Drainage Services Department Practice Note No. 1/2011

Design Checklists on Operation & Maintenance Requirements

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1. SCOPE

1.1 This Practice Note presents the general operation and maintenance requirements, in the form of checklists, which should be taken into account and incorporated whenever practicable, in different aspects in the design of drainage/sewerage systems.

2. INTRODUCTION

2.1 The Working Group on Review of O&M Practice was established in 2009. Apart from reviewing the current O&M practice, the Working Group reviewed the existing O&M requirements for different aspects in design of drainage/ sewerage systems. To facilitate compliance checking by O&M divisions on the general O&M requirements of the works to be handed over, the Working Group formulated a series of design checklists on the O&M requirements. The checklists can also help project officers/ consultants to ensure that the O&M requirements have been incorporated into the design of the works as far as practicable. Should there be any deviations of the design from the specified requirements of the Practice Note, the project office/ consultants should discuss with the relevant O&M and E&M parties as early as possible to reach agreement on the design.

2.2 The checklists generally cover the following aspects:

i. Drainage tunnels
ii. Large deep gravity sewers
iii. Rising mains
iv. Desilting compounds
v. Gravity sewers and storm drainage pipelines
vi. Flood storage tanks
vii. Village sewerage
viii. Stormwater inlets
ix. Septicity control
x. Drainage channels
xi. Flood pumping schemes
xii. Dry weather flow interceptors
xiii. Multipart covers
xiv. Tidal control structures including penstocks, flap valves, inflatable dams & tidal gates
xv. Rain gauges, river gauges and tide gauges
xvi. Flood warning systems

xvii. Design calculation checking

3. DESIGN CONSIDERATIONS

Drainage tunnels

3.1 All elements of the drainage tunnels and its associated works should be designed and constructed with due considerations not only to the fulfillment of the functional requirements but also on the ease of future inspection, operation and maintenance. The checklist is therefore designed based on the above principle and is applicable to drainage tunnels constructed deep underground and its associated works including adits, shafts, intakes and outfalls. It also covers the requirements on accessibility to tunnel, safety aspects, communication and ventilation systems, security concern and the content of operation and maintenance manual.

Large deep gravity sewers

3.2 The checklist is applicable to large deep gravity sewer (i.e. gravity sewers of diameters not less than 675mm and invert levels exceeding 6m below ground level). Difficulties are frequently encountered in the inspection, maintenance and repair of large deep gravity sewers such as (a) available pipeline survey technologies cannot provide effective means to inspect the structural conditions of surcharged sewers; and (b) flow diversion by over pumping is not normally feasible due to large flow, small size of existing manholes, large pump heads required and traffic constraints. This checklist sets out the maintenance considerations for the design of large deep gravity sewers so as to facilitate ease of future maintenance.

Rising mains

3.3 The checklist is applicable to rising mains of all sizes. The design of the ancillary structures of the rising mains, including air valves, isolating valves and inspection chambers should satisfy the requirements in the checklists. The requirements on provision of twin rising mains with both on duty should be followed, in all circumstances except with strong justifications, to facilitate future inspection and repair works of the rising mains.

Desilting compounds

3.4 The checklist provides comprehensive guidelines for designing a desilting compound for effective operation and removal of silts and sediments throughout the design life. The designer shall give thorough considerations on equipment for desilting operation, possible aesthetic impact due to the compounds, design enabling future inspection and

maintenance requirements, safety in operation, reliable communication system, emergency contingency and proper training of personnel.

Gravity sewers and storm drainage pipelines

3.5 The checklist is applicable to gravity sewers and storm drainage pipelines of all sizes. In particular, twin-pipe system should be considered in deep trunk sewers to facilitate future maintenance works while their operation could be maintained. Gravity sewers are also recommended to be surrounded by concrete, especially for those pipes which are susceptible to corrosion and which are critical trunk sewers with high flows where there are no practical means of flow diversion, in order to enhance the pipe strength and durability.

Flood storage tanks

3.6 The checklist is applicable to stormwater storage tanks with or without pumping system serving as a temporary buffer for storing excessive rainwater during rainstorms to relieve the burden of the trunk drainage system. The design shall include considerations on vehicular/pedestrian accessibility, safety, pumping (if applicable), communication system, ventilation & lighting, security, environmental issues and maintenance as well as post-construction monitoring. Essential design parameters shall be clearly recorded in the Operation and Maintenance Manual.

Village sewerage

3.7 The checklist is applicable to village gravity sewerage system. The O&M requirements in respect of pipe size, covers, manhole types, pipe materials are given in the checklists and should normally be followed. Under special circumstances, project office may propose alternatives with justifications for consideration and agreement by the maintenance office.

Stormwater inlets

3.8 The checklist is applicable to stormwater inlets of medium to large size (i.e. conduits of diameter 900 mm or above), and covers the design of stormwater inlets and their ancillary structures. The design considerations cover functional, hydraulic, safety and O&M aspects, which are based on and make reference to DSD Practice Note No. 1/2003.

Septicity control

3.9 The checklist is applicable to all sewerage facilities including gravity sewers, rising mains and sewage pumping stations. Serious attention should be paid in septicity control during design as this issue, if not properly addressed, in addition to causing

nuisance to the public, could cause corrosion problem and affect the safety of the personnel undertaking maintenance works at the sewerage facilities.

Drainage channels

3.10 The checklist provides comprehensive requirements covering channel configurations, linings, maintenance access, sizing, grit traps, safety issues, environmental impacts and landscaping. The designer should approach the maintenance authority for any requirements which cannot be complied with, due to site constraints or other considerations.

Flood pumping schemes

3.11 This checklist covers the design considerations for polders and floodwater pumping schemes with their associated embankments, flood protection structures, flow control devices, hydraulic structures and floodwater storage facilities (excluding requirements on pumping facilities and associated E&M works). These schemes are designed to separate low-lying catchments from surrounding land. Surface runoff collected inside the polder will be pumped appropriately to nearby existing watercourses outside the polder.

Dry weather flow interceptors

3.12 The checklist is compiled with reference to DSD Technical Circular No. 4/99 and DSD Practice Note No. 2/2003. The overriding design principle is to ensure that the dry weather flow interceptor while intercepting and diverting the polluted flow to public sewers should not compromise the proper functioning of the stormwater drain in preventing flooding.

Multipart covers

3.13 The checklist covers the guidelines for designers to ensure that the proposed multipart covers should be suitably located to avoid potential operation and maintenance problems which are commonly encountered.

Tidal control structures

3.14 The checklist is applicable to tidal control structures such as penstocks, inflatable dams, non-return flap valves, tidal gates, and the control mechanism. The design of the ancillary structures of the tidal control structures such as channel outfall, tidal channel bypass and irrigation facilities should also satisfy the requirements in the checklists. The requirements on the O&M aspect should be followed, in all circumstances except with strong justifications, to facilitate future inspection and necessary repairing works of

the tidal control structures.

Rain gauges, river gauges and tide gauges

3.15 The checklist is applicable to the selection of equipment for gauging stations. It gives the general guidelines on O&M requirements and E&M input required in the detailed design.

Flood warning systems

3.16 The checklist is applicable to the selection of equipment for construction of flood warning systems. It gives the general guidelines on O&M requirements and E&M input required in the detailed design.

Design calculation checking

3.17 The checklist is applicable to the design of stormwater drainage and sewerage systems. The major design standard and design requirements are specified in the Stormwater Drainage Manual and Sewerage Manual of DSD. The project office should also observe the requirements stipulated in the Technical Circulars and Practice Notes of DSD, where applicable.

4 HANDOVER OF WORKS

4.1 Due considerations incorporating the O&M requirements in the design checklists should be made in the design stage to facilitate the future operation and maintenance of the works. In case the requirements in the checklists could not be fulfilled, the project officers / consultants shall, during the design stage if appropriate, consult the O&M divisions. The responsible officer of the O&M divisions shall record the compliance of the works against the checklists during handover process, with remarks on the justifications for those not meeting the requirements.

5 ENQUIRY

5.1 Enquiries on this PN should be addressed to Senior Engineer/Tuen Mun, Mainland North Division.

6 REFERENCE DOCUMENTS

i. Stormwater Drainage Manual of DSD
ii. Sewerage Manual of DSD

iii. DSD Practice Note No. 1/2010 – "Guidelines for Hand-over of Completed Works to Operation and Maintenance Parties"

7 ANNEX

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(W H KO)
Deputy Director of Drainage Services

ANNEX 1

Design Checklist on O&M Requirements for Drainage Tunnels

Item	Sub-item	Requirements	Compliance (Y/N)
Accessibility		• Intakes/outfalls and tunnel adits should be accessible from public roads or DSD allocated roads. • The tunnel should be designed with adequate number of access points, chambers and adits to facilitate vehicular or man entry. • Distance between intermediate access chambers and adits should be carefully considered taking into account the confined space nature of the tunnel, limitation of the ventilation and communication systems for maintenance personnel and the access length limitation of the inspection equipment (e.g. workable cable length of CCTV survey camera etc.)	
Safety		• Safe and proper access, such as staircase (long cat ladders not preferred), intermediate platform, safety chain and safety grille to prevent maintenance personnel from falling etc. should be provided. • Handrail, guided rail or barricades should be provided to staircases. • Two earthing systems should be separately provided for electrical installation & lightning protection system. • Emergency rescue procedure shall be provided and agreed with FSD. • On-shore warning signs for the public should be provided to indicate the location of outfall and to warn vessels against the sudden discharge of stormwater.	
Communication System		• A good and reliable communication system for maintenance personnel and rescue team shall be provided.	
Ventilation		• Forced ventilation is preferable to natural ventilation for inspection and maintenance operation. • Natural ventilation may be acceptable subject to detailed assessment of airflow in tunnel design.	
Security		• The entrance of tunnel portals, adits, chambers and access points shall be locked and fenced off to prevent illegal entry and trespassing. • CCTV or other security system such as infra-red movement detection system should be provided if appropriate. Illumination system should be provided at outfalls or critical locations if appropriate.	
O & M Manual	Content	• The O&M manual shall include, amongst other essential information,	

Item	Sub-item	Requirements	Compliance (Y/N)
		1. items to be inspected, possible defects, repair methods with labour, materials and plants specified, 2. regular maintenance works required such as desilting with detailed method statements, labour, materials and plants specified, 3. a maintenance schedule with frequency of inspection, 4. proposed structural inspection by Registered Structural Engineer or engineer with tunnel design/construction experience with scope and frequency given, 5. authorities to be notified such as FSD, EPD, railway companies etc. before and after inspection, operation or maintenance works, 6. arrangement for flow bypass, diversion or temporary storage, 7. temporary traffic arrangement with approved traffic diversion plan, 8. safety procedures, 9. emergency contingency plans, escape routes, and agreed rescue procedures, etc. ● Project team may be required to demonstrate successful inspection and maintenance operation before handover to O&M team.	
Intake/ Outfall	1. Inspection and Maintenance Operations	● Sufficient working area should be provided to facilitate inspection and maintenance operation, such that the intake/outfall shall be able to accommodate construction vehicles or sitting of cranes. If negative, lay-by, parking space, etc. in adjacent to the intake/outfall should be provided. Temporary Traffic Management Scheme for each intake should be provided in the O&M Manual. ● Inspection pits, if appropriate, should be provided to facilitate inspection and maintenance operation. ● Isolation of each compartment of intake/outfall to facilitate inspection and maintenance operation should be provided. Isolation can be achieved by means of stormwater bypass, provision of grooves for shuts, stoplogs, penstocks etc. depending on the design constraints and characteristics of the intake/outfall. ● If electric operated penstocks are proposed, permanent power supply system should be provided for the electric actuator. ● It should be well equipped with provision of lifting devices, ground anchors for securing safety harness, permanent power supply (if appropriate), working platform, etc. ● A safety grille or chain should be placed as a separation between the intake chamber and the vertical drop shaft.	

