EROSION & SEDIMENT CONTROL AT CONSTRUCTION SITES

- for site implementation

GUIDEBOOK

5th Edition (2018)

Produced by:

新加坡建築商公會有限公司
THE SINGAPORE CONTRACTORS ASSOCIATION LTD
Building Our Nation Together

Supported by

PUB SINGAPORE'S NATIONAL WATER AGENCY

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ANNEXES

Joint SCAL-PUB Message

Everyone plays an important role in keeping our waterways and reservoirs clean in our highly urbanised city. On their part, contractors prevent muddy discharge from construction sites by implementing earth control measures (ECM) operated and maintained by ECM-trained staff.

It has been four years since we last revised this ECM guidebook. The 4th edition saw a complete revamp of earlier versions, with clearer guidelines and step-by-step processes to aid site personnel in carrying out ECM at every stage of construction works. We are pleased that the revision was well received by the construction industry.

In this 5th edition, we will share with you the benefits of the Silt Imagery Detection System (SIDS), an automated IT system that leverages on image analytics to detect silty discharge. Since Feb 2016, contractors working on construction sites of 0.2 ha and above are required to install CCTV cameras at their storm water discharge outlet linked to the SIDS. The use of this system has significantly reduced the manual effort required to monitor ECM performance after rain events, while allowing audits to be carried out via the images captured in the video archive.

You will also find comprehensive information on the requirements for a full-time ECM Officer (ECMO) at construction sites of 0.5 ha or above. Trained in ECM, this officer is required to oversee and take care of the ECM needs on site.

Last but not least, you may find it useful to look at some of the common mistakes that may occur when operating and maintaining the ECM on site, and how to avoid them.

We hope that you will continue to find this guidebook easy to read and useful for your site application. Thank you for your support in keeping our waterways clean and free of muddy discharge.

Mr Kenneth Loo
President
Singapore Contractor Association

Mr Yeo Keng Soon
Director, Catchment & Waterways
PUB, Singapore's National Water Agency

Co-ownership Framework

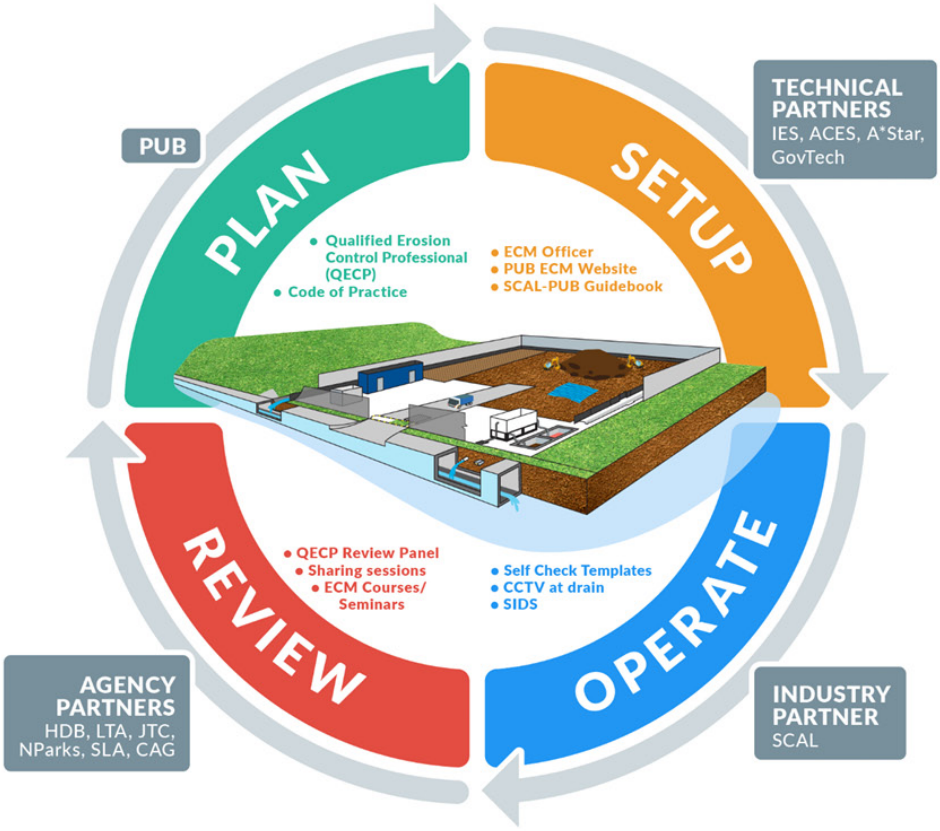

Photo taken from Unmanned Aerial Vehicle

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KEEPING OUR WATERWAYS FREE OF MUDDY WATER

Having clean and beautiful waterways and water bodies is a key to good living standard in our highly urbanised settings. In the 70s and early 80s, we cleaned up the Singapore and Kallang Rivers. Since then, relentless efforts have also been made in land use planning and solid waste management, and providing separate used water and rain water network to sustain and improve the quality of our waters.

These efforts paved the way for us to create Marina Reservoir, a reservoir in the city, as well as beautiful water theme sites like Punggol Waterways and Bishan Parks' meandering streams. Under such programmes, stable bodies of water have been transformed into beautiful waterfronts for the community to enjoy and raised the quality of living environment for all in Singapore.

Photo: ABC Waters at Geylang River

Photo: Kayaking at Kolam Ayer

Photo: ABC Waters site at Sungei Ulu Pandan

Therefore, it is crucial for us to keep the water in the waterways and reservoirs as clean and as pristine as possible.

However, storm water runoff will affect the cleanliness of the water in our waterways and pristine water bodies. When it rains, at times the waters would turn brown and muddy.

The cause of muddy water is mainly from construction activities which disturb existing grounds and expose the earth. Bare earth surfaces would result in muddy runoff when it rains.

The construction industry stakeholder viz. developers, professionals and especially the building contractors, hold the key in preventing muddy water discharge from their construction activities.

The contractor should at all times, implement adequate earth control measures and operate these measures properly at their construction sites to prevent causing muddy discharge. This guidebook, launched since 2001, has undergone several updates. This 5th edition provides an update to the 4th edition, is written, and continues to be written in a simple and easy to read manner, so as to serve as a quick and handy reference for contractors and their site personnel to use.

Photo: Muddy water at Waterway

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10 ESSENTIAL STEPS TO EFFECTIVE ECM

Step	Reference
Price for ECM	Annex 1 – Sample ECM Specifications at Tender Stage Annex 5 – Roles of Construction Industry
Engage Qualified Erosion Control Professional (QECP) to **Design** ECM Submit ECM plan to PUB	Annex 2 – Checklist for ECM Plan Submission Annex 2A – Sample ECM Clearance Certificate Annex 3 – ECM requirements in Sewerage and Drainage Act Annex 4 – ECM requirements in Code of Practice on Surface Water Drainage
Appoint a supervisory **Staff** as an ECM Officer. The staff should attend and pass a certified ECM course	Annex 11 – ECMO requirement Annex 11A – Useful Websites, Contacts and Apps
Implement ECM according to ECM plan	Page 15 & Pull-out Page-ECM Provisions at a Construction Site Annex 13 – Innovative Drain
Check ECM daily	Annex 6 – Sample ECM Inspection Report Annex 12 – Common ECM noncompliance
Check and **Calibrate** silty water treatment system regularly to ensure that the discharge complies with required discharge standard	Annex 10 – Colour of Water Samples at Various Silt Concentrations
Treat silty water at holding sump and clear the sump within 10 hours after rain, to prepare for the next rain event	Page 9 – ECM Best Practices
Monitor discharge at discharge outlet and public drain	Annex 9 – CCTV Requirements with Silt Imagery Detection System
Rectify and report noncompliance to PUB	Annex 7 – Checklist for ECM Rectification Report
Inspect public drain in the vicinity regularly and clear any obstruction	Annex 8 – Sample Drainage Inspection Report

3 ECM BEST PRACTICES

Setup Stage

Seal hoarding footing and hoarding gaps

Provide hump at site entrance

Pave up access path/road

Pave up site office areas

Provide adequate silty water treatment plant

Provide adequate and paved holding pond/area

Provide cut-off drains to prevent the mixing of clean and silty water

Provide silt traps in cut off drain within site

Provide proper silt/turbidity curtains for works near the water bodies

Construction Stage

Carry out earth work in stages to minimise exposed earth surfaces

Cover bare earth with Erosion Control Blanket (ECB) etc.

