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1 PURPOSE

The purpose of this procedure is to:

- To verify the quality of worksmanship and materials used in the construction of Council infrastructure, demonstrating compliance with the Queenstown Lakes District Council (QLDC) Land Development and Subdivision Code of Practise, relevant AS/NZS standards, and industry best practice;
- For pressure pipes, provide confirmation that the pipeline is able to sustain a pressure greater than the design pressure without leakage;
- For non-pressure pipes and manholes, provide confirmation that the installation does not exceed allowable rates of infiltration/exfiltration;
- Provide confidence in the pipeline's structural integrity.

2 SCOPE

The scope of this procedure is to identify the appropriate test methodologies for different pipe and installation types for the purpose of confirming acceptability.

Disinfection protocols associated with water mains are covered in the QLDC Code of Practice Appendix D.

3 ROLES AND RESPONSIBILITIES

All contractors working on the Council network, or involved in the construction of infrastructure that will be vested to Council, must adhere to the requirements of the QLDC Land Development and Subdivision Code of Practice.

Only QLDC Approved Contractors shall undertake work on the network. Contractors shall ensure that appropriately trained and competent personnel are present to supervise all field testing activities.

Contractors shall be responsible for maintaining test equipment in good condition, and ensuring that any calibrations and safety certifications are current.

QLDC may audit the testing practices at their discretion to validate that the requirements of this document is being followed.

4 PIPELINE TESTING – NON-PRESSURE PIPES

Leakage testing is used to reveal locations of potential infiltration and exfiltration due to the inclusion of damaged pipes, seals, or incorrectly made joints in the pipeline at the completion of installation.

Leakage testing for acceptance of non-pressure pipelines shall be carried out by at least one of the following methods:

a) Low pressure air testing;
b) Hydrostatic testing

For pipeline test sections installed below the water table, and for submarine pipelines, the test pressure used for the hydrostatic test, and for the air test, shall be increased to maintain the required differential between internal and external pressure.

A pipeline failing to meet the requirements of the air tests may be retested using the hydrostatic test method.

4.1 LOW PRESSURE AIR TEST – PLASTIC PIPES

The test length shall be acceptable where the gauged pressure exceeds 18 kPa (or not more than 7 kPa less than the pressure at the start of the test) for the time interval shown in Table 1 after the shut-off of the air supply.

Table 1 is based on an air test pressure of 25 kPa (in excess of any external hydrostatic pressure due to groundwater) and, on this basis, air volume losses shall not exceed the greater of:

a) A rate of 0.0009 m3/(min x m2) of pipe wall area; and

b) A rate of 0.056 m3 /min, which is regarded as the lowest detectable individual air leak.

Column 2 and column 3 of Table 1 give the times and lengths up to which (b) prevails over (a).

In the case of concrete pipelines, it is recommended that pipelines be water soaked for a period of 24 hours prior to the air testing.

For safety reasons air test pressures in excess of 50 kPa should not be applied.

Table 1 Low pressure air and vacuum tests – Minimum time intervals for 7 kPa pressure change in pipline

DN	**Minimum time** (minutes)	**Maximum length for minimum time to apply** (metres)	**Test length** (metres)				
			50	**100**	**150**	**200**	**250**
			Minimum test duration (minutes)				
80	1.5	231	1.5	1.5	1.5	1.5	1.6
100	2	185	2	2	2	2	3
150	3	123	3	3	3	5	6
225	4	82	4	5	8	10	13
300	6	62	6	9	14	18	23
375	7	49	7	14	22	29	36
450	9	41	10	21	31	41	52
525	10	35	14	28	42	56	70
600	11	31	18	37	55	73	92
675	13	27	23	46	70	93	116
750	14	25	29	57	86	115	143
900	17	21	41	83	124	165	207
1000	19	19	51	102	153	204	255
1050	20	18.8	56	112	169	225	281
1200	23	15	73	147	220	294	367
1500	28	12	115	230	344	459	574

NOTE –

The time interval may be reduced for a proportionate reduction in the allowable pressure drop. Where there is no detectable change in pressure after 1 hour of testing, the section under test shall be deemed acceptable.

This table is based on the following equation:

$T = 1.02 D_i k L q$

where

T = time for a 7 kPa pressure drop, in seconds

D_i = pipeline internal diameter, in metres

q = allowable volume loss in cubic metre/minute/square metre taken as 0.0009 $m^3/min.m^2$

$k = 0.054 D_i L$ but not less than 1

L = length of test section, in metres.

Columns 2 and 3 have been calculated with $k = 1.0$.

The appropriate air or vacuum test/pressure method for pipes larger than DN 750 should be established by reference to the specifier.

4.1.1 Low Pressure Air Test Procedure

The procedure shall be as follows:

(a) Pump in air slowly until a pressure of 25 +5,−0 kPa is reached. Where the pipeline is below the water table this pressure shall be increased to achieve a differential pressure of 25 kPa. In no circumstances should the actual pressure exceed 50 kPa;

NOTE – Rapid pressurisation may cause significant air temperature changes, which will effect the testing accuracy.

(b) Maintain the pressure for at least 3.0 minutes;

(c) Where no leaks are detected, shut off the air supply;

(d) Where the pipeline fails the test, repressurise to 25 +5,−0 kPa and check for leaks by pouring a concentrated solution of soft soap and water over accessible joints and fittings;

(e) Repair any defects, then repeat steps (a) to (c);

(f) With the air supply shut off, monitor the pressure for the time intervals given in table 1. The test length shall be acceptable where the pressure drops by 7 kPa, or less, over the required (tabulated) test period.