Item	Sub-item	Requirements	Compliance (Y/N)
		• Lighting facility, ventilation and communication systems for entering the vertical drop shaft of confined space nature should be provided as far as possible.	
	2. Desilting Operation	• It should be designed to ease the removal of spoils with safe and effective method. • The collected spoils should be removed conveniently at the ground level as far as possible. • Bar screen is more preferable than square mesh from desilting point of view. • Screen of suitable bar size and spacing should be provided to reduce silts and grits accumulated in the tunnel. • Dead zones should be eliminated to avoid sedimentation. • Baffles proposed at the bottom of the vertical drop shaft for dissipating energy should not accumulate spoils such as sand, debris, rubbish and the like.	
	3. External Intake Design	• Adequate traps, grilles, bottom rack, etc. should be provided immediately at the upstream of intake to minimize ingress of rocks/tree branches/spoils into the intake. • Gratings, boulder barriers or grilles should be properly located such that overshooting or overflow will not occur.	
	4. Accessibility inside Intake/Outfall Chamber	• Transverse end gate railing should be provided at bottom of long and steep channel, if any, to prevent sliding all the way down. • All internal areas of the vertical drop shaft should be accessible for close-up inspection and maintenance as far as possible.	
	5. Outfall Discharge	• For tunnel with inverted siphon design, EPD's comment shall be sought for the water quality of stormwater discharge to the sea and other environmental and hygienic problems at outfall such as odour, stagnant water and mosquito breeding shall be assessed. • Public concern on the sudden discharge of stormwater from the outfall should be assessed.	
	6. Hydraulic Performance	• CE/LD's advice shall be sought.	

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Item	Sub-item	Requirements	Compliance (Y/N)
	7. Affected Slope	• If unavoidable, relevant information including the slope land status, proposed extent of the affected existing slopes, proposed slope improvement works, proposed maintenance party, etc. shall be given. • If the affected slope is to be maintained by DSD, the related works shall be satisfactorily designed and constructed to the satisfaction of appropriate authorities such as GEO, CEDD and all slope registration procedures shall be completed before handing over.	
	8. Aesthetic Impact	• Ventilation column or section of vertical drop shaft above ground level should be located away from sensitive receivers such as residential buildings or schools to avoid adverse impacts as far as possible. • Any above-ground installations that are visible to the public as defined in Para. 4 under DSD Technical Circular No. 9/2006 shall be submitted to VCAB for vetting and approval, unless otherwise advised by in-house landscape architect.	
	9. Planting	• Planting should be provided to improve greening effect. • Proposed planting species shall be submitted to Landscape Architect, DSD for comments. • Automatic irrigation system should be provided as far as possible. • Proper access to the planting area should be provided to facilitate horticultural maintenance.	
	10. Fire Service Installation	• An experienced profession with sufficient knowledge shall be assigned to design the fire service installation, emergency access and rescue procedures, and make a submission to FSD for consideration and agreement.	
Tunnel	1. Design philosophy	• The tunnel shall be designed in such a way that requires minimum maintenance during its service life. • The tunnel shall be designed to facilitate all the inspection, operation and maintenance works to be carried out in an effective, efficient and safe manner.	
	2. Alignment	• It shall be designed in the manner that the development potential in the vicinity shall not be undermined and there shall be no encroachment upon any existing railway protection boundaries without prior agreement from relevant authorities.	
	3. Lining	• Lining design shall satisfy water proofing and water tightness requirements. • Preferably, the tunnel should be designed to satisfy a "no-drip" requirement. If not possible, it is necessary to limit the seepage and leakage with a well-defined and	

Item	Sub-item	Requirements	Compliance (Y/N)
		justified maximum allowable infiltration rate. ● GEO, CEDD's advice shall be sought. ● If high strength concrete, such as Grade 60 or above, is proposed for the lining, sound justifications should be provided. ● The number of construction joints should be minimized. ● Warranty should be provided for the proposed gaskets for lining.	
	4. Inspection and Maintenance Operations	● There shall be sufficient working area to facilitate inspection and maintenance operation, such as there should be open area for the wet silts to be dried out and temporarily stored before disposal to the landfill site. ● It should be well equipped with provision of lifting devices, ground anchors for securing safety harness, permanent power supply (if appropriate), working platform etc. ● Emergency rescue procedure shall be provided and agreed with FSD. ● Lighting facility, ventilation and communication systems for entering the tunnel of confined space nature should be provided as far as possible. ● If the tunnel will run above or below some sensitive structures such as reservoirs, treatment works, water tunnels, railway lines etc., the possible adverse impacts arising from the future inspection and maintenance operation and the running of the tunnel inspection vehicles inside the tunnel to these sensitive structures shall be assessed. ● Chainage should be marked on the tunnel lining for ease of identification of location. Similarly, level markings should be made on the shafts. ● Sufficient maintenance provision to enable to access, inspect & repair leaky cable installation within the tunnel, should be provided.	
	5. Low flow Channel	● The low flow channel should be designed so as to minimise siltation problem during low flow condition and facilitate both desilting operation and manoeuvring of tunnel inspection vehicles.	
	6. Isolation / Flow Diversion	● The design should enable isolation of tunnel for routine inspection and maintenance. Isolation can be achieved by means of a dual tunnel design, temporary storage or stormwater bypass depending on the design constraints and characteristics of individual tunnel. Routine inspection and maintenance for tunnel should be	

Item	Sub-item	Requirements	Compliance (Y/N)
		preferably carried out in the dry season. ● The method of isolation of tunnel has a direct bearing on the time allowed for inspection and maintenance works. The selection of isolation method should aim to maximize the duration of retention of flow and hence the time allowed for inspection and maintenance works within the tunnel.	
	7. Tunnel Inspection Vehicles	● Tunnel design shall allow for entry by tunnel inspection vehicles. For long tunnels, sufficient entry and exit points shall be provided. A minimum of two vehicles (one for operation and the other for standby and rescue) should be provided. ● The vehicles shall be equipped with breathing apparatus and first aid kits and designed to facilitate inspection, maintenance and desilting operations if appropriate. ● Parking area and charging facility for the vehicles should be provided.	
	8. Tunnel Protection Zone	● The extent of the tunnel protection zone shall be determined not only in the horizontal dimension but also the vertical one. ● Guidelines or requirements for protection of tunnel from new works in the vicinity should be formulated such that any ground investigation and construction works that lie wholly or partially within the tunnel protection zone shall be subject to vetting and approval by the maintenance authority prior to commencement of works. In particular, a detailed geotechnical assessment to be carried out by a Registered Geotechnical Engineer on the tunnel in respect to the proposed new works shall be submitted to the maintenance authority. ● If appropriate and whenever possible, the project office shall liaise with Buildings Department to effect the tunnel protection zone through the building plans checking process and to promulgate a Practice Note for Authorized Persons and Registered Structural Engineers for that purpose and a DEVB TCW will be needed to effect the mechanism.	

ANNEX 2

Design Checklist on O&M Requirements for Large Deep Gravity Sewers

Coverage:

Gravity sewers of diameter not less than 675 mm and invert levels exceeding 6 m below ground level

Item	Sub-item	Requirements	Compliance (Y/N)
Design Consideration	1. General	• In the design of new sewerage facilities, evaluation of various alternatives, including the adoption of shallower sewers by the provision of intermediate pumping stations and localized sewage treatment plants if necessary, should be carried out. • To facilitate inspection and maintenance of surcharged sewer, over pumping is usually required to draw down the sewage level in the sewer. If flow diversion by over pumping for regular inspection and maintenance is not practically feasible or at road junction of heavy traffic, the designer should give considerations to a twin line design.	
	2. Choice of Twin Line Design	There are generally three ways, in priority order, to provide twin sewer system for alternate isolation of one line for inspection, maintenance and repair: • The preferred choice is parallel sewers laid in different streets with interconnections at suitable points with stopboards to facilitate diversion and isolation. Sufficient internal space in the manhole shall be provided for placement of stopboards after removal. They may be designed to take peak flow with sufficient spare capacity so that each of the sewer sections may be isolated during low flow at night; • Alternatively, designer may consider providing twin duty sewers as mentioned above but laid at the same route. The manhole spacings shall be suitably set to enable the inspection/maintenance to complete within the low flow period; and • As the last resort, a standby sewer as the duty line with stopboards at access chambers for isolating either line. If the horizontal space is a limitation, the standby sewers can be placed in a "double-deck" form, which acts as siphon or inverted siphon. However, this should be considered as the last resort as isolation of flow is quite complicated.	
Maintenance Requirement If Over Pumping is	1. Manhole Design	• Manhole designed for placing pumps shall be located with due considerations on road traffic diversion and noise generations.	

Item	Sub-item	Requirements	Compliance (Y/N)
Feasible	2. Over Pumping Scheme	• Feasible over pumping scheme including availability of pump, arrangement of multi-pump to cope with future flow capacity/condition (if required) should be provided.	
	3. Manhole Spacing & Location	• Special consideration is required under exceptional conditions such as manhole placed underneath bridge deck with limited headroom. • The manholes should be located at area clear from any obstructions at ground level.	
	4. Configuration of access chamber	The configuration of access chamber shall include: • Proper orientation of access chamber; • Adequate size of manhole opening; • Isolated access ladder/staircase; • Mid-platform; • Backdrop pipe or cascade for sewer larger than 450mm dia. for connecting sewers at significant different levels; and • Internal fittings such as stoplog arrangement (internal space shall be provided for placement of stoplogs after removal), built-in hooks/seats for temporary pulleys for future winching operation.	

ANNEX 3

Design Checklist on O&M Requirements – Rising Mains

Coverage

- Rising mains of all sizes;
- Valves and inspection chambers.

