NORTHWEST ENVIRONMENTAL ADVOCATES

April 11, 2011

Jannine Jennings, Manager
Region X, Water Quality Standards Unit
U.S. Environmental Protection Agency
1200 Sixth Ave., Suite 900
Seattle, WA 98101

Via E-Mail: jennings.jannine@epamail.epa.gov

Re: **Pending EPA Decision on Oregon's Proposed Deletion of Iron and Manganese Numeric Criteria**

Dear Jannine:

I am writing to bring a potential problem to your attention, assuming that EPA has not yet made a decision on Oregon's proposed revisions to its iron and manganese water quality criteria. As you know, at its December 9, 2010 meeting, the Oregon Environmental Quality Commission (EQC) amended Oregon's water quality standards for iron and manganese which, presumably, the Oregon Department of Environmental Quality (DEQ) has now submitted to EPA for action. Specifically, Oregon proposed to delete the human health water +organism criteria for iron and manganese and the human health organism-only manganese criterion as it applies to freshwater.

Northwest Environmental Advocates (NWEA) did not submit comments on these proposed revisions during the Oregon comment period. However, a few days ago I was discussing some pollution sources with some knowledgeable people. During this discussion one of them mentioned that iron and manganese could be problems in fish hatcheries. Naturally, I was struck by the juxtaposition of "iron and manganese" given the DEQ's representations that there was nothing to worry about with regard to these two parameters. At that point, I also realized that Oregon was proposing to delete numeric criteria for parameters where there is sufficient information to suggest that there are health or environmental impacts from these very same constituents. For this reason, I decided to look more carefully at Oregon's proposal.

As a result of this very quick review, we see two problems. First, the removal of the freshwater manganese criteria would leave no numeric criteria for that parameter to protect *any* uses in freshwater because there are no aquatic life criteria for manganese. Second, we are not completely convinced that there is no human health problem associated with consuming freshwater fish containing manganese and we are concerned about some indications that

manganese in water could pose a threat to infants. For these reasons, we are writing to ask that EPA conduct an especially careful review of Oregon's proposed deletions.

In our September 27, 2010 letter commenting on Oregon's proposed revisions to the human health criteria for arsenic, we discussed the problem of the Oregon DEQ staff's having misled the advisory committee into thinking that there was a scientific basis for its conclusion that arsenic in fish tissue did not pose a human health threat. On that basis, NWEA participated in the discussions and negotiations of that committee only to find later, during the public comment period, that DEQ had incorrectly relied on various information sources concerning arsenic, had failed to investigate the current state of available information, and had misrepresented the facts to the advisory committee.

Now we find ourselves in a somewhat similar position. The basis for these proposed iron and manganese deletions was Oregon's determination, as it told the Commission, that these pollutants "do not pose a human health risk."[1] Oregon's representation to the Commission is similar to what it told the advisory committee, namely that iron and manganese needed to be regulated – or not – solely because of their organoleptic properties. But, it turns out that the situation is more complicated. While Oregon has an aquatic life (chronic) criterion for iron of 1000 µg/l (1 mg/l), Oregon has no aquatic life criteria for manganese. In other words, removal of the human health criteria for manganese in freshwater would leave Oregon with no numeric criterion to protect aquatic life from manganese. Regardless of the fact that the current Oregon human health criteria were adopted based on EPA's recommended manganese criteria, which were apparently based solely on organoleptic effects, Oregon's human health criteria for manganese in freshwater perform an important role in protecting Oregon's aquatic life uses from the effects of manganese. For this reason, NWEA believes that EPA should reject Oregon's proposal to delete the manganese human health criteria unless and until Oregon develops a numeric criterion for manganese to protect aquatic life. Similarly, deletion of the human health criterion for iron, currently at 300 µg/l (0.3 mg/l) would leave Oregon with an aquatic life criterion of 1 mg/l, a level at which aquatic life may well not be sufficiently protected. Again, in the absence of Oregon's affirmation that its current iron criterion for aquatic life is sufficient to protect aquatic life, EPA should reject Oregon's proposal to remove the more stringent of Oregon's current criteria.

