▪ Report

Review of Toxicological Appendices in the Gunns IIS Report

Prepared for

Resource Planning and Development Commission Tasmania

By

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1 Background

In the Gunns Draft IIS report for the planned Bell Bay Pulp Mill there are several Appendices relating to the potential toxicological effects of the pulp mill effluent on the marine flora and fauna (Appendices 23, 58 and 59 in Volumes 10 and 18).

The company responsible for the assessments, Toxikos recently submitted a list of Errata to the Appendices "Bell Bay Pulp Mill Draft IIS Erratum 15 September 2006". An important element in the Erratum is that the dioxin concentration originally used in the Toxikos reports was 0,074 pg TEQ/L while according to the Erratum the correct number is 3,376 pg TEQ/L. This relates to Appendix 23.

The Resource Planning and Development Commission (RPDC) has engaged the National Research Centre for Environmental Toxicology at the University of Queensland to comment on relevant issues in the Appendices.

Since ÅF Consult AB (ÅF) has particular expertise in the area of the toxicological effects of pulp mill effluents on aquatic organisms, the RPDC has assigned ÅF (through Beca AMEC) to review the Appendices and supply additional comments with respect to:

- The findings and conclusions in relation to available knowledge in the respective subject area
- Any influence of the Errata on the subject matter or conclusions

ÅF has reviewed the Appendices on behalf of Beca AMEC:

- 23 "Comment on Bell Bay effluent and potential impact on nearby seal colonies"
- 58 "Toxicity Assessment of Pulp Mill Effluent for the Proposed Tasmanian Pulp Mill – Pine Pulping Campaign"
- 59 "Toxicity Assessment of Pulp Mill Effluent for the Proposed Tasmanian Pulp Mill"

In the following, comments on the Appendices are grouped under the headings "Dioxins", "Metals" and "Toxicity tests".

Responsible for the work has been Dr. Hans Norrström. The analysis has been made by Dr. Mikael Malmaeus, Ms. Caroline Grotell and Mr. Magnus Karlsson.

2 Discharge of dioxins to water

The planned Bell Bay mill as presently designed will utilise the best proven processes to eliminate or minimise any dioxin discharge to water. Discharges of these compounds can be estimated based on factors available from various sources.

The dioxin concentration in the effluent originally used in the Toxikos reports was 0,074 pg TEQ/L while the correct number is 3,376 pg TEQ/L. The Erratum of 15 September 2006 analyses any changes in results and conclusions in the Toxikos Reports due to this adjustment in concentration.

The revised estimate of the dioxin content in the mill effluent does not considerably alter the conclusions made in the report. The dioxin concentration is still below the guidelines and below established detection limits. We interpret the numbers as being within the normal range for effluents from modern mills. This being the case there are several studies implying that modern pulp mill effluents do not contribute significantly to the level of dioxins in their environment compared to background concentrations (e.g., MacDonald et al., 1998; Yunker et al., 2002; Bright et al., 2003; Pryke & Barden, 2006).

The general statement in the report that dioxins do not bioaccumulate in seals seems rather provocative and is at best controversial, at worst at odds with most available evidence. The common view is that 2,3,7,8-chlorinated congeners of dioxins and furans are not or only very slowly metabolised by biota and are thus bioaccumulated and biomagnified in ecological food chains (stated, e.g. on the DEH website, www.deh.gov.au.).

There is in fact evidence that seals can metabolise dioxins to some degree, but there is also a large body of evidence showing that seals and other top predators contain the highest tissue concentrations of these substances measured in marine ecosystems. Especially the most toxic, low chlorinated congeners of PCDD/F seem to be bioaccumulated and biomagnified through the food chains.

Whether there is significant biomagnification between fish and seal in the environment is disputed in the Toxikos report, referring to a study where seals were fed for two years with herring that contained certain amounts of dioxins. After the experiment the seals contained lower concentrations of dioxins than their food which in the report is taken as evidence for lack of biomagnification.

Still there must exist a mechanism for bioaccumulation of dioxins in seals as there are several studies presenting elevated concentrations even in seals living in areas where ambient concentrations should be extremely low, such as the Arctic and Antarctic regions. Possibly bioaccumulation occurs to a higher degree in the food chain links below the seals, so that fish that constitute food for the seals contain dioxin concentrations sufficient to generate elevated concentrations in seals without significant biomagnification. Thus fatty fish in the Baltic Sea, herring in particular, are known to contain more dioxin than other fish.