Item	Sub-item	Requirements	Compliance (Y/N)
Rising Mains	1. General Design	● Rising Mains – twin rising mains with both on duty under normal circumstance should be adopted. Either one rising main should have adequate capacity of allowing sewage flow during low flow condition to facilitate the inspection and maintenance of another rising main; ● Design velocity – the maximum design velocity should be limited to 3 m/s; ● Flow – steady flow inside the rising mains should be maintained; ● Settlement – for rising mains to be laid on reclaimed areas, the likely settlement in ground should be checked; ● Joints – allowance for settlement effects should be included in the design of fittings at joints; and ● The rising mains shall be designed in accordance with Section 7 of the Sewerage Manual Part 2.	
	2. Choice of Materials	● In view of durability, HDPE or GRP should be given higher priority as the choice of rising main materials, when compared with ductile iron or welded mild steel pipe lined with sulphate-resisting Portland cement mortar; ● The leakage problems of GRP pipeline due to ground settlement may be encountered and the solutions of emergency repair should be critically assessed; and ● Concrete surround should be considered to strengthen the rising mains at particular locations such as those areas with difficulties in carrying out maintenance.	
Ancillary Structures	1. Discharge Arrangement	● Location of discharge sump – discharge sump should be located away from busy/eye-catching locations and carriageways; ● Discharge sump – a baffle wall in conjunction with drop tube or vertical bell-mouth should be used to reduce turbulence inside the sump; ● The level difference between the rising mains and the possible maximum sewage level in the sump should be minimized, say within 100mm; ● Size of discharge sump should be large enough for man-entry maintenance; and	

Item	Sub-item	Requirements	Compliance (Y/N)
		• Concrete surface of discharge sump should be protected from H_2S attack (e.g. by epoxy coating).	
	2. Profiles and Valves	• Air Valves and Washouts – 1. air valves and washouts should be provided at local high points and local low points respectively; 2. the top of air valve/washout chamber should preferably match with the surrounding ground level if possible; 3. washouts should be located away from carriageways and near discharge point of sewage; 4. for rising mains longer than 1km, washouts should be located at certain intervals not longer than 500m; and 5. the washout chamber should be provided with a pump sump. • Isolating Valve – For rising mains longer than 1km, at least one isolating valve should be provided. • Valve chamber should not be constructed under vehicular access or pavement. It should be properly sealed up to minimize the ingress of water or grit. • The air valve and associated isolation valve should be located above ground level for ease in inspection and maintenance.	
	3. Inspection Chamber	• Inspection chambers should preferably be provided at bends or at interval not longer than 120m for straight sections and must be at appropriate locations (e.g. verge, footpaths, etc.) and not on traffic sensitive locations like carriageways; • A removable standard T-section with inspection hatch should be provided to facilitate the CCTV survey and lining works. As such, a minimum 1,500mm length of pipe section should be removable, which could be made up of a standard T-section with an inspection hatch and an addition short section; • Concrete seating should be provided underneath to support any sections of removable parts/pipes; • A minimum working space of 900mm between the outermost edge of the pipe and the internal wall of the chamber should be provided to facilitate maintenance operation; • The pump sump inside the chamber should be positioned directly beneath one of the openings to facilitate handling of pumps; • A suitable fall of 5% for the bottom slab should be provided such that all remaining water could be collected	

Item	Sub-item	Requirements	Compliance (Y/N)
		from the pump sump; ● A chamfer of 300mm x 300mm should be provided along the turning edge of the vertical wall and the intermediate slab of the chamber to avoid damaging the lining material; ● Lifting eyes / appliance should be provided above the removable section of pipes and under the soffit of the top slab; and ● For pipelines stacking vertically one above the other, the removable sections should be arranged to place above the straight run pipeline. The clearance between the upper and lower pipes should be at least 600mm. The clearance of 600mm is also applicable to pipes placed horizontally at the same level.	

ANNEX 4

Design Checklist on O&M Requirements for Desilting Compounds

Item	Sub-item	Requirements	Compliance (Y/N)
Design Philosophy		● The design standards such as the hydraulic design, material properties, lining design, structural design to achieve the intended use throughout the design life should be well documented. ● The permanent structure should be designed to the latest standards. If the structure is subject to permanent vehicular or pedestrian live loads, Structures Design Manual of Highways Department shall be followed. ● The box culvert shall be designed in accordance with Section 12 of the Stormwater Drainage Manual.	
Equipment for Desilting Operation	1. General	● It should be designed to remove the silts and sediments with safe and effective methods. ● All penstocks and stoplogs supplied should be provided and checked with complete description by the manufacturers, including material information, test certificates, past-job reference, operation and maintenance manuals, etc. ● Project team should demonstrate a workable method for the desilting operation to be carried out with minimum disruption to the operation and the environment. A schedule of permanent equipment should be listed out. Temporary equipment for desilting operation, such as portable submersible pumps and power generators, should be recommended in the O&M Manual.	
	2. E&M Equipment	● All electrical equipment shall be explosion proof, water proof with high reliability and easy maintenance. The electrical installations shall comply with all relevant standards, local codes of practice and CLP Power's/HKE's supply rules. ● Lighting facilities with sufficient luminaries should be provided. Lighting switches should be located with easy access. The light fittings should be suitably located for normal access, maintenance & operation purposes. ● The total flow rate for the deodorizer should be based on the desilting operation and the deodorizer shall satisfy the requirements shown in Table 2 of the Sewerage Manual Part 2. If sedimentation tanks are used during the desilitng operation, the deodorizer will be used to deodorize the odorous and hazardous gas in the sedimentation tanks. If the silt and sediment are stockpiled inside the building, the whole building will be deodorized. The type and design life of the deodorization unit should be specified. ● Forced ventilation is preferable to natural ventilation for inspection and maintenance operation.	

Item	Sub-item	Requirements	Compliance (Y/N)
		● The mechanical ventilation system shall comply with the codes of practices and regulatory requirements. ● Filtering tanks and slurry pumps for handling the silts should be provided if needed.	
Aesthetic Impact		● Any above ground installations that are visible to the public as defined in Para. 4 under DSD Technical Circular No. 9/2006 shall be submitted to VCAB for vetting and approval. ● Planting should be provided to improve greening effect. ● Proposed planting species shall be submitted to Landscape Architect, DSD for comment. ● Automatic irrigation system should be provided as far as possible. ● Proper access to the planting area should be provided to facilitate horticultural maintenance. ● For avoidance of environmental nuisances, the proposed desilting compound should be located away from sensitive receivers and public areas as far as possible.	
Inspection and Maintenance		● Sufficient working area should be allowed for the inspection and maintenance operation. ● An O&M Manual shall, among others, include : 1. Frequency of inspection; 2. Recommended trigger levels for desilting; 3. Operation procedures for the tidal barrier if applicable; 4. Dewatering criteria and procedures; 5. Drying process; 6. Sediment removal; 7. Odour control; 8. Disposal arrangement; 9. Environmental considerations; 10. Maintenance of E&M Equipment; 11. Spare parts and storage; 12. Arrangement for flow bypass, diversion or temporary storage; 13. Safety procedures; 14. Emergency contingency plans, escape routes, and agreed rescue procedures etc.	

Item	Sub-item	Requirements	Compliance (Y/N)
		• Project team is required to demonstrate successful inspection and maintenance operations before handover to DSD.	
Safety		• Safe and proper access, such as staircase (long cat ladders not preferred), intermediate platform, safety chain and safety grille to prevent maintenance personnel from falling etc. should be provided. • Handrail, guided rail or barricades should be provided to staircases. • Earthing installations should be provided for all electrical installations to minimize lightning hazards. • The health and safety of the operatives shall be addressed for the daily operation, inspection, and maintenance of the system. • All temporary and permanent works shall be designed with reference to the guidelines laid down in the DSD Safety Manual. Works in the confined space shall follow the guidelines laid down in the DSD Practice Note No. 1/2007. • The entrance of desilting compounds, access points, chambers should be fenced off and locked to prevent illegal entry and trespassing. • CCTV or other security system such as infra-red movement detection system should be provided if appropriate. Illumination system should be provided at prominent locations if appropriate.	
Communication System		• A good and reliable communication system for maintenance personnel and rescue team shall be provided.	
Contingency Plans for Emergency		• An experienced profession with sufficient knowledge should be assigned to design the fire service installation, emergency access and rescue procedures. • Planned system of work shall be provided for the prompt rescue of any person who may be injured or collapsed. • Emergency rescue procedure shall be provided and agreed with FSD. • Guidelines for the operating procedures shall be established for prevailing warning messages issued by the Hong Kong Observatory such as thunderstorm warning, flood warning, rainstorm warning signals, or tropical cyclone warning signals are in force. • If there is power failure, a separate power supply should be in place to ensure a fail-safe operation for the overflow system, if applicable.	

Item	Sub-item	Requirements	Compliance (Y/N)
		● Power failure alarm signal should be transmitted to one of the regional plants to alert the duty staff.	
Training		● Instruction and training in the key areas shall be provided and documented properly.	

ANNEX 5

Design Checklist on O&M Requirements for Gravity Sewers and Storm Drainage Pipelines

Item	Sub-item	Requirements	Compliance (Y/N)
Design Philosophy	**1. General**	• The hydraulic analysis, structural design of buried pipelines, manhole and other auxiliary drainage design shall be carried out in accordance with the Stormwater Drainage Manual and Sewerage Manual (Part 1). • For trenchless construction methods, the design standards such as the pipe material properties and the structural design of pipelines should be stated. • Inverted siphon or adverse (negative) gradients are undesirable from the maintenance viewpoints. It should only be allowed under exceptional cases and should be well justified. • For deep trunk sewer, twin-pipe system, instead of single pipe system, should be considered for ease of future maintenance works. The designer should discuss and agree with the respective O&M Divisions if there is any deviation from the requirements.	
	2. Choice of Pipe Material	Typical sewer materials and their characteristics should refer to Table 8 of Sewerage Manual (Part 1). In addition, updated sewer material specifications are as follows. • All ductile iron pipes and fittings for sewerage applications shall comply with BS EN 598. The pipes shall be externally coated with a metallic zinc coating covered by an outer epoxy coating and internally lined with high alumina cement mortar. The zinc coating shall be in accordance with ISO 8179. The fittings and accessories shall be externally and internally coated with epoxy coating. • All polyethylene pipes shall comply with BS EN 12201:2003 or BS EN 13244: 2002. • All glass-reinforced thermosetting plastics pipes shall comply with BS EN 1796:2006 or BS EN 14364:2006.	
	3. Hydraulic Performance	• Advice from CE/LD shall be sought. When required, the following documents should be submitted to CE/LD for his examination and endorsement. 1. Design methodology, parameters and criteria; 2. Drainage/Sewerage impact assessment; 3. Hydraulic models with input file, rainfall/runoff file and simulation results for the existing and post development scenarios.	

