

Sharing Session by Catchment and Waterways Dept (C&W)

Best Practices for Stormwater Drainage Design, Implementation and Maintenance

18 Oct 2024



PUB's Efforts in Tackling Climate Change

Important Considerations for Drainage Design

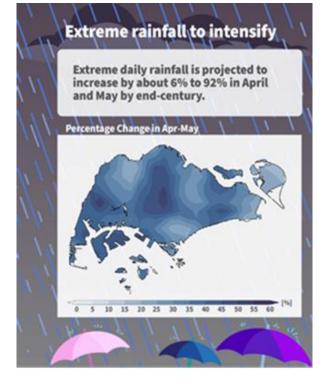
Important Considerations during Implementation & Handing Over Phase

Annual Post-TOP Declaration Process





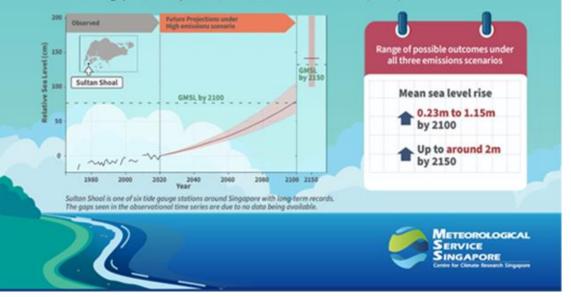
Climate change is increasing flood risk in Singapore



Wet months will be wetter and dry months drier. **Heavy rainfall events** will be more intense and frequent

Sea level rise will continue to accelerate

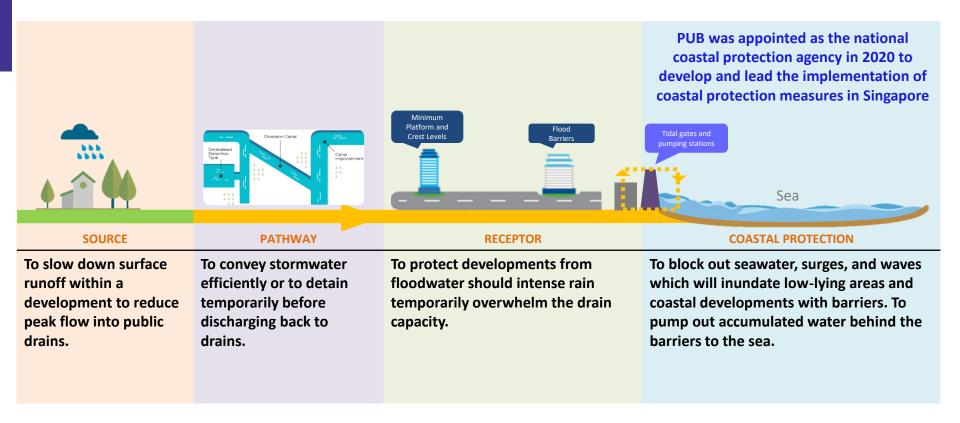
Sea level is expected to rise higher than previously projected due to a better understanding of key processes affecting sea level at global, regional and local scales. Projected sea level rise around Singapore is comparable to the Global Mean Sea Level (GMSL) rise.



Mean sea levels are projected to increase by up to 1.15m by year 2100



PUB has adopted a holistic "Source-Pathway-Receptor" approach to enhance flood protection since 2014



Developments will need to contribute towards overall flood resilience in Singapore by ensuring adequate design, and O&M of the drainage system



In spite PUB's Efforts ... Flood Protection is a Collective Responsibility

- <u>Industry Professionals</u> play a vital role by ensuring proper design and implementation of drainage systems that comply with COP and considering future maintenance aspects during design stage. If flood protection measures are proposed, to include a maintenance regime.
- <u>Developers/Building Owners</u> need to play their part in budgeting for maintenance of their flood protection measures and to ensure that their Managing Agent (MA) or Facilities Management (FM) are well-equipped to implement the maintenance regime.
- <u>MA/FM</u> need to be aware of flood protection measures in the premises, carry out regular maintenance & testing based on established regime and ensure all works are done properly by the qualified personnel.

Collective approach helps Singapore to be more resilient against flooding !





