PUB(WSN) REQUIREMENTS

REQUIREMENTS TO BE COMPLIED BY LTA/CONTRACTOR FOR CARRYING OUT DIVERSION OF WATER MAINS AFFECTED BY MRT WORKS

1 Design of pipelines for main diversions and supports for existing water mains

1.1 The design of the water mains and appurtenances including washouts, air valves, isolating valves, hydrants and any other connections to the water mains, for temporary or permanent diversions shall be done by a Professional Engineer (PE) who has the relevant experience in the design and construction of water pipelines and submitted to Director, Water Supply (Network) Department, PUB (WSN, PUB) for approval. The submission shall include:

(i) Site plan showing the proposed alignment of the diverted pipeline including the size and material of the proposed pipes and appurtenances as well as the alignment of existing services in relation the proposed pipeline alignment;

(ii) Longitudinal sections of the proposed mains showing the design level of the main; location of air valve, washout and isolating valve as well as the position of the existing services in relation to the proposed pipeline;

(iii) Details of valve chambers, fire hydrants, thrust blocks, etc including plans and cross-sections; and

(iv) Programme of diversion work commencing from start of site work till handing over of mains to PUB.

1.2 In general, all water mains are to be diverted out of MRT worksites and where it is not possible, the Contractor shall provide adequate supports, restraints and protection to ensure that the existing mains are safe and secured. The temporary supports, restraints and protections must be designed and endorsed by a PE, who has the relevant experience in the design and construction of water pipelines and submitted to WSN, PUB for approval.

1.3 WSN, PUB reserves the right to require the PE to make necessary changes to the design and construction of the pipeline to comply with PUB's requirements.

2 Procedures for Pipe laying Work

2.1 After approval to the proposal has been given by WSN, PUB, the water mains and appurtenances are to be installed by a pipe laying contractor registered with BCA under Workheads of CR07 (Pipe Laying and Reinstatement) under the supervision of a PE.

22 PE shall submit the following:

(i) List of Pipes and Appurtenances – Appendix 1

This list has to be approved prior to the next stage ie Notification to Commence Work.

(ii) Notification To Commence Work – Appendix 2

At least 14 days before physical work at site.

(iii) Request for PUB to Witness Pressure Testing – Appendix 3

At least 14 days in advance of appointment.

(iv) Request for PUB To Collect Water Samples – Appendix 4

At least 14 days in advance of appointment.

(v) Request to Carry Out Link Up to Existing PUB Water mains – Appendix 5

At least 1 month or period as stipulated in PUB's approval under Clause 1.3 above, in advance of appointment.

(vi) Request for Handing Over of Mains to PUB for Operation and Maintenance – Appendix 6

At least 14 days in advance of appointment. The contractor shall be liable for any defect within one year from the date of handing over of water mains to PUB.

(Note: PUB will endeavor to meet appointment dates but will not be held responsible whatsoever in the event the dates cannot be met and changes to the dates are deem necessary by PUB)

23 The PE shall submit weekly progress reports which shall include the following:

(i) Reports of progress at sites including the laying of new pipes and appurtenances indicated on plan;

(ii) Photographs showing pipe laying in progress and photograph of each completed joints before and after internal and external protection of the joints (photographs are to be taken for all pipes before they are buried); and

(iii) Any activity in the vicinity of the existing pipes which may cause damage to the pipe.

24 Documentation and Records of Pipe laying

The following records of the pipe laying are required and to be kept and submitted as directed by PUB:

(i) As built drawings including plan and longitudinal section of the pipeline showing the alignment, level, dimensions and position of pipes and appurtenances in coordinates including reduce levels ~~of~~ hydrants. The drawings must be prepared in digital format using Microstation or Auto CAD and in accordance to SLA SVY 21 coordinate system endorsed by a registered surveyor;

(ii) Air test and Magnetic Particle Inspection (MPI) records for welded joints, where applicable;

(iii) Internal lining and external wrapping inspection and test records;

(iv) CCTV inspection and video recordings for cleanliness of 700 mm dia and above pipes; and

(v) Daily reports of pipe laying works

25 **In general, water pipes are to be laid with at least 1 meter cover.** There should also be a minimum clearance of 1 meter from other services all round (other services or structure) and in no case other services should overlay the water mains. **In the event that these cannot be met, the Contractor or his PE is required to consult PUB and obtain PUB's permission before the pipe laying work.**

26 The Contractor shall allow PUB officers to gain access to the pipe laying site at any time to check the pipe laying work.