NOTE

1. The test length of pipeline should be restricted to pipeline sections between maintenance holes (the most convenient places for inserting test plugs or fixing temporary bulkheads). The method should not be used for test lengths in excess of 250 m and for pipe diameters larger than 1500 mm.
2. The procedure for low pressure air testing of large diameter pipelines is potentially hazardous because of the very large forces to be resisted by temporary plugs or bulkheads and the serious consequences of accidental bulkhead blow-out. A relief valve, with a 50 kPa maximum setting, should be installed on all pressurising equipment.

4.2 LOW PRESSURE AIR TEST – CONCRETE PIPES

Concrete pipelines shall be tested in accordance with the CPAA Performance Testing of Non-Pressure Concrete Stormwater Pipes publication. The low-pressure air test can provide the criteria for acceptance of a pipeline but not for its rejection. The low-pressure air test shall be used for testing each pipe. If a length fails, the Contractor shall use a hydrostatic test. The following excerpts are from the CPAA publication.

The test is deemed acceptable where the gauged pressure drops from 10 kPa to 8 kPa in a time interval not exceeding that given in Table 22 after the shut-off of the air supply.

It is recommended that pipelines be water soaked for a period of 24 hours prior to the air testing.

Table 2 : Low pressure air tests minimum holding times at average 9 kPa pressure in pipeline (mins – secs)

DN	*Length of Test Section (metres)*									
	10	*20*	*30*	*40*	*50*	*60*	*70*	*80*	*90*	*100*
225	*0:11*	*0:22*	*0:33*	*0:44*	*0:55*	*1:06*	*1:17*	*1:28*	*1:38*	*1:41*
300	*0:19*	*0:39*	*0:58*	*1:18*	*1:37*	*1:57*	*2:14*	*2:14*	*2:14*	*2:14*
375	*0:31*	*1:01*	*1:31*	*2:02*	*2:32*	*2:50*	*2:50*	*2:50*	*3:12*	*3:33*
450	*0:44*	*1:28*	*2:11*	*2:55*	*3:22*	*3:22*	*3:22*	*4:06*	*4:36*	*5:07*
525	*1:00*	*1:59*	*2:59*	*3:55*	*3:55*	*4:11*	*4:53*	*5:34*	*6:16*	*6:58*
600	*1:18*	*2:35*	*3:53*	*4:29*	*4:29*	*5:28*	*6:22*	*7:17*	*8:11*	*9:06*

4.2.1 Low Pressure Air Test Procedure

The procedure shall be as follows:

(a) Pump in air slowly until a pressure just over 10 kPa is reached. Regulate the air supply to maintain pressure between 10 and 11 kPa, whilst check all plugs and fitting with soap solution to ensure there is no leakage. Where the pipeline is below the water table this pressure shall be increased to achieve a differential pressure of 10 kPa. In no circumstances should the actual pressure exceed 20 kPa;

NOTE – Rapid pressurisation may cause significant air temperature changes, which will affect the testing accuracy.

(b) Maintain the pressure for at least 15 minutes to allow air temperature to stabilise with the pipe walls;

(c) After stabilisation period, ensure pressure is at least 10 kPa before shutting off the air supply;

(d) Commence timing as pressure falls to 10kPa and measure time taken for pressure to drop by 2 kPa to 8 kPa;

(e) For the pipeline to pass, the time measured must be less than that given in Table 8 for the length and diameter of the pipe;

(f) Where the pipeline fails the test, either repeat after resoaking the pipe for 24 hours, or undertake a hydrostatic test instead.

NOTE

1. The method should not be used for test lengths exceeding 100 m and for pipe diameters larger than 600 mm.
2. The procedure for low pressure air testing of large diameter pipelines is potentially hazardous because of the very large forces to be resisted by temporary plugs or bulkheads and the serious consequences of accidental bulkhead blow-out. A hydrostatic test should be used instead.

4.3 HYDROSTATIC TEST

The test length shall be acceptable where the specified allowable make up water is not exceeded. Where not specified, the allowable make up water shall be 0.5 L/hour per metre length per metre diameter.

4.3.1 Hydrostatic Test Procedure

The procedure shall be as follows:

(a) The test pressure shall be not less than 20 kPa, or 20 kPa above the groundwater pressure at the pipe soffit at its highest point, whichever is the greater, and not exceed 60 kPa at the lowest point of the section;

(b) Steeply graded pipelines shall be tested in stages where the maximum pressure, as stated above, will be exceeded if the whole section is tested in one length;

(c) The pressure shall be maintained for at least 2 hours by adding measured volumes of water where necessary;

(d) Any visible leaks detected shall be repaired and the pipeline shall be retested.

5 PIPELINE TESTING – PRESSURE PIPES

Hydrostatic pressure testing requires selecting an appropriate configuration of method, pressure, and length of test section. Test parameters and details shall be determined with due consideration to the following:

(a) Pipe material;

(b) Pipe diameter;

(c) Length of test section;

(d) Duration of the test;

(e) Magnitude of test pressure and rate of pressurisation;

(f) Presence of air in the pipeline;

(g) Time required for saturation of porous liners;

(h) Potential movement of pipeline thrust restraints;

(i) Design pressure for thrust and anchor supports;

(j) Accuracy of test equipment;

(k) Ambient temperature changes during testing;

(l) Presence of leaks in equipment used for testing or equipment attachment points (such as sealing plugs);

(m) Potential for leaks in the pipeline.

NOTE – It is advisable to begin testing early in the pipeline installation to confirm adequacy of laying procedures and, where appropriate, to increase the length tested progressively as experience is gained.

5.1 GENERAL TEST REQUIREMENTS

5.1.1 Selection of Test Pressure

The hydrostatic test pressure at any point in the pipeline shall be:

(a) Not less than the design pressure; and

(b) Not more than 25% above the rated pressure of any pipeline component.

