DESIGN GUIDELINE FOR STORMWATER DRAINAGE SYSTEMS

VER 1.0

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1. SCOPE

These guidelines cover aspects that need to be considered when planning and implementing stormwater drainage projects for existing residential areas and developing communities. A stormwater drainage system should be aimed at providing the following

1. Control the quantity of run-off by
    a. Supporting the management of flood risk
    b. Maintaining and protecting the natural water cycle
2. Manage the quality of runoff to prevent pollution
3. Create and sustain better places for people
4. Create and sustain better places for nature

The developed drainage system should consist of achieving the following targets

1. Use surface water runoff as a resource
2. Support the management of flood risk in the receiving catchment
3. Protect morphology and ecology in receiving surface waters
4. Preserve and protect hydrological systems on the site
5. Drain the site effectively
6. Manage on site flood risk
7. Prioritise infiltration as much as possible

The stormwater management system maybe constructed along with new road development projects or before a road development project.

2. GENERAL DESIGN PARAMETERS

2.1 Recurrence Interval

All storm water management systems should be designed for a recurrence interval of 1 in 5 years. If the site considered is extremely sensitive to flooding, an alternative recurrence interval maybe used after discussing with Client.

2.2 Extent of storm water management system

The storm water management system should be designed to cover all flood prone areas of an island. The flood prone locations should be confirmed by Topographical survey of the island and based on information provided by the Island Council.

2.3 Concept design

Once the flood prone areas are identified, a concept design must be made in accordance with guidelines given in Section 1. The concept design must consist of the following

a. Layout map of the island indicating the location of any mechanical pumping systems
b. Layout map of the island indicating flood prone areas verified by island council and topographic survey
c. Proposed discharge locations including sea outfall
d. Public buildings in the island including mosques, schools, health centers and council office
e. Short design report explaining the proposed stormwater management system

f. Sample details of catchpits, collection chambers and any other hard structures proposed for the stormwater management system
g. Same drawing of any pump stations proposed indicating the type of pump proposed

2.4 Detail Design

Detail design submission should consist of a design report, supporting drawings and calculations. All 3 components should be based on section 2.5 to 2.11 described below. The detail design report or drawings should not contain any sample drawings or sketches. All content reported should be for actual site conditions and should be prepared for a ready-for-construction state.

2.5 Design Storm

All design storm intensities and durations should be based on IFD curves produced for the event. The IFD curve should be developed from 20-year rainfall data obtained from weather data obtained from nearest weather station. Currently long-term weather data is available from Hanimaadhoo, Hulhule, Kaadehdhoo and Gan station.

2.6 Stormwater management by Infiltration

For design purposes, up to 30% of the total rainfall runoff can be assumed to be managed by infiltration to ground. The ground infiltration rate should be determined based on tests carried out as described in Section A of this report. In densely populated areas, ground infiltration should not be used as a means to remove run off water. In such areas, run off water should be removed through a conveyance network and pumped off by mechanical means.

2.7 Network design method

Commonly used stormwater design methods such as Rational Method, Modified Rational Method or other methods maybe used. The designer should explain why the particular method was used and should include a 1 page summary of how the method is applied to this project.

2.8 Drainage Catchments

A minimum of 2 catchments must be used to effectively remove stormwater runoff from flood prone areas of the island. Series of collection pits maybe used along the side of the road to collect runoff water and transport it to a common discharge point or pumping station (PS). UPVC pipes of minimum 200mm diameter maybe used to convey the collected runoff water to the discharge point or pumping station (PS) via gravity flow. All UPVC pipes used for stormwater conveyance should be Grey in colour and should have a minimum Nominal Stress grade of 4 MPa (SN4) and a maximum Standard Diameter Ratio of 41 (SDR41). Any pipes placed under road carriage way should have a minimum cover of 600mm. The pipes should be sloped to ensure a minimum self-cleansing velocity of 0.6 m/s. Maximum invert depth of gravity pipes should be 2.5m from Natural Ground level (NGL). Pipes used for gravity flow should be push fit connection type pipes and installation should be done to ensure there is no ground water infiltration into the pipes. All gravity pipe should be connected from chamber to chamber without any bends, so that jetting hose can be inserted easily for cleaning the pipe. All pipes must have a label based on the catchment they are located in. The catchments should be designed and sized such that most of the runoff water will be removed in 30 minutes after a storm.