ANNEX 5

Item	Sub-item	Requirements	Compliance (Y/N)
	4. Concrete Surround	● Gravity sewers are recommended to be surrounded by concrete, especially for those pipes which are susceptible to corrosion and which are critical trunk sewers with high flows where there are no practical means of flow diversion, in order to enhance the pipe strength and durability. The designer should discuss and agree with the respective O&M Divisions if there is any deviation from the requirements.	
Alignment & Accessibility		● New drains/sewers should be accessible from public roads or public footpaths (in case of village drainage/sewerage). ● Manholes and/or desilting manholes shall be provided at appropriate locations as required in the Stormwater Drainage Manual and Sewerage Manual (Part 1). ● For future maintenance operation, the alignment of the new drain/sewer shall be carefully considered taking into account the feasibility of temporary traffic arrangement scheme. Particular attention should be paid to the steep carriageway, heavily trafficked carriageway, single lane one way carriageway and road junction. Project team is required to apply for a drainage reserve condition from DLO, Lands Department if the location of drains/sewers lies outside the public footpath and/or carriageway. ● The depth of the drains/sewers shall comply with the requirements as stipulated in Highways Department Technical Circular No. 3/90 - Minimum cover Requirement for Underground Services.	
Safety		● Safe and proper access to the manhole, such as step iron or cat ladder, intermediate platform, handrailing and safety chain made up of cast iron, or stainless steel to fit the site condition to prevent maintenance personnel from falling etc. shall be provided. ● Cat ladders immediately under multipart covers of manholes/chambers should be equipped with extension handles for safe access/egress. ● Standard 675mm square double triangular ductile iron manhole cover and frame should be used. If necessary, restraint details to manhole cover as per DSD Standard Drawing DS 1086(2) should be provided.	
Inspection & Maintenance	**1. Equipment for Desilting Operation**	● Penstocks or stoplogs provided, if any, shall be checked with complete description by the manufacturer. The choice of penstock or stoplog should depend on site conditions. Designers are advised to discuss with O&M parties before	

Item	Sub-item	Requirements	Compliance (Y/N)
		finalizing the equipment. Spare parts of commonly used apparatus are required to be supplied to O&M team of DSD for custody.	
	2. Manhole Cover	● The use of standard size multipart covers shall be submitted to the O&M team of DSD for comments. Spare parts are required to be supplied to O&M team of DSD for custody.	
	3. Slope Drains	● Project team is required to check if the drains/sewers to be installed are within the influence zone of adjacent slope(s), if any. Relevant information shall be provided for updating in the Slope Drain Maintenance Information System of DSD.	
	4. Manhole Identification Tags	● For all new manholes, project team is required to apply for manhole identification numbers from the drawing office of O&M team of DSD and to install the manhole identification tags upon the completion of the manhole construction.	
	5. Connection	● Proposed outlet pipe should be connected to the existing pipe by means of an existing or new manhole. Direct Connection by Y-junction to existing pipes should be avoided. ● Backdrop manhole shall be provided if the level difference is greater than 600mm.	
	6. Terminal Manholes	● For every drainage connection from a private development, government building, rest garden or housing estates, etc., a terminal manhole in accordance with relevant DSD Standard Drawings should be provided.	

ANNEX 6

Design Checklist on O&M Requirements for Flood Storage Tanks

Item	Sub-item	Requirements	Compliance (Y/N)
Accessibility		● Storage tank, its inlets and outlets should be accessible from public roads. ● Vehicular access ramps should be provided to facilitate inspection, de-silting operation and manoeuvring of inspection vehicles. If ramps could not be provided, multi-covered openings should be considered. ● The storage tanks should be designed with adequate number of access points, and chambers to facilitate vehicular or man entry and/or temporary ventilation purpose. ● Distance between intermediate access chambers should be carefully considered taking into account the confined space nature of the tank, limitation of the ventilation and communication systems for inspection/maintenance personnel and the access length limitation of the inspection equipment (e.g. workable cable length of CCTV survey camera etc.)	
Safety		● Convenient access points for portable gas detection should be provided for safety check before entry to storage tank. ● Emergency exits, routing signs and level markings at appropriate locations should be provided inside the tank for alertness and emergency evacuation. ● Safe and proper access, especially to the conveyance channel and low flow interceptor chambers (if applicable), such as staircase (long cat ladders not preferred), intermediate platform, safety chain and safety grille to prevent maintenance personnel from falling and drowning etc. should be provided. Staircase or cat ladder made by FRP instead of metal is preferred. ● Handrail, guided rail or barricades should be provided to staircases. ● Proper lifting equipment, machinery, adequate anchor points and working procedures, in particular for the lifting of multi-part covers of openings, should be provided. ● Earthing installations should be provided for all electrical installations and communication equipment and metal parts to minimize lightning hazards. ● Emergency rescue and drill procedure shall be provided and agreed with FSD.	

Item	Sub-item	Requirements	Compliance (Y/N)
Pumps		● Effective pumping installation is required for large underground tanks and low flow interceptor chambers or the like for dewatering to facilitate inspection and maintenance works inside the tank. Portable pump for dewatering inside the low flow chamber can be considered and preferred if it is anticipated the pumping installation may be of infrequent usage. ● Pump sumps should be provided and invert slab should be graded to effect draining.	
Communication System		● An efficient and reliable communication system for maintenance personnel and rescue team should be provided. The system shall be safe for the maintenance personnel. i.e. safety risk of lightning strike along the cable and repeaters inside the tank should be considered and be envisaged .	
Ventilation & Lighting		● Forced ventilation with adequate fresh air intake and lighting inside the tank area are required for inspection/maintenance operation and odour/complaint considerations.	
Security		● The entrance of storage tanks, access points, chambers and the ancillary structures/buildings should be fenced off and locked to prevent illegal entry and trespassing. Metal sheet gate with perimeter lighting and CCTV system should be provided for security purposes.	
Environmental Issues	1. Odour	● The odour impact of silting accumulated inside the tank with recommended inspection/maintenance frequency and mitigation measures should be addressed fully before commencing detailed design. This is particularly a problem if tank is affected by tidal water bringing back marine sediments/suspended solids from the sea. ● Dry weather flow and upstream flow going into the tank and potential contamination should be carefully considered in the design stage and proper treatment (if required) and disposal of the potential contamination material should be fully addressed as early as possible before and during the design stage.	
	2. Visual and Other Public Nuisance	● Fresh air intakes and ventilation discharge column above ground level should be minimized and located away from sensitive receivers such as residential buildings or schools to avoid adverse impacts. Suitable screening to reduce the visual impact is required. ● Options like roof garden, sky-lights and open area should be carefully considered in the vicinity of public amusement area such as sportsground, especially for any effects and inconvenience/nuisance brought to the public	

Item	Sub-item	Requirements	Compliance (Y/N)
		during inspection/maintenance operation.	
Operation		● Sound operation philosophy to mitigate flooding should be ensured. ● Robust operation against peak flow should be ensured. ● Worst case scenario consideration (assuming the major system breakdown due to power failure, power breakdown or the like) – flood storage and flood relief path (by-pass, flow diversion) should be considered. ● If electricity penstock, flap gate or sluice gate are installed, provision of electricity and standby power should not be overlooked.	
Maintenance	1. Design Philosophy	● The storage tanks should be designed to be simple, reliable and requiring minimum maintenance during its service life. ● The storage tanks shall be designed to facilitate all the inspection, operation and maintenance works to be carried out in an effective, efficient and safe manner and preferably in the dry season and restricted local de-silting areas.	
	2. Inspection and Maintenance Operations	● The layout of columns and walls of underground tank should facilitate de-silting vehicle operations. ● There should be sufficient working area to facilitate inspection and maintenance operation, such as open area for the wet silts to be dried out and temporarily stored before disposal to the landfill site. ● Chainage should be marked on the storage tanks for ease of identification of location. Similarly, level markings should be made at access points.	
	3. Inlet and Outlets	● Weirs shall be designed to be robust and free from blockage. Vertical bar screen is preferred to be crossed. ● Automatic raking and collection of debris should be provided. In case of congested sites, designated facilities for removal of debris with a portion of manual and/or mechanical input could be a feasible alternative.	
	4. Low Flow Channel	● The low flow channel should be designed so as to minimise siltation problem during low flow condition and facilitate both de-silting operation and manoeuvring of inspection vehicles.	

Item	Sub-item	Requirements	Compliance (Y/N)
	5. Isolation / Flow Diversion	● The design should enable complete isolation of storage tanks for routine inspection and maintenance. ● The method of isolation of storage tanks has a direct bearing on the time allowed for inspection and maintenance works. The selection of isolation method should aim to maximize the duration of retention of flow and hence the time allowed for inspection and maintenance works within the tank.	
	6. Inspection Vehicles	● For large storage tanks, the design should allow for entry by common construction vehicles for inspection/maintenance purpose. For this type of tanks, sufficient entry and exit points should be provided. ● Adequate sweep path and U-turn facility for the vehicles should be provided.	
	7. Drainage Reserve	● Standard drainage reserve clause should be applicable to storage tanks for DSD's maintenance works.	
Post-project Monitoring		● Flow and level sensors should be provided. If the site conditions permits, fixed type flow and level sensors may be provided.	
O & M Manual	Content	● The O&M manual shall include, amongst other essential information: 1. items to be inspected, possible defects, repair methods with labour, materials and plants specified, 2. regular maintenance works required such as de-silting with detailed method statements, labour, materials and plants specified, 3. a maintenance schedule with recommended time and frequency of inspection, 4. proposed structural inspection by Registered Structural Engineer with scope and frequency given, 5. authorities to be notified such as FSD, EPD, railway companies etc. before and after inspection, operation or maintenance works, 6. arrangement for flow bypass, diversion or temporary storage, 7. temporary traffic arrangement with approved traffic diversion plan, 8. safety procedures, 9. emergency contingency plans, escape routes, and agreed rescue procedures etc., 10. as-built drawings and essential construction records, 11. suppliers and manufacturers of material/equipment adopted, 12. schedule of spare parts, if applicable ● Project team may be required to demonstrate successful inspection and maintenance operations	

Item	Sub-item	Requirements	Compliance (Y/N)
		before handover to O&M team. ● All operational settings for the flood protection scheme should be reviewed and updated if necessary amongst all relevant parties in DSD. i.e. LD Division, O&M Divisions, ST Division and BCM. Procedure for such review shall be provided in the O&M Manual.	

ANNEX 7

Design Checklist on O&M Requirements for Village Sewerage

Item	Sub-item	Requirements	Compliance (Y/N)
Sewerage Pipelines	1. Pipe Size	● Village sewers should normally be not less than 200mm in diameter. Under special circumstances, such as congested site conditions, small diameter pipes may be adopted subject to agreement of the maintenance party.	
	2. Y-junction	● No Y-junction is allowed.	
	3. Minimum Cover	● Minimum cover of 900mm and 450mm should be adopted for carriageway and non-carriageway respectively. Since it is difficult to classify carriageway or non-carriageway in village area, minimum cover of 900mm should be adopted for area where vehicle can reach. In case minimum cover cannot be provided due to site constraint, suitable protection measures should be considered to protect the sewer from vehicular load.	
Manholes	1. Special Manholes	● DSD standard manholes should be adopted as far as practicable. Use of special manholes should be justified and agreed by maintenance office.	
	2. Manhole Covers	● For manholes more than 1.2m deep, manhole cover of 675mm x675mm should be used. Step irons should be also installed at 300mm c/c staggered.	
		● Single seal manhole cover should be used except terminal manhole and manhole close to sensitive odour receivers. Use of double seal cover should be agreed by the maintenance party.	
		● Use of recessed manhole cover shall be agreed by the maintenance party.	
		● Chains as restraint to double triangular manhole cover	

Item	Sub-item	Requirements	Compliance (Y/N)
		shall be installed according to DSD Standard Drawing No. DS1086.	
		● Manholes should not be positioned at entrance or crossroads as far as possible.	
Pipe Materials	Choice of Pipe Materials	● Pipe materials should be recommended by the project office with considerations to factors listed in para. 5.3.2. of Sewerage Manual Part 1 and characteristics of village sewerage project. Pipe materials, which may be more than one type in a project, shall be discussed and agreed by the maintenance party. ● Characteristics of village sewerage projects which may affect the choice of pipe materials include:- 1. Pipe laying in narrow carriageways or alleys; 2. Congested underground utilities; 3. Restricted access for construction vehicles and plant. Excavation and works have to be carried out manually; 4. Close proximity to houses/residents; and 5. Durability and corrosion resistance. ● Similar to other sewerage projects, vitrified clay pipe should normally be accepted by maintenance party for small to medium size gravity sewer. ● UPVC pipe would also be accepted as an alternative to vitrified clay pipe for small size gravity sewer if the site conditions satisfy one or more of the following conditions and use of vitrified clay pipe is undesirable:- 1. Pipe laying in narrow alleys; 2. Congested underground utilities; and 3. Restricted access for construction plant and trucks. Delivery and pipe laying works have to be carried out manually.	