Other evidence for the lack of biomagnification of dioxin in marine food chains suggested in the report includes biota-sediment accumulation factors (BSAF) less than unity for these substances in fish and other organisms.

For organisms, such as fish and crustaceans, not in contact with the sediment, the BSAF will depend on a number of site-specific parameters. Such parameters include the relative contributions of pelagic and benthic organisms in their diet, kinetic limitations for chemical transfer from sediment to water (such that surface-sediment concentrations have not reached steady-state with water) and biological processes such as biotransformation or biomagnification. A number smaller than unity is thus not very significant in itself but needs to be compared to BSAF for other substances in the same ecosystem.

In summary, we consider the present argumentation and conclusion that dioxins from the mill effluent will not impact seals or human health to be based upon weak evidence for lack of bioaccumulation and biomagnification in marine food chains.

We believe that the conclusion as such may most likely be correct. We suggest, however, that more appropriate support for the conclusion is the (still) low dioxin concentration expected in the Bell Bay effluent and the many documented cases of improved status in mill recipients where modern bleaching technology has replaced chlorine bleaching in the mills.

3 Discharge of metal ions into water

The effects of discharge of metals from the pulp industry have been evaluated in several field-studies in Sweden (e.g. Lindeström & Sangfors, 1992). The main part of metals that are discharged into the recipients originates from the wood raw material. The concentration of metals in effluent water is normally low but since large amounts of wood and water are handled in the pulping process the amounts being released are not negligible. Thus elevated levels of metals can sometimes be registered in sediments of receiving areas.

Among the metals that are normally being monitored, cadmium often appears in highest concentrations in relation to background levels in aquatic ecosystems. However, there are no signs that the release of metals causes a general increase of metal levels in organisms living in the primary recipients of pulp mills. In the Swedish study, there was rather a tendency towards lower levels of metals in vicinity of the industries and this was most pronounced for cadmium. A likely explanation is the potential of effluent water to form complexes with metal ions and thereby reduce their bioavailability.

Other factors that influence the uptake of cadmium in organisms are water hardness and salinity (WHO, 1992). Increased calcium and magnesium ion concentrations (hardness) reduce cadmium uptake through water. In marine waters it is likely that chloride complexation is responsible for the reduced cadmium accumulation and toxicity that have been observed with increasing salinities.

The conclusions from the Swedish study were that negative effects from the discharge of metals from pulp mills on aquatic life are very unlikely even under the most unfavourable conditions e.g. receiving waters with low dilution. In a marine environment with high dilution, as in the Bell Bay case, any effects are thus highly unlikely.

4 Toxicity tests

Effluents from two different pulp mills, similar to the proposed Gunns pulp mill, have been used for toxicity tests in order to assess the direct effects on living organisms or cells. The samples of the effluents were collected during 24 hour periods. Optimally a longer period of time (3 to 5 days) would have been recommended for the collection of the effluents. Chemical characterisation of the samples of the effluents, which could have shown if the samples were representative for the two mills and for the proposed Gunns mill, is also lacking.

The ESA laboratory together with CSIRO have performed a battery of toxicity tests with different organisms on several trophic levels; bacteria, micro-algae, macro-algae (seaweeds), invertebrates (bivalves and crustaceans) and fish. The tests used in these two cases are broadly established except for one (larval fish test). The bioassays were carried out within 36 hours (as recommended) for the effluent from processing pine, except the fish test (within 12 days). The effluent from processing eucalyptus was exposed to the organisms after 3 days, except for fish test which was 9 days. However, both effluents were stored cold and the Microtox-tests showed little change of the toxicity during storage.

To further evaluate any effects due to storage, results from chemical characterisation of both effluents at sampling and at testing for comparison would have been valuable.

