Comment on: UPL PCD EFFLUENT TREATMENT AND DISCHARGE AD HOC REPORT, DRAFT 2 by M. Graham, A. Lepheana, K. Johnstone and P. Hampson

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Caveat:. This report is for the sole and exclusive use of the addressee and represents a scientific opinion based on personal insights. knowledge and experience, and in the specific context and, therefore, subject to specific boundary- and departure conditions that may not have been explicitly stated in the report. The author understands that this report will be submitted to the relevant authorities as an accompaniment to the Graham et al Report referred to above and consents thereto. None of the implicit or explicit conclusions are to be used for legal- or water treatment process design purposes, without prior consultation with the writer to verify the contextual limitations.

The purpose of this report is to comment on the use and context of the ecotoxicological test results as recorded in the above report.

The authors of this report used and referenced to the document: The management of complex industrial waste discharges: Direct Estimation of Ecological Effect Potential (DEEEP). A discussion document from Department of Water Affairs and Forestry, July 2003. To the best of my knowledge this document has never been superseded by an updated version. In its current form (a discussion document) it has been used since then by a number of service providers.

The DEEEP document represents the efforts of some South African experts in the field of ecotoxicity testing and reflects the philosophy with respect to resource quality management that was influenced by the White Paper on the National Water Act (Act No 36 of 1998). The Act itself (as is proper for legislation of this kind) does not refer to this (or any other) specific methodology. It is, however, in keeping with the water resource strategies that have been developed subsequently (NWRS 1 of 2007 and NWRS 2 of 2013). Some officials were concerned that the methodology was too advanced for general South African application. So, the inclusion of this approach in the UPL study is commendable.

DEEEP itself reflects a development in water resources management philosophy that started to emerge during the 1980's – a change from source-based to resource-based management. The application of DEEEP in the context of the current study is, therefore, deemed appropriate[1].

Using DEEEP as a basis for environmental hazard- and risk assessment in this study one should note:

[1] It should be noted that DEEEP was intended to be used on "complex industrial waste water" as defined under Section 3 of the Revision of General Authorisations In Terms Of Section 39 Of The National Water Act, 1998 (ACT NO. 36 OF 1998) GAZETTE NO 26187. (This deals with Section 21 (f) and (h) of the NWA). I am not aware that to date it has been in formally included in its provisions. This is a matter that should be taken up with the relevant water regulation authorities.

1. The methodological detail for DEEEP is not fixed. This means that the specific biotic species used for testing water are not rigorous in their selection. Rather, the scientific and technical insight must be in keeping with the development of ecotoxicological testing technology. It might be that the sensitivity of a species and the ability to maintain a viable laboratory culture with suitable genetic purity be balanced against ideal test species. While an indigenous species of high sensitivity might be ideal, it does not necessarily follow that such a species is a viable test species. The species described in the above report are generally consider optimal and, in my opinion, fit for purpose and for the intended testing/enquiry considered.
2. As a corollary to the foregoing, there is no guarantee that more sensitive species cannot be found in a given aquatic ecosystem. Toxicity mechanisms are wide ranging and diverse with respect to intra-organismal receptors. For specific receptor agonists, very specific tests could be developed. However, high sensitivity and specificity do not necessarily correlate to measurable ecosystem risk (i.e., probability of impact).
3. The DEEEP methodology has always been intended to be tailored to catchment-specific requirements. Where an ecotoxicological response was detected using this suite of species, it was originally intended that the USEPA's whole effluent toxicity (WET) testing approach, for example, should be followed to determine what type of stressor was involved. This knowledge should then be used to focus the species or receptor selection. It was noted very often that measured impact from environmental samples were due to physical (suspensoids, surfactant micelles, etc.) rather than chemical contaminants. In the case of urban sourced effluents, the presence of water treatment oxidant residues such as hypochlorite is particularly problematic as it produces misleading signals.
4. From this report it would appear that organic contaminants (specifically pesticides) would be a main focus area. The UV/O_3 treatment tends to provide sufficient oxidative power to disrupt most organic chemical structures. One would suspect that the residues should be non-toxic to higher organisms, as is borne out by the results. One would ideally have to make sure that there are no residues with mutagenic properties (perhaps using the standard Ames' Salmonella test, for example, with extraction and concentration). These tests are currently not part of the standard suite of DEEEP tests and not part of any mandatory requirement. While this is not a mandatory requirement, it is understood that UPL is currently in the process of monitoring mutagenic hazard by conducting additional tests as a precautionary measure.

From the results as presented I would conclude that:

a) The chemical measurements do not appear to show clear reason to suspect residual hazard at current concentration levels. With such a low measurable hazard, the aquatic ecological risk is expected to be negligible to low. No further dilution appears to be necessary based on the presented results.
b) Where Class II results are found, it would be prudent to check for sewage impact before any effluent treatment process adjustments are made.
c) If the DEEEP methodology is to be applied outside the scope of the UPL incident study, as a waste water or industrial run-off assessment measure, that the WET procedure be applied to focus biotic testing[2]. This type of study would require both chemical and toxicity testing as

[2] It was noted that there was an attempt made to use an ion exchange approach to eliminate copper as a potential source of toxicity. While these results were inconclusive, this type of approach by UPL is

well as some specifically designed laboratory work. It should be possible for this type of work to produce some form of early warning system.

d) The arsenic levels at the upper stations were noted. This seems anomalously high in the 19th July samples. As noted, this might not be associated with Cornubia effluent, but arsenic is relatively mobile in air in its reduced form. These sampling points should be watched closely in future monitoring. It might merit further investigation by the relevant water authorities to try to understand the source(s) and advection within the broader catchment.
e) I recognize that this is a matter of policy, but my recommendation would be that the regional water authority gives some thought to reclassifying the PCD effluent so that it is no longer considered a complex industrial waste, but rather it could be handled under a general authorization with appropriate stipulations[3].

In summary:

- The use of the aquatic ecotoxicity protocols used in this investigation, and the DEEEP methodology used, is fit for purpose in this instance.
- The results from the discharge from the treated PCD water do not appear to indicate any negative impact on the receiving environment. It does appear though to be highly impacted by the noted sewage impacts.
- The Class I (no lethal/sub-lethal hazard), as achieved in the post treatment of the PCD water, indicates that this water does not pose any additional toxicity risk to any aquatic trophic level beyond which is already within the receiving system – as measured. As such, this plant would appear to be a suitable treatment for any residual pesticide toxicity, and prior to its discharge to the receiving environment.
- Achieving a Class I level with the PCD treatment plant, and toxicity testing, would imply that no further dilution is needed to further reduce the toxicity of the PCD discharge water.
- Once the water in PCD is able to reach a Class I level consistently, it could be discharged safely into the receiving natural water environment, provided that suitable up and downstream monitoring in accord with good scientific practice is followed.

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25th September 2023

commendable, which appears to have done what it can to deal with the existing situation. For future routine monitoring, an analogous approach on the residual organic chemicals could be considered.

[3] A discharge licence could possibly be subject to the requirement that periodic toxicity screening with suitably selected biotic species be included in the discharge licence. (Some examples of how this type of situation has been dealt with in other countries are listed in Table 1 at https://www.concawe.eu/wp-content/uploads/2017/01/cr131-wholeeffluentassessment-2004-01247-01-e.pdf).