Response to WDPH's Health Advisory Level for DNT Mixtures

Environmental Stewardship Concepts
On Behalf of
Citizens for Clean Water Around Badger
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Summary:

The Wisconsin Department of Public Health (WDPH) has elected to evaluate dinitrotoluene (DNT) isomers as the total mixture, not as individual chemicals when determining a Health Advisory Level for DNT in groundwater. Based primarily on information from Federal Agencies and databases, WDPH selected a limit of 0.05 μg/L (ppb) for total DNT, based on carcinogenicity of 2,4 DNT. This value assumes that individuals would be exposed to proportions of the various isomers that are more commonly found in lab mixtures of DNT than the mixtures that occur in the field. Some of the minor DNT isomers are significantly more toxic than the more common forms (2,4 and 2,6-DNT), and WDPH should consider that they may make up a greater proportion of total DNT under field conditions. DNT mixtures also occur in combination with other contaminants, but it is not clear that the WDPH made any special provisions for this phenomenon. The sensitivity of children also has to be considered in the health advisory. Non-cancer health effects have not been extensively investigated and may be more critical in young children, and exposure to other contaminants commonly found with DNT may increase its toxicity.

Comments:

We feel that WDPH is taking the correct approach to DNT by developing a health advisory for DNT mixtures rather than attempting to identify toxic thresholds (and cancer slope factors) for individual isomers. Evaluating the isomers separately could easily lead to an underestimation of risks by ignoring the cumulative aspects of exposure, since all isomers affect the body in similar ways, and therefore most likely act by the same mechanism. In addition, there are relatively little data on the less common isomers of DNT than 2,4 and 2,6-DNT. What little information there is clearly points to these isomers as being more toxic than the more common isomers. This approach is clearly a step towards responsible risk management policy at the Badger Army Ammunition Plant (Badger) and should be supported.

The Army's response to WDPH's proposed health advisory level is not completely accurate and up to date. The Army response is not sufficient to alter the outcome of the HAL process. The arguments presented by the Army use literature over 20 years old that has been replaced by more recent research in toxicology since then. For instance, the Army argues that "2,4-DNT and all of the minor isomers are not responsible for the carcinogenicity for TG-DNT." Current literature (Tchounwou et al 2003, Wintz et al 2006) demonstrates that the less abundant isomers of DNT make a notable contribution to total carcinogenicity, refuting the Army statement. In addition, when non-cancer endpoints are considered, minor isomers seem to be more toxic than the more common forms (Reader and Foster 1990, Spanggord et al 1990, Sorenson and Brabec 2003). Many of the examples cited by the US Army Center for Health Promotion and Preventative Medicine (USACHPPM) actually support the development of a advisory level for DNT mixtures rather than isomers by noting how commonly technical grade DNT is contaminated with other isomers. Technical grade DNT used by the Army contains mixtures of the various isomers of DNT, thus adverse health affects cannot be completely attributed to a single isomer. USACHPPM relied on older scientific literature and primarily government reports as opposed to the open peer reviewed toxicology literature. One example is the use of data over 50 years old to justify retaining high levels of heavy metals at Badger. WDPH should not accept the Army response without question and should hold firm in the position that DNT mixtures should be evaluated together rather than as individual isomers.

The WDPH approach is not perfect in and of itself. If DNT is to be evaluated as a mixture, the default assumption should be that people are exposed to the most toxic isomer unless other data exist to support an alternative method. At the very least, WDPH needs to assume that the most toxic isomers will be present at higher levels than found in technical grade DNT mixtures. The concentrations and proportions of individual isomers at Badger vary wildly and can be difficult to predict, particularly for the less common isomers like 3,5-DNT. Contrary to the Army's claims, this isomer has been found to be a significant contributor to the carcinogenic properties of DNT mixtures (Tchounwou et al 2003). This finding reflects some of the major uncertainties that have hampered the study of DNT and its various isomers. Even the technical grade DNT that is used in laboratory studies contains varying and inconsistent levels of less common isomers like 2,5-DNT. DNT in environmental samples in the field can be expected to have even more variability. In real world situations, it is important to err on the side of caution and select a more protective (lower) health advisory level. In the case of DNT and particularly around Badger, there are ample reasons to err on the side of greater protection.