NOTE – The design pressure is the maximum system pressure at a point in the pipeline, considering future developments, static pressure, dynamic pressure, and an allowance for short-term surge pressure (water hammer), as determined by analysis.

Compressed air testing shall not be permitted for pressure pipe.

In general, QLDC require that pipes are tested to their rated capacity i.e. a PN16 pipe would be tested at 16 bar.

5.1.2 Selection of Test Length

The pipeline length tested shall be either the whole, or a section (capable of being isolated), of the pipeline depending on the length and diameter, the availability of water, and the spacing between sectioning valves or blank ends.

The pipeline shall be divided into test sections such that:

(a) The hydrostatic test pressure at any point in the pipeline is:

(i) Shall be 1.25 times the rated pressure and no more, but not less than the design pressure at the highest point where pipe is tested on a sloped installation; and

(ii) (ii) Not more than 25% above the rated pressure of any pipeline component;

(b) Test sections shall not exceed 1000m and shall be limited to pipe of the same material. Consideration shall be given to the pressure loading time at the maximum filling rate (see C2.2.3) in determining the test length; and

(c) Water is available for the test together with facilities for its disposal, in accordance with regulatory requirements, after the test.

NOTE –

1. Where long lengths are to be tested, radio or other electronic means of communication between test operatives, to coordinate test procedures and thus minimise the test duration, is desirable.
2. Long test sections may incorporate a large number of mechanical (that is, flanged) joints, which should be checked for leakage. The longer the test section the harder it is to locate a leak, or discriminate between a leak and the other effects, such as the absorption of air into solution under pressure.
3. QLDC recommends that test sections are as short as possible to reduce the efforts during fault finding should a test length fail to pass the test. Test lengths of 250m to 500m are typically considered as practical.

5.1.3 Pre-Test Procedures

The pre-test procedures are as follows:

(a) All required temporary and permanent thrust blocks, or other pipeline thrust resisting methods, including integral joint-restraint systems, shall be in place, and all concrete shall be adequately cured (normally a minimum of 7 days);

(b) Blank flanges or caps shall be installed at the beginning and end of the test section. Testing shall not take place against closed valves. Mechanical ends that are not end load resistant shall be temporarily strutted or anchored, to withstand the test pressures without movement;

NOTE – Temporary supports should not be removed until the pipeline has been depressurised. All test personnel should be informed of the loading limits on temporary fittings and supports.

(c) Where practicable, all bolted joints shall be left exposed to allow for retensioning during or after testing;

(d) Compacted embedment and fill material shall be placed to leave all joints, service connections and ball valves exposed wherever possible;

(e) For PE pipelines, the pressurising time shall not exceed 45 minutes;

NOTE – The pressurising time affects the duration of the PE pipeline test.

(f) The test equipment shall be placed in position and checked for satisfactory operation;

(g) The pump shall be of adequate size to raise and maintain the test pressure;

NOTE – A pump that is too small may increase the test duration or where too large it may be difficult to control the pressure.

(h) Two calibrated test gauges shall be used to cross check gauge accuracy;

(i) Slowly fill the test length of pipeline with water, preferably from the lowest point, ensuring air is vented at the high point valves. Allow a period, in the range of minimum 3 hours to 24 hours (preferred), for the temperature of the test length and the test water to stabilise and for dissolved air to exit the system. The recommended rate of filling shall be based on a flow velocity of 0.05 m/s, calculated from the following equation:

$$Qf \leq 12.5\pi D2$$

where

Qf = filling rate, in litres per second

D = pipe diameter, in metres

NOTE – The slow rate of 0.05 m/s avoids air entrainment when the filling water is cascading through downward gradients along the pipeline.

The period of stabilisation will depend on pipe dimensions, length, material, longitudinal profile, and air exit points. For cement-mortar lined pipe, the pipeline shall be filled at least 24 hours before the commencement of the test, to allow the lining to become saturated.

NOTE – A firm foam swab may be used ahead of the fill water to assist air removal especially where the pipeline undulates. Extract the swab at a high-point wash-out.

Typical pressure test equipment and location are shown in figures 1 and 2.

5.1.4 Post Test Procedures

After testing, pipelines shall be depressurised slowly. All air venting facilities shall be open when emptying pipelines. The test water shall be drained to an approved waterway and all connection points shall be reinstated.