Cover Stockpiles

Provide adequate treatment chemicals, erosion control blankets and other ECM spares on site

Isolate bare earth areas with silt fences

ECM Operations Stage

Inspect surrounding drains after rain

Treat silty water and empty holding sumps within 10 hrs after rain to prepare for the next rain event

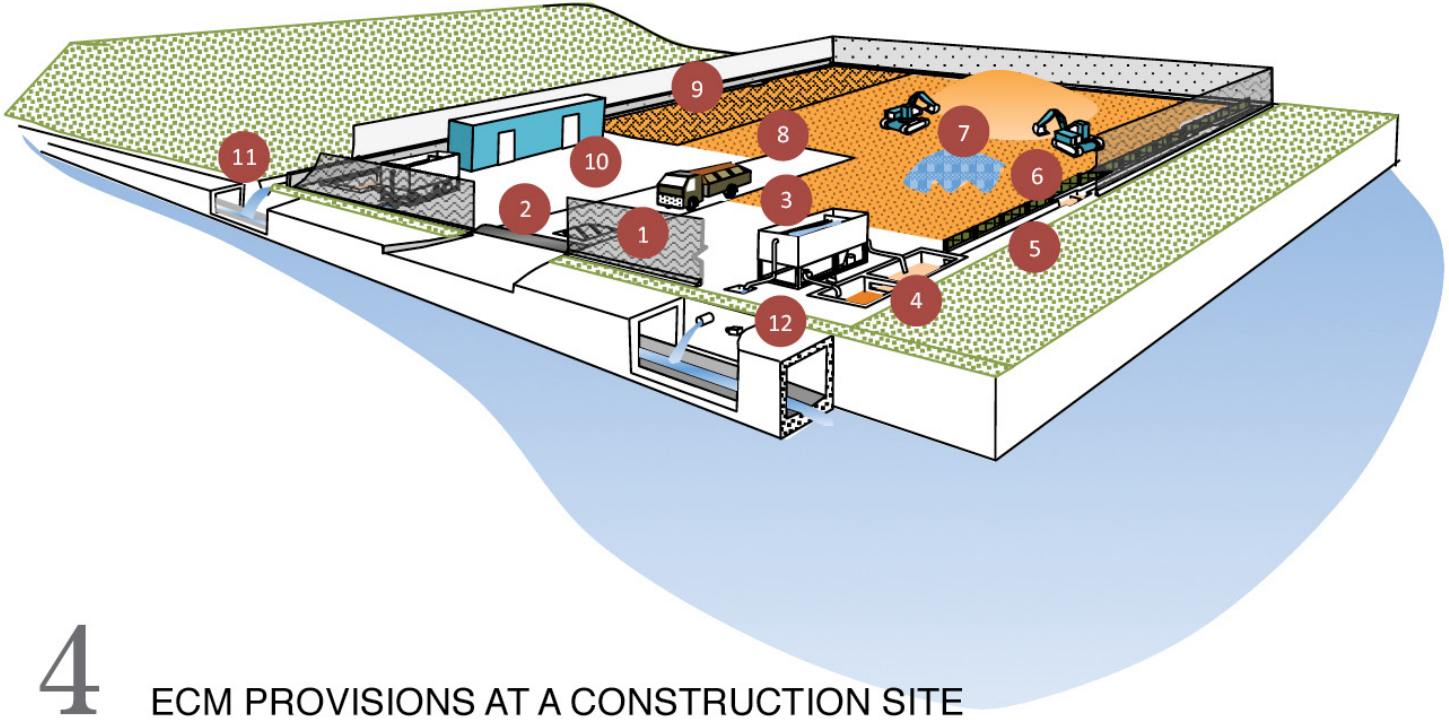
Monitor and calibrate silty water treatment system regularly

Install CCTV at public drain to monitor discharge at discharge outlet

Remove silt at cut-off drain, silt trap and holding sumps regularly

Review ECM with QECP in tandem with change in construction phases

1. Seal hoarding footing and hoarding gaps
2. Provide hump at site entrance
3. Provide adequate silty water treatment capacity
4. Provide adequate holding pond
5. Provide cut-off drain around the site boundary
6. Isolate bare earth areas with silt fences
7. Cover stockpiles
8. Pave up access path/road
9. Cover bare earth area after work
10. Pave up site office areas
11. Provide cut-off drain to separate clean water from silty water
12. Install CCTV at public drain to monitor discharge



4 ECM PROVISIONS AT A CONSTRUCTION SITE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(Revised as at Nov 2013)

1. The Contractor shall implement effective Earth Control Measures (ECM) during construction stage at all time. The ECM shall be implemented according to the Code of Practice on Surface Water Drainage.

   [Important Note: The contractor shall note that ECM are meant for the containment and treatment of silty rainwater runoff only, and not meant for the treatment of process water from construction activities such as slurry from tunnelling, pipe-jacking and bore-piling works. Such process water should be handled and treated to comply with the requirements under Environmental Protection and Management Act (Chapter 94A).]

2. In the tender submission, the Contractor shall provide schematic diagrams outlining the ECM for the whole duration of the construction activities, taking into account the various ECM requirements under different phases of construction activities. The ECM plan shall be designed and endorsed by a Qualified Erosion Control Professional (QECP) and form the basis for the Contractor to price for ECM. The Contractor shall be deemed to have included the price of ECM in the total contract price, even if the contractor did not separately priced for the ECM.

3. The Contractor shall engage a QECP to design ECM. The Contractor shall implement ECM accordingly to the QECP's ECM plan before earth works starts. During the course of construction works, the Contractor shall engage his QECP to review the effectiveness of the ECM regularly, in tandem with the various phases of construction works. The Contractor shall revise the ECM as and when advised by his QECP.

4. The Contractor shall keep good records of the ECM operation and maintenance.

5. The Contractor shall not remove the ECM until all works are completed and upon the advice of his QECP.

6. The Contractor shall submit the ECM plan duly endorsed by his QECP to Director, Catchment and Waterways (PUB) to obtain the necessary clearance before earth works start, in the format as prescribed by PUB. The ECM plan shall include the following content:

   I. Project Brief

      The Brief shall include:

      a. Project description
      b. Name and address of site occupier;
      c. Site area and contract period;
      d. Location map and site plan.
      e. Construction phases and schedules

   II. ECM design calculations

III. Erosion Control Plan

The plan shall include minimise bare earth areas/slopes/stockpiles via sequencing and phasing of earth works, paving up/covering bare earth surfaces with lean concrete, milled waste, erosion control blankets, close-turfing, canvas etc.

IV. Sediment Control Plan

The plan shall include:

a. Concrete-lined cut-off drains (minimum C7 precast channel) along the perimeter of the construction sites.
b. Sealing of site hoarding.
c. Ramp/curb at site entrance/exit.
d. Separate drainage for bare earth surfaces and non-bare earth surfaces.
e. Silt fence properly installed and embedded onto the ground along the internal and perimeter cut-off drains.
f. Silt traps.
g. Holding sumps/ponds for silty water.
h. Adequate silty water treatment systems to treat silty water before the discharge points into public drain.
i. Turbidity curtains for works in or adjacent to water bodies, such as canals, rivers, sea or in a reclamation work.

V. Site ECM Management System

The Management System shall include:

a. Daily ECM inspection and report by a ECM-trained site staff.
b. Regular ECM review and report by QECP.
c. Monitoring and alerts of the treated runoff quality, and if required by PUB, CCTV system to monitor the discharge at the public drain.

7. The contractor shall deploy a ECM-trained site staff to supervise the operation and maintenance of the ECM implemented on site as well as conduct daily checks. The site staff shall be the project manager, a qualified ECO, RTO or Safety Officer, who has attained a valid certificate from attending and passing a IES-endorsed ECM course for site staff, such as "Certificate of Competency in ECM for Construction Site Personnel Course".

Sample Breakdown for Earth Control Measures					
S/No	**Description**	**Qty**	**Unit**	**Rate**	**Amount ($)**
A	Allow for engaging a Qualified Erosion Control Professional to design and supervise the implementation of Earth Control Measures	-	Item	-	
B	Allow for the implementation and maintenance of the Erosion Control Measures	-	Item	-	
C	Allow for the implementation and maintenance of Sediment Control Measures	-	Item	-	
D	Allow for site reporting and monitoring system, inclusive of deployment of a ECM-trained staff	-	Item	-	
E	Allow for regular ECM review by the QECP		Item		
TOTAL					

EARTH CONTROL MEASURES (ECM) SUBMISSION CHECKLIST

APPLICATION FOR EARTH CONTROL MEASURES (ECM) CLEARANCE CERTIFICATE TO COMMENCE WORKS					
Project Title:					
BCA / Project Ref. no.:		Submission Type: New / Resubmission / Update*			
Total Site Area (m^2):		Type of work: Building / Linear / Site Clearance / Others: _____ *			
Max exposed area (m^2):		Sediment yield (ppm):			
Runoff coefficient:		Total treatment plant capacity (m^3/hr):			
Total runoff volume (m^3):		Total holding volume capacity (m^3):			
Scheduled frequency of QECP site inspection	Weekly / Fortnightly / Monthly / pls specify: Every_____ mth	Contract Commencement Date: _____.			Contract Completion Date: _____.

