Chemistry Task Team comments on 2018 industry-sponsored EQS derivation report for Emamectin Benzoate

As part of the data package relating to the fish farm medicine ememectin benzoate, the Chemistry Task Team of UKTAG (CTT) received a 2018 industry-sponsored EQS derivation report produced by the consultancy firm wca environment (wca 2018). The report used the new ecotoxicity studies conducted by industry (see *Chemistry Task Team Recommendation for an EQS for Emamectin Benzoate* document for details) and also includes a summary and appraisal of the industry-led field study (SAMS 2018), and how its results inform their derived sediment EQS. The derivations follow the principles of the Technical Guidance for Deriving Environmental Quality Standards (2011 WFD Common Implementation Strategy technical guidance 27; herein CIS 27). wca Environment did not carry out an evaluation of the reliability and relevance of the pre-existing ecotoxicity data, instead relying on the reliability stated in the 2017 WRc report (WRc 2017; this is relevant for the pelagic derivations).

As CTT was given sight of this report, and the EQS derived in it differ from those recommended by CTT, CTT has provided a discussion of the wca Environment derivations in this document. The derivations focus on the marine environment, as is the case for the CTT proposals based on the substance's use pattern.

Pelagic EQS

MAC-EQS$_{water}$

Proposals summary:

Derived by	MAC-QS$_{water}$ (ng/l)	Data; assessment factor
wca environment 2018	1.1	geo mean of three 96h mysid shrimp studies LC50 0.056ug/l; AF = 50
CTT 2019	7.8	Mysid shrimp 96h LC50 0.078ug/l; AF = 10

Based on the recent mysid shrimp study (EPP 2018a) and the existing acute mysid shrimp studies, wca environment derived a geometric mean of the three LC50s to give the MAC-QS$_{pelagic}$. As discussed in the *Chemistry Task Team Recommendation for an EQS for Emamectin Benzoate* document, CTT does not think the original mysid shrimp studies are reliable (and may in fact be the same study, a point that is relevant for geometric mean derivation). The value wca used for the new study also differs from that used in the CTT recommendation. wca used a value of 0.112ug/l as opposed to 0.078ug/l. This value is not reported for the 96h LC50 in the study report and does not correspond to nominal concentrations. It may be the LC50 for 72 hours' exposure. wca environment did not consider additional data in the dataset that could allow a lowering of the assessment factor, hence the difference in assessment factor from that used in the CTT recommendation. This may have been because they took not only the reliability assessment but also the assessment factor selection in the 2017 WRc report as being agreed.

AA-EQS$_{water}$

Proposals summary:

Derived by	AA-QS$_{water}$ (ng/l)	Data; assessment factor
wca environment 2018	0.47	mysid shrimp 28d EC10 9.44ng/l; AF = 20
CTT 2019	0.19	mysid shrimp 28d EC10 9.44ng/l; AF = 50

Both recommendations use the same datapoint from the new mysid shrimp study. However wca environment used a non-standard assessment factor of 20, as was used in the WRc 2017 report. Again this may have been because they took not only the reliability assessment but also the assessment factor selection in the 2017 WRc report as being agreed. CIS 27 states as a general note:

Evidence for varying the assessment factor should in general include a consideration of the availability of data from a wider selection of species covering additional feeding strategies/ life forms/ taxonomic groups other than those represented by the algal, crustacean and fish species (such as echinoderms or molluscs). This is especially the case, where data are available for additional taxonomic groups representative of marine species. More specific recommendations with regard to issues to consider in relation to the data available and the size and variation of the assessment factor are indicated below.

CTT believes the case for this non-standard AF is not fully justified and that 50 would be more appropriate and in line with CIS guidance, as discussed in the *Chemistry Task Team Recommendation for an EQS for Emamectin Benzoate* document.

Sediment EQS

"Far field" sediment EQS

Proposals summary:

Derived by	EQS$_{sediment}$	Data; assessment factor
wca environment 2018	1290 ng/kg (dwt); 997 ng/kg (wwt)	10d *Arenicola marina* EC10 (casting) 12.9ug/kg dwt (9.969ug/kg wwt); AF = 10
CTT 2019	23.5 ng/kg (dwt)	28d *Chironomus riparius* NOEC (emergence) 1.175ug/kg dwt; AF = 50

Dwt = dry weight

In addition to the full laboratory test dataset, wca also considered the results of the industry field study in their derivation. It is not clear whether they were asked to consider the SEPA field study (SEPA 2018). For details of the available dataset, see the *Chemistry Task Team Recommendation for an EQS for Emamectin Benzoate* document.

