MINERALOGY IRON ORE PROJECT

FORTESCUE RIVER FLOOD STUDY

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1. Introduction

Austeel Pty Ltd propose to construct a minesite to extract ore from a potential ore body located 70 kilometres south west from Dampier adjacent to the lower reaches of the Fortescue River. At this location, the effective Fortescue River Catchment is approximately 20,000 km^2.

Due to environmental issues associated with the project, a Public Environmental Review (PER) has been initiated. The PER included a preliminary flood study of the Lower Fortescue River adjacent to the project area. This flood study involved modelling the river using topographic data based on published maps with a 10 metre contour interval. Further to this preliminary flood study, a detailed flood study has now been undertaken to predict flood levels in the Lower Fortescue River using more accurate survey data and revised 100 year peak flow estimates, derived by Water and Rivers Commission.

The detailed flood modelling, which forms the basis of this study, assesses the impact of the proposed mine infrastructure on upstream flood levels and the potential for inundation and/or protection of the mine infrastructure from floodwaters. Infrastructure located outside of the Fortescue River Floodplain, but within the floodplain of tributary creeks, may require diversion of these creeks. However, this is outside of the scope of this study.

2. Approach

Flood levels in the Fortescue River adjacent to the general project area have been estimated using the HEC-RAS computer program. The HEC-RAS program provides a river backwater analysis model for open channel and floodplain flow with input data including flow cross sections, waterway roughness, discharge and starting water level. In addition to flood levels from river flows, ocean storm surge levels have also been considered.

The flow cross sections input into the model have been estimated using photogrammetry with ground control and river crossings by land survey, to produce a Digital Terrain Model (DTM). The photogrammetry used 1:25,000 aerial photography giving a vertical accuracy of the DTM of +/- 0.8 metres.

Waterway roughness values (Manning's n) input into the model for the channels and floodplains have been estimated from limited site observations, photographs (including aerial) and maps. The 100 year ARI peak river flood estimate of 9220 m^3/s, derived by Water and Rivers Commission, has been used for the analysis.

A starting downstream river water level at the mouth of the river of 4.0 mAHD has been adopted for the modelling based on observed debris levels. This is higher than the Highest Astronomical Tide of 2.43 mAHD, resulting in conservative (higher) river flood level estimates. However, the flood level modelling has been assessed for reasonable variations in starting water level.

Raised water levels from ocean storm surges can cause flooding in coastal areas. In this region, the largest storm surges result from tropical cyclones. Preliminary estimates of the likely cyclone storm surge level at the mouth of the Fortescue River has been predicted by Global Environmental Modelling Systems (GEMS) (Aquaterra, 2000). An in-house computer model was used to simulate the effect of Cyclone Vance crossing the coast at mid-tide (0.0 mAHD), at the mouth of the Fortescue River. The modelling results suggest a worst case outcome of storm surge water levels at 6.5 mAHD which would likely translate to an inland flood level of around 7.0 mAHD. If the cyclone coincided with a high tide, the storm surge water level could increase to around 8 mAHD. As there is potential for flooding from storm surges, sensitive mine infrastructure should be located at least one metre above the preliminary storm surge level estimate of 8 mAHD.

The largest river floods and ocean storm surges in the Lower Fortescue River Catchment both occur as a result of cyclonic activity. A storm surge occurring simultaneously with a river flood is considered a joint probability event for the Fortescue River Catchment, as a cyclone related river flood would occur a number of days after the storm surge, due to the large size of the catchment. It is therefore invalid to use a storm surge level as the starting water level for the river flood modelling in this case.

3. Model Results

The 100 year ARI river flood levels obtained from the HEC-RAS model for the Lower Fortescue River, without the mine infrastructure, and the approximate eastern extent of the floodplain boundary are presented in Figure 1. Over the study area, the predicted river flood levels varied from 6.2 mAHD (4 kilometres from the river mouth) to 15.3 mAHD at the upstream boundary (12.5 kilometres from the river mouth).

The proposed locations for the main mine infrastructure are shown in Figure 1. The proposed waste dump site protrudes into the Fortescue River Floodplain, but all other proposed mine infrastructure (eg plant site, tailings dam, pit etc) are located outside of the floodplain. Some of the mine infrastructure intersect tributary creeks, which may require diverting, but is outside of the scope of this study.

