

Stormwater Management And Road Tunnel (SMART) Project in Kuala Lumpur



Flood Prone Area = 29,720 km²
(9%)



Population Affected by Floods

States	Flood Prone Area	
	Total Area (km ²)	People Affected (no.)
PERLIS	19	13,000
KEDAH	209	124,000
PULAU PINANG	232	510,000
PERAK	535	244,000
SELANGOR	1,652	726,000
W.P. KUALA LUMPUR	3	13,000
NEGERI SEMBILAN	130	42,000
MELAKA	81	31,000
JOHOR	2,367	297,000
PAHANG	6,274	615,000
TERENGGANU	2,223	457,000
KELANTAN	1,640	714,000
SABAH	3,241	635,000
SARAWAK	11,114	494,000
P. MALAYSIA	15,365	3,786,000
SABAH & SARAWAK	14,355	1,129,000
JUMLAH	29,720	4,915,000

Flood damage: RM 915 million annually
RM1.83 billion consequential economic drag



Types of Flooding

- Flash Flooding (localise and short duration)
- Monsoonal Flooding (widespread and long duration)
- Flooding caused by tsunami (an isolated case)

KL hit by floods

Three-hour
downpour
causes
havoc in city

SHAWA RAMPHIL Hundreds of the scores of people were stranded in a flooded city by heavy rain that was accompanied by strong winds that caused damage to the city's infrastructure.

Hundreds of cars were damaged when they were hit by the rain. Some cars were damaged by the rain, while others were damaged by the rain.

The rain was so heavy that it caused a lot of damage to the city's infrastructure. The rain was so heavy that it caused a lot of damage to the city's infrastructure.

Over the three-hour period, the city was hit by a downpour of rain. The rain was so heavy that it caused a lot of damage to the city's infrastructure. The rain was so heavy that it caused a lot of damage to the city's infrastructure.

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TO THE RESCUE: Emergency workers were seen wading through floodwaters at the Jalan Tun Razak and Jalan Ampang intersection on Friday night, getting to them through a three-hour downpour.

Flash Flooding



Floods cause havoc in KL

● Two lives lost ● Businesses and traffic come to a standstill

NST
27/4

Flooding caused by tropical storm
Greg Penampang, Sabah 26 Dec. 1996



Kota Tinggi, Jan 2007

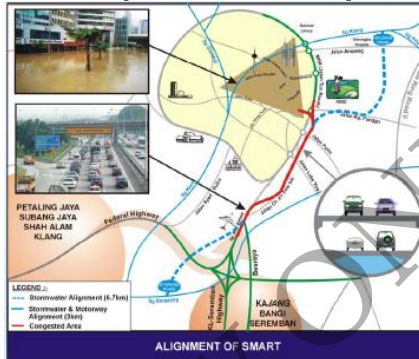


Effect of Tsunami in Kuala Kedah, Dec 2004



Why?

- In April and October of 2001, and again in June 2003, massive floods in Kuala Lumpur caused serious damage.
- It was apparent that the rivers flowing through the city were unable to hold the water and space constraints did not permit river improvement work.



What is SMART?

- SMART is an acronym for Stormwater Management and Road Tunnel
- A project under the **Federal Government** initiated to alleviate the flooding problem in the city centre of Kuala Lumpur.
- The project is implemented through a joint venture pact between **MMC Berhad** and **Gamuda Berhad** with the **Department of Irrigation And Drainage Malaysia** and the **Malaysian Highway Authority** as the executing government agencies.

Overview


- A test on 29 January 2007.
- First multi-functioning tunnel in the world.
- Located 20 m below city
- Use of biggest TBM
- Use of special TBM for soft grounds
- Built pre-cast slabs for highways
- Total cost approximately \$514 million.

