



Photo 6.26 Entrance gate of Istana Maziah.



Photo 6.27 Masjid Abidin Kuala Terengganu.



# 6.4.5.3 Cultural Tourism

Cultural tourism is the subset of tourism concerned with a country or region's culture, specifically the lifestyle of the people in those geographical areas, the history of those people, their art, architecture, religion, and other elements that helped shape their way of life. Cultural heritage is discussed in Section 6.4.6. Cultural tourism includes tourism in urban areas, particularly historic or large cities and their cultural facilities such as museums and theatres. It can also include tourism in rural areas showcasing the traditions of indigenous cultural communities, and their values and lifestyle such as the *Ulek Mayang* traditional dance.

The cultural tourism sites located within the study area are the Terengganu State Museum, Masjid Kristal, Taman Tamadun Islam, China Town Kuala Terengganu (Photo 6.28), Bazar Warisan, and Pasar Payang (Photo 6.29) with their locations shown in Figure 6.58. Most of the cultural tourism attractions in the study area are related to religion and race. Other sites of more local interest also exist around Pantai Teluk Ketapang; these are described further in Section 6.4.6.



Photo 6.28 Gateway of China Town Kuala Terengganu.





Photo 6.29 Entrance to Pasar Payang.





Figure 6.58 Locations of cultural tourism sites with 5 km of the Project area.



#### 6.4.5.4 Food Tourism

Food tourism simply means the act of people visiting a particular place for the purpose of partaking in food festivals or trying out of different food and restaurants in that particular country. Terengganu is rich with local specialities such as Keropok Lekor, Losong, Nasi Dagang, Otak- Otak, Sata, Lok Ching, Udang and Sotong Celup Tepung and these provide an added attraction for visitors (Figure 6.59). People can get frozen, boiled and fried Losong easily from Kampung Losong (south of Sg. Terengganu, west of Sultan Mahmud Bridge) with many of the shops providing tables for customers to dine in.

People also can easily get the previously mentioned and other traditional food at Pantai Teluk Ketapang, Pantai Tok Jembal and Pantai Batu Burok as food hawkers usually do their business along the coastal areas with Pantai Teluk Ketapang being the popular tourism site as discussed in Section 6.4.5.1.





Losong

Sotong Celup Tepung



Lok Ching

Figure 6.59 Variety of food attraction in Terengganu.

#### 6.4.5.5 Coastal Attraction – Scenic Drive

Terengganu is known as the coastal state (Negeri Pesisir Pantai). People, especially tourists, can drive along coastal road, such as Jalan Pantai Teluk Ketapang and Jalan Pantai Tok Jembal to enjoy the scenic view of both beaches. Photo 6.30 to Photo 6.31 and Photo 6.32 show the landscape surrounding Jalan Pantai Teluk Ketapang and Jalan Pantai Tok Jembal respectively. Both roads not only have their own scenic drive, but also have their own beautiful landscape, and are flanked by rhu trees (Casuarina equisetifolia) that make both roads shady, and comfortable to walk through and for recreation.





Photo 6.30 Hawker stalls along Jalan Pantai Teluk Ketapang surrounded by rhu trees.



Photo 6.31 Jalan Pantai Teluk Ketapang along 1 km northern stretch flanked by rhu trees.





Photo 6.32 Jalan Pantai Tok Jembal surrounded by coconut and rhu trees. The Tok Jembal breakwater can be seen in the background.

# 6.4.6 Cultural Heritage / Archaeology

In general, Terengganu has a distinct cultural personality and wealth of traditional arts, culture and rich Malay heritage. The state is known for having many of Malaysia's leading craftsmen and artisans in songket, batik, brass, wood carving, boat building, and traditional carpentry. In essence, Terengganu has contributed and shaped many elements of Malay culture. Terengganu's boat building skills, crafted by hand, is one of the many impressive accomplishments of Terengganu craftsmen. Using no blue prints and no nails, the boat makers of Pulau Duyong are world famous for crafting boats by hand /77/.

The most well-known traditional dance of Terengganu is the *Tarian Ulek Mayang*, the dance is usually performed by the seaside at the Pesta Puje Pata (Sea Worshipping Festival) at the end of the year and is meant to heal sickness. Such dances today are simply considered cultural performances rather than religious. Pantai Teluk Ketapang is not known specifically as a festival site. Other popular traditional cultures in Terengganu are *wayang kulit* and *silat*.

Kuala Terengganu has an Islamic heritage centre and it also has one of the liveliest Chinatowns, known as the Kampung Cina as mentioned under the section on tourism. The indigenous batik painting and handicrafts cottage industry here is well known across the world. There are also beautiful mosques such as Tengku Tengah Zaharah Mosque on the waterfront, which is also known as the floating mosque /78/.

In addition to these, several historical and cultural sites exist between the airport and Kuala Terengganu breakwaters as shown in Figure 6.60. Telaga Batin is said to be where Batin, the captain of Wan Abdul Rahman's (a Johor warrior) boat, died. Telaga Daing is said to be one of the earliest *Bugis* settlements in Terengganu with the two wells (both indicated as "Telaga Daing" in Figure 6.60) being what is left of the settlements. Makam (tomb) Tok Panjang is located behind the Seberang Takir Post Office and has been gazetted as Heritage Site (P.U. (A) 232) in August 1980.

During the rule of Sultan Zainal Abidin, Seberang Takir was only known as Seberang. The place became later known as Seberang Takir as it was the site where anyone



caught stealing had their hand or foot cut off (*takir* meaning to cut). Jeti Bot Penambang was the main transportation across Sg. Terengganu from Seberang Takir to Bandar Kuala Terengganu before the construction of the Sultan Mahmud Bridge.

The tomb of Dato Paduka Raja (Wan Abdul Rahman) whom was murdered in the Seberang Takir area was lost due to coastal erosion.





Figure 6.60 Locations of the historical and cultural heritage sites provided by the Terengganu Museum (March 2018).



# 6.4.7 Marine Traffic

# 6.4.7.1 Port Limit and Anchorage Area

The Project is partially located within the Kuala Terengganu Port Limit, with a chartered anchorage area located and partially overlapping the southern part of the Project site (Figure 6.61). This anchorage area was designated for the use of cruise ships to transport passengers to and from Kuala Terengganu. Although this is the case, it is rarely utilized due to adverse weather conditions outside of the breakwaters.



Figure 6.61 Port limit and anchorage area around the Project area.

