Water for All : Conserve, Value, Enjoy

To: Agencies/Developers/Qualified Persons/Contractors

## PUB (WRN) ADVISORY NOTE (No. 1 of 2006) (1 Apr 2014)

## - PREVENTION OF DAMAGE TO THE SEWERAGE SYSTEM

The sewerage system is a national infrastructure that conveys used water for treatment before it is safely disposed of. The sewerage system thus performs a crucial role in providing us with a healthy and clean environment. If any damage is caused to the sewerage system, environmental pollution may result.

2 The sewerage system includes a network of sewers, pumping mains, the deep tunnel sewerage system (DTSS), and link sewers. To help you protect the sewerage system, we have prepared some guidelines on "Prevention of Damage to The Sewerage System" which can be found in the PUB website at http://www.pub.gov.sg (under General Info-Used Water).

3 In addition, we have attached a list of "Dos and Don'ts" (see **Annex 1**), some highlights (see **Annex 2**) of the main requirements from the Code of Practice on Sewerage and Sanitary Works and the General requirements for protection of sewers and pumping mains / Consultation and Submission Requirements (see **Annex 3**) as easy references to help you prevent damage to the sewerage system.

4 Causing damage to the sewerage system is an offence. We have highlighted, in **Annex 4** attached, some Sections of the Sewerage and Drainage Act (SDA), which show the severity of punishment with respect to damage to the sewerage system.

5 For further clarification on :

(i) General Protection Requirement please contact Mr Dave Koh at Tel: 65172208 or Mr Han Yoke Siew at Tel: 65172204 of the Network Management Branch;
(ii) Consultation and Submission requirements please contact Planning Division at 67313656 or 67313352

Issued by:

**DIRECTOR**
**WATER RECLAMATION (NETWORK) DEPARTMENT**
**PUB**

**Annex 1**

## DOs AND DON'Ts ON THE PREVENTION OF DAMAGE TO THE SEWERAGE SYSTEM

*[Reminder: Under the Sewerage and Drainage Act, the penalty for erecting any building or structure over, across or adjacent to any sewerage system without prior approval from PUB is a fine of up to $20,000. The penalty for causing any damage to sewer is a fine of up to $200,000 or to imprisonment for a term up to 2 years or to both.]*

**DO**

1. Do purchase a **Sewerage Interpretation Plan (SIP)** from **CBPD (NEA)**.

2. Do obtain approval from PUB, Water Reclamation (Network) Department before you carry out any works including piling works within the Sewer Protection Zone.

3. Do trial holes to identify the exact location of existing sewers/pumping mains/sanitary drainlines /sewer connection lines before any excavation or piling work. Use only manual excavation near the pipes.

4. Do peg/barricade the route along the sewers/pumping mains to forewarn sub-contractors of the presence of sewers/pumping mains, etc.

5. Do consult **PUB, Water Reclamation (Network) Department** when you are unable to locate existing manholes/chambers/ sewers/pumping mains, etc.

6. Do have proper protection for our existing sewers/pumping mains during excavation. Prior approval must be obtained from Water Reclamation (Network) Department for protection/ diversion works.

7. Do submit a Notification to our **Network Management Branch (NMB) (@WaterHub Toh Tuck Complex, 82 Toh Guan Road East #C3-08, Singapore 608576)** at least 7 days before commencement of any excavation works near any sewers or sewerage system.

8. Do report to our **Network Management Branch (NMB)** at Tel: **62894013** should any of our services be damaged, exposed or any sealing work is required for immediate attention.

**DON'T**

1. Don't excavate, pile or construct any structures in the Sewer Protection Zone without prior approval from **PUB, Water Reclamation (Network) Department.**

2. Don't allow heavy machinery to move over our existing sewers/pumping mains without adequate protection (e.g steel plate).

3. Don't use excavator for trial holes to locate the existing sewers/pumping mains/sanitary drainlines.

4. Don't lay any services on top of our existing sewers/pumping mains.

5. Don't lay any services inside our manholes/chambers.

6. Don't cover our manholes/chambers with concrete or premix or construction debris during the construction work.

7. Don't place excavated earth on top of our sewers/pumping mains/ manholes/chambers. No overburden load should be imposed on the sewers/pumping mains/manholes/chambers.

8. Don't leave the manhole or inspection chamber cover open. If the cover is damaged in the course of the construction work, replace them immediately or call the **Network Management Branch (NMB)** at Tel: **62894013** for assistance.