Overview

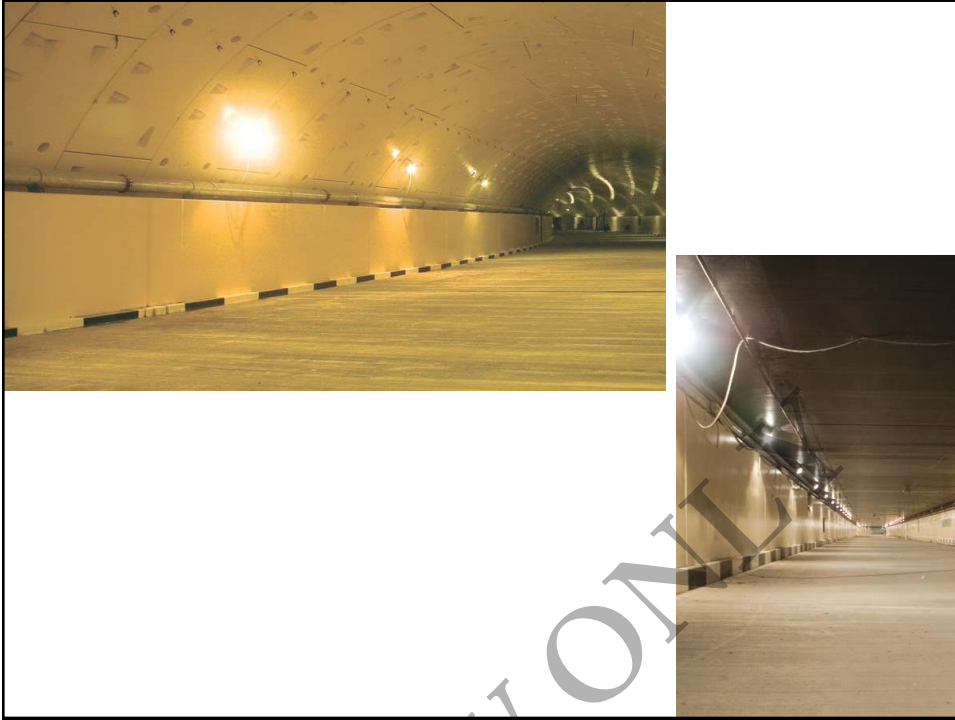
- The motorway tunnel is suitable for **light vehicles** only (< 2.0m height). **No motorcycles and heavy vehicles.**
- **Unidirectional traffic flow** - reduce accident risk
- 2 traffic lanes and 1 emergency lane – expedite emergency response

Diagram illustrating the water supply system for the 1000-bed hospital. The system includes a **STORAGE POND** and a **HOLDING POND**, connected by a pipe. The distance from the storage pond to the hospital is 3 km, and the distance from the hospital to the holding pond is 9.7 km.

- **Stormwater tunnel length:** 9.7 km **Diameter:** 13.2 m (outer diameter)

- **Tunnelling method:** Tunnel Boring Machine (TBM)
 - **TBM type:** Slurry shield
- 
- The diagram shows a cross-section of a tunnel boring machine (TBM) with two main decks labeled 'Upper deck' and 'Lower deck'. The machine is shown cutting through a rock face, with a large circular tunnel opening visible behind it. The machine is colored in shades of blue and grey, and the rock face is a light brown color.

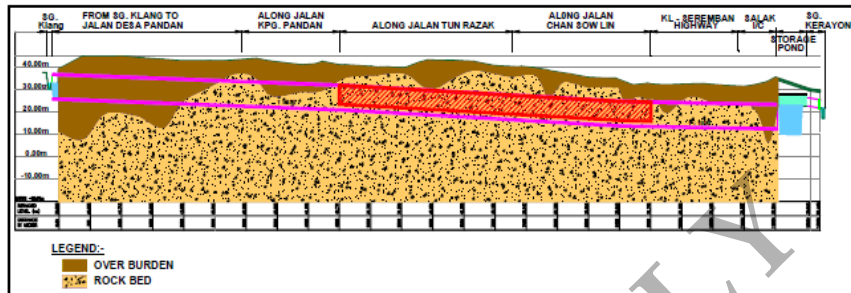
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- Diagram illustrating the cross-section of a road with the following dimensions and lane types:
- Emergency Lane: 2000
 - Traffic Lane: 3350
 - Traffic Lane: 3350
 - Marginal strip: 150
- Overall dimensions: I.d. 11.83m, o.d. 13.2m



Geological Profile

- Kuala Lumpur city is sitting on Karstic limestone geology with high ground water table.
- The special features of Karstic limestone include cliffs, pinnacles, cavities, collapsed cavities and sinkholes.
- Overlying these Karstic limestones is loose alluvium from previous tin mining activities.
- Due to the nature of the soil condition, much thought and planning was channeled towards the selection of a construction method that would have minimal negative impact on the geological condition of the soil.