Before discussing the critical datum and assessment factor to use in this EQS derivation, how the chronic marine dataset has been treated needs to be examined. There are two chronic leptocheirus studies (EPP 2018e and EAG 2018). In their summary of the chronic leptocheirus data, wca presented an EC10 (growth) of 17.6ug/kg for the EPP 2018e study as the most sensitive endpoint in truly chronic studies. However this result is not presented in the study report, instead a NOEC of <21.7ug/kg (the lowest concentration tested) is presented alongside an EC50 of 65.6 µg/kg (95% confidence intervals 58.9, 74.2) for the endpoint (the report did not present EC10s for any

endpoints, just NOECs, LOECs and EC50s). CTT can agree with the EC10 value as presented by wca as the most sensitive endpoint in this study (and the more sensitive between this and the EAG 2018 study). However CTT thinks wca environment's approach to combining EC10 growth results from the two leptocheirus studies, as the most sensitive endpoint for this species in both studies, is incorrect, as follows. The EAG 2018 study derived an EC10 for growth for males and females separately, whereas the EPP 2018e study did not consider sexes separately. However wca have taken a geometric mean of the three results (i. EC10 for growth (males) and ii. EC10 for growth (females) from the EAG 2018 study, iii. derived EC10 for growth EPP 2018e study), in effect treating them as if they are from three different studies, not two. Although CIS 27 guidance recommends the use of the geometric mean to combine results from multiple studies, the guidance does not specify what to do when combining results within a study. CTT believes an average of the male and female growth rates in the EAG 2018 study must first be taken, then a geometric mean of the two studies derived. Using either the geometric or arithmetic mean gives a mean EC10 (growth) for the EAG 2018 study of 53ug/kg, and so a geometric mean for the species/endpoint (17.6 and 53ug/kg) of 30.5ug/kg, as opposed to 36.6 ug/kg as presented by wca.

Of the four available chronic studies, the most sensitive is the freshwater midge study. However, wca discounted this study as not relevant. They state:

> "*The data derived for marine species significantly expands the available reliable data for EMB (emamectin benzoate) ecotoxicity to benthic organisms and they are sufficient to derive a marine sediment EQS without the need to include the freshwater (C. riparius) data. The larvae of C. riparius live and feed in freshwater sediments, but adults are not aquatic. In addition, the most sensitive endpoint in the C. riparius study was adult emergence from pupae (i.e. following metamorphosis from larvae). There are no truly marine insect species. From the 25,000-30,000 insect species that are aquatic or have aquatic larval stages, only a fraction, perhaps several hundred species, are marine or intertidal (Cheng 1976). Their habitat is limited to transitional environments provided by estuaries, saltmarshes, mangrove swamps, and the intertidal zones (Cheng 1976). Furthermore, since there are no marine invertebrate species which have life cycles involving aquatic larvae and non-aquatic adults, this study could be considered as not relevant for the derivation of a long-term marine sediment EQS for EMB. We have therefore derived a sediment EQS for EMB using only marine sediment data.*"

CTT does not agree with this conclusion, as there are valid reasons for using the freshwater midge study (see CTT's sediment EQS recommendation in the *Chemistry Task Team Recommendation for an EQS for Emamectin Benzoate* document).

In their derivation wca did not comment on the relative sensitivities of marine benthic organisms in the available acute toxicity dataset. Reliable studies are available in:

- *Arenicola marina*: 2 studies 10-day LC50s 111ug/kg & 40.8ug/kg
- *Corophium volutator*: 2 studies 10-day LC50s 193ug/kg & 141 ug/kg[1]
- The spot prawn *Pandalus platyceros*: 8d EC20 (mortality) 138ug/kg

It can be see that the most sensitive species was arenicola (wca used the sub-lethal casting endpoint in as the key datum in their derivation), however two amphipod species were chosen in the first instance for chronic testing rather than an annelid. This means the current chronic dataset does not represent known sensitive species.

[1] A sediment-free corophium study is also available but deemed not relevant

In the dataset wca considered (ie marine organisms only), a sub-lethal endpoint from the acute lugworm study listed above gave a lower result than those observed in the three marine chronic studies. This is the 10-day EC10 for casting of 12.9ug/kg dwt (the lowest endpoint from the chronic studies is the geometric mean for the EC10 for growth rate from the two leptocheirus studies discussed above, cited as 36.6ug/kg dwt by wca). wca recognised that there is uncertainty in this approach with respect to chronic effects in lugworms since no chronic study is available in arenicola:

> "*However, the Arenicola casting endpoint is derived from an exposure of relatively short duration (10 days) and could be considered to be unrepresentative of the long-term toxicity of EMB to polychaetes."*

However, they did not discuss how the EC10 for casting was derived and the fact that it appears the study authors did not did not take into account the decreasing number of worms per test vessel in statistical analysis for the endpoint (see discussion in CTT sediment EQS section in the *Chemistry Task Team Recommendation for an EQS for Emamectin Benzoate* document). wca environment go on to describe the ongoing conduct of an additional chronic study in the polycheate *Hediste diversicolor* (the European ragworm) to address this deficiency. What they do not do is adjust the assessment factor, the lowest available according to CIS 27 for the deterministic approach to deriving EQS, to account for this uncertainty in their derivation.