**Annex 2**

## Requirements of the code of Practice on Sewerage and Sanitary Works

1. Qualified Persons/Professional Engineers are required to comply with the sewer protection zone requirements. Sewer Protection zone is defined as the horizontal distance of 25m from the outermost edge of any part of the public sewers (including pumping mains) or 36m from the outmost edge of any part of the DTSS tunnel & facilities within which no works, either permanent or temporary, should be carried out unless the Director, Water Reclamation (Network) Department has given the written permission to do so.

2. Qualified Persons/Contractors working in the vicinity of the sewerage system shall carry out thorough site investigation to ascertain the exact locations of the sewerage system within and around their project site and mark their locations and plot the information in the proposal drawings.

3. Qualified Persons/Professional Engineers shall consult and make a submission to PUB, Water Reclamation (Network) Department on any proposed works, either permanent or temporary, within the following sewer protection zones:

   (i) 25m for any sewers, and
   (ii) 36m for Deep Tunnel Sewerage System (DTSS)

   He shall ensure that a written clearance from PUB is obtained before commencement of any works within the sewer protection zone.

4. Qualified Persons/Contractors shall consult PUB's **Network Management Branch (NMB) (@ WaterHub Toh Tuck Complex, 82 Toh Guan Road East #C3-08, Singapore 608576, Tel: 62894013)** when they are unable to locate existing manholes/ chambers/sewers/pumping mains, etc which are indicated on the SIP at the work site.

5. Qualified Persons/Contractors shall submit a Notification to our **Network Maintenance Branch (NMB)** at least 7 days before commencement of any excavation works near any sewers or sewerage system.

6. Developer/Contractors to note that for construction sites, sullage water from any shower/bathroom compartment/wash area shall be discharged into a silt trap before connection to an inspection chamber. This is to prevent the sand/silt from entering the sewerage system.

7. **Developers/Contractors shall note that temporary septic tank/sewage treatment plant is not allowed to serve the temporary work site facilities**. In such cases, temporary sewer connection to existing sewer is to be provided.

8. If sewer is not available, Developer/Contractor will have to bring forward the extension of public sewer to serve the construction site. During the interim, temporary holding tanks (i.e. no discharge to sewer/drain) of sufficient capacity (design flow is 200 liters per person per day and minimum capacity is 2000 liters) for sullage water and portable chemical toilets are to be provided. Licensed Waste Contractor shall empty the temporary holding tanks/chemical toilets regularly.

9. Developers/Contractors shall note that ends of the abandoned sewers/pumping mains shall be sealed watertight with 225mm thick brick plugs and rendered with cement mortar. The abandoned sewers / pumping mains of 300mm diameter and above on public roads shall be filled with concrete, cement grout or other approved material. All abandoned manholes/chambers are to be demolished and manhole frames and covers removed.

**Annex 3**

# GENERAL REQUIREMENTS FOR PROTECTION OF SEWERS AND PUMPING MAINS

1. Where there are public sewers or pumping mains within your development lot or the sites of your proposed works (eg excavation, soil investigation, piling, tunneling, structure, etc), either permanent or temporary, or if your works are within the sewer protection zone [ie. 25m for sewers and 36m for Deep Tunnel Sewerage System (DTSS)], you are required to **obtain a written clearance from the Director, PUB Water Reclamation Network (WRN) before carrying out the works at the site**. Please click here for the application form.

2. Work carried within the development lot shall take into consideration the sewer setback distance and sewer protection zone.

3. No structure either permanent or temporary shall be erected over or within the below minimum sewer setback distance from the public sewers or pumping mains. The requirements on the sewer setback distance is stipulated in the Code of Practice on Sewerage and Sanitary Works and the below minimum clearance distances can also be found at: http://www.pub.gov.sg/general/usedwater/SewerageandSanitaryWorks/Pages/SewerProtectionZone.aspx

## SEWER SETBACK DISTANCE CLEARANCE REQUIRED

| Sewer Pipe Diameter (mm) | Nett Clearance Required |
|---|---|
| 150 to 600 (depth ≤ 3m) | 1.0m from outer edge of any structure to centreline of sewer pipe |
| 150 to 600 (depth > 3m to 5m) | 1.5m from outer edge of any structure to centreline of sewer pipe |
| 150 to 600 (depth > 5m) | 2.0m from outer edge of any structure to centreline of sewer pipe |
| > 600 to 1500 | 2.5m from outer edge of any structure to outer edge of sewer bedding |
| > 1500 to 2500 | 3.0m from outer edge of any structure to outer edge of sewer bedding |
| > 2500 | 4.0m from outer edge of any structure to outer edge of sewer bedding |
| DTSS Tunnel & Facilities | 6.0m from outer edge of any structure to outer edge of tunnel or structure |