Geological Profile



Construction Challenge

- **No straight tunneling line**
- Unpredictable grounds . Highly erratic karstic features
 - Probe ground in front of TBM
 - Use of liquid concrete
- **Ideal path: straight line**
- Local property law: property extends to the center of earth.
- Tunnel right: will cost millions of dollars to buy.

Construction Challenge

- Construction challenges due to non-straight path:
 - The tunnel follows streets and highways already owned by the City
 - SMART requires a series of sharp bends.
- Turning the 4 story high drill 20m underground is not easy.

Tunnel Boring Machine (TBM)

- It is known that the TBM is the most advanced and cost effective method used in the construction of tunnel in Europe.
- For SMART, the Slurry Shield TBM was opted for – *to overcome problems of groundwater drawdown, to create a pressured shield made up of bentonite and air pressure.*
- This pressured shield is able to counter balance the pressures of the groundwater and loose soil acting on the face of the boring machine.

Slurry Shield TBM

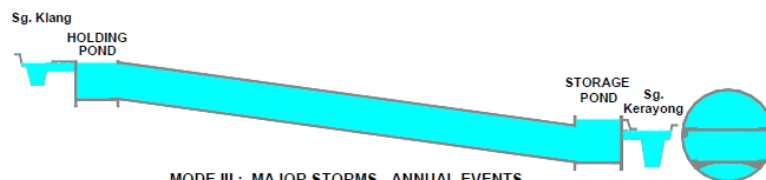
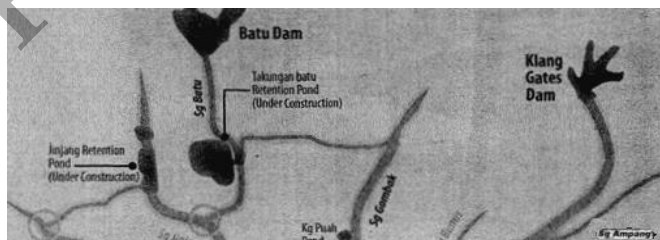
- Four main parts:
 - **Rotary Cutter Head** with tungsten pick bits used for excavation of soil and disc cutters used for the excavation of rock.
 - **Bulkhead** located immediately behind the Rotary Cutter Head. This is where the pressured bentonite slurry shield is formed to provide stability during the tunnel excavation.
 - **Hydraulic rams**, which are used to propel the machine forward and to keep the tunnel in its right alignment.
 - **Tunnel lining erector** used to install the pre-cast concrete lining of the tunnel.





Primary Role: Solve Flooding

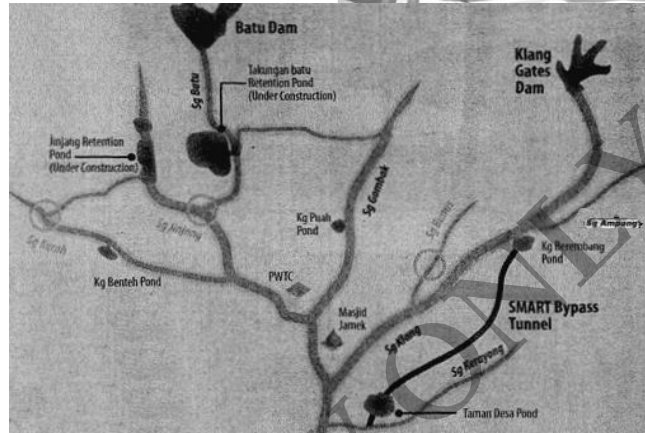
- The storm water tunnel helps divert flood water entering Sungai Klang and Sungai Ampang into a holding basin in Kg Berembang.



MODE III : MAJOR STORMS - ANNUAL EVENTS
(OCT '01)

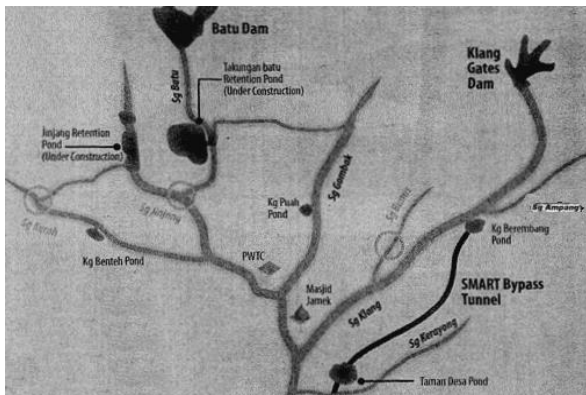
Primary Role: Solve Flooding

- The water will subsequently be channeled via the tunnel to a reservoir in Taman Desa before being released into Sungai Kerayong.



