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UniQuest Project No. 14611

**Report Prepared for: Ms Pam Scott
Resource Planning and Development
Commission
GPO Box 1691
Hobart TAS 7000**

**Subject: Peer Review Regarding an Integrated Impact
Statement**

**Part A – Review of Volume 17 of the Gunns’
Report**

Date: 13 November 2006

**Report Prepared By: Professor Michael Moore
Dr Heather Chapman**

Signed for and on behalf of UniQuest Pty Limited

A handwritten signature in black ink, appearing to read "G Heyden".

Mr Gary Heyden

It was requested by the Resource Planning and Development Commission (RPDC), to review a section of the Integrated Impact Statement (IIS) Bell Bay Pulp Mill provided by Gunns Limited.

Specifically the review will include the following (for Volume 17) as identified by Ms Pam Scott:

- Adequacy of how the Draft IIS addresses the issues as set out in the Guidelines. (Note: It does not comment on how the Draft IIS has been carried out).
- Is it adequate for the RPDC's assessment purposes?
- Validity of methodology and findings (including studies and surveys and modelling where relevant).
- Whether the proponent's conclusions are reasonable and scientifically based.
- Identify any major/critical errors or omissions in the Draft IIS and identify what further work is required.

Approach to Review

In the absence of specific Terms of Reference for Volume 17 being available to the reviewer, the Draft IIS in its entirety was consulted in order to identify sections relevant to the volume being assessed. This identified the **Executive Summary, Volume 5_A3** 'Final Scope Guidelines for Integrated Impact Statement' and **Volume 5_A5** 'Recommended Environmental Emission Limit Guidelines for Any New Bleached Eucalypt Kraft Pulp Mill In Tasmania' as having relevance to the context in which the toxicity testing was carried out.

On enquiry to the RPDC, advice was provided that "A critical aspect of the proposal is for Gunns to establish that the mill would be able to comply with the Tasmanian Government's Environmental emission limit guidelines for any new bleached eucalypt kraft pulp mill in northern Tasmania (2004).

The primary purpose of the Ecotox work appears to be an attempt to draw together a body of evidence to demonstrate ability to comply with the Tas. Govt. emission limit guidelines." (Refer to Appendix A). The review has therefore been conducted with this in mind.

Structure of this report

Relevant sections of Volumes V5_A3 and V5_A5 relating to ecotoxic effects are reproduced and summarised below (Tables 1&2). The comments, **highlighted in bold**, are considered in the review as these were taken as the reference documents on which the work was presumably conducted. V5_A5 (Recommended Environmental Emission Limit Guidelines for Any New Bleached Eucalypt Kraft Pulp Mill in Tasmania Volume 2) is included as this was referred to in V5_A3 as the basis on which the toxicity testing was to be conducted.

Table 1 – V5_A3 Final scope guidelines for the integrated impact statement

Section and page number	7. POTENTIAL ENVIRONMENTAL IMPACTS AND PROPOSED MANAGEMENT MEASURES.
<p>7.8 Emissions from the pulp mill and on-site environmental management issues</p> <p>Page 8 – item 5</p>	<p>“Possible impacts on the survival, breeding, and migration of marine mammals, birds, fish (including marine reptiles, invertebrates and marine plants) and other aquatic wildlife with particular reference to commercial, recreational fish and EPBC listed threatened and marine species. This must include information on the predicted toxicity and mutagenicity, including teratogenic effects, of the combined final effluent from the mill.</p> <p>Long term acute and chronic impacts should be discussed. (Refer to effluent toxicity testing as required in the Tasmanian Government 2004, Environmental emission Proposed bleached kraft pulp mill in Northern Tasmania by Gunns Limited)</p> <p>...consideration must be given to potential cumulative, antagonistic and synergistic effects of pollutants when combined with other pollutants or chemicals in the receiving environment”.</p>

Table 2 – V5_A5 Recommended Environmental Emission Limit Guidelines For Any New Bleached Eucalypt Kraft Pulp Mill In Tasmania Volume 2