## PUMPING MAIN SETBACK DISTANCE CLEARANCE REQUIRED

| Pumping Main Diameter (mm) | Nett Clearance Required |
|---|---|
| 100 to 600 (depth ≤ 3m) | 1.0m from outer edge of any structure to centreline of the pipe |
| 100 to 600 (depth > 3m to 5m) | 1.5m from outer edge of any structure to centreline of the pipe |

| | |
|---|---|
| 100 to 600 (depth > 5m) | 2.0m from outer edge of any structure to centreline of the pipe |
| > 600 to 1500 | 2.5m from outer edge of any structure to outer edge of the pipe |
| > 1500 | 3.0m from outer edge of any structure to outer edge of the pipe |

4. No utilities services (cable, gas pipe, water pipes, etc) either permanent or temporary shall over-cross / under-cross **within one metre (1m)** from the outer edge of sewers or pumping mains. For those utilities services that over-cross / under-cross with a vertical clearance of less than one metre to any sewer, you are required to **obtain a written clearance from the Director, PUB (WRN) before carrying out any works at the site**. In addition, pre- and post-construction CCTV inspection shall be carried out on the affected sewer(s) and manholes. The CCTV reports and video shall be submitted to PUB (WRN) Department. From 1 Jan 2013, PUB only accept CCTV inspection and reports from PUB Registered CCTV contractors. The list of latest PUB registered CCTV contractors is available in our website, http://www.pub.gov.sg/general/usedwater/Documents/RegisteredCCTVContractor.pdf

5. A thorough site investigation shall be carried out to determine the exact position and levels of the existing sewers / pumping mains before commencement of works. QP shall refer to PUB's advisory on 'Prevention of Damage to the Sewerage System' which can be viewed at: http://www.pub.gov.sg/general/Pages/PreventionofDamage.aspx#Prevention for measures to prevent damage to sewerage systems.

6. All necessary precautions and protection measures shall be taken to safeguard the sewers or pumping mains during construction works. The cost of repairs to any sewers / pumping mains damaged as a result of work carried out shall be borne by the party who causes the damage. PUB's approval shall be obtained before carrying out any diversion of existing sewers / pumping mains. The cost of diverting any existing sewers / pumping mains shall be borne by the party necessitating the diversion works.

7. The construction works or activities shall not cover up/bury any sewer manholes or valve chambers and appurtenances for pumping mains.

8. The public sewers and pumping mains must be accessible for maintenance and repair works at all times.

9. Any work carried out in the vicinity of existing sewers or pumping mains shall not subject the sewers or pumping mains to a vibration of more than 15mm/s peak particle velocity at any frequency.

10. QP shall supervise the works and in accordance with PUB's advisory on "Prevention of Damage to the Sewerage System", plans / drawings submitted and approved by PUB (WRN) and Clearance Certificates issued by CBPD (NEA).

11. No deviation from the plans approved by PUB or CBPD (NEA) shall be made unless with prior written approval from PUB (WRN) or CBPD (NEA).

12. Copies of all PUB or CBPD's approvals including approved plans shall at all times be kept at the site and made available for audit check by PUB staff when required.

13. QP shall comply with the submission and monitoring requirements pertaining to the protection of public sewers as given in **Appendix 1**. If the proposed works are close to larger sewer(s) (≥

900mm in diameter) or DTSS tunnel/structures, the QP shall also comply with the additional protection requirements given in **Appendix 2**.

14. Where works need to be carried out in public sewers or manholes, QP shall submit to PUB, (WRN), Network Management Branch, an application (Form B) to work in the public sewerage system through CORENET e-submission.

15. Web-based IP surveillance cameras shall be provided to continuously monitor the construction activities in the vicinity of the DTSS tunnel/structures and large diameter (≥ 900mm) sewers. The number of cameras to be provided shall be approved by PUB and shall be sufficient to cover at least the sewer setback distances of the DTSS tunnel/structures and large diameter sewers.

16. Please call PUB's **Network Management Branch (NMB)** at Telephone **No. 62894013** or PUB-ONE hotline at 1800-2846600 / **Fax at 63820692** immediately should any of the public sewers or pumping mains be damaged or exposed.