Important Considerations for Drainage Design

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Minimum Platform Level (MPL) & Crest Level (CL)

- MPL is critical for a development as it is a structural protection against flood risk from external factors (e.g. intense rainfall, high tides and etc). For development with basement, additional CL must be complied.
- QPs should always consult PUB early on the MPL requirement especially for Critical/Key Infrastructure.
- Where MPL/CL cannot be met after comprehensive assessment, QP will need to provide clear justification and supporting information on why the MPL/CL cannot be met to seek a deviation, and incorporate flood protection measures in the design to make up the shortfall from the MPL/CL.

		Type of Developments			
		General (i.e. Landed Houses)	Multi-Unit Residential / Industrial / Commercial / Institutional	Special Facilities (SF)^ / Devs with linkages to SF	
Road Level		Private House	Shopping Mall	B S 2 Beaut Entrance to MRT	
Minimum Platform	(i)	4m SHD [#] for Southern Coast, 4.5m SHD for Northern Coast			
Level (whichever criteria is	(ii)	300mm above adjacent road	600mm above adjacent road	1m above adjacent road	
the highest)	(iii)		300mm^ above modelled flood levels* (for CI/KI)	300mm^ above modelled flood levels* (for CI/KI)	
Crest Level – ingress/egress to basement to have extra crest		150mm above MPL	300mm above MPL		



Minimum Platform Level (MPL) & Crest Level (CL) – Critical M&E

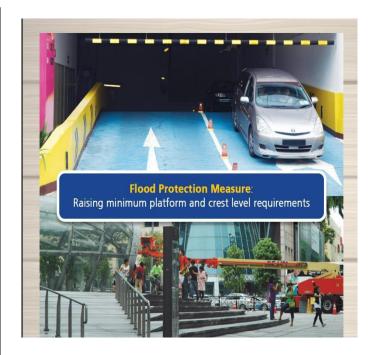
- QP shall advise the developer/owner on the need to identify power, communications, and other critical M&E equipment prior to the design of the development site.
- All critical M&E equipment for <u>CIs/KIs</u> must meet MPL and crest protection requirements.
- All critical M&E equipment should be designed to locate as high as possible.

Definition extracted from COP for Surface Water Drainage :

CI: refers to physical infrastructure and assets that are **vital to the continued delivery of the essential services that Singapore relies on**, the loss or compromise of which would lead to a debilitating impact on security, economy or public health and safety.

KI : refers to developments that fall outside the definition of a critical infrastructure but are **identified by agencies to be important to agencies' function.** (e.g. distribution substations (22kV, 6.6kV), prison complexes, bus interchange and depots, and neighbourhood police centres)

Special Facilities: refers to developments such as Rapid Transit systems, port/aviation facilities, wafer fabrication plants, underground road networks, power generation plants, healthcare with A&E services, gas transmission/ receiving station, transmission substations, exchange or central office used for telecommunication purpose, or any developments as specified by the Board.





Drainage Affecting Other Premises

- One of the commonly overlooked design considerations by QPs that can lead to flooding incidents.
- QPs should conduct detailed study on the surrounding terrain adjacent to the project boundary and ensure all runoff from the development site can be discharged properly into internal cut-off drain before entering public drains and not overflow into the adjacent premises.
- If required, a minimum 600 mm high solid wall shall be erected along the boundary of the development site abutting adjacent premises to prevent surface runoff from overflowing into adjacent premises.



Water from development site on higher ground overflowing to the house at the lower ground



Surface runoff from higher ground flowing to lower ground area caused flooding as the perimeter drain is not sized for the additional catchment

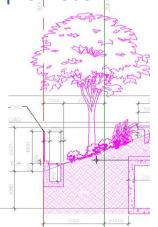


Drainage Affecting Other Premises

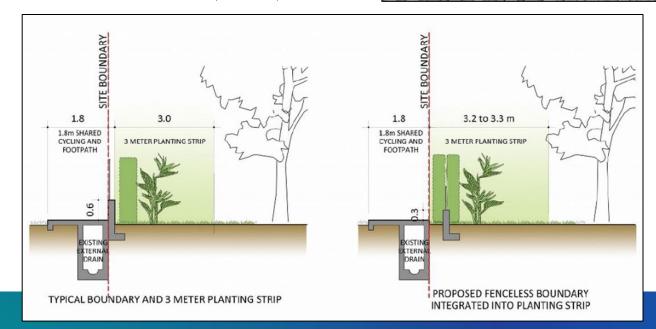
QPs can explore alternative design as long as it is effective to prevent surface runoff from overflowing into the adjacent premises.

E.g. Perimeter drain all around the boundary of site with a gentle 1:2.5 berm from the landscape deck FFL.

