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July 27, 2007

VIA ELECTRONIC MAIL AND U.S. MAIL

Hank Kuehling
Wisconsin Department of Natural Resource
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Madison, WI 53711
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Re: Preliminary Determination of Final Remedy for Propellant Burning Ground Waste Pits Subsurface Soils, Badger Army Ammunition Plant

Dear Mr. Kuehling,

Citizens for Safe Water Around Badger is a non-profit environmental organization that was formed in 1990 by neighbors of the Badger Army Ammunition Plant in support of a healthy and sustainable future that will protect and restore the integrity of soil, water, air, and biological diversity. We appreciate the opportunity to present these comments on the proposed remedy and the modification of the Department's Plan Modification Approval issued on June 1, 1995. These comments are an amendment to our prior comments dated June 4, 2007.

I. THE PROPOSED REMEDY AND PERMIT MODIFICATION MUST ENSURE THAT GROUNDWATER CONTAMINATION DOES NOT THREATEN PUBLIC HEALTH AND WELFARE.

- **The Proposed Remedy and Modification must achieve and require compliance with the PAL and other applicable standards to the extent practicable, within a reasonable timeframe, and to minimize the harmful effects of the contamination to the air, land, and waters of the state.[1]**

[1] Wis. Admin. Code NR § 722.02(3)(a).

Dinitrotoluene (DNT) is a hazardous chemical substance used extensively in ammunition production at Badger Army Ammunition Plant (Badger) during the 1960s and 1970s.[2] Records indicate hazardous wastes, including solvents and DNT, were discarded into unlined pits at the Propellant Burning Grounds. Environmental testing by the Army indicates that these pits are the source of groundwater contaminant plumes that extend past the facility's boundaries, affecting private residences to the south,[3] and discharging to the Wisconsin River.

The U.S. Environmental Protection Agency (EPA) has concluded that DNT is a major health concern. Studies indicate that human exposure to DNT through contact, inhalation, or ingestion can result in serious adverse health problems including nervous system disorders and heart disease.[4]

The EPA has classified two DNT isomers, 2,4-DNT and 2,6-DNT, as class 2B human carcinogens.[5] Laboratory bioassay and animal studies often found that 2,4-DNT caused kidney cancer and that mixtures of 2,4-DNT and 2,6-DNT caused liver cancers.[6]

High exposure to carbon tetrachloride can cause liver, kidney, and central nervous system damage. These effects can occur after ingestion or breathing carbon tetrachloride, and possibly from exposure to the skin. The liver is especially sensitive to carbon tetrachloride because it enlarges and cells are damaged or destroyed.[7]

Drinking small amounts of trichloroethylene for long periods may cause liver and kidney damage, impaired immune system function, and impaired fetal development in pregnant women, although the extent of some of these effects is not yet clear.[8]

Like carbon tetrachloride and trichloroethylene, chloroform has been classified as Group B2 (probable human) carcinogen by EPA based on "sufficient evidence" of carcinogenicity in animals. Chloroform can enter your body if you breathe air, eat food, or drink water that contains chloroform. Chloroform easily enters your body through the skin. Therefore, chloroform may also enter your body if you take a bath or shower in water containing chloroform.[9]

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[2] Badger Army Ammunition Plant: Environmental Restoration Advisory Board, Meeting Minutes (Oct. 16, 2006) (meeting held at Badger Army Ammunition Plant, Baraboo, WI).
[3] *Id.*
[4] Department of Health and Human Services: Agency for Toxic Substances and Disease Register (Updated Jan. 31, 2007), http://www.atsdr.cdc.gov/toxprofiles/phs109.html.
[5] Department of Health and Human Services: Agency for Toxic Substances and Disease Register, http://www.atsdr.cdc.gov/toxprofiles/tp109-c7.pdf.
[6] U.S. Department of Health and Human Services, Public Health Service, *Health Consultation: Dinitrotoluene in Private Wells*, Badger Army Ammunition Plant, page 9, September 30, 2006.
[7] ATSDR, *ToxFAQs for Carbon Tetrachloride*, August 2005.
[8] ATSDR, *ToxFAQs for Trichloroethylene*, July 2003.
[9] ATSDR, *Public Health Statement forChloroform*, September 1997.

Infants who are fed water or formula made with water that is high in nitrate can develop a condition that doctors call methemoglobinemia. The condition is also called "blue baby syndrome" because the skin appears blue-gray or lavender in color. This color change is caused by a lack of oxygen in the blood.

All infants under six months of age are at risk of nitrate poisoning. Some babies may be more sensitive than others. Infants suffering from "blue baby syndrome" need immediate medical care because the condition can lead to coma and death if it is not treated promptly.[10]

Some scientific studies have found evidence suggesting that women who drink nitrate-contaminated water during pregnancy are more likely to have babies with birth defects. Nitrate ingested by the mother may also lower the amount of oxygen available to the fetus.[11]

People who have heart or lung disease, certain inherited enzyme defects, or cancer may be more sensitive to the toxic effects of nitrate than others. In addition, some experts believe that long-term ingestion of water high in nitrate may increase the risk of certain types of cancer.[12]

- **The Proposed Remedy and Modification for subsurface soils at the Propellant Burning Grounds must not be artificially segmented from the connected groundwater contaminant plume/s.**

  In accordance with the National Environmental Policy Act (NEPA)[13] and WEPA, the WDNR should consider the "whole" or integrated project. NEPA further requires consideration of the whole of the proposed action, even if the agency is only permitting a portion of it. The proposed remedy is an interdependent part of the overall environmental impact of the Propellant Burning Grounds and should be considered and assessed as one project.

- **The WDNR must require evaluation of Partial Excavation and other viable remedies not carried forward for consideration.**

  Decisions subject to WEPA cannot be made with appropriate environmental impact information and analysis that includes a discussion of meaningful alternatives.[14]

  Soil borings conducted in 2005 show that the vast majority of residual 2,4-Dinitrotoluene contamination in subsurface soils is contained within the remaining top

[10] Wisconsin Department of Natural Resources, *Nitrate in Drinking Water*, Publication WS-001, undated.
[11] Wisconsin Department of Natural Resources, *Nitrate in Drinking Water*, Publication WS-001, undated.
[12] Wisconsin Department of Natural Resources, *Nitrate in Drinking Water*, Publication WS-001, undated.
[13] 40 CFR 1508.25(a).
[14] Wis. Admin. Code NR § 150.025(2)(d).

11-19 feet of Waste Pit 1, the top 12-30 feet of Waste Pit 2, and the top 7-17 feet of Waste Pit 3.[15]

Based on prior excavations at these sites (which ranged from 13 to a maximum of 23 feet below grade), the remaining contaminated soils are "readily accessible". If the perimeters of the waste sites were increased sufficiently to allow safe access of machinery to the original waste pit site periphery, excavation of the majority of contamination could be readily achieved (based on the facility's assumption that other site contaminants are co-located).

Unfortunately, the Army only evaluated removal of entire soil column down to the water table and did not evaluate the potential for a more moderate approach to source removal which would have a far greater comparative environmental benefit per dollar expended. Moreover, improved source removal (additional excavation) would be expected to reduce the number of years groundwater extraction is required, resulting in a significant cost savings in excess of $1 million per year.

- **Before finalizing the Proposed Remedy and Modification, the Department must consider whether or not the proposed remedy is effective by first evaluating the remedy at the Deterrent Burning Ground.** [16]

  The requirement for a detailed evaluation of a proposed remedial action addressing hazardous substances present at a site is contingent on the proven effectiveness and success and experience gained at other sites with similar site characteristics and conditions. [17]

  Although the Deterrent Burning Grounds and Existing Landfill were covered with a RCRA cap/cover in 2003,[18] recent testing indicates that DNTs in groundwater are higher than expected and correspond with increasing trends both in source and boundary monitoring wells at the NE corner of Badger.

  The 3,4-DNT isomer was reported at 1.74 ug/l (micrograms per liter) in groundwater monitoring well ELM-8908 and 0.098 ug/l in ELM-9501 in December 2006. In March 2007, 2,3-DNT was detected at 0.018 ug/l and 3,4-DNT was detected at 0.139 ug/l in monitoring well ELM 9501.

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[15] U.S. Army Corps of Engineers Omaha District, Draft Alternative Feasibility Study Propellant Burning Ground Waste Pits Subsurface Soil, Badger Army Ammunition Plant Baraboo, Wisconsin, Revision 1, Appendix C, Table 1, *Summary of Soil Analysis Data BAAP Propellant Burning Grounds, Soil Borings Performed 2005*, April 6, 2006. See also: Figures 4 ,5, and 6: Propellant Burning Ground *Cross Sections, Extent of DNT Contamination* for Pits 1,2, and 3 accordingly.

[16] Wis. Admin. Code NR § 722.07(3)(b)2.a.

[17] Wis. Admin. Code NR § 722.07(3)(b)2.a.

[18] U.S. Department of Health and Human Services, Public Health Service, *Health Consultation: Dinitrotoluene in Private Wells*, Badger Army Ammunition Plant, page 2, September 30, 2006.

