

# Health Risk Limits for Perfluorochemicals

*Report to the Minnesota Legislature 2007*

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**Minnesota Department of Health**

**Interim Report  
September 30, 2007**



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# Health Risk Limits For Perfluorochemicals

## Executive Summary

The Minnesota Legislature directed the Minnesota Department of Health to report on the department's progress toward determining the health effects of perfluorochemicals and progress toward developing health risk limits for perfluorochemicals.

Perfluorochemicals (PFCs) have been found in the groundwater in Washington County, and in surface water and waste water effluent in other parts of the state. PFCs have also been found in some fish in the greater metropolitan area. Health Risk Limits (HRLs) for PFCs are concentrations in water (in ug/L or parts per billion) that pose little or no appreciable risk to a person drinking the water.

On August 27, 2007, the department established HRLs for the perfluorochemicals perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS).

- The health effects of concern for PFOS are effects on the liver and thyroid.
- The health effects of concern for PFOA are effects on the liver and slowed development of fetuses, reduced number of red blood cells, and changes to the immune system.
- Water intake of 95 percent of the US population is used for the exposure.
- The HRLs for PFOA and PFOS are 0.5 ug/L and 0.3 ug/L, respectively.

Currently the MDH is acquiring and reviewing data on the toxicity of perfluorobutanoic acid (PFBA) and other perfluorochemicals.

- The department intends to use the available toxicity information to develop a Health Based Value for PFBA in the near future.
- New data on PFBA toxicity are expected in the future, and any Health Based Value could change within the next few years.
- A cursory review of the available studies on other PFCs indicates that other PFCs are no more toxic than PFOA or PFOS.
- There are no immediate plans to develop Health Based Values for additional PFCs.

The department provides instructions in the HRL rules on a Hazard Index approach to assess risks from exposures to mixtures of chemicals. The department will continue to advise the use of a hazard index to assess risks from mixtures of PFCs.

The department has compared the health-based values for PFOA established in Minnesota (0.5 ug/L) to the PFOA values established by New Jersey (0.04 ug/L) and North Carolina (0.63 ug/L). In comparison to Minnesota:

- The New Jersey value was based on a different species (rat) and divided the serum level of concern by 100 to estimate a water level of concern.
- The North Carolina value was based on the monkey study and modeled the serum level of concern to estimate a dose of concern.

## **Introduction**

The Minnesota Legislature requested a report from the commissioner of health on legislation (Minnesota Session Laws 2007, Chapter 37) requiring Health Risk Limits for perfluorochemicals in groundwater. The legislature asked for a report by January 15, 2008, and an interim report by September 30, 2007. This report fulfills the requirement of an interim report.

The legislature asked that the report describe the department's progress toward determining the health effects of perfluorochemicals and progress toward developing health risk limits for perfluorochemicals. In particular, the report was to include

1. The health effects and health risk limits adopted for perfluorooctanoic acid and perfluorooctane sulfonate;
2. The health effects and the need to develop health risk limits for perfluorobutanoic acid and other perfluorochemicals;
3. The health effects and the need to develop health risk limits for combinations of perfluorochemicals; and
4. A comparison of health-based values for perfluorochemicals established in Minnesota and the values established for those chemicals in other states including the state of New Jersey.

The Health Risk Assessment Unit (within the Division of Environmental Health's Environmental Surveillance and Assessment Section) prepared the following report to answer these requests for information. The Health Risk Assessment Unit is responsible for developing Health Risk Limits and providing technical support on the toxicity evaluation of perfluorochemicals.

### **I. The health effects and health risk limits adopted for perfluorooctanoic acid and perfluorooctane sulfonate**

#### **Perfluorochemicals**

Perfluorochemicals (PFCs) are substances that were manufactured by the 3M Company (3M) in Cottage Grove, Minnesota (in Washington County) from the 1950s to 2002. The chemicals have unique properties, which made them ideal for use in products that resist heat, oil, stains, grease and water. Common uses included nonstick cookware, stain-resistant carpets and fabrics, fire-fighting foam, and other industrial applications. Wastes from the production process were placed in several disposal sites in Washington County.

The chemical structures of PFCs make them extremely resistant to environmental actions (e.g., heat, sunlight, bacterial action) that break down large molecules into smaller molecules. The intact chemicals have been found in water, wildlife, and humans around the world. How these chemicals move from locations where they are made, used, or disposed to remote areas is an area of active scientific research.

The chemicals that concerned the legislature and state agencies include perfluorooctane sulfonate (PFOS; C<sub>8</sub>F<sub>17</sub>SO<sub>3</sub>), perfluorooctanoic acid (PFOA; C<sub>8</sub>F<sub>15</sub>O<sub>2</sub>H), and perfluorobutanoic acid (PFBA; C<sub>4</sub>F<sub>7</sub>O<sub>2</sub>H). Each of these chemicals has been found in groundwater in Washington County, Minnesota. PFOS has also been found in fish collected from some lakes in Washington County, other lakes in the St. Paul and Minneapolis metropolitan area, and sections of the Mississippi River. PFCs have also been found in surface water and in water discharged from waste water treatment plants (<http://proteus.pca.state.mn.us/hot/pfc.html>).

The health effects (that is, the toxicity) of PFCs is another area of active scientific research. Many toxicity studies on laboratory animals (rats, mice, and monkeys) have been conducted with a few PFCs, such as PFOS and PFOA, while other PFCs, such as PFBA, have not been thoroughly studied. In laboratory animal studies, high concentrations of PFOA and PFOS cause harmful changes in the liver and other organs. Developmental problems (for example, delays in growth and maturation) have been seen in the offspring of rats and mice that were exposed to PFCs while pregnant. The ways in which the chemicals cause health effects is not fully understood, but toxicologists assume that these health effects might also occur in humans exposed to high concentrations of the chemicals. PFOA in high concentrations over a long period of time also causes cancer in rats by a process that has been studied and is arguably unlikely to occur in humans.

There are a few studies of health effects in people. 3M studied the health of 3M workers exposed to PFCs during manufacturing and found no apparent harm to worker health. Two studies have been conducted to determine if there is a relationship between the health of newborn babies and PFC levels in the mother's blood. Each study found a small decrease in birth weight or other measures of growth with increasing PFC levels in the mother. A health study of 70,000 people exposed to PFOA in drinking water in Ohio and West Virginia is underway. In general, these studies show that the levels of PFCs in the environment may be linked to changes in the body, but the studies have not shown that the PFCs have harmed people. Therefore, toxicologists have relied on animal studies to determine whether an exposure to PFCs may be harmful.

Another area of active research is the length of time that PFCs may be retained in the body ("half-life"). Scientists need to understand how humans are different than animals in eliminating PFCs from the body. PFCs circulate through the body in the blood, and are slowly removed by the kidneys and gut to be eliminated in urine and feces. 3M has studied the length of time that it takes for serum levels of PFCs to decrease once occupational exposures end. The results of these studies suggest that it may take more than 5 years for even one-half of a single exposure to PFCs to leave the human body. In contrast, some animals eliminate PFCs in a few hours to a few weeks. Most scientists studying PFC toxicity believe that the PFC that circulates in the blood is responsible for harmful effects so that the fact that humans eliminate PFCs very slowly must be taken into account when animal toxicity studies are used to determine a safe exposure for people.