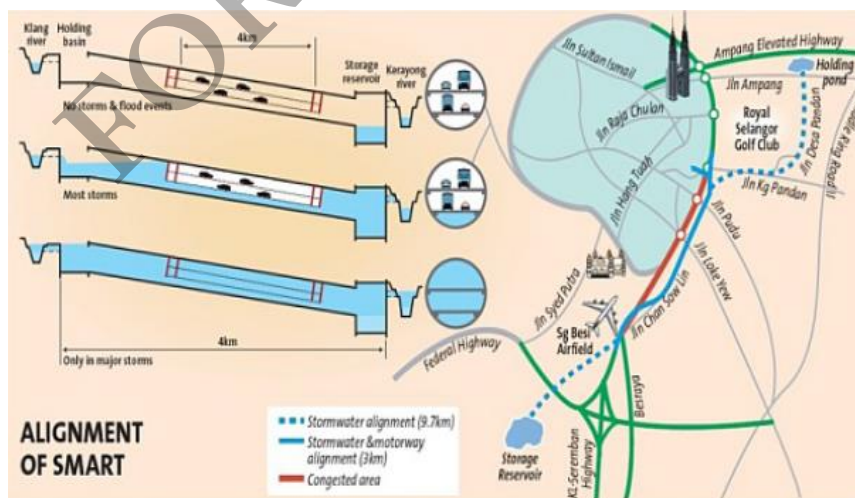
Primary Role: Solve Flooding

- This process reduces the floodwater coming from Sg Klang and thereby preventing Sg Gombak and Sg Klang from bursting their banks and overflowing in the event of a storm. It is the tunnel's primary role - to ease flooding caused by heavy rains at the confluence of Sg Klang and Sg Ampang.



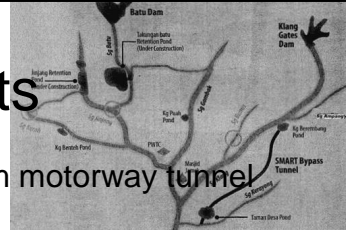
How Does SMART Help?

- Main purpose to divert floodwaters and prevent spillover into communities near the Jalan Tun Perak Bridge.
- Reduces traffic congestion during rush hour.
- Motorists reduce travel times between Jalan Istana Interchange and Kampung Pandan from 15 min to 4 min.



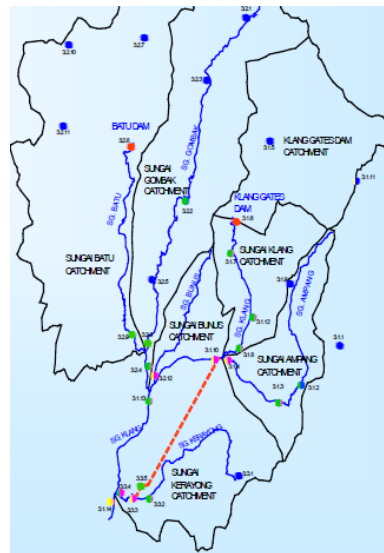
Components

- A 9.7 km stormwater tunnel. A 3 km motorway tunnel (within the stormwater tunnel).
- Ingress and Egress connections to the motorway tunnel linking KL-Seremban Highway.
- A holding basin at Kampung Berembang (off Jalan Ampang).
- A storage reservoir at Taman Desa (ex mining pond).
- A twin-box culvert to release flood discharge from storage reservoir to Sungai Kerayong.
- An operation control centre complete with administration, supervision, river management and traffic management facilities for management, operation and maintenance of the SMART system.