At the Deterrent Burning Grounds, the 2,4-DNT and 2,6-DNT isomers exceeded the groundwater enforcement standard in DBM-8201 – contaminant levels were 0.119 and 0.107 ug/l respectively in March 2007. At this same monitoring well, 2,3-DNT was detected at 2.2 ug/l in groundwater, 3,4-DNT was detected at 9 ug/l , and 3,5-DNT was detected at 1.27 ug/l.

Monitoring well ELM-9501 is located at the plant boundary just west of the Dan Purcell farm and more than 3,000 feet from the Deterrent Burning Grounds hazardous waste disposal site.

The Enforcement Standard for 2,4-DNT and 2,6-DNT is only 0.05 ug/l. The Interim Drinking Water Health Advisory Level for the sum of all six DNT isomers is 0**.**05 ug/l.[19]

Waste disposal activities at the Propellant and Burning Grounds were very similar. According to Army records, during the period of 1968-1975, a liquid chemical waste, extracted from a process which reclaims nitrocellulose from unusable ball powder, was poured into unlined pits in both the north and south burning grounds.

According to interviews with former Badger Army Ammunition Plant employees, approximately 500 gallons per week of deterrent was dumped in pits located in the Propellant Burning Grounds from 1966 to 1970. After 1970, deterrent was dumped and burned Deterrent Burning Grounds.[20] According to historical Army reports, this deterrent contained: "the following toxic chemicals: dinitrotoluene, diphenylamine, dibutylphthalate, benzene, trinitrotoluene, and suspected carcinogens".[21]

- **The Proposed Remedy and Modification must require an enforceable Five-Year Site Review for a minimum of 40 years.**

- **The Proposed Remedy and Modification must require quarterly monitoring for ALL isomers of DNT in groundwater.**

  We were very surprised to find that the BEST System database[22] did not contain ANY data for 2,5-DNT, 3,4-DNT, and 3,5-DNT. As this was the same data provided to the WDNR, neither regulators not the public were provided with all necessary data to fully evaluate the proposed remedy. The missing data alone is sufficient cause to not approve the proposed remedy.

[19] Linda Knobeloch, Ph.D., Wisconsin Division of Public Health, *Drinking Water Health Advisory for Dinitrotoluenes,* June 14, 2007.
[20] U.S. Army Environmental Center, Final Remedial Investigation Report, Volume I, page 7-1, April 1993.
[21] Department of Army, U.S. Army Environmental Hygiene Agency, Aberdeen Proving Ground, Maryland, *Water Quality Special Study No. 24-0039-78, Part I – Geohydrology, Badger Army Ammunition Plant, Baraboo, WI, 12 – 17 June 1977.*
[22] Shaw Environmental & Infrastructure, BEST System Database, Badger Army Ammunition Plant, March 2007.

Evaluating levels and trends in 2,3-DNT was difficult as the Level of Quantification (LOQ) varied so significantly. The LOQ ranged from 1,300 to 0.02 ug/l. Nonetheless, it is clear that 2,3-DNT levels in groundwater remain very high. On March 6, 2006, 2,3-DNT was detected at 48 ug/l. The Interim Drinking Water Health Advisory Level for the summed concentration of all six DNT isomers is only 0.05 ug/l.[23]

Both 2,4-DNT and 2,6-DNT have a low affinity for organic particulate matter and are considered "highly mobile" in soil.[24] The relatively low volatility and moderate solubility of DNT indicate that it will remain in water for long periods of time. DNT is degraded by light, oxygen, and biota. As a result, it can be transported to groundwater or surface water (ATSDR, 1998). [25]

The 2,-3 DNT isomer has not been shown to biodegrade.[26] No studies have been conducted to demonstrate that 3,4-DNT, 3,5-DNT, or 2,5-DNT will biodegrade in soils or groundwater.

Technical grade DNT, which is a mixture of six isomers, is known to cause cancer in animals. All six isomers have shown mutagenic effects in short-term studies. Published studies indicate that the four less common isomers of DNT are "as toxic or more toxic than 2,4-DNT and 2,6-DNT".[27]

- **The Proposed Remedy and Modification must require and assure compliance with the PAL both at Badger and in the neighboring community.**

  Preventive action limits are intended to provide regulator agencies time to take preventive measures to ensure that the enforcement standard is not attained or exceeded.[28]

  The U.S. Army at Badger Army Ammunition Plant, as the party responsible for the disposal and discharge of carcinogenic and hazardous substances at the Propellant Burning Grounds (PBG) and to the environment is required to take action necessary to

[23] Linda Knobeloch, Ph.D., Wisconsin Division of Public Health, *Drinking Water Health Advisory for Dinitrotoluenes*, June 14, 2007.
[24] U.S. Environmental Protection Agency, *Drinking Water Health Advisory for 2,4-Dinitrotoluene and 2,6-Dinitrotoluene*, Proposal Draft, August 2006.
[25] U.S. Environmental Protection Agency, *Drinking Water Health Advisory for 2,4-Dinitrotoluene and 2,6-Dinitrotoluene*, Proposal Draft, page 13, August 2006.
[26] Shirley F. Nishino and Jim C. Spain, Air Force Research Laboratory, Tyndall AFB, Florida *Technology Status Review: Bioremediation of Dinitrotoluene (DNT)*, pages 2 and 5, February 2001.
[27] Linda Knobeloch, Ph.D., Wisconsin Division of Public Health, *Drinking Water Health Advisory for Dinitrotoluenes*, June 14, 2007.
[28] Wisconsin Department of Natural Resources, Wisconsin Groundwater Standards, *An Explanation of Chapter 160. Wis. Stats*., undated.

restore the environment to the extent practicable and minimize the harmful effects from the discharge to the air, lands, or waters of the state.[29]

At the PBG, DNT has been consistently found in groundwater, with concentrations ranging between 0.04 ug/l and 43,000 ug/L (micrograms per liter). [30] DNT is rapidly degraded by sunlight and bacteria, but when DNT reaches groundwater, it tends to undergo very little degradation.[31]

Preventive action limits are applicable both to controlling new releases of contamination as well as to restoring groundwater quality contaminated by past releases of contaminants.[32] Although a preventive action limit is not intended to always require remedial action, activities affecting groundwater must be regulated to minimize the level of substances to the extent technically and economically feasible, and to maintain compliance with the preventive action limits unless compliance with the preventive action limits is not technically and economically feasible.[33]

To the extent practicable, contaminated groundwater must be restored to comply with the PAL[34] and remedial actions must be designed to regain and maintain compliance with the Preventative Action Limit.[35] When substances are detected in groundwater for which a standard does not exist in ch. NR 140, the WDNR may require clean-up of the groundwater to the extent practicable which may "be overly conservative depending upon the actual toxicity of the substance detected".[36]

Waiting until an exceedance occurs in drinking water resources is not protective of human health as it does not prevent exposures to levels at or above the ES.

- **Monitoring of potential degradation products of DNT and other Contaminants of Concern must have a Level of Detection consistent with the PAL or the Lowest Possible Level of Detection for "unregulated"[37] groundwater contaminants.**

  Laboratories testing groundwater are required to select the analytical methodology which is specified in rules or approved by the regulatory agency, is appropriate for the concentration of the sample, and has a limit of detection and limit of quantitation below

[29] Wis. Stats. § 292.11(3).
[30] U.S. Department of Health and Human Services, Public Health Service, *Health Consultation: Dinitrotoluene in Private Wells,* Badger Army Ammunition Plant, page 2, September 30, 2006,.
[31] EPA, Integrated Risk Information System (IRIS). 2,4-Dinitrotoluene (CASRN 121-14-12), August 22, 2002.
[32] Wis. Admin. Code NR § 140.02(3).
[33] Wis. Admin. Code NR § 140.02(3).
[34] Wis. Admin. Code NR § 722.09(2)b.1.
[35] Wis. Admin. Code NR § 722.09(2)b.1. Notation.
[36] Scott Hassett, Secretary Wisconsin DNR, Correspondence/Memo to Members of the Natural Resources Board, *Background Memo – Proposed amendments to Wisconsin Administrative Code Chapter NR 140, Groundwater Quality*, February 26, 2007.
[37] For the purpose of this paper, an "unregulated" groundwater contaminant is one that does not have health-based Enforcement Standard pursuant to Wis. Admin. Code NR § 140.

the preventive action limit, or produces the lowest available limit of detection and limit of quantitation if the limit of detection and limit of quantitation are above the preventive action limit.[38]

- **The Proposed Remedy and Modification must require quarterly monitoring of all residential wells when levels of regulated contaminants attain the PAL near the Badger boundary or beyond.**

  While there have been substantial investigations of groundwater on and around Badger, it appears the degree and extent of DNT contamination in groundwater has not been fully characterized.[39] DHFS supports the ongoing groundwater investigations being conducted by the Army, and recommends the continued testing of nearby private wells in order to ensure that the public is not being exposed to unsafe levels of DNT in drinking water. [40]

  Given the serious threat DNT poses to human health, its documented use at the Badger facility, and the recent detection of several forms of DNT in residential wells down-gradient from the plant, the Remedy and Modification should take all precautions by monitoring for all DNT isomers at all discharges.

