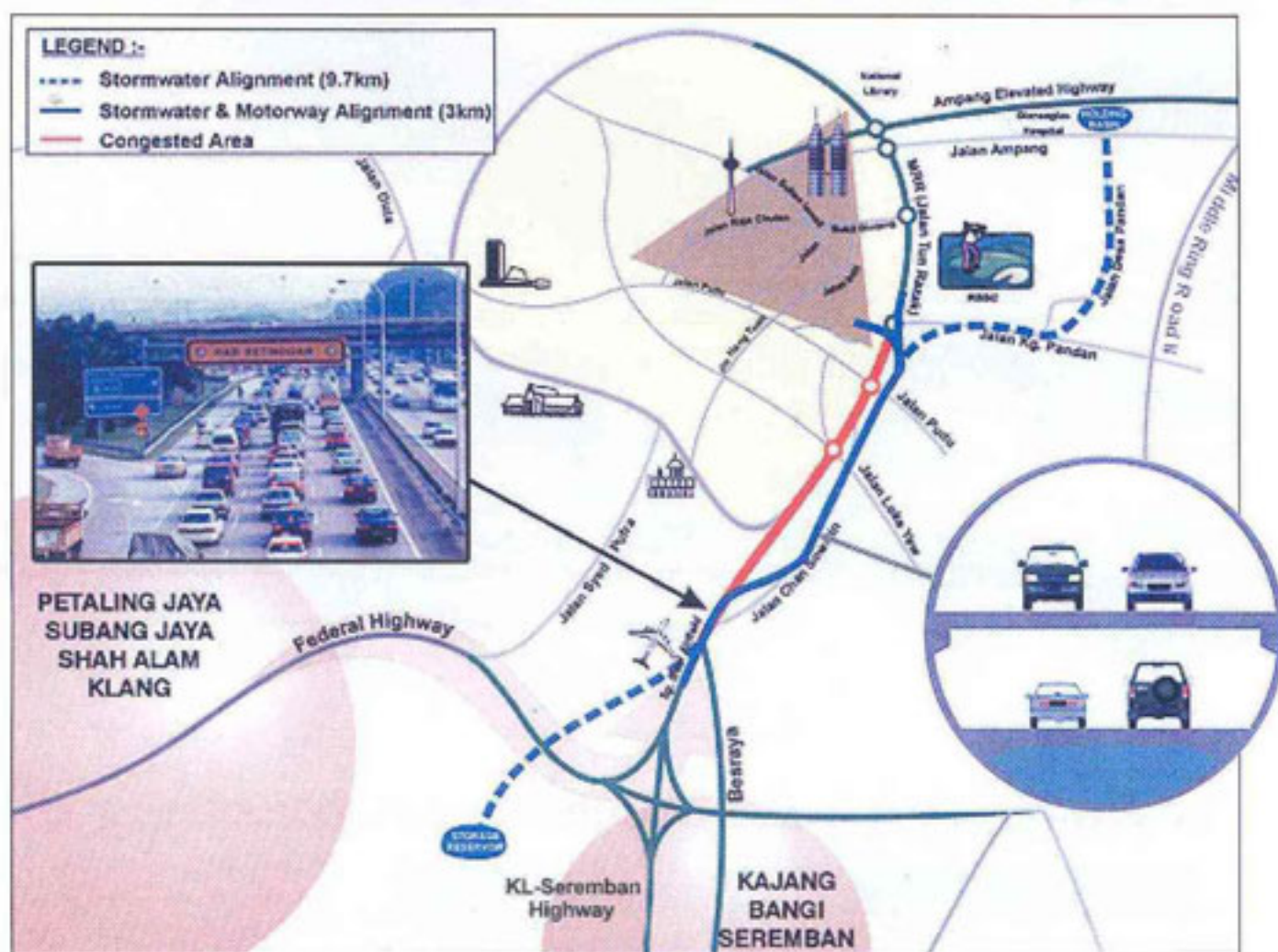


SMART... A Novelty In The Making, An Innovation Coming True

By MMC Berhad-Gamuda Berhad Joint Venture

STORMWATER MANAGEMENT AND ROAD TUNNEL PROJECT



Alignment of SMART

A unique engineering feat is being implemented in Kuala Lumpur to address two major issues plaguing the city centre: flooding and traffic congestion. A single tunnel serving two distinct purposes is a novelty by design that has attracted global attention. Costing just under RM2billion and being implemented by MMC Berhad-Gamuda Berhad Joint Venture, SMART's innovative concept and novelty in design is believed to be the first of its kind in the world.