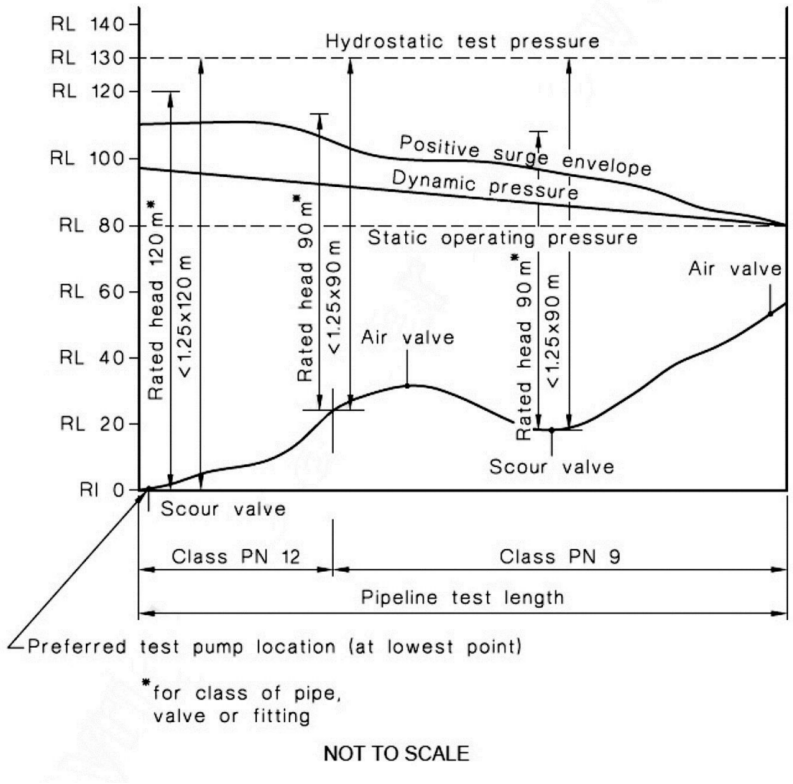

Figure 1 Typical pressure pipeline under typical field test

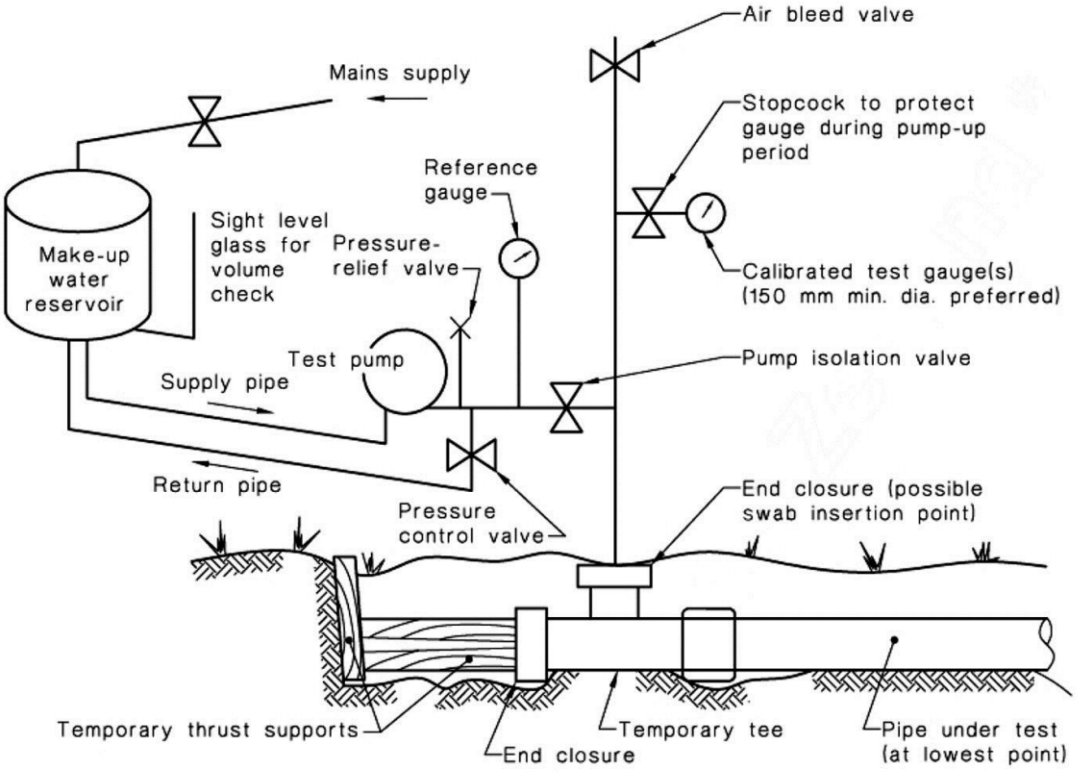

Figure 2 Typical field pressure test equipment layout

A pressure log of the test, recorded at 5 second intervals (or less), must be submitted in .xls or .csv format with the test report.

5.2 CONSTANT PRESSURE TEST (WATER LOSS METHOD) – NON-VISCOELASTIC PIPELINES

This test is applicable for PVC, DI, GRP, and steel pipelines.

5.2.1 Procedure

The procedure shall be as follows:

(a) Close all valves apart from the test pump input and pressurise the test length to the specified test pressure (STP) – (see 5.1.1);

(b) Apply and then maintain the test pressure by the addition of measured and recorded quantities of make-up water at regular intervals over a period, in the range of 1 hour to 12 hours. Note, that after the test section has been filled with water, it is often necessary to use a hand pump to complete the test as a motorised test pump can prove to be difficult to control when testing short lengths of relatively small diameter pipeline ;

(c) Where pressure measurements are not made at the lowest part of the test length, make an allowance for the static head, between the lowest point of the pipeline and the point of measurement,

The quantity of make-up water necessary to maintain the test pressure shall comply with the following equation:

$Q \leq 0.14LDH$

where

Q = allowable make-up water, in litres per hour

L = length of the test length, in kilometres

D = nominal diameter of the test length, in metres

H = average test head over length of pipeline under test, in metres

NOTE – The make-up water is not a leakage allowance, but is an allowance to cover the effects of the test head forcing small quantities of entrapped air into solution. Normally the test should last for a minimum of 2 hours and be concluded within 5 to 8 hours. The make-up water requirement should reduce with time as air goes into solution. Where, after 12 hours the make-up water still exceeds the allowable limit, testing should cease and the cause of loss investigated.

5.2.2 Acceptance

The test length shall be acceptable where:

(a) There is no failure of any thrust block, pipe, fitting, joint, or any other pipeline component;

(b) There is no physical leakage;

(c) The quantity of make-up water necessary to maintain the test pressure complies with 5.2.1.

5.3 CONSTANT PRESSURE TEST (WATER LOSS METHOD) – VISCOELASTIC PIPELINES

This test is applicable to PE, PP, and ABS pressure pipelines. The test lengths may be several kilometres in length.

