ACSA's jet fuel pollution solution

by Tony Stone, with contributions from John Mosheim of BaySaver Technologies and InterOceans Systems

After the second incident of jet fuel spillage at OR Tambo International Airport in 2006, which polluted the nearby Blaauwpan Dam, and a third incident in 2007, the Airports Company of South Africa (ACSA), under pressure from government and environmentalists, commissioned a R450 million project to reduce the probability of the dam ever being polluted again.

They say mishaps occur in threes. In ACSA's case, this unfortunately proved true – in 2005, 2006 and 2007. The worst incidence was in 2006. Jet fuel from a collapsed fuel valve, caused by mechanical failure, spilled 1.2 million litres of jet fuel into OR Tambo's storm-water system and into the Blaauwpan Dam, causing extensive pollution and a massive public outcry. Applying the principle that prevention is better than cure, the implemented solution is multifaceted and ingenious.

But, assuming nothing was done, just how big could a future spillage be? Using ACSA's airport statistics, over the last five years, OR Tambo averaged 102 000 aircraft movements per year with approximately 27% of these being international flights. With your typical 747 carrying approximately 200 000 ℓ of fuel and your typical 737 carrying approximately 24 000 ℓ of fuel, the average amount used, in one month, averages roughly 600 million litres. So, potentially, if nothing was done, a future spillage could equal or exceed the 2006 figure of 1.2 million litres. Given the approximate daily requirement of 20 million litres per day, fuel is stored in nine bulk storage tanks at OR Tambo's fuel farm.

In terms of the 'old' fuel management system, the moment a drop in pressure is detected – the result of dispensing fuel to an aircraft via one of the apron fuel valves – pumps located at the fuel farm switch on, keeping the pressure in the system at a constant level. The problem with this system is that it would not know whether the drop in

OR Tambo airport's fuel farm

InterOceans Systems oil-spill detection monitor

pressure was caused by normal dispensing or a by fuel leak. Only a physical examination of the fuel valve chamber would identify the leak, as happened in 2006 – after some delay. A call to the fuel farm, alerting them of a leak, would result in the pumps being switched off. Hindsight points to a shortfall in the initial design of the system or a failure to carry out regular maintenance, appreciating of course that it is very difficult to predict mechanical failure. On the positive side, the design did take the leaking fuel into the storm-water system and not out of the pump valve chamber onto the apron, where a simple spark could trigger a massive fire and destroy any aircraft parked on the apron. One could imagine the possible chain reaction such an inferno would have.

The 'new' fuel management system still operates as the 'old' system did, but has a few interesting modifications – an early warning system, a backup warning system, a spillage trap and a huge attenuation dam as backup.