ANNEX 7

Item	Sub-item	Requirements	Compliance (Y/N)
		• UPVC pipe should be concrete surrounded according to DSD Standard Drawing No. DS1049B to avoid damage by point loading. • For exposed pipework which may be required to suit topography, ductile iron pipe can be used. • For sewer larger than 600mm diameter, concrete pipe with internal protective layer such as modified PVC and HDPE liners should be considered. Other pipe materials such as ductile iron pipe, glass-reinforced plastics pipe and HDPE pipe might also be used if they are justified and agreed by maintenance party.	
Tapping Point		• Tapping points reserved for sewer connection should be properly end-plugged to prevent stormwater inflow into the sewers.	

ANNEX 8

Design Checklist on O&M Requirements for Stormwater Inlets

Coverage

- Stormwater inlets of medium to large size (conduit of diameter 900 mm or above)

Item	Requirements	Compliance (Y/N)
Design Objectives	● The design objective of stormwater inlet is to ensure efficient transfer of flow from natural stream or engineered channels to underground conduits. ● Hydraulic adequacy should be checked (e.g. Avoid risk of flooding or overshooting). ● Risk of flooding due to blockage at inlet or downstream drains by materials washed down should be minimized. ● Risk of safety to the public and workers carrying out maintenance should be minimized. ● Required maintenance resources should be minimized with introduction of measures to facilitate future maintenance.	
Risk Assessment	● Assess probability and impact of flooding according to DSD Practice Note No. 1/2003.	
Hydraulic Analysis	● Hydraulic analysis should be carried out to check hydraulic adequacy at peak flow. ● Design return period of flood event as specified in DSD Practice Note No. 1/2003.	
General Layout	● Stormwater inlet is to provide smooth transition from upstream stream/channel to underground pipeline/culvert. The following situation should be paid with special attention : 1. Transition in width from upstream stream/channel to downstream conduits; 2. Change in slope and the consequential change in flow regime and flow depth; 3. Whether the flow is of high velocity and the need for dissipating the energy; 4. Change in horizontal alignment and the need for specially designed bend (long radius bend), benching, cover, etc.	

ANNEX 8

Item	Requirements	Compliance (Y/N)
Retention of Solids Washed Down with Flow	• Devices to retain solids washed down with the flow (trash grille, silt trap and boulder trap) should be installed if these may cause blockage of the inlet or the downstream pipelines/culverts and result in flooding, or if the solids will be difficult to clear when deposited in downstream pipelines/culverts. • The following considerations should be taken into account in assessing the need for such devices : 1. Amount of silt, boulders, rubbish and/or debris (including branches of tree/shrubs) washed down with the flow, particularly during heavy rainstorms; 2. Susceptibility of stormwater inlet and downstream pipelines/culverts to blockage/sedimentation by materials washed down; 3. Difficulty in clearance of materials washed down into downstream pipelines/culverts; 4. Risk of flooding or overshooting due to : i. Blockage of trash grille by rubbish, debris and vegetation washed down; ii. Obstruction by grille or weir of traps to high velocity flow. • Design shall be in accordance with DSD Practice Note No. 1/2003. • For trash grilles, it is advisable for the bar spacing to be sufficiently wide (say, not less than 200 mm) to reduce the chance of blockage during heavy rainstorms. For trash grilles meant to retain only large-sized debris (like logs), the spacing should be even wider.	
Energy Dissipation	• Measures to dissipate the energy of high velocity flow (such as stepped channel, stilling basin or hydraulic jump) should be introduced if there is chance of overshooting/overflow (e.g. at bends, trash grilles, weirs or other obstructions). • Design shall be in accordance with DSD Practice Note No. 1/2003.	
Secondary Pipeline / Culvert	• Provision of a secondary discharge pipeline/culvert of equal capacity should be considered if the inlet is still subject to risk of blockage despite all measures taken.	
Safety Objectives &	• Prevention of entry by public to inlet and upstream channels (should these be easily accessible) – Continuous handrails, parapet wall,	

ANNEX 8

Item	Requirements	Compliance (Y/N)
Some Suggested Safety Measures	fencing or caging should be provided; ● Prevention of fall of persons into inlet/channel (for inlets/channels of substantial depth) – Fencing, horizontal grille cover or open-mesh flooring as appropriate should be provided; ● Prevention of person from being washed away – Safety grille, safety bar, safety grab-chain or similar man-arresting devices as appropriate should be provided.	
Accessibility	● Stormwater inlet should be accessible to maintenance vehicles and workers (especially for trash grille, silt trap, boulder trap, etc.). ● Method of removing materials retained in solid retention devices should be considered and the design should facilitate the method of removal (e.g. if lorry with grab is used to remove materials in a silt trap, the grab should reach most parts of the trap), and access for workers with shovel should be provided.	
O&M Requirements	● Use of pipes of too small diameter, e.g. for the drain pipes of silt traps, should be avoided. ● Dead zones in inlet should be minimized (e.g. through use of benching). ● For channels which are covered up, either the cover should be removable for inspection/maintenance, or inspection/desilting openings should be provided at suitable intervals.	

ANNEX 9

Design Checklist on O&M Requirements for Septicity Control

Item	Sub-item	Requirements	Compliance (Y/N)
Gravity Sewer	1. Gradient	● Sufficient gradients should be provided in sewers to ensure that minimum flow velocities for self-cleansing can be achieved during the lifetime of the system, including early lifetime when actual flow are much less than design flow.	
	2. Drops and Falls	● It is recognized that drop structures can result in the sewage stream picking up substantial amounts of oxygen, helping to maintain aerobic conditions and preventing sulphide generation. However, for system with sewage containing dissolved sulphide (e.g. downstream of food processing factory), drops and falls should be avoided as far as possible to reduce odour and corrosion problems caused by H_2S released from turbulence.	
		● For large flows and relatively large drop distances, vortex drops may be considered to maintain a continuous air core down the draft and provide conditions for oxygen uptake.	
	3. Junctions	● Junctions at sewer should be so designed to achieve smooth transitions between incoming and outgoing lines for prevention of eddies and deposition of solids.	
	4. Pipe Materials	● In choosing pipe materials for sewers, corrosion resistance should be one of the factors to be considered. Vitrified clay pipe is normally accepted for small or medium size sewers (up to 600mm diameter). UPVC, GRP and MDPE/HDPE pipes are also of good corrosion resistance. Concrete pipe without protective coatings should be avoided.	
Pumping Station	1. Wet well	● Wet wells of pumping stations should be so designed that it can be partitioned in order to allow efficient operation of pumps during low initial flow. Also penstocks should be provided between the partitioned wet wells.	
	2. Pump Sets	● Pump sets should be configured to enable continual pumping during low flow and enable regular flushing of sewers/rising mains.	
Rising Mains	1. Long Rising Mains	● Excessive long rising mains, say with traveling time more than 2 hours, should be avoided since prolonged retention time will enhance sulphide generation.	
	2. Twin Pipes	● Twin rising mains system should be adopted in order to reduce the volume of individual rising main and allow for the closing down of 1 pipe for inspection and maintenance if required.	
Discharge Chamber	1. Long Rising	● Special attention should be paid to discharge chambers at the end of long rising mains. Enhancement of	

Item	Sub-item	Requirements	Compliance (Y/N)
	Mains	corrosion resistance to concrete works and use of deodorization may be considered.	
	2. Bell-mouth outlet	● A vertical 'bell-mouth' outlet should be designed at the downstream end of the rising mains for a gentle submerged plume flow to minimize the release of H_2S from the discharged sewage.	
Concrete Protection		● For concrete structures including those in sewerage network, pumping stations, sewage screening plants and treatment works, use of linings or coatings should be considered. Materials with high corrosion resistance such as fiberglass should also be used.	
Self-cleansing Velocity		● Apart from sewerage networks, self-cleaning velocities should also be achieved in all channels and pipelines inside the sewage screening plants and treatment works in order to prevent solids deposition.	
Ventilation		● Adequate ventilation should be provided in enclosed areas in sewage treatment plants and pumping stations. Ventilation columns should be provided at the terminal manholes, discharge chambers and several immediate downstream manholes. De-odourizors may also be employed to control emission of H_2S into the atmosphere from the sewage facilities.	

ANNEX 10

Design Checklist on O&M Requirements for Drainage Channels

Item	Sub-item	Requirements	Compliance (Y/N)
Channel Configuration		● The horizontal and vertical profiles of the channel section should be checked such that no unaddressed violent turbulent flows or critical hydraulic jump flow profiles would result during extreme weather. ● No overtopping especially at bends due to superelevation of flow. ● Creation of fall for natural aeration and ponding for fish refuge.	
Channel Linings	1. General	● Side slope and bottom lining should normally be provided along the whole channel if the flow velocity exceeds 1 to 2m/s. If necessary, lining at slope toe should be strengthened to protect the slope from failure due to high flow velocity. ● Surface channels should be provided at the crest of the slope. ● Appropriate design should be allowed for the boundary between different slope linings.	
	2. Rigid linings	● Weep-holes should be provided in the lining for the free passage of groundwater. ● If cellular reinforced concrete paving with infill soil for grassing (CRCPG) is to be used in locations subject to tidal influence, careful considerations should be given to ensure that there are suitable grass species to be established under such condition. Sufficient establishment and maintenance period for grass, shrubs and trees of at least one year after the handing over of the landscaping works should be allowed.	
	3. Flexible linings	● If gabion is used, durability of the mesh materials should be checked. ● If the channel is subjected to tidal influence, the flexible linings should be designed to withstand wave action.	
Access for Maintenance	1. Access ramp	● Sufficient concrete or similar hard paved access ramps should be provided along the drainage channel for the access of maintenance vehicles. ● The access ramp should have a width of 3.5m and a sloping ranging from 1 in 12 to 1 in 15. ● Along the edge of the access ramp, concrete upstands instead of railings are preferred for ease	

Item	Sub-item	Requirements	Compliance (Y/N)
		of maintenance. ● For channel which base slab is always submerged due to tidal effect, intermediate platform should be provided in the ramp at level of 2.5mPD with minimum size of 5m x 20m to facilitate mobilization of dredging plant and loading and unloading of dredged materials.	
	2. Maintenance Road	● A maintenance road with a minimum width of 3.5m should be provided along one or both sides of the channel bank for maintenance works. ● If crossing structure has to be provided spanning over the channel, sufficient headroom of at least 3.5m should be provided for the maintenance vehicles. ● If the provision of a maintenance road is restrained by the availability of land, access points at strategic locations should be provided such that the whole length of the channel can still be accessed by the maintenance vehicles via the invert of the channel. If necessary, a crossing deck over the dry weather flow channel should be provided for the maintenance personnel and vehicles. The channel invert access should be in the form of narrow parallel stone or concrete tracks instead of a full width access. A 1.6 m wide footpath should also be provided along the top of the channel bank for regular inspection of the channel. ● If the maintenance road is to be open for public use, comments on the road layout design, pavement design, proposed road markings and street furniture, etc. shall be obtained from relevant maintenance authorities. Fire hydrants and proper road lighting shall also be installed according to the current standards for public road. ● For maintenance road not open to public, it is usually necessary to block off the road to guard against illegal entry. In this case, the maintenance road could be provided only along one side of the channel bank or at the channel base, if the site situation warrants. With the agreement of TD, a notice declaring the maintenance road to be a restricted zone should be posted at all entrances of the maintenance road. Adequate public consultation should be conducted if the maintenance road at the top of the channel bank is not open to public as such road would likely be requested to be open to public in future.	