With another 18 months to go before completion, SMART's fame and popularity comes as no surprise given the revolutionary twist to what began as

a conservative but non-conventional flood mitigation project at early stages of planning.

SMART has been discussed widely in the tunneling and construction publications at the international level, the latest being a special 40-page supplement by T&T magazine written by specialist writer and editor Shani Wallis.

Tris Thomas, the editor of *T&T International* commented, "... the project is a great example of not only innovative design, incorporating a road tunnel and stormwater tunnel, but an adventurous concept combining established foreign expertise with local 'will to learn', that will

surely increase the experience of home grown talent for future domestic projects".

In the *Engineering News Record* (a US based weekly-April 2005), writer Peter Reina contends, "By building a 9.7km long water diversion tunnel, and putting a two-deck highway inside, local contractors are working to alleviate monsoon floods while showing talent for novel engineering and smart financing".

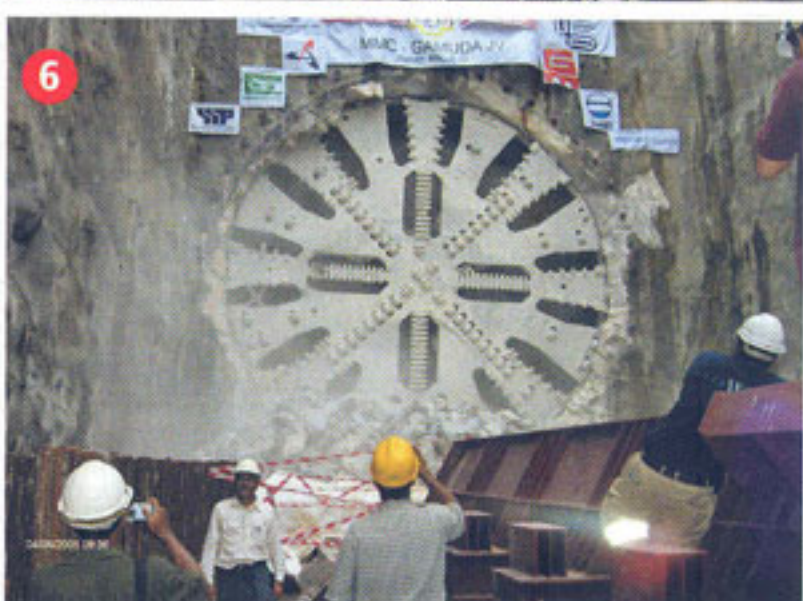
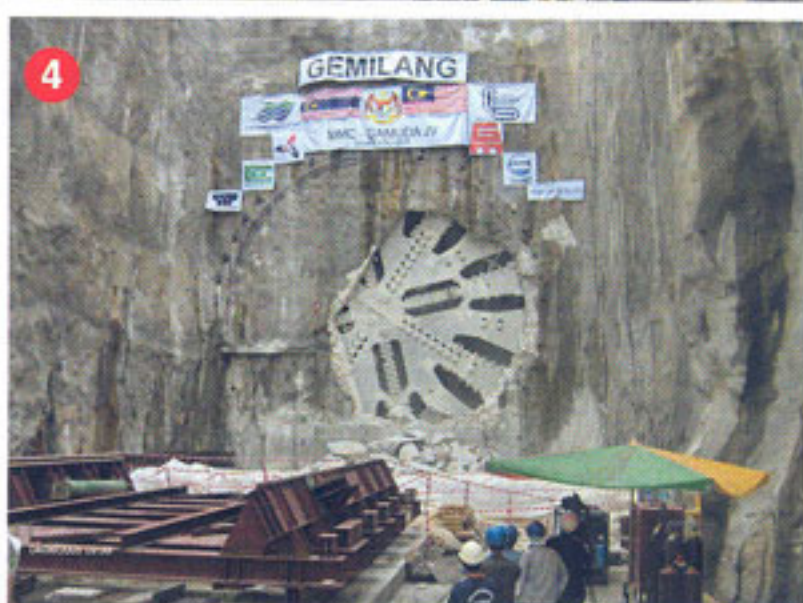
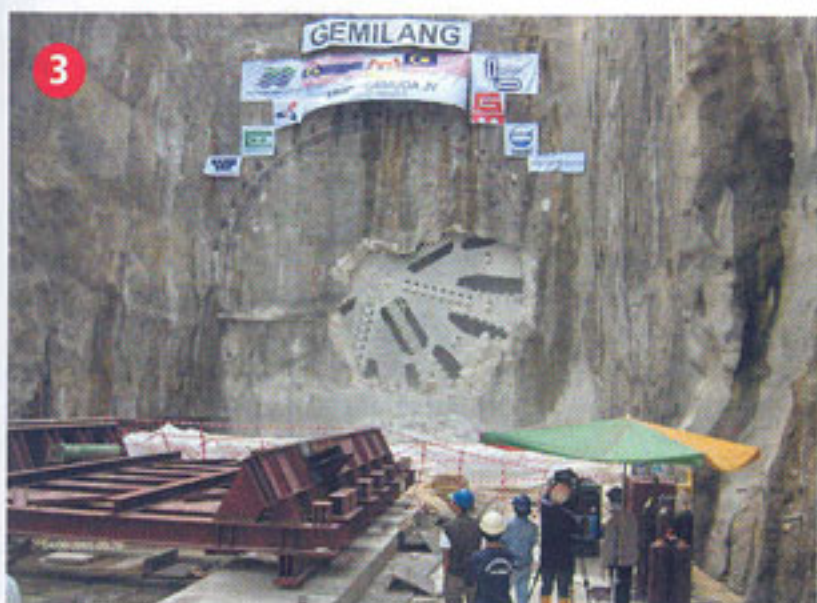
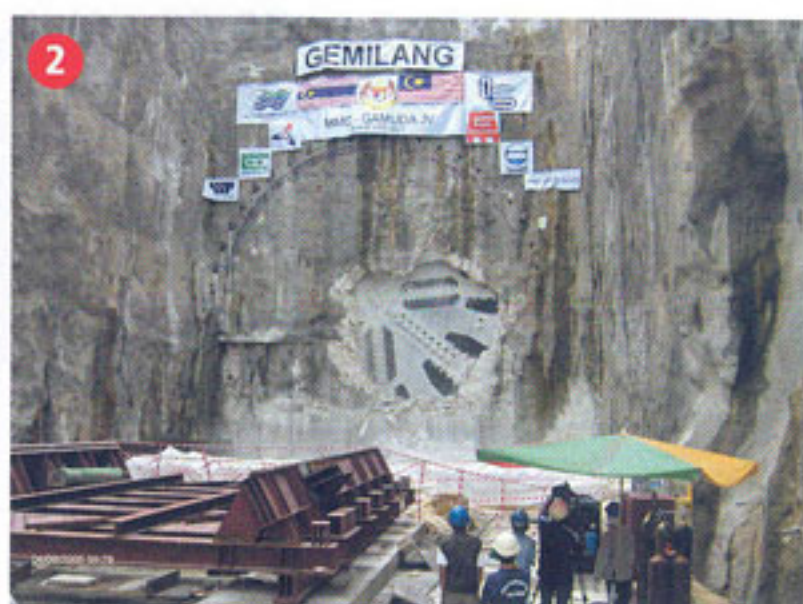
SMART's unique financial packaging is another feature that won the JV the contract. The JV came up with an option to finance part of the project by incorporating a motorway within the

stormwater tunnel. A deal too good to refuse, killing two birds with a single stone, the JV was awarded the contract to address first, flooding in the city centre and second, to provide an alternative traffic dispersal system into the city centre.