# 6.4.7.2 Traffic Profile

Types of Vessels

Five categories of vessels ply the Project area, namely:



- Ferries to Pulau Redang
- Fishing boats (see also Section 6.4.4 on Fisheries)
  - Inboard engine fishing boats: 30 outbounds and inbounds per day
  - Outboard engine fishing boats: 98 inbounds and outbounds per day
- Offshore supply vessels (OSV)
  - A daily transit of six inbound and six outbound OSVs travelling to offshore platforms (i.e. Malong and Dulang Oilfields), which are located northeast of Kuala Terengganu
- Patrol and marine boats
  - Malaysian Maritime Enforcement Agency (MMEA), Marine Department patrol boats and Marine Police patrol boats pass close to the Project area while patrolling
- Research vessels and leisure yachts
  - Universiti Malaysia Terengganu (UMT) research vessel and leisure yachts with no specific schedule



Photo 6.33 Fishing trawlers berthed inside the northern breakwater at the Kuala Terengganu Port.

# **Traffic Routes**

# Ferry Route

The ferry route between Shahbandar Jetty at Kuala Terengganu and Pulau Redang is approximately 4.3 km away from the Project site (Figure 6.62).





Figure 6.62 Ferry route (Kuala Terengganu to Pulau Redang).

# Commercial Traffic

The nearest established commercial traffic route is approximately 1.44 km away from the Project site as shown in Figure 6.63.





Figure 6.63 Established commercial shipping routes from Kuala Terengganu.

# 6.5 Environmentally Sensitive Areas (ESA)

# 6.5.1 Definition and Concept

The EIA Order 2015 defines an Environmentally Sensitive Area (ESA) as "(a) any area specified as such in the development plan or national physical plan under the Town and Country Planning Act 1976, or (b) any area specified as environmental protection area or environmental conservation area under any Enactment in the State of Sabah or any Ordinance in the State of Sarawak." This means that an ESA is an area gazetted or earmarked in either:

- the National Physical Plan 3 (NPP3); or
- the National Physical Plan for Coastal Zone (NPP-CZ); or
- the State Structure Plan; or
- the Local Plan.



Furthering this, according to the Planning Guidelines for Conservation and Development in Environmentally Sensitive Areas (*Garispanduan Perancangan Pemuliharaan dan Pembangunan Kawasan Sensitif Alam Sekitar*, GPPPP) by PLANMalaysia /79/, an ESA is "a special area that is highly sensitive to any form of change to its ecosystem due to natural processes or activities in or around it, either directly or indirectly, where its sensitivity level is determined based on the integration of characterization of disaster risk function elements, as well as the value of the area's heritage and heritage."

This definition is also in line with the National Physical Plan 3 (NPP3), which states that ESAs refer to "areas that are of critical importance in terms of the goods, services and life-support systems they provide such as water purification, pest control and erosion regulation. In addition, they also refer to areas that harbour the wealth of the nation's biodiversity."

# 6.5.2 ESA Categories within Study Area

According to the GPPPP /79/, ESA is a physical area which can be identified by the following criteria:

- Special areas sensitive to developments or special activities
- Preservation area
- Special heritage value
- Special living support value
- Disaster risk

In accordance with the ESA categorization by NPP3, an ESA can be categorised into three types, namely ESA Rank 1, ESA Rank 2 and ESA Rank 3 as summarised in Table 6.25 and Figure 6.64, which also details the ESA categorization for the Project area and the study area (i.e. 5 km radius from the Project). Where applicable, the management criteria outlined in NPP3 is also summarised.

Table 6.25ESA categorisation within Project area as per NPP3.

| Туре                                    | Project Area and Zone of<br>Impact   | Management Criteria |
|---|--|---------------------|
| ESA Rank 1                              |  |                     |
| Existing and proposed<br>protected area | Based on the Terengganu State<br>Structure Plan 2006 – 2020, the<br>State of Terengganu has gazetted<br>four marine parks within its<br>waters, namely Pulau Kapas,<br>Pulau Bidong, Pulau Redang and<br>Pulau Perhentian Besar.<br>The Project is located more than<br>10 km from these marine parks,<br>as follows:<br>• Pulau Kapas – 17 km | Not applicable.     |
|   | <ul> <li>Pulau Bidong – 23 km</li> <li>Pulau Redang – 40 km</li> </ul>   |                     |



| Туре   | Project Area and Zone of Impact  | Management Criteria   |
|--|--|---|
|  | <ul> <li>Pulau Perhentian Besar – 68<br/>km</li> </ul>   |   |
| Threatened habitat<br>outside of protected<br>area: turtle landing<br>area, seagrass bed,<br>coral reef area,<br>limestone outcrop,<br>quartz ridge and bird<br>migratory area | No threatened habitat is present<br>within 5 km radius from the<br>Project area.   | Not applicable.   |
| Existing and proposed dam catchment area   | Not applicable as the Project is located along the shoreline.  | Not applicable.   |
| Areas of more than<br>1,000 m contour  | <ul> <li>Not applicable as the Project is located:</li> <li>in Terengganu, outside of the areas mentioned, and</li> <li>along the shoreline.</li> </ul>  | Not applicable.   |
| ESA Rank 2   |  |   |
| All forest and<br>wetlands outside of<br>protected area  | <ul> <li>The Project does not encroach on any mangrove area:</li> <li>The nearest mangrove ecosystem is located 1 km from the southern inland boundary of the Project, which is along a tributary of Sg. Terengganu. As detailed in Section 6.3.7, the mangroves along this tributary cover an area of approximately 15.7 ha.</li> <li>Mangroves are also present farther upstream in Sg. Terengganu, where patches of mangroves comprising mainly nipah trees are scattered along the shorelines of Kuala Terengganu, Pulau Wan Man, Pulau Duyong and Pulau Sekati</li> </ul> | <ul> <li>Development and<br/>agriculture are not<br/>allowed. Sustainable<br/>logging and low impact<br/>ecotourism are permitted<br/>but subjected to local<br/>constraints; and</li> <li>Sustainable logging<br/>activities should be<br/>emphasised in monitoring<br/>and enforcement<br/>activities.</li> </ul> |
| Peat swamp area,<br>quicksand, sink hole<br>and former<br>underground tunnel   | No peat swamp area, quicksand,<br>sink hole and former underground<br>tunnel can be located within 5 km<br>radius of the Project.  | Not applicable.   |
| 500 m buffer zone<br>from ESA Level 1  | Not applicable.  | Not applicable.   |
| Contour area between<br>300 m – 1,000 m  | Not applicable. The Project is not<br>located on or near an area with<br>contours between 300 m and<br>1,000 m as it is along a shoreline.   | Not applicable.   |
| ESA Rank 3   |  |   |



| Туре   | Project Area and Zone of Impact  | Management Criteria  |  |
|--|--|--|--|
| 500 m buffer zone<br>from ESA Level 2                                    | Not applicable – the Project is 1<br>km from ESA Level 2 (mangrove<br>area).   | Not applicable.  |  |
| Catchment for water<br>intake point and<br>ground water<br>recharge zone | Not applicable.  | Not applicable.  |  |
| Contour area between<br>150 m – 300 m                                    | Not applicable. The Project is not<br>located on or near an area with<br>contours between 150 m and 300<br>m as it is along a shoreline.   | Not applicable.  |  |
| Islands and marine<br>parks  | <ul> <li>Based on the Terengganu State<br/>Structure Plan 2006 – 2020, the<br/>State of Terengganu has gazetted<br/>four marine parks within its<br/>waters, namely Pulau Kapas,<br/>Pulau Bidong, Pulau Redang and<br/>Pulau Perhentian Besar. Although<br/>this is the case, the Project is<br/>located more than 10 km from<br/>these marine parks, as follows:</li> <li>Pulau Kapas – 17 km</li> <li>Pulau Bidong – 23 km</li> <li>Pulau Redang – 40 km</li> <li>Pulau Perhentian Besar – 68<br/>km</li> </ul> | Not applicable.  |  |
| Coastal area   | The Project is located along a shoreline already categorised as ESA Rank 3 by the NPP-CZ.  | All development along<br>coastal areas must<br>comprehensively adhere to<br>the requirements of the NPP-<br>CZ. State ISMP, and existing<br>and future guidelines. |  |