Item	Sub-item	Requirements	Compliance (Y/N)
Dry Weather Flow Channel	1. General	• To minimize siltation during low flow conditions in non-tidal areas, a dry weather flow (DWF) channel with adequate silt trap facilities at appropriate locations should be provided in the invert of the main channel. • DWF channels should be shallow and narrow, and of trapezoidal or rectangular in cross section. • For narrow drainage channels, the DWF channel may be located on one side of the invert to accommodated maintenance plant. • Shallow dish channels should be provided to intercept runoff from lateral drainage inlets to the central DWF channel. Such branch off channels should be designed not to obstruct the movement of maintenance plant along the bottom of the channel. • If the dry weather flow is polluted, consideration should be given to divert the flow to the nearby sewerage system. Under such circumstances, to cope with the increased flow due to the intercepted dry weather flow, a flow limiting device should be added and the capacity of the downstream sewerage system should be checked.	
	2. Design	• A self-cleansing velocity of about 0.75 to 1m/s is normally used to size the DWF channel. • Sizing of DWF channel shall ensure 80% of the time that the dry weather flows is confined within the DWF channel.	
Grit Traps/ Sand Traps		• For drainage channels at the upstream reaches of a drainage basin, grit traps/sand traps should be provided to intercept and collect the silt and grit conveyed along small watercourses in times of storms. • The grit trap/sand trap is normally in the form of a sump or a chamber which should be accessible by grab-mounted lorries for easy desilting. Sufficient drainage should be provided to prevent stagnant water inside the trap.	
Tidal Channels		• For tidal channels where maintenance dredging is envisaged, prior consultation with Port Works Division of CEDD is required to determine the minimum water depth for their marine plant. • For tidal channels with crossing bridges, the soffit level of the bridges has to be checked to determine the minimum height for the passage of marine	

Item	Sub-item	Requirements	Compliance (Y/N)
		plant. ● Consideration should also be given to the effect of the design invert level of a tidal channel on its rate of sedimentation which is the prime factor affecting recurrent cost of the channel.	
O&M Manuals	1. Maintenance and Management Responsibilities	● The maintenance and management responsibilities of various departments concerned including DSD should be clearly defined in early planning/design stage especially in abandoned meanders, fish ponds, wetlands adjacent to the drainage channels, maintenance roads and landscaping works.	
	2. O&M Manuals	● For major drainage channel, a draft operation and maintenance manual should be provided by the design office before the handing over of the project. The final version of the manuals should include the comments by various relevant parties. It should include as-built channel profiles, system hydraulics, spare parts provided, technical requirement or catalogues of the drainage facilities or components employed, division of maintenance responsibility among departments, trigger levels for maintenance dredging, suggested monitoring schedule during operational phase, environmental issues relating to maintenance dredging, conditions of Environmental Permit, geotechnical monitoring schedule of channel embankment, safety requirements in relation to the operation and maintenance of the works and other maintenance items, such as that for the plantation requirements and the special ecological features inside the channels. ● Any requirement during operation stage under the Environmental Permit of the EIAO should be clearly spelt out.	
Safety Concerns	1. Safety Barriers	● In order to safeguard the safety of the maintenance personnel and the public, both sides of the channel should be provided with handrailings or parapets. Gates with locks should be provided at the entrances of access ramps to prevent vehicles from inadvertently entering the channel.	
	2. Staircases	● Sufficient staircases should be provided at the channel sides. The staircases should not protrude from the surface of the channel sides to obstruct the flow. Proper gates should be provided in the parapet or handrailing as entrance to these staircases. Warning signs should be erected at the parapet or handrailings near these staircases and other prominent locations to remind the public not	

Item	Sub-item	Requirements	Compliance (Y/N)
		to enter into the channel.	
	3. Notice Boards	● All embankment slopes formed in association with the construction of the channel shall be registered with GEO according to the relevant technical circular. Standard DSD signboards / notice boards for slopes and drainage channels should be erected alongside the slope edges and drainage channel edges according to the relevant technical circular before the slopes and drainage channels are handed over to the maintenance department.	
Marking System	1. Staff Gauge	● Staff gauges should be installed at the channel sides for the checking of water level in the channel. Details and installation locations of staff gauges shall be agreed with the respective operation and maintenance division of DSD.	
	2. Chainage Marker and Survey Marker	● Chainage markers and survey markers are to be installed at 100m and 200m intervals respectively on the coping of both sides of the channel. Exact details and locations of these markers shall be agreed with the respective operation and maintenance division of DSD.	
Landscaping / Plantation		● All drainage channel works should be design to blend in with the environment. Attention should be drawn to the aesthetic aspects of the channel structures and landscaping works. ● Advice for landscape consultant should be sought for any landscape treatment.	
Environmental/ Ecological Aspects		● Reference shall be made to Schedule 2 or 3 of the EIA Ordinance (EIAO) to check the necessity for and the extent of a Project Profile and an Environmental Impact Assessment for drainage channel works and shall follow the procedure laid down in the EIAO. ● For large scale of drainage channel works, impact on the ecology of the surrounding areas should be assessed in details. Mitigation measures such as wetland compensation should be devised when required. ● Conditions for abiding the Environmental Permit during operation stage under the EIAO requirements should be clearly spelt out for discussion and agreement before finalization.	

Item	Sub-item	Requirements	Compliance (Y/N)
Flap Valves		● For some low-lying areas at either side of the drainage channel, flap valves might be required at the drainage outlets to the main channel to prevent backwater flow from the main channel to those low-lying areas. ● For large diameter drain pipes or large box culverts, multi-cell flap valves should be used so as to reduce the possibility of malfunctioning of the flap valves due to blockage. ● Desilting facilities should be provided at upstream of the flap valve. ● The hydraulic impact of the flap valves on the upstream flow should be checked against potential flooding risk.	
Use of Inflatable Dam as Tidal Barrier		● Inflatable dam, if found necessary to be installed, should be equipped with an alarm system to inform the operator/controller/public in case of any unexpected deflation of the dam or loss of pressure inside the dam.	

ANNEX 11

Design Checklist on O&M Requirements for Flood Pumping Schemes

Coverage

1. Polders and floodwater pumping schemes
2. Associated embankments, flood protection structures, flow control devices, hydraulic structures and floodwater storage facilities
3. The checklist excludes the requirements on pumping facilities and the associated E&M works. The designer should consult the relevant O&M/E&M parties during detailed design stage.

Please read in conjunction with Annex 6 – "Design Checklist on O&M Requirements for Flood Storage Tanks"

Item	Sub-item	Requirements	Compliance (Y/N)
Design Objectives		• The design objectives of flood pumping schemes should tally with the following: 1. To separate low-lying catchments from surrounding land ; 2. To prevent external floodwater from entering the polder; 3. Surface runoff collected inside a polder to be pumped to nearby existing watercourses outside the polder; and 4. Minimize risks of flooding to the low-lying catchments, with reliable and safe pumping facilities combined with flood storage ponds .	
General Layout		• The general layout of the flood pumping scheme should make reference to Fig. 14 & 15 in the Stormwater Drainage Manual. • The downstream streamcourse should be upgraded when necessary to cater for the pumped discharge.	
Retention of Solids Washed Down with Flow		• All intake structures should be designed with devices to retain solids washed down with the flow. • Trash screens are required at inlets to pump sump and outlets from floodwater storage pond.	
Flood Protection Embankment		• Vehicular access with minimum width of 3.5m on top of embankment should be provided. • Railing/fencing at top edge of embankment should be provided if there is a risk of falling at height. • The embankment should be designed for at least 1 in 200 years return period and taken into account of all adverse weather conditions such as wave actions, freeboard, etc.	

ANNEX 11

Item	Sub-item	Requirements	Compliance (Y/N)
Flow Control Devices		• Flow control devices should be provided for flow diversion during routine maintenance and emergency repair of the pumping station and storage pond.	
Floodwater Storage Pond		• Dry pond is preferred over wet pond from maintenance point of view. • For a wet pond, 1. Care shall be taken to ensure that water inside the pond will not stay stagnant and become septic. 2. Public shall be kept away by signs and fencing. 3. Vehicular access to the pond should be provided to enable mechanised maintenance. 4. Good fish habitat should be provided such that mosquito eating fish can be placed and maintained. 5. The storage ponds (wet or dry) should be fenced off from public as far as possible. • For a dry pond, 1. Peripheral surface channels should be provided to convey runoff to gravity outlet under normal situation. 2. Vehicular access to the pond should be provided for maintenance and desilting purpose. 3. Warning signs to alert the public should be provided for the possible flash flooding and slippery conditions; 4. If the pond will be used for other purposes such as playground, prior agreement with relevant authority should be sought on satisfactory arrangements of future management and maintenance of the area. 5. Fencing should be provided where appropriate.	
Storage Tank		• Adequate ventilation and other provisions should be made for enclosed area. • Suitable access, openings and lifting appliances should be provided for future maintenance. • Sufficient safety and lighting system should be provided for routine maintenance and inspection purpose. • Facilities for the tank should be provided to be regularly drained.	

Item	Sub-item	Requirements	Compliance (Y/N)
		• Floor should be provided with sufficient gradient to prevent any stagnant water after draining.	
Pumping Station		• Vehicular access and parking area should be provided for maintenance vehicles. • Unhindered direct access should be provided from a public road (fire fighting purpose). • Pumping station should be isolated from storage pond by fencing or boundary wall. • Adequate noise abatement measures should be provided. • Pump house details should be agreed with maintenance authorities. • Small pumps at inlet should be provided to pump the dry weather flow for avoidance of odour generation due to long retention time. • Security issues (design of main gate, fencing, boundary wall, etc) should be addressed in the design.	
Monitoring and Control System		• For monitoring, inspection and control of floodwater pumping schemes, the system should comprise: 1. telemetry system for control and monitoring of plant operation status; 2. video surveillance system for visual monitoring of crucial E&M and civil engineering components; and 3. SCADA system should be considered.	
Safety Objectives & Suggested Safety Measures		• Prevention of entry by public to inlet and upstream channels (should these be easily accessible) – Continuous handrails, parapet wall, fencing or caging; • Prevention of fall of persons into inlet/channel (for inlets/channels of substantial depth) – Fencing, horizontal grille cover or open-mesh flooring as appropriate; and • Prevention of person from being washed away – Safety grille, safety bar, safety grab-chain or similar man-arresting devices as appropriate.	
Accessibility		• Stormwater inlet should be accessible by maintenance vehicles and workers (especially for trash grille, silt trap,	

Item	Sub-item	Requirements	Compliance (Y/N)
		boulder trap, etc.). ● Method of removing materials retained in solid retention devices should be considered and the design should facilitate the method of removal (e.g. if lorry with grab is used to remove materials in a silt trap, the grab should reach most parts of the trap), and access for workers with shovel should be provided.	
O&M Requirements		● Comments shall be sought from operation and maintenance authorities to agree on the construction details. ● Agreements with GEO on slope maintenance issues shall be sought. ● Clear definition of maintenance and management responsibilities shall be made.	

