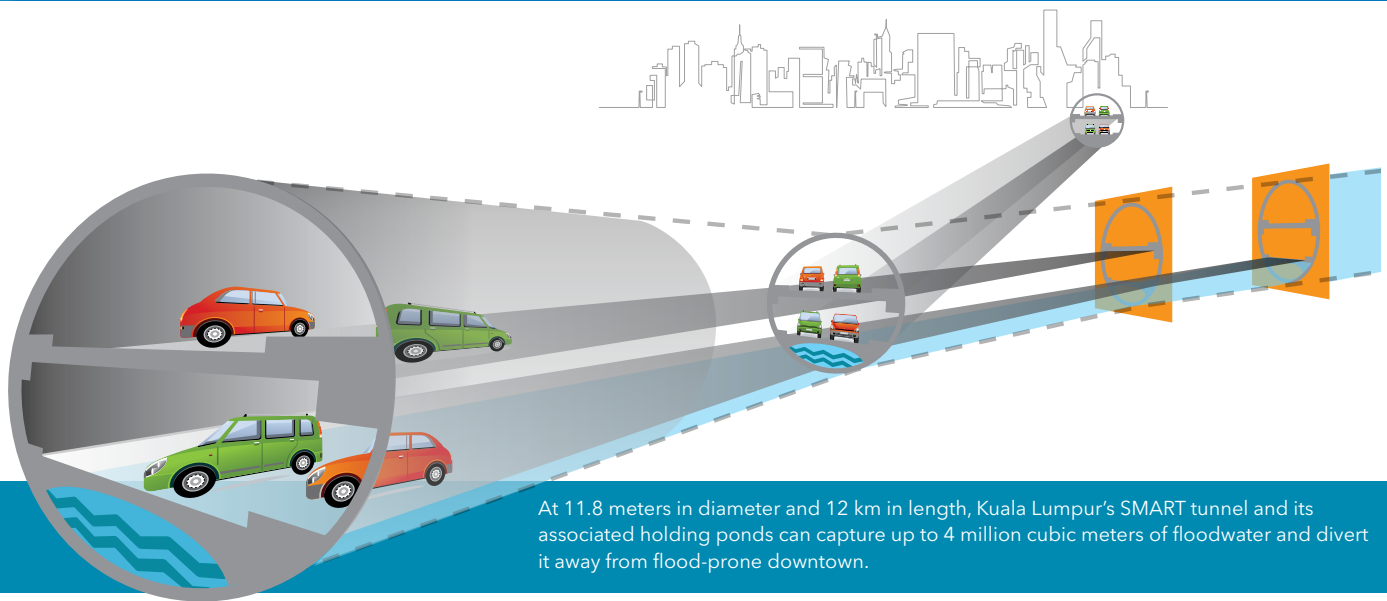# Accoustic Doppler Current Meters

GUIDING INTELLIGENT DECISIONS ON MALAYSIA'S SMART PROJECT

At 11.8 meters in diameter and 12 km in length, Kuala Lumpur's SMART tunnel and its associated holding ponds can capture up to 4 million cubic meters of floodwater and divert it away from flood-prone downtown.

Situation

The awe-inspiring scope of Malaysia's Stormwater Management and Road Tunnel (SMART) Project – 12 kilometers of tunnels 11.8 meters in diameter, capturing up to 4 million cubic meters of floodwater – staggers the imagination. The concept of a tunnel that detours traffic under crowded Kuala Lumpur streets during dry weather and shunts stormwater safely beneath downtown during flood events is as exciting as it is creative.