Thus, surface runoff on the berm to the perimeter drain will be slowed down by lush planting on the berm.



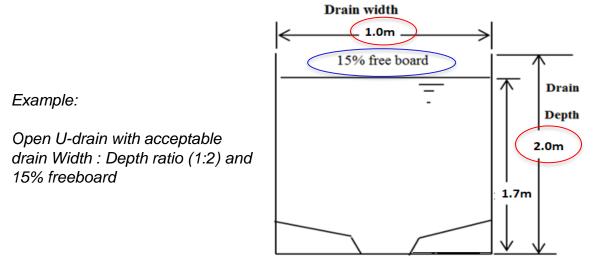






Drain Design

- Drain Width : Drain Depth Ratio shall not exceed 1:2 (rule of thumb) to facilitate safety and ease of maintenance. E.g. 0.8m wide drain x 2m depth drain will pose safety concern and not possible to maintain or repair.
- Velocity of flow in drain shall not be lower than 1.0m/s and not higher than 3.0m/s with Froude Number less than 0.8. This is to achieve self-cleansing velocity, reducing the need for maintenance and choking of drain. A higher velocity must be avoided as it will cause excessive erosion and hydraulic jumps (will requires more frequent drain repair and flow splashing out of the drain).
- Freeboard should be maintained at 15% to prevent waves or fluctuation of the water surface from overflowing from the drain cope/bank. It is not a valid reason to reduce this allowance to justify proposing a smaller drain.



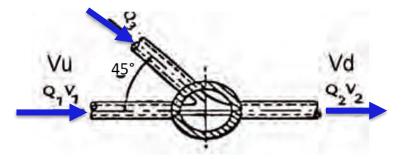


Drain Design

• Typical drain gradients range between 1:150 to 1:3000 depending on the size of the drain. Do not propose very steep gradient just to achieve the required drain capacity.

Type of drains	Bed gradient not to be gentler than
Roadside Drain	1:150
Outlet Drain	1:900
Major Waterways	1:3000

- Where there is a drop in invert level greater than 900mm, QPs should design a gradual drop in the form of cascade.
- For connection of drain into Outlet drain/waterways, the drain should be connected at 45 degrees towards the outlet drain/ waterways so that to ensure the stormwater runoff is graded together with the incoming flow from upstream catchment of the outlet drain/ waterways.



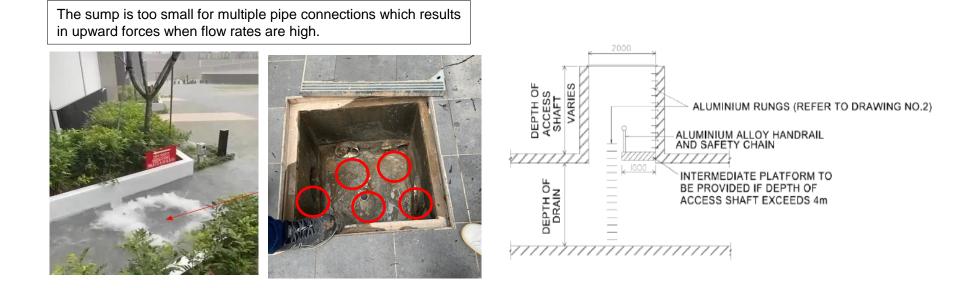
Lateral Connection of drain into outlet drain/waterways

• Avoid designing drains with 90-degree bend. If unavoidable, provide a properly sized sump.



Drainage Appurtenances

- Sump of sufficient size shall be provided where drains converge. General guideline is minimum internal width of the sump shall not be less than 1.5 times the width of the drain leading away from the sump.
- Drains connecting into the sump shall not form an acute angle with the outgoing drain flow and shall connect at different levels wherever possible. The **invert level of the downstream drain shall be lower than the invert level of the sump to avoid stagnation of water** (lead to mosquito breeding).
- For sump > 4m depth, must design intermediate platform with railings for safe maintenance access.





Drainage Appurtenances

- Many flooding incidents occur due to lack of maintenance (chokage from dead leaves and debris). QPs did not design a proper access gate and space for workers to clean the internal drain. Out of sight, out of mind !
- Avoid excessive long concealed scupper drainage (DIC). Intermediate sump shall be provided if the length of the concealed scupper drainage exceeds 6m. The longer and smaller the pipe, the harder to maintain and choke will happen easily.
- Selection of grating design should consider following aspects:
 - Function (e.g. cater for pedestrian or heavy vehicular loading);
 - Ease of access (not to site in the middle of driveway); and
 - **Ease of maintenance** (i.e. lifting requirements)





*Q***PUB**

Drainage for Underground Facilities

• Basements, tunnels and other underground facilities should be designed to prevent any ingress of storm water.

