



Sustainability Driven Strategy for Achieving Sustainable Infrastructure: Musameer Pumping Station and Outfall Project

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Abstract

The increasing emphasis on global sustainability issues such as climate change, loss of biodiversity, deforestation, and water scarcity has provided a strong mandate for the construction industry to incorporate sustainable practices, more efficient processes and innovative technologies to deliver sustainable project outcomes. Implementing sustainability rating and assessment schemes throughout the lifecycle of projects has been instrumental in achieving high levels of environmental and social performance. This paper presents a case study; the Musameer Pumping Station and Outfall (MPSO) project, a strategic asset for Qatar, and discusses the sustainability strategy adopted for achieving the 'Very Good' level Civil Engineering Environmental Quality and Assessment Award Scheme (CEEQUAL) certification for the project. The paper sets out how the project's registration with CEEQUAL International resulted in achievement of sustainability best practice in design and construction phases. Specific achievements with regards to the key CEEQUAL topic areas including project strategy, project management, people and communities, land use and landscape, historic environment, ecology and biodiversity, water environment, physical resources use and management (such as energy, water, materials), and transport are also highlighted in this paper. The paper also provides the importance of the adopted strategy in translating the overarching Qatar National Vision 2030 and alignment with the United Nations (UN) Sustainable Development Goals (SDGs). The challenges faced throughout the project lifecycle and the benefits achieved by undertaking a CEEQUAL assessment for this project are also discussed in this paper.

Keywords: Sustainability; Infrastructure; CEEQUAL; SDGs

1 Introduction

Musameer pumping station and outfall (MPSO) project is designed to manage surface and rainwater received from the drainage networks from 270 km² of urban areas in southern Doha, which has witnessed rapid urbanization and has experienced heavy rains over the recent years. To address the urbanization challenges and to alleviate the flooding in the catchment area, MPSO project has been designed. The project includes a pumping station with a capacity of 19.7 m³/s, a 10.2 km long, 3.7 m internal diameter under seabed outfall tunnel, an offshore riser shaft and 84 port diffuser field. MPSO project organization comprises of Ashghal, Qatar's Public Works Authority (PWA), Project Management Consultant (PMC), Mott MacDonald and HBK-PORR, the main Contractor.

2 PROJECT ACHIEVEMENTS

2.1 Strategy

The key objective of the MPSO project was to build a sustainable asset, achieving a minimum ‘Good’ rating level with Civil Engineering Environmental Quality and Assessment Award Scheme (CEEQUAL), and delivering social, environmental and economic benefits. To achieve this objective, the MPSO project adopted a sustainability-driven strategy, registering the project with CEEQUAL and implementing a wide range of practices that led to sustainability outcomes. The project has focused on the following practices throughout the project lifecycle:

- Assessing the impact of climate-change and consideration of future projections
- Minimizing the carbon footprint of the project
- Minimizing the impact on the environment and the communities
- Utilizing innovative technologies to enhance resource consumption
- Achieving financial savings and commercial benefits.

2.2 People and Communities

The southern and western areas of Doha have been experiencing a rapid urbanization in recent years. As a consequence, the need to increase the drainage capacity to accommodate additional storm-water runoff and construction activities has become critical. The MPSO project is built to increase the drainage capacity within Doha to accommodate storm-water runoff, addressing potential flooding risks, and enhancing the communities’ living quality and to minimize the potential adverse impacts of flooding on the residents and communities of Doha, as well as minimizing negative impacts on the environment, particularly the marine ecosystems. The site selection for the MPSO project was carried out strategically to ensure that the location of the pumping station was remote from the residential communities eliminating the potential environmental impacts. Furthermore, a rigorous site-wide environmental monitoring programme has been implemented throughout the construction phase to mitigate the potential environmental and social impacts.

2.3 Land Use and Landscape

The following ‘land use and landscape’ measures were implemented by the MPSO project:

- A comprehensive Environmental Impact Assessment (EIA) was carried out.
- 22 design alternatives were assessed for disposing of storm and ground water to ensure the optimal solution was chosen in terms of engineering viability, cost effectiveness, operational efficiency, environmental impact and climate-resilience.
- A 10.2km-long outfall tunnel was constructed 15m below the seabed by Tunnel Boring Machine (TBM) to avoid seabed disturbance of seabed.
- Geotechnical studies have been carried out to assess the potential geotechnical hazards and risks; associated mitigation measures were established and implemented.
- Comprehensive Hazard and Operability Study / Control Hazard Operability Study (HAZOP/HAZOP) were undertaken to assess the severity and the likelihood of flooding hazards and the adverse impacts on the equipment, materials, buildings, and other assets. Associated mitigation measures were established and implemented.
- The pumping station was designed for flood resilience; integrating measures to address potential flooding risks from a 1-in-50-year storm event.

