tee-sections;
- valves, reducers and expanders; and
- multiple closely-spaced pipe fittings.

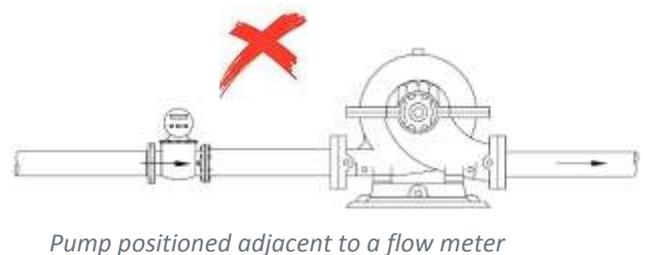
Examples of unsuitable arrangements are illustrated as follows:



PULSES AND SURGES

Pumps and some valve arrangements producing strong pulses and velocity surges in the flow pattern can disrupt flow patterns leading to flow meter measurement errors. Applying pumping and valve arrangements that support smooth flow patterns will minimise this potential error source.

Installing a flowmeter adjacent to a pump should also be avoided to prevent pressure impacts and potential damage to the lining of the measuring tube, i.e.



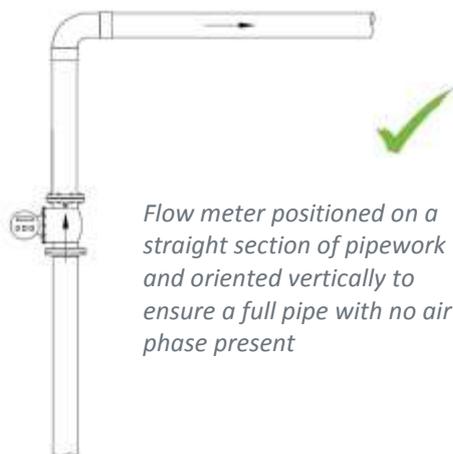
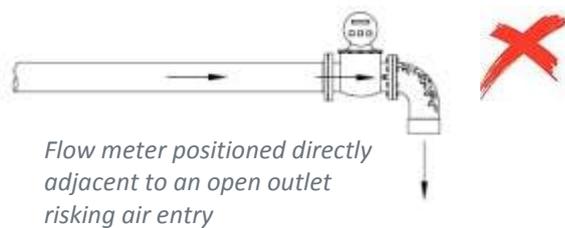
AIR PHASES AND AIR BUBBLES

Closed conduit flow meters are designed to function with full pipes. Partially filled pipes continuing air will result in significant flow measurement errors.

Where there is a risk of air moving through a flowmeter, pipework and pumping arrangements must be established to ensure full pipe conditions through the flow meter.

Air bubbles introduced to the wastewater stream can also produce flow measurement errors. As such, the meter should not be located directly upstream from an outlet or in another location that could result in bubbles entering the pipeline.

Where allowed by the manufacturer's specifications, fitting the flowmeter in a vertical orientation could be considered as a configuration to ensure a full pipe and avoid the entry of air bubbles into the flow meter's measuring tube, i.e.



Installing air release valves suitable for wastewater applications at any high points of pipework leading to the flow meter will also minimise air entering the wastewater flow profile.

SOLIDS EFFECTS

Flow meter measurement errors can also result from solids in wastewater depositing on electrodes or building up on pipe walls. Fitting the flow meter to the recycled water outlet of the treatment plant rather than the raw wastewater inlet can minimise the potential for the build-up of such deposits. Flow meter manufacturers' instructions may also include some preventative maintenance options to address solids deposition and build-up.

EXTERNAL FACTORS

The flow meter, data display and associated equipment needs to operate continuously without deterioration. As such, the installation and arrangements for the flow meter will need to ensure it is protected from:

- excessive temperatures and weather (including excessive temperature changes;
- direct sunlight and dust;
- vibration and shock;
- electrical interference; and
- unauthorised access or adjustments.

It is recommended that the flow meter should be enclosed in a protective housing or chamber to minimise the above effects.

If vibration and shock risks exist, consideration should also be given to installing suitable mounting arrangements on pipework sections adjacent to the flow meter.

POWER SUPPLY

Reliable power supply arrangements for the flow meter must be in place to prevent power interruptions to the flow meter and loss of data.

If connecting the flow meter directly to mains power is not feasible, the licensee will need to consider installing a battery-powered flow meter.

INSTALLATION PERSONNEL

Flow meters must be installed in strict accordance with the manufacturer's instructions by suitably qualified installation personnel.

The minimum capabilities considered suitable for personnel installing flow meters at small licensee sites are:

- the ability to read the language of the manufacturer's instructions that are supplied with the flow meter;
- possession of formal plumbing qualifications, or a person with more than 10 years' experience in installing or maintaining plumbing fittings and instrumentation.

Where Licensees do not have staff with these capabilities, the licensee shall make arrangements for the installation to be performed by a contractor or flow meter supplier personnel who possess these capabilities.

Annex C: Flow data collection and exchange

DATA COLLECTION

Licensees can collect flow data via manual readings of the flow meter by the wastewater treatment plant staff, collection of paper charts, or electronic data logging techniques.

An extract from the Bureau's *Recycled Water Quality Management Manual* template that licensees' can use to record daily flows with other daily operational monitoring data is presented below.