### **PFC Risk Assessment**

Information on toxicity and exposure is used to determine an exposure to humans that does not cause harmful effects. The risk assessment work that the department conducted for PFOA and PFOS in 2006 and 2007 was extensive (Appendices A and B). The risk assessment led to

guidance in 2007 on water concentrations (called “Health Based Values”) that are safe for people to drink and fish tissue concentrations that are safe for people to eat. The water concentrations are expressed as parts per billion (ppb), which is the same as micrograms per liter of water (ug/L), and are used to evaluate the levels of PFOA and PFOS measured in drinking water wells. Similarly, the fish concentrations are expressed in ppb or micrograms PFOS per gram of fish (ug/g) and are used to evaluate the levels of PFOS in the edible portion of fish. PFOA is not detected in fish or is at levels too low to prompt an advisory.

The department calculated Health Based Values using data on how much tap water people of different ages drink each day. The drinking water intake (in liters of water per kilogram body weight per day) that was selected for each of the PFC risk assessments is an amount of water greater than what the average person drinks. The selected values encompass the drinking water intake of 95 percent of the population and are averaged over time according to different life stages and the length of time over which the chemical accumulates in the body.

The drinking water intake was combined with a daily dose (in milligrams of chemical per kilogram body weight per day) that is not likely to cause a health effect in humans. Toxicity studies are carefully reviewed and often the scientists who conducted the studies are consulted. Staff in the department select doses of interest, make adjustments to account for human variability and uncertainties in the data, and compare the resulting doses of interest from the different studies. The result is a daily dose (the “reference dose”) that is unlikely to cause health effects over either a short or very long period of time.

The PFOA reference dose was based on a study in monkeys in which some of the animals dosed with 3 milligrams per kilograms per day (3 mg/kg-day) had increased liver weights, which appeared to be reversible when dosing stopped. At higher doses the animals showed other effects (indicating liver damage and changes in thyroid) and some animals died. Studies in rats showed comparable doses had similar effects on the liver and also showed that additional health effects may be a concern (slowed development of fetuses, reduced number of red blood cells, and changes to the immune system). The next step was to calculate a human equivalent dose of concern that took into account the slow elimination of PFOA in the human body compared to the monkey. The 70-fold difference between the two species was used to calculate a human dose of concern. Over a long period of time, a human daily dose of 0.043 mg/kg-d would result in the same dose inside the body as the 3 mg/kg-d dose of concern from the monkey study because the chemical accumulates to a greater extent in humans than in monkeys. Adjustments were also made for human variability, uncertainty about differences between monkeys and humans in sensitivity to the chemical, and the fact that an effect on the liver was observed at the lowest dose tested (which meant that the true dose without any effect was likely lower). The total adjustment was a factor of 300. The human equivalent dose of 0.043 mg/kg-d was divided by 300 and the result was a reference dose of 0.00014 mg/kg-day.

Similar steps were taken to develop a reference dose for PFOS. The reference dose for PFOS was also based on a study in monkeys. In this study a dose of 0.15 mg/kg-day caused liver effects (increase liver weight) and changes in levels of thyroid hormone, cholesterol, and high-density lipoprotein. The dose that caused an effect was adjusted for the slower elimination of PFOS by humans compared to monkeys (a 20-fold difference in time). Over time, a human daily

dose of 0.0075 mg/kg-d would result in the same dose inside the body as the 0.15 mg/kg-d dose of concern in monkeys. Adjustments were also made for human variability, uncertainties about the true no effect level, and uncertainties about the differences between monkeys and humans in sensitivity to the chemical. The total adjustment was a factor of 100. The human equivalent dose of 0.0075 mg/kg-d was divided by 100. The result was a reference dose for PFOS of 0.000075 mg/kg-day.

The reference doses represent a safe daily dose of a chemical. But if there are other possible sources of exposure to the chemical, drinking water standards may be set so that the intake just from drinking water is lower than the reference dose. This is accomplished using a factor called the relative source contribution factor. This factor, typically 0.2, is a well-established factor for developing standards for drinking water. By using this factor, the department limits the exposure from drinking water so that any other sources of exposure (for example, food, air, or soil) are unlikely to cause the total exposure to be greater than the reference dose.

The selected reference dose, the intake rate, and the relative source contribution factor were used to calculate the limit for drinking water. The resulting water value for PFOA was 0.5 ug/L and the value for PFOS was 0.3 ug/L. These values were calculated as described in memoranda dated February 26, 2007 (Appendices A and B) and called Health Based Values. The values were used for making decisions on whether exposures needed to be reduced when PFOA or PFOS were measured in drinking water. Similar steps were taken more recently to calculate a PFOS fish tissue concentration for eating fish.

Since developing the February 2007 values, the department has continued to closely track the status of toxicity studies that the department knows are in progress. At this time, no data have been received that alter the risk assessment that was completed in February. However, the department will closely monitor the ongoing studies and evaluations conducted by federal agencies and states to determine if additional studies would result in a different reference dose and new Health Risk Limit. The department is currently receiving monthly status reports from 3M (Appendix C) and contacting the US Environmental Protection Agency (EPA) on a regular basis to receive updates on studies that staff are tracking.

The information above on health risks from exposure to these chemicals and the calculation of the water levels associated with no health risks was used to propose rules for PFOA and PFOS. This work is carried out by toxicologists in the department with many years of experience in laboratory research and risk assessment, and reviewed by supervisors and managers with many years of experience in toxicology, risk assessment, and public health.

### **Promulgation of Health Risk Limits for Perfluorochemicals**

In 1993 and 1994, health protective water values for 120 chemicals were promulgated as permanent rules called Health Risk Limits or HRLs. A HRL value, by definition, is a concentration of contaminant in water that has no appreciable affect on health. Since 1994, the department has met the need for new or updated water values by calculating Health Based Values. These calculations use current scientific data and current risk assessment procedures. Health Based Values are not rules but are offered as advice to agencies in the form of a memo.

The department intends to promulgate new Health Risk Limits for multiple chemicals in the next year based on the new procedures that were used to calculate the Health Based Values for PFOS and PFOA.

Minnesota Session Laws 2007, Chapter 37, instructed the department to adopt by rule Health Risk Limits for PFOS and PFOA according to Good Cause Exemption (clause 1, “the rules address a serious and immediate threat to public health, safety, or welfare”). The language was signed into law on May 3, 2007 and the department was given a deadline of August 1, 2007 to adopt the rules.

The department prepared all of the necessary paperwork to adopt rules through good cause exemption. The rule language was drafted and sent to the office of the revisor on June 18. The department executive office was briefed for approvals on July 11. The preliminary proposal form was given to the Governor’s office on July 23. On August 1, 2007, the rules were sent to the Office of Administrative Hearings and notice was given to the public that the rules were proposed for adoption. This notice followed department and state guidelines for public comment on rule making by good cause exemption. During the mandatory five-day comment period four sets of comments were sent to the Office of Administrative Hearings.

All of the comments were critical of the rules, suggesting (variously) that: the comment period was too short or otherwise inadequate (e.g., no statement of need and reasonableness), the HRL values are underprotective, alternative studies should be used as the basis of the reference dose, specific uncertainties should be (variously) used or not used, an equation used in 1993 should be used to calculate the HRL, the slow elimination of the chemical should not be factored into the reference dose, and different exposure inputs into the equation should be used.