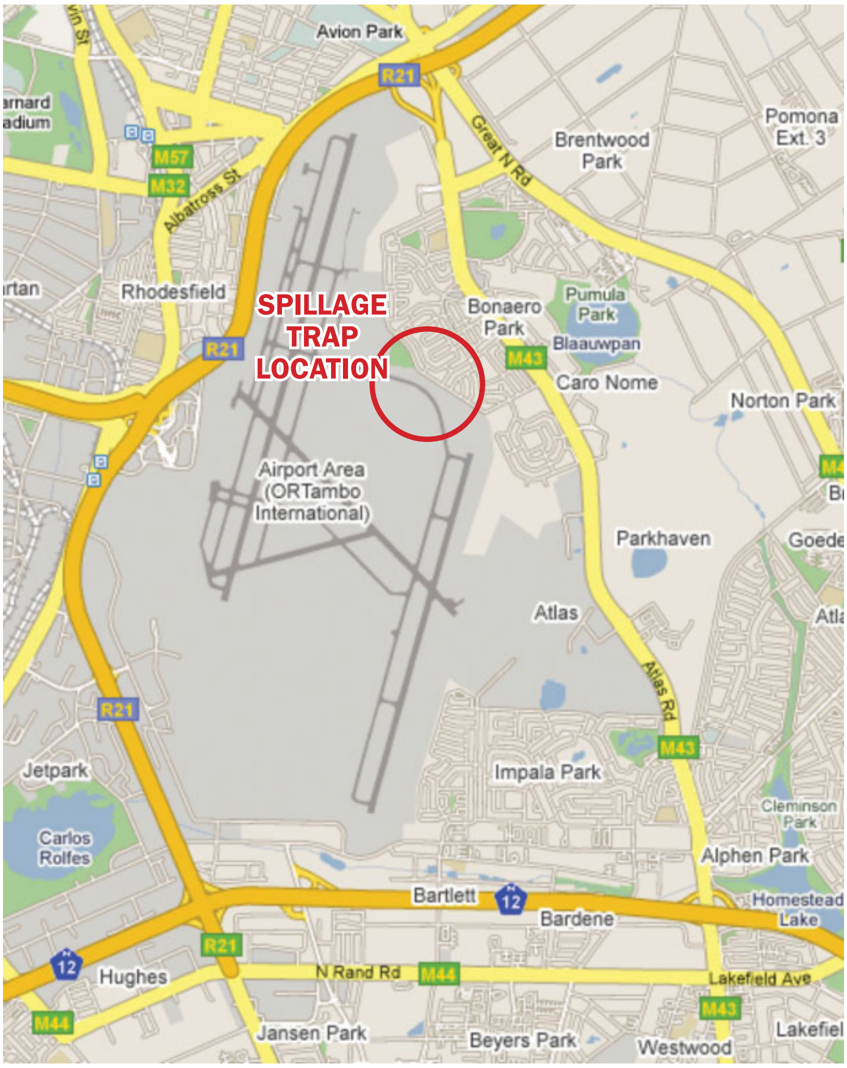
Each pump-valve chamber is fitted with an ultrasensitive level detector. In the case of a fuel leak, the level detector sends off an alarm to the technical maintenance contractors who operate 24/7. They in turn will assess and validate the leak and, in such an instance, press the emergency stop button and confirm the shutdown with the fuel farm. By this time, however, jet fuel would be in the storm-water system. Previously, storm water flowing out from underneath the aprons and the runways would enter a natural stream, which flows down to the Blaauwpan Dam. The need therefore was to catch the spillage before it got to the dam. This required the construction of a spillage trap with a separation capability and, given the potential volumes, it needed to be big enough to handle the job. It also needed to have a backup should a 1:100 'perfect storm' situation occur.

The first task was to construct 2 x 350 m long 3 m wide x 2.5 m high culverts to channel the storm-water outflow into the spillage trap. However, due to the geology of the soil, being wetland, piling to varying depths was needed in order to stabilise the base upon which the prefabricated culverts would stand. This added a considerable amount to the final cost. Then came the spillage trap, with its separation chamber to clean 2.5 m^3 per second, and a 400 000 ℓ jet fuel recovery tank. From here, the outflow runs into a 1.1 million cubic metre attenuation dam before flowing out and eventually ending up in the Blaauwpan Dam.

Oil-spill detection

Jet fuel flowing down the twin storm-water culverts will be detected by two oil-spill detection monitors installed at the point just before the storm-water culverts enter the spillage trap. These monitors will trigger an alarm.

According to InterOceans Systems, manufacturers of the Slick Sleuth oil spill detection monitor and alarm system installed at OR Tambo, the system is ideal for detection of oil spills and sheens in fresh, brackish, or saltwater environments. It is equally suitable for oil detection over solid substrates such as earth, concrete, metal, etc. The downward-looking sensor can be used to detect petroleum products, commonly referred to as Poly Aromatic Hydrocarbons or PAH/BTEX compounds, which include crude oil, bunker 'C', diesel/fuel oil, lube oil, turbine oil, hydraulic



Map showing OR Tambo Airport and the location of the jet fuel spillage trap

oil, motor oil, gasoline, jet fuel, etc., as well as various food oils, process oils, and many other oils of concern.

