

# Effort to ensure flood resilience

With a \$300 million upgrade to the 3.2km Bukit Timah First Diversion Canal, it is now able to convey 30 per cent more rainwater. The canal's upgrade will help Singapore's flood resilience in the face of future weather patterns influenced by climate change.

## PHASES OF DRAINAGE IMPROVEMENT WORKS

### PHASE 1 | Ulu Pandan Road (278m)

#### Project duration

September 2012 to January 2016

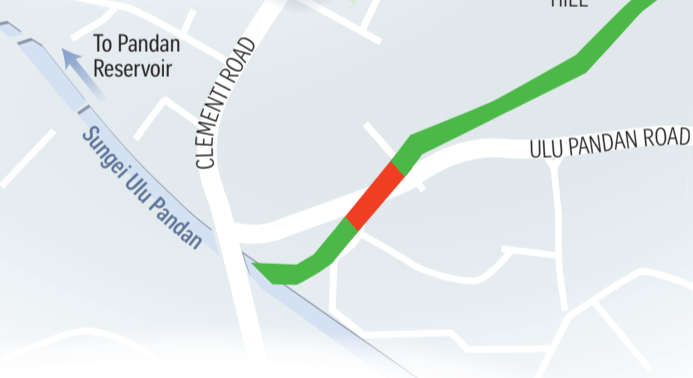
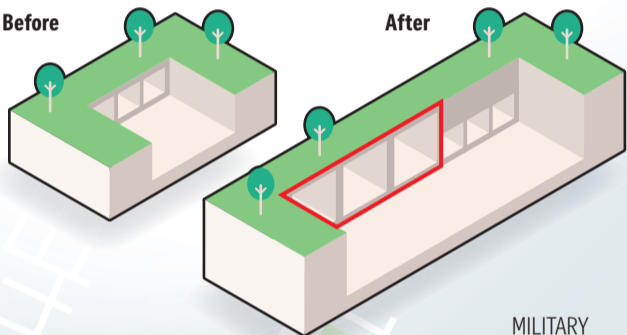
#### Challenges

- Upgrades required construction across Ulu Pandan Road, which experiences heavy vehicular traffic
- The upgrades required

- extensive traffic diversions in three separate stages.
- Construction was slowly completed "lane by lane" in order to minimise disturbance to regular traffic flow.

#### Upgrades

Three box culverts, 8m wide each, were added to supplement the existing three 3.6m-wide box culverts.



## BY THE NUMBERS

- Costs **\$300 million**
- Length of canal **3.2km**
- Increase in drainage capacity **30%**
- Upgrading works **Took over 7 years (2012-2019)**, representing **6 million man hours**
- 66** Number of ongoing drainage upgrade projects
- About two-thirds of the upgraded canal is covered, creating **4ha** of land space.

## FOR THE FUTURE

Drainage improvement works will continue against the backdrop of more frequent and intense rainfall.

### \$400 million

Amount to be spent, over the next two years, on upgrading and maintaining Singapore's drainage system

Upgrading the main **Bukit Timah Canal** between Rifle Range Road and Jalan Kampong Chantek (due to begin in October and completed by 2023)

#### Other upgrading projects

- Sungei Tampines (Tampines Avenue 7 to Tampines Expressway)
- Construction of a detention pond (Alkaff Lake) in the upcoming Bidadari estate

### PHASE 2 | Between Bukit Timah Road and Holland Green (1,600m)

#### Project duration

February 2013 to July 2017

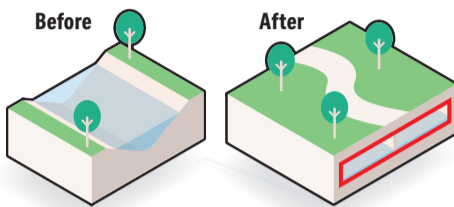
#### Challenges

- As some of the construction overlapped with residential areas, there was limited space for machinery and equipment.
- The twin pipe tunnels crossing under Garlick Avenue required extensive slope protection and deep excavation.