NOTE - This method is based on VAV P78, as outlined in AS/NZS 2566.2, Appendix A.

5.3.1 Procedure

The procedure shall be as follows:

(a) Purge the air from pipeline;

(b) Apply the specified test pressure (STP) (see C3.1) to the test length;

(c) Shut off main and allow pressure to settle for 12 hours (pressure will drop significantly);

(d) Re-apply and maintain test pressure for 5 hours by successively pumping a sufficient amount of water;

(e) Measure and record water volume (V1 in litres) required to maintain this pressure between Hour 2 and Hour 3;

(f) Measure and record water volume (V2 in litres) required to maintain this pressure between Hour 4 and Hour 5;

(g) Calculate:

$$0.55V1 + Q$$

where

Q is the allowable make-up volume obtained from 5.2.1.

5.3.2 Acceptance

The test length shall be acceptable where:

(a) The test length shall be acceptable where there is no failure of any thrust block, pipe, fitting, joint, or any other pipeline component;

(b) There is no physical leakage; and

(c) $V2 \leq 0.55\ V1 + Q$

5.4 PRESSURE REBOUND TEST (PE PIPES UP TO DN315)

This test is applicable to PE, PP, and ABS pressure pipelines up to and including DN315, where a short test time is required.

NOTE – This test is based on BS EN 805:2000, Appendix A (refer to AS/NZS 2566.2).

5.4.1 Pressure Measurement Rig

The test rig shall be a recently calibrated pressure transducer, data logger, and check pressure gauge that has a dial of at least 100 mm diameter and a pressure range that places the specified test pressure (STP) (see 5.1.1) in the range 35% to 70% of the gauge's full scale. The transducer and the check gauge shall read within ±5% of each other. If they do not agree within this tolerance, the equipment shall be recalibrated or replaced.

5.4.2 Procedure

The test procedure has the following three phases:

(a) A preliminary phase in which the pipeline is —

(i) Depressurised and allowed to relax after the C3.3 pre-test procedure

(ii) Pressurised quickly to the test pressure and maintained at this pressure for a period of time without further water being added

(iii) The pressure is allowed to decay by viscoelastic creep, and

(iv) Provided the pressure drop does not exceed a specified maximum, the pressure test can proceed to the second phase;

(b) A phase in which the volume of air remaining in the pipeline is assessed against an allowable maximum;

(c) The main test phase in which the pipeline is maintained at the test pressure for a period of time and decay due to viscoelastic creep commenced. The creep is interrupted by a rapid reduction of the pressure in the pipeline to a specified level. This rapid reduction in pressure results in contraction of the pipeline with an increase (rebound) in pressure. If, during the rebound period, the pressure versus time record shows a fall in pressure, the pipeline fails the test.

5.4.3 Preliminary Phase

The procedure shall be as follows:

(a) Reduce pressure to just above atmospheric at the highest point of the test length, and let stand for 60 minutes. Ensure no air enters the line;

(b) Raise the pressure smoothly to STP in less than 10 minutes. Hold the pressure at STP for 30 minutes by pumping continuously, or at short intervals as needed. Do not exceed STP;

(c) Inspect for leaks during the 30 minute period, then shut off pressure;

(d) Allow the pressure to decay for 60 minutes;

(e) Measure the pressure remaining at 60 minutes (P60);

(f) If P60 ≤ 70% of STP the test is failed. The cause shall be located and rectified. Steps (a) to (e) shall be repeated. If P60 > 70% of STP, proceed to the air volume assessment.

5.4.4 Air Volume Assessment

The procedure shall be as follows:

(a) Quickly (<5 mins) reduce pressure by ΔP (10% - 15% of STP)

(b) Measure water volume bled out (ΔV)

(c) Calculate $\Delta V_{max\ allowable}$ as follows:

$$\Delta V_{max\ allowable} = 1.2 \times V \times \Delta P(1/E_W + D/eE_R)$$

where

1.2	=	air allowance
V	=	pipe volume, in litres
ΔP	=	measured pressure drop, in kilopascals
D	=	pipe internal diameter, in metres
E_R	=	pipe material modulus, in kilopascals (see table 2)
E_W	=	bulk modulus of water, in kilopascals (se table 3)
e	=	pipe wall thickness, in metres

(d) If ΔV > ΔVmax allowable the test has failed. The cause shall be located and rectified. The preliminary phase shall be repeated. If ΔV ≤ ΔVmax allowable, proceed to the main test phase.

NOTE – ΔV and ΔP should be measured as accurately as possible, especially where the test length volume is small.

5.4.5 Main Test Phase

Observe and record the pressure rise for 30 minutes.

In the event of failure, locate and repair leaks. If failure is marginal or doubtful, or if it is necessary to determine leakage rate, use a reference test (see 5.3).

NOTE – Figure 3 gives an example of a full pressure test with the main test phase extended to 90 minutes

Table 3 Pipe E material modulus for PE 80B and PE 100

Temp (°C)	**PE 80B – *E* Modulus** (kPa×10³)			**PE 100 – *E* Modulus** (kPa×10³)		
	1 h	**2 h**	**3 h**	**1 h**	**2 h**	**3 h**
5	740	700	680	990	930	900
10	670	630	610	900	850	820
15	600	570	550	820	780	750
20	550	520	510	750	710	680
25	510	490	470	690	650	630
30	470	450	430	640	610	600

Table 4 Bulk modulus E_w – Water

Temperature (°C)	**Bulk Modulus** (kPa×10^3)
5	2080
10	2110
15	2140
20	2170
25	2210
30	2230