The administrative law judge approved the rules for adoption on August 17. The department received a report from the law judge concerning the comments that had been submitted. In the report the judge said that the consideration that the department gave in developing the HRL values was reasonable, and that the commentators did not show that the department had been unreasonable (Appendix D).

The HRLS for PFOA and PFOS have now been adopted and became effective August 27, 2007, when they were published in the State Register (Volume 32, Number 9, page 373). The final version of the rule, received from the revisor’s office on August 27, 2007, is attached (Appendix E).

These are temporary rules that can only be in place for two years. The department intends to include PFOA and PFOS in a revision of the entire HRL rule that is currently underway. A notice soliciting comment on the possible revision of the HRL rule was published in the State Register on September 10, 2007. Other necessary steps (drafting the rules and Statement of Need and Reasonableness and notifications) are in progress.

Multiple public meetings to inform the public about the department’s draft of a rules revision have been held. The most recent public meeting held on September 13, 2007, focused on the draft rules and SONAR released September 10, 2007. Information about meetings is published



on the rules revision web site, <http://www.health.state.mn.us/divs/eh/groundwater/hrlgw/index.html>. Individuals interested in following the rules revision process are encouraged to subscribe to the HRL Rules Revision Gov Delivery service available through the department web site.

## **II. The health effects and the need to develop health risk limits for perfluorobutanoic acid and other perfluorochemicals**

The department has assembled literature for other PFCs based on literature reviews and contacts with the EPA and 3M. Staff have talked with toxicologists and risk assessors in other states to determine if there may be additional studies and data to review. The data for perfluorobutanoic acid (PFBA) are limited, but as of now the quality of the data appear adequate for developing a Health Based Value. Staff scientists are currently acquiring additional data, final versions of data, and preparing the assessment that the department will use to establish a Health Based Value.

The department's advice for using drinking water supplies contaminated with PFBA has been based on a guidance value of 1 ug/L. This value was used for PFOA prior to February 2007 (when the Health Based Values were established) and used for any other PFC that had an acid form. At the time that the PFOA Health Based Value was established, the department was aware that animal studies showed that PFBA was less toxic than PFOA. The department believed that the toxicity and half-life information meant that PFBA would be less toxic to humans than PFOA and the department continued to use the guidance value of 1 ug/L for PFBA after the PFOA Health Based Value of 0.5 ug/L was established.

The PFBA animal toxicity studies that the department has reviewed were conducted by the EPA, by an independent contract laboratory on behalf of 3M, and by other researchers. The studies include four 5-day to 14-day studies in male rats and mice that assessed liver effects, and one 28-day study in male and female rats. Preliminary results from a developmental study (dosing during gestation) in female mice have also been reviewed. The department has received verbal reports from 3M on the likely results of a 90-day study in rats. The department has recently received short summaries (from poster presentations at scientific meetings) on the comparative pharmacokinetics (half-life information) of PFBA in rats, mice, and monkeys. A report regarding half-life in humans (workers) was submitted to the department in August 2007 and updates to that information are expected.

Of these studies, the study that appears most useful for risk assessment is the 28-day study in rats in which changes in serum cholesterol and thyroid hormone levels were found at low doses. The study has not been published, but the department received the study report (the study was conducted by an independent laboratory under contract with 3M). The department intends to use this information to develop a Health Based Value in the near future. New data on PFBA toxicity are expected in the future, and any Health Based Value could change within the next few years. The department will consider all of the available data in calculating a value and take into account the uncertainty around any lack of data.

There are few studies on other PFCs, but staff conducted a cursory review of the available studies to compare the toxicity of the PFCs. This initial review showed that other PFCs are no more toxic than PFOA or PFOS. The department has listed known studies in Appendix E. There are no plans at the present time to develop Health Based Values for other PFCs.

### **III. The health effects and the need to develop health risk limits for combinations of perfluorochemicals**

The legislature asked for information on the need to develop HRLs for mixtures of perfluorochemicals. The preferred scientific approach is to base a risk assessment for a particular exposure on the results of a toxicity study that perfectly duplicates the exposure. This means that a study might be done with the exact mixture found in a well. This type of mixtures work has not been done with perfluorochemicals and has rarely been done with other chemical mixtures. Even when toxicity studies have been completed with mixtures, the results are difficult to apply to the results of environmental sampling because the ratio of chemicals found in each water sample may not be the same as the ratio of chemicals used in the toxicity study. Mixtures in the environment can be very different across different geographic locations and may change over time, so there might be an endless number of unique toxicity studies that would need to be conducted to accurately assess a complex or changing mix of chemicals.

Since toxicity data on mixtures is rarely available, the department offers rules and advice on developing a risk assessment when multiple chemicals are present. The department's recommendation is to consider the combined effects of chemicals when two or more chemicals in a mixture affect the same tissue, organ, or organ system. The methods in the HRL rule for considering risks from multiple chemicals did not change with the adoption of the PFC rules, and these methods will continue to be recommended by the department for PFCs as well as other chemicals. This guidance is well accepted nationally (US EPA 2000) and within the state as a simple yet protective procedure.

In order to consider the combined health risk of multiple chemicals, the department advises the risk assessor to first compare the measured water concentration of each chemical to the corresponding HRL value. The result is a "hazard quotient." For example, a water concentration of 1.2 ug/L water compared to the corresponding HRL of 3 ug/L results in a hazard quotient of 0.4 (see Table 1). A hazard quotient of 1 or less shows that the HRL has not been exceeded and that the exposure is not harmful.

Table 1. Examples of hazard quotient calculations for three chemicals found in a single water sample.

Chemical	Amount detected in water ug/L)	HRL (ug/L)	Hazard Quotient*	Health Effects
A	1.2	3	$1.2/3 = 0.4$	Liver, Developmental Effects
B	150	500	$150/500 = 0.3$	Liver, Blood
C	0.48	0.6	$0.48/0.6 = 0.8$	Developmental Effects

\* The Hazard Quotient is the ratio of the amount detected in water and the HRL value (that is, the water concentration divided by the HRL value). The resulting quotient is unitless because each value has the same units of micrograms per liter (ug/L).

To determine the health risks when multiple chemicals are present, the hazard quotients for each health effect are added together. A sum of hazard quotients is called the “hazard index.” In the example in Table 1, a hazard index for liver effects and a hazard index for developmental effects should be calculated when chemicals A, B, and C are present in a sample of drinking water.

The hazard index for liver effects is calculated by adding the hazard quotients for chemicals A and B ( $0.4 + 0.3 = 0.7$ ). The hazard index for developmental effects is calculated by adding the hazard quotients for chemicals A and C ( $0.4 + 0.8 = 1.2$ ).

The risk assessor advises the risk manager of the resulting hazard index. A hazard index that exceeds one (as is the case with the hazard index for developmental effects in the example above) indicates that an intervention to reduce exposure may be needed. For example, the well owner may be advised to use bottled water until a filter is installed.

The department decides which health endpoints should be included in the risk assessment for a mixture based on an understanding of the toxicity of each of the chemicals. The health endpoints (there may be more than one) for each HRL chemical are included in the HRL rule. The health endpoints for PFOS are the liver and thyroid. The health endpoints for PFOA are liver, the hematologic (blood) system, developmental effects, and the immune system. These are effects that the department believes occur at similar doses across the different studies that have been conducted in animals. These are also effects that the department believes are appropriate groupings. For example, the department believes that various liver effects (for example, abnormal liver cells and increased serum liver enzymes) should be considered together even if the effects are not identical or caused by the same toxic action in the organ.