  In the end, the only way to know if a residential well is safe to use is to actually test the well. While monitoring wells are vital tools in assessing groundwater quality and movement, they are not a legitimate replacement for testing private well water.

- **The Proposed Remedy and Modification must require the attainment of the lowest possible concentration of "unregulated" groundwater contaminants.**

  The WDNR is authorized to take action necessary to protect public health and welfare or prevent a significant damaging effect on groundwater or surface water quality for present or future consumptive or non-consumptive uses, <u>whether or not an enforcement standard and preventive action limit for a substance have been adopted under Wis. Admin. Code NR 140</u>. [41]

  For substances which do not have an established standard in ch. NR 140, the department may take or require the responsible parties to conduct any necessary actions, such as developing site-specific environmental standards in cooperation with the department of health and social services, to protect public health, safety and welfare or to prevent a significant damaging effect on groundwater or surface water quality for present or future consumptive or non-consumptive uses.[42]

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[38] Wis. Admin. Code NR § 140.16(2)
[39] U.S. Department of Health and Human Services, Public Health Service, Health Consultation: Dinitrotoluene in Private Wells, Badger Army Ammunition Plant, September 30, 2006, page 7.
[40] U.S. Department of Health and Human Services, Public Health Service, Health Consultation: Dinitrotoluene in Private Wells, Badger Army Ammunition Plant, September 30, 2006, page 7.
[41] Wis. Admin. Code NR § 140.02(4).
[42] Wis. Admin. Code NR § 722.09 (2)(b)2.

Wisconsin Stat. §144.76(3) (1977) requires those in violation of its provision to "take the action necessary to restore the environment to the extent practicable and minimize the harmful effects from any discharge to the air, lands or waters of the state." In a 1998 opinion, the Supreme Court of Wisconsin determined that use of this phrase "restore the environment to the extent practicable" necessary implication reveals an intent to address past conduct. Even when conduct predated the Spills Law, the responsible party must perform remediation of a spill site to "make the environment whole again". [43]

This is further consistent with intent of the legislature which directs the Department of Natural Resources to promote environmental performance that voluntarily exceeds legal requirements related to health, safety, and the environment and that results in continuous improvement in Wisconsin's environment, economy, and quality of life.[44]

In March 2007, groundwater monitoring wells corresponding with License Number 2814 (Propellant Burning Grounds) detected 2,4-DNT at concentrations ranging from no detect (ND) to 4.5 ug/l. The 2,6-DNT isomer was detected at concentrations ranging from ND to 2.7 ug/l. By comparison, the other isomers were detected at much higher concentrations. The 2,3-DNT was detected at concentrations as high as 63.3 ug/l and 3,4-DNT levels were as high as 71.7 ug/l. The 3,5-DNT isomer was detected at 9.7 ug/l and 2,5-DNT levels were as high as 2.2 ug/l.

At the Deterrent Burning Grounds – a similar site that has been capped since 2003 – has followed the same pattern. The 2,4-DNT isomer was detected at 0.017 ug/l, and the highest reported concentration of 2,6-DNT was 0.119 ug/l. By comparison, 2,3-DNT was detected at 9 ug/l and 3,4-DNT concentrations were as high as 9 ug/l. The 3,5-DNT isomer was reported at 1.27 ug/l and 2,5-DNT was not detected.

These findings are not surprising as the 4 less common isomers of DNT (2,3-DNT, 2,5-DNT, 3,4-DNT, and 3,5-DNT) have not been shown to biodegrade.

- **The Proposed Remedy and Modification must require quarterly monitoring of nearby residential wells when "unregulated" contaminants are detected near the Badger boundary or beyond.**

- **The Proposed Remedy and Modification must stipulate that quarterly groundwater and residential well monitoring will continue after termination of the groundwater pumping and treatment system to assure that compliance with applicable standards is sustained now and in the future.**

[43] Supreme Court of Wisconsin, Case No. 96-1158 State of Wisconsin, Plaintiff-Appellant v. Chrysler Outboard Corporation, June 19, 1988.
[44] Wis. Stats. § 299.83 **(1m)** (b).

- **The Proposed Remedy and Modification must require a comprehensive monitoring plan to assure that groundwater and nearby residential wells do not exceed Nitrogen Limits as a result of releases from Badger.**

  Accumulation of nitrite/nitrate resulting from biodegradation of DNTs must be considered both to meet regulatory standards for any effluents generated.[45] In situ bioremediation of DNTs is viable at sites where: (1) aerobic conditions are present or can be engineered; (2) appropriate organisms are present or can be introduced effectively; and (3) the potential for nitrite or nitrate accumulation can be managed.[46] Transformation of DNT leads to partial reduction and formation of amines. [47]

  Accumulation of nitrite/nitrate, generated as a result of degradation of DNT, must be considered both to meet regulatory standards for any effluents generated. [48]

  Even after the BEST system was shut down, nitrates continue to exceed the ES. In June 2006, nitrates at the Propellant Burning Grounds were reported as high as 23 mg/l[49] exceeding the groundwater and safe drinking water standard of 10 mg/l. Combined with nitrates released to groundwater by the sanitary wastewater system, ongoing exceedance of the groundwater standard will occur.

  Groundwater monitoring conducted in November 2003 and continuing through August 2004 found high concentrations of nitrate + nitrite, with the average concentration in two boundary wells exceeding the enforcement standard (ES) of 10 milligrams per liter (mg/l). Testing at these two wells resulted in readings of 16.2 mg/l and 10.1 mg/l.[50] NR 140.10 Wis. Admin. Code states that nitrate + nitrite is "a substance of public health concern," as it relates to groundwater.[51] Therefore, the WDNR is required by law to prevent groundwater concentrations of nitrate + nitrite from exceeding the enforcement standard (ES) of 10 mg/L as a result of surface effluent discharge. [52]

  Yet, rather than requiring Badger to comply with existing effluent limits, the WDNR in June 2005 granted Badger an exemption for nitrate + nitrite standards under NR 140.28(2) Wis. Admin. Code. The exemption, however, was subject to several

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[45] Shirley F. Nishino and Jim C. Spain, Air Force Research Laboratory, Tyndall AFB, Florida, *Technology Status Review: Bioremediation of Dinitrotoluene (DNT)*, page 5, February 2001.
[46] Shirley F. Nishino and Jim C. Spain, Air Force Research Laboratory, Tyndall AFB, Florida, *Technology Status Review: Bioremediation of Dinitrotoluene (DNT)*, page 5, February 2001.
[47] Shirley F. Nishino and Jim C. Spain, Air Force Research Laboratory, Tyndall AFB, Florida, *Technology Status Review: Bioremediation of Dinitrotoluene (DNT)*, page 1, February 2001.
[48] Shirley F. Nishino and Jim C. Spain, Air Force Research Laboratory, Tyndall AFB, Florida *Technology Status Review: Bioremediation of Dinitrotoluene (DNT)*, page 5, February 2001.
[49] Shaw Environmental & Infrastructure, BEST System Database, Badger Army Ammunition Plant, March 2007.
[50] Letter from Joan Kenney, Installation Director, Badger Army Ammunition Plant, to Mr. Osipoff, Wisconsin DNR, Fitchburg, WI (March 31, 2005) (concerning Total Nitrogen Variance Request; refer to Table 1. Total nitrogen in quarterly WPDES wells).
[51] Wis Admin. Code NR § 140.10 (2007) (refer to Table 1. Public Health Groundwater Quality Standards).
[52] Wis Admin. Code NR § 140.10 (2007) (refer to Table 1. Public Health Groundwater Quality Standards).

limitations. Pursuant to NR 140.28(2)(a) Wis. Admin. Code, "the WDNR may grant an exemption [to groundwater quality standards only if]…the existing or anticipated increase in the concentration of that substance does not present a threat to public health and welfare." In granting this exemption, the WDNR assumes that nitrogen is effectively removed from the water prior to it reaching down-gradient residential wells.

The WDNR, however, has no data on hand establishing the extraction wells' success in removing the nitrogen, nor has it provided evidence to support its finding that the concentration of nitrate + nitrite in the groundwater is below that which threatens the public's health and welfare. If WDNR has no historical data and does not require regular monitoring of nitrogen concentrations at the extraction wells, the surface water discharge at Outfall 004, or groundwater monitoring wells that could be installed along the length of Final Creek, the decision to exempt Badger from meeting groundwater quality standards is based in part on speculation. The WDNR has simply assumed that the MIRM system adequately removes the nitrogen from the groundwater.

This is especially disconcerting since Badger plans to decommission those very wells that it relies on to protect public health and welfare.[53]

The implementation of comprehensive monitoring now will provide valuable insight regarding nitrogen limits in the soil and groundwater when the MIRM extraction wells are taken offline. Monitoring will also help in setting nitrogen effluent limits for Outfall 002 necessary to maintain compliance with NR 140.10 Wis. Admin. Code.