3 Standards for Pipes and Appurtenances

31 All water fittings such as valves, pipes, pipe fittings, etc. for use in potable water service installations in Singapore shall comply with the standards and requirements stipulated by PUB and conform to the Public Utilities (Water Supply) Regulations and Singapore Standard CP48: Code of Practice for Water Services.

32 A water fitting shall be deemed to comply with the stipulated standards if it is certified or tested as complying with such standards by a conformity assessment body (product certification body/testing laboratory) accredited by the Singapore Accreditation Council (SAC) or its Mutual Recognition Arrangement (MRA) partners. Separate approval from PUB for the water fitting is not required. However, fittings must be supported with valid, complete and full test reports and certificates.

3.3 If standards and requirements for a water fitting are not stipulated, the installer shall approach PUB to stipulate the necessary standards and requirements for compliance.

3.4 All pipes and appurtenances used shall comply with the standards as given in Appendix 6.

4 PUB's Involvement

4.1 Witness for pressure testing

Prior to the date of appointment with PUB, PE/pipe laying contractor shall carry out charging and flushing of the newly laid pipes to ensure that the water main is clean. For pipes of 700 mm dia and above, a video recording confirming the cleanliness of the pipe shall also be carried out. Likewise, for pressure testing, PE/pipe laying contractor should carry out his own checks and rectification works to meet the test pressure of 10 bar prior to the appointment day with PUB. Please see details of procedures of pressure testing in Appendix 7 - Commissioning of Newly Laid Pipes. The PE/pipe laying contractor is responsible to provide their own source of water supply for flushing and pressure testing.

On the appointment date with PUB, PE/pipe laying contractor is to provide the necessary manpower to carry out the necessary works eg operation of valves to facilitate PUB officers to witness the flushing and pressure testing. The flushing and pressure testing are to be carried to the satisfaction of PUB. The pipe laying contractor must be present during the test. If pressure test fails, the PE/pipe laying contractor is to carry out the necessary rectification and re-arrange with PUB for another appointment.

4.2 Collection of Water Sample

PE/pipe laying contractor shall carry out disinfection/sterilization of the newly laid pipes in accordance with the procedures given in Appendix 7 – Commissioning of Newly Laid Pipes. On the appointment date with PUB, PE/pipe laying contractor is to provide the necessary manpower to carry out the necessary works eg operation of valves to facilitate PUB officers to collect the water samples as described in Appendix 7.

4.3 Link Up to Existing PUB Water mains

Prior to the link up, PUB officers will arrange with PE/pipe laying contractor to walk through the entire length of the newly laid pipes to ensure all valves and appurtenances are accessible and operational. As built drawings indicating the valves and appurtenances are to be submitted by this stage. The PE/LP is required to carry out any rectification work as deemed necessary by PUB to ensure the operational readiness of the valves and appurtenances to facilitate the link up.

The PE/LP shall prepare the link up site by completing as much as possible any pipe work and also the exposure of the existing PUB water mains prior to the link up day. The PE/pipe laying contractor is required to carry out trial holes to locate the positions of existing water mains. PUB will check to ensure the preparation works are adequate and if required by PUB, PE/pipe laying contractor may be required to carry out any other additional preparation work for the link up.