This procedure not only addresses the potential combined effects of PFOS and PFOA on the liver (a shared health endpoint of concern), it also addresses the combined effects of any other chemicals that are analyzed for and found in the water. For example, the potential harmful effects of the pesticides alachlor and simazine on the blood system should be added to the potential for harmful effects of PFOA on the blood system if all three are found in a water sample.

To date, the department has included PFBA in the approach of adding hazard quotients for PFCs found in a water sample. Although the department has not finalized a Health Based Value for

PFBA, the department is using 1 ug/L as a decision point for recommending reduced exposure. Since the health endpoints (potential harm to the liver) on which this guidance is based is shared with PFOA and PFOS, the department has considered the hazard index to be exceeded if PFBA levels exceed 1 ug/L and PFOA and/or PFOS are present at measurable levels.

#### **IV. A comparison of health-based values for perfluorochemicals established in Minnesota and the values established for those chemicals in other states including the state of New Jersey.**

Two states have developed health protection values for PFOA contamination of drinking water. The states of New Jersey and North Carolina published values of 0.04 ug/L and 0.63 ug/L, respectively, in 2007. The department is not aware of any other values developed by any other states. The EPA derived an action value of 0.50 ug/L for PFOA as part of a Consent Order for the DuPont Washington Works facility (<http://www.epa.gov/opptintr/pfoa/index.htm>). The United Kingdom and Germany have also developed values for PFOA or PFOS that range from 0.1 to 5 ug/L and higher (Appendix G).

##### **The New Jersey Water Value**

The State of New Jersey based their preliminary risk assessment for PFOA on an analysis of the serum level in animal studies and a factor to convert a human equivalent serum level to a water level (Post, 2007). New Jersey used information from a 2005 EPA draft risk assessment of PFOA (US EPA 2005) to determine a no effect level of PFOA in the serum of tested female rats (1,800 ug/L serum). Default uncertainty and variability factors (totaling 100) were used to divide the no effect serum level of 1,800 ug/L in rats to a lower serum level (18 ug/L) that would be unlikely to harm humans. In comparison, a recent study at the US Centers for Disease Control and Prevention (CDC) found that the level of PFOA in the general population does not reach this concentration (Calafat et. al., 2007). Fifty percent of the more than 2,000 randomly selected people in the CDC study had serum concentrations of 4.0 ug/L and 95 percent of those tested had a serum level of 9.8 ug/L or less.

New Jersey next calculated a drinking water concentration that would result in an accumulation of 18 ug/L PFOA in the serum. New Jersey scientists felt that the appropriate conversion or mathematical relationship between serum and water was a factor of 100. The factor of 100 came from a study of individuals who drank from a contaminated water supply in Little Hocking, Ohio. The median serum concentration among the 371 subjects in the Little Hocking study was 354 ug/L and the average PFOA concentration in Little Hocking system distribution water was 3.55 ug/L (Emmett, et. al, 2006a; 2006b). A simple comparison between the two values is the ratio of 354/3.55 or 100. The 100-fold factor does not distinguish between exposures from the water supply and other exposures. However, New Jersey used a relative source contribution factor of 0.2 in the same way that the department took into account other sources of exposure.

New Jersey used the factor of 100 to calculate drinking water values from seven animal toxicity studies. The seven results were compared and the lowest water concentration, 0.04 ug/L, was selected as the health-based drinking water guidance for the state. Details of the analysis of data

and calculations that were used are at [http://www.state.nj.us/dep/watersupply/pfoa\\_dwguidance.pdf](http://www.state.nj.us/dep/watersupply/pfoa_dwguidance.pdf).

### **The North Carolina Water Value**

The State of North Carolina calculated an interim value of 2 ug/L for PFOA in water in November 2006 followed by a Public Health Goal of 0.63 ug/L in June 2007. The first calculation (the interim value of 2 ug/L) was calculated by the North Carolina Division of Water quality (<http://h2o.enr.state.nc.us/csu/documents/IMACBasisC8.pdf>) and was based on a reference dose from a rat study. The more recent calculation (the Public Health Goal of 0.63 ug/L) was calculated by the North Carolina Division of Public Health (Williams, L.C., and Rudo, K., 2007) and was based on a reference dose from a monkey study. According to the authors, the Public Health Goal (PHG) is subject to change following the completion of a North Carolina Science Advisory Board review of the toxicology.

The PHG calculation was based on a reference dose calculated by researchers at CIIT Centers for Health Research in Research Triangle Park, NC; a relative source contribution factor of 0.2; an intake rate of 2 L/day; and a body weight of 70 kg. The reference dose calculated by researchers at CIIT was based on the same monkey study and health effect selected by the department. The CIIT researchers, however, chose to use serum level rather than the administered dose as a starting point. Uncertainty factors (totaling 30) were used to reduce the serum level from the study to a “safe” serum level for humans. The CIIT researchers used a pharmacokinetic model developed in monkeys but scaled to humans to estimate that an oral dose (in ug/kg-d) is about 0.1 times the serum level (in ug/mL). The resulting reference dose was approximately 0.00009 mg/kg-d (Appendix H).

### **Comparisons to the Minnesota Department of Health Value**

A risk assessment is based on toxicity studies, and the selection of the appropriate toxicity study and analysis is a fundamental decision for PFC risk assessments. The New Jersey assessment used a pharmacokinetic model based on an acute study with female rats that have a half-life that is shorter than the dosing interval used in the study. This model was applied to a chronic rat feeding study to estimate a PFOA serum level that caused chronic health effects. The department is concerned that the model may not be adequate for estimating serum levels from chronic studies. When serum level data from toxicity studies are compared, the PFOA serum levels of concern tend to be more consistent in studies of animals with longer half-lives, such as monkeys. In addition, serum levels were not actually measured in the rat study used by New Jersey (New Jersey scientists had to rely on modeled serum data for rats). In contrast, researchers measured PFOA serum levels in the monkey study. The department believes that measured serum levels in monkeys are more reliable than modeled data from female rats.

Another important consideration in risk assessment is the selection of uncertainty and variability factors. Both the type of uncertainty and the magnitude of uncertainty are important considerations in evaluating studies and comparing the results. New Jersey’s supporting documentation for their water value shows that New Jersey scientists also derived a water value based on the same monkey study selected by the department. The New Jersey water value based

on the monkey study was ten-fold lower than the value derived by the department. The reason for the difference is explained by the selection of uncertainty factors. New Jersey used a ten-fold uncertainty factor for the possibility that a longer study conducted with lower doses (the monkey study lasted six-months) would result in a lower dose of concern. The department made the determination that the critical effects at low doses in all of the PFOA studies were similar and took a minimal period of time to develop, and the department did not use a subchronic-to-chronic uncertainty factor.

The approach of using serum levels as a basis for deriving reference doses and HRLs is of great interest, but there remains considerable uncertainty about describing the relationship between the oral dose in humans and the resulting human blood serum level of PFOA. New Jersey used a very simplistic ratio of human serum and water concentration from the study by Emmett. The Emmett study did not take into account additional sources of exposure besides water; the length of time individuals had been drinking the water; or the amount of water each person drank. Emmett presented data that indicated the potential for wide variation in the relationship between water concentration and serum level. For example, six people drinking from a contaminated private well as the only source of residential drinking water exhibited ratios ranging from 142 to 855 (Emmett 2006a).