Section and page number										
<p>Continued reduction of organochlorines</p> <p>Page 5</p>	<p>B.11 Current evidence suggests that at the low levels of organochlorines produced by AMT, BAT as regards the Stockholm Convention and BPEM there is no consistent relationship between adsorbable organic halide (AOX) and toxicity, and that other compounds may be causing toxicity in effluents. The National Pulp Mills Research Program (Fandry, Johannes and Nelson 1989) has shown that 2,3,7,8 TCDD (dioxins), 2,3,7,8 TCDF (furans) and certain polychlorinated biphenyls are not detectable in modern pulp mill effluent, even using the improved analyses now available. The issues of concern are now related to the possibility of long-term or short-term sub lethal impacts from any effluent. Not all technologies now available use chlorine-based bleach compounds and it is now recognised that some of the toxicity in kraft pulp mill effluents, bleached or unbleached, originates from natural compounds in the wood.</p>									
<p>Discharge limits</p> <p>Page 21</p>	<p>D.1.14 Table 6 lists additional parameters, and their discharge limits, which should be included in the effluent permit. These discharge limits apply to each individual biologically treated effluent sample analysed and are not averaged. The effluent sample should be taken at the point of discharge and should exclude any uncontaminated water (such as indirect cooling water).</p>									
<p>Discharge limits</p> <p>Page 22</p>	<p>Subset of Table 6 Discharge limits for each biologically treated effluent sample analysed</p> <table border="1" data-bbox="505 1245 1308 1350"> <thead> <tr> <th>Parameter</th> <th>Units</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>Acute toxicity</td> <td>LC50/EC50</td> <td>a</td> </tr> <tr> <td>Chronic toxicity</td> <td>EC50</td> <td>b</td> </tr> </tbody> </table> <p>Notes:</p> <p><i>a</i> Acute toxicity should be measured in 100% effluent. The effect from the effluent should be less than 50%.</p> <p><i>b</i> Chronic toxicity should be measured in effluent at various dilutions above and below the dilution expected at the edge of the mixing zone. The concentration at which a 50% effect is obtained should be determined. The Lowest Observed Effect Concentration (LOEC) and the No Observed Effect Concentration (NOEC) should also be determined. The discharge limit will be set such that the NOEC is not exceeded at the edge of the mixing zone.</p> <p><i>c</i> If the proponent proposes to use the ECF bleaching method in the mill process, the environmental impact assessment must include a study of the effects of chlorate ion on any sensitive marine flora and fauna species living within a 1 kilometer radius of the proposed discharge point for treated mill effluent. The discharge limit for chlorate will be set based on the results of this study so that no detectable environmental damage occurs beyond the dilution zone.</p>	Parameter	Units	Value	Acute toxicity	LC50/EC50	a	Chronic toxicity	EC50	b
Parameter	Units	Value								
Acute toxicity	LC50/EC50	a								
Chronic toxicity	EC50	b								