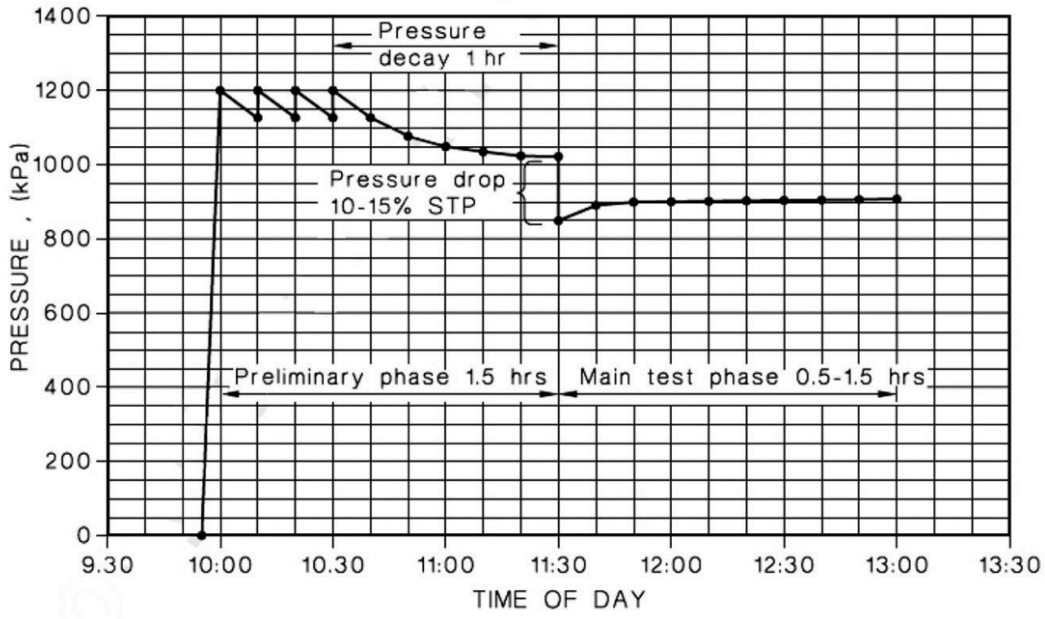

Figure 3 Typical successful modified rebound test for a PE pipeline

5.4.6 Acceptance

The test length shall be acceptable if:

(a) There is no failure of any thrust block, pipe, fitting, joint, or any other pipeline component;

(b) There is no physical leakage;

(c) The pressure rises or remains static in the 30-minute period. If doubt exists about the pressure recovery, the monitoring period may be increased to 90 minutes, and any pressure drop that does occur shall not exceed 20 kPa over the 90-minute period.

If the pressure drops by more than 20 kPa during the 90-minute extended period, the test fails.

Repetition of the main test phase shall only be done by carrying out the whole test procedure, including the relaxation period of 60 minutes described in 5.4.3.

5.5 VISUAL TEST FOR SMALL DIAMETER PRESSURE PIPELINES

This test is applicable for small pipelines of all materials (less than 200 m in length), and pipelines where pipeline joints have been left exposed for the test operation (such as coiled pipe).

5.5.1 Procedure

The procedure shall be as follows:

(a) The test pressure (see 5.1.1) shall be applied and the test section isolated by closing the high point air release valves and the pump feed valve;

(b) The test section shall be visually inspected for leakage at all joints, especially bolted joints, all fittings, service connections, and ball valves;

(c) Pressure gauges shall be checked to ensure that pressure has not fallen significantly indicating an undetected leak;

(d) Any detected leak shall be repaired and the section shall be retested;

(e) Where no leak is detected, high point air release valves shall be opened, the pipeline shall be depressurised to slowly drain the line into an approved waterway and all connection points shall be reinstated.

5.5.2 Acceptance

The test length shall be acceptable where:

(a) There is no failure of any thrust block, pipe, fitting, joint, or any other pipeline component;

(b) There is no physical leakage; and

(c) There is no pressure loss indicative of a leak.

6 MANHOLE TESTING

The type of test shall be selected according to the performance requirement of the system, the type of installation methodology, ground conditions and Health and Safety risk factors associated with the installation. All manhole tests shall include 300mm of the connecting pipework with the lid fitted into place.

6.1 HYDROSTATIC TEST (CONCRETE MANHOLES)

This test may be used for manholes up to 3.5m depth and relies on obtaining a proper seal from the pipeline plugs to withstand the hydrostatic pressure. The limitation on this test is the non-uniform pressure distribution and the low pressure at the top of the manhole will not sufficiently test the top seal of the lid. To test the top seal this test shall be supplemented with the visual check (smoke test) in section 6.4 or the low pressure air test as per section 6.2. The manhole shall be completely backfilled and interconnected pipework and manholes be vacated before starting the test.

6.1.1 Procedure

Ensure that there is no entry into the connecting trench or any connected manhole associated with the manhole being tested. The manhole shall not be pressurised beyond the static pressure alone and the lid shall remain open.

The procedure shall be as follows:

(a) Seal openings using properly sized or inflatable plugs;

(b) Completely fill the manhole to the top of the lid frame with water;

(c) Allow the filled manhole to soak for minimum 4 hours;

(d) Top up any water loss to the top of the lid frame during the soak period;

(e) Measure the water loss over every 1 hour for 8 hours;

(f) Empty the manhole and allow to stand for 1 hour before completing a visual inspection for groundwater infiltration.

6.1.2 Acceptance

The test shall be acceptable where:

(a) The average quantity of make-up shall not be more than 0.3 litres per 1m diameter per 1m depth per hour, and;

(b) The post-test visual inspection shall show no evidence of groundwater ingress through any joint.

