

PARTICULAR SPECIFICATION

APPENDIX AU

**PUB'S REQUIREMENTS FOR PREVENTION
OF DAMAGE TO PUB WATERMAIN**

PREVENTION OF DAMAGE TO PUB WATERMAIN

General

1. Before commencing any works in the vicinity of PUB watermain, the QP shall verify the exact locations of the watermain.
2. The QP shall design both the temporary and permanent works in such a way to ensure that ground movements are kept to an absolute minimum. The employment of proven techniques and good workmanship are important to minimise ground loss and in turn ground movements.
3. The QP shall select and ensure the operation of construction equipment shall be in a manner such that vibration induced damage to the watermain is prevented.
4. The QP shall establish and inform PUB of the procedures and methods for all excavation and other construction works within 10 meters radius of PUB watermain to prevent damage to the watermain during the work.
5. Before commencement of works, the QP shall submit the detailed method statement and drawings for the construction works, details of the machinery/equipment used with analyses / assessment to demonstrate that the construction method proposed is non-invasive and will not cause any impact or damage to the watermain.
6. Equipment Vibrations - Construction activities such as piling, excavation, soil improvement, diaphragm wall and retaining wall construction etc and the use of construction equipment such as piling/boring machine etc shall not subject the watermain to a peak particle velocity (PPV) exceeding 15 mm/s at any frequency. The QP shall provide a detailed impact assessment that clearly demonstrates the vibration attenuation for each of the equipment proposed to be used at the development site and in similar ground conditions to show that this vibration limit would not be exceeded on the existing watermain.
7. Ground Displacements - Ground displacements caused by construction or other activities shall be "zero". If the QP's analysis shows that the ground displacement due to the construction or other activities exceeds "zero", a further design check shall be undertaken to ensure that the construction or other activities will not induce any damage to the watermain.
8. Groundwater Drawdown - The groundwater drawdown shall not exceed 10 kPa in the vicinity of the PUB watermain
9. No heavy machinery or vehicles shall be located or driven over PUB watermain.

10. Construction Impact Assessment Report (CIAR) - The QP shall carry out a construction impact assessment of the construction effects of the works on the watermains in the vicinity of the works and submit the report to PUB for records. The report shall include the following details:
- i. The ground conditions, geotechnical profiles and relevant borehole logs.
 - ii. The proposed construction equipment and methods, and sequencing of construction.
 - iii. Assessments on the use of the proposed construction equipment /methodology on the existing watermain, vibrations, ground displacements and groundwater draw downs and how the impacts would be mitigated to meet requirements.
 - iv. Vibration characteristics and attenuation for major construction equipment/methodology.
 - v. Instrumentation and monitoring proposals.
 - vi. The damage potential and risks to the watermains.
 - vii. Preventative and precautionary measures to protect the watermain from damage and remedial measures to be taken in the event of damage/incidents.
11. The QP shall advise PUB on the assessed probable risk and level of damage to the watermain and his proposed mitigating measures for preventing the watermain and watermain structures from damage to the satisfaction of PUB.

Instrumentation and Monitoring Programme

12. The QP shall carry out an instrumentation and monitoring programme to monitor the surface and subsurface ground movements, vibrations, the variation of ground water table and pore pressures, and the displacement and distortion of watermains.
13. The QP shall include in the monitoring plan all watermains that in his view are likely to be affected by the works.
14. The QP shall submit full details of the proposed monitoring procedures and instrumentation to PUB for concurrence before commencing the works.
15. The QP's method statement shall include the proposed monitoring intervals and all requirements imposed by PUB.

16. The QP shall be responsible for ascertaining and setting the safe limits of ground movements, vibration levels or other changes for ensuring the structural integrity and proper functioning of all watermains. He shall provide comprehensive basis for the proposed safe limits.
17. The QP shall verify and certify by monitoring that construction works have not resulted in displacements or vibration levels that have or will cause damage to any watermains. As a minimum, the following are required to be carried out and the relevant details are to be submitted to PUB:
 - i. Monitoring of the displacements or vibration levels of watermains or the adjacent ground from the construction works.
 - ii. Preparation of action plan for remedial action in the event that displacements or vibration levels exceed the design limitations or cause damage.
18. It shall be clearly understood that the submissions of the instrumentation monitoring results and reports to PUB are only for PUB's information. The QP shall be fully responsible for the analysis and interpretation of all the readings and measurements and for taking all remedial measures where necessary. When abnormal readings or measurements are obtained, QP shall immediately investigate the causes of the abnormalities and take all necessary remedial measures. QP shall promptly inform PUB should such abnormalities be likely to affect the structural integrity of the watermain
19. Instrumentation monitoring regime consists of inclinometers, ground settlement markers, vibration meters, piezometers, strain gauges, rod extensometers, etc. shall be carried out by QP to check whether ground movements & vibration impacts are within allowable limits during the construction works. Records of the instrumentation monitoring regime shall be endorsed by the QP and properly maintained at the site, submitted to PUB or made available for inspection by PUB upon request.
20. QP shall monitor and review the instrumentation monitoring results daily, looking out particularly for excessive ground movements that may cause damage to the watermain. The QP shall submit the instrumentation monitoring records to PUB at a frequency stipulated by PUB. QP shall highlight in his submission if there are any excessive ground movements monitored or any other abnormalities.
21. QP shall stop the works immediately if the instrumentation monitoring results exceed the allowable limits and inform PUB immediately before investigating whether the works have any impacts on the sewers. The QP shall submit his assessment of the impacts of the works on the watermain, including his proposed mitigating measures to address the excessive ground movement or any other abnormalities, to PUB for approval, before resuming the works.

Surveillance Cameras above Large Diameter Watermains (> 300mm in Diameter)

22. Contractor shall provide web-based IP surveillance cameras to continuously monitor construction activities in the vicinity of the large diameter (> 300mm) watermain. The number of cameras to be provided shall be approved by PUB and shall be sufficient to cover at least 6 meters from the watermains
23. The surveillance cameras must be able to capture still pictures and perform continuous video recording.
24. The Contractor shall provide PUB with the Internet website address for centralized viewing of the still picture and video recordings of the construction activities above watermains/structures and large diameter watermains captured by the surveillance cameras.