During scientific meetings and in conversations with EPA the department has heard that serum levels represent the best measure of body burden and are a better choice than administered dose for PFC risk assessments. The department is seriously interested in using serum level data in an approach similar to that used by North Carolina. The department has recently discussed additional research that would be necessary in order to use the serum levels in combination with water intake rates throughout life. One area of research is to better describe the mathematical relationship between oral exposure and serum level under different exposure scenarios (for example, a child's higher water intake). The department would like to use mathematical models that take into account the longer retention of PFOA in humans. The department is currently discussing this approach with potential research partners who can conduct pharmacokinetic and exposure modeling.

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EPA action value for the DuPont Washington Works facility:

<http://www.epa.gov/opptintr/pfoa/index.htm>

New Jersey drinking water value:

[http://www.state.nj.us/dep/watersupply/pfoa\\_dwguidance.pdf](http://www.state.nj.us/dep/watersupply/pfoa_dwguidance.pdf)

North Carolina Division of Water quality interim drinking water value:

<http://h2o.enr.state.nc.us/csu/documents/IMACBasisC8.pdf>

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Appendix C: 3M Fluorochemical Research Report for August 2007

Appendix D: Report of the Administrative Law Judge

Appendix E: PFOA and PFOS Health Risk Limits Rules

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Appendix G: PFC Water Values from the United Kingdom and Germany

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## **Appendix A**

### **PFOA Health Based Value Memo**

# Memo



**Date:** February 26, 2007

**To:** John Stine, Environmental Health Division Director *JS 3/1/07*

**Via:** Larry Gust, Environmental Surveillance and Assessment Section Manager *Larry Gust*  
Pamela Shubat, Health Risk Assessment Unit Supervisor *Pam Shubat*

**From:** Helen Goeden, Health Risk Assessment Unit staff *Helen Goeden*

**Subject:** Health Based Values for Perfluorooctanoic acid (PFOA)

In 2002 the Minnesota Department of Health (MDH) developed a HBV of 7 ppb for PFOA. Since 2002 additional toxicity data, toxicokinetic data, and reviews of preexisting data have been produced. After a careful review of this information the Health Risk Assessment Unit staff recommends that the HBV for PFOA be lowered to 0.5 ug/L (ppb).

The following information was utilized in generating the revised HBV:

<u>Chemical</u>	<u>CAS #</u>	<u>Endpoint</u>	<u>RfD (mg/kg-d)</u>	<u>HBV (ug/L)</u>	<u>Source</u>
PFOA	335-67-1	hepatic (liver) system, hemotopoietic (blood) system, developmental, and immune system	0.00014	0.5	MDH 2007

More detailed information, supporting the development of the HBV, is attached. Please be advised that, although we believe that this number will provide an adequate level of protection, there is a degree of uncertainty associated with all HBVs, and they should be considered provisional. Professional judgment should be used in implementing this HBV. MDH will review this HBV if and when additional studies have been conducted.

The MDH's authority to promulgate health risk limits under the Groundwater Protection Act is limited to situations where degradation has already occurred. Similarly, health-based values, which are unpromulgated exposure values, serve as interim advice issued for specific sites where a contaminant has been detected. As such, neither health risk limits nor health-based values are developed for the purpose of providing an upper limit for degradation.

cc: Larry Gust, MDH  
Pam Shubat, MDH  
Rita Messing, MDH

Cathy Villas-Horns, MDA  
Shelley Burman, MPCA  
Paul Hoff, MPCA  
Doug Wetzstein, MPCA

## ATTACHMENT

### DATA FOR DERIVATION OF GROUND WATER HEALTH BASED VALUE (HBV)

Chemical Name: Perfluorooctanoic Acid (PFOA)

CAS: 335-67-1(acid)

3825-26-1 (ammonium salt, APFO)

2395-00-8 (potassium salt)

335-95-5 (sodium salt)

Non-Cancer Health Based Value (HBV) = 0.5 ug/L

$$\begin{aligned} &= \frac{\text{toxicity value, mg/kg/d} \times (\text{relative source contribution}) \times (1000 \text{ ug/mg})}{(\text{intake rate, L/kg-d})} \\ &= \frac{(0.00014 \text{ mg/kg/d}) \times (0.2) \times (1000 \text{ ug/mg})}{(0.053 \text{ L/kg/day})} \\ &= 0.5 \text{ ug/L} \end{aligned}$$

Toxicity value:	0.00014 mg/kg-d (Cynomolgus monkeys)
Source of toxicity value:	MDH 2007 (RfD derived by MDH)
Point of Departure:	LOAEL, 3 mg/kg-d
Dose Metric Adjustment:	70 (to adjust for half-life duration of 3.8 years in humans versus 20 days in male Cynomolgus monkeys)
Total uncertainty factor:	300
UF allocation:	3 interspecies toxicodynamic differences, 10 intraspecies variability; and 10 LOAEL-to-NOAEL (for lack of a no effect dose in the critical study)
Critical effect(s)*:	Increased relative liver weight
Co-critical effect(s)*:	Reduced number of erythrocytes, reduced body weight and body weight gain, developmental effects (decreased weight gain, delayed developmental progress, hypoactive response in nicotine-induced behavior test), suppressed IgM titers
Additivity endpoint(s):	Hepatic (liver) system, hematopoietic (blood) system, developmental, immune system
Secondary effect(s)*:	Decreased postnatal survival, increase in the incidence of full litter resorptions, altered mammary gland development, decreased thyroid hormones (T4 & T3), disruption of spontaneous behavior, changes in the adrenal cortex

\* for explanation of terms see Glossary located at: <http://www.health.state.mn.us/divs/eh/groundwater/hrlgw/glossary.html>

**Cancer Health Risk Limit (HRL) = N/A**

**Volatile: No**

**Summary of changes since 2002 HBV:**

**Toxicity Value (RfD):**

Improved toxicokinetic (e.g., half-life) information allowed for the incorporation of a 70-fold dose-metric adjustment based on half-life differences between humans and monkeys and a 10-fold decrease in the total UF. In 2002 a 30-fold factor (3 interspecies extrapolation + 10 subchronic-to-chronic) was used to address uncertainties around toxicokinetics.

**Intake rate:**

PFOA, unlike most ground water contaminants, has a long half-life and therefore will accumulate in the body if repeated exposure occurs over long-periods of time. Eventually the internal concentration of PFOA will reach a plateau (steady-state). The length of time to reach steady state conditions is equivalent to approximately 5 half-lives. In the case of PFOA the time to steady-state would be approximately 19 years (5 x human half-life of 3.8 years). The intake rate selected for the revised HBV was a time-weighted average intake of an upper-end consumer over the first 19 years of life (0.053 L/kg-d). This intake rate incorporates the higher intake rates early in life (i.e., infants and children) as well as the accumulation of the chemical over time.

**Consideration of Sensitive Populations:**

Delayed development and growth deficits in the offspring of females mice exposed during pregnancy have been reported at dose levels similar to the LOAEL of the critical study (3 mg/kg-d). Studies have shown that the developmental effects are mainly due to exposure during pregnancy rather than after birth. Possible HBVs, based on protection of a pregnant woman and her fetus, were also calculated. Two scenarios were evaluated: 1) a long-term exposure – exposure to the mother from birth to age 19 years, and 2) a short-term exposure – exposure to an infant. The long-term exposure scenario incorporated accumulation over time and utilized a time-weighted intake rate 0.053 L/kg-d. The short-term exposure scenario did not incorporate accumulation over time but did utilize a young infant intake rate of 0.221 L/kg-d. The resulting potential HBVs for both scenarios were higher than the HBV based on the selected critical study in monkeys.