Approving the deletion of the human health iron and manganese criteria would appear to create a serious deficiency in Oregon's standards. While with some additional effort NWEA could obtain scientific literature on the problems with iron and manganese to fish, for the purposes of this

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[1] Memorandum from Dick Pedersen, DEQ to EQC Re: Agency Item I, Rule adoption: Amending water quality standards for iron and manganese: December 9-10, 2010, EQC meeting, November 15, 2010, at 1.

letter we are relying on the power of the internet. A Google search of "iron manganese hatcheries" brings up quite a few references. For example, initial studies on groundwater being used for the Fairbanks Experimental Fish Hatchery in Alaska "established that iron removal [from the groundwater] would be required for long-term fish culture."[2] This groundwater has an iron concentration of 5 to 6.5 mg/l.[3] The article from the Alaska Department of Fish and Game states that "[s]tudies involving histological examination of fish gills revealed tissue damage and iron deposition occurring with iron levels of 0.2 mg/l or greater in groundwater. However, fish gill tissue and physiology appeared normal and healthy when iron was 0.15 mg/l or less."[4] This initial information suggests that removing Oregon's human health criterion for iron, leaving only its existing aquatic life criterion for iron in place, may not provide sufficient protection for aquatic life.

Manganese removal from groundwater used at this same hatchery is also discussed.[5] The Alaska Department of Fish and Game concludes that although fish can be raised in 0.7 mg/l of manganese without injury to gill tissue or apparent toxicity to fish, it is preferable to remove the manganese due to its impact on equipment.[6] Elsewhere, however, manganese levels associated with toxicity in freshwater fish are identified at under 0.01 mg/l for continuous exposure in water used for fish culture[7], a 96-hour LC_{50} for freshwater coho salmon (*Oncorhynchus kisutch*) of 2.4 - 17.4 mg.l[8], a multitude of effects at 4.43 mg/l[9], and a range of effects including mortality at 0.5 to

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[2] http://www.adfg.alaska.gov/index.cfm?adfg=wildlifenews.view_article&articles_id=427&issue_id=74.

[3] *Id*.

[4] *Id*.

[5] Fish, J.T., Groundwater water treatment for iron and manganese reduction and fish rearing studies applied to the design of the Ruth Burnett Sport Fish Hatchery, Fairbanks, Alaska, viewed at http://cat.inist.fr/?aModele=afficheN&cpsidt=22088136

[6] *See* footnote 2.

[7] Noga, Edward J., Fish Disease: Diagnosis and Treatment, at 228, viewed at http://books.google.com/books?id=SAdDtT7YRRoC&pg=PA227&lpg=PA227&dq=manganese+fish+hatcheries&source=bl&ots=5ANMW-dH_j&sig=vDqzbdbVwWy51ZbnD6E85ePUuSQ&hl=en&ei=LaWfTbeuOc_OiALOwoGEAw&sa=X&oi=book_result&ct=result&resnum=5&ved=0CDAQ6AEwBA#v=onepage&q=manganese%20fish%20hatcheries&f=false.

[8] Manganese and its Compounds: Environmental Aspects, World Health Organization, Section 7.2, Table 3, viewed at http://www.inchem.org/documents/cicads/

1.0 mg/l.[10] There are numerous publications available as to the necessity of removing iron and

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cicads/cicad63.htm

[9] *Id.* at Section 7.2 ("Most reports on the mechanisms of toxicity of manganese to fish have used unrealistically high manganese concentrations to obtain observable effects. However, Wepener et al. (1992) examined the mechanism of toxicity of manganese (added as manganese chloride) to the banded tilapia (Tilapia sparrmanii) in South Africa. In contrast to the previous studies, manganese was tested at an environmentally relevant concentration of 4.43 mg/litre, the mean level of local waters of the Witwatersrand, at both pH 7.4 and pH 5. There were no mortalities after 96-h exposures. However, there were significant decreases in red blood cells, haemoglobin, mean cell volume, haematocrit, and white blood cells. The decrease in red blood cells and haematocrit was due to internal haemorrhaging, possibly as a result of necrosis of the intestinal mucosa and kidneys. Manganese-induced anaemia was also evident, possibly from damage to haematopoietic tissue in spleen and kidney. Decreased mean cell volume was due to the release of immature red blood cells as a result of bleeding. The enzyme delta-aminolevulinic dehydratase (ALA-D), a key enzyme in haem biosynthesis, showed increased activity to compensate for the hypoxic conditions experienced by the fish. The authors suggested that the decreases in white blood cells may be due to increased secretion of corticosteroids, a non-specific response to environmental stress.")