	<p>Laboratory tests suggest that concentrations required to protect brown algae are less than 10 µg/L [Rosemarin et al. 1986]. It is strongly recommended that the EIS include specific study of the effects of appropriate levels of chlorate on algal communities in the particular discharge zones.</p> <p>d These limits are not applicable to BEK pulp mills employing a TCF bleaching sequence.</p>										
<p>Test methods Page 23</p>	<p>D.1.17 The test methods suggested for the environmental parameters listed above are presented in Table 7. Other approved methods equivalent to, or better than, those listed may be used.</p> <p>Subset of Table 7 Suggested test methods for analysis of liquid effluent pollutants</p> <table border="0"> <thead> <tr> <th data-bbox="506 730 771 760">Parameter</th> <th data-bbox="776 730 1328 760">Test method</th> </tr> </thead> <tbody> <tr> <td data-bbox="506 766 771 1165">Acute toxicity</td> <td data-bbox="776 766 1328 1165"> <p>Australian and New Zealand Guidelines for Fresh and Marine Water Quality, ANZECC and ARMCANZ, October (2000): Volume 1, Table 3.4.1 – Trigger Values for Toxicants at Alternative Levels of Protection.</p> <p>Volume 2, Table 8.3.5 – Summary of the Major Toxicity Bioassays used in Australia for Direct Toxicity Assessment (DTA) Purposes for Marine Test Organisms. Test organisms should be agreed upon by the proponent and the regulatory authority</p> </td> </tr> <tr> <td data-bbox="506 1171 771 1201">Chronic toxicity</td> <td data-bbox="776 1171 1328 1201">as for acute toxicity</td> </tr> </tbody> </table>	Parameter	Test method	Acute toxicity	<p>Australian and New Zealand Guidelines for Fresh and Marine Water Quality, ANZECC and ARMCANZ, October (2000): Volume 1, Table 3.4.1 – Trigger Values for Toxicants at Alternative Levels of Protection.</p> <p>Volume 2, Table 8.3.5 – Summary of the Major Toxicity Bioassays used in Australia for Direct Toxicity Assessment (DTA) Purposes for Marine Test Organisms. Test organisms should be agreed upon by the proponent and the regulatory authority</p>	Chronic toxicity	as for acute toxicity				
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<p>Monitoring Table 9 Page 31 - 34</p>	<p>Subset of Table 9 Indicative core chemical, biological and other parameters to be monitored</p> <table border="0"> <thead> <tr> <th data-bbox="506 1312 917 1344">Parameter/assay</th> <th data-bbox="922 1312 1328 1390">Discharge Water</th> </tr> </thead> <tbody> <tr> <td data-bbox="506 1402 917 1470">Effluent toxicity tests ^f – on 100% effluent</td> <td data-bbox="922 1402 1328 1470"></td> </tr> <tr> <td data-bbox="506 1501 917 1533">Microtox®</td> <td data-bbox="922 1501 1328 1533">W ^f</td> </tr> <tr> <td data-bbox="506 1564 917 1596">Others ^f</td> <td data-bbox="922 1564 1328 1596">M ^f</td> </tr> <tr> <td data-bbox="506 1627 917 1659">– more sensitive tests ^g</td> <td data-bbox="922 1627 1328 1659">T</td> </tr> </tbody> </table> <p>^F Microtox® tests can be performed rapidly and provide a good routine indication of mill performance. Weekly tests should enable any significant fluctuations in effluent quality to be detected and remedied. However, Microtox® tests alone cannot ensure that the full range of potential toxicant functions on higher organisms is detected if present. An invertebrate and a vertebrate test should be conducted monthly to ensure other possible types of toxicity are detected. Appropriate tests should be chosen as part of the monitoring program at such time as implementation is required.</p>	Parameter/assay	Discharge Water	Effluent toxicity tests ^f – on 100% effluent		Microtox®	W ^f	Others ^f	M ^f	– more sensitive tests ^g	T
Parameter/assay	Discharge Water										
Effluent toxicity tests ^f – on 100% effluent											
Microtox®	W ^f										
Others ^f	M ^f										
– more sensitive tests ^g	T										

	<p>Other tests that have been validated for pulp mill effluents may also be available when the guidelines are required to be implemented.</p> <p>⁹ A suite of short-term sublethal toxicity tests using organisms from at least three trophic levels represented by different taxonomic groups (e.g. algae, invertebrates and fish) and a range of potential mechanistic effects should be conducted at three-monthly intervals in effluents. Research conducted for the National Pulp Mills Research Program has developed short-term sublethal toxicity tests using <i>Nitzschia</i>, <i>Hormosira</i> fertilisation, sea urchin fertilisation, doughboy scallop larval development and <i>Allorchestes</i> larval development. With the exception of the <i>Allorchestes</i> test, these bioassays have been trialed with modern laboratory bleached eucalypt kraft effluents for both ECF and TCF bleaching sequences. The test protocols are available and are being published as part of the Technical Report series of the National Pulp Mills Research Program (e.g. Stauber et al. 1994). Other research conducted by the Program has seen some progress in designing tests of larval development using <i>Tisbe</i>.</p> <p>There should be yearly short-term sub-lethal toxicity tests on sediments as soon as suitable tests are available. Developing such tests has proved to be an extensive and difficult task for all countries. Environment Canada has begun an extended five year program to focus on developing sediment toxicity tests suitable for their pulp and paper industry. The National Pulp Mills Research Program also recognised the need for suitable sediment tests. However, appropriate expertise was not forthcoming and suitable tests have not yet been developed for Australian conditions. Some methods are described in Dickson et al. (1987). Environment Canada (1992) has published a method using amphipods. This is an important area which needs to be addressed to ensure appropriate monitoring of potential long-term effects of any effluents. Choice of tests will need to be assessed when the guidelines are required to be implemented.</p>
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General Comments on Volume 17

The test methods used were based on short term acute and sub acute ('chronic'¹) toxicity testing. The tests were carried out using species local to the region using Direct Toxicity Assessment (DTA) as described in the ANZECC/ARMCANZ 2000 Guidelines for fresh and marine water quality Volume 2 for direct toxicity assessment (DTA). These tests were broadly established or evaluated by the National Pulp Mill Research Program (NPMRP) established by the Commonwealth Government and managed by the CSIRO.