On the link up day, PUB officers will carry out necessary valve operations on PUB water mains and PE/pipe laying contractor shall be responsible for any valve operations, if required, on their newly laid pipes. PUB will inform the PE/pipe laying contractor when the shutdown and dewatering are completed so that the pipe laying contractor may proceed with the cutting and linking up of PUB water mains under the instructions of PUB officers. Notwithstanding PUB's officers' presence, PE/pipe laying contractor is responsible for the link up work and to ensure that sufficient labour, plant and materials are available on site for continuous work until the link up work are completed.

On completion of the link up work, the pipe laying contractor is also responsible for the proper capping of the ends of the abandoned water mains as directed by PUB officers.

Upon completion of the link-up, the newly laid-up mains will be part of PUB's water mains network. Therefore, only PUB officers are permitted to carry out any valve operation. The PE/pipe laying contractor may continue to carry out any other works in preparation for the handing over of the newly laid mains to PUB.

4.4 Handing Over of Mains to PUB for Operation and Maintenance

On the appointed day for handing over, the PE/pipe laying contractor must ensure that all necessary tools and manpower required for inspection are available during the inspection. All valves, fire hydrants, washouts etc must be operated to ensure they are in working order. All couplings and joints must be inspected to ensure there are no leaks. The PE/pipe laying contractor shall also provide a copy of the as-built drawings at the site. After the inspection, PUB will provide a list of defects, if any, for the PE/pipe laying to follow-up. The defects are to be rectified as soon as possible and no later than 4 weeks from the date the list. Upon completion of the rectification works, PE/pipe laying contractor will contact PUB for another inspection.

Upon confirmation of the satisfactory completion of rectification of all defects, PUB will issue a letter of confirmation of taking over. The PE/pipe laying contractor LP shall be liable for any defects which occur within one year from the date of handing of main to PUB.

5 Payment to PUB

The Contractor is required to bear all costs relating to the diversion and reinstatement including final inspection, testing, commissioning and other related works carried out. Payment must be made to PUB before the PE/pipe laying Contractor is permitted to submit the Notification to Commence Work.

APPENDIX 1

LIST OF PIPES AND APPURTENANCES

To : Director, Water Supply (Network) Department

Diversion of Water mains at :

Location	
Size of Water mains	
PUB Project Reference	

The following pipes and fittings shall be used for the above diversion work.

Materials	**Brand**	**Source of Origin**	**Remarks**
Steel Pipes			
Steel Pipe Fittings			
Ductile Pipes			
Ductile Iron Fittings			
Sluice Valves			
Valve covers			
Butterfly Valves			
Others			

Note : All pipes and fittings are subject to PUB's prior approval notwithstanding that they may comply with the relevant Standards.

The main diversion shall be carried out by experienced pipe laying contractors registered with BCA under the Workheads of CR07 (Pipe Laying and Road Reinstatement).

Name of pipe laying contractor	
BCA Registration: Workheads and Financial Grade	
Contact Number	

Submitted by :_____Date : _____

Signature of PE with PE stamp

Name of PE	
Contact Number	

APPENDIX 2

NOTIFICATION TO COMMENCE WORK

To : Director, Water Supply (Network) Department

Diversion of Water mains at :

Location	
Size of Water mains	
PUB Project Reference	

The above diversion work shall be carried by the following pipe laying contractor

Name of Pipe Laying Contractor	
BCA Registration: Workheads and Financial Grade	
Contact Number	

Expected Commencement Date	
Expected Completion Date (prior to link up)	

Attached are the drawings for the diversion work (mandatory) :

1 **Drawing No :**
Description :

2 **Drawing No :**
Description :

3 **Drawing No :**
Description :

Submitted by : _____ Date : _____

Signature of PE with PE stamp

Name of PE	
Contact Number	

APPENDIX 3

REQUEST FOR PUB TO WITNESS PRESSURE TESTING

To : Director, Water Supply (Network) Department

Diversion of Water mains at :

Location	
Size of Water mains	
PUB Project Reference	

The above diversion work has been carried by the following pipe laying contractor

Name of pipe laying contractor	
BCA Registration: Workheads and Financial Grade	
Contact Number	

I, the undersigned, the Professional Engineer-in-charge hereby certify that I have supervised the laying of the water pipes and all associated works for the above diversion work and inspected the completed works. I confirm that the work was carried out in accordance with Public Utilities Board's requirements. All the water pipes and appurtenances installed are of the types that comply with standards stipulated by PUB. Also, I have supervised the flushing of the newly laid pipes and confirmed that they are clean.