S/no	Checklist Item	YES	NO (Pls explain)	NA (Pls explain)	REMARKS
1	Project background, description and construction activities described?				
2	Design calculations provided?				
3	Runoff coefficient ≥ 0.65?				
4	To-scale ECM drawing, location plan, topo plan provided?				
5	Boundary hoarding with sealed footing, and crest at site entrance provided and indicated in drawing?				
6	Total holding /storage capacity > total run off provided and indicated in drawing?				
7	Exposed areas and covered areas indicated in drawing?				
8	Separate drainage systems for clean runoff and silty runoff provided and indicated in drawing?				
9	Drainage catchment, flow direction, cut-off drain provided and indicated in drawing?				
10	Holding tank(s), treatment plant(s), and discharge outlets, provided and indicated with dimensions in drawing?				
11	Copy of Valid QECP License attached?				

Endorsement by QECP	Endorsement by Contractor
I have checked that the above items have been provided in my ECM plan.	*I have fully read and understood the ECM plan and will implement according to design.*
QECP name, sign & date and stamp: **PE Registration No.:** **Company Name:**	**Contractor Rep name, sign & date:** **Designation:** **Company Name and Stamp:**

Your Ref:
Our Ref:
Date:

(Cert No: ECM/0000)

PLEASE QUOTE THE CASE ID
IN FUTURE CORRESPONDENCE /
TELEPHONE ENQUIRY

Contractor
Address

CLEARANCE CERTIFICATE
TO COMMENCE WORKS REQUIRING EARTH CONTROL MEASURES (ECM)
(Section 33(5) of the Sewerage and Drainage Act, Chapter 294)

PART I - PARTICULARS OF APPLICATION

1. Date of Application:

2. Description of the proposed development in the application:
PROPOSED DEVELOPMENT….

PART II - PARTICULARS OF CLEARANCE

1. The Earth Control Measures (ECM) proposal for the above development is hereby registered with PUB. This Clearance Certificate is issued under Section 33(5) of the Sewerage and Drainage Act Chapter 294 for the application referred to in Part I.

PART III - NOTES

1.You are required to:

(a) Implement the ECM in accordance to the approved ECM plan before start of earthwork;

(b) Have a full time staff with ECMO qualification to supervise the implementation, operation and maintenance of the ECM on site;

(c) Provide, operate and maintain a CCTV system in accordance with the requirements as stipulated in Annex 2 at all times, especially to ensure that (i) clear CCTV images is provided at all times; and (ii) any silty water discharge is stopped immediately;

(d) Ensure that treatment plant of adequate capacity is in good working condition and connected to power supply on site at all times;

(e) Monitor the quality of discharge during the silty water treatment process, and stop immediately any silty water discharge from entering the public drain;

(f) Check that the ECM provided is effective during and after a rain event and take immediate rectification actions to prevent any silty water within the site from seeping out into the public drain;

(g) Keep proper ECM operation and maintenance record and make available to PUB officers as and when required;

(h) Submit incident report for any silty water discharge incident within 3 working days from the date of incident or such period as required by PUB;

(i) Ensure all earthworks are completed and site is fully reinstated before ECM are removed from site; and

(j) Comply with all ECM requirements as stipulated in the Code of Practice on Surface Water Drainage.

2. Information on ECM is available at our website https://www.pub.gov.sg/drainage/earthcontrolmeasures. For any queries please email to pub_cwenf@pub.gov.sg or contact the undersigned at 67313464

for DIRECTOR
CATCHMENT & WATERWAYS DEPARTMENT

cc Developer / Owner

QECP

QP

The following legislation and requirements pertaining to the control of erosion and sediment are highlighted:

THE SEWERAGE AND DRAINAGE ACT, CAP. 294

Works affecting storm water drainage system

Section 26(1) No person shall carry out or cause to be carried out —

(a) any works which affect or are likely to affect any storm water drainage system, drain or drainage reserve, directly or indirectly; or
(b) any works that could lead to the discharge of silt directly or indirectly into any storm water drainage system, drain or drainage reserve,

without obtaining, in respect of those works, a clearance certificate or the approval of the Board under section 33.

Section 26(2) Every person given a clearance certificate or approval by the Board to carry out any works under subsection (1) shall —

(a) notify the Board in writing before the commencement of the works;
(b) provide adequate silt control measures in accordance with any standards or guidelines issued by the Board before the commencement and for the duration of the works; and
(c) comply with the conditions of the clearance certificate or approval, if any.

Section 26(3) The Board may prescribe standards and limits in respect of any discharge of silt into any storm water drainage system, drain or drainage reserve.

Section 26(4) Where any works are or have been carried out in contravention of subsection (1) or (2), or as a result of which silt is discharged which exceeds the standards or limits prescribed under subsection (3), the Board may do all or any of the following:

(a) by notice in writing require the person who carried out, or caused to be carried out, the works, or the owner or occupier of any premises in respect of which the works were carried out, to do one or more of the following:
    (i) to cease immediately the carrying out of those works, either indefinitely or for such period as may be specified by the Board;
    (ii) to carry out such works as the Board may think necessary to restore the storm water drainage system, drain or drainage reserve to its original condition or to protect the storm water drainage system, drain or drainage reserve, within such time as may be specified in the notice;
    (iii) to take such measures as the Board may think necessary to comply with subsection (2)(b) or (c) or adhere to the standards or limits prescribed under subsection (3);

(b) revoke the clearance certificate or approval given, or suspend the clearance certificate or approval for such period as the Board considers reasonable.

Default in compliance with notice

Section 26(5) Any person who —

(a) contravenes subsection (1) or (2);
(b) without reasonable excuse, fails to comply with a notice of the Board under subsection (4)(a); or
(c) carries out any works after the clearance certificate or approval relating to those works has been revoked or during such period as the clearance certificate or approval is suspended under subsection (4)(b),

shall be guilty of an offence and shall be liable on conviction to a fine not exceeding $50,000.

SEWERAGE AND DRAINAGE (SURFACE WATER DRAINAGE) REGULATIONS REVISED EDITION 2007

Prohibition of discharge of silt, etc., into storm water drainage system

Regulation 4(1) No person shall discharge or cause or permit the discharge into the storm water drainage system of Total Suspended Solids in concentrations greater than 50 milligrams per litre of the discharge.

Regulation 4(2) Every person carrying out earthworks or construction works shall comply with the Code of Practice and, in particular, with the following requirements:

(a) earth control measures shall be provided and maintained in accordance with the Code of Practice;
(b) runoff within, upstream of and adjacent to the work site shall be effectively drained away without causing flooding within or in the vicinity of the work site;
(c) all earth slopes shall be set outside a drainage reserve;
(d) all earth slopes adjacent to any drain shall be close turfed; and
(e) adequate measures shall be taken to prevent any earth, sand, top-soil, cement, concrete, debris or any other material to fall or be washed into the storm water drainage system from any stockpile thereof.

Penalty

Regulation 6 - Any person who contravenes any provision of these Regulations shall be guilty of an offence and shall be liable on conviction to a fine not exceeding $5,000 and, in the case of a continuing offence, to a further fine of $500 for every day or part thereof during which the offence continues after conviction.

6.3 Earth Control Measures

6.3.1 Water Quality Parameters to be Complied with

The discharge from any construction / earthwork sites into storm water drainage system shall not contain Total Suspended Solids (TSS) in concentrations greater than, the prescribed limits under Regulation 4(1) of the Sewerage and Drainage (Surface Water Drainage) Regulations.

6.3.2 Minimal or No Discharge

A construction / earthwork site should practise recycling of water. The recycled water could be used for non-potable purposes in order to minimise discharge into the stormwater drainage systems

6.3.3 ECM Specifications in Tenders

Developers / owners and Qualified Persons should include the earth control measures (ECM) specifications and schematic or conceptual ECM plans in the tender documents and allow for the cost of ECM in the tenders.

6.3.4 Permit to start Earthworks

The site operator / contractor shall obtain a written permission (or a clearance certificate) from the Board before the commencement of any earthwork.