**Summary of toxicity testing for health effects identified in the Health Standards Statute:**

	Endocrine	Immunotoxicity	Development	Reproductive	Neurotoxicity
Tested?	Sec. Observations <sup>1</sup>	Yes	Yes	Yes	Yes
Effects?	Yes	Yes <sup>2</sup>	Yes <sup>3</sup>	Unclear <sup>4</sup>	Yes <sup>5</sup>

Note: Even if testing for a specific health effect was not conducted for this chemical, information about that effect may be available from studies conducted for other purposes. Most chemicals have been subject to multiple studies in which researchers identify a dose where no effects were observed, and the lowest dose that caused one or more effects. A toxicity value based on the effect observed at the lowest dose across all available studies is considered protective of all other effects that occur at higher doses.

**Comments on extent of testing or effects:**

<sup>1</sup> Hormonal perturbations (e.g., decreased thyroxine (T4) and triiodothyronine (T3) levels) have been observed in laboratory animals at dose levels approximately 3-fold higher than the LOAEL and have been identified as secondary effects.

<sup>2</sup> Short-term immunotoxicity studies have shown that PFOA exposure suppresses humoral immunity and may adversely affect cell mediated immunity at doses similar to the critical study LOAEL. These effects have been identified as co-critical effects.

<sup>3</sup> Developmental delays, lower body weight/weight gain and behavior in offspring have been observed at dose levels similar to the LOAEL. These effects have been identified as co-critical effects. At doses 3-fold higher than the LOAEL additional developmental effects (decreased pup viability, delays in eye opening, increased incidence of full-litter resorption, alterations in mammary gland development) are observed. Effects occurring at doses approximately 3 fold higher have been identified as secondary effects.

<sup>4</sup> The results of the 2-generational study indicate that fertility is not affected by treatment. Full-litter resorption was observed at dose levels 3-fold higher than the LOAEL, however, it is unclear whether this resulted from maternal toxicity or a direct effect on the developing organism. Altered mammary gland development during the lactational period was observed in mice exposed to dose levels slightly higher than the critical study LOAEL during pregnancy. Increased incidence of full-litter resorption and alterations in mammary gland development have been identified as a secondary effects.

<sup>5</sup> Hypoactive response to nicotine has been observed in neonatal mice and has been included in the list of co-critical effects. A dose-related increase in ataxia in the female rats was reported in the chronic 2 year study at dose levels greater than the LOAEL, however, this effect was not observed in males with higher body burdens or in 90 day studies utilizing higher doses. Disruption of spontaneous behavior following acute neonatal exposure to doses approximately 3-fold higher than the critical study LOAEL have been observed and are identified as a secondary effect. The SAB has recommended additional neurological testing.

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## **Appendix B**

### **PFOS Health Based Value Memo**

# Memo



**Date:** February 26, 2007

**To:** John Stine, Environmental Health Division Director *JStine 3/1/07*

**Via:** Larry Gust, Environmental Surveillance and Assessment Section Manager *Larry Gust*  
Pamela Shubat, Health Risk Assessment Unit Supervisor *Pam Shubat*

**From:** Helen Goeden, Health Risk Assessment Unit staff *Helen Goeden*

**Subject:** Health Based Values for Perfluorooctane Sulfonate (PFOS)

In 2002 the Minnesota Department of Health (MDH) developed a HBV of 1 ppb for PFOS. Since 2002 additional toxicity data, toxicokinetic data, and reviews of preexisting data have been produced. After a careful review of this information the Health Risk Assessment Unit staff recommends that the HBV for PFOS be lowered to 0.3 ug/L (ppb).

The following information was utilized in generating the revised HBV:

<u>Chemical</u>	<u>CAS #</u>	<u>Endpoint</u>	<u>RfD (mg/kg-d)</u>	<u>HBV (ug/L)</u>	<u>Source</u>
PFOS	1763-23-1	hepatic (liver) system and thyroid	0.000075	0.3	MDH 2007

More detailed information, supporting the development of the HBV, is attached. Please be advised that, although we believe that this number will provide an adequate level of protection, there is a degree of uncertainty associated with all HBVs, and they should be considered provisional. Professional judgment should be used in implementing this HBV. MDH will review this HBV if and when additional studies have been conducted.

The MDH's authority to promulgate health risk limits under the Groundwater Protection Act is limited to situations where degradation has already occurred. Similarly, health-based values, which are unpromulgated exposure values, serve as interim advice issued for specific sites where a contaminant has been detected. As such, neither health risk limits nor health-based values are developed for the purpose of providing an upper limit for degradation.

cc: Larry Gust, MDH  
Pam Shubat, MDH  
Rita Messing, MDH  
Cathy Villas-Horns, MDA  
Shelley Burman, MPCA  
Paul Hoff, MPCA  
Doug Wetzstein, MPCA

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**ATTACHMENT**  
*(Corrected March 9, 2007)*

**DATA FOR DERIVATION OF GROUND WATER HEALTH BASED VALUE (HBV)**

**Chemical Name: Perfluorooctane Sulfonate (PFOS)**

**CAS: 1763-23-1 (acid)**

**29081-56-9 (ammonium salt)**

**70225-14-8 (diethanolamine salt)**

**2795-39-3 (potassium salt)**

**29457-72-5 (lithium salt)**

**Non-Cancer Health Based Value (HBV) = 0.3 ug/L**

$$\begin{aligned} &= \frac{(\text{toxicity value, mg/kg/d}) \times (\text{relative source contribution}) \times (1000 \text{ ug/mg})}{(\text{intake rate, L/kg-d})} \\ &= \frac{(0.000075 \text{ mg/kg/d}) \times (0.2) \times (1000 \text{ ug/mg})}{(0.048 \text{ L/kg/day})} \\ &= \mathbf{0.3 \text{ ug/L}} \end{aligned}$$

Toxicity value:	0.000075 mg/kg-d (Cynomolgus monkeys)
Source of toxicity value:	MDH 2007 (RfD derived by MDH)
Point of Departure:	minimal LOAEL, 0.15 mg/kg-d
Dose Metric Adjustment:	20 (to adjust for half-life duration of 5.4 years in humans versus 110 - 132 days in Cynomolgus monkeys)
Total uncertainty factor:	100
UF allocation:	3 interspecies toxicodynamic differences, 10 intraspecies variability; and 3 LOAEL-to-NOAEL (a value of 3 was applied to the study LOAEL rather than using the NOAEL or the default UF of 10 because the effect observed at the LOAEL was considered to be of minimal severity)
Critical effect(s)*:	Decreased HDL and T3
Co-critical effect(s)*:	None
Additivity endpoint(s):	Hepatic (liver) system, Thyroid (E)
Secondary effect(s)*:	Developmental (decreased body weight/weight gain, decreased total T4), decreased gestation length, immune system alterations

\* for explanation of terms see Glossary located at:  
<http://www.health.state.mn.us/divs/eh/groundwater/hrlgw/glossary.html>

**Cancer Health Risk Limit (HRL) = N/A**

**Volatile: No**

Attachment Page 1 of 7

**Summary of changes since 2002 HBV:**

Toxicity Value (RfD):

Improved toxicokinetic (e.g., half-life) information allowed for the incorporation of a 20-fold dose-metric adjustment based on half-life differences between humans and monkeys and a 10-fold decrease in the total UF. In 2002 a 30-fold factor (3 interspecies extrapolation + 10 subchronic-to-chronic) was used to address uncertainties around toxicokinetics.