¹ The use of the term 'chronic' for several of the tests in the report is not strictly correct. Chronic usually refers to long term effects (weeks or months) on metabolism, growth, reproductive success etc. and may not be appropriate for the short term tests (0-4 days) used. Sub-lethal or sub-acute should be used instead.

Of the tests, only the larval fish toxicity test using the striped trumpeter was newly adapted for this project. Pulp Mill effluents from pulp mills with similar technology to that proposed was sourced from South America and Thailand. The justification that this was appropriate as the technology was similar is only partly valid if the same tree types were processed as the effluent tested is the same as the trees to be processed in the Tasmanian project. For example sterols are high in conifers and eucalypts and lignin content is lower in softwoods. Sterols have been identified as causing reproductive effects in fish through disruption of the endocrine system.

The suite of biota tested provided a representative suite of species for environment (Bass Strait) which the proponents of the pulp mill are seeking to protect, but would not represent all components of the marine environment. Longer term sub lethal impacts including mechanistic assays may be needed.

Tables 3 below summarises the issues raised in **V5_A3** *Final Scope Guidelines for the Integrated Impact Statement* and **V5_A5** *Recommended Environmental Emission Limit Guidelines for any New Bleached Eucalypt Kraft Pulp Mill in Tasmania* as discussed above and compares that to the work carried out and reported on in **Volume 17_A58, 59 & 60**. Column one lists the issues raised, columns 2 & 3 whether the tests address short and/or long term responses and a column indicating tests used and/or comments made. It is not clear what Terms of Reference were provided to the consultants so addressing some of these issues may well have been outside the scope of their work, but have been included here in an attempt to address all of the issues raised in the IIS documents referred to.

Table 3 – Summary of issues raised in V5_A3,5 and if they were addressed by toxicity testing in Volume 17

Issues raised	Short term	Long term	Test used / comments
Toxicity (acute)	yes	No	Microtox [®] , sea urchin fertilisation
Toxicity (“chronic”) ¹	yes	No	Tests in addition to those above.
Mutagenicity	No	No	Not covered in suite of tests
Toxicity (Long term acute and chronic)	No	No	Tests were not designed to detect long term impacts
Cumulative	no	-	Long term cumulative effects are not able to be detected in these type of tests
Antagonistic and synergistic	Yes	-	Use of DTA in these tests would have allowed for these interactions for the whole effluent but would not consider interactions between individual chemicals.
Specific response to chlorate	Yes	-	Brown algae test conducted
Mechanistic assays (e.g. endocrine disruption)	No	No	Referred to in V5_A5

¹ The use of the term ‘chronic’ for several of the tests in the report is not strictly correct. Chronic usually refers to long term effects (weeks or months) on metabolism, growth, reproductive success etc. and may not be appropriate for the short term tests (0-4 days) used. Sub-lethal or sub-acute should be used instead.

Comments on Individual Questions Asked of the Reviewer

1. *Adequacy of how the Draft IIS (Volume 17) addresses the issues as set out in the Guidelines.*

The tests conducted address some, but not all of the issues identified in the Tasmanian Guidelines and also listed Table 3 of this document. In the absence of a Terms of Reference (for the reviewer) these comments have been included for completeness (refer to Heading 5. for further detail). The suite of tests conducted will not detect long term responses such as mutagenic and synergistic and antagonistic effects. These tests are available in the research laboratories, although may not be available commercially at this stage. The possible expansion of the range of tests conducted if the project goes ahead, needs to be given serious consideration.

2. *Is it adequate for the RPDCs assessment purposes?*

For the RPDCs assessment purposes it should be noted that several assumptions are made. Firstly that the dilution at the “edge of the mixing zone’ was 1% effluent or less, and secondly that the effluent discharged was the same as those tested. It would appear that water use in the proposed process plant is significantly less than in the effluent tested, so the effluent may be more concentrated. This also needs to be considered in the assessment of the data.