- **The Proposed Remedy and Modification must incorporate and address potential synergistic and additive risks associated with multiple contaminants in both groundwater and residential wells.**

  At sites or facilities where there may be synergistic effects of contamination, multiple pathways of exposure or both that pose an unacceptable threat to public health, safety or welfare or the environment, responsible parties shall attain more stringent, facility or site-specific numeric standards to ensure that public health, safety and welfare and the environment are protected. In such a situation, the department may require that the responsible parties develop a site-specific numeric or performance standard, or both, that is protective of public health, safety and welfare and the environment for the specific media, migration or exposure pathways and contamination.[54]

  Like nitrates, both newborns and the unborn are more sensitive than adults to certain chemicals such as DNT which also causes methemoglobinemia. It is well documented that DNT is reduced in the digestive tract and then oxidizes the iron in hemoglobin to form methemoglobin, which prevents the transport of oxygen by the blood.[55] Infants

[53] WPDES Permit Fact Sheet for Badger Army Ammunition Plant, p. 2 (May 8, 2007).
[54] Wis. Admin. Code NR § NR 722.09 (3)
[55] U.S. Department of Health and Human Services, Public Health Service, *Health Consultation: Dinitrotoluene in Private Wells,* Badger Army Ammunition Plant, page 16-17, September 30, 2006.

appear to be 10 times more sensitive than adults to nitrate-related methemoglobinemia and it is expected that DNT would have a similar ratio.

- **The Proposed Remedy and Modification must have a Contingency Plan in anticipation that groundwater contaminant levels will increase.**

  Even with capping to reduce infiltration of clean surface water through residual contaminated soils to groundwater, continued monitoring of soil moisture and groundwater quality after the cap is placed will be critical so there must be some contingency in the plan if the cap is found not to work properly.

  One of the aspects of an inactive Propellant Burning Grounds (PBG) infiltration will likely be increased concentrations. As less water is passed through the PBG soils, contaminant concentrations in groundwater may be expected to increase. While the rate of movement may be reduced, soils will still release mass into the groundwater. If the cap operates as expected, without fresh water passing through or near the soils, the groundwater DNT concentrations will tend to climb.

  The Proposed Remedy and Modification should estimate not only concentrations, but how fast water is leaving the area through groundwater. Cutting off a portion of the groundwater flow by a cap (to reduce infiltration) is only part of the long-term management of the site.

  Long-term management of the PBG, including continued plans for source control (pumping) in the area, and monitoring plans (including soil moisture) should be tied to groundwater management as the PBG may affect groundwater quality for some time.

  Tracking concentrations in groundwater is not enough, the Proposed Remedy and Modification must require an assessment of the rate of contaminant release from the PBG area into the groundwater. Calculating downstream concentrations will be indicative of the mass released in a given amount of time.

- **The Proposed Remedy and Modification must establish Design Management Zones that shall consider and include likely methods for abatement if an enforcements standard (which includes the PAL) is exceeded or "unregulated" contaminants are detected.**

  The Proposed Remedy and Modification must establish Points of Standards Application for the purpose of determining whether the Preventive Action Limit or the Enforcement Standard is attained or exceeded beyond the Badger property as necessary to protect future groundwater uses and the public interest in the waters of the state.[56]

[56] Wis. Stats. § 160.21(2)(a)2. and Wis. Stats. § 160.21(2)(b)1.b.

Points of Standards Application must also be established for "unregulated" groundwater contaminants which require remediation to the extent practicable.[57]

Points of Standards Application must include all private drinking water wells, municipal wells, offsite groundwater monitoring wells, current and future areas of development, and irrigation and livestock water wells. These points all apply as they have or will be monitored to determine if a Preventative Action Limit or Enforcement Standard has been attained or exceeded.[58]

"Point of standards application" means the specific location, depth or distance from a facility, activity or practice at which the concentration of a substance in groundwater is measured for purposes of determining whether a preventive action limit or an enforcement standard has been attained or exceeded.[59] A "design management zone" means a 3-dimensional boundary surrounding each regulated facility, practice or activity established under s. NR 140.22 (3).[60]

A point of standards application shall include any point of present groundwater use; any point beyond the boundary of the property on which the facility, practice or activity is located; and any point within the property boundaries beyond the 3-dimensional design management zone if one is established by the department at each facility, practice or activity.[61]

- **The Proposed Remedy and Modification must establish Design Management Zones that consider anticipated future uses of land and groundwater.** [62]

- **In response to exceedances of the PAL, near or beyond the Badger property, the Proposed Remedy and Modification must evaluate the existing effects and potential risk of contaminants on potable water supplies.**

  The WDNR shall consider the current and anticipated future extent of groundwater contamination in 3 dimensions. If water supplies are affected or threatened, the department shall evaluate the existing effects and potential risks of the substance on the potable water supplies. If the extent of contamination is not known, the department may require further documentation of the extent of contamination.[63] This includes proximity to private and public water supplies, including current and potential use of the aquifer (including agriculture, recreation, and conservation), development to the north of the Village of Prairie du Sac, and the municipal well for Prairie du Sac.

[57] Wis. Admin. Code NR § 140.02(4).
[58] Wis. Admin. Code NR § 140.22(1)(d).
[59] Wis. Admin. Code NR § NR 140.05(15)
[60] Wis. Admin. Code NR § NR 140.05(6)
[61] Wis. Admin. Code § NR 140.22(2)(b)
[62] Wis. Stats. § 160.21(d)
[63] Wis. Admin. Code § NR 140.24(1)(c)9.

NR 722.07(4)(a)4 requires consideration of the proximity of contamination to receptors. Anthropogenic types of receptors include local pumping wells (eg., domestic, irrigation, industrial and public wells), dewatering activities, and conduits of preferential flow-paths (eg., utilities). Natural receptors include surface water discharge points (eg., lakes, streams, wetlands and springs). The relevance of such potential receptors depends upon their location (upgradient, side gradient or downgradient from the plume), their distance from the plume and projected contaminant travel times, the number of receptors, the receptors effects on local groundwater flow gradients (eg., well pumping rates and volumes, connection between hydrogeologic layers, geologic characteristics, etc.), and the likelihood that local pumping regimes and other receptors will change over time. If the potential exists for near-term or future impacts to existing or "planned" receptors due to plume migration, then more aggressive remedies are required in order to meet the reasonable period of time requirement in NR 140.

Further, the Department may direct or enter into a contract with any person to take action to establish a program of long-term care, as necessary, for a site or facility which is repaired or isolated. [64]

- **The Proposed Remedy and Modification must stipulate that boundary groundwater extraction and monitoring wells shall be kept on-line and in operating order until the proposed new configuration of the groundwater extraction system configuration (utilizing only the SCW-1 and SCW-2, without operating extraction wells at the plant boundary) has been shown to be sufficient to capture all discharges and assure long-term compliance (40 years) with Preventative Action Limits for regulated contaminants and until "unregulated" contaminants are no longer detected now and in the future.**

  Source control measures are only considered adequate if, in addition to other factors, the groundwater plume margin is stable or receding, and after case closure, groundwater contamination exceeding ch. NR 140 preventive action limits does not migrate beyond the boundaries of any property for which a PAL exemption has been granted.[65]

  Source control measures are only considered adequate if, in addition to other factors, there is no existing or anticipated threat to public health, safety or welfare, or the environment.[66]

  Source control measures are only considered adequate if, in addition to other factors, the concentration and mass of a substance and its breakdown products in groundwater have been reduced due to naturally occurring physical, chemical and biological processes as necessary to adequately protect public health and the environment, and

[64] Wis. Stats. § 292.31 (3)(b) and (3)(b)6.
[65] Wis. Admin. Code NR § 726.05(2)(b)3.a.
[66] Wis. Admin. Code NR § 726.05(2)(b)5

prevent groundwater contamination from migrating beyond the boundaries of the property or properties for which groundwater use restrictions have been recorded.[67] The points of standards application, or PSA, for hazardous substance discharge is anywhere groundwater is monitored (NR140.22(2)} both inside and outside of a site's property boundary.[68]

At Badger, the contaminant plume that has migrated offsite contains solvents, multiple isomers of DNT, nitrates, and other contaminants.

The IRM and then the MIRM have operated by the Army since 1990 in an effort to stop additional groundwater contamination from leaving the site. In March 2007, the highest reported level of carbon tetrachloride – 24.4 micrograms per liter (ug/l) – was found in a groundwater monitoring wells along County Z, nearly 2 miles from the Propellant Burning Grounds. Along the plant boundary, carbon tetrachloride was found in SPN-8904C at 20.2 ug/l. Even with dilution as the only factor, one would expect offsite monitoring wells to detect some improvement in groundwater quality. Instead, carbon tetrachloride levels are comparable to those at the plant boundary. The same holds true in previous rounds. In June 2006, the highest levels of carbon tetrachloride were detected offsite and along County Z at more than 30 ug/l.

It is therefore plausible that shutting down boundary wells could result in even higher concentrations of persistent groundwater contaminants such as solvents and the less common isomers of DNTs which do not biodegrade.