**Appendix 1**

# CONSULTATION AND SUBMISSION REQUIREMENTS

## 1. Consultation and Submission

Where there are public sewers or pumping mains within your development lot or the sites of your proposed works (eg excavation, soil investigation, piling, tunneling, structure, etc), either permanent or temporary, or if your works are within the sewer protection zone [ie. 25m for sewers and 36m for Deep Tunnel Sewerage System (DTSS)], you are required to **obtain a written clearance from the Director, PUB (WRN) before carrying out any temporary works/piling works/building works at the site**. Please note the documents that need to be submitted as stipulated in the application form.

Please also note the following:

(a) you need to get the Development Control (DC) plan and BP Plan / detailed plan sewerage plan approved by CBPD (NEA) prior to seeking written clearance from Director, PUB (WRN).

(b) If a diversion is proposed for the existing sewer, proposal for the diversion sewer shall have to be approved by PUB. Then, the diversion sewer shall first be completed and passed for operation by PUB before any work is allowed to start on the diversion of the existing sewer.

(c) For works within the DTSS and/or large diameter sewers (≥ 900mm in diameter) protection zone (25m for sewers and 36m for DTSS)**;** QP shall submit the following additional documents to **PUB (WRN)** to obtain the written clearance.

(i) Detailed Plans of development or engineering works and survey plan indicating the alignment of the sewers in relation to the works;

(ii) Construction Impact Assessment Report (CIAR). Please refer to **Appendix 2** item 11 for details on the report.

(d) QP shall submit a **Notification** to PUB's (**Network Management Branch)** Fax 63820692 at least 7 days before commencement of any excavation / tunneling / piling / soil investigation / temporary works near any sewers or sewerage system.

(e) A pre-construction CCTV inspection report together with the CCTV video (DVD) shall be submitted if any sewer is within or adjacent to the development lot. From 1 Jan 2013, PUB only accept CCTV inspection and reports from PUB Registered CCTV contractors. The list of latest PUB registered CCTV contractors is available in our website, http://www.pub.gov.sg/general/usedwater/Documents/RegisteredCCTVContractor.pdf.

(f) For small redevelopment/A&A works of single landed property (terrace, semi-detached and detached house), the submission of pre-construction CCTV survey report is waived and QP is only required to submit the post-construction CCTV survey report upon completion of the development work.

## 2. Monitoring and Submissions Required during Construction Stage

Where there is any public sewer(s) or pumping main(s) within and/or adjacent to the development lot, QP shall comply with the following general requirements and ensure that copies of all PUB's

approvals, including approved plans, shall at all times be kept at the site and made available for audit check by PUB when requested.

Before Commencement of Works

(i) Registered Surveyor to verify, set out and carry out the pegging of the sewer alignment, tunnel/pipe jacking alignment, pile/drilling hole positions, temporary earth retaining system (TERS) alignment on site and endorse on setting out plan.

(ii) QP shall verify and check that the setting out plan is as per DC/BP/Detailed plan submissions.

(iii) QP shall check the positions of all heavy construction machinery and lifting equipment and material storage area in the vicinity of the sewer and ascertain that the imposed loads will not cause any damage to the sewer.

(iv) If the proposed work is likely to affect the existing sewers, the QP shall install a level sensor at the nearest manhole upstream of the affected sewer section. The level sensor shall be provided with data logger and auto alarm system at preset trigger levels. When the preset level is triggered, the alarm system should be capable of informing PUB via SMS. Details of the trigger levels and PUB staff to receive the SMS will be conveyed to the QP when the system is installed.

(v) The QP shall provide contingency plan to ensure that the flow is not disrupted should the existing sewer be damaged during construction works. QP shall ensure that the contingency plan is activated and repair works to the damaged sewer are immediately carried out in the event that any sewer is damaged due to the works.

During Implementation of Works (for sewers)

(vi) QP/QP's competent site representative shall closely monitor the works and provide standing supervision and conduct verticality and penetration depth checks on the piles, TERS and excavation works to ensure that they are installed within the allowable construction tolerance limits in terms of setting out, eccentricity and verticality. Records of the standing supervision, verticality and penetration depth checks, as-built piling, and TERS drawings shall be properly maintained on-site and made available for inspection upon request.

## 3. Submission upon Completion of the Development

Where there are public sewers or pumping mains within and /or adjacent to your development lot, upon completion of the development, QP shall submit:

(i) the "as-built" survey plan endorsed by a registered surveyor to show the exact location/clearances (horizontal/vertical) between the existing sewer(s)/manhole(s) and all the existing/new buildings/structures including wall, drains, boundary lines, etc. The top and invert levels of all the sewer manholes shall be indicated in the plan. The QP shall:

- highlight and certify if there are any changes in the condition of the existing sewer(s) / manhole(s) between the post and the pre-construction survey plan.