The results from the two tested effluents showed in general no or negligible acute toxicity towards the exposed organisms, except for sea urchin and doughboy scallop. The Lowest Observed Effect Concentration (LOEC) of the two tested effluents was recorded in the doughboy scallop larval development test (bivalve) using effluent from processing eucalyptus. In this case LOEC was 30 % effluent and EC50 was 37 % effluent (50 % of the exposed organisms were affected at a concentration of 37 % effluent), which can be considered as quite toxic. However, the concentration of effluent in the mixing zone of the effluent from the Bell Bay mill is calculated to be 1 %. Therefore, no acute toxicity of the effluent should be expected.

The results are in line with results from toxicity tests on effluents from modern pulp mills in Sweden during the late 1990s and the early 2000s where no or little acute toxicity towards organisms has been recorded.

It can always be argued that the effluents do not originate from the Bell Bay mill but since such effluents are not available at present, the realistic alternative is to take samples from similar mills using similar raw materials. We would however have liked to see more process and wood raw material details and analytical details of the effluents in order to make comparison with the corresponding factors for the Bell Bay mill possible.

To summarise, we do not see any reason to question the results from the toxicity tests. The number of tests that have been undertaken is sufficient to draw the conclusion that with the expected effluent concentrations in the recipient, there will be no acute toxic effects in organisms living in the primary recipient.

However, results from acute toxicity tests cannot be used to predict whether any chronic toxic effects on aquatic life including nearby seal colonies will occur or not. That issue is better evaluated by results from chronic toxicity tests on aquatic organisms and by the predicted levels of potentially harmful and bioaccumulative substances in the final, treated effluent. Such results can then be compared with the levels obtained in relation to existing mills and the status of the receiving waters outside the mills.

5 Concluding comments

The conclusion that dioxins from the mill effluent will not impact on seals or human health is in our opinion based upon weak evidence for lack of bioaccumulation and biomagnification in marine food chains. We believe, however, that the conclusion as such may most likely be correct. We suggest that more appropriate support for the conclusion is the (still) low dioxin concentration expected in the Bell Bay effluent and the many documented cases of improved status in mill recipients where modern bleaching technology has replaced chlorine bleaching in the mills.

The release of metal ions from pulp mills is directly dependent on the intake of metal ions with the wood raw material. The impact of such release of metals from pulp mills has been evaluated in Sweden. The conclusions from the study were that negative effects from the discharge of metals from pulp mills on aquatic life are very unlikely even under the most unfavourable conditions viz. receiving waters with low dilution. In a marine environment with high dilution, as in the Bell Bay case, any effects are thus highly unlikely.

The results from the acute toxicity tests done on "simulated" Bell Bay mill effluent and the calculated dilution outside the effluent discharge indicate that no acute toxicity of the effluent should be expected. The results are in line with results from toxicity tests on effluents from modern pulp mills where no or little acute toxicity towards organisms has been registered.

6 References

Bright D.A., Hodson P.V., Lehtinen K-J., McKague A.B., Rodgers J.H. and Solomon K. R., 2003. Evaluation of Ecological Risks Associated with the Use of Chlorine Dioxide for the Bleaching of Pulp: Scientific Progress since 1993. In Environmental Impacts of Pulp and Paper Waste Streams, Stuthridge, T., van den Huevel, M.R., Marvin, N.A., Slade, A.H. and Gifford, J. (Ed). SETAC Press.

Lindeström, L. & Sangfors, O., 1992. Metals in organisms and sediments from forest industry recipients (in Swedish). SSVL-report nr 29.

Macdonald R.W., Ikonomou M.G., and Paton D.W., 1998. Historical Inputs of PCDDs, PCDFs, and PCBs to a British Columbia Interior Lake: The Effect of Environmental Controls on Pulp Mill Emissions. Environ. Sci. Technol. 32, 331-337.

Pryke D.C. & Barden M.T., 2006. Environmental performance of Maine's bleached kraft pulp and paper mills. Sixth International Conference on Fate and Effects of Pulp and Paper Mill Effluents.

WHO, 1992. Environmental Health Criteria 135 Cadmium – Environmental Aspects. Geneva, 135 p.

Yunker M.B., Cretney W.J., and Ikonomou M.G., 2002. Assessment of Chlorinated Dibenzo-p-dioxin and Dibenzofuran Trends in Sediment and Crab Hepatopancreas from Pulp Mill and Harbor Sites Using Multivariate- and Index-Based Approaches. Environ. Sci. Tech. 36, 1869-1878.