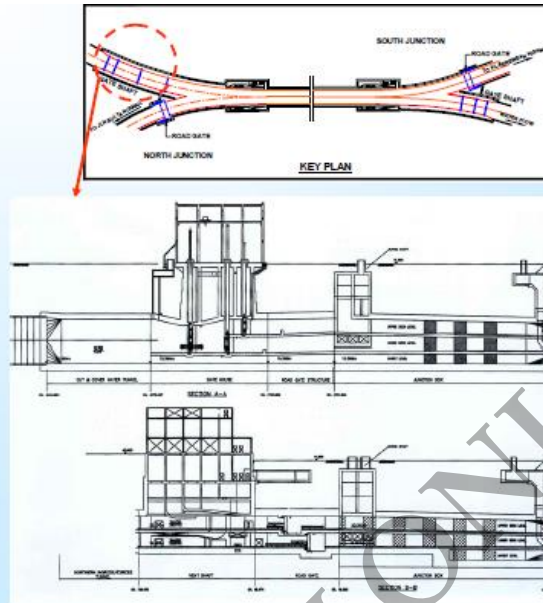
Flood Detection System : Catchment Monitoring & Warning System

- Rainfall Gauging Stations
- Water Level Gauging Stations
- River Flow Monitoring
- Warning Stations
- Remote Terminal Unit
- Radio Telemetry
- Repeater Stations
- Radar System (future)
- Flood



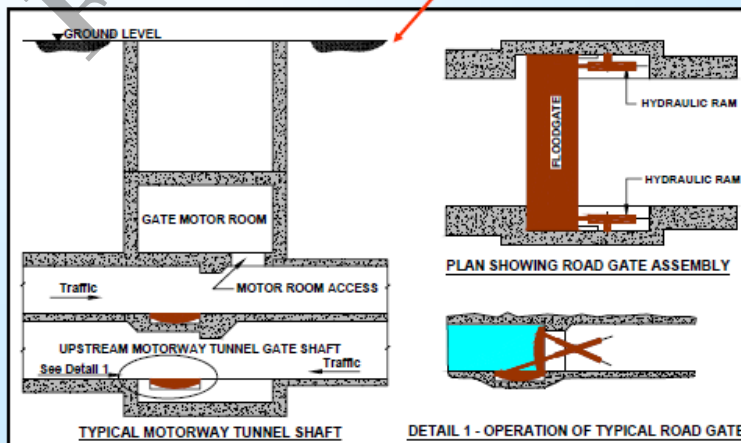
Weather Stations layout

Flood Gates : North Junction Box / South Junction Box

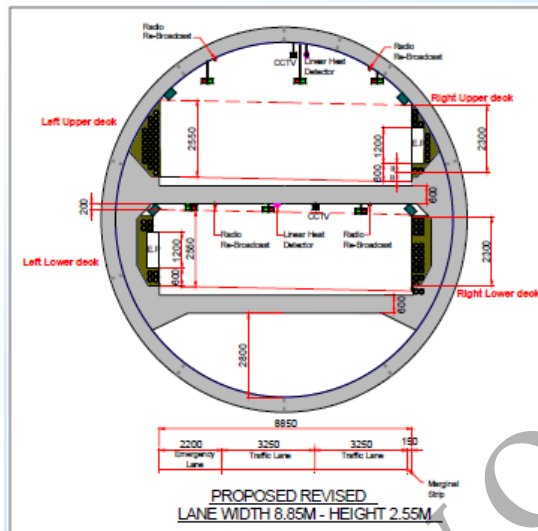


Road Gates : North Junction Box / South Junction Box

- Prevention of vehicles entry during storm events
- Prevention of flood discharge entering to the ingress/egress connection