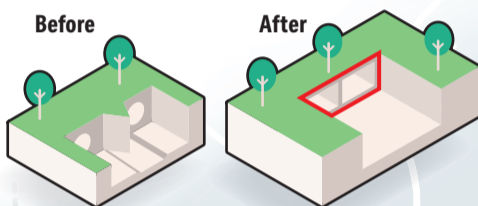
#### Upgrades

##### From Maple Lane to Garlick Avenue

- 10m wide and 3.5m deep open drain upgraded to twin box culverts 9.5m wide and 4m deep each.

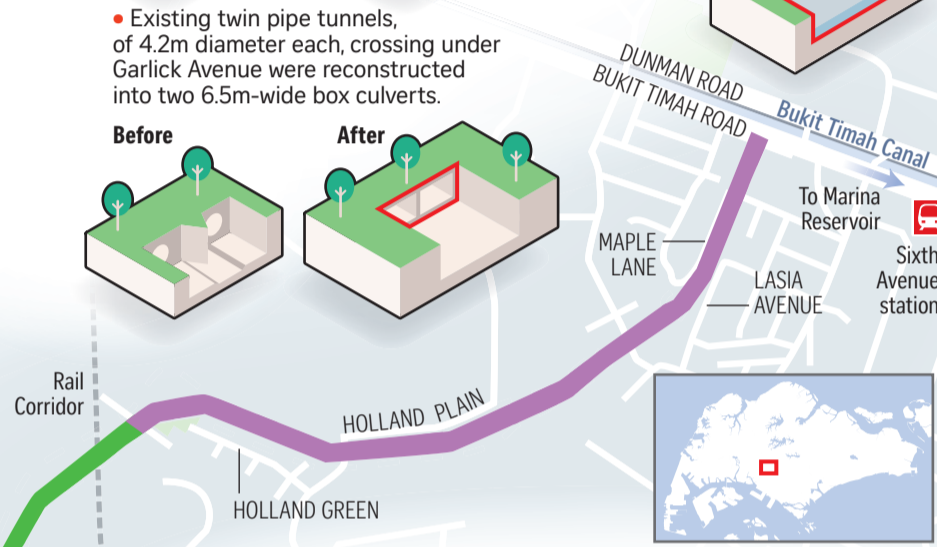
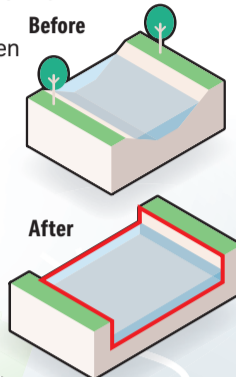


- Existing twin pipe tunnels, of 4.2m diameter each, crossing under Garlick Avenue were reconstructed into two 6.5m-wide box culverts.



##### In Holland Green and Holland Plain

- The existing open trapezoidal canal was opened up from 18m to 33m and deepened from 4m to 4.6m.



### PHASE 3 | Between Holland Green and Clementi (1,270m)

#### Project duration

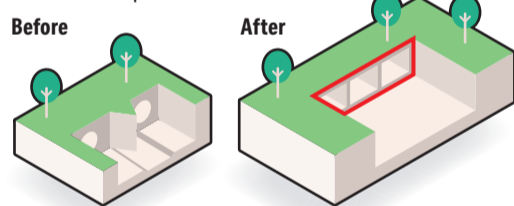
May 2015 to July 2019

#### Challenges

- The terrain had steep slopes. A "soil nail" method was implemented where reinforcing bars (at least 10m in length) were inserted into the slopes on either side of the canal, so as to stabilise them.
- Hard rock was also encountered here.

#### Upgrades

- Twin tunnels 4.2m in diameter each were expanded to three box culverts measuring 12m wide and 6m deep.



- Further downstream, the trapezoidal open drain with a top width of 10.5m to 18m was converted into a box culvert and U-drain with widths of up to 36m (below).



Holland Green before (inset) and after the upgrading works.