Compared to other sites nationwide, the levels of carbon tetrachloride in groundwater in adjacent neighborhoods are exceedingly high. Less than 1% of all groundwater-derived drinking water systems have levels of carbon tetrachloride greater than 0.5 ug/l.[69]

- **The Proposed Remedy and Modification must require that monitoring wells and residential wells are tested utilizing test methods with a level of detection (LOD) level of quantification (LOQ) below the Preventative Action Limit or that produces the lowest available LOD and LOQ.**[70]

- **Given the disparity in data at Gruber's Grove Bay, we encourage the WDNR to conduct its own tests of groundwater at several critical points as a requisite measure of quality assurance.**

[67] Wis. Admin. Code NR § 726.05(2)(b)1.f.
[68] WDNR Bureau for Remediation and Redevelopment, Interim Guidance for Selection of Natural Attenuation for Groundwater Restoration and Case Closure under Section NR 726.05(2)(b), PUBL RR-530-97, page 19n, March 1997.
[69] ATSDR, *Toxicological Profile for Carbon Tetrachloride*, page 179, August 2005.
[70] Wis. Admin. Code NR § NR 140.16(2)(c)1,2.

Despite a second multi-million dollar cleanup effort by the Army last summer, the WDNR found mercury concentrations more than 25 times the required cleanup goal and almost 400 times higher than levels reported by the Army in sediments at Gruber's Grove Bay on Lake Wisconsin. WDNR test results for mercury ranged from 0.24 to more than 9 ppm. The Army's contractors tested 65 sediment samples from the same areas of the bay and reported that all were well below the required cleanup goal; their results ranged from 0.006 to 0.34 ppm.

II. THE PROPOSED REMEDY AND MODIFICATIONS MUST ENSURE THAT MASS CONTAMINATION IN SUBSURFACE SOILS DOES NOT THREATEN PUBLIC HEALTH AND WELFARE.

- **Uptake by plants in the vicinity of the Propellant Burnings Grounds, especially agricultural crops and certain indigenous prairie species with very deep root systems, should be evaluated as a potential route of exposure to animals and to people through the human food chain.**

  Each remedial action option identified may be utilized to address more than one contaminated medium or migration or exposure pathway if that remedial action option would be protective of public health, safety and welfare and the environment for each media and migration or exposure pathway that it is proposed to address.[71]

  Land adjacent to the Propellant Burning Grounds is presently used for agriculture, mainly growing crops of alfalfa, corn, and beans. This land use is anticipated to continue in the future.[72] Alfalfa roots grow about 6 feet per year in loose soil. Metabolically active alfalfa roots have been found 60 feet or more below ground level.[73]

  Both 2,4-DNT and 2,6-DNT are quite soluble in water and is expected to "accumulate readily" in plants via root uptake from soils (ATSDR, 1998).[74]

- **WDNR Must Maintain And Enforce Remedial Goals For All Contaminants of Concern in Subsurface Soils and Groundwater Contained in the Infield Conditions Approval.**

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[71] Wis. Admin. Code NR § 722.05(5) Notation.
[72] U.S. Army Corps of Engineers Omaha District, Draft Alternative Feasibility Study Propellant Burning Ground Waste Pits Subsurface Soil, Badger Army Ammunition Plant Baraboo, Wisconsin, Revision 1, page 1-6, April 6, 2006.
[73] Deborah A. Samac et al, USDA-ARS, St. Paul, MN, *Alfalfa Root Health and Disease Management: A Foundation for Maximizing Production Potential and Stand Life*, April 16, 2007.
[74] Agency for Toxic Substances and Disease Registry. *Toxicological Profile for 2,4- and 2,6-Dinitrotoluene*, 1998.

Exempting the Army from the Remedial Goals established for the Propellant Burning Grounds will set an unfavorable precedent and provide the basis for the facility to argue in favor of modified cleanup levels at the Settling Ponds and other major contaminated areas of the plant.

A compromised level of cleanup also undermines the Badger Reuse Plan in which the WDNR and other parties endorsed a final level of cleanup that would not restrict future use and pose no risk to people or the environment, including soil, water, air, and biodiversity.[75]

III. HIGH EXPLOSIVES, DEGRADATION AND TRANSFORMATION PRODUCTS OF HIGH EXPLOSIVES, AND OTHER CARCINOGENIC WASTES MUST NOT THREATEN PUBLIC HEALTH

If, after a remedial action selected in accordance with the requirements of ch. NR 722 is implemented, the soil cleanup standards in ch. NR 720 or the groundwater quality standards in ch. NR 140 are modified by the department to be more stringent, or if soil or groundwater quality standards are promulgated for additional substances, the department shall require responsible parties to comply with the new or modified soil or groundwater quality standards if the department determines that, for a specific site or facility, compliance with the more stringent standards is necessary to ensure that the interim action or remedial action will be protective of public health, safety and welfare and the environment.[76]

- **The Proposed Remedy and Modification Must Require an Investigation to Establish and Define the Extent of Potential Residual High Explosives (TNT, RDX, HMX, and Tetryl) Contamination At and Near the Propellant Burning Grounds.**

According to Army records, during the period of 1968-1975, a liquid chemical waste, extracted from a process which reclaims nitrocellulose from unusable ball powder, was poured into unlined pits in both the north (PBG) and south (DBG) burning grounds**.** This chemical waste called deterrent contained "the following toxic chemicals: dinitrotoluene, diphenylamine, dibutylphthalate, benzene, trinitrotoluene, and suspected carcinogens".[77]

[75] Badger Reuse Committee, *Badger Reuse Plan*, Value and Criteria, Criterion 2.3, March 28, 2001.
[76] Wis. Admin. Code NR § NR 724.19(1)
[77] Department of Army, U.S. Army Environmental Hygiene Agency, Aberdeen Proving Ground, Maryland, *Water Quality Special Study No. 24-0039-78, Part I – Geohydrology, Badger Army Ammunition Plant, Baraboo, WI, 12 – 17 June 1977.*

The EPA has determined that 2,4,6-trinitrotoluene is a possible human carcinogen.[78] Workers involved in the production of explosives who were exposed to high concentrations of 2,4,6-trinitrotoluene in workplace air experienced several harmful health effects, including anemia and abnormal liver function. Similar blood and liver effects, as well as spleen enlargement and other harmful effects on the immune system, have been observed in animals that ate or breathed 2,4,6-trinitrotoluene. [79]

It is not known whether 2,4,6-trinitrotoluene can cause birth defects in humans. However, male animals treated with high doses of 2,4,6-trinitrotoluene have developed serious reproductive system effects. [80]

TNT is not substantially degraded during aerobic treatment of DNT. [81] Solid chunks of 2,4,6-trinitrotoluene buried in soil or exposed on the soil surface can persist for many years.[82]

Degradation products of TNT include 4-ADNT (4-amino-2,6-dinitrotoluene) and 2-ADNT (2-amino-4,6-dinitrotoluene) and diamines.[83] Transformation products in soils were detected under both oxidized and reduced conditions.[84]

TNT is also a constituent of technical grade DNT (Tg-DNT). Analysis of Tg-DNT reveals the following composition: 76.49% 2,4-DNT, 18.83% 2,6-DNT, 0.65% 2,5-DNT, 2.43% 3,4-DNT, 1.54% 2,3-DNT, 0.040% 3,5-DNT, 0.050% trinitrotoluene (TNT), 0.005% cresols, 0.003% mononitrobenzene, and 0.003%, 0.0005%, and 0.006%, for ortho-, meta-, and para-, mononitrotoluenes, respectively (Hazardous Substances Data Bank [HSDB], 2004a,b,c). [85]

RDX stands for Royal Demolition eXplosive. It is also known as cyclonite or hexogen. The chemical name for RDX is 1,3,5-trinitro-1,3,5-triazine. It is used as an explosive and is also used in combination with other ingredients in explosives.[86] RDX dissolves very slowly in water, and it also evaporates very slowly from water. It does not cling

[78] ATSDR, ToxFAQs for 2,4,6-Trinitrotoluene (TNT), September 1996. Available online at: http://www.atsdr.cdc.gov/tfacts81.html
[79] ATSDR, ToxFAQs for 2,4,6-Trinitrotoluene (TNT), September 1996. Available online at: http://www.atsdr.cdc.gov/tfacts81.html
[80] ATSDR, ToxFAQs for 2,4,6-Trinitrotoluene (TNT), September 1996. Available online at: http://www.atsdr.cdc.gov/tfacts81.html
[81] Shirley F. Nishino and Jim C. Spain, Air Force Research Laboratory, Tyndall AFB, Florida *Technology Status Review: Bioremediation of Dinitrotoluene (DNT)*, page 5, February 2001.
[82] Rosenblatt DH. 1980. Toxicology of explosives and propellants. In: Kaye SM, ed. Encyclopedia of explosives and related items. Vol. 9. Dover, NJ: U.S. Army Armament Research and Development Command, 332-345 (as cited in ATSDR's Toxicological Profile for 2,4,6-Trinitrotoluene, page 103, June 1995).
[83] ATSDR, Toxicological Profile for 2,4,6-Trinitrotoluene, page 104, June 1995.
[84] Pennington JC, Patrick WH Jr. 1990. Adsorption and desorption of 2,4,6-trinitrotoluene by soils. J Environ Qua1 19(3):559-567 (as cited in ATSDR's Toxicological Profile for 2,4,6-Trinitrotoluene, page 99, June 1995).
[85] U.S. Environmental Protection Agency, *Drinking Water Health Advisory for 2,4-Dinitrotoluene and 2,6-Dinitrotoluene*, Proposal Draft, pages 6 and 9, August 2006.
[86] ATSDR, ToxFAQs for RDX, September 1996.

to soil very strongly and can move into the groundwater from soil. RDX can be broken down in air and water in a few hours, but it breaks down more slowly in soil. [87]

The EPA has determined that RDX is a possible human carcinogen.[88] RDX can cause seizures (a problem of the nervous system) in humans and animals when large amounts are inhaled or eaten.