Attached are the following (for pipes of 800 mm dia and above) :

1 Air test/MPI records for welded joints; and
2 Video recordings of pipe interior as proof for cleanliness inside ~~of~~ the pipes;

I hereby request PUB to witness the pressure testing of the newly laid mains on :

Proposed Date of Pressure Testing	

Submitted by : _____ Date : _____

Signature of PE with PE stamp

Name of PE	
Contact Number	

APPENDIX 4

REQUEST FOR PUB TO COLLECT WATER SAMPLES

To : Director, Water Supply (Network) Department

Diversion of Water mains at :

Location	
Size of Water mains	
PUB Project Reference	

The above diversion work has been carried by the following pipe laying contractor

Name of pipe laying contractor	
BCA Registration: Workheads and Financial Grade	
Contact Number	

I, the undersigned, the Professional Engineer-in-charge hereby certify that I have supervised the sterislisation of the water pipes for the above diversion work in accordance with Public Utilities Board's requirements. Also, I have supervised the flushing of the newly laid pipes and confirmed that they are clean.

I hereby request PUB to collect water samples for testing of the newly laid mains on :

Proposed Date of Collection of Water Samples	

Submitted by : _____ Date : _____

Signature of PE with PE stamp

Name of PE	
Contact Number	

APPENDIX 5

REQUEST FOR PUB TO LINK UP TO EXISTING PUB WATER MAINS

To : Director, Water Supply (Network) Department

Diversion of Water mains at :

Location	
Size of Water mains	
PUB Project Reference	

The above diversion work has been carried by the following pipe laying contractor

Name of pipe laying contractor	
BCA Registration: Workheads and Financial Grade	
Contact Number	

I, the undersigned, the Professional Engineer-in-charge hereby certify that I have supervised the preparation works in preparation for the link up to the existing PUB water mains.

Attached are the following (mandatory requirement):

As built drawings including plan and longitudinal profile of the pipeline showing the alignment, level, dimensions and position of pipes and appurtenances in coordinates including hydrants. The drawings must be prepared in digital format using Microstation or Auto CAD and in accordance to SLA SVY 21 coordinate system endorsed by a licensed surveyor.

I hereby request PUB to arrange for the link up on :

Proposed Date of Link Up	

Submitted by : _____ Date : _____

Signature of PE with PE stamp

Name of PE	
Contact Number	

APPENDIX 6

REQUEST FOR HANDING OVER OF MAINS TO PUB FOR OPERATION AND MAINTENANCE

To : Director, Water Supply (Network) Department

Diversion of Water mains at :

Location	
Size of Water mains	
PUB Project Reference	

The above diversion work has been carried by the following pipe laying contractor

Name of pipe laying contractor	
BCA Registration: Workheads and Financial Grade	
Contact Number	

I, the undersigned, the Professional Engineer-in-charge hereby certify that I have supervised the all necessary works in preparation for the handing over of the water mains for the above project to PUB and this includes the rectification of all defects as highlighted by PUB.

I hereby request PUB to arrange for the taking over on:

Proposed Date of Taking Over	

Submitted by: _____ Date : _____

Signature of PE with PE stamp

Name of PE	
Contact Number	

APPENDIX 7

COMMISSIONING OF NEWLY LAID PIPES

7.1 Procedures for testing, disinfection and commissioning of New Water mains

All newly laid mains shall be properly charged up with water, subjected to pressure and leakage test and disinfected/sterilized before they can be commissioned. The procedures for charging, testing and sterilizing the main are as follows:

1) Both ends of the pipeline shall be capped with one end cap provided with pipe connection for charging of main for pressure and leakage test, and disinfection of pipeline. The pipe connection shall include isolating valves, flowmeter as well as test connection complete with flowmeter, pressure gauge and recorder. The pipe end shall also be provided with air valve and washout for the charging and draining of main. For mains with flexible joints, the end caps shall be adequately restraints to prevent movement of mains due to end thrust. Any bends and tees shall also be adequately restrained by thrust blocks or anchor blocks.