6.3.5 Submission of ECM proposal before commencement of works

Before commencement of works, the site operator / owner shall engage a Qualified Erosion Control Professional (QECP) to plan and design a system of earth control measures (ECM) to meet the requirements cited in Clause 6.3.1.

The site operator / owner shall submit the detailed ECM proposal, endorsed by his QECP, to the Board for record, prior to the commencement of works. The ECM proposals (with calculations) shall include a plan (a typical plan is as shown in Drawing No. 8).

6.3.6 Design Criteria of ECM

The ECM shall be designed to cope with a minimum design rainfall intensity of a return period of 1 in 5 years storm.

6.3.7 ECM to be installed before commencement of work

The ECM shall be installed by the site operator / contractor according to the endorsed plans and the completed ECM at site shall be approved by the QECP before commencement of construction and earthworks.

6.3.8 General Guidelines for Effective ECM

An effective ECM requires 2 components which shall include, but is not limited to, the following minimum measures in order to meet the legal requirements cited under Regulation 4(1) of the Sewerage and Drainage (Surface Water Drainage) Regulations:

(A) Erosion Control Measures

The erosion control measures shall minimise the extent and duration of any exposed / bare / erodible surfaces by:

a. Proper Work Sequencing - Adopting proper construction staging and work sequencing will help to ensure that no large bare / erodible surfaces are exposed for a long duration of time.

b. Covering up of all bare / erodible surfaces - All bare surfaces (including earth stockpiles) shall be by concrete-lining, concrete-paving, milled waste, erosion control blankets, close turfing or other suitable materials. Accesses within the site and at exit / entrance as well as the surfaces where site facilities (such as office, fabrication and storage yards) shall be paved. For those work areas, they shall be covered by canvas sheets, tarpaulin sheeting or other suitable materials during rains or before work stops every day.

c. Progressive and timely revegetation and stabilisation – This is to ensure that all bare surfaces are restored immediately upon completion of work at every stage. If a construction site has very little bare / erodible surfaces, the operator / contractor will have less difficulty in containing and treating the silty discharges as described in Clause 6.3.8 (B) below. For those areas within a construction site which have been paved / covered and will not cause silty discharge, it is possible to drain these areas directly into the storm water drainage system without treatment.

(B) Sediment Control Measures

The sediment control measures shall trap, contain and treat the silty discharges from within a construction / earthworks site (including rain, runoff, water from washbay, underground water at basement, etc.) by providing:

a. Perimeter Cut-off Drain – Perimeter cut-off drains shall be concrete-lined and adequate to capture all runoff from the site. For sites located above slope, a boundary wall of at least 600 mm high shall be provided along the entire perimeter of the site to prevent overflow onto adjacent properties.

b. Perimeter Silt Fence – Silt fences shall be erected along the perimeter cut-off drain (between the construction site and perimeter cut-off drain). The silt fence is to be embedded firmly into the ground and made from an approved geotextile filter fabric or equivalents to capture the sediment from stormwater runoff. The sediment built-up behind the silt fence must be regularly removed.

c. Intermediate Silt Trap – Intermediate silt traps of suitable size shall be installed at regular intervals along the perimeter lined cut-off drain. Within the intermediate silt traps, suitable geotextile filter fabric or equivalents shall be installed across the full depth and width and / or coagulation-assistance materials shall be placed. Silt traps relying primarily on hardcore, granite chips or sands for filtration, are not acceptable.

d. Sedimentation Basin or Storage Pond / Tank - Before silty discharge leaves the site, the silt and sediments shall be separated from the water. This can be achieved by either:

   i. in a sedimentation basin / pond (which will take days for settlement to take place and a large basin volume), or

   ii. through a treatment system–cum–storage tank. The basin / tank shall have a storage capacity to cope with the volume of water from a rain based on a minimum design return period of 1 in 5 years storm.

e. Treatment System – If the design of a sedimentation basin cannot meet the TSS requirement, then other suitably-sized treatment system shall be installed to treat all silty discharge from construction and earthwork sites. The treated effluent could be recycled for non-potable use.

f. Turbidity Curtains - For works in or adjacent to water bodies, such as canals, rivers, sea or in a reclamation work, turbidity curtain(s) shall be installed along all the exposed slopes / riverbanks. The silty discharge trapped within the turbidity curtain shall be allowed to be settled or treated, and the settled silt removed.

g. Wheel wash – the waters used to wash the wheels of the trucks / vehicles shall not be discharged into stormwater drainage system at any time. The silty water within the wheel wash basin shall be connected to the sedimentation basin / treatment system. The silt collected at the bottom of the wheel wash shall be removed.

6.3.9 Review of ECM during Contract duration

The site operator/ contractor shall ensure that the ECM designed and installed shall be continuously reviewed by the QECP for every stage of the construction and earthworks. The ECM shall remain effective throughout the whole duration of works. The site operator / contractor shall add or amend the ECM at site according to the design of the QECP.

6.3.10 Maintenance of ECM during Contract duration

The site operator / contractors shall operate and maintain the ECM regularly to ensure the ECM remains effective throughout the whole duration of works. This may involve replacing of silt fences and erosion control blankets or re-paving of concrete surfaces or replacing of membrane module or polymers blocks.

6.3.11 Monitoring of Discharge during Contract duration

The site operator/ contractor shall monitor the discharge water quality as cited in Clause 6.3.1 before it enters the storm water drainage system. The site operator/ contractor shall for this purpose provide a continuous monitoring system which include the necessary monitoring instrument and CCTV system upon requested by the Board for their ECM. The site operator/ contractor shall submit regular reports (including photographic and monitoring records) of the site ECM as well as those for discharge quality to the Board over the whole duration of the project.

6.3.12 Removal upon Completion

The ECM shall not be removed before the completion of work. The site operator/ owner shall inform the Board prior to removal of the ECM on completion of the project

Roles of the Construction Industry

Project Development Process	ROLES	
	Owner / Developer / Qualified Person	**QECP (Engaged by Owner / Developer)**
(I) Planning & Design	1. Qualified Person could consult PUB on the need to engage QECP for proposals that involve minimum early disturbance in the early stage (i.e. during DC Clearance). Qualified Person to advise the owner / developer accordingly 2. Developer to engage QECP for preliminary ECM & specifications. 3. Developer to endorse BP for compliance with ECM as specified in Code of Practice on Surface Water Drainage (Latest Edition)	1. Conduct site assessment, plan, design and submit preliminary ECM to PUB for record 2. Advise Owner / Developer / Qualified Person to: a. include ECM specifications in tender to allow for costing (attach the preliminary ECM plan for project) b. refer to ECM website @ www.pub.gov.sg/ECM
(II) Tender	1. Developer / Qualified Person to evaluate preliminary ECM plan in tender submission 2. Qualified Person to submit successful Contractor's particulars to PUB	1. Stipulate ECM requirements according to site conditions of the project and allow tenderers to price for them in the tender document 2. Provide advice / evaluation on submitted preliminary ECM plan and method statements received from tenderers

Project Development Process	ROLES	
	Contractor	**QECP (Engaged by Contractor. May or may not be the same QECP of Developer / Owner above)**
(III) Before Commencement of works	1. Engage QECP to design ECM 2. Provide information on topography, soil, construction work and schedule, site facilities, etc. to QECP 3. Submit ECM plan prepared and endorsed by both QECP and Contractor to PUB together with an application for Clearance Certificate to commence earthworks 4. Obtain Clearance Certificate to commence earthworks from PUB 5. Engage a trained person in ECM 6. Implement QECP's endorsed ECM plan before commencement of works <u>Erosion Control</u> Minimise exposure of bare surface by paving up, using erosion control blankets or scheduling works in phases, etc. <u>Sediment Control</u> Perimeter silt fence Perimeter cut-off drains Silt trap Storage tanks / ponds Treatment system etc.	1. Prepare a detailed ECM plan (basing on information provided on topography, soil, construction work and schedule, site facilities, etc.) for all phases of the project for submission to PUB. QECP may be required to make presentation to PUB 2. Advise Contractor to submit ECM plan to PUB and obtain Permit or Clearance Certificate to commence earthwork before commencement of works 3. Advise Contractor on setting up of a monitoring and control system at site, including: a. Appointment of a trained person in ECM on the ECM plan and checklist b. Monitoring the installation of ECM to QECP's specifications and ensuring its effectiveness c. Scheduling of maintenance of ECM and inspections