In their derivation, wca have not normalised results relative to a standard organic carbon content as is recommended in CIS 27. Most of the new toxicity studies have very low OC contents; at 0.2 to 0.3%, more than ten times lower than the CIS 27 standard (the chronic corophium study (Scymaris 2018) is far higher, at 5.75% OC). The arenicola study wca used for their EQS derivation had an OC content of 0.2%, far from the standard content recommended by CIS 27.

wca also estimate chronic toxicity in sediment dwelling organisms using the equilibrium partitioning approach. Based on the chronic mysid shrimp result, they estimated a lowest QS of 1199ng/kg dwt (much higher estimates were presented depending on input values for organic carbon content and emamectin's organic carbon partition coefficient, Koc). This estimated QS is slightly lower than the EQS derived by wca. The equilibrium partitioning approach is designed to be precautionary as its main use is in guiding the need for sediment or soil toxicity testing under regulatory regimes like the EU REACH regulation in the absence of acute and/or chronic test data.

wca environment also provided a critique of the industry-sponsored field monitoring study (SAMS 2018), stating that it is of limited use in setting an EQS because no dose-response relationship was apparent between emamectin concentrations and measures of benthic impact (the key one being crustacean richness), even though various statistical approaches were followed in interpreting the data. They go on to state that the study is still useful because they believe it supports their far field EQS derivation precisely because no dose/response relationship was derived for concentrations within the concentration range that includes their proposed EQS (ie they deem their EQS proposal a protective, "responsible" value). CTT agree with their explanation of the study's result but interpret the study's shortcomings as being a strong reason for not "proving" the absence of effects, contrary to wca environment's conclusion.

Wca's sediment EQS development uses the lowest possible assessment factor for the deterministic approach, despite their recognition of some of the shortcomings in the dataset (EQS based on a sub-lethal endpoint from an acute study of short duration). They state that the industry field study indicates that field concentrations in the range of the EQS do not indicate any dose-response relationship, however given the difficulties in interpreting the study and their omission of information from the SEPA study (SEPA 2018), with its alternative findings, this justification seems

questionable. Derivation should take account of the uncertainty with the key data through assessment factor selection; in this case that would mean deciding to use a higher assessment factor than the lowest permitted according to CIS 27.

"near field" sediment EQS

Proposals summary:

Who	nf-$QS_{sediment}$	Data; assessment factor
wca environment 2018	2580 ng/kg (dwt); 1994 ng/kg (wwt)	10d *Arenicola marina* EC10 (casting)12.9ug/kg dwt (9.969ug/kg wwt); AF = 5
CTT 2019	n/a – see *Chemistry Task Team Recommendation for an EQS for Emamectin Benzoate* document	

wca environment chose an assessment factor half that of the AF used in the far field derivation. CTT has not recommended an EQS for this situation as it is not covered by CIS 27 (see *Chemistry Task Team Recommendation for an EQS for Emamectin Benzoate* document).

References

CIS 27. European Commission (EC). 2011. Common implementation strategy for the water framework directive (2000/60/EC) Guidance document No. 27. Technical guidance for deriving environmental quality standards. ISBN : 978-92-79-16228-2. https://circabc.europa.eu/sd/a/0cc3581b-5f65-4b6f-91c6-433a1e947838/TGD-EQS%20CIS-WFD%2027%20EC%202011.pdf

EAG 2018. EAG Laboratories. Emamectin benzoate: A life-cycle toxicity test with the marine amphipod (*Leptocheirus plumulosus*) using spiked sediment. PROJECT NUMBER: 706A-104.

EPP 2018a Determination of acute toxicity of emamectin benzoate to mysid shrimp (*Americamysis bahia*) (96-hour static).

EPP 2018b. Determination of chronic toxicity of emamectin benzoate to mysid shrimp (*Americamysis bahia*) (28-day flow-through).

EPP 2018c. Determination of acute toxicity of emamectin benzoate to lugworm (*Arenicola marina*) (10-day static).

EPP 2018d. Determination of acute toxicity of emamectin benzoate to marine amphipods (*Corophium volutator*) (10-day static).

EPP 2018e Emamectin benzoate: marine sediment chronic toxicity with amphipod (*Leptocheirus plumulosus*).

SAMS 2018. PASSIVE FIELD MONITORING SURVEY FINAL REPORT. Document number 01963.2_0010, September 2018.

Scymaris 2018. Scymaris Ltd. Emamectin benzoate: Determination of effects in a water/sediment system on growth and reproduction of *Corophium volutator* using spiked natural sediment.

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