2) The pipe laying contractor shall apply to PUB for water supply to charge up the main for the testing and disinfection of the mains.

3) The water used for testing and disinfection of the pipeline will be metered by the flowmeter and the water usage will be billed to the pipe laying contractor.

4) For underground mains with flexible joints, the trench shall be partially backfilled wherever possible, leaving the joints exposed for inspection and repairs when necessary during pressure and leakage test. If the main is above ground, adequate restraints shall be provided at the bends, tees, pipe ends besides adequate supports to the pipeline.

5) The charging the main shall be such that all the air is expelled from the main before commencement of pressure and leakage test.

6) After the main is charged and left for 24 hours, pressure test shall commence by pumping water into the main through the test connection using high pressure piston pump. The test pressure shall be 1.0 N/mm^2 (10 bar) for all new mains.

7) The testing connection shall be provided with an isolating valve, which when closed, shall leave the pressure gauge connected to the main under test, and at the same time isolate the pump. When the specified pressure is reached, pumping to pressure the main shall stop and the isolating valve shall be closed. The main shall remain pressurize for 24 hours.

8) The pressure and leakage test is deemed to have passed if there is no drop in pressure or the quantity of water required to restore to specified test pressure is less than 10 cc per mm diameter per km of pipeline under test. If the test is unsatisfactory, the source of leak shall be traced and repaired. The main shall then be retested in the presence of PUB. The process of repairing and retesting shall be repeated until a satisfactory result is obtained.

9) After passing the pressure test, the main shall be disinfected/sterilized by means of liquid chlorine or chloride of lime. The procedures are described in Clause 7.2.

10) Chlorinated water shall remain in the main for twenty-four hours. After which, the main shall be thoroughly flushed until the chlorine content falls to acceptable level. The chlorine content can be measured by means of a chlorine comparator.

11) Three samples of water shall be taken from the new main on three consecutive days starting the day after the sterilisation. If any one of the samples fails, the main shall be flushed again and more samples are to be taken. The process of chlorination shall be repeated if two unsatisfactory tests are obtained. At least two consecutive samples must pass the chemical/bacteriological test before the new main could be connected to the existing network for commissioning.

12) Following the successful disinfection of the pipeline, PUB will give the go ahead for the pipe laying contractor to carry out the final connection of the new main to the existing mains. Upon completion of final connection, the main laying contractor shall introduce some chloride of lime at the connection points before closing up the main for commissioning of the new main.

7.2 Sterilisation Procedures

Sterilisation by chlorine is most commonly used and is most practical. A dose of chlorine preferably using chloride of lime sufficient to effect sterilisation is added to the water. Sterilisation of mains can be effected by means of introducing Chloride of Lime/Liquid sodium hypochlorite into the mains. The procedures for sterilisation are as follows:

1) Use of Chloride of Lime/Liquid Sodium Hypochlorite for the Sterilisation of Mains

   a) The isolated main will be thoroughly flushed and emptied, if possible.

   b) Where an air valve can be used as the point of application of the Chloride of Lime/Liquid sodium hypochlorite, the emptied main will be charged with treated water through a metered pipe freely discharging into the bowl of the air valve, and the Chloride of Lime / sodium hypochlorite will be added to the bowl in proportion to the rate of flow of the water. The main will then contain chlorinated water throughout its length.

   c) Where it is not possible to apply Chloride of Lime/Sodium hypochlorite as in (b), the main shall be charged slowly with treated water through the hole drilled on the main for the test meter connection, but not under pressure,

and the Chloride of Lime/sodium hypochlorite shall be added through a funnel into which the treated water is discharged, in proportion to the rate of flow of the water. This will result in distribution of chlorinated water throughout the length of the main.

d) Where it is not possible to empty the main, the application of the Chloride of Lime/sodium hypochlorite shall be done as in (b) or (c) on the first charging of the main.

e) In (b), (c) and (d) the treated water must remain in the main for 24 hours before flushing.

f) The usual leakage test will be carried out at the same time after the main is completely filled with the chlorinated water.