Example: Implement shelter so that any runoff can flow from roof and discharge to 1st level drainage system or implement cut-off drain at ramps/ accessway to discharge into 1st level drainage system instead of entering the basement.

• If ingress of storm water cannot be completely prevented, the catchment contributing to the ingress shall be kept to the minimum and an adequate pumped drainage system shall be provided.



Runoff overflow via air duct and enter basement because of missing inlet pipes to pumped drainage system





Important Considerations during Implementation & Handing Over Phase

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Earthworks

- ✓ QECPs shall submit ECM plans via PUB's Business & Professional Portal(<u>https://www.eservices.pub.gov.sg</u>) for approval.
- QECPs shall work with Contractors to ensure proper ECM measures are implemented and maintained on site according to approved plans.
- ✓ Any change of original approved plans due to site challenges or change of work sequence, QECPs shall resubmit the amended ECM plan for PUB's approval before proceeding with further works on site.



PUB taking enforcement action against contractor over silty discharge in Hougang



video posted on the Nature Society Singapore's Facebook page shows silt in a canal in Hougang. PHOTOS: SCREENGRABS FROM ED BKL/FACEBOO

Everyone has a part to play to keep our waterways free of muddy pollution! OPUB

Unauthorised drainage works caused flooding at Pasir Ris-Tampines junction, PUB to take action against company



 Matthew Mohan

 Image: Comparison of the state of th

PUB takes action against contractor whose drainage works caused Upper Thomson flood



Temporary Works that affects public drains/ Drainage Reserves

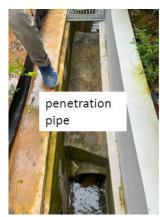
- ✓ QPs shall submit Temporary work proposal via PUB's Business & Professional Portal (<u>https://www.eservices.pub.gov.sg</u>) for approval.
- ✓ QPs shall submit their proposal to PUB for any temporary works that will affect existing public drainage system. No commencement of any physical works before obtaining approval from PUB.

Note: Approval of Temporary Works does not equate to Approval of ECM plan. They are two separate submissions for different purposes.



\checkmark All drainage works to be constructed onsite must be done accordingly to the approved plans.

- ✓ If there are site constraints, contractor shall highlight the issue to QPs. QPs should seek re-approval from relevant agencies if there are changes to the approved plans <u>before commencing of physical works at</u> <u>site</u>.
- QPs shall conduct proper thorough inspection of constructed drainage system before applying for TOP.
 Example:
 - QP should check on detention tank's inlet and outlet connections to ensure it was constructed according to the approved plans. Not just focusing on the volume and structural aspect of the DT.
 - Check the constructed internal drain size is according to approved plan and not obstructed.
- ✓ QPs shall exercise his/her due diligence before making any declaration during submission for TOP.



Case Study:

Not constructed according to approved plans. QP did not submit amendment plans for re-approval.



Case study:

Contractor did not construct according to approved plan where the constructed inlet to DT was 3x smaller than the approved size. This result flooding to the premises.

QP also never check properly during the inspection prior TOP.



Rectification of unauthorized works will involve a lot of abortive works which will be very costly and time-consuming with serious legal implications !

Storm water drainage system not to be constructed or altered without Board's certificate or approval

23.—(1) No person shall construct, alter, discontinue or close up any storm water drainage system or drain without obtaining in respect of those works, a clearance certificate or the approval of the Board under section 33.

Works affecting storm water drainage system

26.—(1) No person shall carry out or cause to be carried out any works which will affect any storm water drainage system, drain or drainage reserve, directly or indirectly, without obtaining in respect of those works, a clearance certificate or the approval of the Board under section 33.

Drains and drainage reserves not to be interfered with

24.--(1) No person shall ---

- (a) erect or place any structure or object in, above or across any drain;
- cause any obstruction to the flow of any storm water drainage system; or
- (c) erect, construct or lay within any drainage reserve any fence, retaining wall, foundation, manhole pipe, cable mains or any obstruction or structure (whether temporary or permanent),

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

Never carry out any drainage works without clearance certificate from PUB.