- confirm that the minimum clearance distance between the building/structure and the sewer met the stipulated requirements in the code of practice and is in accordance with the requirements/conditions imposed by PUB(WRN) when the development plans were approved.

- certify with submission of the as-built drawing of the installed piles/drilling boreholes that there are no impacts/damages caused to the sewers, manholes and pumping mains

based on the as-constructed works, instrumentation monitoring results, sewer pre/post construction CCTV survey report and pre/post level construction condition survey report submitted to PUB.

(ii) A post-construction CCTV report together with the CCTV video (DVD) for new / existing sewer(s) and manholes within or adjacent to the development site. From 1 Jan 2013, PUB only accepts CCTV inspection and reports from PUB Registered CCTV contractors. The list of latest PUB registered CCTV contractors is available in our website, http://www.pub.gov.sg/general/usedwater/Documents/RegisteredCCTVContractor.pdf.

**Appendix 2**

**ADDITIONAL REQUIREMENTS TO PROTECT EXISTING LARGE DIAMETER SEWERS (≥900mm IN DIAMETER) / AND DTSS TUNNELS & STRUCTURES**

## General

1. Before commencing any works in the **vicinity of sewers, pumping mains and DTSS structures (i.e. DTSS tunnels, shafts and ancillary structures);** the QP shall verify the exact locations of the sewers, pumping mains and DTSS structures.

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 minimize 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 sewers and DTSS structures is prevented.

4. The QP shall be fully liable for any repair of the sewers, pumping mains and DTSS structures damaged by the construction works. He shall also carry out any precautionary, protective or recovery measures deemed fit by PUB or as conveyed to him during the construction or the defects liability period of the works.

## Construction within the Sewer and DTSS Setback Distances (see Annex 3, item 3)

5. The QP shall establish and inform PUB of the procedures and methods for all excavation and other construction works within the sewers and DTSS setback distances to prevent damage to the sewers and DTSS structures during the work.

6. If the proposed works involve the installation of piles or structure or excavation to a level **within 3m** of the DTSS tunnel, pre-probing shall be conducted to ascertain if the DTSS tunnel is in the way of the works. Before commencement of works, the QP shall submit the detailed method statement and drawings for the pre-probing works, details of the machinery/equipment used (especially that for the advancement of the probe) with analyses / assessment to demonstrate that the pre-probing method proposed is non-invasive and will not cause any impact or damage to the DTSS tunnel.

7. 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 sewers and DTSS tunnels 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 sewers and DTSS tunnels. On-site testing and monitoring with a seismometer may be requested by PUB to verify the QP's assessment.

8. 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 a calculated crack width of 0.1mm in the DTSS concrete structure.

9. Load Transfer from Foundations to sewers and DTSS Tunnel - Load transfer (if any) from the foundation elements to the sewers and DTSS tunnels (e.g. by skin friction) shall not exceed an average of 10 kPa (10 $kN/m^2$). This requirement may necessitate the "debonding" of the entire foundation elements above the sewers and DTSS tunnel levels.

10. Groundwater Drawdown - The groundwater drawdown shall not exceed 10 kPa in the vicinity of the sewers and DTSS tunnels.

## Assessment of Construction Effects on Existing Structures

11. Construction Impact Assessment Report (CIAR) - The QP shall carry out a construction impact assessment of the construction effects of the works on the sewers and DTSS structures in the vicinity of the works and submit the report to PUB for approval. 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 sewers/DTSS tunnels, vibrations, ground displacements, load transfer from foundation elements to the sewers and DTSS tunnels 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 sewers and DTSS structures.

    (vii) Preventative and precautionary measures to protect the sewers and DTSS structures from damage and remedial measures to be taken in the event of damage/incidents.

12. The QP shall advise PUB on the assessed probable risk and level of damage to the sewers and DTSS structures and his proposed mitigating measures for preventing the sewers and DTSS structures from damage to the satisfaction of PUB.

## Instrumentation and Monitoring Programme

13. 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 sewers and DTSS structures, and assess the effect of construction works on the sewers and DTSS structures in the vicinity.

14. The QP shall include in the monitoring plan all sewers and DTSS structures that in his view are likely to be affected by the works.

15. The QP shall submit full details of the proposed monitoring procedures and instrumentation to PUB for concurrence before commencing the works.