The Army's April 1993 Remedial Investigation did not recommend carrying high explosives (RDX, HMX, TNT, and Tetryl) forward for further study because (1) the 1988 Master Environmental Plan (MEP) "data summaries did not indicate the presence of these types of explosive-type compounds", and (2) because the facility's known operating history indicated that military explosives such as TNT, RDX, HMX, and Tetryl "were not manufactured, used, stored, or disposed of" at Badger. [89] As a result, environmental samples conducted as part of the Remedial Investigation (RI) at the Propellant Burning Grounds "did not include analysis for these explosives compounds".[90]

Both these reasons, however, are faulty and misleading. First, while the RI states that the data summaries in the Master Environmental Plan did not identify high explosives at Badger – the text from this report certainly did. And second, the presence of high explosives at Badger is recorded as early as 1987 in the A.T. Kearney Report for Badger.

The referenced 1988 Master Environmental Plan for Badger reports that a soil sample was collected from a drain pipe "in a runoff area approximately 25 feet southwest of the burning pads".[91] This runoff area is Badger land that was leased for farming. The land had been plowed shortly before and was being fertilized at the time of the sampling. Five additional background samples were also taken to determine the explosives content of background samples at the Propellant Burning Grounds waste pits.

The drain pipe sample showed concentrations of 2.5 parts per million (ppm) 2,4,6-TNT, 1.8 ppm 2,6-DNT, and 3.1 ppm 2,4-DNT.[92] The explosives HMX and RDX were found under Phase 4 in some samples from pad 1, the area west of pad 2, refuse pit 2, and waste pit 1. The depths of the samples ranged from 10 to 40 feet. Up to 25.3 ppm RDX was measured. These contaminants were also found in pad 1. [93]

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[87] ATSDR, ToxFAQs for RDX, September 1996.
[88] ATSDR, ToxFAQs for RDX, September 1996.
[89] U.S. Army Environmental Center, Final Remedial Investigation Report, Volume I, page 6-3, April 1993.
[90] U.S. Army Environmental Center, Final Remedial Investigation Report, Volume I, page 6-4, April 1993.
[91] S.Y. Tsai et al, Master Environmental Plan for Badger Army Ammunition Plant, Volume 2: Appendix B (U), September 1987, page 139.
[92] S.Y. Tsai et al, Master Environmental Plan for Badger Army Ammunition Plant, Volume 2: Appendix B (U), September 1987, page 139.
[93] S.Y. Tsai et al, Master Environmental Plan for Badger Army Ammunition Plant, Volume 2: Appendix B (U), September 1987, page 139.

EPA officials have recently commented that historical studies at Badger that identified explosives (and other contaminants not carried forward for study) may not be reliable especially when compared to current methodologies.[94] For groundwater testing methods, this is especially true. In 1984, the level of detection for RDX in groundwater was only 30 ug/l.[95] By comparison, the federal health advisory for RDX in drinking water is only 2 ug/l.

Most propellants may be grouped as single-based, double-based, or multi-based propellants. Single-based propellants contain nitrocellulose; double-based propellants contain nitrocellulose and nitroglycerine; and multi-base propellants usually contain nitrocellulose, nitroglycerine, and nitroguanidine. Composite propellants are usually a physical mixture of a fuel such as a metallic aluminum, a binder, and an inorganic oxidizing agent such as ammonium perchlorate.[96]

While the principal components of a specific propellant are consistent, there is a wide range of substitutes and additives used in propellant composition. For example, ethyl centralite, dinitrotoluene, or potassium perchlorate may be added to control the burning rate. Nitroguanidine, barium nitrate, dibutylphthalate, or potassium perchlorate may be added to reduce flash. TNT (trinitrotoluene), while not thought of as a propellant, is often used as an additive to control the burning rate.[97] Conversely, potassium perchlorate may be listed as a component rather than an additive, as in propellant M7.[98]

Many materials are added to propellants for the purpose of controlling burning rates, moisture content, rate of decomposition, plasticity, sensitivity, stability, and molding. A list of additives to propellants may contain 50 compounds and this is by no means a list of all additives.[99] These additives may include such components as sugars, pesticides, glues, inorganic metal salts, and plastics.[100] According to the U.S. Army Defense Ammunition Center, chances are good that stored excess propellant will have an "absolutely unknown" stabilizer content. [101]

Badger was the only military propellant production facility that had the capability to use nitrocellulose recovered from excess or surplus propellant.[102] If a single base propellant was no longer needed by the Department of Defense because of a change in weapon system or replacement of a weapon system or because of age of the propellant,

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[94] Robert J. Egan, USEPA Region V, Public Meeting, Badger Army Ammunition Plant, June 21, 2007.
[95] S.Y. Tsai et al, Master Environmental Plan for Badger Army Ammunition Plant, Volume 2: Appendix B (U), September 1987, pages 160-161.
[96] U.S. Army Environmental Hygiene Agency, Aberdeen Proving Ground, Technical Guide 140, *Water Pollution Aspects of Explosive Manufacturing*, page 34.
[97] U.S. Army Environmental Hygiene Agency, Aberdeen Proving Ground, Technical Guide 140, *Water Pollution Aspects of Explosive Manufacturing*, page 37.
[98] U.S. Army Defense Ammunition Center, *Propellant Management Guide*, Appendix D, 1998.
[99] U.S. Army Defense Ammunition Center, *Propellant Management Guide*, Appendix D, 1998, page 6-2.
[100] U.S. Army Environmental Hygiene Agency, Aberdeen Proving Ground, Technical Guide 140, *Water Pollution Aspects of Explosive Manufacturing*, page 3.
[101] U.S. Army Defense Ammunition Center, *Propellant Management Guide*, Appendix D, 1998, page 6-2.
[102] D. Thurow, Olin Corporation, operating contractor at Badger Army Ammunition Plant, email communication to L. Olah, CSWAB, 8/22/01.

this propellant was shipped to Badger. This single-base propellant would have the nitrocellulose recovered and reused at Badger for the manufacture of new double-base propellant.[103]

While Badger's principal mission was the production of propellants[104], evidence of high explosives contamination is reported as early as 1987. Boreholes drilled in Burning Pad #1 had levels of TNT (trinitrotoluene), 2,4-DNT (dinitrotoluene), and/or 2,6-DNT between 1 and 10 ppm (parts per million) at various depths down to 20 feet.[105] One sample beneath Pad #1 contained 2.5 ppm of the explosive HMX (1,3,5,7-tetranitro-1,3,5,7-tetraazacyclo-octane).

Samples from the burning ground that had detectable levels of TNT, 2,4-DNT, and 2,6-DNT were located within the first 20 feet. The explosive RDX (1,3,5-Trinitro-1,3,5-triazacyclohexane) was discovered in several borehole soil samples from 10-40 feet.[106]

A 1989 Health and Safety Plan prepared for the U.S. Army Toxic and Hazardous Material Agency identified 2,4,6 -TNT and RDX as hazardous compounds detected at Badger.[107] High explosives are cited as a contaminant in soils at the Propellant Burning Ground and Landfill #1. Reported maximum concentrations of HMX, RDX, and TNT were 2,100 micrograms per kilogram (ug/kg), 1,400 ug/kg, and 4,200 ug/kg respectively.[108] Other historical references to TNT disposal at Badger include correspondence to the Wisconsin State Board of Health.[109]

- **The Proposed Remedy and Modification must require the Army to research and identify all potential degradation products of DNT and other explosives in soils and groundwater.**

  The public, regulators, and health officials have not been provided with a comprehensive list of potential degradation products associated with DNT and other

[103] D. Thurow, Olin Corporation, operating contractor at Badger Army Ammunition Plant, email communication to L. Olah, CSWAB, 8/22/01.
[104] U.S. Army Toxic and Hazardous Materials Agency. *Installation Assessment of Badger Army Ammunition Plant*, May 1977, Page II-1.
[105] A.T. Kearney, *Revised Preliminary Review Badger Army Ammunition Plant*, April 13, 1987, page 16 (Investigation of Soil Contamination at the Open-Burning Ground, Badger Army Ammunition Plant, May 8-15, 1984, US Army Environmental Hygiene Agency).
[106] A.T. Kearney, *Revised Preliminary Review Badger Army Ammunition Plant*, April 13, 1987, page 16 (Investigation of Soil Contamination at the Open-Burning Ground, Badger Army Ammunition Plant, May 8-15, 1984, US Army Environmental Hygiene Agency).
[107] E.C. Jordan, U.S. Army Toxic and Hazardous Material Agency, *Phase I Remedial Investigation*, Badger Army Ammunition Plant, *Final Health and Safety Plan*, page 2-3 & Appendix B, January 1989.
[108] E.C. Jordan, U.S. Army Toxic and Hazardous Material Agency, *Phase I Remedial Investigation, Badger Army Ammunition Plant, Final Health and Safety Plan*, Table 2-1, January 1989.
[109] Badger Army Ammunition Plant, June 15, 1942 and July 3, 1942 letters to State Board of Health regarding disposal of TNT wastes. (Also referenced in A.T. Kearney, *Revised Preliminary Review Badger Army Ammunition Plant*, April 13, 1987, Reference 110, page 67.)