Duties of qualified person

35.—(1) Every qualified person appointed to supervise any works for the purposes of section 34 shall —

- (a) take all reasonable steps and exercise due diligence in supervising and inspecting the works to ensure that those works are carried out in accordance with this Act and with, the plans submitted under section 33(3) and with any condition imposed by the Board under that section;
- notify the Board of any contravention of the provisions of this Act pertaining to the works; (b)
- (c) keep and maintain at the premises on which works are carried out such documents, books and records as may be prescribed;
- carry out such inspection of the works as the Board may require; (d)
- submit to the Board at the prescribed times such reports and certificates as may be prescribed; and
- on completion of the inspection referred to in paragraph (d), submit to the Board a certificate containing such particulars as the Board may require.

[8/2001]





Proper Handing Over

Even with the best design and implementation, stormwater drainage system will still fail without proper maintenance.

QP should provide advice to the owner of the premises by not limited to the following:

- Cater adequate Opex budget for maintenance;
- Provide a detailed list of drainage assets within their premises including as-built plans/relevant documents;
- The recommended maintenance regime and SOP for the list of drainage assets; and
- Appoint professional maintenance agent to carry out the routine maintenance.

Flooding at condominium car park at Balmoral Crescent not caused by rainfall: PUB

A faulty valve in the basement's sprinkler storage tank caused water to overflow and flooded the car park, says the national water agency.







Proper Handing Over – Post-TOP Declaration

Upon obtaining TOP, QPs shall remind Developer/Owner/ Managing Agent/MCST/Town Council the need to make annual declaration to PUB for stormwater drainage system via PUB's Business & Professional Portal (<u>https://www.eservices.pub.gov.sg</u>).

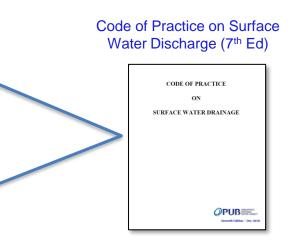
13 MAINTAINING THE INTEGRITY OF THE STORM WATER DRAINAGE SYSTEMS INCLUDING FLOOD PROTECTION MEASURES

13.1 Responsibility of Developer/Owner/Managing Agent/MCST/Town Council

The Developer/Owner/Managing Agent/MCST/Town Council shall be responsible for the maintenance, operation and monitoring of the storm water drainage systems within their premises. These include, but are not limited to, regular adequacy checks on the flood protection measures such as minimum crest levels, detention/retention pond systems and pumped drainage system.

13.2 Declaration on Storm Water Drainage Systems

- 13.2.1 Upon obtaining the Temporary Occupation Permit (TOP), the Developer/ Owner, Managing Agent/ MCST/ Town Council shall make annual declarations and submissions for the following storm water drainage systems via PUB website-Qualified Persons Portal:
 - i. For developments installed with automated flood protection devices, a certificate of inspection of the automated flood protection device endorsed by a PE (Civil or Mechanical) together with supporting documents such as on-site leak test report and photographs shall be submitted. The inspection shall make reference to any relevant international standards or any requirements specified by the Board.
 - For developments constructed with pumped detention tanks for detention function as stipulated in Clause 7.1.5, the following documents shall be submitted:
 - (a) Annual electrical installation license issued by EMA;
 - (b) Quarterly maintenance records of pumps;
 - (c) Quarterly maintenance records of level control system; and
 - (d) Quarterly cleaning and desilting records of tank and pump sump.
- 13.2.2 The Developer/Owner/Managing Agent/MCST/Town Council shall submit amendments to the standard operating procedure (SOP) of the flood protection measures endorsed by a PE (Civil and/or Mechanical) to the Board for record.



Who need to submit & What to submit ?

- Developments with automated flood protection devices (flood barrier)
- Developments with pumped detention tank





Thank You

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Annual Post-TOP Declaration (Annex - Step by Step guide)

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Step 1 - Login to B&P Portal