Figure 6.64 ESAs within study area (see Drawings for A3 figure).

# 7 Evaluation of Impacts

Potential environmental impacts are identified, assessed and discussed in this section. Section 7.1 describes the methodological framework used for the evaluation of impact significance, and presents a summary of the findings in the assessment matrix, while Section 7.2 provides the full details of the impact prediction and evaluation. Based on the findings of the individual components, Section 7.3 provides an overall Project evaluation indicating the environmental tradeoffs anticipated from the Project.

The impact assessment scope and methods for this EIA were documented and endorsed in the TOR approved by DOE. It is worth reiterating that as per the TOR, this EIA focuses solely on the assessment of the reclamation and horizontal development, whereas the operational activities associated with the proposed mixed development comprising the hotels, commercial and recreational areas, ferry terminal among others are not considered in this EIA.

The EIA scope was carefully determined through in-depth consideration of the environmental characteristics of the Project area, the Project and its activities and the spatial extent of any likely impacts. These impacts are identified for the two main stages in the Project implementation, namely:

- Construction stage
- Post-construction stage.

It is noted that permanent impacts resulting from the Project footprint (for example loss of benthic habitat in the reclamation area or impacts to adjacent shorelines), are considered under the post-construction stage, although the impact may occur or be initiated during the construction stage.

In broad terms, the agreed focus issues for the Project are:

- Coastal hydrodynamic and morphological impacts of the Project footprint;
- Water quality, particularly suspended sediment plume impacts during reclamation and capital dredging;
- Socioeconomic impacts due to the change in landscape and fisheries; and
- Impacts on marine ecology, principally the loss of marine habitat, due to the Project footprint.

Equally important to the types of impact to be assessed is the spatial scope for the analysis. Consistent with the DOE general guidelines for Second Schedule EIA projects, the primary spatial scale of analysis was set in the TOR to be within 5 km of the Project area for the marine environment, land-based and socioeconomic components. Nevertheless, for all analyses, appropriate scales were considered based on the type of impact to ensure that the assessment encompasses all areas where it was predicted or anticipated that the impacts might be realised. For example, model boundaries were determined to ensure sufficient coverage of potential impact areas, and this was different for example for the effects of changes to wave regimes by the reclamation compared to the dispersion of suspended solids from dredging.

By evaluating the interaction of Project activities (as described in Section 5) with specific components from the existing environment (as described in Section 6) the probable impacts for each of these stages can be predicted and evaluated according to the structured framework outlined in the following subsection. Impacts are also considered in terms of the extent they can be mitigated through proactive management processes (Section 8) and the residual risks of impact.

Table 7.1 lists the environmental components or issues addressed in this section, covering both construction and post-construction.

| Section | Type of Environmental Impact      |
|---------|-----------------------------------|
| 7.2.1   | Water Quality                     |
| 7.2.2   | Coastal Morphology                |
| 7.2.3   | Hydrology and Drainage            |
| 7.2.4   | Air Quality                       |
| 7.2.5   | Ambient Noise                     |
| 7.2.6   | Primary Producer Benthic Habitats |
| 7.2.7   | Macrobenthos                      |
| 7.2.8   | Plankton                          |
| 7.2.9   | Fish Fauna                        |
| 7.2.10  | Marine Megafauna                  |
| 7.2.11  | Mangrove                          |
| 7.2.12  | Terrestrial Ecology               |
| 7.2.13  | Socioeconomics                    |
| 7.2.14  | Fisheries                         |
| 7.2.15  | Tourism and Recreation            |
| 7.2.16  | Cultural Heritage / Archaeology   |
| 7.2.17  | Land Use                          |
| 7.2.18  | Marine Traffic                    |

 Table 7.1
 Environmental impacts evaluated and chapter outline.

# 7.1 Identification and Prediction of Impacts

# 7.1.1 Impact Assessment Framework

To quantify the impact significance, an environmental assessment matrix was developed to determine the associations between the Project activities and the environmental parameters. This is based on the predicted changes to the existing environmental conditions resulting from various activities during the construction and post-construction stages of the Project. For each possible combination of activity and environmental parameter, an assessment was made of likely changes from the Project activity on the baseline condition for a specific set of environmental parameters.

For each potential impact, the impact severity is evaluated based on the spatial importance, magnitude of impact, its permanence, its reversibility and whether the impact is cumulative. These considerations are addressed in a structured manner through the Rapid Impact Assessment Matrix (RIAM) /80/ as outlined below:

# 7.1.1.1 Rapid Impact Assessment Matrix (RIAM)

# **Evaluation Criteria**

The RIAM framework structures the assessment on five criteria that are grouped into two categories - the Group A Criteria and the Group B Criteria:

### Group A Criteria

There are two criteria within Group A:

- A1: **Importance** of the condition, which is assessed against the spatial extent of zone of impacts, (Table 7.2); and
- A2: **Magnitude**, which is defined as a measure of the scale or severity of benefits/disbenefit of an impact (Table 7.3).

| Table 7.2 | Importance of the | ne condition - | <ul> <li>scoring and</li> </ul> | Project-specifi | c definitions. |
|-----------|-------------------|----------------|---------------------------------|-----------------|----------------|
|-----------|-------------------|----------------|---------------------------------|-----------------|----------------|

| Score | Project-specific Description  |
|-------|---|
| 4     | Malaysia /Terengganu  |
| 3     | Kuala Terengganu/ Kuala Nerus area (more than 5 km from Project area) |
| 2     | Areas within 5 km from Project area                                   |
| 1     | Project area and within 1 km of the Project area                      |
| 0     | No importance/ not relevant   |

Table 7.3 Magnitude of the impact.

| Score | Definition                                 |
|-------|--|
| +3    | Major positive benefit                     |
| +2    | Significant improvement in status quo      |
| +1    | Improvement in status quo                  |
| 0     | No change/status quo                       |
| -1    | Negative change to status quo              |
| -2    | Significant negative dis-benefit or change |
| -3    | Major dis-benefit or change                |

# Rating of Magnitude

The general rating of the impact magnitude for environmental components as shown in Table 7.4.

| Table 7.4 | Rating of magnitude. |
|-----------|----------------------|
|           |                      |

| Category    | Rating of magnitude                       |  |
|-------------|---|--|
| Major       | Impact with major changes to receptors.   |  |
| Significant | Impact with moderate changes to receptors |  |
| Negative    | Impacts with minor changes to receptors   |  |
| Beneficial  | Improvement                               |  |

### Group B Criteria

Group B criteria are:

- **Permanence (B1):** This defines whether a condition is temporary or permanent and should be seen only as a measure of the temporal status of the condition.
- **Reversibility (B2):** This defines whether the condition can be changed and is a measure of the control over the effect of the condition. It should not be confused or equated with permanence.
- **Cumulative (B3):** This is a measure of whether the effect will have a single direct impact or whether there will be a cumulative effect over time, or a synergistic effect with other conditions.