[10] *Id.* ("In soft water tests, significant embryonic mortality was observed in rainbow trout (Oncorhynchus mykiss) eggs exposed to 1 mg manganese sulfate/litre for 29 days (Lewis, 1976), and brown trout (Salmo trutta) yolk sac fry showed significant reductions in calcium and sodium levels after 30 days' exposure to 6400 nmol manganese/litre (as manganese chloride) at pH 6.5 (Reader et al., 1989). Rainbow trout fry did not significantly avoid manganese sulfate concentrations of up to 10 mg/litre (Lewis, 1976). Increased mortality of rainbow trout (Oncorhynchus mykiss) was observed at a fish hatchery in Arkansas, USA, during 1966. A positive correlation was found between mortality and manganese concentrations (<0.5–1 mg/litre); the presence of oxidized forms of manganese at the interface between anoxic and oxygenated zones was proposed as a possible explanation for the mortalities (Nix & Ingols, 1981). Acid precipitation has caused acid episodes and elevated concentrations of metals such as iron, aluminium, and manganese in streams in mountain regions of Sweden. Cage experiments were carried out with yearling brown trout (Salmo trutta) in the 1980s. Canonical distribution analysis showed that pH (4.5–5.4) and the concentration of labile inorganic manganese (0.1–0.4 mg/litre) explained all the observed mortality. The rate of accumulation on/in trout gills was correlated with the concentration of labile inorganic manganese (Nyberg et al., 1995).")

manganese from water prior to its being used in a fish hatchery.[11] The conclusion one can quickly draw is that iron and manganese are a hazard to freshwater fish.

Oregon might claim that it is more appropriate to delete its numeric criteria for human health and rely on its narrative criteria for the protection of aquatic life but the stark reality is that Oregon has no implementation methods for applying its narrative criteria. As a result of having no implementation methods, and no agency interest in using those narrative criteria, we would venture to say that Oregon has never applied its narrative criteria in any NPDES permit or 401 certification and likely has never or very rarely applied its narrative criteria in developing its 303(d) lists in any instance when to do so provided a greater level of protection to beneficial uses than numeric criteria. In other words, if Oregon were to allege an interest in using its narrative criteria in lieu of numeric criteria, EPA has no basis upon which to believe that the state would, in fact, do that. Likewise, DEQ does not use its authority to protect existing and designated uses in taking regulatory actions of any kind.

Turning to the possible human health effects, we note that Oregon chose to leave in place a saltwater human health criterion for manganese. This is based on "high bioconcentration rates among marine mollusks (oysters). A fish consumption criterion for freshwaters is not needed because BCFs for manganese in freshwater species are low."[12] Quite frankly, NWEA does not know whether this is a correct statement or not. However, based on the experience with DEQ's misrepresenting information on BCFs in the context of the proposed arsenic criteria revisions, mentioned above, we are not inclined to believe it just because DEQ said it. We note that DEQ presented BCF ranges for three species groups of freshwater species on Table 5 of its issue paper but the species themselves are not listed. We are not in a position to evaluate these data but, once again, we did a quick Google search for "manganese BCF." The first link in this search is a Google books link to "Manganese and its compounds: environmental aspects by Paul Howe, Heath Malcome, World Health Organization"which is primarily a discussion of saltwater BCFs. It does however, make reference to manganese being "readily accumulated in tissues of brown trout (*Salmo trutta*)," with trout having been exposed to 0.1µg/L in freshwater and, as a

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[11] *See, e.g.*, Stone, Nathan et al., Understanding Your Fish Pond Water Analysis Report, Cooperative Extension Prgoram, University of Arkansas at Pine Bluff at 2, viewed at http://www.google.com/url?sa=t&source=web&cd=14&ved=0CC0QFjADOAo&url=http%3A%2F%2Faquanic.org%2Fmanagement%2520practices%2Fdocuments%2Fcoppersulfatephosphateissue.pdf&rct=j&q=iron%20manganese%20hatcheries&ei=76GfTeb8MMzQiALS4qSDAw&usg=AFQjCNG8iBTvvkJziKdAPrWl1y9VtRdfiw&cad=rja.

[12] Memorandum from Dick Pedersen, DEQ to EQC Re: Agency Item I, Rule adoption: Amending water quality standards for iron and manganese. December 9-10, 2010, EQC meeting, November 15, 2010, Attachment D at 15.

consequence, accumulating "1.78 mg manganese/kg (whole body) within 6 weeks . . . ." *Id*. at 14. In light of this information, and possibly other data, we urge EPA to ensure that DEQ has correctly stated the most current scientific understanding of the ability of manganese to bioconcentrate in freshwater organisms.