The SMART project is implemented under the close supervision of the Government, namely the Drainage and Irrigation Department of Malaysia and the Malaysia Highway Authority. Engineering support for SMART project is provided by a local consultant, Sepakat

Setia Perunding Sdn Bhd in association with Mott MacDonald of UK.

The grandeur and inimitable nature of this project can generate pages of insightful industry revelations, however, due to space constrain, the emphasis



Sequence showing Gemilang breaking through at the South Junction Box on June 4, 2005



Tunnel crew at the cutterhead after the breakthrough at the South Junction Box

would be on the motorway which is the fascination of many.

SMART Alignment

The stormwater tunnel between the two ponds is about 9.7km long and it runs beneath the city limits, avoiding private properties, mostly going underneath public roads. It is only the central three km portion of the route that will double up as motorway. Convenient ingress and egress ramps at each end of the motorway will direct traffic into and out of the motorway from the existing and highly congested stretches of Jalan Tun Razak and KL-Seremban Highway, among others.

At the North end of the motorway, the forked entry and exit ramps are located in front of the RHB Bank in Jalan Tun Razak and the other at the Jalan Sultan Ismail Extension (which is under construction by DBKL connecting Jalan Davis to Jalan Sultan Ismail).

At the South end, the motorway ingress and egress fronts the Sungai Besi airfield providing an alternative for traffic coming into the city centre via the Southern Gateway (KL-Seremban Highway), KESAS and Federal Highway.

The motorway alignment which is strategically located at this stretch, with critical traffic problems, also functions as an alternative traffic dispersal system for other arteries in and out of the city centre.

There are two decks in the motorway, the upper deck carries traffic from Kampung Pandan Roundabout to KL-Seremban Highway while the lower deck carries traffic from KL-Seremban Highway into the city centre.

Each deck is designed for uni-directional traffic to further reduce risks of accidents and fire in the tunnel. Another precaution adopted by SMART is limiting the motorway to light vehicles only (Class A).

The 3 Modes of Operation

The operation of the motorway in the SMART system works on the three-principle mode based on the flood discharge at the Klang River/Ampang River confluence and the operation status of the motorway.

- The first mode, under normal condition where there is no storm or low rainfall, no flood water will be diverted into the system.

- Under the second mode, SMART system will be activated and this happens when there is moderate storm. When the second mode is activated, flood water is diverted into the bypass tunnel in the lower channel of the motorway tunnel and it is important to note, that, at this stage, the motorway section is still open to traffic.
- At the third mode of operation the motorway will be closed to traffic. With extensive and effective monitoring stations, when the third mode of operation is needed, the motorway will be closed to traffic. Sufficient time will be allocated to allow the last vehicle to exit the motorway before the automated water-tight gates are opened to allow flood water to pass through. The motorway will be reopened to traffic within 48 hours after the closure.

The Gates

The motorway section of the tunnel is fitted with water-tight flood and traffic gates at either end to separate the motorway from the stormwater tunnel for the safety of the motorway users. The flood gates at both ends of the motorway will remain closed at all times during traffic operation and opened only when the tilting road gates in the ingress and egress are closed. The first line of protection against water entering the road tunnel is an emergency gate at each end. There will be five gates at either end of the motorway: two flood gates, two road gates and an emergency gate. Similar gates have been used successfully in the London underground tunnel to prevent flooding.

Flood Detection System and Evacuation

In terms of operations, the upstream monitoring facilities and the retention capacities of the two holding ponds and the tunnel give the system operators at least an hour warning for the need to close the motorway to traffic and avail it for flood water diversion. Clearing the road tunnel will only take about 30-45 minutes including closing of the gates and cross passage doors, conducting a walkthrough check and opening the flood tunnel barrier. As added precaution, there is no possibility of opening the flood control gates without



A completed section of the motorway tunnel taken during a demonstration session

first closing the road's on and off ramp gates and likewise no possibility of opening the ramp gates without first closing the flood control gates. The two are deliberately linked as part of the scheme's failsafe/defect-proof operation. This is the only way the dual purpose operations could be combined safely in a dual purpose structure.