The scale of each Group B criterion is shown in Table 7.5.

| Score | Permanence (B1)          | Reversibility (B2) | Cumulative (B3)        |
|-------|--------------------------|--------------------|------------------------|
| 1     | No change/Not applicable |                    |                        |
| 2     | Temporary                | Reversible         | Non-cumulative/Single  |
| 3     | Permanent                | Irreversible       | Cumulative/Synergistic |

Table 7.5Scale for Group B criteria.

### Score and Range System

For each potential impact / issue, an environmental score (ES) is calculated based on the following formula:

#### ES = A1\*A2\*(B1+B2+B3)

The ES scores are then banded together into ranges as detailed in Table 7.6. The range values span from major positive impact +E to major negative impacts -E.

| RIAM Environmental Score<br>(ES) | Range Value<br>(RV) | Description of RV           |
|----------------------------------|---------------------|-----------------------------|
| 72 to 108                        | E                   | Major positive impact       |
| 36 to 71                         | D                   | Significant positive impact |
| 19 to 35                         | С                   | Moderate positive impact    |
| 10 to 18                         | В                   | Minor positive impact       |
| 1 to 9                           | А                   | Slight positive impact      |

Table 7.6 Range bands used for RIAM.

| RIAM Environmental Score<br>(ES) | Range Value<br>(RV) | Description of RV                      |
|----------------------------------|---------------------|--|
| 0                                | Ν                   | No change/Status quo/Not<br>applicable |
| -1 to -9                         | -A                  | Slight negative impact                 |
| -10 to -18                       | -В                  | Minor negative impact                  |
| -19 to -35                       | -C                  | Moderate negative impact               |
| -36 to -71                       | -D                  | Significant negative impact            |
| -72 to -108                      | -E                  | Major negative impact                  |

# 7.1.2 Assessment Matrix

All the environmental components considered under the construction and postconstruction phases are summarised in Table 7.7 and Table 7.8 respectively.

Table 7.7Summary of construction phase impacts (Note: 'I' – Importance, 'M' – Magnitude, 'P' –<br/>Permanence, 'R' – Reversibility, 'C' – Cumulative and 'ES' – Environmental Score).

| Environmental<br>Component           | Potential Impact                 | I | м  | Р | R | С | ES  | Impact<br>Significance |
|--------------------------------------|----------------------------------|---|----|---|---|---|-----|------------------------|
| Water Quality                        | Suspended sediment               | 2 | -1 | 2 | 2 | 2 | -12 | Minor<br>negative      |
| Coastal Morphology                   | Sedimentation                    | 3 | -1 | 2 | 2 | 2 | -18 | Minor<br>negative      |
| Hydrology and<br>Drainage            | Airport drainage outlet blockage | 2 | -1 | 2 | 2 | 2 | -12 | Minor<br>negative      |
| Air Quality                          | Airborne dust                    | 2 | -1 | 2 | 2 | 2 | -12 | Minor<br>negative      |
| Ambient Noise                        | Increased noise exposure         | 2 | -1 | 2 | 2 | 2 | -12 | Minor<br>negative      |
| Primary Producer<br>Benthic Habitats | Suspended sediment               | 2 | -1 | 2 | 2 | 2 | -12 | Minor<br>negative      |
|                                      | Sedimentation                    | 2 | -1 | 2 | 2 | 2 | -12 | Minor<br>negative      |
|                                      | Risk of damage to FADs           | 1 | -1 | 3 | 3 | 2 | -8  | Slight<br>negative     |
| Macrobenthos                         | Suspended sediment               | 2 | -1 | 2 | 2 | 2 | -12 | Minor<br>negative      |
|                                      | Sedimentation                    | 1 | -1 | 2 | 2 | 3 | -7  | Slight<br>negative     |
|                                      | Loss of habitat                  | 1 | -1 | 2 | 2 | 2 | -6  | Slight<br>negative     |
| Plankton                             | Changes in water quality         | 2 | -1 | 2 | 2 | 2 | -12 | Minor<br>negative      |

| Environmental<br>Component         | Potential Impact  | I | м  | Р | R | С | ES  | Impact<br>Significance |
|------------------------------------|---|---|----|---|---|---|-----|------------------------|
|                                    | Ship ballast water  | 3 | -1 | 2 | 2 | 3 | -21 | Moderate<br>negative   |
|                                    | Sediment plume  | 1 | -1 | 2 | 2 | 2 | -6  | Slight<br>negative     |
| Fish Fauna                         | Suspended sediment and sedimentation                      | 2 | -1 | 2 | 2 | 2 | -12 | Minor<br>negative      |
| Marine Megafauna                   | Boat strike   | 3 | -1 | 2 | 2 | 2 | -18 | Minor<br>negative      |
| Mangrove                           | Sedimentation   | 1 | 0  | 1 | 1 | 1 | 0   | No change              |
| Terrestrial Ecology                | Not applicable  | - | -  | - | - | - | -   | -                      |
| Socioeconomics                     | Health and social wellbeing                               | 2 | -1 | 2 | 2 | 2 | -12 | Minor<br>negative      |
|                                    | Aesthetic value   | 1 | -2 | 2 | 2 | 2 | -12 | Minor<br>negative      |
|                                    | Public safety   | 1 | -1 | 2 | 2 | 2 | -6  | Slight<br>negative     |
|                                    | In-migration  | 2 | -2 | 2 | 2 | 2 | -24 | Moderate<br>negative   |
|                                    | Job opportunities   | 1 | +1 | 2 | 2 | 2 | +6  | Slight positive        |
|                                    | Economic activity   | 1 | -1 | 2 | 2 | 2 | -6  | Slight<br>negative     |
| Fisheries                          | Decrease in fish catch                                    | 2 | -1 | 2 | 2 | 2 | -12 | Minor<br>negative      |
|                                    | Increase navigation risk<br>and loss of access to sea     | 2 | -2 | 2 | 2 | 2 | -24 | Moderate<br>negative   |
| Tourism and<br>Recreation          | Loss of recreational areas                                | 1 | -2 | 3 | 3 | 2 | -16 | Minor<br>negative      |
| Cultural Heritage /<br>Archaeology | Impacts to cultural<br>heritage facilities or<br>function | 1 | 0  | 2 | 2 | 2 | 0   | No change              |
| Marine Traffic                     | Risk of collision   | 3 | -1 | 2 | 2 | 2 | -18 | Minor<br>negative      |