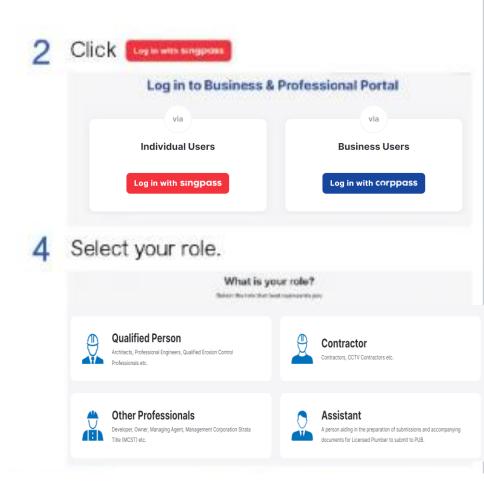
Log in as Individual User

Access B&P Portal either via: https://www.eservices.pub.gov.sg/bpp



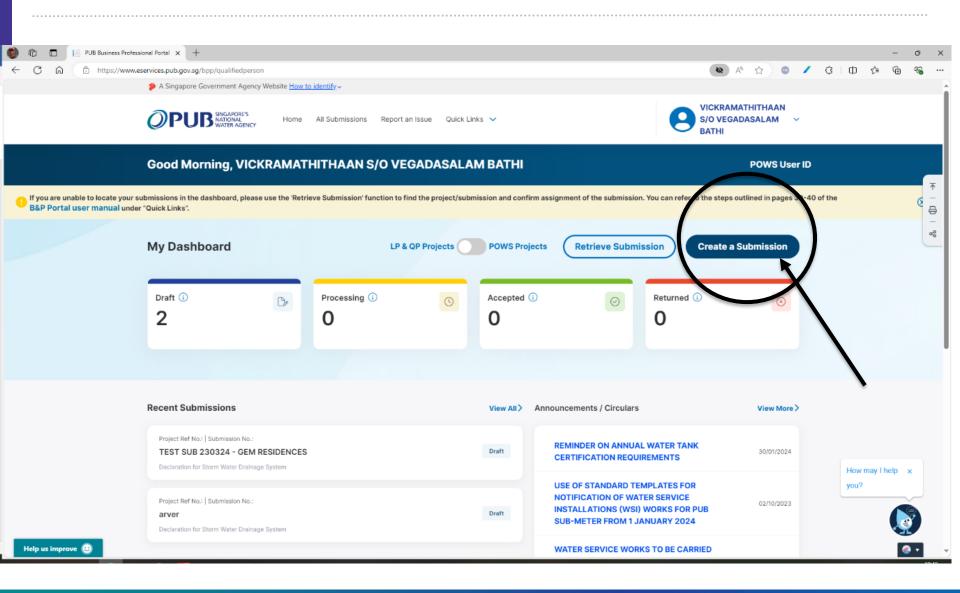
3 Scan QR code using Singpass app or Tap on 1 to open it on mobile device or Use Password login.