But behind the massive tunnels and the huge catch basins is a system just as staggering – the SMART Project's nerve system, a network of flood detection equipment and automated management machinery linked by a Supervisory Data Acquisition and Control (SCADA) brain that uses the information it gathers to automatically engage flood management gates and pumps.
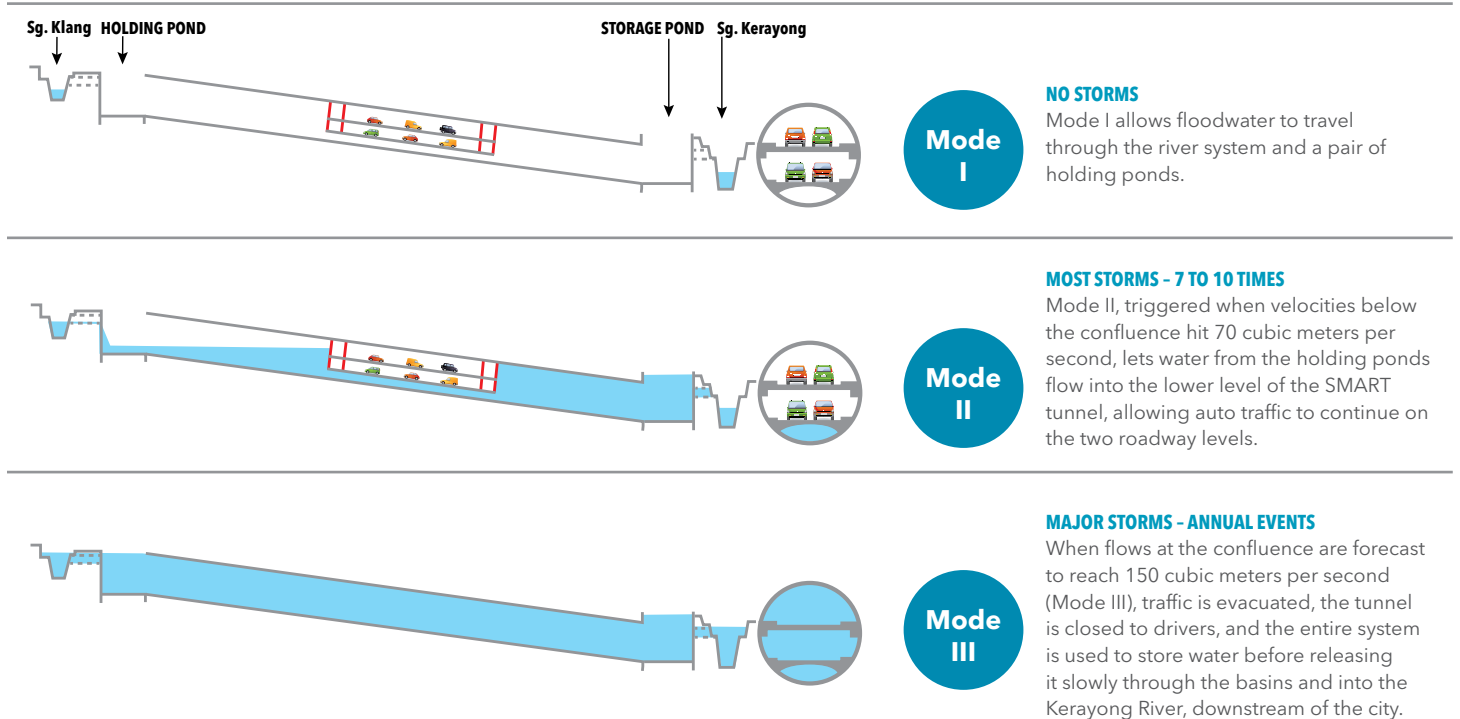
Technology

Designed by systems integrator Greenspan Technology Pty Ltd., the flood detection and automated management system relies on 28 remote monitoring stations to guide decisions on 31 gates, seven huge pumps, and four independent generator setups (gensets) along the project.

Three-Stage System

The SMART Project is designed to operate in three stages to keep floods like the 2007 event from crippling the city, explains Bruce Sproule, Singapore-based International Manager for Greenspan.

NO STORMS
Mode I allows floodwater to travel through the river system and a pair of holding ponds.