The dosages of Chloride of Lime/sodium hypochlorite required are set out in the TABLES below.

TABLES

The following table shows the quantity of chloride of lime required to give a dose of 50 parts per million chlorine for 100 meters of different sizes of pipe:

Dia of Main (Nominal) mm	Per 100 meters of pipe
	Chloride of Lime based on 33% available chlorine (kg)
100	0.091
150	0.227
200	0.409
300	0.970
400	1.742
500	2.758
700	5.455
800	7.152
900	9.076
1200	15.73
1500	24.676

The following table shows the quantity of liquid sodium hypochlorite required to give a dose of 50 parts per million (or mg/l) chlorine for 100 meters of different sizes of pipe:

Dia of Main (Nominal) mm	Per 100 meters of pipe
	Liquid Sodium Hypochlorite based on 13 % weight/volume of available chlorine (kg)
100	0.314
150	0.707
200	1.256
300	2.826
400	5.024
500	7.850
700	15.386
800	20.096
900	25.434
1200	45.216
1400	61.544
1600	80.384
1800	101.736
2200	151.976

Note: 50 mg/l = = 50 g/m^3

Sample Calculation:
If d = 300 mm (=0.3 m), L = 100 m,

Q = (50 g/m^3 / 0.13) x Volume of pipe

= 400 g/m^3 x Π/4 x d^2 x L

= 400 g/m^3 x Π/4 x $(0.3)^2$ x 100

= 2826 g or 2.826 kg

The recommended dosage listed in the above table is based on fresh stock of sodium hypochlorite with 13% weight/volume of available chlorine. As sodium hypochlorite is unstable upon storage, the contractor shall adjust the amount of sodium hypochlorite accordingly to ensure chlorine dose concentration meet the specified dose of 50 mg/l. The Contractor shall submit, when requested, to the Officer-in-charge a certificate of analysis issued by the supplier of the batch of sodium hypochlorite proposed for use. Alternatively, other disinfecting agents may be proposed subjected to the concurrence of the Officer-in-charge.

2) Procedure:

The sterilisation of the main will be supervised by the Senior Technical Officer/Technical Officer and/or the Engineer:

a) Flush the main thoroughly through hydrants until clear water appears for 15 to 20 minutes.

b) Provide a 25 mm dia tapping on the main at a point on the down-stream side of the main valve.

c) It is essential that during the period of dosing, the main is in full flow. Firstly, open the main valve a few turns and then regulate the hydrant valve until the required rate of flow is obtained.

d) Once the flow through the main has been regulated to the required liters per minute, commence dosing at the corresponding rate and for the corresponding length of time as shown in the TABLE. The TABLE gives the necessary quantities for the complete sterilization of 100 meters of main.

e) Before the full dose has been applied, the chlorination unit will test the water collected from the end hydrant for free chlorine until a positive chlorine test of not less than 10 ppm is obtained. When this has been obtained, all valves are then shut and the chlorinated water is left in the main for at least 6 hours.

f) After this period, the main is flushed thoroughly and a bacteriological sample shall be taken for analysis at the Water Science Division at Toh Tuck Complex.

g) Samples of water shall also be taken over the next two days. If any of the samples fails, the main shall be flushed again and more samples are to be taken. The process of chlorination shall be repeated if two unsatisfactory tests are obtained. At least two consecutive samples must pass the bacteriological and chemical test before the main can be commissioned.