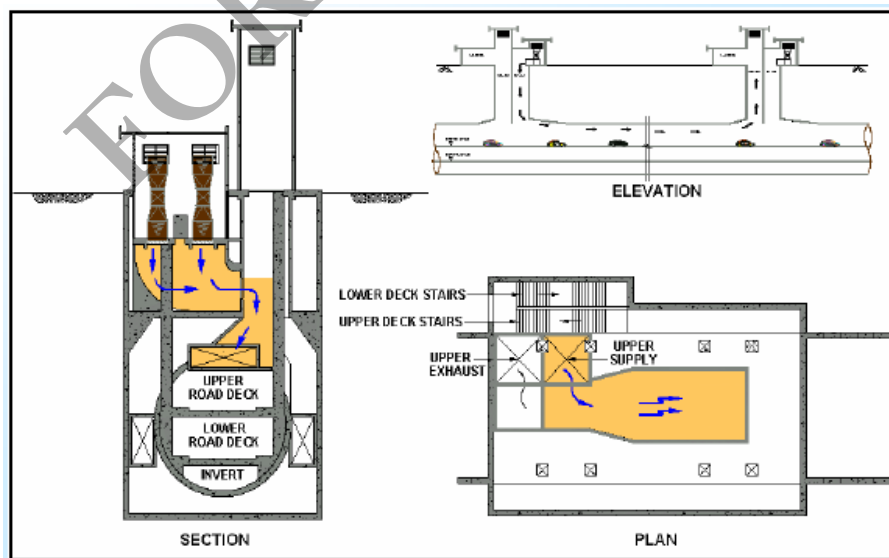


Typical Tunnel Section

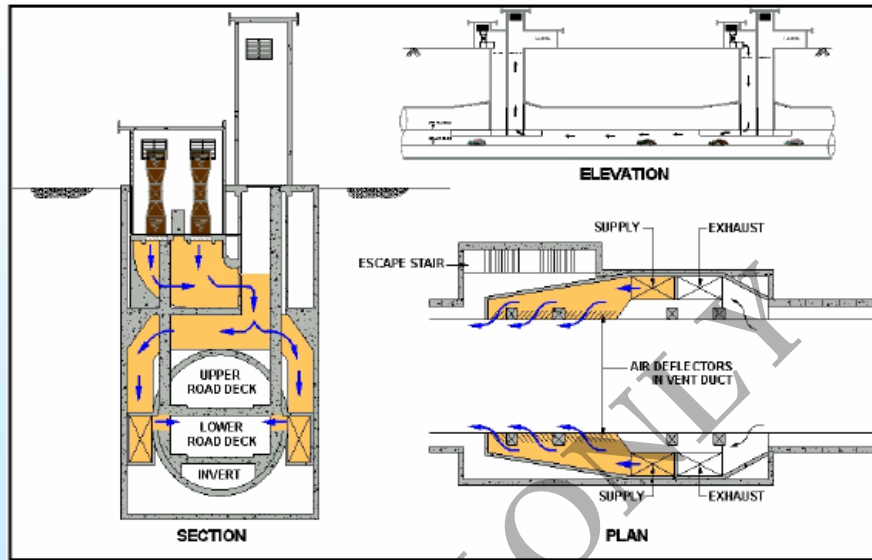


- Heat Detection
- Tunnel Lighting
- Hydrant and etc.
- Leaky Feeder Cable for Radio and Cellular
- CCTV
- Lane Traffic Signal
- Gas Analyzer

Tunnel Ventilation (Upper Deck)

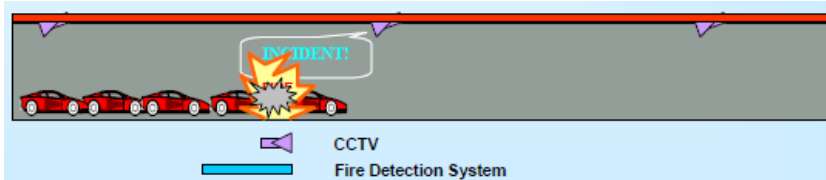


Tunnel Ventilation (Lower Deck)



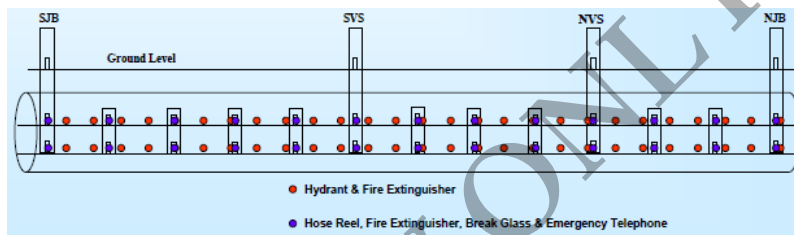
Tunnel Heat Detection System

- The system will respond to the rate of temperature rise, about 10 seconds.
- Programmable fire zones
- Triggering CCTV system and Fire Alarm System during the case of tunnel fire.