Table 7.8 Summary of impact assessment during post-construction (Note: 'l' – Importance, 'M' – Magnitude, 'P' – Permanence, 'R' – Reversibility, 'C' – Cumulative and 'ES' – Environmental Score).

| Environmental<br>Component           | Potential Impact                              | I | М  | Р | R | С | ES      | Impact<br>Significance  |
|--------------------------------------|---|---|----|---|---|---|---------|-------------------------|
| Water Quality                        | Flushing capacity                             | 1 | -2 | 3 | 3 | 2 | -16     | Minor<br>negative       |
| Coastal Morphology                   | Changes to coastal morphology                 | 1 | -1 | 3 | 3 | 1 | -7      | Slight<br>negative      |
| Hydrology and<br>Drainage            | Airport drainage outlet<br>blockage           | 1 | -1 | 3 | 3 | 2 | -8      | Slight<br>negative      |
|                                      | Flooding risk                                 | 1 | 0  | 3 | 1 | 1 | 0       | No change               |
| Air Quality                          | Not applicable                                | - | -  | - | - | - | -       | -                       |
| Ambient Noise                        | Not applicable                                | - | -  | - | - | - | -       | -                       |
| Primary Producer<br>Benthic Habitats | Eutrophication,<br>Sedimentation and Erosion  | 1 | 0  | 3 | 3 | 2 | 0       | No change               |
| Macrobenthos                         | Loss of habitat                               | 1 | -2 | 3 | 3 | 2 | -16     | Minor<br>negative       |
| Plankton                             | Eutrophication                                | 1 | -1 | 2 | 2 | 2 | -6      | Slight<br>negative      |
| Fish Fauna                           | Loss of habitat                               | 1 | -2 | 3 | 3 | 2 | -16     | Minor<br>negative       |
| Marine Megafauna                     | Not applicable                                | - | -  | - | - | - | -       | -                       |
| Mangrove                             | Flushing                                      | 1 | 0  | 1 | 1 | 1 | 0       | No change               |
| Terrestrial Ecology                  | Loss of habitat                               | 1 | -1 | 3 | 3 | 2 | -8      | Slight<br>negative      |
| Socioeconomics                       | Aesthetic value                               | 1 | -3 | 3 | 3 | 2 | -24     | Moderate<br>negative    |
|                                      | Property value                                | 2 | -2 | 2 | 2 | 3 | -28     | Moderate<br>negative    |
|                                      | Socio-cultural differences and social network | 2 | -2 | 2 | 2 | 2 | -24     | Moderate<br>negative    |
|                                      | Job opportunities                             | 3 | +2 | 3 | 2 | 2 | +4<br>2 | Significant<br>positive |
|                                      | Economic activities                           | 3 | +3 | 3 | 2 | 3 | +7<br>2 | Major positive          |
|                                      | Transportation and rural accessibility        | 2 | +2 | 3 | 3 | 3 | +3<br>6 | Significant positive    |
| Fisheries                            | Loss of fishing ground / access to sea        | 2 | -2 | 3 | 3 | 2 | -32     | Moderate<br>negative    |

| Environmental<br>Component         | Potential Impact  | I | м  | Р | R | С | ES  | Impact<br>Significance |
|------------------------------------|---|---|----|---|---|---|-----|------------------------|
| Tourism and<br>Recreation          | Loss of Pantai Teluk<br>Ketapang                          | 1 | -2 | 3 | 3 | 2 | -16 | Minor<br>negative      |
| Cultural Heritage /<br>Archaeology | Effect on value of existing cultural heritage features    | 1 | -1 | 3 | 3 | 2 | -8  | Slight<br>negative     |
| Land Use                           | Compatibility with Kuala<br>Terengganu Local Plan<br>2020 | 2 | 0  | 3 | 3 | 1 | 0   | No change              |
| Marine Traffic                     | Changes in current patterns                               | 1 | 0  | 0 | 0 | 0 | 0   | No change              |

# 7.2 Detailed Examination of Impacts

# 7.2.1 Water Quality

Water quality impacts during the construction phase are likely from two activities. One is the spill overflow or runoff of water when sediment is deposited as part of the reclamation activity, the other is during the dredging for the construction of the breakwater and of the harbour access channel and basin. In both situations, the material being moved is mostly sand with low fines content, low organic content and low metals concentrations (see Section 6.2.5). As a result, the predominant water quality impact will be a result of the release of fine suspended sediment leading to an increase in turbidity. Wave and current actions can then transport and disperse the sediment plumes generated in this way.

Impacts to water quality once the construction phase is completed (post-construction phase) will be more permanent. While it is anticipated that the Project footprint will not result in water quality impacts outside of the Project area, there is some risk that water quality may deteriorate as a result of limited flushing capacity within the channels and basin within the Project area. Any changes to flushing capacity may change the water quality in the long term, particularly if discharges from the topside works and operations are allowed to enter these water ways. It should be noted that the present EIA does not address runoff or any discharges from the future topside development.

# 7.2.1.1 Evaluation Framework

# Sensitive Receptors and Key Baseline Characteristics

In general, the marine water quality within and around the Project area is good while the water quality in Sg. Terengganu estuary is fair (refer to Section 6.2.6). Suspended solids and turbidity were low at the coastal areas during sampling in the inter-monsoon period (11-29 mg/L total suspended solid concentration), however, it is recognised that heavy rainfall and storm events can result in peaks well beyond this level.

The data indicate that elevated nutrient levels may occur occasionally in the nearshore area. Faecal coliform counts were also high in some areas particularly

within the Sg. Terengganu estuary. Therefore, any changes to the hydraulics which could cause poor flushing combined with added pollution sources may result in reduced water quality.

The sediments from the dredging areas have low levels of nutrients and heavy metals, which implies this material will not be a significant source of contaminants when disturbed during the dredging process.

Water quality-sensitive receptors include recreational areas at Pantai Batu Burok and Tok Jembal, and marine ecology. It is noted however, that cascading impacts to marine ecology, fish fauna, fisheries etc. are discussed in their respective sections.

#### Methodology

The potential impact of the Project to the surrounding water quality has been investigated using numerical models. The hydraulic modelling study was carried out in accordance with the Department of Irrigation and Drainage (DID) guidelines and the hydraulic report was submitted to DID in June 2019 /81/.