The system works by detecting the presence of oil using a high-power light source within the detection station. UV light is used to 'excite' the target area beneath the sensor. The collimated light beam is filtered to provide maximum stimulation of the target area. The resulting fluorescence from any oil present passes through the sensor's proprietary optical system, and is detected using photo-diodes within the detection station. Whenever oil is present, the monitor immediately signals detection, and automatically actuates (on or off) external mechanisms such as remote alarms, valves, and/or pumps, according to installation logic/design. The detector automatically filters out ambient conditions ('background noise'), providing highly reliable detection and alarm at the first appearance of oil, day or night, in all light and weather, and regardless of substrate or water surface conditions. Each detection station is completely self-contained, incorporating a non-contact optical sensor, CPU and electronics, optional DC/solar recharge power supply, and optional wireless signal telemetry link. Sensor stations are designed for installation in hazardous (explosive gas) environments, either by the addition of a compatible, positive pressure, instrument-air purge system, or by housing the sensor in an optional explosion-proof enclosure.

For industrial applications, one or more sensor(s) are strategically placed within and around the facility to protect against either discharge or intake of oil pollution. Sensors are typically co-located with visual and/or audio alarm for local spill notification, as well as signal transmission to the facility's control centre for real-time spill alert. Additional options are available for spill notification via dedicated computer monitor, telephone, or pager, providing a system tailored to user's specific needs for early warning alert and immediate spill response and containment capabilities. Slick Sleuth provides users with the best available technology, for use as a best management practice (BMP) device and spill prevention and control countermeasure (SPCC) tool. Each station monitors for oil on a preset schedule (user selectable ½ second to 1½ hour interval). Data communication is available via RS232 serial interface, dry-contact relay switches, and/or optional 4-20 mA analog signal output. Integral alarm indicators are also available. Flexible design and user-specified signal output options make integration convenient and straightforward with users' PLC, SCADA, or other customary analog data acquisition systems. Alternatively digital output may be used for serial data communication (typically for stand-alone systems, for example in applications such as harbour monitoring or sensitive habitat protection arrays). Each automated detection station has built-in test capabilities and fault detection, constantly reporting sensor status and health to the base station computer or local control centre.

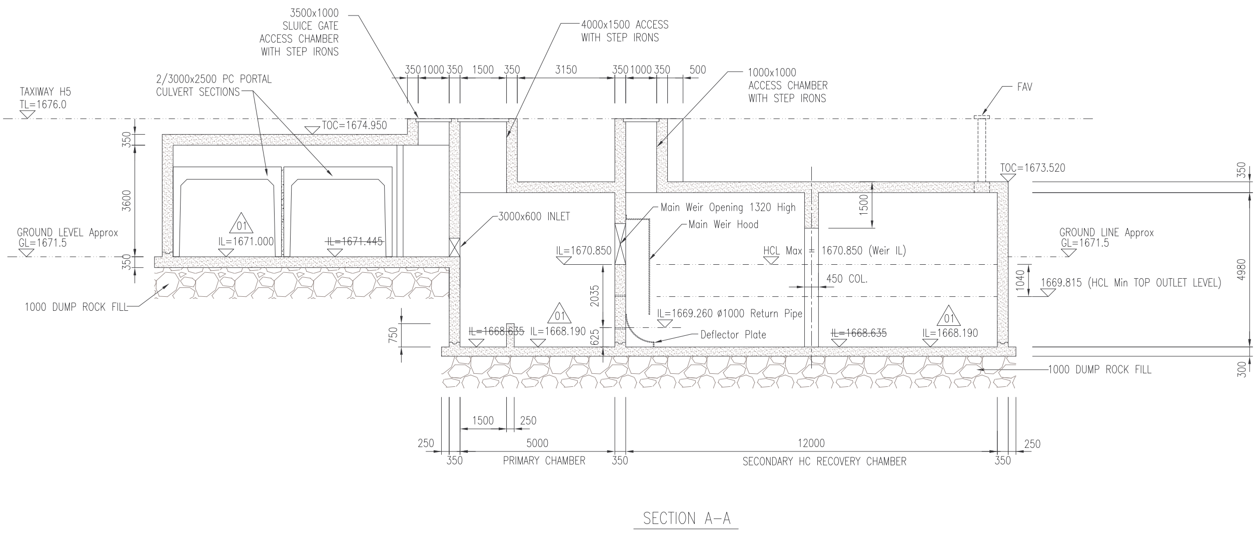
Propriety software is used to interface with the sensor to allow users to customise sensor operation by programming sampling parameters. The simple-to-use utility tool is only required for communication during installation/initialisation, to change user-specified settings, or for troubleshooting purposes. User-adjustable settings include sampling interval, flash rate, baseline measurement, detection offset/threshold, adaptive baseline, operating modes, logging features, etc.