6.2 VACUUM TEST

The vacuum test creates differential pressure between the inside and outside of the manhole. This test shall be completed with the manhole completely backfilled and the lid in place.

6.2.1 Procedure

The procedure shall be as follows:

(a) Clean manhole thoroughly;

(b) Seal openings using properly sized or inflatable plugs;

(c) Connect seal plate to manhole opening;

(d) Draw vacuum of -254mmHg (or -338.6mbar) and isolate valves;

(e) Hold test time according to the manhole sizes as listed in the table below:

Table 5 Manhole Test Duration Requirements

Depth (m)	Diameter (mm)								
	675	900	1050	1200	1300	1500	1800	2400	3000
	Time (s)								
<2	11	14	17	20	23	26	33	39	45
3	14	18	21	25	29	33	41	49	57
3.5	17	21	25	30	35	39	49	59	69
4.3	20	25	30	35	41	46	57	69	81
5	22	29	34	40	46	52	67	81	95
5.5	25	32	38	45	52	59	73	87	101
6	28	35	42	50	53	65	81	97	113
6.7	31	39	46	55	64	72	89	107	125
7.3	33	42	51	59	68	78	97	115	133
8	36	46	55	64	75	85	105	125	145
8.5	39	49	59	69	81	91	113	135	157
9	42	53	63	74	87	98	121	145	169
9.5	46	58	69	81	94	105	129	153	177
10	49	63	74	87	98	113	139	165	191

(f) Release the vacuum and remove the test gear and plugs

6.2.2 Acceptance

The test shall be acceptable where:

(a) For the duration of the test the vacuum did not drop below -228mmHg (or - 304mbar).

(b) There are no visible wet patches or “sweating” at any of the pipe penetrations, seals, or riser joints.

6.3 INFILTRATION TEST (CONCRETE MANHOLES)

This test is completed by creating an external water column around the manhole to that will force groundwater through any leaking joints. This method is recommended where manholes are over 3.5m deep or can only be part tested using the hydrostatic testing method up to 3.5m depth. However, the limitation on part testing to 3.5m is that the hydrostatic pressure shall be demonstrated to be higher than the groundwater pressure at the location of the joints being tested. The vacuum test procedure is preferred over this option.

This test does not confirm the lid seal and shall be supplemented with the visual check (smoke test) in section 6.4 or the low pressure air test as per section 6.2.

6.3.1 Procedure

The procedure shall be as follows:

(a) Excavate or provide a moat of approximately 500mm around the circumference of the manhole and fill with water;

(b) A 32mm PVC sleeve is provided adjacent to the manhole wall to 1 m below the hydrostatic test depth. The bottom 1m of the sleeve shall be perforated to allow groundwater to enter the sleeve;

(c) The water in the moat is filled until the groundwater in the sleeve reaches the level of the water in the moat;

(d) The groundwater level is maintained for eight (8) hours.

6.3.2 Acceptance

The test shall be acceptable where:

(a) There are no visible leaks, wet patches or “sweating” at any of the pipe penetrations, seals or riser joints.

6.4 VISUAL CHECK/SMOKE TEST (CONCRETE MANHOLES)

This test shall only be conducted on manholes where the joints and pipe penetrations being tested have not been backfilled over and are visible for inspection of forced smoke leaking through defective seals. The limitation of this test is to manholes that are not located within a 100 year flood plain level and is ideally suited for low risk shallow manholes.

6.4.1 Procedure

The procedure shall be as follows:

(a) Seal openings using properly sized or inflatable plugs;

(b) Connect seal plate to opening of manhole lid with appropriate connection to introduce the smoke;

(c) Introduce smoke into manhole being tested according to the manufacturer’s recommendation;

(d) The smoke shall be introduced for a minimum of 5 minutes;

(e) Inspect joints for smoke leaks.

6.4.2 Acceptance

The test shall be acceptable where:

(a) There is no smoke leaking from any of the joints

6.5 PLASTIC/GRP MANHOLE TESTING

Manholes shall be tested twice:

1. Off-site as a single unit at the manufacturer's facilities according to industry best practice for the material being used; and
2. On installation on site, fully backfilled and connected, and tested per the vacuum test described in section 6.2.

Records associated with the off-site test shall be provided to the QLDC.

7 PROCESS OUTPUTS

Completed test records sheet, in accordance with the attached templates, shall be provided to QLDC for each field test completed.

APPENDIX 1 – LOW PRESSURE AIR TEST (NON PRESSURE PIPE)

GENERAL INFORMATION			
Contract No. or Resource Consent No.			
Contractor			
Site Supervisor			
Site Location			
Date & Time			
Pipe ID		**Pipe Diameter**	
Pipe Material & Class		**Pipe Length**	

TEST RESULTS	
Parameter	**Result**
Minimum Duration (from Table 1)	
Test Duration (mins)	
Pressure at Start of Test (kPa)	
Pressure at End of Test (kPa)	
Calculate Pressure Drop ΔP (kPa)	
Acceptance Criteria	**Pass (Y/N)**
Pass Criteria - ΔP < 7kPa	
Visual Inspection	

Signed on behalf of Contractor:

Signed on behalf of QLDC:

Print Name: _____

Print Name: _____

APPENDIX 2 – HYDROSTATIC TEST (NON PRESSURE PIPE)

GENERAL INFORMATION			
Contract No. or Resource Consent No.			
Contractor			
Site Supervisor			
Site Location			
Date & Time			
Pipe ID		**Pipe Diameter**	
Pipe Material & Class		**Pipe Length**	

TEST RESULTS	
Parameter	**Result**
Test Duration (mins)	
Test Pressure (kPa)	
Volume of Make Up Water (l)	
Make Up Water Rate (l/hr)	
Specify Allowable Make Up Rate	
Acceptance Criteria	**Pass (Y/N)**
Allowable Make Up Rate > Measure Make Up Rate	
Visual Inspection	