16. The QP's method statement shall include the proposed monitoring intervals and all requirements imposed by PUB.

17. The QP shall commence the monitoring programme as soon as possible and several months before the construction work is scheduled to start. This is crucial for capturing the on-going rate of intrinsic settlement, subsurface ground movement, background vibration levels, etc. at the site so that it would be possible to differentiate them from those induced by the works later.

18. 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 sewers and DTSS structures. He shall provide comprehensive basis for the proposed safe limits.

19. 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 sewers or DTSS structures. 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 sewers and DTSS structures or the adjacent ground from the construction works

    (ii) Preparation of action plans for remedial action in the event that displacements or vibration levels exceed the design limitations or cause damage.

20. 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 sewers, pumping mains and structures.

21. All deformation monitoring instrumentation shall be designed to allow for any ground settlements, heaves or deformations that may occur. A new set of instrumentation shall be provided or resetting of the instrumentation shall be carried out, as recommended by the manufacturer, if the instrumentation reading exceeds 85% of its design value.

22. 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.

23. QP shall monitor and review the instrumentation monitoring results daily, looking out particularly for excessive ground movements that may cause damage to the sewer. The QP shall submit the instrumentation monitoring records to PUB (NMB) at a frequency stipulated by PUB. QP shall highlight in his submission if there are any excessive ground movements monitored or any other abnormalities.

24. QP shall stop the works immediately if the instrumentation monitoring results exceed the allowable limits and inform PUB (NMB) 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 sewer, 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 Sewers (≥900mm in Diameter) & DTSS Tunnel/Structures

25. Contractor shall provide web-based IP surveillance cameras to continuously monitor construction activities in the vicinity of the DTSS tunnel/structures and large diameter ($\geq$ 900mm) sewers. The number of cameras to be provided shall be approved by PUB and shall be sufficient to cover at least the setback distances of the DTSS tunnel/structures (ie. 6m from both edges) and large diameter sewers (ie. 2.5m for 900mm to 1500mm diameter; 3m for >1500mm to 2500mm diameter and 4m for >2500mm diameter, from both edges).

26. The surveillance cameras must be able to capture still pictures and perform continuous video recording.

27. 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 DTSS tunnel/structures and large diameter sewers captured by the surveillance cameras.

## Pre and Post-Construction CCTV, Laser and Sonar Inspection for DTSS Tunnel for Construction Works carried out within DTSS 6m Setback Distance

28. A pre and post-construction CCTV, sonar and Laser inspection for the DTSS tunnel, to be carried out by a specialist contractor with proven track records for deep tunnel inspections, may be required for construction works carried out within the **DTSS 6m setback distance**.

29. The specialist contractor's inspection system for the DTSS tunnel shall comprise CCTV, laser and sonar inspection technologies for a complete assessment of the condition of the DTSS tunnel. The proposed inspection system shall have proven track records for carrying out similar inspections of large diameter deep sewer tunnels.

30. The QP shall submit the pre-construction CCTV, Laser and Sonar inspection report (highlight all minor and major geometric defects) and records (in DVD) of the DTSS tunnel prepared by the specialist contractor prior to the commencement of works within the **DTSS 6m setback distance**.

31. For every pre- and post-construction CCTV inspection carried out, the QP shall compare the two inspection reports and highlight / certify whether there is any deterioration in the tunnel condition. QP shall promptly inform PUB WRN should any abnormalities be found that may have affected the structural integrity of the DTSS. CCTV reports together with the CCTV video shall be in accordance with **PUB (WRN)'s CCTV requirements**.

32. The QP would have to apply to PUB for a permit to access the DTSS Shafts to carry out the DTSS tunnel inspection. His application for permit shall include the proposal for the implementation of the DTSS tunnel inspection. The proposal shall include a Risk Assessment Report, deployment procedures & methodology, format/details of analytical reports with details of the inspection system used, the CVs of competent personnel with track record of similar inspections, safety plans and odour control system.

33. The QP/QP's representative (RE/RTO) and safety officer must provide standing supervision while the access shaft is opened and during the DTSS tunnel inspection to ensure that no damage is caused to the DTSS tunnel and safety of the contractors or any personnel and public is not compromised.

34. The QP/QP's representative (RE/RTO) shall ensure that adequate ventilation and lighting are provided to ensure sufficient brightness and clear views for inspection and that details of the tunnel are not obscured by gases in the tunnel. Ventilation should not lead to public health concerns and sufficient odour control systems must be provided.