The construction stage modelling of suspended sediment plume concentrations and dispersion has been carried out using MIKE 21 MT as shown in Table 7.9. The Mud Transport (MT) module of the MIKE 21 FM describes erosion, transport and deposition of mud or sand/mud mixtures induced by the dredging and reclamation works. The MT module operates interactively with the hydrodynamic model and was used to assess the extent (importance), concentrations of suspended sediment levels. The model assumptions are outlined in further detail below.

Post-construction impacts to water quality have been assessed by modelling of flushing capacity within the newly created canals and harbour within the proposed project area as an indicator of potential water quality impacts. This has been carried out using the advection-dispersion model, MIKE 21 AD as listed in Table 7.9.

Good water exchange would lead to good water quality as it is a process that allows the dilution or dispersion of nutrients, heavy metals, organic matter and replenishment of dissolved oxygen, whereas limited water exchange may result in poorer water quality conditions.

Nevertheless, it must be noted that water quality is also governed by the amount of contaminants (e.g. nutrients, heavy metal, oil and grease, etc.) introduced into the water, also known as pollutant loads. For example, a waterway that has good water exchange but with high pollutant load can lead to poor water quality if the waterway does not have the capacity to fully dilute or disperse the pollutant. Vice versa, a waterway with poor water exchange but with no pollutant load at all would still have fair to good water quality. It is once again highlighted that this EIA does not address or evaluate discharges from the topside developments that will eventually operate on the Project footprint.

| Table 7.9 | Impact assessment methodology. |
|-----------|--------------------------------|
|           | impact assessment methodology. |

| Phase                 | Impact Indicator   | Methodology  | Description  |
|-----------------------|--|--|--|
| Construction          | Suspended sediment<br>plume dispersal<br>generated from<br>dredging and<br>reclamation works | Modelling - MIKE 21<br>MT (Mud Transport)            | Simulation of the transport<br>of spill during each phase<br>of the dredging and<br>reclamation works. |
| Post-<br>construction | Flushing capacity of the reclaimed area  | Modelling - MIKE 21<br>AD (Advection-<br>dispersion) | Simulation of the flushing capacity.   |

# Sediment Plume Modelling

The assumptions and modelling scenarios developed to represent the Project activities are described in the following subsections. In particular, it is highlighted that the sediment plumes will vary depending on the production rate (how much sand and how the material is being placed at the reclamation area) and the amount of fine sediments in the dredging and reclamation material, since fine sediments remain in suspension for longer and can be dispersed farther than coarser sediments, i.e. sand. It is important to note then that the impact predictions and evaluations presented here only hold true for the assumptions given in this section.

It is further noted that the sediment transport model has been set up to simulate the sediment plume derived from reclamation and capital dredging "in excess" of the background ambient concentrations. Ambient suspended sediment concentrations, re-suspension of existing bottom material and from other sources (e.g. sediments in discharge from Sg. Terengganu) are not included in the model. Therefore, in evaluating the modelling results, background concentrations from the baseline surveys are considered.

# (i) Construction Equipment, Production and Sediment Spill Assumptions

The sediment plume impacts are primarily focused on the excursion of spill generated from the dredger's overflows. Estimation of spill rates was based on the percentage of fines in the seabed material and the likely spills based (on the type of the dredgers) to the ambient waters during the construction activities.

The reclamation and dredging can be divided into three main categories or work packages, using different equipment as outlined below:

- a) Package 1 Reclamation for Phases 1 to 5 using material from the offshore borrow site will be carried out with two Trailer Suction Hopper Dredgers (TSHD). The proportion of fines in the borrow material is assumed to be 4%, corresponding to the maximum percentage of fine materials derived from the seabed samples at the approved sand source /11/; see Table 7.10;
- b) Package 2 Dredging along the breakwater (Phase 1) and navigation channel (Phase 2) using one TSHD and reclamation using the dredged material; see Table 7.11;

c) Package 3 - Dredging at Turning Basin (Phase 2) using one cutter suction dredge (CSD) and reclamation using the dredged material; see Table 7.12.

For both cases 2 and 3, the amount of fines in the dredged material is based on surface grab sampling and analysis of six samples within the dredging area, which indicated predominantly low fines, but with a maximum of up to 34% fines. In the modelling, the maximum percentage of the mud/silt range (34%) was applied.

Table 7.10 Work package 1 - Reclamation during Phase 1 to Phase 5 - summary of production and spill assumptions.

| Parameter                                | Quantity                                 | Unit           |  |  |
|--|--|----------------|--|--|
| Dredger Type                             | Trailer Suction Hopper<br>Dredger (TSHD) | -              |  |  |
| Number of dredgers                       | 2  | -              |  |  |
| Hopper capacity                          | 15,000                                   | m <sup>3</sup> |  |  |
| Daily production volume                  | 30,000                                   | m <sup>3</sup> |  |  |
| Number of trips per one TSHD per day     | 1  | trip           |  |  |
| Material and spill rates (in % of fines) |  |                |  |  |
| % Fines in fill material                 | 4  | %              |  |  |
| % Spill from land reclamation works      | 5  | %              |  |  |

Table 7.11Work Package 2 - dredging works during Phase 1 (along the breakwater) and 2<br/>(navigation channel) and the dredged materials used for reclamation - summary<br/>of production and spill assumptions.

| Parameter  | Quantity                                 | Unit           |
|--|--|----------------|
| Dredger Type                                     | Trailer Suction Hopper<br>Dredger (TSHD) | -              |
| Number of dredgers                               | 1  | -              |
| Hopper Capacity                                  | 6,000                                    | m <sup>3</sup> |
| Percentage load in barge                         | 75                                       | %              |
| Daily production volume                          | 12,600 <sup>1</sup>                      | m <sup>3</sup> |
| Material and spill rates (in % of fines)         |  |                |
| % Fines in fill material                         | 34                                       | %              |
| % Spill from the dredger's draghead and overflow | 25                                       | %              |
| % Spill from land reclamation works              | 5  | %              |

Note 1: The assumption is that the THSD is making 2.8 trips per day, as we considered only 75% load in barge of 6,000 m3, which means only 4500 m<sup>3</sup> per trip.

| Parameter   | Quantity                        | Unit           |  |  |
|---|---------------------------------|----------------|--|--|
| Dredger Type  | Cutter Suction Dredger<br>(CSD) | -              |  |  |
| Number of dredgers                                  | 1                               | -              |  |  |
| Dredging rate                                       | 1,000                           | m³/hour        |  |  |
| Daily production volume                             | 24,000                          | m <sup>3</sup> |  |  |
| Material and spill rates (in % of fines)            |                                 |                |  |  |
| % Fines in fill material                            | 34                              | %              |  |  |
| % Spill from the dredger's draghead and<br>overflow | 5                               | %              |  |  |
| % Spill from land reclamation works                 | 5                               | %              |  |  |

Table 7.12Work Package 3 - dredging works during Phase 2 (turning basin) and the dredged<br/>materials used for reclamation - summary of production and spill assumptions.