The predicted 100 year ARI river flood levels at the waste dump site (prior to construction of the waste dumps) varied from around 10.0 mAHD at the downstream end to 13.0 mAHD at the upstream end. The impact on flood levels of the 20 and 40 year waste dump options as illustrated on Figure 1, have been investigated and are presented in Table 1.

Table 1
Impact of Proposed Waste Dump on River Flood Levels

Waste Dump Option	Increase in 100 Year ARI River Flood Level (m)	
	At Waste Dump Site	3 km Upstream of Waste Dump Site
20 Year	0.0	0.0
40 Year	0.6	0.5

The 40 year waste dump option protrudes the furthest into the floodplain, so results in the largest increase in river flood levels of 0.6 metres adjacent to the waste dump site and 0.5 metres 3 kilometres upstream. The 20 year waste dump option had negligible impact on flood levels.

The average velocity of flow in the undeveloped floodplain adjacent to the proposed waste dump site is about 1.7 m/s for the 100 year ARI river flood. With development of the waste dumps, these average flow velocities are predicted to not significantly change. The maximum velocities are likely to occur within small channels across the floodplain and to be in the order of 50% greater than the average velocity.

4. Sensitivity Analysis

A sensitivity analysis has been undertaken on the HEC-RAS model parameters. By increasing the starting water level at the mouth of the river from 4.0 mAHD to 6.0 mAHD, the predicted water level at the first surveyed cross section, some 4 kilometres inland, increased by 0.6 metres. Adjacent to the proposed waste dump location, this water level increase was only about 0.2 metres. Therefore, adjacent to the waste dump area, the model has been shown to be relatively insensitive to changes in the starting water level.

The waterway roughness parameter (Manning's n) was varied +\- 20% to assess the sensitivity of the modelled water levels. Adjacent to the proposed waste dump site, in response to this roughness change, the water level variation was +\- 0.4 to 0.5 metres. This variance should be considered for any design in the floodplain area.

The Water and Rivers Commission supplied 100 year ARI peak river flow estimate is based on the gauging station at Jimbegnyinoo Pool near the North West Coastal Highway crossing, some 20 kilometres upstream from the study area. About 15 kilometres downstream from the highway crossing, extreme events such as the 100 year ARI flood, break away from the main channel and adjacent floodplains and overspill to the north west. The extent of this overspill for the 100 year event has been estimated at around 1200 m3/s, based on levels from topography maps. The difference in flood level between the full flow used in the analysis (9220 m3/s) and the reduced flow (8,000 m3/s) taking into account the overspill, was 0.2 metres at the waste dump site. The flood level difference at other locations was also minimal.

5. Conclusions and Recommendations

A detailed flood study of the Lower Fortescue River using the HEC-RAS hydraulic backwater model has been undertaken. Revised 100 year ARI peak flow estimates, derived by Water and Rivers Commission, and survey data have been used. Over the study area, 100 year ARI river flood levels and the extent of the floodplain have been predicted. The flood levels varied between 6.2 mAHD (4 kilometres from the river mouth) to 15.3 mAHD at the upstream study boundary (12.5 kilometres from the river mouth). These flood level predictions are shown in Figure 1.

All proposed mine infrastructure, except for the waste dump site, have been found to be outside of the main Fortescue River Floodplain. Some diversion of tributaries around the mine infrastructure outside of the floodplain may be required, but was not in the scope of this study.

The predicted 100 year ARI river flood levels at the waste dump site (prior to waste dump construction) varied from around 10.0 mAHD at the downstream end to 13.0 mAHD at the upstream end. The proposed 40 year waste dump is estimated to increase the river flood level adjacent to the site by 0.6 metres and 3 kilometres upstream by 0.5 metres. The proposed 20 year waste dump has minimal impact on flood levels.

To protect the waste dump from scour during flood events, it is recommended that rock armouring or similar be placed up to a freeboard of about one metre above the 100 year river flood level. Alternatively, the waste dump site could be re-located outside of the floodplain.

There is potential for flooding from ocean storm surges. It is recommended that all of the mine infrastructure sensitive to flooding be located at least one metre above the predicted storm surge level of 8 mAHD.