Contingency

In the event the traffic comes to a standstill in the tunnel due to congestion at both ends of motorway (ie Jalan Tun Razak/Jalan Sultan Ismail and KL-Seremban Highway) when there is an urgent need to activate Mode 3 operation, SMART has identified alternatives. In the North, traffic from the motorway heading towards the city centre will be temporarily diverted into the service roads off Jalan Davis and off Jalan Tun Razak.

Traffic from the motorway heading towards the South will be diverted onto the East-West Link which is historically not known to have any congestion.

Motorway Fittings and Safety Features

The motorway has all the fittings and safety features in compliance with the European standards. However, as special requirement unique to SMART, the entire fitting and road furniture in the motorway is designed to last for the dual-purpose nature of the tunnel. The philosophy

adapted for the design of the road tunnel fixtures and fitting is for them to be sufficiently robust to remain in place during flood control operations as well as during restoration back to road operations. The lightings, the heat detection system cables, the CCTV surveillance cameras and the road signages are some of the items which are water tight to a hydrostatic pressure of 2.5 bar and can survive a minimum of 24 hours.

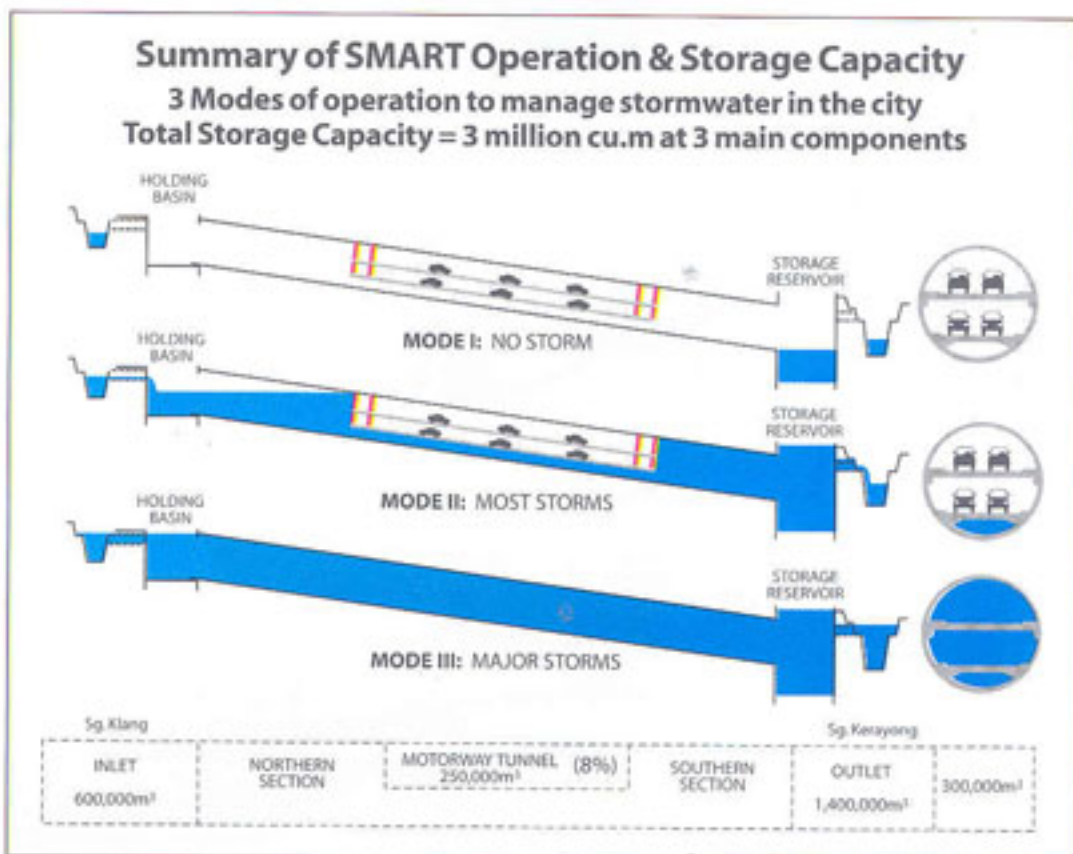
An important feature in the motorway section of the tunnel is the efficient and