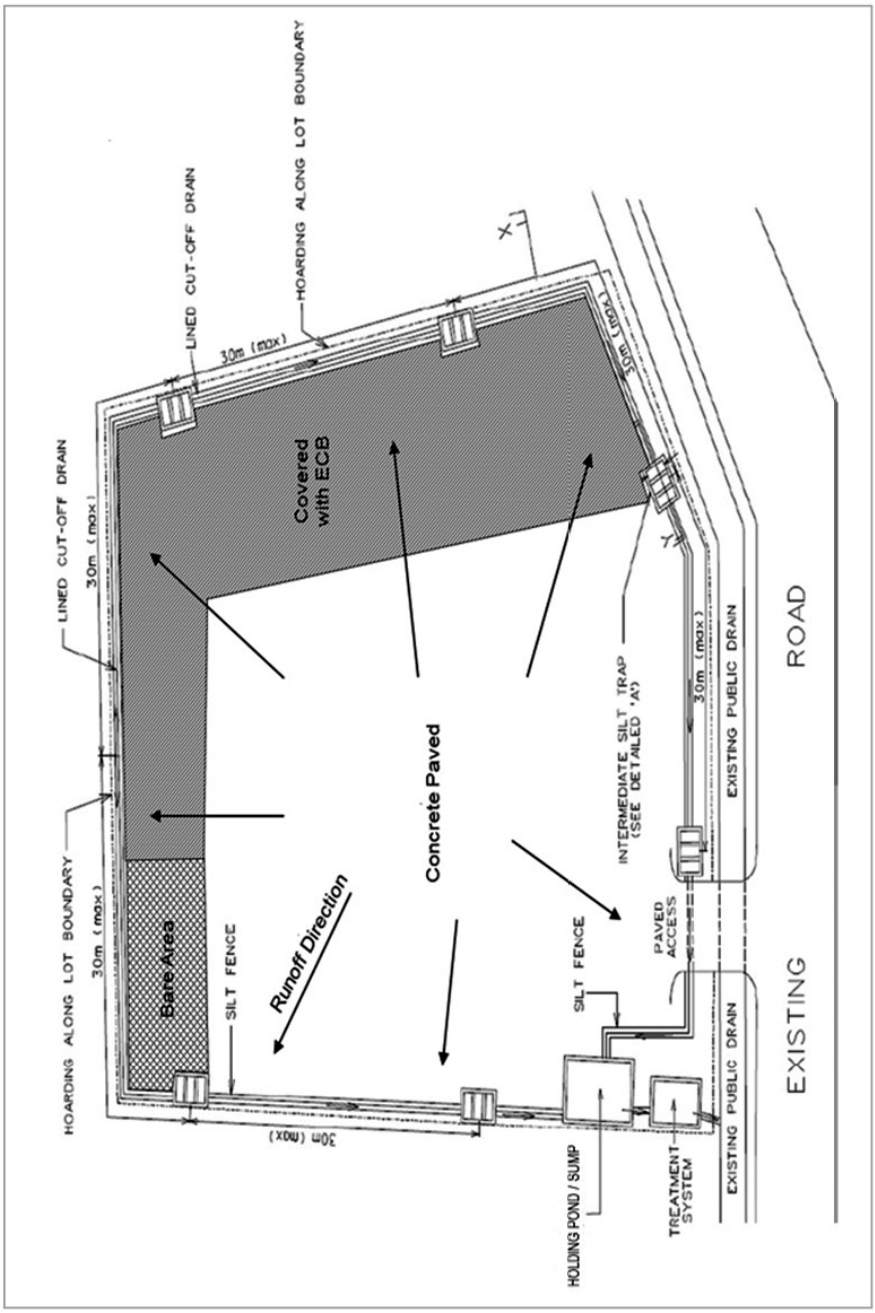
Project Development Process	ROLES	
	Contractor	QECP (Engaged by Contractor. May or may not be the same QECP of Developer / Owner above)
(IV) During Construction	1. Monitor, Maintain the ECM to ensure effectiveness 2. Engage QECP to a. Set up site monitoring and management system for ECM b. Review in tandem with progress of works and implement the revised ECM accordingly 3. Submit weekly reports of ECM at site to QECP 4. Provide continuous monitoring and recording system at discharge point before public drain 5. Cover up the active work surfaces with canvas sheet during rain or at the end of the workday 6. Make available to PUB Officers at all times of visits the following: a. Endorsed ECM plan b. Records of inspections by QECP and trained person in ECM c. Continuous CCTV monitoring records	1. Advise contractor on the effectiveness of the site monitoring and management systems 2. Review ECM in tandem with progress of works 3. Oversee the keeping of ECM inspections records. 4. Requiring Contractor's trained person in ECM to submit weekly reports for checking and compilation 5. Inform PUB of any non-compliances of ECM plan
(V) Before Completion	1. Provide / establish finishing surfaces (close turfing, concrete paving, road surfaces etc) 2. Obtain QECP's approval before ECM is removed	Ensure ECM is removed only after completion of all works

Project Site:	
Name of Developer:	
Name of Contractor:	
Name of QECP	
Date/Time of Inspection: _____(_____ am/pm) Weather: _____Last rain event: _____	
(1) Silty Water Sump/Holding Area	
Capacity (on site): _____	Water Level: High / Medium /Low
(2) Silty Water Treatment Plant(s)	
No. of plants: _____ *Capacity (on site): _____*	*In Operation: Yes / No* *Operable: Yes / No*
(3) Discharge Point(s)	
CCTV installed: Yes/ No Angle of CCTV clearly showing the discharges: Yes / No	if yes, is CCTV in operation: Yes / No Traces of muddy water at discharge point and public drain downstream: Yes / No
(4) Internal Drainage and others	
Approved ECM Plan available on site: Yes / No Cut-off drains - Clearly configured to lead all silt discharges to holding area: Yes / No Extensive use of ECBs and other covers: Yes / No (_____% covered)	Gaps at the foot of hoarding around Site Boundary: Yes / No Adequacy and proper erection of silt fencing: Yes / No Siltation of public drain: Yes / No
(5) Public Drain	
Obstruction / Damage / Interference to Public Drain: Yes / No	

Prepared by:	Acknowledge by:
Date & Sign	Date & Sign
Name / Designation:	Name / Designation:
Contact Number:	Contact Number:

Project Title:

ECM Layout Plan



Project Title:	
Name of Contractor:	
Photos	
Project Signboard	Overview Project Site
Holding Area 1	Holding Area 2
Treatment Plant Photo 1	Treatment Plant Photo 2
Discharged point photo 1	Discharge point photo 2
Discharge point photo 3	Discharge point photo 4
Site hoarding photo	use of ECBs and covers photo
Cut-off drain/Silt Fence photo	Public drain overview photo
Closed drain photo 1	Closed drain photo 2
Remarks:	

Guidelines for Submission of ECM Rectification Report

The Earth Control Measures (ECM) report shall include the following:

(i) Photos of problem areas before/after rectification

(ii) A site layout plan indicating clearly the following:

- The ECM implemented on site and quantities eg. indicate holding pond volume, treatment plant capacity.
- The bare earth areas (shade and indicate percentage as compared to total area)
- Bare earth areas are configured to drain to the holding pond.
- Bare areas covered up
- Curbs, hoardings, cut-off drain and silt fencing are properly provided at the site boundary including at the site entrance and exit
- Points where the photos were taken (photos should also be labelled accordingly)

(iii) Endorsement by QECP

Note:
For clarifications, please contact Mr Aw Kwong Yew at DID: 67313464 or Mr Alan Tan at DID: 67313334