ANNEX 12

Design Checklist on O&M Requirements for Dry Weather Flow Interceptors

Item	Requirements	Compliance (Y/N)
General	• Dry weather flow interceptors (DWFI) shall be designed in accordance with DSD Technical Circular No. 4/99 – Dry Weather Flow Interceptors and DSD Practice Note No. 2/2003 – Dry weather Flow Interception.	
Design Principle	• The overriding principle is to ensure the proper functioning of the stormwater drain (SWD) in preventing flooding. Interception and removal of polluted flow should not compromise this primary function.	
Classification	• DWFI with duration of service within 3 years and with definite plan of removal should be considered as a temporary structure. Otherwise, it should be considered as a long term structure.	
Essential Design Criteria for Both Temporary and Long-term DWFI	• There should be no adverse effect on the hydraulics of SWD. • There should be no risk of blockage of the SWD during heavy rain. • There should be no adverse effect on the hydraulics and capacity of the foul sewer (FS) receiving the dry weather flow (DWF). The volume of DWF to be intercepted should either be determined by flow measurement or by calculation and the flow to the FS should be strictly limited to this amount. • All DWFI devices should be fail-safe so as not to adversely affect either the SWD or FS in the event of failure or malfunctioning of the device. • DWFI should not lead to an excessive increase in silt deposition in the SWD or lead to transfer of excessive amounts of silt and rubbish to the FS. • At the planning stage the project proponent shall prepare design memorandum including the degree of effectiveness in controlling pollution expected from each DWFI. The quantity of sewage to be intercepted should also be stated. At the design stage, an O&M manual shall be prepared in order to demonstrate that the target effectiveness can be achieved. • At the planning stage the project proponent shall prepare a	

Item	Requirements	Compliance (Y/N)
	decommissioning programme, setting targets and criteria for dealing with the pollution by other methods. (*For detailed explanations on the above, refer to the "Remarks" column of Table 1 of DSD Technical Circular No. 4/99*)	
Additional Essential Design Criteria for Long-term DWFI	• Interceptors should be effective and reliable in removing the DWF from the SWD. • DWFI should be located so that easy access is available for frequent inspection, operation and maintenance.	
Additional Design Guidelines	• There shall be calculations for both temporary and long-term DWFI proposals to conclusively demonstrate that there will be no adverse effects on the hydraulics and capacity of both the SWD and FS. • If pumping station is used, the O&M aspects and reliability of the pumping station, in particular the E&M equipment for the DWFI, should also be taken into account to ensure the effectiveness of the whole system. • For DWFI in tidal region, there should be means to prevent ingress of seawater during high-tide. • Vortex type flow control device or other devices may be used to limit the DWF into the FS. • Solid separator may be used to remove solids from the DWF.	

ANNEX 13

Design Checklist on O&M Requirements for Multipart Covers

Item	Sub-item	Requirements	Compliance (Y/N)
Design Objectives	1. General	● The design objectives of the multipart covers should tally with the following: 1. To enable the transport and setting up of equipment and plants (e.g. small size loaders or bobcats, winching or dredging systems) into and out of box culverts or decked nullahs for the purpose of carrying out desilting works. 2. To minimize the risk of workers for entering and exiting box culverts or decked nullahs to carry out maintenance works as compared with accessing through regular size manholes.	
	2. Design Guidelines	● Multipart covers shall be designed in accordance with DSD Practice Note No. 1/2008 – Design Guidelines for Multi-part Covers.	
Material Classification		The classification of the covers should comply with the following: 1. Medium grade covers (C250) - for areas subject to light traffic load such as car parks and footpaths. 2. Heavy grade covers (D400) – for carriageways with normal traffic loads. 3. Extra heavy grade covers (E600) - for carriageways with exceptionally heavy traffic and/or subject to heavy wheel loads such as docks and container terminals.	
General Layout	1. Choice of Location	● Location of the opening should be avoided at road junctions and intersections. (If absolutely necessary to provide openings at such locations, standard inspection opening to DSD standard drawing no. DS1077 and standard desilting openings to DSD standard drawing no. DS1034 should be used.) ● Sufficient distance should be maintained between the openings and road junction/intersection taking into account the need to allow sufficient spaces on the front and rear ends for stationing of plants like grabs, backhoes, trucks, equipments and placement of desilted materials. Adequate distance should also be allowed for temporary traffic arrangements such as temporary traffic signs and guardings according to Code of Practice for Lighting, Signing and Guarding of Road Works. If possible, a minimum distance of 50m from the major road junction/intersections should be provided.	

Item	Sub-item	Requirements	Compliance (Y/N)
	2. Orientation	● Absolute width (including the frame) of the opening should be confined within one traffic lane and in any case not exceeding 3m. ● Opening should be provided at off-road areas or in the slow traffic lane of carriageway as far as possible.	
Specifications		● The structural seating and seating of covers, structural requirements, materials for covers and frames, and submission and specialist supervision shall be provided in accordance with the Particular Specification annexed to the DSD Practice Note No. 1/2008. ● All cover parts to be provided under the same contract shall be fitted with the same type of keyway to enable interchangeable use of lifting keys. ● Standard size of openings (2m x 3m or 3m x 4m) shall be used. The smaller size opening is preferred on carriageways. ● All individual part covers should be of same size under the same contract for ease of future replacement.	
Provision of Spare Parts		● Spare parts should be provided on project basis. Adequate number of spare parts to be provided such as lifting keys, shifting spanner, water pipes, grease, sealant etc. should be specified in the contract specifications. ● A complete inventory of spare parts and sufficient copies of operation manual should be provided.	
O&M Considerations		● If provision of multipart cover is considered impractical or unsuitable at a location upon environmental, site and traffic considerations, provision of DSD standard inspection opening(s) with desilting opening(s) should be recommended as alternative in the design after consultation with maintenance party.	

ANNEX 14

14.1 Design Checklist on O&M Requirements for Penstocks/Vertical Lift Gates

Item	Sub-item	Requirements	Compliance (Y/N)
Design	**1. General**	● The design objective of penstock / vertical lift gate is to stop the flow of water from upstream by inserting plate vertically across the channel or waterway.	
	2. Hydraulic Performance and Structural Aspect	● The following design aspect for penstock / vertical lift gate should be checked: 1. Design to prevent obstruction of any floating objects; 2. Size of penstock/lift gate; 3. The vertical and horizontal arrangements of the openings for the tidal control purpose; 4. Discharge capacity of the design channel (maximum, minimum and average discharge capacity); 5. Discharge capacity of the penstock/lift gate; 6. Type of construction material for the design life; and 7. Requirement of mechanical operation. If required, design of mechanical lifting equipment should take into account of hydraulic pressure on penstock/lifting gate.	
	3. Environmental Aspect	● The following environmental aspect in design of penstock / vertical lift gate should be considered: 1. Prevent altering the pulsed nature of upstream habitats; 2. Control upland flooding; 3. Minimize changing the flow velocity, turbulence, and pattern of freshwater discharge; 4. Prevent the mixture of waters of different temperatures and chemical components; and 5. Minimize increase in upstream sedimentation.	
Safety		● Safe and proper access should be provided for regular inspection and cleaning operation around the penstock/lift gate.	
Inspection & Maintenance	**1. Safety Access**	● Maintenance stair and access should be secured by fencing. ● Hand wheels of penstocks should be safely accessible and free from any injury hazard for operators.	
	2. Maintenance	● Penstock/lift gate should be accessible to maintenance vehicles and workers. If vehicular access cannot be provided, special access arrangement should be agreed with the maintenance department. ● Method of removing materials retained in the upstream channel should be considered and the design should facilitate the method of removal (e.g. if lorry with grab is used to remove retained materials, the grab should reach most parts of the penstock/lift gate), and access for workers with	

Item	Sub-item	Requirements	Compliance (Y/N)
		shovel should be provided. ● Handles should be provided on the top of the penstock/lift gate.	

14.2 Design Checklist on O&M Requirements for Tidal Control Structures - Flap Valves

Item	Sub-item	Requirements	Compliance (Y/N)
Design	**1. General**	● The design objective of the flap valve is to prevent backflow from the downstream water body while at the same time enabling normal discharge towards the downstream.	
	2. Hydraulic Performance and Structural Aspect	● The following design aspect for flap valve should be checked: 1. Design to prevent obstruction of any floating objects; 2. Size of flap valve; 3. The vertical and horizontal arrangements of the openings for the tidal control purpose; 4. Discharge capacity of the design channel (maximum, minimum and average discharge capacity); 5. Discharge capacity of the flap valve; and 6. Type of construction material for the design life.	
	3. Environmental Aspect	● The following environmental aspect in design of flap valve should be considered: 1. Prevent altering the pulsed nature of upstream habitats; 2. Control upland flooding; 3. Minimize changing the flow velocity, turbulence, and pattern of freshwater discharge; 4. Prevent the mixture of waters of different temperatures and chemical components; and 5. Minimize increase in upstream sedimentation.	
Safety		● Safe and proper access should be provided for regular inspection and cleaning operation around the flap valve.	
Inspection & Maintenance	**1. Safety Access**	● Maintenance stair and access should be secured by fencing.	
	2. Maintenance	● Flap valve should be accessible to maintenance vehicles and workers. ● Method of removing materials retained in the upstream channel should be considered and the design should facilitate the method of removal (e.g. if lorry with grab is used to remove retained materials, the grab should reach most parts of the flap valve), and access for workers with shovel should be provided. ● Handles should be provided on the outside face of the flap valve. ● Non-metallic or plastic coated flap valves should be considered for use as far as practicable, as metallic ones may be prone to theft, especially in remote areas.	

14.3 Design Checklist on O&M Requirements for Tidal Control Structures – Inflatable Dams

Item	Sub-item	Requirements	Compliance (Y/N)
Design	**1. General**	● The design objective of inflatable dam should tally with at least one of the following: 1. To prevent or minimize the tidal influence or potential backflow of polluted downstream water. 2. To create a pleasant and tranquil river environment by damming a pool of amenity water upstream of the structures.	
	2. Hydraulic Performance and Structural Aspect	● The following design aspect for inflatable dam should be checked: 1. Pre-set conditions according to which the inflatable dam is inflated / deflated; 2. Hydraulic impact of the dam structure, especially during adverse weather condition; 3. Structural integrity & stability; 4. Type of materials for the dam body and anchoring system, etc; 5. Failsafe system employing mechanical deflation device; 6. Prevent deposition of sediments; 7. Avoid damage due to ageing or caused by other factors; 8. Cost-effectiveness of pumping dry weather flow downstream; and 9. Alarm system to alert any unexpected/undesirable operating pressures.	
	3. Environmental Aspect	● The following environmental aspect in design of inflatable dam should be considered: 1. Prevent altering the pulsed nature of upstream habitats; 2. Control upland flooding; 3. Minimize changing the flow velocity, turbulence, and pattern of freshwater discharge; 4. Prevent the mixture of waters of different temperatures and chemical components; 5. Minimize increase in upstream sedimentation; and 6. Avoid blocking movement of fishes.	
Safety		● Safe and proper access should be provided for regular inspection and cleaning operation around the dam. ●	
Inspection & Maintenance	**1. Safety Access**	● Maintenance access should be secured by fencing and guarded against any possible trespasses and vandalism.	
	2. CCTV Surveillance	● Advice shall be sought from ST Division on installation of CCTV system for 24-hour surveillance.	