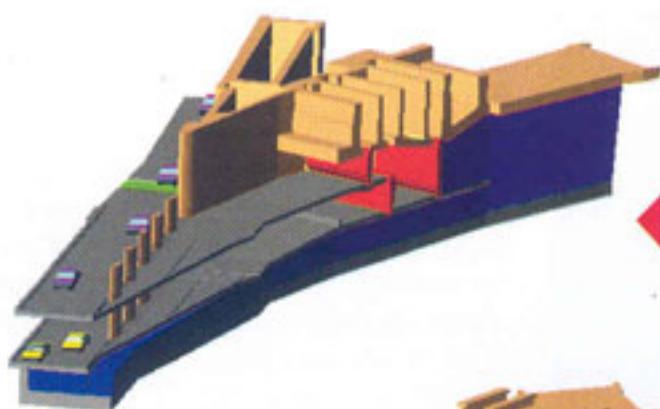
effective ventilation system to ensure safety of motorway users during emergencies such as fire. The ventilation system provided will ventilate both upper and lower decks. The motorway consists of four ventilation buildings, each containing eight ventilation fans and pressurized fans for the stairway and lift shaft. The system will be supplemented by jet fans located at each of the motorway ingress/egress portals. The operation of the tunnel ventilation system will be linked to the main flood control monitoring system for automated operation during wet and dry periods.

The pressurized fans have the main function of preventing smoke from entering the staircase and lift in the cross passage in case of a fire. The tunnel ventilation system will provide longitudinal flow of fresh air through the use of nozzles. To control the air quality in the motorway, the exhaust fumes are extracted from the motorway via separate exhaust fans.

Air quality measurement equipment for carbon dioxide concentration and visibility will be located at the cross passage for consistent monitoring.

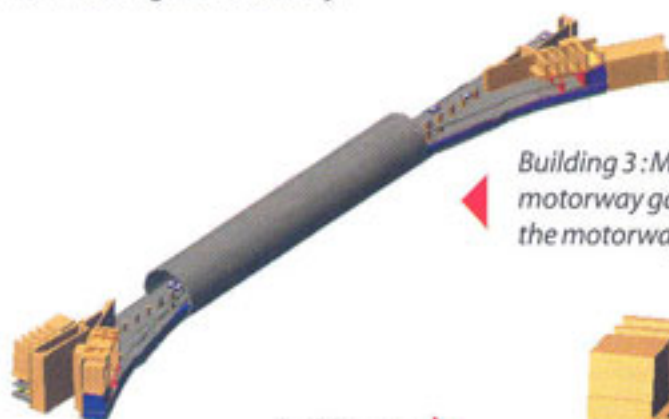
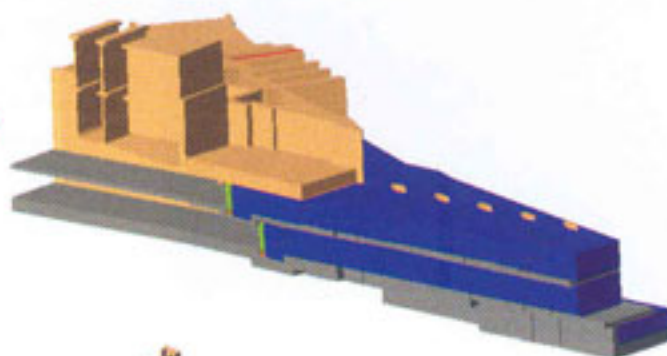
Safety passages are constructed at every 250m interval within motorway to allow access between decks, in case of emergencies.