2.9 Collection pits and chambers

All collection pits and chambers made from concrete should be reinforced. Concrete grade and cover to reinforcement should be selected based on design durability of the structures, but design life should not be less than 20 years. HDPE or UPVC chambers are also acceptable, provided that they are suitable for use in stormwater drainage projects. All covers used for chambers should have easy lifting mechanism and should not be made excessively heavy. Any chamber or pit placed in carriageway must have vehicle grade cover. All collection pits and chambers must have a label based on the catchment they are located in.

2.10 Pumping Station

Pump stations (PS) maybe used to discharge collected run-off water via pressure pipes. Pump stations maybe placed in the carriage way but emphasis should be given to keep them in empty plots located near the center of the catchment. Pump stations should not be placed near schools, mosques, health centers or other buildings where people may congregate or visit often. All pump stations must have minimum 2 pumps with 1 working and 1 duty pump, and they should alternate operation in successive cycles. Minimum 1m must be maintained from lowest invert level of inlet pipe to base of pumping station. The pump station could be made from reinforced concrete or a package type pump station could be used. If RC type pump station is used, all internal surfaces must be covered by a FRP coating of 125 microns. Maximum excavation depth of PS should be 3.7m from NGL.

The working volume of the PS should be adjusted such that pumps will not have more than 6 start – stop cycles per hour. Discharge rates of pumps should not be more than 40 l/s. Pumps must be controlled by float switches or ultrasonic level sensors and the controllers must be fixed in a panel board. Panel board should be kept under shed protected from direct sunlight or rain, and the shed should have a sufficient awning to cover the panel board even when the panel board door is open. Dry mount or submersible pumps maybe used in the PS but they should be explosion proof grade, to avoid damage by dry run. Where dry mount pumps are used, the pumps should be kept in sheltered space and made free from damage by vandalism. Where submersible pumps are used, the impeller blade should be cutter type and all components of the pump should be cast iron with fiber coating or SS 316 grade steel. Where pump weight exceeds 25kg, pump lifting stand with pulley arrangement must be provided. The lifting stand should have easy assembling and dissembling mechanism.

Discharge from the pumps must be controlled by valve chamber and each outlet pipe from the pump must have a gate valve and a swing check valve. All discharge pressure pipes must be HDPE black pipe and should have minimum nominal diameter (ND) of 90mm. Pipe should have a maximum SDR of 17 with minimum PE 100 and PN 10 rating. All pump station covers and valve chamber covers should have easy lifting mechanism and should not be excessively heavy. Flow velocity in the pipe should be in the range of 2m/s to 4m/s when flowing full bore. All pump station design and drawing should mention the duty point of the pumps used in the pump station.

Starting current of all pump motors should be controlled as Direct on-line (DOL), Star Delta or Variable Frequency Drive (VFD) based on the power demand. Single Line Diagram (SLD) and Control Wiring Diagram should be designed, stamped and attached to the Detail Design report. All utility service providers require a kWh meter to be installed in the panel board and so this should be included in the design and installed in the panel board accordingly.

2.11 Discharge outfalls

Where storm water is discharged to environmentally sensitive areas such as wetlands, care must be taken to reduce the possibility of discharging pollutants to the waterbody as much as possible. Suitable mechanisms should be incorporated to remove grease, oil and dirt from the water as much possible and also to reduce the velocity with which the pumped runoff water enters the waterbody. The outfall should be secured to the ground and well protected against any sort of vandalism.

Where stormwater is discharged into the sea, care must be taken to discharge them further away from the shoreline such that the discharged waste will not flow back to the shoreline. Minimum 160mm OD HDPE black pipe with a thickness ratio of 11 (SDR 11) and minimum PE 100 and PN16 rating must be used. The pipe should be secured by RC anchor blocks which should be designed as two halves fixed around the pipe and bolted together. OPC maybe used to cast these blocks and bitumen coating should be applied on all surfaces of the block. Bolts and nuts used to tighten the block should be SS 316 grade steel. Unless confirmed by site specific measurements, the outfall anchor blocks must be designed to independently withstand waves of Hs = 1.8m. The center to center spacing of these blocks should not exceed 3m.