Project Title : _____

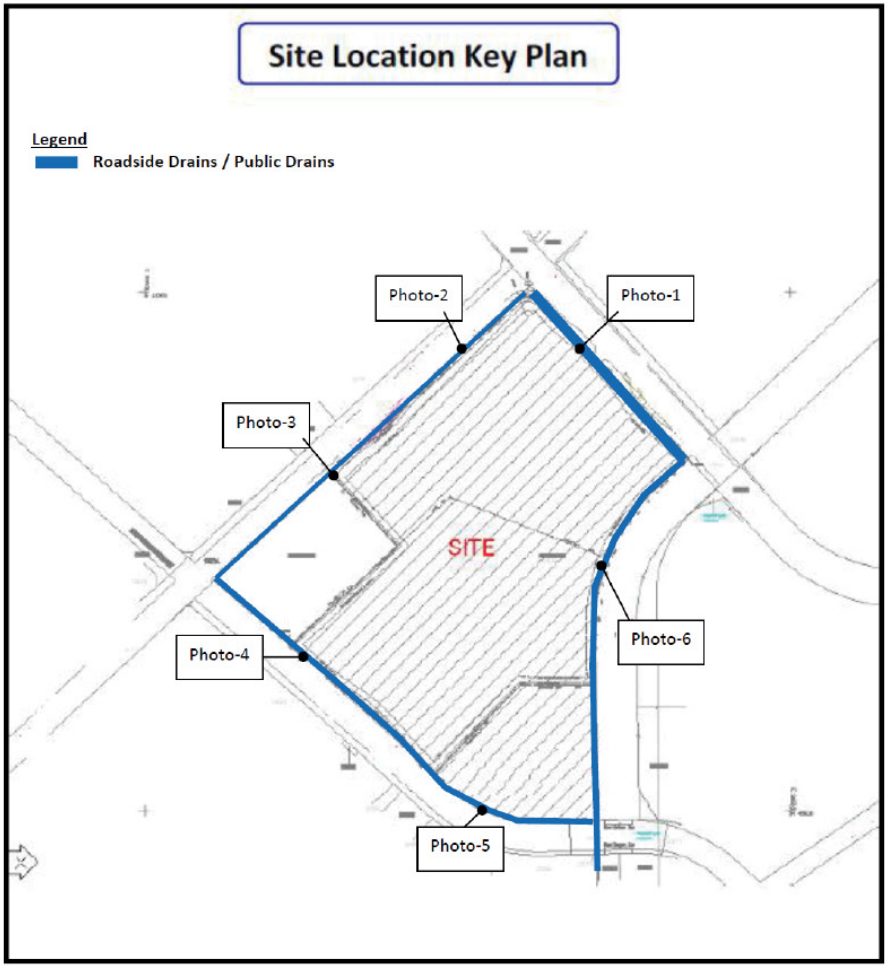
: _____

Contractor : _____

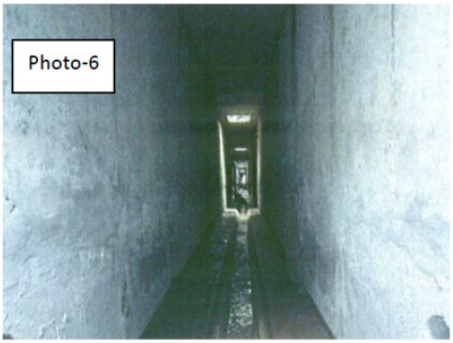
Developer : _____

Project Manager : _____

Date of Inspection : _____



Drainage Inspection Report



Name of Project Manager or QP / Signature / Date

Background

Since Feb 2016, contractors of construction sites with 0.2ha site area or above are required to provide CCTV at their discharge outlet at the public drain to monitor their storm water run-off discharge. Besides, the contractors are also required to connect their CCTV to SIDS, which leverages on image analytics to detect silty discharge. Please see PUB's CCTV circular at Annex A

By connecting to SIDS, the contractor will be able to access:

(i) Auto alert on silty discharge and system downtime

(ii) Archival of 5-min snapshots of their CCTV images for up to 14 days

Auto Alerts

Upon receiving an auto alert, the contractor should take action to stop the silty discharge immediately or to take actions to resume the CCTV operation and rectify any poor images. A sample of the alert sent via smart phone is attached at Annex B

The contractor should also keep PUB informed of the alerts and action taken.

Image Archive for Post Rain Analysis

With the image archive of 14 days, the contractor could do a post rain analysis to review their treatment of silty water and check that the treatment is completed and the holding pond is emptied within 10-hour after a rain event. This will prepare the contractor for the next rain event.

Steps to do post rain analysis:

(a) Identify the past rain period

(b) Log into SIDS

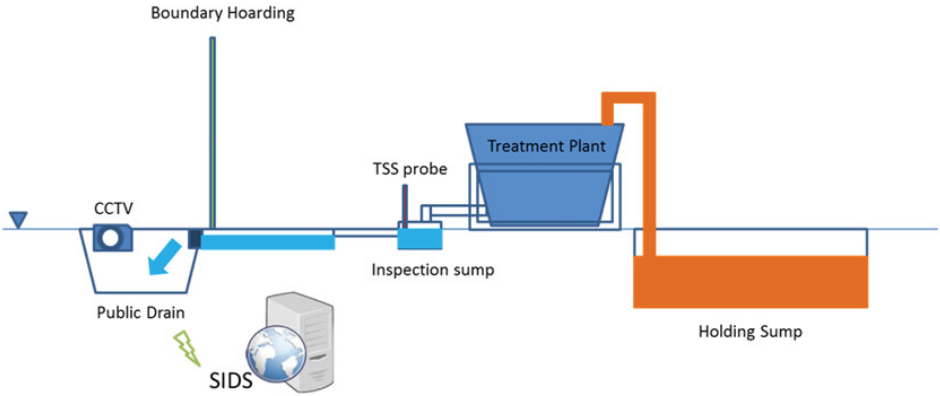
(c) Retrieve the CCTV images of the same raining period and 10 hours after then.

(d) Check the images and count the hours of treatment (5-min per image) made.

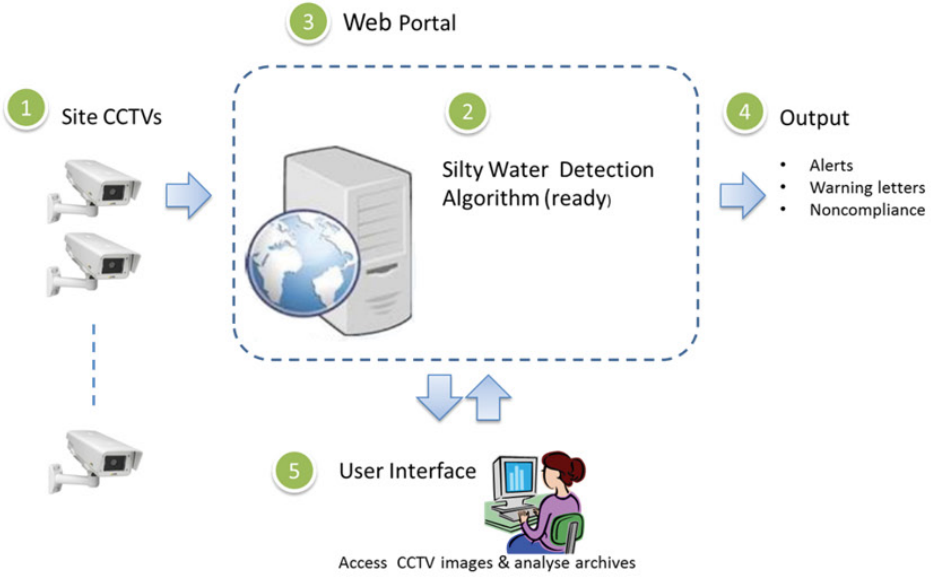
(e) Review the period of silty water discharge, clean water discharge and no/poor image in the selected archive.

(f) Take corrective action.

Schematic diagram of SIDS Implementation



Scenario	Action
Camera not working/misaligned	SIDS Alert
Silty discharge	SIDS Alert
No discharge within 10 hours after rain	User detect Not treating water within 10 hours (holding sump filled) or discharge elsewhere(holding sump emptied)
Muddy water from upstream	User detect



PUB Circular on SIDS

PUB
Water for All: Conserve, Value, Enjoy

Our Reference: PUB (CW) 90505/16

28 Oct 2015

See Distribution

Dear Sir

PREVENTING MUDDY WATERS FROM THE CONSTRUCTION SITES
Revised CCTV Requirements with Implementation of Silty Imagery Detection System (SIDS)

Since Sep 2013, contractors of construction sites of 0.5 ha area size and above, problematic sites and sites within sensitive areas are required to implement CCTV at the public drain to monitor the surface runoff discharges from the sites.

2 Currently, about 500 such CCTVs are installed by the contractors. These cameras enable the contractors, developers, consultants, construction industry professionals and PUB, to monitor the ECM performance at the construction sites via the web portal provided by the CCTV vendors.

3 Physical monitoring of these cameras however, is both laborious and time consuming. To overcome these challenges, PUB is working with A*Star to develop Silt Imagery Detection System (SIDS). SIDS uses image processing technology to detect silty discharge as well as CCTV downtime. PUB also worked with the various CCTV vendors to prepare a selection of CCTVs for the testing. Upon detection of silty discharge and high downtime, alerts would be sent to relevant stakeholders including the contractors and PUB. The system has been tested successfully and ready.