Step 2 - Create a Submission in Dashboard Interface

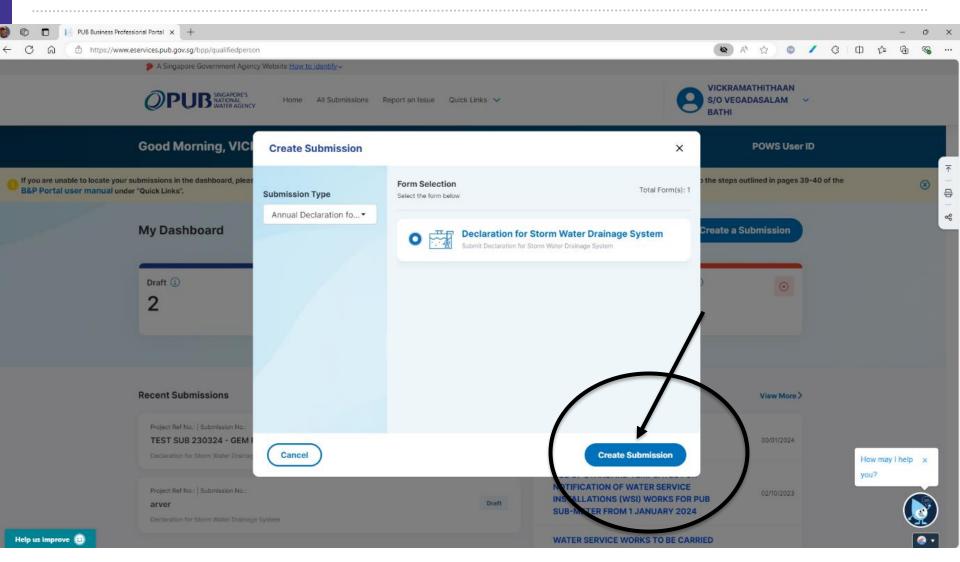




Step 3 - Select "Annual Declaration for Stormwater Drainage System" under the dropdown box options G PUB Business Professional Portal X + 0 🖎 A 🟠 💿 🖊 G 🗇 🏠 C ŵ https://www.eservices.pub.gov.sg/bpp/qualifiedperson G -A Singapore Government Agency Website How to identify ~ VICKRAMATHITHAAN PUB SINGAPORE'S NATIONAL WATER AGENCY Home All Submissions Report an Issue Quick Links V S/O VEGADASALAM BATHI **Good Morning, VIC POWS User ID Create Submission** × If you are unable to locate your submissions in the dashboard, plea the steps outlined in pages 39-40 of the B&P Portal user manual under "Quick Links". 0 Form Selection Total Form(s): 0 Submission Type Select the form below ŝ --Please Select--My Dashboard reate a Submission --Please Select--Works in Public Sewerage System anage works and ECM Annual Declaration for Storm Water Drainage System Draft (1) 2 No form selected yet Select from "Submission Type" to show form select **Recent Submissions** View More > TEST SUB 230324 - GEM | Cancel Create Submission How may I help **USE OF STANDARD TEMPLATES FOR** you? NOTIFICATION OF WATER SERVICE INSTALLATIONS (WSI) WORKS FOR PUB Draft arver SUB-METER FROM 1 JANUARY 2024 Help us improve 🙂 WATER SERVICE WORKS TO BE CARRIED

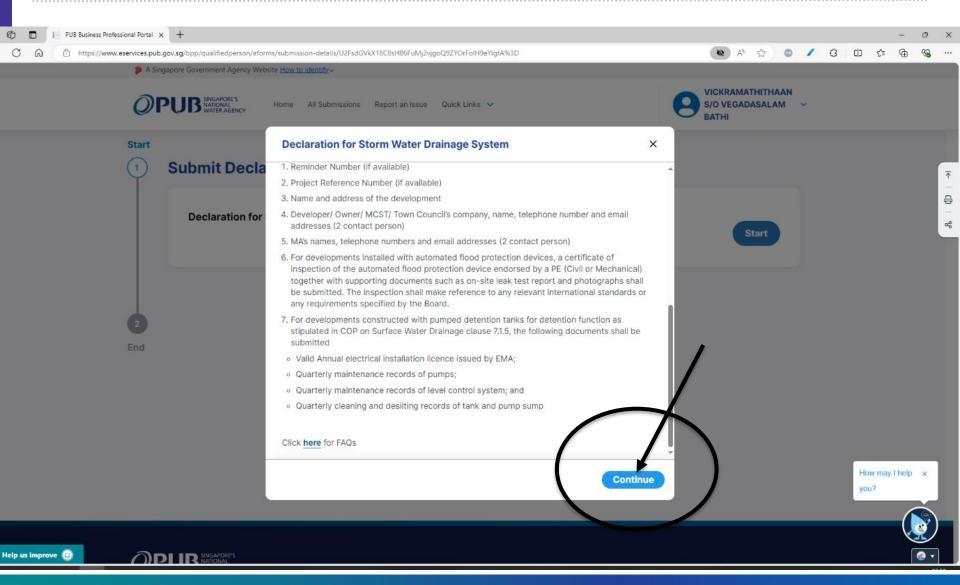


Step 4 - Click "Create Submission"