Intake rate:

PFOS, unlike most ground water contaminants, has a long half-life and therefore will accumulate in the body if repeated exposure occurs over long-periods of time. Eventually the internal concentration of PFOS will reach a plateau (steady-state). The length of time to reach steady state conditions is equivalent to approximately 5 half-lives. In the case of PFOS the time to steady-state would be approximately 27 years (5 x human half-life of 5.4 years). The intake rate selected for the revised HBV was a time-weighted average intake of an upper-end consumer over the first 27 years of life (0.048 L/kg-d). This intake rate incorporates the higher intake rates early in life (i.e., infants and children) as well as the accumulation of the chemical over time.

**Consideration of Sensitive Populations:**

Growth deficits, alterations in thyroid hormone levels (T4 and T3), increased liver weights, and delays in development have been reported in offspring exposed during development. These effects were observed at doses approximately 3 to 7 times higher than the critical study minimal LOAEL. Potential health-based values based on protection of a pregnant woman and her fetus were evaluated. Two scenarios were evaluated: 1) a long-term exposure – exposure to the mother from birth to age 27 years, and 2) a short-term exposure – exposure to an infant. The long-term exposure scenario incorporated accumulation over time and utilized a time-weighted intake rate 0.048 L/kg-d. The short-term exposure scenario did not incorporate accumulation over time but did utilize a young infant intake rate of 0.221 L/kg-d. The resulting potential HBVs for both scenarios were not lower (i.e., more restrictive) than the HBV based on the selected critical study in monkeys.

**Summary of toxicity testing for health effects identified in the Health Standards Statute:**

	Endocrine	Immunotoxicity	Development	Reproductive	Neurotoxicity
Tested?	Sec. Observations <sup>1</sup>	Yes	Yes	Yes	Yes
Effects?	Yes	Yes <sup>2</sup>	Yes <sup>3</sup>	Yes <sup>4</sup>	Yes <sup>5</sup>

Note: Even if testing for a specific health effect was not conducted for this chemical, information about that effect may be available from studies conducted for other purposes. Most chemicals have been subject to multiple studies in which researchers identify a dose where no effects were observed, and the lowest dose that caused one or more effects. A toxicity value based on the effect observed at the lowest dose across all available studies is considered protective of all other effects that occur at higher doses.

**Comments on extent of testing or effects:**

<sup>1</sup> Thyroid hormonal perturbations have been observed in laboratory animals at dose levels similar to the critical study LOAEL. Alterations in thyroid hormone levels have been identified as critical effect.

<sup>2</sup> Short-term immunotoxicity studies have shown that PFOS exposure alters several immunologic parameters (suppression of SRBC-specific IgM production and T-cell proliferation, increased natural killer cell activity) at levels below the critical study LOAEL. The biological significance of these effects

is not entirely clear. Further study is needed to determine whether PFOS poses potential health risks to humans as a result of alterations in immune function, however, the MDH will include immune system as a secondary effect at this time.

<sup>3</sup> Lower body weight in offspring, decreased T4, increased sternal defects and decreased gestation length have been reported at levels approximately 3-fold higher than the critical study LOAEL. These effects have been identified at secondary effects. At doses approximately 10-fold higher than the LOAEL additional developmental effects (decreased pup viability, developmental delays) are observed.

<sup>4</sup> A male reproductive study reported decreases in sperm count and increases in sperm deformities at levels 10-fold higher than the critical study LOAEL.

<sup>5</sup> Hypoactive responses to nicotine has been observed in neonatal mice acutely exposed to levels 75-fold higher than the critical study LOAEL but these effects were not observed at levels 5-fold higher. Convulsions, severe rigidity and body trembling have been observed in Rhesus monkeys subchronically exposed to levels approximately 30-fold higher than the critical study LOAEL.

**The following sources were reviewed in the preparation of the HBV:**

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Appendix B- Page 9

## **Appendix C**

### **3M Fluorochemical Research Report for August 2007**

## 3M Perfluorochemical Studies In Progress

August 2007

Study	Submitted to MDH	Research Organization	3M Internal Research	Contract Research	Grant	Collaboration	Status
<b>PFOS TOXICOLOGY</b>							
Developmental Neurotoxicity	Copy of TSCA 8(e) letter sent to MDH 6/6/2007.	WIL Research		X			Audited draft final report received. Issuance of final is pending completion of analytical report (3M in-house laboratory) and limited RT-PCR for PPAR $\alpha$ -regulated genes (Univ. MN). Both reports are in-preparation and are expected by mid-September. Report finalization expected third quarter.
Rat Liver and Thyroid Response, Mode-of-Action		CXR Biosciences		X			Letter summarizing aspects of the study submitted to EPA TSCA 8(e) docket in June, 2007.  Draft reports are being prepared by CXR Biosciences. Finalization of reports expected by end of third quarter.
<sup>35</sup> S-PFOS Synthesis		Stockholm University			X		On-going. This project is funded as a non-restricted gift. There is no requirement for the investigator to prepare a report for 3M. <sup>35</sup> S-PFOS has been produced, and improvements to yield are being pursued.
Fetal/Neonatal		Karolinska Institute			X		On-going. This project is funded as a non-

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Distribution and Retinoids						restricted gift in support of a Ph.D. candidate and his major advisor. There is no requirement for the investigator to prepare a report for 3M. 3M has provided tissues from studies to investigators.
28-day oral study in rats with extensive follow-up to investigate the relationship of toxicokinetics on repeat dosing to thyroid hormone status.	ICT Poster provided July 26, 2007	3M Toxicology Lab	X			In-life complete. Data presented as poster in Montreal at the ICT meeting in July. Some detailed pharmacokinetic analyses still outstanding. A manuscript will be prepared from the data. Due to other priorities, detailed pharmacokinetic analyses have not been undertaken, but are planned for August or September. Work on the manuscript may begin in September.
PFOS-exposed rat brain study		3M and EPA/ORD/NHEERL			X	On-going (analysis pending). Analytical results are expected by end of third quarter. Manuscript will eventually be prepared.
Pharmacokinetics in rats		3M	X			On-going. In life phases are largely completed. Analysis of samples has not begun. Completion of analyses and report expected by end of year (2007).
Interaction thyroid hormone transporters and other transporters		University of Minnesota, Duluth			X	On-going. This project is funded as a non-restricted gift. There is no requirement for the investigator to prepare a report for 3M.
<b>PFOA TOXICOLOGY</b>						
Study Material Audit of 3M 2-Year Study and Pathology Peer Review of Mammary Tumors and Publication of Review		EPL		X		On-going. Peer review was completed and has been available on USEPA docket. Audit completed and reported received. Manuscript to be prepared. Not possible to provide completion date for manuscript at this time. Target for end of 2007.
Humanized PPAR- $\alpha$ /Sv129 Wild Type Mice		Pennsylvania State University			X	Funded. On-going. This project is funded as a non-restricted gift. There is no requirement for the investigator to prepare a report for 3M.