# (ii) Construction Sequence and Modelled Spill Sources

The five construction phases described in the detailed sequence of works in Section 5.3 have been summarised and further divided into seven phases for the modelling exercise. The representative activities and their respective sediment spill sources for each construction phase as applied in the modelling are summarised in Table 7.13 and illustrated in Figure 7.1. The selection of reclamation and dredging spill locations for input to the modelling considered the following:

- 1 Areas with stronger (than average) current speeds were selected as the sediment spills could disperse faster and further away from the source of spill. This approach is considered conservative when predicting the potential extent of the sediment plume; and
- 2 Due to the large extent of the Project area (approximately 6 km in length), the sediment spill locations were selected at two ends of the Project (refer spill locations Phase 1b and Phase 1c in Figure 7.1) to assess the full possible extent of the sediment plume impacts.

| Modelled<br>Phase | Activity   | Work Packages<br>(refer to (i))  |
|-------------------|--|--|
| 1a                | <ul> <li>Reclamation works only.</li> <li>The reclamation works are proposed to start at the northern part of proposed Phase 1 reclamation extent to form the sand bund as shown in next Phase 1b/1c.</li> </ul> | Package 1<br>(reclamation<br>from offshore<br>borrow site, 2<br>TSHDs) |

 Table 7.13
 Details on representative phases applied for modelling purposes.

| Modelled<br>Phase | Activity  | Work Packages<br>(refer to (i))   |
|-------------------|---|---|
| 1b                | <ul> <li>Reclamation and dredging simultaneously</li> <li>The selected reclamation source is next to the completed land, to further continue the reclamation works.</li> <li>Dredging works are to be carried out along the proposed breakwater, and the dredged materials will be used for land reclamation of this Project.</li> </ul>  | Package 1<br>(reclamation<br>from offshore<br>borrow site, 2<br>TSHDs) and<br>Package 2<br>(capital dredging<br>and reclamation<br>with TSHD) |
| 1c                | <ul> <li>Reclamation and dredging simultaneously</li> <li>The selected reclamation source is at the southern part of proposed Phase 1 reclamation extent.</li> <li>The dredging works continues at the same locations described in Phase 1b.</li> </ul>   | Package 1 and 2   |
| 2                 | <ul> <li>Reclamation and dredging simultaneously</li> <li>The selected reclamation source is at the tip of proposed Phase 2 reclamation extent (deeper waters).</li> <li>Dredging works at the proposed navigation channel and the basin will be carried out using TSHD (moving source) and CSD (stationary source) respectively. The dredged materials will be used for land reclamation of this Project.</li> </ul> | Package 1,2 and<br>3 (capital<br>dredging and<br>reclamation with<br>CSD)   |
| 3                 | Reclamation works only.   | Package 1   |
| 4                 | Reclamation works only.   | Package 1   |
| 5                 | Reclamation works only.   | Package 1   |

# (iii) Climatic Scenarios

As described in Section 6, the climatic conditions, in particular the monsoon periods, govern the hydraulic conditions at the Project area and in turn will influence the movement and dispersion of the suspended sediment plumes. Each of the construction stages listed in Table 7.13 have been simulated for three climatic scenarios representing typical wind and tidal conditions during the inter-monsoon, NE monsoon and SW monsoon periods, with the exception of Phases 1 and 2. As indicated in the Project schedule, construction works for Phase 1 and 2 will not be conducted during NE monsoon as it is anticipated that the wind and waves will not allow marine works to proceed safely. However, Phases 3 to 5 will be sheltered by the newly reclaimed areas of Phases 1 and 2, thus allowing construction to proceed during all climatic conditions.

It is noted that wind and waves in the modelling for each climatic scenario represent the directions / speeds / heights that are considered representative conditions, or 'typical' of the season in question. This should not be interpreted as absolute conditions during the NE, SW or inter-monsoon periods but typical conditions that allow the assessment of the construction works. It should be noted that these representative climatic conditions do not include extreme events, which would increase the current flows, thus leading to greater plume dispersion, but it is considered unlikely that reclamation and dredging works will be carried out during these events.

The model was simulated for a 28-day period for each climatic scenario, in order to cover two full spring-neap tidal cycles.



Figure 7.1 Location of spill sources released during the construction period for Phases 1 to 5.

# Flushing

The simulations have been carried out by applying the 2D advection-dispersion module to describe the physical mixing (dispersal) of a conservative tracer that represents any type of pollutant which does not decay / breakdown. Tracers have been released as 100% at two separate areas within the model domain (Figure 7.2):

- Tracer 1: located along the inner channel of the proposed land reclamation; and
- Tracer 2: located inside proposed dredged basin.

The flushing capacity is expressed as the time (in hours or days) required for flushing of 50% of the initial amount of tracer. Retention time,  $T_{50}$  is defined as the duration of time taken for 50% of the water, for example in a tidal channel, to be replaced with fresh water from the outside the system. It reflects the flushing capacity of a body of water, with a short retention time signifying good flushing capacity and hence a rapid transport out of the system or exchange.

The flushing time may be sensitive to the point in the tidal cycle at which the tracer is released. To account for this, the simulations have been run with the tracer being released at two different tides, spring and neap, where the spring tide represents the best case with regards to flushing times and conversely for the neap tide where flushing time will be greater due to a lower net water exchange.

The modelling was carried out for inter-monsoon conditions only, as this represents the worst- case scenario where wind and wave energy is low.





# Impact Indicators

# Suspended Sediments

The threshold limit for total suspended sediment (TSS) utilised in this assessment is **50 mg/L** as specified under Class 2 of the Malaysian Marine Water Quality Standards (MMWQS). The Class 2 standards are related to the protection of aquatic ecosystems and encompasses fisheries and mariculture activities /25/.

The evaluation of the impact magnitude in the RIAM uses the scale as described in Table 7.14.

| Score | Definition                                 | Evaluation Framework                      |
|-------|--|---|
| 0     | No change/status quo                       | No sediment plume impact                  |
| 1     | Negative change to status quo              | Exceedance between 1 and 25% of the time  |
| 2     | Significant negative dis-benefit or change | Exceedance between 25 and 50% of the time |
| 3     | Major dis-benefit or change                | Exceedance > 50% of the time.             |

Table 7.14Evaluation of the impact magnitude for suspended sediment – exceedance of 50 mg/L.

It should be noted that the standard in Table 7.14 is an absolute value while the modelling results presented in this section are predicted concentrations above background (ambient) levels.