35. During the inspection, the QP/QP's representative (RE/RTO), in consultation with the safety officer, shall ensure that all necessary/adequate measures are taken to safeguard the safety of the contractors' personnel and public. The measures shall include risk assessment, confined space entry safety requirements, prevent access by public to the access shaft while the access shaft is opened, securing of contractors' personnel to the secured scaffolding members (metal based) (which can take human weight as a minimum) when near opened shaft and confirmation that access shaft covers opened for inspection are tightly closed and secured with bolts at the end of the inspection. Risk Assessments should include "Hazop" to ensure all measures necessary to prevent damage to the tunnel and shaft are adopted during the inspection.

36. During the inspection process, the QP shall ensure that all precautionary actions are taken to prevent damage to the DTSS tunnel and shafts. The precautionary actions shall include but not limited to the following:

During the deployment and retrieval of the inspection system into and out of the DTSS shaft

(i) Measures must be in place to prevent excessive swaying during the deployment and retrieval of the inspection system into and out of the DTSS shaft to prevent damage to the shaft. Adequate padding shall also be provided at appropriate locations on the inspection platform to prevent damage to the DTSS shaft's internal lining.

(ii) Pan-Tilt and Zoom (PTZ) CCTV camera that can rotate 180 degrees shall be mounted on the inspection system and used to view backward and forward during the deployment and retrieval to ensure that the inspection platform maintains a safe distance from the access shaft wall and does not cause any damage to the shaft.

During the inspection of the DTSS tunnel

(iii) The Contractor shall examine carefully the shaft and tunnel interior for areas that might be susceptible to scratching by the tether or the inspection instrument and take additional measures/care to prevent any potential damage to the protective liner covering the shaft and tunnel interior or structural components of the DTSS. Adequate protection such as the use of “Tiger Tails” shall be provided to prevent damage to the DTSS tunnel/shaft.

(iv) An example on the deployment of "Tiger Tails" to protect the tether from scrapping against the shaft or tunnel is shown in Figure 1 below.

(v) Upon the completion of the inspection of the tunnel, QP shall ensure that the inspection platform re-inspect in the reverse direction using the Pan-Tilt and Zoom (PTZ) CCTV camera system to check and ensure that the DTSS tunnel was not damaged in any way due to the inspection.