14.4 Design Checklist on O&M Requirements for Tidal Control Structures - Tidal Gates

Item	Sub-item	Requirements	Compliance (Y/N)
Design	**1. General**	● The design objective of tidal gate is to prevent backflow from the downstream water body while at the same time enabling normal discharge to allow tidal water to return to the estuaries when the upstream flow is small.	
	2. Hydraulic Performance and Structural Aspect	● The following design aspect for tidal gate should be checked: 1. Design to prevent obstruction of any floating objects; 2. Size of tidal gate; 3. The vertical and horizontal arrangements of the openings for tidal control purpose; 4. Discharge capacity of the design channel (maximum, minimum and average discharge capacity); 5. Discharge capacity of the tidal gate; and 6. Type of construction material for the design life.	
	3. Environmental Aspect	● The following environmental aspect in design of tidal gate should be considered: 1. Prevent altering the pulsed nature of upstream habitats; 2. Control upland flooding; 3. Minimize changing the flow velocity, turbulence, and pattern of freshwater discharge; 4. Prevent the mixture of waters of different temperatures and chemical components; and 5. Minimize increase in upstream sedimentation.	
Safety		● Safe and proper access should be provided for regular inspection and cleaning operation around the tidal gate.	
Inspection & Maintenance	**1. Safety Access**	● Maintenance stair and access should be secured by fencing.	
	2. Maintenance	● Tidal gate should be accessible to maintenance vehicles and workers. ● Method of removing materials retained in the upstream channel should be considered and the design should facilitate the method of removal (e.g. if lorry with grab is used to remove retained materials, the grab should reach most parts of the tidal gate), and access for workers with shovel should be provided. ● Handles should be provided on the outside face of the tidal gate. ● A failsafe system should be designed to ensure the proper function of the mechanical operated tidal gate during emergency.	

Item	Sub-item	Requirements	Compliance (Y/N)
		● Trapping of silt and rubbish affecting the lifting operation should be avoided.	

ANNEX 15

15.1 Design Checklist on O&M Requirements for Rain Gauges

Coverage

- Installation of rain gauges on sites
- Collection of local rainfall data

Item	Requirements	Compliance (Y/N)
Design Objectives	● The design objective of rain gauges should tally with the following: 1. To collect the rainfall data of the site. 2. To obtain the local rainfall intensity. ● The designer should check the following aspects for operation of the rain gauges: 1. Could real time report to LD Divison via wireless telemetry system be achieved? 2. If real time report could not be achieved, could post-event data collection be provided?	
Specifications	● Rain Gauge 1. Tipping bucket type rain gauge with bucket size 0.5mm. 2. Aperture: 400cm^2. 3. Accuracy: ±1% at 1 litre/hour. 4. Calibration: complies with Method 1 of BS7483. 5. Capacity: unlimited. 6. Operation temperatures range: -20°C to 85°C. 7. Transducer: Magnet/Reed switch. 8. Cable rating: 2A at 24V AC, 4-Core. 9. Connector rating: IP67. 10. Output: Contact closure. 11. Weight: not more than 5 kg. 12. Base plate requirements: holding lugs which are 26.8cm apart should be provided at base and accept 9.5mm rawl bolts to fix onto stand. 13. Provide one year warranty for the Tipping Bucket Rain gauge free-of-charge commencing on the date of acceptance.	
General Layout	● The general layout should suit the existing site conditions. ● Site clearance should be made for proper collection of rain. ● Rain gauges should not be obstructed by shelters.	

ANNEX 15

Item	Requirements	Compliance (Y/N)
O&M Requirements	● The following O&M requirements should be specified by the designer: 1. Is periodical maintenance of warning system required? 2. Cleaning of bucket, nozzle and funnel. 3. Checking of electrical contact. 4. Access for inspection and maintenance should be provided. 5. Calibration arrangement of equipments.	

15.2 Design Checklist on O&M Requirements for River Gauges

Coverage

- Installation of river gauges on sites
- Collection of local water levels
- Collection of local discharges

Item	Requirements	Compliance (Y/N)
Design Objectives	● The design objective of river gauges should tally with the following: 1. To collect the water level of the site. 2. To collect the local discharges. 3. To obtain the local storm water levels at sensitive areas such as flooding black spots. ● The designer should check the following aspects for operation of the river gauges: 1. Could real time report to LD Divison via wireless telemetry system be achieved? 2. If real time report could not be achieved, could post-event data collection be provided? ● Detailed design and selection of equipment shall be conducted by E&M professionals.	
Specifications	● Ultra sonic level sensor 1. The ultrasonic level sensor shall measure the water level by sensing the echo of ultrasonic with IP 67 or equivalent. 2. The output signal of the ultrasonic level sensor shall be 4-20mA. 3. The ultrasonic level sensor shall operate over a temperature span of 0 to 60°C. 4. The measurement accuracy of the sensor shall be within ±0.15% of span. The analogue output accuracy shall be within ±0.125% of span. 5. The sensor shall have built-in temperature compensation. 6. The sensor shall have multi-segment alphanumeric liquid display with bar graph representing level. 7. The ultrasonic level sensor shall be with a measurable range to suit the site conditions. ● Flow Meter 1. Acoustic Doppler Flow Meter, or equivalent type approved by the Engineer's representative. 2. Capable of measuring bi-directional horizontal flow velocity of ± 5 meters/second to an accuracy of 1.0% of reading in the normal	

Item	Requirements	Compliance (Y/N)
	direction of flow in the drainage system. 3. Have a minimum resolution of 0.01 meters/second. 4. Measure water level using acoustic beam to 0.1% accuracy. 5. Calculate flow inside the sensor, referred to as internal flow calculation.	
General Layout	● The general layout should suit the existing site conditions. ● Proper protection to the ultra sonic level sensors should be provided. ● Proper protection to the flow meters should be provided.	
O&M Requirements	● The following O&M requirements should be specified by the designer: 1. Is periodical maintenance of warning system required? 2. Cleaning of sensors and clearing of foreign objects from the sensors. 3. Checking of electrical contact and power supplies. 4. Access for inspection and maintenance should be provided. 5. Calibration arrangement of equipments.	

15.3 Design Checklist on O&M Requirements for Tide Gauges

Coverage

- Installation of tide gauges on sites
- Collection of local tide levels

Item	Requirements	Compliance (Y/N)
Design Objectives	● The design objectives of tide gauges should tally with the following: 1. To collect the tidal level of the site. 2. To obtain the local seawater level. ● The designer should check the following aspects for operation of the tide gauges: 1. Could real time report to LD Division via wireless telemetry system be achieved? 2. If real time report could not be achieved, could post-event data collection be provided? ● Detailed design should be conducted by E&M professionals.	
Specifications	● Ultra sonic level sensor 1. The ultrasonic level sensor shall measure the water level by sensing the echo of ultrasonic with IP 67 or equivalent. 2. The output signal of the ultrasonic level sensor shall be 4-20mA. 3. The ultrasonic level sensor shall operate over a temperature span of 0 to 60°C. 4. The measurement accuracy of the sensor shall be within ±0.15% of span. The analogue output accuracy shall be within ±0.125% of span. 5. The sensor shall have built-in temperature compensation. 6. The sensor shall have multi-segment alphanumeric liquid display with bar graph representing level. 7. The ultrasonic level sensor shall be with a measurable range to suit the site conditions. ● Pressure Gauge 1. The output signal of the pressure gauge shall be 4-20mA. 2. The ultrasonic level sensor shall be with a measurable range to suit the site conditions.	
General Layout	● The general layout should suit the existing site conditions. ● Proper protection to the ultra sonic level sensors should be provided. ● Proper protection to the pressure sensors should be provided.	

Item	Requirements	Compliance (Y/N)
O&M Requirements	● The following O&M requirements should be specified by the designer: 1. Is periodical maintenance of warning system required? 2. Cleaning of sensors and clearing of foreign objects from the sensors. 3. Checking of electrical contact. 4. Access for inspection and maintenance should be provided. 5. Calibration arrangement of equipments.	

ANNEX 16

Design Checklist on O&M Requirements for Flood Warning Systems

Coverage

- Installation of Flood Warning Systems
- Providing flood risk warning to the local villagers
- Sending flood information back to LD Divsion, other Divisions and concerned parties

Item	Requirements	Compliance (Y/N)
Design Objectives	● The design objective of flooding warning system should tally with the following: 1. To provide flood risk warning to the local villagers. 2. To address concern on flooding black spots. ● The designer should check the following aspects for operation of the flooding warning system: 1. Could interim measures to flooding be provided? 2. Could real time report to LD Division via wireless telemetry system be achieved? 3. If real time report could not be achieved, could post-event data collection be provided?	
Specifications	● The following details should be designed by E&M professionals: 1. Trigger by preset level with sensor rods. 2. Trigger by preset level with ultra sonic level sensors. 3. Auto Dialers with SMS functions.	
General Layout	● The general layout of flooding warning system should suit the existing site conditions.	
O&M Requirements	● The following O&M requirements should be specified by the designer: 1. Is periodical maintenance of warning system required? 2. Operation and maintenance requirements / details of sirens, sensors, etc. 3. Operation and maintenance requirements /details of electrical supplies and contacts? 4. Access for inspection and maintenance should be provided. 5. Calibration arrangement of equipments.	

Design Checklist on O&M Requirements for

Design Calculation Checking

Item	Sub-item	Requirements	Compliance (Y/N)
Stormwater Drainage and Sewerage Systems	**1. General**	• Design standards and design requirements specified in the Stormwater Drainage Manual and Sewerage Manual shall be complied with. The project office shall also comply with the design requirements stipulated in DSD Technical Circular and DSD Practice Notes where applicable (e.g. TC No. 4/99 – Dry Weather Flow Interceptor, PN No. 1/2003 – Design of Stormwater Inlets, etc.). • Detailed requirements on the use of hydraulic / hydrological mathematical models shall be obtained from CE/LD. • The Designer should agree with O&M divisions on design parameters including but not limited to the pipe materials, internal lining and roughness coefficients as these parameters would affect the calculation of self-cleansing velocities.	
	2. Large Stormwater Drainage System	• Large stormwater drainage system, particularly within reclamations and/or tidal zone, may have the potential for siltation due to the flat gradient of pipes and the phasing arrangement of their handing over upon completion. Therefore, for project involves large stormwater drainage systems in reclamation areas or within tidal zone, the project office shall consider and agree with O&M Divisions the need and details of sediment management options or special maintenance provisions which may be required to control the ingress of sediment or facilitate frequent cleansing operation on pipes where it is impractical to achieve self-cleansing conditions.	
	3. Sewerage System	• Sewerage works, particularly in newly-developed sites where slow build-up of population and consequently insufficient flows for testing and commissioning, may have operational problems such as septic and odour problems. Therefore, the project office shall consider and agree with O&M Divisions the need and details of special maintenance provisions which may be required to avoid the septic and odour problems on sewers where it is impractical to achieve self-cleansing conditions. • The following EPD's guidelines should be adopted: 1. "Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning" (GESF) as the reference for the build-up of sewage flows (average and peak); 2. "Guidelines for Sewer Network Hydraulic Model Build and Verification" and "Infoworks CS – Model Acceptance Criteria" should be used as the reference for checking of sewerage hydraulic model.	