Toxicity was very low in the test effluents under the conditions of testing. It should be noted however that these results are only relevant to diluted effluent (at the edge of the mixing zone) or beyond due to the alteration of the salinity in the test solutions to that of seawater to protect the test biota during the tests. The water that will be discharged from the diffusers will have low salinity due to source of the process water, and therefore there is likely to be a barren zone around the point of discharge as fresh water in a marine environment can be just as or more harmful than trace chemicals that may remain after effluent treatment. Freshwater can act as a synergist when present with chemicals (on the assumption they are present) that the biota is not normally exposed to. The testing therefore does not cover all expected impacts.

The results found in these tests found that the effluent tested (from Thailand and South America) would comply with the Guidelines in that the “acute toxicity of the effluent should be less than 50%” (V5_A5 Table 6, page 22) for most of the tests with the exception of doughboy scallop larval development (V17_A59 and V17_V58). However it needs to be determined that the test effluent was representative. Effluent quality depends on what is being processed as well as the technology involved.

For ‘chronic’ toxicity, the NOEC found was 25% which still complies with the Guidelines in that “The discharge limit is not exceeded at the edge of the mixing zone” (V5_A5 Table 6, page 22, comment b). This would also apply for the data for the doughboy scallop if this was accepted as a ‘chronic’ response, rather than acute.

3. *Validity of methodology and findings.*

The methods used and the conclusions may be valid for the tests conducted, however they only apply to the range of test organisms and test methods used. There was no discussion on how the data may relate to the field environment. It may still be possible to extrapolate from these results, as a representative range of species was included in the suite of tests, but this type of discussion was not provided by the consultants. There is an

assumption (based on information provided by Gunns Limited) that there will be a 1 in 100 dilution (i.e. 1% effluent) at the edge of the mixing zone. The report states that no acute or sub-acute toxicity would be expected at this dilution and the comments are valid, but no comment was made of what could happen within the mixing zone. The data produced would not be relevant for the mixing zone, as the salinity would be quite different to in the laboratory tests.

4. *Whether the proponent's conclusions are reasonable and scientifically based.*

Based on the tests conducted, the conclusions were appropriate but limited. For example the data does not provide information about long term cumulative effects or effects due to bioaccumulation, differences in effluent quality and concentration etc. Many other variables (time in mixing zone), mode of feeding (bottom feeders or pelagic), sessile or mobile etc are likely to be of influence. It is likely that mobile species will simply avoid the mixing zone (due to the presence of freshwater) and therefore exposure would be minimised. Sessile species such as some bivalves (if any exist at the outfall) would not be able to avoid exposure. Larval species are highly mobile and migratory so would not be resident for prolonged periods in the vicinity of the outfall. The discussion in the reports does not consider anything other than the actual test results, but that may have been all that was required. It is unlikely that there will be no effect at all, from a discharge of significant volume.

5. *Identify any major/critical errors or omissions in the Draft IIS and identify what further work is required.*

It is not possible to identify omissions without a Terms of Reference being available to the reviewer however there may be additional tests that could be considered if the project proceeds. For example for some timber species, bioactive substances (e.g. lignins and terpenoids, plant sterols, sterol esters, ketones and steroid hydrocarbons) have been reported to have sub-lethal or chronic effects on fish reproduction.

These effects are identified by mechanistic in vitro and in vivo bioassays. Chemicals from process waters can originate from the wood itself and result in formation of so called pitch deposits that can cause problems in the pulp mill industry.

Further work could include determination of the full range of monitoring methods required. The toxicological aspects need to be considered along with the physicochemical and chemical parameters.

Three modes of monitoring are specified as:

1. Surveillance monitoring aimed at assessing long term water quality changes and providing baseline data.
2. Operational monitoring aimed at providing additional and essential data for water bodies at risk or failing environmental objectives.
3. Investigative monitoring aimed at assessing causes of failure or to determine what surveillance and/or operational monitoring will be required.

Aquatic ecosystems are complex and there are many problems associated with monitoring their quality. If a good quality status is achieved, then only surveillance monitoring is required to make sure this is maintained. However for water bodies considered to be at risk, then further information will be required so that remediation strategies can be implemented and subsequently monitored.