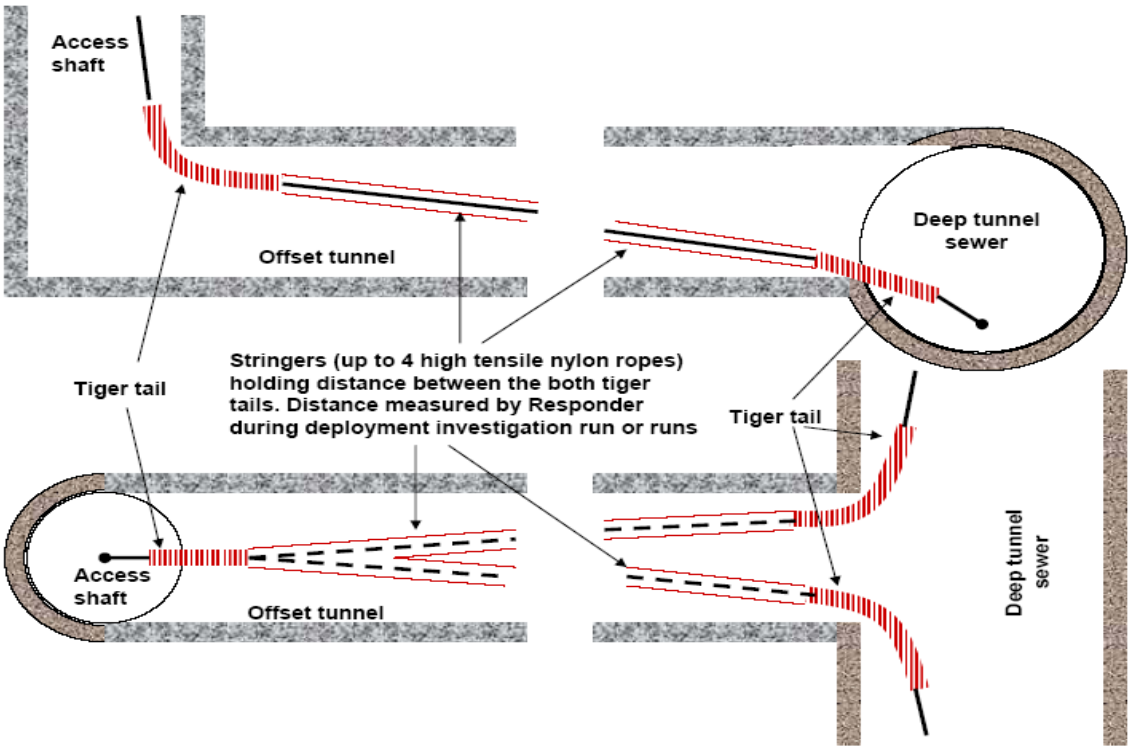



FIGURE 1 – PLAN & ELEVATION VIEW SHOWING DEPLOYMENT OF “TIGER TAILS” TO PROTECT DTSS

**Annex 4**

## Sewerage and Drainage Act (chapter 294)

| SDA Section | Description of Section | Description of Section Penalty |
|---|---|---|
| 13A(1) | **Duty to enquire before excavation**<br><br>No person shall dig, bore, trench, grade, excavate, tunnel or break any ground with any mechanical equipment, tool or explosive, or allows his employee or agent to do so, without first –<br>a) obtaining from the Board the relevant drainage plan or sewerage plan or other plans or records to ascertain the location of any public sewerage system or part thereof that may be interfered with by such works;<br><br>b) carrying out trial trenches to physically ascertain the location of any such public sewerage system or part thereof that may be interfered with by such works; and<br><br>c) complying with such other requirements as the Board may specify to protect any such public sewerage system or part thereof within the vicinity of such works, | Any person found guilty shall be liable on conviction to a fine not exceeding $50,000 or to imprisonment for a term not exceeding 3 years or to both. |
| 14(1) | **Works likely to affect sewer or sewerage system not to be carried out without Board's certificate or approval**<br><br>No person shall –<br>a) erect or cause or permit to be erected any object, building or structure over, across or adjacent to any sewer or sewerage system; or<br><br>b) carry out or cause to be carried out any other works which adversely affect or are likely to adversely affect any sewer or sewerage system, directly or indirectly<br><br>without obtaining, in respect of those works, a clearance certificate or the approval of the Board | Any person found guilty shall be liable on conviction to a fine not exceeding $20,000. |
| 18(1) | **Discharge of sewage, etc.**<br><br>No person shall, without the written approval of the Board, discharges or causes or permits the discharge of any sewage, waste matter or effluent into any public sewerage system or any drain-line or sewer communicating with a public sewerage system –<br>a) directly or indirectly, from any conveyance or mobile toilet; or<br><br>b) by opening a manhole or an inspection chamber or any other means of access to the public sewerage system, | Any person found guilty shall be liable on conviction to a fine not exceeding $20,000 |
| 19(1) | **Restrictions on use of public sewerage system**<br><br>No person shall throw, empty or pass, or suffer or permit to be thrown or emptied or passed, into any public sewer, or into any drain-line or sewer communicating | Any person found guilty shall be liable on conviction to a fine not exceeding $20,000. |

| | | |
|---|---|---|
| | with a public sewer –<br>a) any matter or other substance likely to injure the sewer or drain-line, to interfere with the free flow of its contents or to affect prejudicially the treatment and disposal of its contents; or<br><br>b) any sand, earth, gravel, cement, cement grout, brick, timber, wood or other building materials. | |
| 20(1) | **Damage caused to public sewer, etc.**<br><br>No person shall –<br>a) cause any damage to any public sewer or any drain-line or sewer communicating with a public sewer; or<br><br>b) renders any public sewer or private sewer a nuisance. | Any person found guilty shall be liable on conviction to a fine not exceeding $40,000 or to imprisonment for a term not exceeding 3 months or to both |
| 20(2) | **Damage caused to public sewer, etc.**<br><br>No person shall –<br>a) do any act which renders any public sewer or private sewer dangerous or injurious to health;<br><br>b) cause any damage to a pipe of 0.9 metres or greater in diameter that is part of or connected to the public sewerage system; or<br><br>c) do any act which disrupts the operation of or causes damage to any sewage treatment plant, sewage treatment works or water reclamation facility. | Any person found guilty shall be liaible on conviction to a fine not exceeding $200,000 or to imprisonment for a term not exceeding 2 years or to both. |
| 63(b) | No person shall fail to comply with any condition subject to which any clearance certificate is issued or approval is granted by the Board under section 33, | Any person found guilty shall be liable on conviction to a fine not exceeding $15,000 or to imprisonment for a term not exceeding 3 months or to both, and in the case of a continuing offence, to a further fine not exceeding $500 for every day or part thereof during which the offence continues after conviction. |