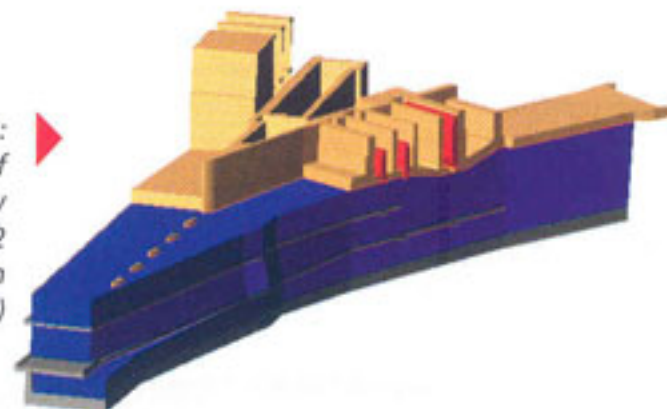
Building 1: 3D drawing showing the Mode 2 operation (view of motorway) where the motorway is open to traffic while the bottom most deck conveys flood water

Building 2: 3D drawing showing the Mode 2 operation (view of stormwater section) where the flood gates (in red) is closed, preventing water from flooding the motorway.



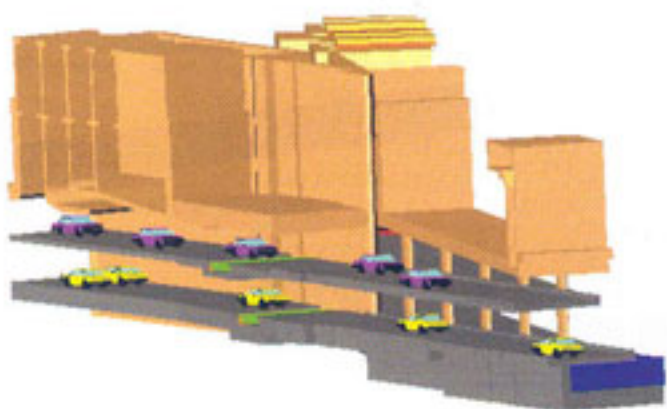
Building 3: Mode 3 in Operation where the motorway gate is closed (green), view from the motorway side.

Building 4: Longitudinal view of the motorway showing Mode 2 operation (view from stormwater side)



Building 5: Mode 3 in Operation, view from the stormwater side, where the flood gates (red) is open and the motorway is flooded.

Building 7: Longitudinal view of the motorway section showing Mode 2 Operation (view from motorway side)



The Tunnel Management System

Operation of the flood mitigation scheme relies on automatic reception of data coming in from control stations and monitoring gauges installed along the length of the Sungai Kelang and in the catchment of its tributaries. Further information will also be provided by radar. This information will be monitored and processed by operators in the flood control centre building. Under extreme flood alert conditions, high river flows at the confluence of Sungai Ampang and Sungai Kelang will be diverted by way of a diversion weir into the holding basin at Kampong Berembang. From the holding basin the flood water flows in the tunnel and into the storage reservoir at the other end of the tunnel. From the storage reservoir, flood water will be released in stages into Sungai Kerayong, which is a tributary of Sungai Kelang. **MB**

LATEST UPDATE

SMART'S second tunnel boring machine, Gemilang achieved its first milestone at the South Junction box breakthrough on June 4, 2005

Another feather in the cap for Gemilang is having achieved 12 rings per day, believed to be the world record advancement for this type and machine size.

Gemilang which started boring in August 2004 has covered a distance of 1,822m and 1,067 rings with another 2,127m to go before the final breakthrough at the storage reservoir in Taman Desa in the South of the alignment. The machine will be walked through the shaft for about 89m before it resumes boring works early July, 2005.

Meanwhile, SMART's first tunnel boring machine, Tuah has covered a total of 1,200m. Tuah broke through at the North Junction Box on December 11, 2004.