The ANZECC/ARMCANZ Water Quality Guidelines includes trigger values which if exceeded indicate that site specific assessment is required. Trigger values only exist where there is robust scientific data is available and not all chemicals that may be found as a result of the operations are included at present.

Specific Comments on Reports

The following are specific comments on each of the reports. Much of this is editorial. The documents (V17_A59 & 60) were difficult to navigate due to the numbering system used for the appendices. Each appendix had a cover page numbered sequentially, but each appendix had its own numbering system within each one so it was difficult to cross reference from the report text to the Appendices.

Volume 17 Appendix 58

Page 3. Reference to Appendix A in last paragraph should be Appendix B.

Page 3. Last paragraph. Reference to number of Microtox[®] assays is incorrect. Microtox[®] was run on Days 0, 1, 2 and 5, 6 and 7. This is six days (over an 8 day period). This is also repeated on page 7, and 12.

Page 7. Paragraph 3 “Incipient concentration”. I would have expected this to be ‘inhibitory concentration’ as it was referring in this instance to growth of cells.

Page 9. Glossary “LC50 is the median ‘effective’ concentration”, should read median ‘lethal’ concentration.

Page 12. Comment below table. This indicates that the effluent will be more concentrated in the proposed mill compared to the water that was tested. This is relevant (but not commented on) to the results of the toxicity testing.

Page 14. Last paragraph. “undiluted 75% and 50% sample treatments.” Shouldn’t this read “less diluted”

Page 17. Table 4.2. Heading of third column does not describe the data.

Page 20. Table 5.2. Heading of third column does not describe the data.

Page 23. Table 6.2. Heading of third column does not describe the data.

Page 28. Table 7.4. Observed value for Control germination minimum does not agree with data in Table 7.2.

Page 30. Table 8.2. Include units for column 3.

Volume 17 Appendix 59

Page 3. Reference to Appendix A in last paragraph should be Appendix B.

Page 4. typo in last sentence of paragraph 2.

Page 6. Paragraph 3, “Incipient concentration” I would have expected this to be ‘inhibitory concentration’.

Page 6. Last sentence. This is irrelevant as the test endpoint is what was happening at 48hrs, not some time later.

Page 9. Glossary. “LC50 is the median ‘effective’ concentration”, should read median ‘lethal’ concentration.

Page 12. Comment below table. Not clear what this is referring to in this document.

Page 19. Last paragraph. The difference between 'normal' and 'abnormal' larvae is not stated.

Page 20. Table 5.2. Heading of third column does not describe the data.

Page 23. Table 6.2. Heading of third column does not describe the data.

Page 27. Table 7.2. Heading of third column does not describe the data.

Page 27. Second paragraph. Controls omitted. Explanation noted.

Volume 17 Appendix 60

Volume 17_A6 only reported the test results of an assay using sodium chlorate in a 72hr macroalgae test using *Hormosira banksii* on which there was no effect under the test conditions used. No discussion of this result was included so this cannot be commented further.

APPENDIX A

Hi Heather

I don't know what terms of reference Gunns Limited gave to Ecotox.

A critical aspect of the proposal is for Gunns to establish that the mill would be able to comply with the Tasmanian Government's Environmental emission limit guidelines for any new bleached eucalypt kraft pulp mill in northern Tasmania (2004).

The primary purpose of the Ecotox work appears to be an attempt to draw together a body of evidence to demonstrate ability to comply with the Tas Govt emission limit guidelines.

Attached is a copy of these guidelines for your info.

Call me if I can help clarify / explain process etc.

Many thanks

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Heather Chapman
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02/10/2006 10:53 AM

To Pam.Scott@rpd.tas.gov.au
cc
Subject Re: Peer review of Gunns' Draft Integrated
Impact Statement - toxicology assessments

Pam,

Was there a specific terms of reference or scope for the work done by Ecotox? I am reading through the 'Final scope guidelines...' at the moment but have not found anything directly related to the tox testing yet. Also have chemical analyses been carried out on the effluent used for the tox testing?

I see that the health risk is in Part 7.7 but can't (yet) see an equivalent for the toxicity testing. Was it a part of a broader assessment? I am trying to put the Ecotox work into the context of other activities.

Heather

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