xylem
Environmental Solutions

Application Note
SonTek, a Xylem brand • XA00103

Automated Gaging of the Narmada Main Canal

MONITORING THE LARGEST CONCRETE-LINED IRRIGATION CHANNEL IN THE WORLD

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

Situation

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 Argonaut-SL500 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-SL500 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 in Gurgaon, India. Reservoirs Act 1975."

Argonaut-SL500

SonTek-SL1500

SonTek-SL3000

SonTek
a xylem brand

"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."

"To serve the demands of water users and accurately track the transfer of state-owned water across political boundaries, such technology will be vital,..."

Massive Challenge

At its head in Kevadia, Gujarat, the Narmada Main Canalhasa 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-SL500 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 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.

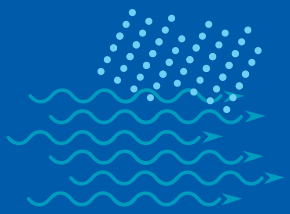
Installation of a Argonaut-SL500 ("side-looking") into the Narmada canal.

CHALLENGE

Narmada Main Canalhasa Seasonal Flow Differences

"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."

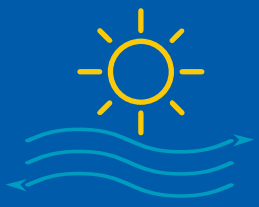
AT CAPACITY



1.69
meters/second

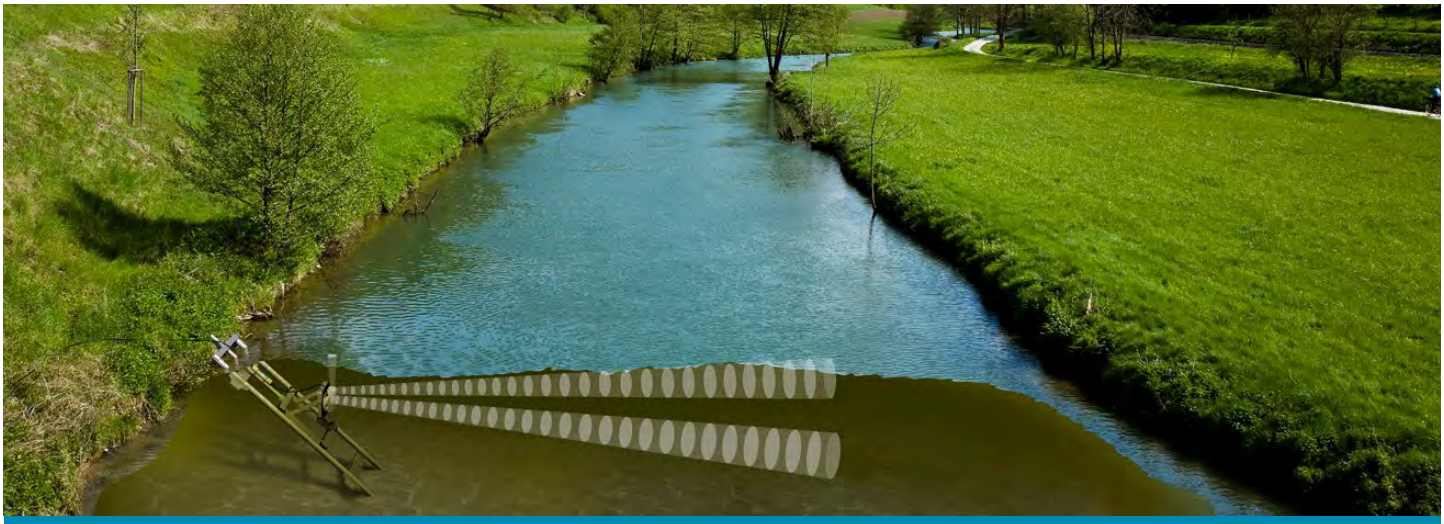
1,133
cumecs

SUMMER



1.2
meters/second

.3
cumecs



SonTek SL1500 allows for highly accurate measurements anywhere along a water system in minutes

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.

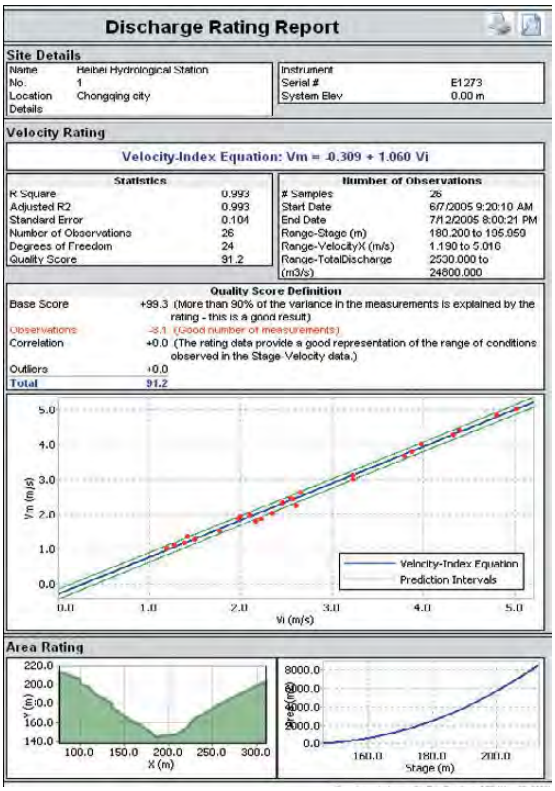
The system is powered by a battery and solar panel, and uses minimal power to gather and store its data, making it durable enough to weather the rugged conditions in the desert along the Gujarat-Rajasthan border.

Measuring the Ever-Changing Profile

SSNNL authorities, working with the SonTek 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 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.



Example of a Flowpack Velocity Indexing Report.

Flowpack Software The Windows-based Stationary Measurement real-time and post-processing software program was designed specifically for use in rivers and canals. The features in this software make the ADP a more powerful tool, and allow you to reliably use our RiverSurveyor systems in more places than ever before. The RiverSurveyor system includes a built-in compass—essential when measuring discharge with a profiler from a vessel in moving-bed conditions. Combined with the Stationary Measurement software, the system can be used from a floating vessel in moving bed conditions without the need to use complicated (or undependable) DGPS systems. In northern climates, RiverSurveyor systems can even be used "year-round" with the ability to make discharge measurements under ice!

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

"...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."

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

"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.*

*This is a redraft of a story that was earlier published in 2007.

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/Sontek-sl-series