MOST STORMS – 7 TO 10 TIMES
Mode II, triggered when velocities below the confluence hit 70 cubic meters per second, lets water from the holding ponds flow into the lower level of the SMART tunnel, allowing auto traffic to continue on the two roadway levels.

MAJOR STORMS – ANNUAL EVENTS
When flows at the confluence are forecast to reach 150 cubic meters per second (Mode III), traffic is evacuated, the tunnel is closed to drivers, and the entire system is used to store water before releasing it slowly through the basins and into the Kerayong River, downstream of the city.

Accurate and timely information on discharge and velocity are vital to the success of the SMART Project and to the safety of Kuala Lumpur's 1.8 million residents.

To ensure the flow of quality data, Sproule's team, led by Project Director Mark Wolf and Project Manager Marc Schmidt, set out an array of 22 rain gauges, 50 pressure sensors coupled to gas bubble systems, and 16 SonTek Argonaut acoustic Doppler current meters.

Accurate and timely information on discharge and velocity are vital to the success of the SMART Project and to the safety of Kuala Lumpur's 1.8 million residents.

Greenspan's Control Centre Operations Team, led by Mark Van Elswyk, maintains a communications system that includes VHF radio, GSM, fiber optic signals and microwave transmissions to maintain constant communication between sensing stations and the SCADA system.

Kuala Lumpur's SMART tunnel diverts traffic as well as floodwater under moderate-rain conditions.
If deluges persist, operators can close the tunnel and flood the roadways for greater water-holding capacity.

Argonauts connected by Ethernet report every minute; those connected by high-speed VHF broadcast every five to 10 minutes. SCADA Engineers Jarrah Watson, Nick Hitchins and Peter Johnson keep the control/acquisition system finely tuned.

Data from the rivers, holding ponds and tunnels are integrated with rainfall information in Greenspan's Time Series Database, then channeled through the company's forecasting models. Results drive automatic gates that govern flow into the SMART basins and tunnels, and activate massive pumps to dewater the tunnel when downstream flows can accommodate the release.

"It's more accurate information," Sproule says. "If you have tidal influence or a backwater effect, you may get hysteresis and depth:discharge data isn't accurate.'

When levels rise and the influence of the downstream tides are increasingly felt on floodwaters in Kuala Lumpur, the forecasting model switches from gas-purge pressure sensors readings to data from the acoustic Doppler current meters to track discharge, says Sproule.

He explains that the tidal effect from downstream creates hysteresis, a slowing of the usual reactions of the floodwaters to the forces coming from upstream. It's critical to track what's really happening in the river rather than rely on mathematical estimates that are based on conditions in unobstructed, gravity-fed systems.

"It's more accurate information," Sproule says. "If you have tidal influence or a backwater effect, you may get hysteresis, and depth:discharge data isn't accurate." Greenspan developed its own Velocity Index software, he adds, to ensure accurate calculations of flow.

Careful Placement

In and around the tunnel, SonTek Argonaut SL (side-looking) current meters are set at carefully determined heights to be ready for high-flow situations, notes Sproule. Two Argonaut SW (shallow-water) current meters measure flow and velocity through twin box culverts at the downstream discharge point, feeding a discharge model. The flow of information provides valuable insight even when floods aren't imminent. In fact, notes Sproule, data from the SWs revealed that the Klang stores a surprising amount of water in its water table after a flood event and releases it over a longer period than the Greenspan model originally assumed.
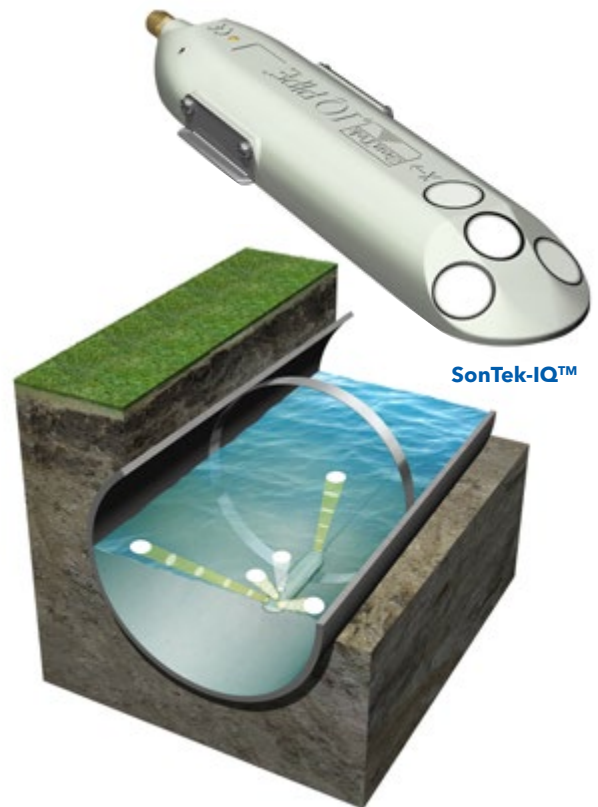
SonTek-IQ™

