

AUTOMATED GAGING OF THE NARMADA MAIN CANAL

Monitoring opportunities and challenges that face the largest concrete-lined irrigation channel in the world

India is emerging as a world leader in irrigation schemes, and the 458-km Narmada Main Canal – the largest concrete-lined irrigation canal in the world – stands as a monument to the opportunities and challenges that face water providers. The scale of the SSNNL canal system, velocity changes due to volume and management, and the constant battle against siltation illustrate the importance for accurate measurement of flow and discharge.

A side-looking SonTek/YSI Argonaut SL 500 acoustic Doppler profiler (ADP) positioned where the Narmada Main Canal crosses from Gujarat into Rajasthan, supported by a portable acoustic Doppler profiler, deliver highly accurate data on deliveries across the border. Hourly readings from the stationary Argonaut SL 500 are available by dial-up access at all times, and accumulate to provide high-resolution data on deliveries throughout the year.

To serve the demands of water users and accurately track the transfer of state-owned water across political boundaries, such technology will be vital, notes Sham Chaudhari, South Asia Manager for SonTek/YSI in Gurgaon, India.

“It’s very important for authorities to have time-series data,” Chaudhari notes. “With the kind of infrastructure we have here, the challenge is to make a good measurement, to capture the complete flow. There’s no way, if you’re making three measurements per day, for you to get the total quantity of water being

released for irrigation, or an accurate assessment of water consumption.”



One of the many canals that make up the SSNNL canal system.

Massive Challenge

At its head in Kevadia, Gujarat, the Narmada Main Canal has a capacity of 1,133 cumecs (40,000 cusecs), with water flowing at 1.69 m/sec through a canal 73.1 meters wide at the water surface and 7.6 meters deep. At kilometer 458, where the canal crosses into Rajasthan, the canal is 35 to 40 meters wide at the water’s surface and runs at a maximum depth of 4.2 meters.

However, during the peak of the summer, water depth can drop to 1.2 meters and flows slow to a nearly stagnant 0.3 cumecs – undiscernable to the manual flow measurement techniques traditionally used along the canal. Canal management procedures can also create significant backwater effects, notes application specialist Lee Pimble in SonTek’s European Support Office in the U.K., who helped SSNNL install the new equipment.

“Backwater effects always make it difficult to measure discharge,” Pimble notes. “If the water is moving slowly or even backwards, assumptions about the relationship between level and discharge no longer apply. But because of the instruments, we’re able to very accurately measure velocity and calculate discharge.”

The Argonaut 500 SL is a side-looking Doppler profiler that sends a 0.5-MHz signal from its transducers and reads the echo off of suspended particles in the water to

SonTek/YSI, founded in 1992 and advancing environmental science in over 100 countries, manufactures affordable, reliable acoustic Doppler instrumentation for water velocity measurement in oceans, rivers, lakes, harbors, estuaries, and laboratories. Headquarters are located in San Diego, California.



Installation of a Argonaut-SL500 (“side-looking”) into the Narmada canal.

gauge the velocity of the current. Mounted 1 meter from the bottom of the canal, the Argonaut’s large-diameter transducers produce extremely narrow beams, which can reach as far as 100 meters.

Data is collected hourly and stored in a Design Analysis Associates/YSI WaterLOG 500XL datalogger. A GSM modem allows dial-in access for authorities in Gujarat to download the readings from the Argonaut. SonTek FlowPack software computes discharge using index-velocity correlation, a calculation that takes into account the actual volume and dimensions of the canal’s heavily silted channel at the time of the data measurement.

The system is powered by a battery and solar panel, and uses minimal power to gather and store its data, making it durable enough to weather the rugged conditions in the desert along the Gujarat-Rajasthan border.

Measuring the Ever-Changing Profile

SSNNL authorities, working with the SonTek/YSI team in India, collect profile data several times per year to keep abreast of changes in canal depth and shape, which can be heavily influenced by siltation and vegetation growth.

“When the profile changes, you have to update the rating curve,” says Chaudhari.

For that task – as well as to take instant measurements of velocity and flow anywhere along the canal system – SSNNL deploys a SonTek/YSI RiverSurveyor. The RiverSurveyor is a floating platform with a multi-beam profiler that automatically manages cell size, pulse scheme and acoustics to deliver three-dimensional velocity profiling, bathymetric measurement and discharge calculations. That allows SSNNL to make highly accurate discharge measurements anywhere along the system in minutes.

Chaudhari and his team helped SSNNL gather profile data when canal depth was 4.2 meters, 3 meters and 1.2 meters, allowing them to keep the Argonaut SL calibrated with revised rating curves using velocity index equations derived from the FlowPack software.

The RiverSurveyor deployments illustrated the importance of updating the rating curve data – and not relying on assumptions about the dimensions of the canal. “There was a lot of vegetation at the bottom,” Chaudhari says. “We had to use our stationary mode of operations because of the difficult hydrological conditions at the channel bed.”

Good Fit

The scale of India’s canals can be addressed by the breadth of SonTek’s line of equipment, notes Chris Ward, SonTek/YSI director of international business development at the company’s headquarters in San Diego, California, USA.

“Our acoustic Doppler profiling technology is extremely adaptable across a wide range of conditions,” Ward says. “Our hardware also is designed for a large variety of situations. We have sensors that are used in tiny streams and canals, and we also have sensors that might be used in a port or harbor that can be adapted for India’s largest irrigation canals.”

Pimble adds that the velocity/area principles behind



SonTek hydrologist and Application Specialist, John Sloat, shows real-time flow data SSNNL engineers.

discharge calculations from the Argonaut and RiverSurveyor ADPs is a good fit with India's hydrology experience.

"They're extremely good engineers, they know their hydrology very well, and they know velocity/area techniques very well," he says of the SSNNL team members with whom he worked on the Narmada Main Canal installation. "The Argonaut SL fits in well with their knowledge."

Durable, highly accurate automated instruments like the Argonaut SL are the future for India's irrigation infrastructure as the nation continues to build monumental projects, notes Chaudhari. In fact, authorities from another massive Indian irrigation system have ordered more than 100 Argonaut ADPs and several RiverSurveyors that will be linked via a SCADA system to automate flow monitoring along more than 600 km of canals.

"These are the largest canals in the world," he says. "The only way they can be operated is by automation."

As India engineers its way to the forefront of the world's irrigation delivery systems, state-of-the-art monitoring and management will become increasingly important. Constant, accurate, automated monitoring of flow will help India smoothly track the flow and transfer of state-owned water, serve millions of farmers, and provide the greatest boost to many of the nation's parched regions since the Green Revolution.

*SonTek/YSI
9940 Summers Ridge Road
San Diego, CA 92121
Tel: +1 858 546 8327
Fax: +1 858 546 8150
Email: inquiry@sontek.com
Web: www.sontek.com*