Signed on behalf of Contractor:

Signed on behalf of QLDC:

Print Name: _____

Print Name: _____

APPENDIX 3 – CONSTANT PRESSURE TEST (NON VISCOELASTIC PRESSURE PIPE)

GENERAL INFORMATION			
Contract No. or Resource Consent No.			
Contractor			
Site Supervisor			
Site Location			
Date & Time			
Pipe ID		**Pipe Diameter**	
Pipe Material & Class		**Pipe Length**	

TEST RESULTS	
Parameter	**Result**
Test Duration (mins)	
Test Pressure (kPa)	
Volume of Make Up Water (l)	
Make Up Water Rate (l/hr)	
Calculate Allowable Make Up Rate Q ≤0.4LDH	
Acceptance Criteria	**Pass (Y/N)**
Allowable Make Up Rate > Measured Make Up Rate	
Visual Inspection	

Signed on behalf of Contractor:

Print Name: _____

Signed on behalf of QLDC:

Print Name: _____

APPENDIX 4 – CONSTANT PRESSURE TEST (VISCOELASTIC PRESSURE PIPE)

GENERAL INFORMATION			
Contract No. or Resource Consent No.			
Contractor			
Site Supervisor			
Site Location			
Date & Time			
Pipe ID		**Pipe Diameter**	
Pipe Material & Class		**Pipe Length**	

TEST RESULTS	
Parameter	**Result**
Test Pressure (kPa)	
Pressure after 12 hrs (kPa)	
Volume of Make Up Water (l) **V1 (between hours 2 & 3)**	
V2 (between hours 4 & 5)	
Allowable Make Up Rate (Q = 0.4LDH)	
Calculate 0.55 V1 + Q	
Acceptance Criteria	**Pass (Y/N)**
Pass Criteria V2 ≤ 0.55 V1 + Q	
Visual Inspection	

Signed on behalf of Contractor:

Signed on behalf of QLDC:

Print Name: _____

Print Name: _____

APPENDIX 5 – PRESSURE REBOUND TEST (PE PIPES UP TO DN315)

GENERAL INFORMATION			
Contract No. or Resource Consent No.			
Contractor			
Site Supervisor			
Site Location			
Date & Time			
Pipe ID		Pipe Diameter	
Pipe Material & Class		Pipe Length	

TEST RESULTS – PRELIMINARY PHASE	
Parameter	**Result**
Test Pressure (kPa)	
Pressure after 60 mins decay (kPa)	
Acceptance Criteria	**Pass (Y/N)**
Pass Criteria - P60 > 70% of STP	
Visual Inspection	

TEST RESULTS – AIR VOLUME ASSESSMENT	
Parameter	**Result**
Record volume of water bled out (ΔV)	
Calculate: $\Delta V_{max\ allowable} = 1.2 \times V \times \Delta P\ (1/E_W + D/E_R)$	
Acceptance Criteria	**Pass (Y/N)**
Pass Criteria - $\Delta V \leq \Delta V_{max}$	

TEST RESULTS – MAIN TEST PHASE	
Parameter	**Result**
Record pressure at start of test phase (kPa)	
Pressure after 60 mins decay (kPa)	
Acceptance Criteria	**Pass (Y/N)**
Pass Criteria – Pressure rises or remains static*	

* If doubt exists about the pressure recovery, the monitoring period may be increased to 90 minutes, and any pressure drop that does occur shall not exceed 20 kPa over the 90-minute period.

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Signed on behalf of Contractor:

Signed on behalf of QLDC:

Print Name: _____

Print Name: _____

APPENDIX 6 – MANHOLE HYDROSTATIC TEST

GENERAL INFORMATION			
Contract No. or Resource Consent No.			
Contractor			
Site Supervisor			
Site Location			
Date & Time		**MH Diameter**	
Manhole ID		**MH Material**	

TEST RESULTS								
Parameter	**Hour 1**	**Hour 2**	**Hour 3**	**Hour 3**	**Hour 4**	**Hour 5**	**Hour 6**	**Hour 7**
Volume of water added (l) to maintain level								
Acceptance Criteria	**Pass (Y/N)**							
Pass Criteria - 0.3 litres per 1m diameter per 1m depth per hour								
Visual Inspection								

Signed on behalf of Contractor:

Signed on behalf of QLDC:

Print Name: _____

Print Name: _____

APPENDIX 7 – MANHOLE VACUUM TEST

GENERAL INFORMATION			
Contract No. or Resource Consent No.			
Contractor			
Site Supervisor			
Site Location			
Date & Time		**MH Diameter**	
Manhole ID		**MH Material**	
TEST RESULTS			
Parameter	**Result**		
Pressure at start of test (mbar)			
Test duration (refer Table 4)			
Pressure at end of test period (mbar)			
Acceptance Criteria	**Pass (Y/N)**		
Pass Criteria – Pressure at end of test < -304mbar			
Visual Inspection			

Signed on behalf of Contractor:

Signed on behalf of QLDC:

Print Name: _____

Print Name: _____

APPENDIX 8 – MANHOLE INFILTRATION AND VISUAL TEST

GENERAL INFORMATION			
Contract No. or Resource Consent No.			
Contractor			
Site Supervisor			
Site Location			
Date & Time		**MH Diameter**	
Manhole ID		**MH Material**	
TEST RESULTS			
Acceptance Criteria	**Pass (Y/N)**		
Visual Inspection			

Signed on behalf of Contractor:

Print Name: _____

Signed on behalf of QLDC:

Print Name: _____