2.4 Historic Environment

The status of the historic environment of the project site was assessed during the Environmental Impact Assessment (EIA) process to determine the presence of any features that are of archaeological, historical and cultural nature and value, which may be adversely affected by the project activities. As an outcome of the rigorous engagement and consultation held with the local authorities, and the baseline studies carried out, the project site was determined to be of no archaeological, cultural, or historical nature and value.

2.5 Ecology and Biodiversity

The following ‘ecology and biodiversity’ measures were implemented by the MPSO project:

- Sensitive receptors around the MPSO project and their proximity to the site location were identified and considered for design options.
- Out of all 22 design options, the project selected an outfall chamber with the least potential to have an impact on the environment and the communities.
- The outfall chamber was extended from 7 km to 10.2 km, to increase the distance from the sensitive receptors.
- Instead of an outfall pipeline with dredged trench on the seabed, the project considered the construction of an outfall chamber below the seabed, to minimize the potential adverse impacts on the marine ecology.
- A detailed Biodiversity and Ecology Management Plan was developed and implemented.
- A comprehensive environmental management and monitoring program (that included air quality, noise, water quality, marine water quality management and monitoring) was implemented for monitoring and management of identified ecological features on and around the project footprint.
- Acacia trees located nearby the site were preserved.
- Birds’ and honeybees’ colony observed on site were protected.

2.6 The Water Environment

The following measures were implemented by the MPSO project for the protection and enhancement of the ‘water environment’:

2.6.1 Storm Water and Ground Water during Operation

As per the design requirements, the MPSO pumping station is equipped with mechanical process equipment such as bar screens, grab rake mechanism, grit collection system & grit classifier, and oil & grease removal system to achieve high level primary treatment to remove debris, grit, oil & grease. This allows the collected storm water runoff to be discharged into the marine environment after going through primary treatment.

2.6.2 Marine Water

During the operation of the MPSO project, the storm and groundwater from Abu Hamour tunnel will be discharged 10.2 km offshore via the outfall chamber. To ensure that the marine environmental conditions are not affected by the discharge of this water, it was key to understand the existing seawater quality baseline data throughout the design & build phase, evaluating the trends and to compare with the operational data. To gather this information, a comprehensive seawater quality program was established. The program included establishing online, oceanographic buoys that

allowed for continual monitoring of seawater quality on an hourly basis, and monthly seawater sampling by a third-party accredited laboratory. The results of the monitoring program have been shared with the respective authorities throughout the project lifecycle.

2.6.3 Water from Tunneling Works

The water generated from the tunnelling works – the TBM water, as well as the dewatering water from the shafts was treated by a water treatment plant (WTP) that was established on site. A specific environmental permit was obtained from the Ministry of Environment and Climate Change (MOECC) for the operation of the WTP. To meet the general and specific conditions set forth within this permit; a comprehensive monitoring program (including daily, weekly, and monthly sampling & analysis) was established to mitigate the potential environmental impacts associated with the tunneling activities.

2.6.4 Dewatering

A specific environmental permit for dewatering was obtained from the Ministry of Environment and Climate Change (MOECC) and Kahramaa, for the dewatering activities carried out around the construction site. To meet the general and specific conditions set forth within this permit; a comprehensive monitoring program (including daily, weekly, and monthly sampling & analysis) was established to mitigate the potential environmental impacts associated with the dewatering activities.

2.7 Physical Resources – Use and Management

2.7.1 Energy

The following ‘energy’ measures were implemented by the MPSO project:

- The outfall tunnel is a gravity-based tunnel with no pumping energy midway.
- The operational power demand is met via the 11kV power connection reducing the need for on-site diesel generators.
- Energy star equipment and energy-efficient light fixtures have been used.
- Using daylight resulted in reduced energy consumption.
- Materials were selected considering the energy conservation measures.
- Variable Frequency Drives (VFDs) were utilized to reduce the energy consumption and line losses.
- The cast in-situ roof was replaced with prefabricated elements reducing the CO₂ emissions and eliminating the need for 190 tons of form work and scaffolding.
- The adopted energy conservation measures helped the project to reduce the overall carbon footprint of the project.