4 In view of the above, PUB has revised the CCTV requirements to factor in the necessary requirements in order to integrate the CCTVs with SIDS. The added requirements include painting a small sky blue background at the discharge outlet as well as setting the CCTV image link for SIDS to grab real-time images from the servers of the various CCTV vendors. The CCTV vendors have been prepared for the revision. The revised CCTV requirements is attached at Annex 1. Upon completion of the CCTV installation, the contractor, with the necessary assistance from his CCTV vendor, would also need to complete and submit a checklist (at Annex 2), comprising CCTV Installation and SIDS Interface details, to PUB.

5 Along with the increasing affordability of CCTV monitoring system and data transmission cost, PUB will also extend the CCTV requirements to construction sites between 0.2 ha and 0.5 ha.

6 The revised CCTV requirements would take effect from 1 Feb 2016, for all new construction sites with site area of 0.2 ha and above, sites with problematic ECM, and sites within sensitive areas.

7 With SIDS providing the auto-detection and alerts, we would like to urge the contractors to operate and maintain their CCTV in good working order and prevent causing silty water discharge at all time, so as to help keep our waterways and reservoirs free from muddy discharge.

8 For clarifications on the revised CCTV requirements and SIDS, please contact Ms Kadie Tan at DID: 67313953 or Mr Goh Hearn at DID: 67313419.

Thank you

Yours faithfully

RIDZUAN ISMAIL
DIRECTOR
CATCHMENT AND WATERWAYS DEPARTMENT

SIDS Alert via Smart Phone

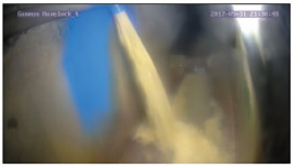
From: noreply@sids.com
Sent: Wednesday, 31 May, 2017 10:12 PM
To: Jian FU (PUB)
Subject: TSS CCTV Station Silt Discharge Alert

Dear Sir/Madam,

Project title: Proposed Residential Building At 1 Singapore Road

Silty Discharge Detected On CCTV – – 1 SINGAPORE ROAD – ABC CONTRACTOR PTE LTD

On 31 May 2017 at 22:12, our Silt Imagery Detection System has detected a possible silty water discharge or poor CCTV image at your discharge point. The CCTV image is attached.



Please check and stop the silty water discharge or rectify the poor CCTV image immediately.

Thank you.

This is a computer generated alert. No reply is required.

The contractor shall provide and operate a CCTV system as follows:

(1) Provide a CCTV system at the public drain near the discharge outlet(s) of the site to monitor the discharge from the site.

The CCTV shall display the following clearly:

(i) Site discharge outlet(s) at the public drain

(ii) Upstream public drain cross-section

(iii) Colour image that can distinct if the flow/discharge is clear or muddy.

(iv) Blue-Marker (see item #2) with size of at least 100x100 pixels in the captured image when there is no water discharge.

(v) Lighting shall be provided such that the Blue-Marker is clearly visible in the CCTV image and can distinct from the image if the flow/discharge is clear or muddy at all time.

(2) A water proof (plastic board or solvent-based matt Sky Blue paint) **Blue-Marker** with the painting colour code of RAL 5012 (CMYK 77% 41% 4% 0%, Sky Blue) shall be installed at discharge point in one of the two formats explained below:

- To be placed at a fixed location at the discharge outlet where the discharged water would always flow over the marker in the captured image as shown in Figure 1.

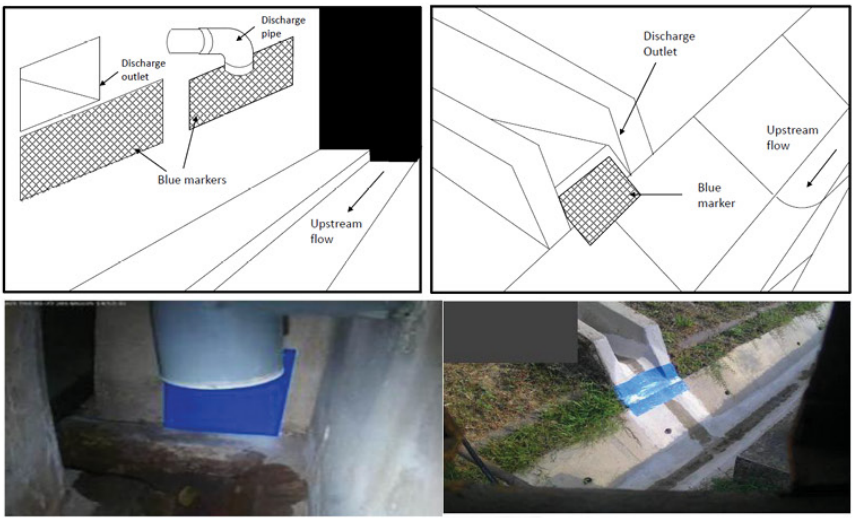


Figure 1. Examples of painted Blue-Marker at discharge points.

- Or, to be implemented on the end of the discharge pipe. The pipe shall have an elbow to direct the flow downwards and cut open to expose the inner side where a blue background can be implemented, as shown in Figure 2.

Figure 2. Example of Blue-Marker painted on cut-opened discharge pipe.

(3) The CCTV system shall be connected to an all-day power supply and operated at all time. The CCTV shall not have more than 4% downtime per month. An auto-alert system via email shall be provided to the contractor if the system is not in operation.

(4) Both CCTV and Blue-Marker shall be well maintained to be free of debris, stain or silt deposit.
The marker should be replaced or repainted if the blue colour fades.

(5) The position of ROI (Region of Interest) on the blue mark shall be checked and maintained at all time.

(6) Provide at least the past 15-day, 5-min interval snapshots of the CCTV within 2 days upon request by PUB.

(7) Provide web access to the CCTV system include the following:

(i) A colour snapshot of the drain for that 5 min interval at 1280x720 resolution in JPEG image format.

(ii) The snapshot shall be imprinted with a short description of the project title and date/time stamp at the top right corner of the image.

(iii) Read access for the snapshot image of the CCTV via a URL link with no username/password required.

(iv) Example: http://www.CameraVendorCo.com/SiteName/current_image.jpg

- "SiteName" is unique for each CCTV camera and must be in the following format:

  [Catchment Code]–[Road]–[Company]–[Camera no.]

- There should be no space in SiteName.

  Examples: E4-Seletar_West_Link-AAA-02
  E4-Seletar_West_Link-BBB-01

(v) The web access shall be of open platform and easily accessible via smart phones and PCs without the need to install any extra/specific version of software.

(vi) Project profile including signboard information and key contact personnel and contact nos, shall be inserted in the vendor's and SIDS's web portals and updated when there is change of information.

(8) Complete the attached CCTV installation checklist and submit to PUB.

Note:

- The contractor should take note of the following when installing the CCTV:
  (a) Type of weather proofing required for closed or open drain and other considerations.
  (b) Adequate lighting
  (c) Continuous power supply.

- For information on CCTV vendor, please refer to ECM website at http://www.pub.gov.sg/drainage/earthcontrolmeasures

CCTV Installation Checklist

BCA Ref No:			
Project Title:			
Contractor:			
Company Address:			
Contact Person:		Designation:	
Contact Person Hp:			
Contact email:			
Developer:			
CCTV Vendor:			
Number of CCTVs:	_____ of _____	(separate checklist to be provided for each CCTV)	
Image URL:			
Site Latitude:		Site Longitude:	

S/No:	Items	Yes	No
1	The installed CCTV shows the discharge outlet and upstream public drain cross-section (as shown in Photo-1)	☐	☐
2	The discharge outlet is painted **water-proof sky blue** (as shown in Photo-2)	☐	☐
3	Adequate lighting is provided (as shown in Photo-3)	☐	☐
4	The blue marker and cross-section of public drain are clearly captured in the CCTV image during day and night time (as shown in Photo-4 and Photo-5)	☐	☐
5	The CCTV system is connected to an all-day power supply (as shown in Photo-6)	☐	☐
6	The web-link and its contents including project profile, prepared in according to the CCTV requirements and ready to be accessed by the users (attached Photo-7)	☐	☐
7	The CCTV vendor has access to SIDS portal	☐	☐
8	The CCTV vendor has configured/entered the CCTVs in the SIDS portal (as shown in Photo-8)	☐	☐

☐ I confirm that the above information and the CCTV installation are in order.