Due to it's many directions of measurement, the SonTek-IQ is well suited in situations where hystersis is present.

- Proprietary flow algorithms are ideal for data collection in irrigation canals, natural streams and pipes.
- The instrument uses SonTek's exclusive SmartPulseHD adaptive sampling.
- Self-calibrating water level using vertical acoustic beam and pressure.

SonTek Acoustic Doppler Argonaut SL

The Greenspan team installed 16 SonTek Argonaut acoustic Doppler current meters at carefully determined heights to measure current and depth during floods with extreme accuracy.

Protecting valuable equipment during flood events can be a challenge, notes Sproule. Wayne Farrell of Greenspan designed "Knight's head" stations that protect sensors with automatically retracting shields reminiscent of medieval helmets. Carefully placed at the optimum height to measure high water in the system, the Knight's head stations must be maintained after every flood event. "The mechanisms are designed to keep the instrument from getting washed away with large debris, but they do become silt traps," Sproule notes. Greenspan developed its own calibration software for easy routine and post-storm maintenance of the current meters, he adds. The company also developed a proprietary system to create an 80,000-point cross-section for each sampling site.

Innovative "Knights Head" stations use automatically retracting hoods to protect SonTek Argonaut current meters.

"The support is good and the equipment is reliable," he adds. "The instrument is robust, and when things go wrong, the company has been quick to react."

Sproule says the Greenspan team, which also includes Hydrographic Technicians Ben Noble, Clem Williams and Faizal Yusoff, saw SonTek Argonauts as a natural choice for SMART. "We were looking at radar/sonar, but it was prohibitively expensive, and we have a lot of experience using SonTek equipment," he explains. "It was the easiest and most accurate to incorporate into this project. We had an eight-man stormwater monitoring team in Singapore using SonTek equipment for 14 months, so we know what it does and doesn't do.

"The support is good and the equipment is reliable," he adds. "The instrument is robust, and when things go wrong, the company has been quick to react."

Fast reaction is vital when it comes to a project as massive as SMART. During a system test in September 2007, the system delivered an accurate prediction of rising river levels 30 minutes in advance and managed the successful diversion of 500,000 cubic meters of water.

As traffic flows through the massive tunnel and a silent network of sensors reports to the Greenspan SCADA system, Sproule reflects on the SMART Project. "This is the most sophisticated system that Greenspan has ever designed," he notes. That makes its smooth operation no less of a marvel than the 11.8-meter-high tunnel that protects Kuala Lumpur from below.

Intakes for the SMART system can draw millions of cubic meters of floodwater into a massive underground tunnel, sparing the streets above from crippling floods.

Greeenspan photo and Graphics Credits: Mark Van Elswyk, Greenspan Technology

SonTek, a Xylem brand
9940 Summers Ridge Rd.
San Diego, CA 92121

📞 +1.858.546.8327
✉ inquiry@sontek.com
🌐 SonTek.com

Sound Principles.
Good Advice.

SonTek.com