# Flushing Capacity

There are no absolute standards for flushing capacity as an indicator of water quality. However, based on experience, the  $T_{50}$ , which is the time it takes to flush 50% of the water, should be generally be less than two days in a tropical environment to avoid poor water quality. For an area to obtain fair water quality, the  $T_{50}$  should be less than one day whereas the  $T_{50}$  must be less than 12 hours to obtain good water quality. These indicators are comparable to the flushing guidelines set in USEPA (1985) Coastal Marinas Assessment Handbook /82/ where the recommended target is a complete water exchange of a basin in four days as being "good" which is consistent with above, an exchange of water in ten days as "fair", and poor if longer time is required. It should be noted that the USEPA guidelines are established for temperate conditions and not tropical.

# 7.2.1.2 Construction Phase

# Suspended Sediment

Figure 7.4, Figure 7.5 and Figure 7.6 shows the predicted maximum excess concentration of suspended sediment generated from the reclamation and dredging works over the 28-day modelling period for selected phases: Phase 1a, Phase 2 and Phase 3 during all climatic conditions. As presented in Figure 7.1, Phase 4 and 5 works are sheltered by the preceding phases and hence the sediment spills are largely confined to within the Project footprint.

#### Maximum Suspended Sediment Concentrations

The modelling has been carried out for 28 days and the results analysed to provide the statistical maximum excess (above background) concentration. This means that Figure 7.4, Figure 7.5 and Figure 7.6 show the maximum TSS concentration that can be reached at any particular model cell over the course of the entire simulation period of 28 days.

It is emphasised that these are statistical plots and do not represent an actual plume in space or time, because there is little likelihood of any of the maximum values recorded occurring simultaneously. In addition, the duration of which the maximum value persists in any given mesh will vary and could be for as little as one time-step. The actual TSS concentrations will depend on the actual construction activity and the prevailing currents at that point in time which are driven by tidal oscillation, see example time series animations linked here for a selected point inside KT river mouth over the 28 day simulation period (Figure 7.3).



Scan this QR code to watch suspended sediment plume animation for Phase 1c during inter-monsoon.

During Phase 1a, the predicted plume extent is much larger during NE monsoon compared to the SW and inter-monsoon conditions where the plume excursions and concentrations are similar (Figure 7.4). The maximum excess TSS concentrations extending northwest and southeast of the Project area are predominantly between 5 to 10 mg/L above ambient levels.

During Phase 2, the maximum concentrations are similar for all climatic conditions (Figure 7.5). The plume excursion is predicted to be much larger as reclamation and dredging works are conducted simultaneously. The highest TSS concentrations (above 50 mg/L), are however confined to the dredging area.

For Phase 3 (Figure 7.6), maximum excess concentration of more than 50 mg/L only occurs at source of reclamation, whereas beyond this the TSS concentrations are between 5 to 20 mg/L during all climatic conditions. The plume dispersion is again higher during the NE monsoon climatic conditions compared to SW and intermonsoon which both have similar plume extent.

Figure 7.3 shows a time series of TSS concentrations from a location just off the airport runway extension over the 28-day simulation period. In this example, predicted excess TSS concentrations are actually below 50 mg/L for the majority of the time, with peak TSS occurring on only six occasions in 28 days.



Figure 7.3 Example of maximum excess concentration time series over the period of 28days near the dredging area. Excess suspended sediment of 50 mg/L and above is mostly instantaneous.



Figure 7.4 Maximum excess suspended sediment plume excursion for Phase 1a reclamation for all climatic scenarios.



Figure 7.5 Maximum excess suspended sediment plume excursion for Phase 2 reclamation and dredging for all climatic scenarios.



Figure 7.6 Maximum excess suspended sediment plume excursion for Phase 3 reclamation for all climatic scenarios.

Given that most of the reclamation and dredging works are to be carried out during SW and inter-monsoon only, and as evidenced in the figures (Figure 7.4 to Figure 7.6), the plume excursion and concentrations during the SW monsoon and intermonsoon climatic conditions are very similar, only results from the SW monsoon will be presented in the following sections. These results are presented as exceedance plots of the selected water quality threshold of 50 mg/L in percent of time.

#### Percent of Time in Exceedance of 50 mg/L

The exceedance plots indicate the percentage of time that a value, in this case 50 mg/L, is exceeded within each model cell over the course of the 28-day simulation period. This indicates the duration for which this concentration persists at a given location and hence provides a better indication of the impact.

It is again emphasised that these are statistical plots and do not represent an actual plume in space or time, nor do they indicate the actual TSS concentration or severity above the selected 50 mg/L threshold value (i.e. how much 50mg/L is exceeded by).

### Exceedance of 50 mg/L

As shown in Figure 7.7, minimal impact is anticipated during Phase 1a with exceedance of 50 mg/L occurring less than 10% of the time. During Phase 1b and 1c where dredging and reclamation occurs simultaneously, the plume excursion is less than 4 km from the spill source and the duration in exceedance of 50 mg/L is below 20% for a large part of this area. Exceedances of 50 mg/L during Phase 2, Phase 3, Phase 4 and Phase 5 are all confined to within the Project area.

### Impact Evaluation

Based on the RIAM matrix, the impact is **minor negative** impact. Nevertheless, mitigation measures to further reduce impacts are recommended.

| Criteria            | Score | Rationale  |
|---------------------|-------|--|
| Importance          | 2     | The maximum of extent of the sediment plume is less<br>than 4 km from the Project area. The zone of impact<br>where Class 2 standard are exceeded is limited to<br>approximately 2 km from the Project area. |
| Magnitude           | -1    | Exceedance of 50 mg/L only occurs less than 20% of the time.   |
| Permanence          | 2     | Temporary, as the suspended sediment plumes occur only during construction phase.  |
| Reversibility       | 2     | The impact is reversible upon cessation of dredging and reclamation  |
| Cumulative          | 2     | Non-cumulative   |
| Environmental Score | -12   |  |
| Description         | -В    | Minor negative impact  |



Figure 7.7 Percentage exceedance of 50 mg/L during SW monsoon.

# 7.2.1.3 Post-construction Phase

# Flushing Capacity

Figure 7.8 and Figure 7.11 show the concentration plots for Tracer 1 and Tracer 2 respectively at neap tide during inter-monsoon (IM) at the start, after 12-, 24- and 48hrs. Concentration time series during neap and spring tide for the locations indicated in these figures are shown in Figure 7.9 for locations within the channels (Tracer 1) and in Figure 7.11 for the basins (Tracer 2).

With the length and enclosed nature of the inner channels together with the low winds during the inter-monsoon periods; the flushing rate in the centre of the channel is poor with the retention time predicted to be relatively high as shown in Figure 7.8. These correspond to  $T_{50}$  values of three and up to seven days for Points 2 and 3 respectively, as shown in Table 7.15.

Similarly, flushing of the basin, in particular the inner parts, is also poor, with  $T_{50}$  within basin of over seven to nine days whereas the  $T_{50}$  at the mouth of the basin is between one to just over two days as shown in Table 7.16.

In general, the high  $T_{50}$  within the inner channel and basin means that the waters are not flushed well and may lead to poor water quality if any contaminants are introduced under low wind and wave energy conditions.