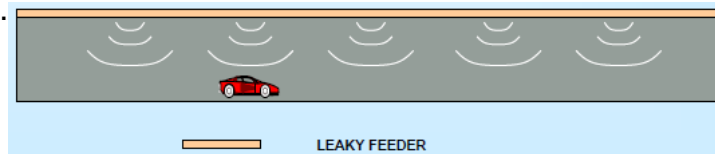
Tunnel Fire Protection : Emergency Points And Equipment

- Hose Reel, Fire Extinguishers, Breakglass and Emergency
- Telephone are located at each cross passages, ventilation shafts and escape shafts.
- Hydrants & Fire Extinguisher are installed along the tunnel

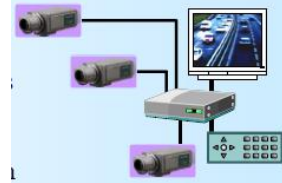


Tunnel Radio Communication and Cellular System

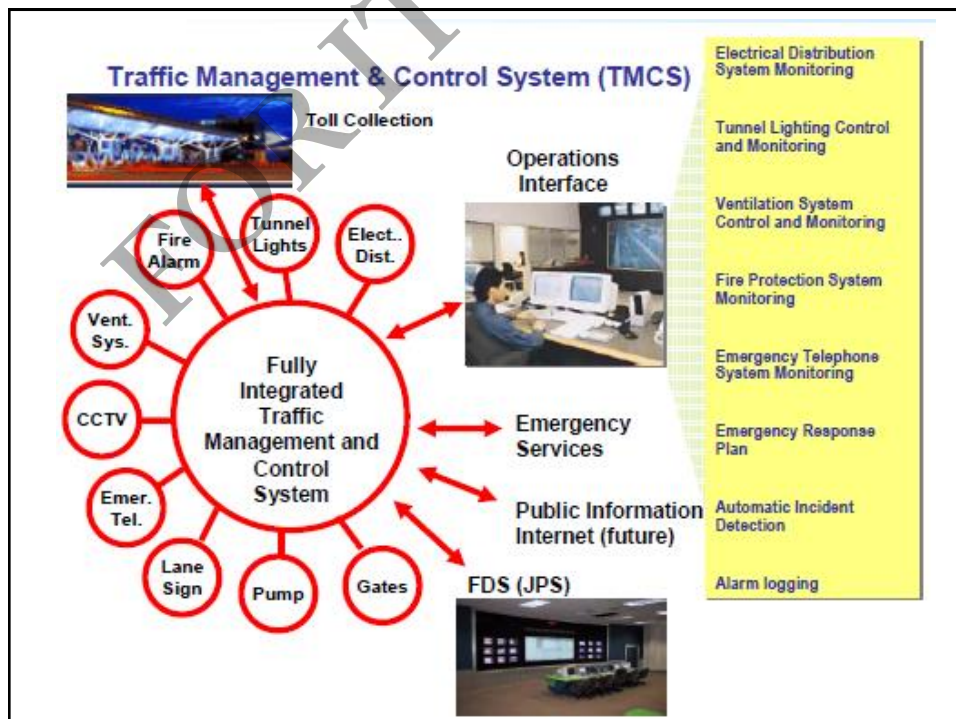
- Re-broadcast FM radios, cellular (telco), fire department, police and ambulance signal into the tunnel.
- Audio break-in facility to broadcast emergency messages from the control center into the tunnel through FM frequencies.
- IP 68 antenna installed to enable the use of mobile phones.
- Public Address and emergency phone are provided in the cross.