2.7.2 Water

The following ‘water’ measures were implemented by the MPSO project:

- The water fixtures that comply with international codes and standards for efficient plumbing were selected.
- Treated TBM and dewatered water was reused for dust suppression and cleaning activities at the project site.
- Daily, weekly, and monthly monitoring and reporting of accumulative water consumption data was carried out throughout the project lifecycle.

2.7.3 Materials

The project used prefabricated construction elements to deliver substantial savings and efficiencies. The following ‘materials’ measures were implemented by the MPSO project:

- Principles for Design for Manufacture and Assembly (DfMA) were followed.
- Material resource efficiency measures were established and integrated into the design and construction.
- Pre-cast tunnel segments were used for the 10.2 km tunnel.
- Geometrical optimization and enhancement of the shafts resulted in generation of reduced quantity of excavated materials and reduced concrete consumption.
- Use of 4D BIM model eliminated over-procurement and helped reduce waste and rework.
- Concrete & steel with pre- and post-consumer recycled contents were procured.
- Responsibly-sourced wood & timber products with Forest Stewardship Council (FSC) and Program for the Endorsement of Forest Certification (PEFC) certificates were utilized for both temporary & permanent works.
- 49% of total material used was procured from local and regional businesses.
- Low Volatile Organic Compound (VOC)/bio-degradable coatings were used as applicable.

2.7.4 Waste

The following ‘waste’ measures were established by the MPSO project:

- A comprehensive Waste Management Plan (WMP) and associated waste hierarchy procedures were implemented.
- 100% of the excavated materials generated by the tunneling works are reused for a regional coastal reclamation project.
- 100% of the dredged materials generated by the dredging works were reused in the backfilling works.
- A ‘Pledge for a Plastic-free Future’ was established for the project, eliminating the single use plastics (SUPs) at project office and site.
- High recycling rates were achieved for paper, cardboard, steel, wood, and plastics; by establishing well-managed, individual waste segregation, storage, and disposal areas for each waste stream.
- Comprehensive training and awareness sessions were delivered, responsible waste management and resource conservation related project bulletins were prepared and shared with project staff.

2.7.5 Transport

The following ‘transport’ measures were implemented by the MPSO project:

- Proactive logistics and transportation planning was implemented.
- Sustainable transportation awareness programs were delivered, resulting in 30% of staff utilizing carpooling instead of individual vehicles.
- Traffic flow design was followed during all project site works.
- Designated traffic paths and schedules were allocated for construction vehicles.
- Materials delivery measures were established.
- Rigorous monitoring and management of site access road were implemented.

3 Summary of Project Challenges

There were various challenges faced throughout the project lifecycle, which also impacted the smooth delivery of the sustainability strategy of the project.

The site allocated for the MPSO project was very tight, requiring detailed scheduling and organization of construction activities. The lack of storage space within the project site for excavated materials from tunneling works was the key obstacle that the project team had to resolve. Then there were the environmental challenges, specifically the marine environmental impacts associated with the dredging, drilling, and other offshore works.

Another challenge was the construction of the outfall tunnel below the seabed under high water pressure conditions. There was only one access/exit point with potential hazards, requiring continual monitoring and control of every single operation inside the tunnel.

Last but not least, the site activities did not pause or stop during the COVID-19 pandemic. Rigorous measures to meet the Qatar Ministry of Public Health (MoPH) requirements were implemented to mitigate the adverse effects of the pandemic.

4 Summary of Benefits Achieved

Below is a summary of the immediate economic benefits achieved by the project:

- The project is designed to withstand climate change effects up to the year 2060 and to minimize the environmental impact during operation.
- An in-depth assessment of the potential flooding hazards was carried out.
- The final design incorporated measures to address potential flood risks from a one-in-50-years storm event.
- 100% of the excavated materials are fully reused for a regional coastal reclamation project.
- 100% of dredged materials were fully utilized during the backfilling works.
- Pre-cast tunnel segments were used for the 10.2 km tunnel.
- Pre-cast beams and slabs were used for the roof structure saving steel formwork.
- A gravity system with low-maintenance requirements has been utilized for the outfall.
- Environmentally friendly materials were considered and selected for the project.
- A local segment factory was used to supply the tunnel segments.
- Local manpower and local companies were considered and engaged with for various project activities such as marine works, oceanographic buoy supply and maintenance services.

