

Question by: Mr Kwek Hian Chuan Henry, Member of Parliament for Nee Soon GRC

To ask the Minister for the Environment and Water Resources (a) whether the flood prevention systems will be able to prevent flash floods similar to those that occurred on 8 January 2018 after the completion of the drainage upgrades in 2019; (b) what are the guiding principles used to determine the drainage capacity needed in an area; and (c) whether these include balancing the potential collateral damage versus the investment cost.

Question by: Miss Cheryl Chan Wei Ling, Member of Parliament for Fengshan SMC

To ask the Minister for the Environment and Water Resources with regard to the flash flood on 8 January 2018 at Bedok North Avenue 4 (a) whether the ongoing enhancement drainage works at Bedok Canal was one of the reasons that limits the water capacity that can be stored or discharged through the canal during heavy downpours and high tides; (b) if so, what are the interim measures to prevent potential flash floods at this area until enhancement works are completed in 2019; and (c) what measures are in place to ensure the public living and working near any canals are alerted before possible water overflow occurs.

Question by: Miss Cheng Li Hui, Member of Parliament for Tampines GRC

To ask the Minister for the Environment and Water Resources (a) what current mechanisms are in place to notify motorists of impending flash floods in order to redirect traffic from affected areas; and (b) whether such mechanisms are can be further enhanced to achieve broader and more effective notifications.

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Question by: Mr Dennis Tan Lip Fong, Non-Constituency Member of Parliament

To ask the Minister for the Environment and Water Resources (a) what caused the heavy flooding at the nine locations in the eastern part of Singapore on 8 January 2018; (b) whether each location has a history of flooding; (c) whether existing drainage works is a cause; (d) what measures have been taken to assist members of the public who were affected by the flooding; and (e) what measures will be taken to prevent similar flooding.

Question by: Mr Murali Pillai, Member of Parliament for Bukit Batok SMC

To ask the Minister for the Environment and Water Resources how does PUB ensure that existing drains and canals are kept free of debris that have potential to create constrictions or bottlenecks, so as to alleviate flooding.

Reply by Minister:

Flash Floods on 8 Jan 2018

1. On the morning of 8 January 2018, the prevailing Northeast Monsoon, aggravated by the development of a Sumatra squall gave rise to intense rainfall across several parts of Singapore. The highest recorded total rainfall that morning was 118.8mm. This means that about half of Singapore's average monthly rainfall in January fell over just four hours.

2. Eight of the nine locations that experienced flash floods that morning are low-lying and therefore susceptible to flash floods. Two of these, Tampines Road (opposite Jalan Teliti) and Arumugam Road, have a history of flash floods. PUB is already carrying out drainage improvement works in these eight locations to enable the drains there to discharge more water in a shorter time when completed. During drainage improvement works, PUB ensures that the drainage capacity of the area is maintained at the original level before works commence; drainage works did not cause the flash floods in these locations. For the ninth location at Tampines Avenue 12, apart from intense rainfall which exceeded the drain's design capacity, a temporary construction access road built by the contractor had obstructed the earth drain in an adjacent worksite. This aggravated the flash flood. PUB has worked with the developer to improve the drainage at the earth drain and this will help to improve the situation at Tampines Avenue 12 in an event of intense storm. The longer term measure is the permanent drainage system which will be built in tandem with the upcoming development project at the adjacent worksite.

3. The flash floods were caused by the intense rainfall temporarily exceeding the existing design capacity of the drains. Although the flood waters affected only certain stretches of the roads, and subsided within 15 to 60 minutes, we acknowledge that members of the public were inconvenienced and a number of cars were stalled. When flash floods occur, we urge members of the public to exercise caution and avoid traversing in submerged areas even if they appear safe. Flash floods are usually of short duration and it is better to wait for them to pass before continuing the journey. To aid the public, PUB, together with Traffic Police and LTA, will help divert vehicles at the earliest possible.

Drainage Design and Improvement Works

4. Let me go back to drain design. PUB takes into account terrain, the extent and type of developments in the area, catchment area served by the drain, as well as the design rainfall intensity over the catchment. This is standard international practice. However, with climate change, we can expect more intense rainfalls to be the norm in future. A study by the Potsdam Institute for Climate Impact Research found that flood risks from rainfall changes will increase in the next two to three decades, due to global warming from greenhouse gases already emitted into the atmosphere. The need for adaptation is significant, even in countries with good infrastructure such as Singapore.

5. To prepare for this, PUB has raised the drainage design standards since 2011, so that our drains can handle up to 45% higher rainfall intensities. These new standards were endorsed in 2012 by a Drainage Expert Panel comprising local and international specialists.

6. Since 2012, PUB has commenced and completed drainage improvement works at 327 locations. There are another 73 locations undergoing similar works, with 22 more planned this year. The Government has invested \$1.2 billion on these works, and has set aside another \$500 million for the next two to three years.

7. However, it is not feasible to build our drains to accommodate every extreme rainfall event as this would require massive land take and much higher costs. Bedok Canal, which serves some of the affected areas, is being widened at a cost of \$128 million from its existing width of 38 metres to 44 metres, wide enough to accommodate an expressway of 10 lanes, 5 lanes each way. Even with this widening, we cannot guarantee that there will be no floods in future, as rainfall events of even higher intensity could still occur that exceed the design capacity. This is especially so with climate change. To deal with the most extreme historical rainfall events, the Bedok Canal would need to be widened to at least 62 metres, displacing the Bedok Park Connector and community spaces adjacent to the Canal, and possibly even affecting the surrounding residential areas. This will look like a 16-lane expressway. Given competing needs for other land uses such as housing, parks and roads, we have to be practical in our drainage expansion in Singapore. We have to design with practical considerations and not for extreme conditions all the time for all places. Building our drains for extreme conditions would mean that much of the capacity would be extremely costly, but not needed most of the time. We will however ensure our critical infrastructure is well-protected from such extreme rainfalls. This is achieved through the “source-pathway-receptor” approach which was developed based on the recommendation of the Drainage Expert Panel to implement a holistic range of interventions.