explosives. Lists provided by the RAB TAPP Consultant, Dr. Jerry Eykholt, the Wisconsin Division of Health, and Army consultants vary significantly**:**

Potential degradation compounds of dinitrotoluene identified by the Wisconsin Division of Public Health include 2-nitroaniline, 3-nitroaniline, 4-nitroaniline, 1,3-dinitrobenzene, *p*-nitrotoluene, *m*-nitrotoluene, *o*-nitrotoluene, and nitrobenzene.[110]

In addition to these, U.S. Army contractors[111] have identified the following as DNT degradation compounds:

- 5-Nitro-o-toluidine
- 2-Methyl-3-Nitroaniline
- 2-Methyl-5-Nitroaniline
- 2-Methyl-6-Nitroaniline
- 4-Methyl-2-Nitroaniline
- 4-Methyl-3-Nitroaniline
- 5-Methyl-2-Nitroaniline
- Bis(2-chloroethyl)ether
- 1,3-Dinitrobenzene

One scientific study found that intermediates formed during degradation of 2,4-DNT include 1,3-dinitrobenzene, hydroxynitrobenzene derivatives, and carboxylic acids.[112] Multiple studies show that the breakdown/intermediate products of 2,4-DNT include 4-amino-2-nitrotoluene, 2-amino-4-nitrotoluene, and/or 2,4-diaminotoluene.[113]

These varying lists demonstrate the inconsistencies in information currently available to regulators, health officials, and the community.

- **The Proposed Remedy and Modification must provide the public with Drinking Water Health Advisory Levels for degradation products of DNT and other explosives that do not have an Enforcement Standard pursuant to NR 140.**

  The WDNR is required to notify the Department of' Health and Social Services when monitoring data indicate that a substance is detected in groundwater and to coordinate the collection of groundwater monitoring data and the exchange of these data among

[110] U.S. Department of Health and Human Services, Public Health Service, *Health Consultation: Dinitrotoluene in Private Wells*, Badger Army Ammunition Plant, page 15, September 30, 2006.
[111] Badger Restoration Advisory Board, Minutes, Attachment 1, *Dinitrotoluene Degradation Compounds Analyzed in September 2006 Round*, June 7, 2007
[112] Ho, P.C. 1986. Photooxidation of 2,4-dinitrotoluene in aqueous solution in the presence of hydrogen peroxide. Environ Sci Technol 20(3):260-267 (as cited in ATSDR, *Toxicological Profile for 2,4 and 2,-6 Dinitrotoluene*, 1988).
[113] Bradley et al., 1997; Cheng et al., 1996; Freedman et al., 1996; Liu et al., 1984; Noguera and Freedman, 1996, 1997 (as cited in U.S. Environmental Protection Agency, *Drinking Water Health Advisory for 2,4-Dinitrotoluene and 2,6-Dinitrotoluene*, Proposal Draft, page 14, August 2006.)

agencies**.**[114] A number of contaminants detected in groundwater monitoring wells and private drinking water wells located in neighborhoods near Badger are not regulated under NR 140 and do not have drinking water standards. As a result, community members do not know if groundwater in their neighborhood is safe to use and consume. Health Advisory Levels help residents to make informed decisions about their drinking water, their health, and the health of their children.

- **The Proposed Remedy and Modification must require regular monitoring of groundwater and residential wells for all potential degradation products of DNT, explosives, and other site contaminants.**

  The applicant must also demonstrate that naturally occurring biodegradation processes are reducing the **total mass** of contaminants in an effective and timely manner. This is demonstrated with historical site monitoring data which indicates an overall decreasing trend in contaminant concentrations over time and distance. This includes a decreasing trend in contaminant breakdown products and demonstrating a stable or receding plume.[115]

  Natural attenuation is defined in s. NR 140.05(14m) and s. NR 700.03(38m) as the "reduction in the concentration and mass of a substance and its breakdown products in groundwater, due to naturally occurring physical, chemical, and biological processes without human intervention or enhancement. These processes include, but are not limited to, dispersion, diffusion, sorption and retardation, and degradation.

  Biodegradation of DNT in subsurface soils may result in either mineralization or transformation of DNT. The latter produces organic derivatives of DNT whose toxicity may vary from the parent molecule. Transformation also leads to partial reduction of and the formation of amines.[116] Once conditions become anaerobic, DNT degradation is negligible. [117]

  Based on hepatic tumor initiation-promotion experiments, several animal studies demonstrated that technical grade (Tg) DNT has tumor-promoting and tumor-initiating activity. These studies further concluded that 2,6 DNT is a complete hepatocarcinogen and has the primary role in Tg-DNT's carcinogenic activity. [118]

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[114] Wis. Stats. § 160.27.
[115] WDNR Bureau for Remediation and Redevelopment, Interim Guidance for Selection of Natural Attenuation for Groundwater Restoration and Case Closure under Section NR 726.05(2)(b), PUBL RR-530-97, page 10, March 1997.
[116] Shirley F. Nishino and Jim C. Spain, Air Force Research Laboratory, Tyndall AFB, Florida *Technology Status Review: Bioremediation of Dinitrotoluene (DNT)*, page 2, February 2001.
[117] Shirley F. Nishino and Jim C. Spain, Air Force Research Laboratory, Tyndall AFB, Florida *Technology Status Review: Bioremediation of Dinitrotoluene (DNT)*, page 2, February 2001.
[118] U.S. Environmental Protection Agency, *Drinking Water Health Advisory for 2,4-Dinitrotoluene and 2,6-Dinitrotoluene*, Proposal Draft, page 38, August 2006.

The U.S. Environmental Protection Agency classifies the 2,4-DNT/2,6-DNT mixture as "likely to be carcinogenic to humans". [119]

Studies suggests that when these two DNT isomers are present, their combined ability to increase cancer risk is more than just additive, and may be synergistic or multiplicative (ATSDR 1998).[120]

IV. THE PROPOSED REMEDY AND MODIFICATIONS MUST ENSURE THAT THE SENSITIVE POPULATIONS AT RISK ARE NOT EXPOSED TO ANY LEVEL OF GROUNDWATER CONTAMINATION FROM BADGER ARMY AMMUNITION PLANT.

Populations at risk are a population subgroup that is more likely to be exposed to a chemical, or is more sensitive to the chemical, than is the general population.[121] The Agency for Toxic Substances and Disease Registry (ATSDR) as well as the U.S. EPA recognize that certain subpopulations, such as children, may be more sensitive to environment contaminants and having a higher probability of developing a condition, illness, or other abnormal status.[122]

For example, elderly persons may not be particularly sensitive to the effects of sulfur dioxide pollution but are considered to be at risk because lowered respiratory function may reduce their ability to withstand the additional reduction in respiratory function caused by exposure to sulfur dioxide.

At sites or facilities where there may be synergistic effects of contamination, multiple pathways of exposure or both that pose an unacceptable threat to public health, safety or welfare or the environment, responsible parties shall attain more stringent, facility or site–specific numeric standards to ensure that public health, safety and welfare and the environment are protected. In such a situation, the department may require that the responsible parties develop a site–specific numeric or performance standard, or both, that is protective of public health, safety and welfare and the environment for the specific media, migration or exposure pathways and contamination.[123]

As stated in the introduction, people who have heart or lung disease, certain inherited enzyme defects, or cancer may be more sensitive to the toxic effects of nitrate than others. In addition, some experts believe that long-term ingestion of water high in nitrate may increase the risk of certain types of cancer. [124]

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[119] U.S. Environmental Protection Agency, *Drinking Water Health Advisory for 2,4-Dinitrotoluene and 2,6-Dinitrotoluene*, Proposal Draft, page 46, August 2006.
[120] U.S. Department of Health and Human Services, Public Health Service, *Health Consultation: Dinitrotoluene in Private Wells*, Badger Army Ammunition Plant, page 9, September 30, 2006.
[121] USEPA, Terminology Reference System, *population at risk.*
[122] US Environmental Protection Agency. Air quality criteria document for lead. Washington, DC: US Environmental Protection Agency, 1977 (as cited in CDC MMRW, Populations at Risk from Air Pollution -- United States 1991, published April 30, 1993 ref. 42(16);301-304).
[123] Wis. Admin. Code NR § 722.09 (3)
[124] Wisconsin Department of Natural Resources, *Nitrate in Drinking Water*, Publication WS-001, undated.