The entry for 2,4 and 2,6-DNT in the EPA IRIS database (EPA 1990) focuses primarily on the two more common isomers and is based on laboratory conditions. The lab conditions may under-represent the more toxic isomers like 3-5 DNT that make up less than 1% of lab grade DNT but may be more abundant in the field. The DNT at Badger and other DNT contaminated sites contain a much more diverse mixture of isomers than in the lab. The 3-5 DNT isomer has been detected at Badger, indicating that it is present at the facility at concentrations greater than those found in technical grade DNT. Another aspect of real world conditions not addressed by the EPA is the likelihood of interactions with other pollutants commonly found at contaminated sites.

PCBs are present at Badger, and there is evidence that prior exposure to PCBs (specifically Aroclor 1254, the Aroclor most commonly found at Badger) can promote the mutagenic toxicity of DNT by as much as four-fold by increasing the number of genotoxic metabolites produced by the liver (Chadwick et al 1993). The study by Chadwick et al that identified this synergy focused on the genotoxicity of DNT, and it is more than possible that non-cancer endpoints could be affected as well because the changes in genetic structure that may lead to cancer also affect the ability of the liver to process lipids (Wintz et al 2006). Regarding the PCB occurrence at Badger, while the drinking water levels of PCB’s are non-detect, the exposures of the population in the immediate vicinity is greater because Badger is a PCB source. Other investigations on exposures related to proximity to sources indicate that human exposures and body burdens of PCB’s and dioxins are elevated in people living in the vicinity of known PCB or dioxin sources. The lesson for Badger is that the people in the area likely have elevated levels of PCB’s in their bodies.

WDPH’s review noted the number of non-cancer health effects such as neurotoxicity and reproductive effects that are associated with exposure to DNT. The review of these effects was quite thorough, and yet there is a high degree of uncertainty regarding fetuses and neonates because there is no direct experimental evidence addressing this developmental stage.

WDPH’s review noted that the EPA non-cancer reference dose for 2,4-DNT is 0.0001 mg/Kg/day, reflecting a high sensitivity and uncertainty. This RfD uses two safety factors of 10, including one for interspecies differences. This RfD can be used to set a drinking water limit by assuming body size and drinking water rate. Assuming a child of 4 Kg body size and a drinking water rate of 1 L per day, then the drinking water standard would be 0.01 mg/L or 4 ug/L. This value is much higher (80 times higher) than the drinking water limit based on cancer, 0.05 ug/L. The only other adjustment that might be made to the 4 ug/L drinking water value would be to adjust for the proportion of DNT that might come from drinking water compared with other sources. If only 25% of all DNT comes from drinking water, then the drinking water standard would be 1.0 ug/L instead of 4 ug/L, still 20 times higher than the value based on cancer.

Sensitive individuals exposed to concentrations above the drinking water limit have the potential to experience adverse health effects. It should be noted that EPA’s RfD was determined to be below most detection limits (ATSDR 1998), and based on studies using laboratory grade DNT. There is ample evidence that virtually any exposure to DNT is dangerous for some sensitive individuals, and risks could be even higher when more diverse mixtures of DNT are considered and exposures to other chemicals are included. WDPH has a responsibility to protect the entire population, not just the “average” individuals.

Based on the uncertainties regarding which isomer will be the primary risk driver at a given site, the low threshold for non-cancer effects, and the significant increase in toxicity that occurs when individuals are exposed to PCBs we recommend that WDHFS revise its Health Advisory level for DNT mixtures to 0.005 µg/L, and certainly not greater than 0.01 ug/L. The lower, more protective HAL accounts for greater toxicity of mixtures in the field, co-exposure to PCB's, and increased sensitivity of fetuses and children. The weight of the evidence points to greater toxicity levels for less common isomers. This result combined with the difficulty of isolating or even detecting these isomers under real world conditions should signal a need to be more conservative when evaluating the health effects of DNT. Given the likely underestimation of risks that result from laboratory studies and the significantly higher concentrations of more toxic isomers such as 3-5 DNT found in field conditions, this value is much more protective than the concentration of 0.05 µg/L.

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