Source-Pathway-Receptor Approach

8. Under this approach, other than improving the *pathways*, or drains, we also manage the *source*, which refers to where the rain falls. Measures include detention tanks to slow down surface runoff and reduce the amount of stormwater entering the drains during peak rainfall. For instance, the Stamford Detention Tank and the Stamford Diversion Canal are constructed to protect Orchard Road against floods. Built beneath a nursery and coach bay of the Tyersall Learning Forest, the Stamford Detention Tank will temporarily hold excess stormwater from the drains. After the rain subsides, the stormwater will be pumped back into the drains for subsequent discharge into Marina Reservoir.

9. For areas that are most at risk of flooding, PUB stipulates that buildings must have receptor features, such as higher platform levels, crest protection and flood barriers to prevent floodwaters from damaging them.

10. Apart from structural interventions, PUB places equal emphasis on non-structural measures such as the maintenance of drains. PUB and NEA's Department of Public Cleanliness carry out regular inspections to remove debris, litter and leaves from the drains. We encourage everyone to keep our environment litter-free. Any obstruction in the drain reduces its capacity and impedes water flow, which could lead to or aggravate a flash flood. We urge developers and contractors to ensure that the drains in and around their work sites function well. Members of the public are encouraged to provide feedback on drain conditions through PUB's MyWaters app or MSO's OneService App or call PUB 24-hour Call Centre.

Keeping the Public Prepared

11. As flash floods cannot be completely eliminated, PUB seeks to help members of the public better cope with a flash flood by warning them and providing alerts and timely situation updates. Members of the public can subscribe to NEA's and PUB's SMS alerts or mobile apps for updates on impending heavy rain and the water level in drains at designated locations. While PUB strives to give early warning to the public, the weather systems in our equatorial region pose a forecasting challenge. These weather systems comprise mainly convective thunderstorms which tend to be localised, develop rather suddenly, and are of short duration. This limits the lead time of our warnings of heavy rain and consequent flash floods.

12. During flash floods, members of the public can stay updated through radio broadcasts, PUB's Facebook and Twitter pages, mobile apps as well as LTA's Expressway Monitoring Advisory System, or EMAS.

13. Our approach to flood management is a comprehensive one that seeks to alleviate flood risks while minimising disruption to the public. We will continue to take all necessary steps to enhance flood resilience across Singapore, and keep the public informed of flash flood incidents.

Supplementary question by Mr Dennis Tan Lip Fong (Non-Constituency Member): I thank the Minister for his answer to the question. Just one supplementary question. In respect of the measures for the eight out of nine locations in the eastern part of Singapore that the Minister mentioned will be taken or undergoing, how soon will these measures be completed?

Minister: Before I answer that question, I would like Members to recognise that PUB must also manage extremities of weather in both directions. We have to take care of intense drought, prolonged drought, that challenges or may affect our water supply. At the same time, we have to take care of extreme weather such as rain of higher intensity and frequency which will bring about floods.

And therefore, when we talk about floods, we must also remember to ask questions about the other extreme. What should we do and how much resources do we have for both extremities?

Climate change actually has brought extreme weather conditions in many parts of the world. Many of us would have read that Paris has just experienced one of the worst floods because of the rising Seine River, prolonged rain for two weeks that recently has closed even the Louvre Museum. At the same time down south, Cape Town is experiencing drought condition for three years, just like us. But they were not ready. They did not put in the right things at the right time and now may run out of water within two to three months. Cape Town is now racing to look at solutions to solve their water problem.

Therefore, when we look at our problems, we have to look at conditions of what we need to do and how fast we can do what, and which we should put priorities on. We have 8,000 kilometres of drains, canals and rivers. If you put this end to end, from the surface of the earth, it will go through the centre of the earth with 2,000

kilometres to spare. That is how long our drains, canals and rivers are.

So, we have to be cautious about making commitments that everything will be settled quickly. We also have to ensure that drains are not the only ones that will solve the problem. We have to ensure at the source or the receptor of where this rainfall happens, the developers and the people who own this part of land, must also play their part.

So, it is not easy to answer. Just because the drains will be ready by this time, the flash floods will be gone. For example, right now, there are about 500 submissions for plans to do retention tanks for those developments above 0.2 hectares. Of this, only 158 have been completed. Now, together with the drain and the receptor, source and completion of all the projects there, we will have a better chance of avoiding the flash floods. But like I said, it is impossible to totally eliminate them because this will occur. It is more important for us to give as much timely warning as possible to our public, to ensure that they do not traverse these flash floods, which will usually go away within 50 to 60 minutes. Perhaps, take a detour.

Supplementary question by Mr Murali Pillai (Bukit Batok): I thank the Minister for his comprehensive response to my question. May I ask the Minister how does his Ministry propose to exercise oversight over the developers and the construction companies, so that their activities would not block the drains and canals and keep them free of debris?

Minister: Contractors, in preparing the site, have to submit to PUB their plans for diverting drains, for keeping the original drain design, for taking away the water from the site intact so that rain falls or the design capacity of the drain will not affect the surrounding areas. This has worked most of the time.

Where we have found flash floods occurring in areas where we know do not frequently occur or rarely occur, it is usually because the contractors have not implemented what they are supposed to do, or implemented something else in order to make their worksite either

accessible or easier to work on. When this happens, as in the recent case of Tampines Ave 12, we will take action against the contractor, bring them to court and fine them.

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