Template for Daily Log – WWTP Operational monitoring
(Note: this is an illustrative template only and a customised checklist needs to be developed to address the requirements of each individual wastewater system)

Date: _____

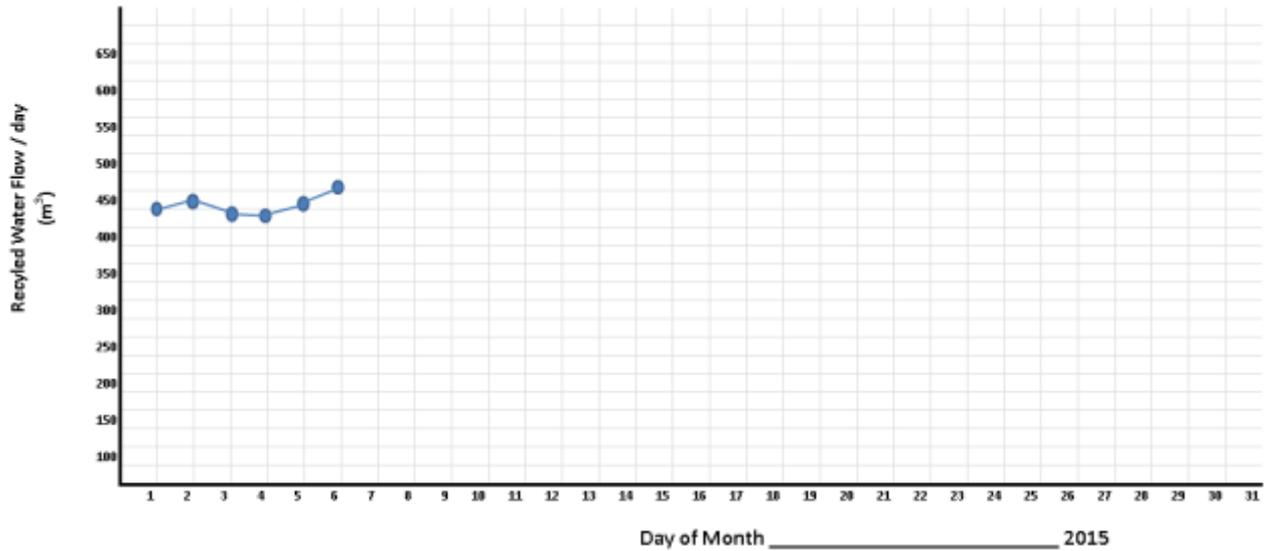
Operator name: _____

Parameter / sampling point / routine	Test results							
Dissolved Oxygen: Aeration tank (mg/l) <i>Sample 4 times/day</i>	Time	Result	Time	Result	Time	Result	Time	Result
Suitable remaining holding capacity in wastewater balancetank <i>Inspect 4 times/day</i>	Time	Result	Time	Result	Time	Result	Time	Result
Screens clear of blockages: <i>Inspect 4 times/day</i>	Time	Result	Time	Result	Time	Result	Time	Result
Turbidity: Recycled Water (NTU) <i>Sample 2 times/day</i>	Time	Result	Time	Result				
Residual chlorine: Recycled Water (mg/l) <i>Sample 2 times/day</i>	Time	Result	Time	Result				
pH: Bioreactor <i>Sample 2 times/day</i>	Time	Result	Time	Result				
Total flow (m³) <i>Flow meter reading - 1 time/day</i>	Time	Result						

DATA TRACKING AND REVIEW

A graph template that can be used by licensees to compile and track daily flows, and to identify any trends or events

suggesting problems with the flow meter or the other aspects of the wastewater management system is presented below.



Indications of problems could include:

- large variations in day-to-day flow values;
- constant flow values for extended periods where some flow variation would be expected; and
- development of a trend in the data indicating long-term drift caused by a slowly developing problem, such as fouling of the flow meter sensors.

off-line while a maintenance procedure is being performed.

In such situations, licensees will need to estimate the likely flows that occurred during these periods. Such estimates must be logical, such as basing the estimate on average flows measured for similar periods in the past.

DATA ESTIMATIONS AND REPORTING

Licensees may need to make flow data estimations or adjustments in some circumstances. For example, where a flow meter is temporarily not functioning due to a power supply problem or where the meter is

Licensees must include details in the submitted Annual Information Register of any estimations or adjustments made to the data to address any missing or faulty data. An example of recording such missing data and the associated data estimation technique applied is presented below.

Annual Information Register - Year 2013				
Month	Raw Wastewater Flow (m ³)	Recycled Water Produced (m ³)	Biosolids tankered off site (m ³)	Biosolids to Direct Use (m ³)
Jan	N/A	9,604.00	N/A	N/A
Feb	N/A	15,523.00	N/A	N/A
Mar	N/A	11,237.00	<div style="border: 1px solid black; padding: 5px;"> <p>Note: The flow meter was off-line from 1 July 2013 to 7 July 2014 due to piping repairs.</p> <p>The missing seven days flow data was estimated by calculating the average weekly flow from January - June 2013, and adding this weekly average to the July 2013 measured figure.</p> </div>	
Apr	N/A	8,264.00		
May	N/A	12,639.00		
Jun	N/A	9,658.00		
Jul	N/A	5,660.00		
Aug	N/A	7,885.00		
Sep	N/A	13,375.00		
Oct	N/A	14,405.00	182.00	N/A
Nov	N/A	13,698.00	136.50	N/A
Dec	N/A	9,217.00	364.00	N/A
Total per year	N/A	131,165.00	1,228.50	N/A