Name of Contractor/ Signature/Date

Company stamp

Photos of CCTV Installations

Photo-1

Photo-2

Photo-3

Photo-4

Photo-5

Photo-6

Photo-7

Photo-8 [Region of Interest (ROI) on the blue marker]

Colour of Water Samples at Various Silt Concentrations

Measurement of Total Suspended Solids (TSS) in mg/l

PUB
Water for All : Conserve, Value, Enjoy

Our Reference: PUB(CWD) 513/13/001

09 Dec 2014

See Distribution List

Dear Sir/Madam,

IMPLEMENTATION OF EARTH CONTROL MEASURES OFFICER (ECMO) AT THE CONSTRUCTION SITES

This circular is to inform the construction industry of the requirement to have a full-time site personnel with Earth Control Measures Officer (ECMO) qualification for construction projects involving earthworks.

Background

2 The Earth Control Measures (ECM) programme, implemented in about 2006, has been evolving for the better. The erosion control sub-committee comprises representatives from The Institution of Engineers Singapore (IES), Association of Consulting Engineers Singapore (ACES), PUB, industry professionals and government agencies meets regularly to review the technical aspect of programme implementation. The committee noted that while the ECM design is amply supported by the Qualified Erosion Control Professional (QECP), the operation of ECM still lacks a ECM-trained staff on site to link up with the QECP, as well as to supervise the operation and maintenance of the ECM implemented on site.

3 In this aspect, the committee has recommended that a ECMO be made available on site to assist the building contractors to implement effective ECM on site.

ECMO Requirement and Roles

4 The ECMO need not be a site personnel dedicated solely to perform the ECMO role. The ECMO role could be covered by the site project manager, project supervisor, ECO, or safety officer. This arrangement of not needing an additional staff as ECMO is to integrate the requirement into the current construction site setup as seamlessly as possible.

40 Scotts Road #22-01 Environment Building Singapore 228231 Republic of Singapore
Tel: 62358888 Fax: 67313020 Website: www.pub.gov.sg

5 To attain the ECMO qualification, the site personnel shall complete and pass a 1-day ECM course conducted by IES or its affiliates and be registered as a ECMO under the IES ECMO Registry. More details on the registry framework is attached at Annex 1 and can be obtained from IES's website at http://www.ies.org.sg.

6 The ECMO's role shall include: (1) implement ECM plan according to QECP design; (2) devise ECM operation; (3) maintenance and inspection programme on site; and (4) assist the QECP to monitor ECM effectiveness throughout various stages of construction.

Implementation

7 In consultation with The Singapore Contractors Association Ltd, we will require all construction sites of site area 0.5 ha and above to have at least a full-time site staff with ECMO qualification at the construction site.

8 In conjunction with the above, the consultant team involved in supervising construction projects is also advised to have a full-time site staff with the ECMO qualification, so as to enable the team to supervise the ECM implemented on site accordingly.

9 This requirement will take effect for all new construction sites with site area of 0.5ha and above, and starting construction works on and after 1 Apr 2015.

Thank you

Yours faithfully

RIDZUAN ISMAIL
DIRECTOR
CATCHMENT AND WATERWAYS DEPARTMENT

PUB, The National Water Agency
Catchment & Waterways Department
40 Scotts Road, #17-01
Environment Building
Singapore 228231
Phone: 6731 3419, 67313464
PUB ECM Website: www.pub.gov.sg/ecm
Code of Practice on Surface Water Drainage:
http://www.pub.gov.sg/general/code/Pages/default.aspx
Email: PUB_CWENF@pub.gov.sg

The Singapore Contractors Association Limited
Construction House, 1 Bukit Merah Lane 2, Singapore 159760
Phone: +65 6278 9577
Fax: +65 6273 3977
www.scal.com.sg
Email: enquiry@scal.com.sg

IES ECM Certificate of Competency Course:
http://www.ies.org.sg/#&panel1-8

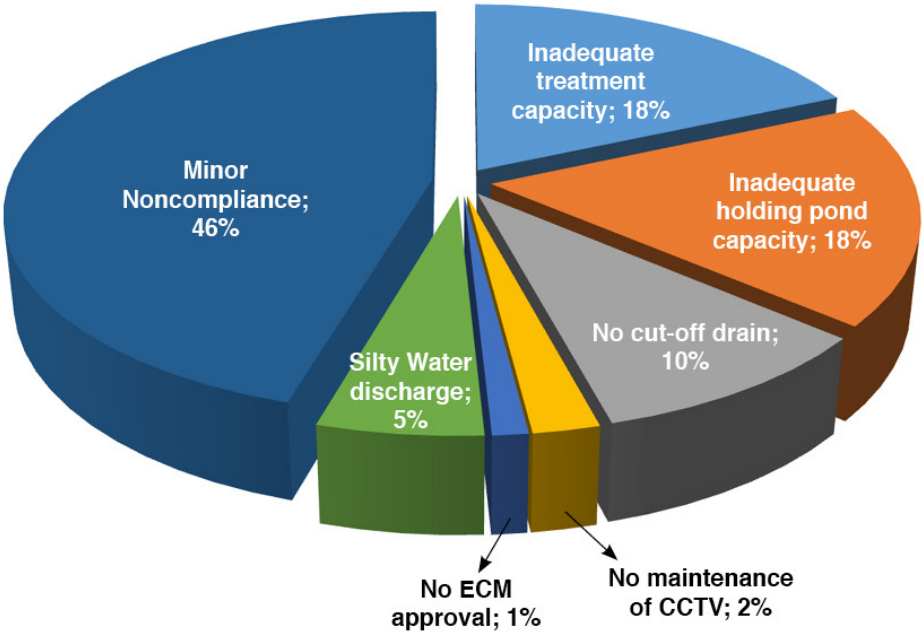
IES / ACES Qualified Erosion Control Professional Registry (QECP)
http://www.ies.org.sg/pageview.php?page_id=357

Useful Mobile Applications:

my ENV

MyWaters

Annex 12 Breakdown of Noncompliance Found in 2017 Site Inspections



Note:

Include data of:
- Multiple visits to a same site
- Site with multiple noncompliance
- 10% of about 6000 sites checked were found to have non-compliance

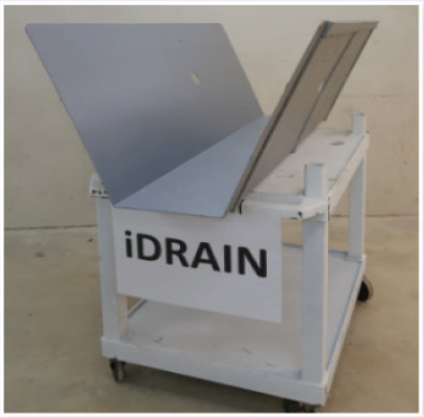
Minor noncompliance include:
- Lack of silt fencing
- Lack of covering of bare areas
- No sealing of hoarding footing
- etc

Innovative Drain (iDrain - The Durable-Reusable ECM Drain)

ECM drain is an integral part of the ECM requirement by PUB prior to commencement of substructure works or earthworks in the construction site. This drainage system is installed to collect silty water for treatment and eventually discharging the treated water to the public drain.

In the construction industry, it has been the practice to use concrete channels to construct ECM drains. The C7 concrete channel which weighs 70 kg per piece is bulky and heavy. Because of its weight, it is time-consuming and labour-intensive to construct, install and dismantle, requiring lifting machinery during the processes. Workers are also exposed to potential safety hazards such as getting struck by the heavy loads, loud noises and dust under prolonged working hours during the installation and demolition processes.

In 2016, Lian Soon Construction Pte Ltd developed an innovative "iDrain" that aims to improve productivity and minimise workers' exposure to workplace safety and health (WSH) risks. Made of galvanized mild steel, the iDrain is much lighter, corrosion resistant, reusable and durable. It can be easily carried and installed by two workers. Measuring 1.2 m long and 3 mm thick, each piece of iDrain is installed by overlapping each section on top of the other in the trench. The



iDrain can also be manually lifted from its position and replaced with another piece when required. When not in use, the iDrain can be easily stacked up for easy storage or recycled as scrap metal after several years of repeated use.

With the iDrain, installation of the ECM drainage system is now simpler, safer and more cost-effective. It eliminates the use of heavy machinery during installation and lessens exposure of workers to loud noise and dust during the removal process. With lesser manpower and shorter construction/ dismantling processes, it is estimated that the iDrain will increase productivity by up to 67% compared with current conventional method! Its sustainability, durability and zero disposal waste concepts also contribute to a greener environment.

iDrain has won several awards such as SCAL WSH Innovation Gold Award 2016, SCAL Productivity & Innovation Gold Award 2016 and the Workplace Safety and Health Council (WSHC) Innovation Awards 2016.

Article contributed by Ruel Ariola, Head of Department, EHS, Lian Soon Construction Pte Ltd