



DHI CASE STORY

RECLAIMING THE LAND, PROTECTING THE ENVIRONMENT

Using EMMP to protect Singapore's natural heritage

Shell needed more land for the Bukom Refinery – their largest one in Singapore. To do this, they asked JTC Corporation (JTC) to reclaim the land by connecting three islands off the country's southwest coast. To ensure that the land reclamation would not harm the environment, JTC asked us to execute an Environmental Monitoring and Management Plan (EMMP). The EMMP enabled JTC to detect unexpected effects on the environment at a very early stage. As such, JTC could take the necessary actions to address the impact of the reclamation work. The result: minimal long-term impacts of land reclamation activities on the surrounding marine environment.

PROTECTING A DIVERSE ECOSYSTEM

Located off Singapore's southwest mainland is Shell's largest refinery: the Bukom Refinery. In 2005, Shell required more land to expand their petrochemical plant in order to develop a new world class ethylene cracker. To create this additional space, Shell decided to reclaim additional land by connecting three islands: Pulau Busing, Pulau Ular and Pulau Bukom Kechil. For this, Shell worked closely with

SUMMARY

CLIENT

- JTC Corporation

CHALLENGE

- Difficulty predicting the effects of land reclamation work on the environment
- Loss of biodiversity in the surrounding area during land reclamation activities
- Possibility of negative impacts on or destruction of marine habitats

SOLUTION

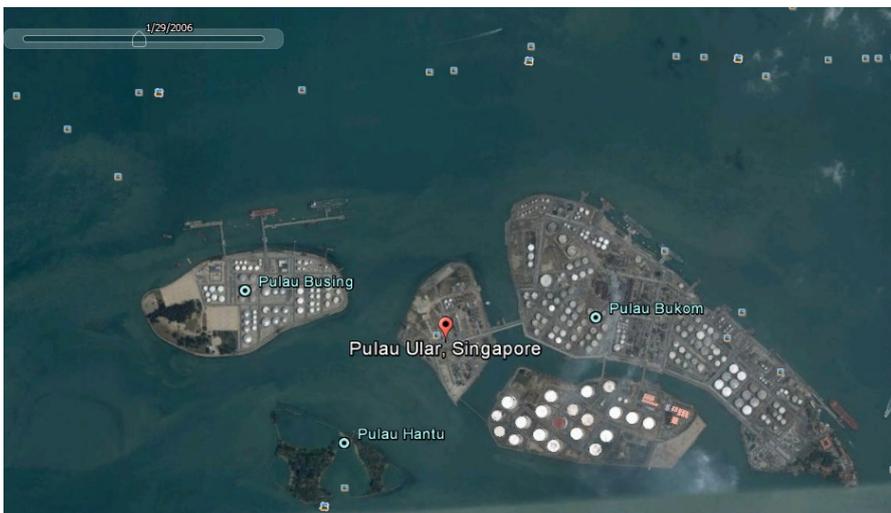
Environmental Monitoring and Management Plan (EMMP) to analyse the impact of land reclamation on the environment

VALUE

- Enabling early detection of unexpected impacts on the environment
- Ability to take steps to mitigate the possible negative effects of the reclamation project on marine habitats

LOCATION / COUNTRY

Singapore



Land layout prior to the reclamation works in 2006.

Singapore's national developer of industrial infrastructure – JTC Corporation (JTC) – to plan and carry out the Pulau Ular reclamation work.

The three islands contained a diverse ecosystem with a variety of terrestrial and marine plant and animal species. In addition, the reclamation works took place across from the island of Pulau Hantu. High in biodiversity, this island is one of the few recreational diving locations open to the public in Singapore. To ensure the works had minimal potential environmental impact on the surrounding area, JTC asked DHI Singapore to execute an Environmental Monitoring and Management Plan (EMMP).

The EMMP investigated the impact of the reclamation work on the surrounding islands. It also established the requisite Environmental Quality Objectives (EQOs). Based on recommendations from the Environmental Impact Assessment (EIA), the EQOs indicated the maximum level of impact allowed on each relevant marine habitat around the reclamation works. Our EMMP ensured that throughout its duration, the works met the EQOs for the relevant marine habitats (corals, seagrass and mangroves) and other environmental receptors – including recreational beaches, industrial water intakes and aquaculture facilities.

HELPING TO MITIGATE THE EFFECTS OF THE RECLAMATION WORK

Our EMMP included:

- establishment of an environmental baseline
- sediment plume forecast modelling
- sediment spill monitoring
- control monitoring of environmental indicators
- spill hindcast modelling
- habitat monitoring
- information management systems
- real-time data collection
- daily compliance reporting (seven days a week)

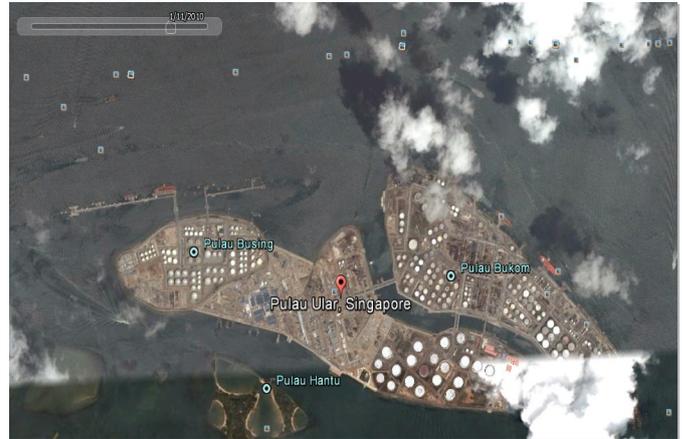
It was setup to be highly responsive and reported the effects of the reclamation activities within 42 hours of reclamation trips, seven days a week. This allowed JTC to take the necessary actions to mitigate any unexpected impact of the reclamation work on the environment before it became a serious threat.

The sequence of the reclamation activities varied from what was predicted during the EIA. This required the EMMP to be very flexible in terms of:

- daily assessment of potential impacts
- environmental monitoring
- managing the client's and stakeholder's expectations

We applied international best practices for feedback monitoring systems. This ensured a reliable response system in compliance with the project's environmental objectives on a

daily basis. In addition, the EMMP's sediment spill modelling allowed JTC to separate the project's impact from any other potential impact caused by third parties. Extensive documentation throughout the project ensured that developers



Land layout after completion of the reclamation works in 2010.

and contractors were not exposed to unwarranted claims from external parties of harming the environment.

SUPPORTING CORAL RELOCATION

The Terumbu Bayan reef is an undisturbed coral reef with high coral cover and rich biodiversity. Located close to Pulau Ular, just off the fairway between Pulau Ular and Pulau Hantu, the reclamation work's footprint covered most of this reef.

To preserve this coral biodiversity, JTC undertook a coral relocation project prior to the start of the reclamation works. More than 3,500 coral colonies – 35% of the live hard coral cover of the Terumbu Bayan reef – were moved from Terumbu Bayan to other designated receptor sites in Singapore. The coral relocation ensured the preservation of Singapore's marine biodiversity, while our EMMP helped safeguard the overall marine habitats around the project site.

The reclamation works commenced after the coral relocation took place. Throughout the project, our EMMP ensured that the reclamation works did not negatively impact:

- the sensitive coral, seagrass and mangrove habitats of the surrounding areas – including Pulau Hantu, Pulau Busing and Pulau Bukom Kechil
- Shell's nearby cooling water intakes

JTC completed the reclamation works in February 2007. Thanks to the success of the EMMP, JTC was able to facilitate the large scale reclamation of three islands with minimal impact to the local environment and without harming Singapore's natural heritage.

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