- **The Proposed Remedy and Modifications must ensure that the expectant mothers, infants, and children are not exposed to contamination from Badger Army Ammunition Plant.**

  Children are not small adults. A child's exposure may differ from an adult's exposure in many ways. Children drink more fluids, eat more food, breathe more air per kilogram of body weight, and have a larger skin surface in proportion to their body volume.[125]

  There are very limited data on the effects of carbon tetrachloride exposure on children. Adult data cannot simply be extrapolated to children for a variety of different reasons.[126] Exposures of the embryo or fetus to volatile organic compounds such as carbon tetrachloride may occur if the expectant mother is exposed. A newborn infant may be exposed by breathing contaminated air and by ingestion of mother's milk, which can contain small amounts of carbon tetrachloride.[127]

  Several studies suggest that maternal drinking water exposure to carbon tetrachloride might possibly be related to certain birth defects. Studies in animals showed that carbon tetrachloride can cause early fetal deaths, but did not cause birth defects. A study with human breast milk in a test tube suggested that it would be possible for carbon tetrachloride to pass from the maternal circulation to breast milk, but there is no direct demonstration of this occurring.[128]

- **The Proposed Remedy and Modifications must assure that residents and workers that have already been exposed to contaminants from Badger Army Ammunition Plant are not exposed to any additional contamination from Badger.**

  Both families at Private Well #879 and #843 were exposed to high levels of solvents from Badger Army Ammunition Plant in their drinking water for more than 15 years. In March 2007, low levels of explosives have been detected in their replacement wells. Any additional exposure to toxins from Badger places these families at excessive and unacceptable health risk.

  Still other community members that lived and played at Gruber's Grove Bay were exposed to toxins in the water and sediments. Many of these same residents live in areas that are threatened by groundwater toxins from Badger. Again, any additional exposure to contaminants from Badger places these individuals at excessive and unacceptable health risk.

[125] ATSDR, *Toxicological Profile for Carbon Tetrachloride*, page 192, August 2005.
[126] ATSDR, *Toxicological Profile for Carbon Tetrachloride*, page 197, August 2005.
[127] ATSDR, *Toxicological Profile for Carbon Tetrachloride*, page 197, August 2005.
[128] ATSDR, *ToxFAQs for Carbon Tetrachloride*, August 2005.

Other community members that live downgradient from the Propellant Burning Grounds are former workers that were exposed to many of these same environmental contaminants while working at Badger. Any additional exposure to toxins from Badger places these residents at excessive and unacceptable health risk.

- **The Proposed Remedy and Modifications must assure that residents that have been diagnosed with cancer, with compromised immune systems, or are otherwise considered a population at risk, are not exposed to additional contamination from Badger.**

  Community member have testified at a number of public meetings that they or someone in their family has suffered from cancer or other debilitating illness. Any additional exposure to toxins from Badger places these residents at excessive and unacceptable health risk.

V. DISCHARGE OF THE GROUNDWATER CONTAMINANT PLUME AND STORMWATER RUNOFF TO THE WISCONSIN RIVER MUST NOT HARM THE AQUATIC LIFE OR WATER QUALITY CONDITIONS OF THE RIVER.

- **The Proposed Remedy and Modification must require an antidegradation analysis consistent with the provisions set forth in NR 207 and Title 40 section 131.12 of the Code of Federal Regulations.**

  At sites or facilities in, or in close proximity to, surface water bodies or wetlands, active remedial actions shall be taken to prevent or minimize, to the extent practicable, potential and actual hazardous substance discharges and environmental pollution that may attain or exceed surface water or wetland criteria established in accordance with chs. NR 102 to 106.[129]

  Where a discharge to surface water exists, impacts to surface water quality must be evaluated as required under NR 722.09(2)(c). Receptors in surface waters include aquatic organisms living in the soils and sediments of the seepage zone, waterborne aquatic life, and humans indirectly through recreation and consumption of fish containing the bioaccumulated contaminant.[130]

  The 3**,** 4-DNT isomer is designated as a hazardous substance under section 311(b)(2)(A) of the Federal Water Pollution Control Act and is further regulated by the Clean Water Act Amendments of 1977 and 1978.[131] Moreover, the National Institute

[129] Wis. Admin. Code NR § NR 722.09 (2)(c)3.
[130] WDNR Bureau for Remediation and Redevelopment, Interim Guidance for Selection of Natural Attenuation for Groundwater Restoration and Case Closure under Section NR 726.05(2)(b), PUBL RR-530-97, page 8, March 1997.
[131] Clean Water Act, § 311(b)(2)(A) (2007).

for Operational Health and Safety has listed 3, 4 DNT as a significant health threat to humans and extremely toxic to aquatic organisms.[132]

The 2,4-Dinitotoluene isomer is toxic to aquatic organisms and may cause long-term adverse effects in the aquatic environment.[133] Acute toxicity data available for the single isomers of the technical mixture show that the toxicity of 2,4- and 2,6-DNT is in the same order of the toxicity found for the technical mixture. However, the other isomers are about an order of magnitude more toxic to fish than the main isomers.[134]

The 2,3- and 3,4-DNT isomers are considered very toxic to aquatic organisms.[135,136] The 2,5-DNT isomer is considered toxic to aquatic organisms.[137]

- **The Proposed Remedy and Modification should incorporate a general stormwater permit and its accompanying SWPPP in an effort to eliminating, to the extent possible, soil and groundwater contamination from stormwater runoff.**

  As recent as 1996, Badger's WPDES permit contained a stormwater discharge permit pursuant to NR 216, Wis. Admin. Code.[138] This condition was due largely to Badger's industrial classification (i.e. likelihood that its industrial activities would affect or contaminate stormwater runoff). The incorporation of the stormwater permit was necessary to coordinate storm water monitoring and the implementation of the Storm Water Pollution Prevention Plan (SWPPP), as it relates to the industrial activity of the facility.

  Although Badger's status as an industrial facility has changed from "standby" to "decommission," the facility still maintains its industrial character. Soil and groundwater contamination are, unfortunately, the remnants of this industry activity, acting as an able substitute to industrial operations. The chief concern is that contact between stormwater and the contaminated soil is resulting in both onsite and offsite groundwater contamination.

  The land along the southern boundary of the plant is of particular concern. As previously mentioned, this large elongated section of land known as Final Creek and Absorption ponds 1, 2, 3, 4 has been designated as a solid waste management unit under RCRA due to the contamination of soils and subsurface soils with lead, sulfates,

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[132] Centers for Disease Control and Prevention, International Chemical Safety Cards (developed by the National Institute for Occupational Safety and Health), http://www.cdc.gov/niosh/ipcsneng/neng0729.html.
[133]ScienceLab.com, Material Safety Data Sheet, 2,4-Dinitrotoluene, Dangerous Substances Classification and Labeling /European Economic Community (DSCL/EEC), 06/10/99.
[134]Organisation for Economic Co-operation and Development Screening Information DataSet (OECD SIDS) DINITROTOLUENE (ISOMERS MIXTURE) Initial Assessment Report for SIAM 18, Paris, France, April 20-24, pages 38-39.
[135] International Labor Union, 2,3-Dinitrotoluene Material Safety Data Sheet, April 2005.
[136] International Labor Union, 3,4-Dinitrotoluene Material Safety Data Sheet, April 2005.
[137] International Labor Union, 2,5-Dinitrotoluene Material Safety Data Sheet, June, 2006.
[138] WPDES Permit Fact Sheet for Badger Plant, p. 7 (July 19, 2001).

tin, 2, 4 DNT, 2, 6 DNT, diphenylamine, zinc, and nitrocellulose.[139] This interconnected series of ditches and depressions drains 40% of stormwater that falls on the 7,350 acre plant, in addition to the 0.054 mgd discharge from Outfall 002. Considering that none of this water is discharged to Gruber's Grove Bay,[140] the polluted soil interacting with an immense amount of rainfall is likely resulting in the leaching of contaminants into groundwater as it permeates the soil.

NR 216.27 Wis. Admin. Code requires a SWPPP include a short summary of major activities conducted throughout the facility, a drainage map containing the location of outfalls and of activities and materials that have the potential to contaminate stormwater.[141] Moreover, the SWPPP must specifically "identify all potential source areas of storm water contamination including…areas containing residual pollutants from past industrial activity."[142]

Lastly, any time an onsite activity affects the stormwater flow or exposure of stormwater to pollutants the facility is required to reexamine the SWPPP, and, if necessary, amend it.[143]

The amount of contaminated soil still found on the Badger facility, coupled with the long and intense task of future remedial efforts will trigger the constant re-examination of the SWPPP. The incorporation of this plan into the WPDES permit will promote a comprehensive understanding of the facility's soil and groundwater contamination, Badger's cleanup efforts, and the stormwater issues affecting the Badger plant.

VI. THE PROPOSED REMEDY AND MODIFICATION MUST PROMOTE REUSE AND RECYCLING.

- **The Proposed Remedy and Modification must require re-use and recycling of materials and equipment wherever possible rather than burial in place or off-site disposal.**

Sincerely,

Signature on original

Laura Olah
Executive Director

[139] RCRA finding
[140] Badger Stormwater Pollution and Prevention Plan (SWPPP as amended 1999).
[141] Wis. Admin. Code NR § 216.27(3)(c)1-10 (2007).
[142] Wis. Admin. Code NR § 216.27(3)(d) (2007).
[143] Wis. Admin. Code NR § 216.27(4) (2007).