Spillage trap

The huge storm-water gravity separator system designed by WSP for OR Tambo is based on the design of the US-patented BaySaver System, which typically is used for roadside storm-water systems. John Mosheim of BaySaver Technologies describes the BaySaver System as a physical separator, relying on gravity settling, flotation, and other related mechanisms, to remove sediments, floating debris, and free oils from storm water. The system is comprised of three main components: the BaySaver separator

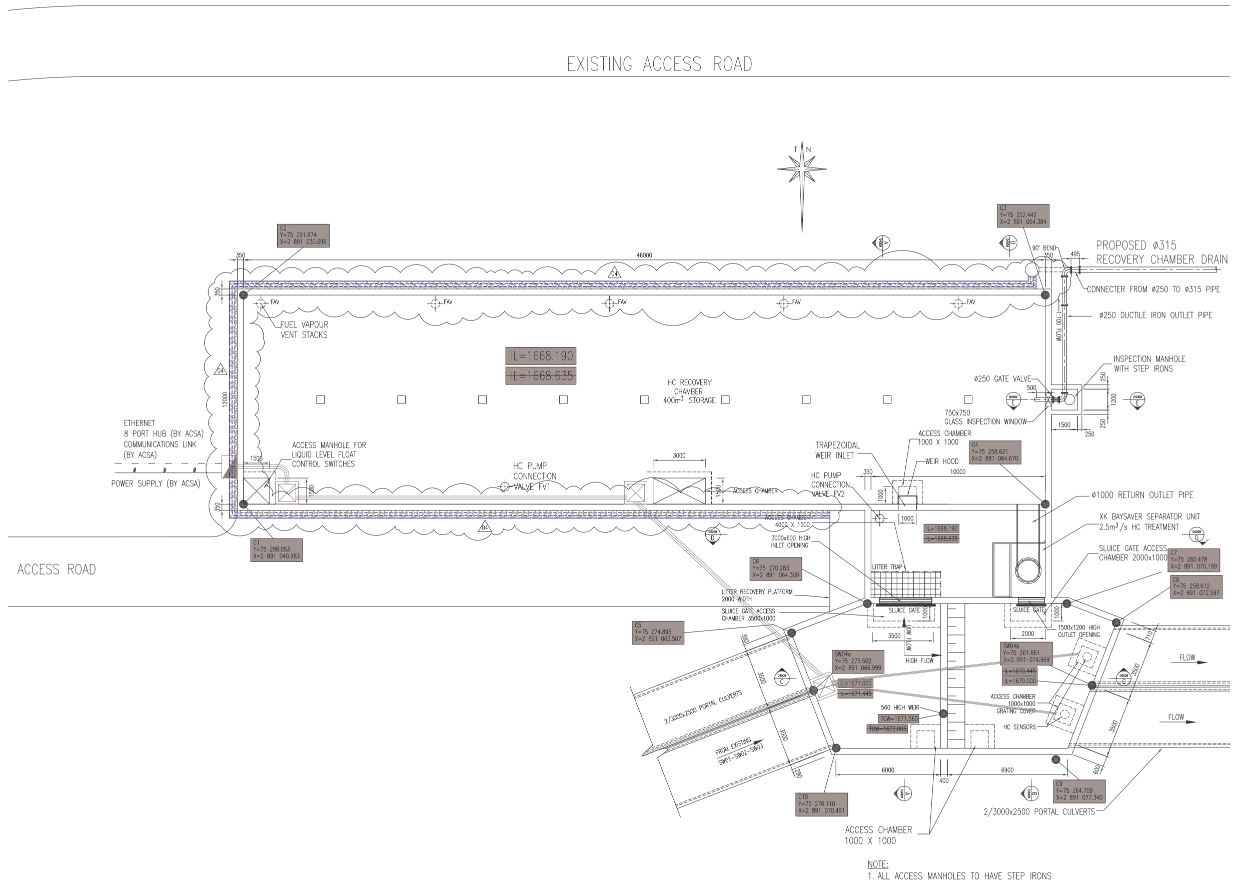
STORM WATER SEPARATOR FACILITY-SW04 DETAIL PLAN