5 Conclusion

Registering the project with globally recognized and third party audited CEEQUAL International enabled the MPSO project to incorporate sustainability considerations into the key project components and milestones. Sustainability, effective resource allocation, a sustainable, innovative and durable design, the use of local goods and service providers and meeting future capacity needs were prioritized for the MPSO project. Despite all the challenges faced throughout the project lifecycle, the project received environmental awards including the Ashghal Green Award in 2020 and the CEEQUAL ‘**Very Good**’ in 2022, the highest rating ever in Qatar. Adopting a sustainability-driven strategy helped the project not only achieve CEEQUAL ‘**Very Good**’ rating (that is higher than the contractually required ‘Good’ level), but also further receive industry excellence awards from ICE Qatar and MEED. The project also yielded value far beyond its immediate benefits contributing

directly to the United Nations (UN) Sustainable Development Goals (SDGs); particularly UN SDG 9, SDG 11, SDG 12, SDG 13, SDG 14, and SDG 17.

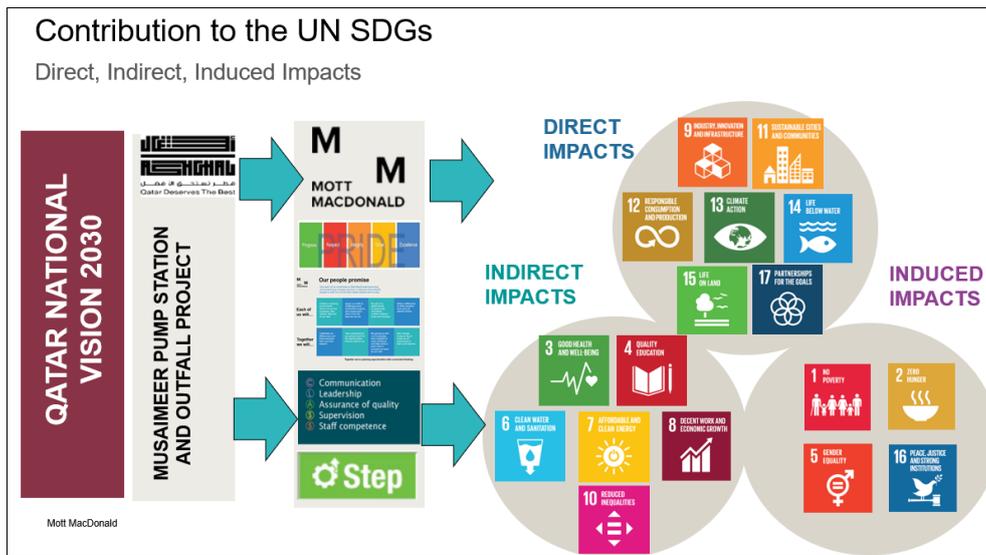


Fig. 1: Alignment of the MPSO project with the UN SDGs

The alignment of the MPSO project with the UN SDGs is shown in Fig. 1 and also summarized below:

- MPSO project contributes directly to the **UN SDG 9** through building a resilient, sustainable infrastructure, focusing on efficient resource consumption and adopting innovative technologies, minimizing the potential adverse environmental impacts.
- The main objective of the MPSO project is to increase the drainage capacity within Doha to accommodate storm-water runoff, and to minimize the potential adverse impacts of flooding to the residents and communities of Doha, as well as minimizing the negative impacts on the environment, and particularly the marine ecosystems, contributing directly to the **UN SDG 11**.
- The innovative and sustainable practices adopted for the project, local supply of materials and selection of local/regional companies have resulted in achieving economic benefits, directly contributing to the **UN SDG 12**, and leading to positive outcomes for the national economy as well.
- Utilization of advanced Building Information Modeling (BIM) for the design of prefabricated roof slabs has also enabled the MPSO project contribute directly to the **UN SDG 12**.
- MPSO project contributes directly to the **UN SDG 13** by implementing mitigation measures to minimize the CO₂ emissions as much as possible. Selected examples include considering more sustainable solutions during design; use of new, innovative technologies with reduced emissions during construction; and enhanced office settings to reduce the project overall carbon footprint.
- To ensure that the marine and coastal ecosystems are protected during the construction of the 10.2 km outfall chamber below the seabed, and the potential significant adverse impacts are avoided, a comprehensive seawater quality monitoring is undertaken for the project, contributing directly to the **UN SDG 14**.
- MPSO project contributes directly to the **UN SDG 15** by protecting the natural habitats, preventing the loss of biodiversity, and protecting the threatened species.

- MPSO project promoted collaboration and partnerships to create opportunities for delivering a sustainable, socially inclusive asset for the country, while raising awareness on sustainability, and capacity building for future generations, contributing to the **UN SDG 17**.

References

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