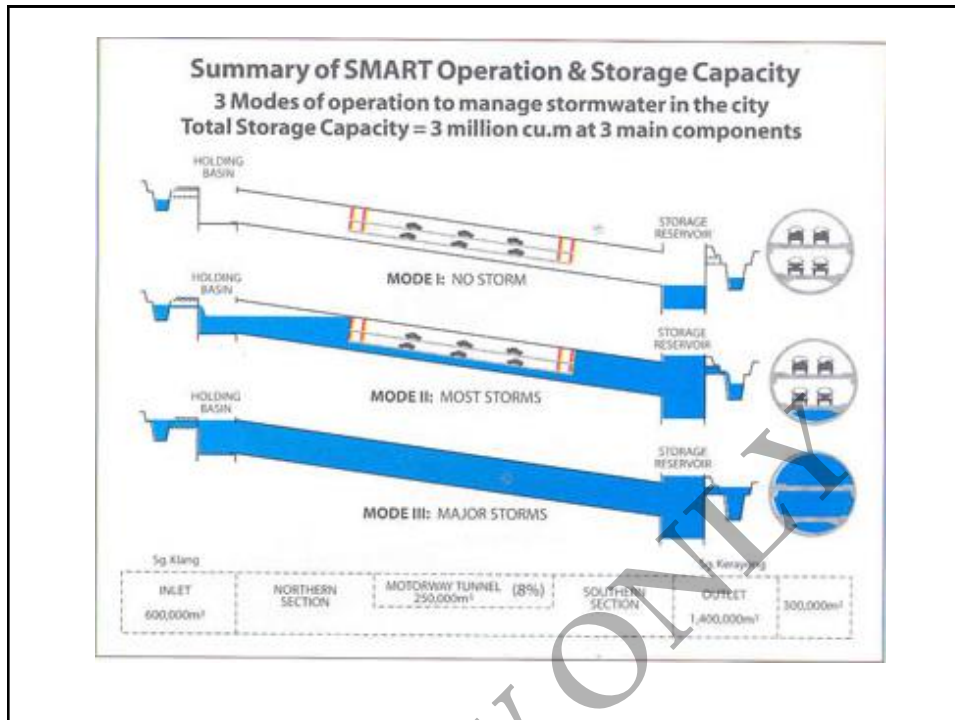


CCTV



- Tunnel Surveillance
 - PTZ CCTV at selected locations
 - Fixed CCTV along the tunnel
 - Linked to Fire Detection System
 - Linked to Control Center via Fiber Optic Cable
- Automatic Incident Detection
 - Measurement of traffic flow speed, occupancy count
 - Detection of speed drop, stop vehicles, inverse direction and smoke





Operation of the SMART Tunnel

- The unique feature of this project is the 3 km double-deck motorway within the stormwater tunnel. The operation of the SMART system works on the three-principle mode of operation based on the flood discharge at the Klang River/ Ampang River confluence and the operation status of the motorway.

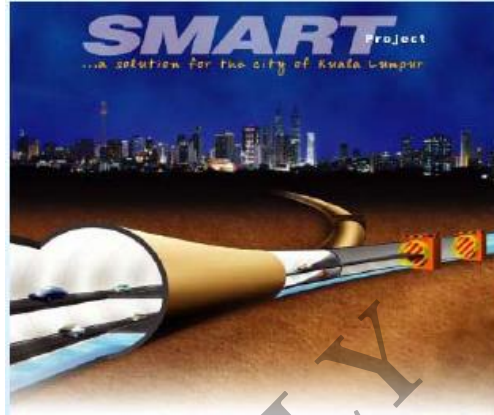
Three Modes of Operation

- **First mode (Normal conditions)**
 - The first mode, under normal conditions where there is no storm, no flood water will be diverted into the system.
- **Second mode (Most storms)**
 - When the second mode is activated, flood water is diverted into the bypass tunnel in the lower channel of the motorway tunnel. The motorway section is still open to traffic at this stage.
- **Third mode (Major storms)**
 - When this mode is in operation, the motorway will be closed to all traffic. After making sure all vehicles have exited the motorway, automated water-tight gates will be opened to allow flood waters to pass through. The motorway will be reopened to traffic within 48 hours of closure.

Why the flooding problem still occurred at certain area in Kuala Lumpur (e.g the massive flood on 3 March 2009 at PWTC) and which area is under the SMART system control?

- During 3 March 2009 flashflood in Kuala Lumpur (PWTC), the bulk of the intense heavy rainfall was concentrated in the Sungai Batu and Sungai Gombak catchments. As a result, this intense and localised heavy rainstorm caused Sungai Batu to swell quickly and overtop in a number of low lying areas for example in the vicinity of PWTC and Sentul (Jln Ipoh) areas and caused massive flood at PWTC area. These two rivers are beyond the catchment areas of the SMART tunnel system as the areas are located along the Sungai Gombak and Sungai Batu whereby SMART designated areas are Sungai Ampang and Sungai Klang catchments.
- On 3 March 2009, the SMART system began to divert floodwater from Sungai Klang/Sungai Ampang and managed to divert a total of 700,000 cubic meters floodwater in Kg Berembang Holding Pond to the Taman Desa Attenuation Pond via the tunnel. As a result, areas around the vicinity of Masjid Jamek LRT station did not overflow its bank. This shows that SMART system was operational and fulfilled its objective in preventing flood in the designated areas during the heavy downpour.

Thank You



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Source: TS45-Weei-ppt.pdf

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