HORIZONTAL VIEW



STORM WATER SEPARATOR FACILITY-SW04 DETAIL PLAN

VERTICAL VIEW



unit, the primary manhole (PM), and the storage manhole (SM). The SM is an offline pollutant-storage structure. Figure 1 displays a simple schematic of the BaySaver Separation System. Influent flow-containing pollutants enter the system by first passing through the PM. In this structure, coarse sediment settles while the flow passes into the separator unit and is routed to the SM. The influent flow to the SM, at this point, still contains pollutants of concern, such as fine sediments, oil and grease, floating trash, and other debris. Floatable trash, oils, and grease float to the surface of the SM and the influent flow returns to the outfall of the system

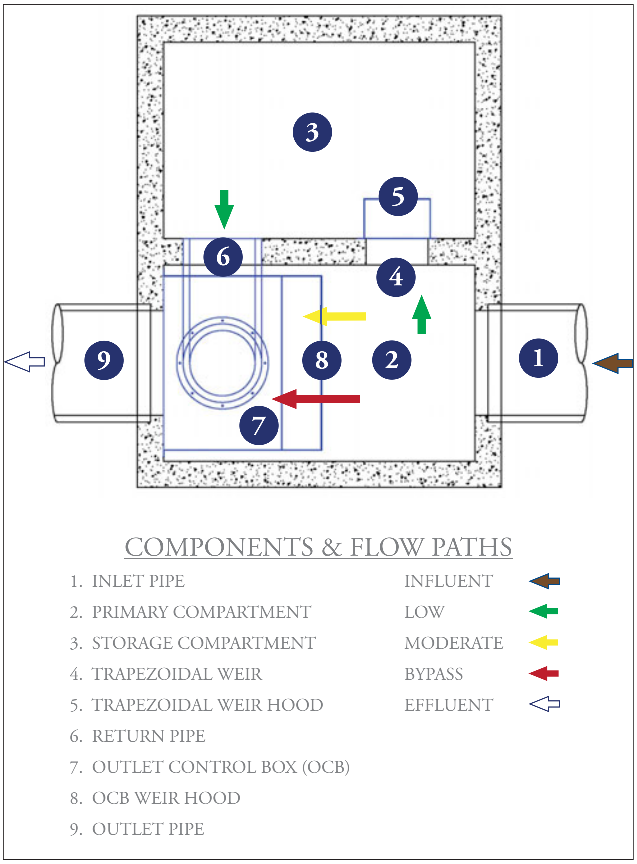


Diagram showing the flow through a Baysaver XK separator

through the separator unit. Both manholes are of standard concrete construction and function as sediment accumulation sites.

During a storm event, as the rate of flow Q increases through the treatment system, the separator unit acts as a dynamic flow control to route the influent flow through the most effective flow path for treatment. For example, under low-flow conditions the entire influent flow is treated as described in the previous paragraph. Under moderate flows and up to the maximum treatment rate (MTR), water is continuously treated through both the PM and SM, with a portion of these flows diverted through the T-pipes and the remainder flowing into the separator unit and then to the SM. The T-pipes are structures that enhance the performance of the system during higher-intensity storm events that are below the MTR of the separator. This flow path allows for full treatment of floatable pollutants, while still treating sediments under moderate flow conditions. During maximum flow conditions or maximum hydraulic rate (MHR), most of the influent flow passes over the bypass plate and will not be treated.

In summary, during all storms, storm water flows through the primary manhole and, depending on the MTR of the separator, might be treated in its entirety ($Q < MTR$) or bypass the system ($Q > MTR$) in the case of high-intensity storms. For storm-water flows with $Q < MTR$, storm water can flow through the SM and T-pipes depending on the magnitude of Q. BaySaver Separators are designed based on the MHR, MTR, and the percentage of suspended-sediment removal requirements.

In conclusion

ACSA has certainly made every effort to ensure that a reliable and effective solution be put in place to prevent jet fuel leakages from damaging the environment in future. OR Tambo serves as a model for all other South African airports, and industries where parallels can be drawn. 3S