Under all conditions, the discharge location of an outfall must be confirmed based on an EIA.

2.12 Drawings

All drawings submitted at detail design stage should be clearly presented and made self-explanatory. A layout map showing the full island, all catchments, pump stations and outfall must be presented in the beginning. Following the layout map, each catchment layout must be shown on a separate page. Details of the proposed drainage system can be presented thereafter. All drawings must be properly scaled and neatly presented to fit A3 size paper. As mentioned in Section 2.4, all drawings given in detail design stage must be reflect actual working drawings and not sample drawings.

2.13 Calculations

Hydraulic and Hydrologic software maybe used to perform the analysis and design of stormwater drainage system. Calculations for the first 100m on any selected catchment must be shown in detail to show how important design input parameters such as rainfall intensity (i), wetted tributary area (A), time of concentration (Tc), time of entry (Te) and time of flow (Tf) are selected. These calculations should also show how the pipe diameter, slope and invert levels allow to maintain the minimum cleansing velocity inside the pipe. The calculations should show how much water is flowing out as final discharge and show that all runoff water is removed in 30 minutes.

3. MAINTENANCE CONSIDERATIONS

The stormwater drainage network should be designed with full consideration for maintenance. As stormwater travels in the pipes, sediment deposition can take place over time which could

block the pipes and bring the system to a halt. Hence, adequate measures must be given in the design to enable cleaning of the pipes via a jetting hose.

SECTION A – GROUND INFILTRATION TEST

Infiltration test must be done at least on 3 locations in each catchment. The locations selected must give a good representation of the drainage characteristics of the soil in the catchment area. All locations selected to perform the infiltration test must be shown on a map and submitted with the detail design report. The infiltration test should be carried out as follows

1. Soak the area where the infiltration test is to be carried out until the sand is fully saturated.
2. Cut a 150mm long pipe section from a 100mm dia pvc pipe.
3. Provide a mark on the inside of the pipe at about 20mm below the top. This mark should be labelled as “A”
4. Provide a second mark 50mm below mark “A” and label this second mark as “B”.
5. Provide a third mark 50mm below mark “B” and label this third mark as “C”.
6. Place the pipe vertically up on the ground and tap on it using a wodden stick until the base of the pipe is firmly embedded in the ground. The arrangement should be as shown below.

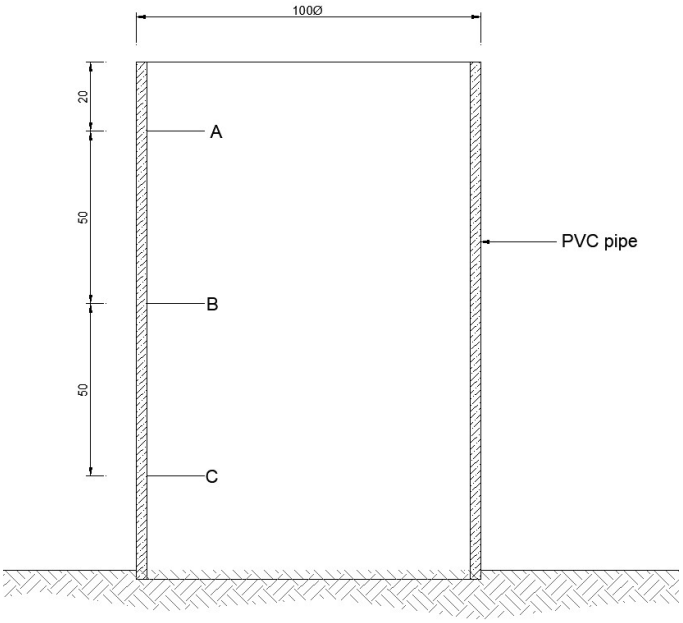

Figure 1: Infiltration test setup arrangement

7. Fill the pipe with water until the water just spills from the top.
8. Wait for the water level to drop to mark A and then start the stop watch. Record the time taken for water level to drop from mark A to B and then from B to C. The average of this time is the approximate ground infiltration rate in mm/minute of the soil in the tested area.
9. Use the value obtained in (8) to determine how much runoff water can be removed by ground infiltration. As mentioned in section 2.6, at most only 30% of the total runoff water should be considered as water removed by infiltration.