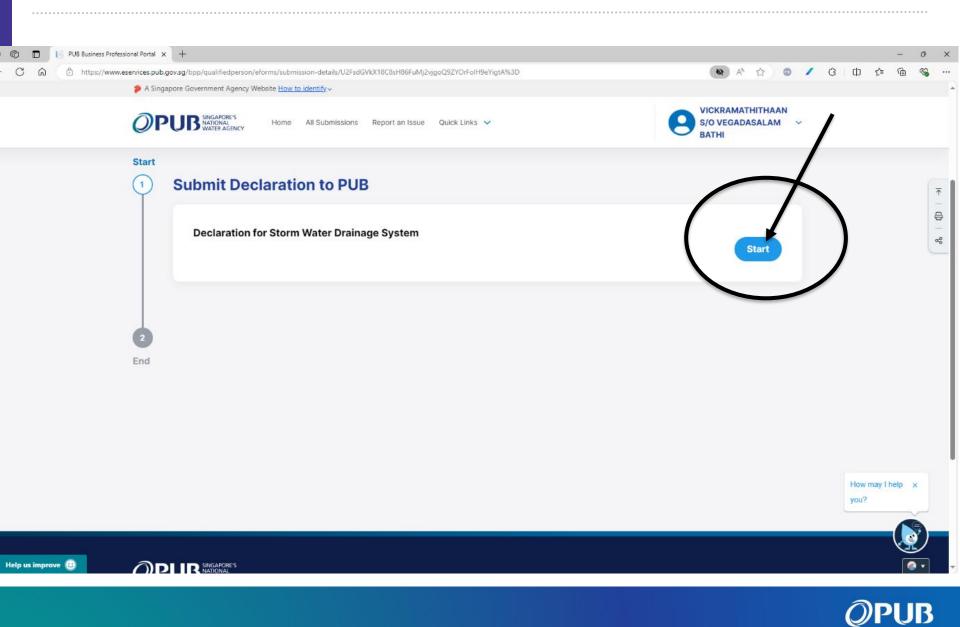


Step 5 - Click "Continue"





Step 6 - Click "Start" & Proceed



Step 7 - Fill up relevant information and/or upload supporting documents

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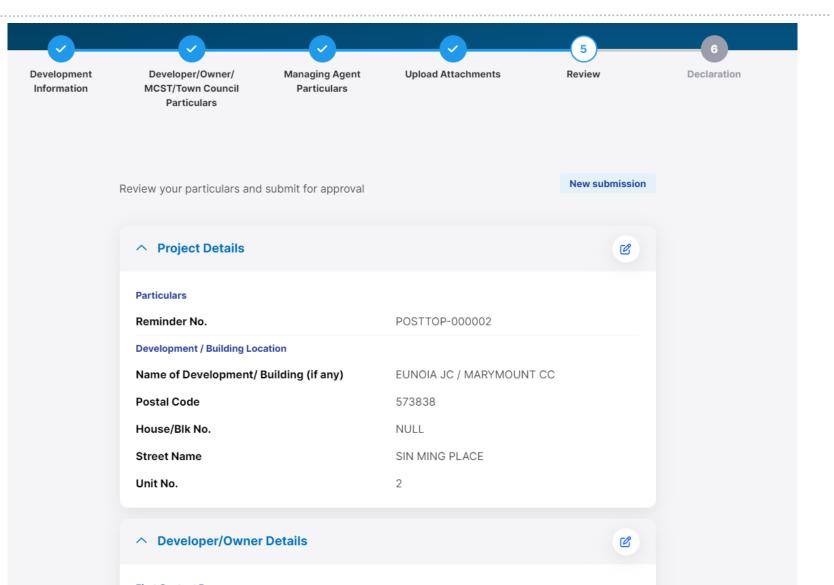


Step 8 - Fill up relevant information and/or upload supporting documents

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Development Information	Developer/Owner/ MCST/Town Council Particulars	Managing Agent Particulars	Upload Attachments	Review	Declaration
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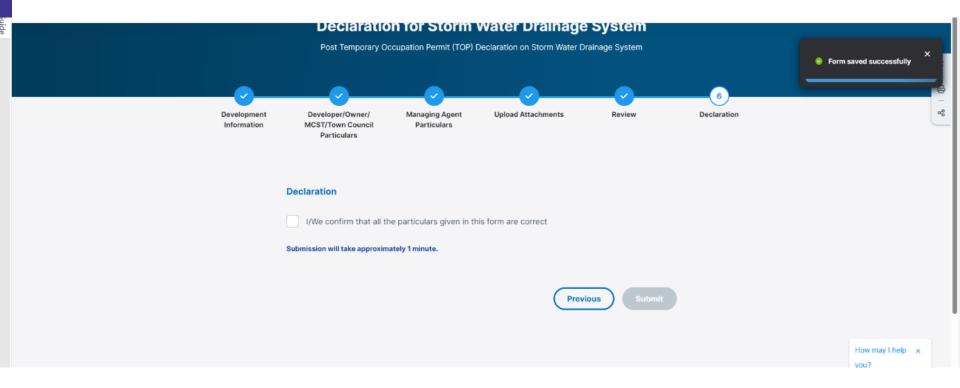


Step 9 - Fill up relevant information and/or upload supporting documents





Step 10 - Fill up relevant information and/or upload supporting documents



Should there be any issue encountered during the submission, please contact Vickram via email (vickramathithaan_vegadasalam_bathi@pub.gov.sg) for assistance.