In addition, since one basis for Oregon's proposed deletion of the manganese criteria is the fact that the EPA-recommended criteria are based on work completed in 1976, we urge EPA to evaluate whether Oregon is using the proper risk factors in concluding that manganese presents a human health risk only in saltwater species. As Oregon represented to the advisory committee that there were no human health concerns, only organoleptic concerns, related to manganese, it would be inappropriate for EPA to defer to the findings of that committee. Again, NWEA is not certain that there is a problem but there may very well be. For example, we did a quick Google search for "manganese reference dose" to see whether EPA or other agencies have evaluated the potential hazards of manganese to human health since 1976, the date upon which Oregon seems to rely. It appears so as, once again, the first link is to EPA's Integrated Risk Information System (IRIS) which shows that the oral reference dose was last revised on May 1, 1996 and the carcinogicity assessment was revised on December 1, 1996.[13] Likewise, the toxicological profile for manganese was put out for public comment by the Agency for Toxic Substances and Disease Registry (ATSDR) in September, 2008.[14] Last, yet one more link, from a publication entitled "From Vitamin and Mineral Safety 2nd Edition" by John D. Hathcock, PhD., states that in 2004 EPA established a reference dose for oral manganese of 10 mg per day for a 70 kg man.[15] These references all suggest that there is now more updated information on the health impacts of manganese than whatever EPA used in 1976. Given there is no analysis of these IRIS and ATSDR sources for iron and manganese in the DEQ issue paper (in contrast to Oregon's evaluation of arsenic which references both of these sources), our concerns mount. Without extensive investigation by us we cannot determine the degree to which EPA's 1976 recommended criterion is or is not affected by these studies and analyses. What we do know is that it is essential that EPA draw its own conclusions rather than relying on Oregon's.

Finally, we ask that EPA investigate concerns with the potential health effects of manganese on infants, particularly those fed with infant formula. According to the Environmental Working Group

> There are unresolved concerns about the safety of manganese found in baby

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[13] http://www.epa.gov/iris/subst/0373.htm.

[14] http://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=102&tid=23.

[15] http://www.crnusa.org/safetypdfs/026CRNSafetyManganese.pdf.

> formula. Manganese is a neurotoxic chemical found in much higher concentrations in infant formula than in mother's milk. In fact, soy-based formulas contain about 80 times more manganese than breast milk, and formulas made with animal protein about 30 times more. Studies conducted as early as the 1970s and 80s show an association between various learning or behavior problems and elevated manganese levels.[16] Infants are not able to absorb and excrete excess manganese during their first year of life, a period of rapid development. Developmental deficits have been reported in primates fed 50 to 100 ounces of Isomil per day.[17] [18]

Combining high levels of manganese in infant formula with manganese in drinking water could result in a health threat to infants. EPA's addressing this concern would be consistent with Executive Order No. 13045, signed April 27, 1997, Protection of Children from Environmental Health Risks and Safety Risks.[19]

In conclusion, looking back on Oregon's decision to delete the freshwater human health criteria for iron and manganese, NWEA believes this was a mistake. Contrary to DEQ's representations, there appear to be both human health and aquatic life concerns with regard to these two parameters. There may or may not be sufficient information upon which Oregon could derive appropriate alternative numeric criteria for the protection of human health rather than to have just deleted the criteria. However, assuming that Oregon could not derive such alternative criteria, in the absence of sufficient information upon which to derive criteria and in the absence of a demonstration that the existing – or not existing – aquatic life criteria are sufficiently protective of aquatic life such that the human health criteria can safely be removed while still protecting all the designated uses, NWEA believes that it would be a far better course of action to leave the existing iron and manganese human health criteria in place.

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[16] Collipp PJ. Manganese in infant formula and learning disability. Ann Nutr Metab 27:488-494. 1983.

[17] Van Scoy, H. Soy-based formulas may be linked to ADHD: elevated levels of manganese the suspected culprit. Health Scout News Reporter. October 8, 2002. http://www.hon.ch/News/HSN/509534.html.

[18] *See, e.g.*, Environmental Working Group, Mother's Milk: Breast milk is still best, viewed at http://www.ewg.org/node/8415.

[19] 62 Fed. Reg. 19885 (April 23, 1997), as amended by Executive Order No. 13296 (68 Fed. Reg. 19931 (April 23, 2002)).

We appreciate your consideration of these observations.

Sincerely,

Nina Bell
Executive Director

cc: Mike Bussell
Ephraim King