



## PROJECT DOSSIER

# MUHARRAQ STP



## PROJECT OVERVIEW

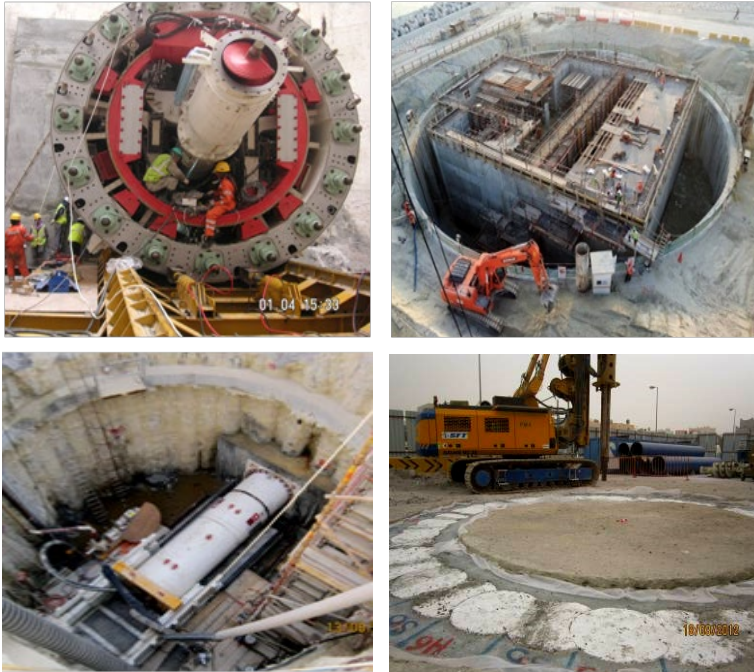
Project	Muharraq Sewage Treatment Plant (STP) and Sewer Conveyance System
Location	Bahrain
Client	Ministry of Works (MOW), Bahrain
Contractor	Samsung Engineering Co. Ltd.
Consultants	Hyder Consulting Middle East
Duration	2011 - 2014

Muharraq Sewage Treatment Plant (STP) and Sewer Conveyance System Project is first of its kind in the country. The plant has a treatment capacity of 100,000 m<sup>3</sup>/d and will provide clean water for Bahrain's northeast region

The Muharraq STP micro-tunneling project involved construction of sewage treatment plant (STP), a 16.5 km Deep Gravity Sewer (DGS) with 50 Shafts and network connections. The shafts were constructed with 42-54 secant piles, to facilitate

and receive the micro-tunneling heavy equipment and pipes that would be 'jacked' into position for the sewer network. After the pipeline installation, the shafts were used as manholes.

The project is overseen by the Muharraq STP Company (MSC) as part of a 27-year build, own, operate and transfer (BOOT) scheme. The project won the Middle East Water / PPP Deal of the Year 2011 awarded by Project Finance Magazine and two MEED Quality Awards for Projects: 2015 GCC Winner in the "Sustainable Projects of the Year" category and 2016 National Winner in the "Power & Water Project of the Year" category.



## Monitoring solution

Encardio-rite was awarded the Instrumentation and monitoring sub-contract by the EPC contractor Samsung Engineering Co. Ltd. Encardio-rite was responsible for the complete monitoring and surveying solutions for the project.

### Turnkey services

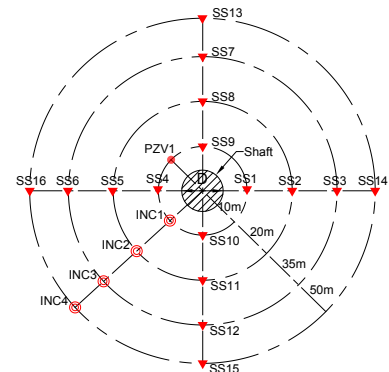
- Pre-construction building condition survey
- Post-construction building condition survey
- Supply and installation of geotechnical sensors
- Optical Surveying
- Monitoring with daily, weekly and monthly reporting with interpretations
- Calibration of dataloggers and sensors

Monitoring reports were submitted on daily, weekly and monthly basis. Monitoring reports included interpretations of variations observed in instrument data with respect to the construction progress in the respective area.

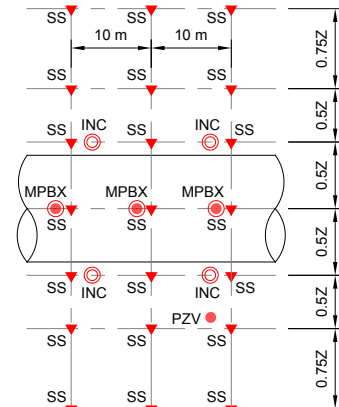
## INSTRUMENT USED

- **Inclinometer:** To monitor lateral movement around shafts and in monitoring zones across tunnel alignment. Almost 200 Inclinometers were used for 50 shafts and 7 monitoring zones.
- **Borehole extensometer:** To monitor sub surface settlement over tunnel alignment. Three-point MPBX were used in monitoring zones while single point BHE was installed at every 500 m over tunnel axis. Overall 60 BHEs were installed and monitored for the project.
- **Vibrating wire piezometer:** To monitor ground water pressures around shafts and in monitoring zones.
- **Surface settlement points:** Soils type and pavement type settlement points were installed in quantities above thousand. These were used to monitor ground settlements around shafts, in monitoring zones and over tunnel axis.
- **Building settlement points:** 2 no. of building settlement points were installed at each building within zone of influence of tunnel alignments and shafts for monitoring building settlement.
- **Tilt meters:** Tilt plates were installed on critical buildings as well as buildings close to the tunnel alignment and excavation works. Portable tilt meter was used to record the tilt readings.
- **Prism targets:** Mini-prism targets were installed on critical structures for 3-D monitoring.

A typical monitoring plan for shaft and monitoring zone is shown in adjacent figure. Experienced and proficient team of Encardio-rite provided installation, monitoring and surveying services for complete 3 years. Pre & post construction survey of almost 300 structures and 200 utilities was completed successfully. The project proudly recorded over 10 million safe man-hours without a lost-time incident on the project.



Typical shaft monitoring scheme



Typical monitoring zone scheme