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									Branched versus linear poster given at ICT meeting in Montreal in July.
Pharmacokinetics in Mice	2007 SOT CCT poster provided on 2/28/2007	EPA/ORD/NHEERL					X		Completed. Manuscript in-preparation (see above) with targeted completion by end of August 2007 (part of overall pharmacokinetic manuscript).
Developmental Toxicity in Mice		EPA/ORD/NHEERL					X		On-going
PPAR $\alpha$ -null vs. Sv129 WT vs. CD-1 dose-response study		EPA/ORD/NHEERL					X		On-going. In-life completed. EPA to write manuscript or report.
Humanized PPAR- $\alpha$ Sv129 Wild Type Mouse Liver Response		Pennsylvania State University				X			Funded. On-going. This project is funded as a non-restricted gift. There is no requirement for the investigator to prepare a report for 3M. Licenses from NIH are being processed and are expected to be finalized in September.
PFBA drinking water palatability		3M			X				In-life phase completed; report in-preparation
<b>STUDIES INVOLVING MULTIPLE CHEMICALS</b>									
Toxicokinetic Modeling		Hammer Institute				X			On-going from existing data. Additional proposals in development.
Lipid Homeostasis, Hypothalamic Salty Regulation		Stockholm University					X		Funded. On-going. This project is funded as a non-restricted gift. There is no requirement for the investigator to prepare a report for 3M.
Thyroid Hormone Homeostasis		3M			X				On-going with assistance from Mayo Medical Laboratories, NHPP-UCLA, EPA, Fairview University Hospital
Pulmonary Surfactant Interaction	Poster presented at SOT CCT in Arlington, VA in February, 2007	University of Calgary					X		Funded. On-going. This project is funded as a non-restricted gift. There is no requirement for the investigator to prepare a report for 3M.
Cholesterol Synthesis and	MDH staff invited to and attended	TNO					X		Reports issued. Additional work in proposal stage.

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Metabolic Effects Research	presentation on completed work on April 17, 2007					Manuscripts will be prepared.
Comparative Molecular Responses of Human and Rodent Liver Cells		University of Minnesota, Duluth		X		Funded. On-going. This project is funded as a non-restricted gift. There is no requirement for the investigator to prepare a report for 3M.
Short-Chain Perfluoroalkyl Acid Comparative Pharmacokinetics in Rats		3M	X			On-going. Some in-life completed. Analyses pending. Completion targeted in first or second quarter 2008.
Biochemical Toxicology		Stockholm University		X		Funded. On-going. This project is funded as a non-restricted gift. There is no requirement for the investigator to prepare a report for 3M. Two manuscripts have been submitted.
<b>BIOMONITORING AND/OR EPIDEMIOLOGY</b>						
PFBS human, monkey and rat half-life study		3M	X			Manuscript in-preparation Goal Q407
American Red Cross 2006 Biomonitoring study		3M / American Red Cross			X	Manuscript in-preparation Goal Q407
PFBA Human Half Life Study	Report to MDH August 2007	3M	X			Final report completed July 2007
Cottage Grove cohort mortality study - update		University of Minnesota / 3M		X		On-going Expect Q407 On-going
Danish birth outcome study		International Epidemiology Institute		X		Multi-year study; more than one publication See Fei et.al., Environmental Health Perspectives doi: 10.1289/ehp.10506
Danish case -- cohort study		International Epidemiology Institute		X		On-going Multi-year study; more than one publication



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2005 PFBA biomonitoring study	Report to MDH August 2007	3M	X			Final report completed July 2007
<b>ANALYTICAL</b>						
European 6 <sup>th</sup> Framework PERFORCE World- Wide Analytical Challenge		3M			X	On-going
<b>OTHER</b>						
British Toxicology Society (BTS) PFOA workshop		British Toxicology Society			X	3M participating in the organizing committee, Workshop to be held in November 2007

## **Appendix D**

### **Report of the Administrative Law Judge**



**STATE OF MINNESOTA  
OFFICE OF ADMINISTRATIVE HEARINGS**

100 Washington Square, Suite 1700  
100 Washington Avenue South  
Minneapolis, Minnesota 55401-2138

TELEPHONE: (612) 341-7600  
TTY: (612) 341-7346

August 17, 2007

Pamela Shubat  
Minnesota Department of Health  
Freeman Building 3C  
P.O. Box 64975  
St. Paul, MN 55164-0975

RE: Review of the Proposed Exempt Rules of the State Department of Health  
Relating to Health Risk Limits for Perfluorochemicals, Minn. R. parts  
4717.7200, 4717.7500, and 4717.7650.  
OAH Docket No. 70-0900-19137-1. Governor's Tracking No. AR 346.

Dear Ms. Shubat:

This is to inform you that the amendments to Minnesota Rules, parts 4717.7200, 4717.7500, and 4717.7650 have been approved as to legality on August 17, 2007, under Minnesota Statutes, sections 14.386 and 14.388, subdivision 1, clause 1. The amendments to the rule parts are exempt from the rulemaking requirements of Minnesota Rules, Chapter 14, by the direction of the Legislature in Laws of Minnesota 2007, Chapter 37, Section 1.

Further, because this Office received detailed and vigorous public comment regarding the selections made by the Department in these amendments, the undersigned ALJ has issued a brief report which details the rule review.

With the approval of the adopted rules, our office has closed this file and is returning the rule record to you so that your agency can maintain the official rulemaking record in this matter as required by Minnesota Statutes, section 14.365. Our office will file four certified copies of the rules with the Secretary of State's office. The Department may publish a copy of the amendment in the State Register pursuant to Minn. Stat. § 14.386(a)(4). The amendments will be effective upon publication.

If you have any questions, please contact Maria Lindstrom at 612/349-2527.

Sincerely,

ERIC L. LIPMAN  
Administrative Law Judge

Enclosures

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Providing Impartial Hearings for Government and Citizens  
An Equal Opportunity Employer

Administrative Law Division & Administrative Services  
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Workers' Compensation Hearings Division  
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STATE OF MINNESOTA  
OFFICE OF ADMINISTRATIVE HEARINGS

FOR THE MINNESOTA DEPARTMENT OF HEALTH

Review of the Proposed Exempt Rules of  
the State Department of Health Relating  
to Health Risk Limits for  
Perfluorochemicals, Minn. R. parts  
4717.7200, 4717.7500, and 4717.7650.

**ORDER ON REVIEW  
OF RULES UNDER  
MINN. STAT. § 14.386**

The Minnesota Department of Health (the Department) is seeking review and approval of the above-entitled rules, promulgated pursuant to Minn. Stat. § 14.388. On August 3, 2007, the Office of Administrative Hearings received the documents from the Department required to be filed under Minn. Stat. § 14.388 and Minn. Rule 1400.2400.

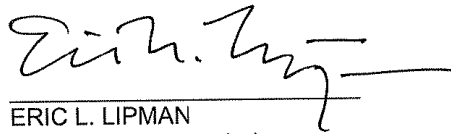
This matter came before Administrative Law Judge Eric L. Lipman during the review for legality pursuant to Minnesota Statutes, sections 14.386 and 14.388, subdivision 1, clause 1. This legal review was undertaken because the proposed amendments to Part 4717 are otherwise exempt from the rulemaking requirements of Minnesota Rules, Chapter 14, by the direction of the Legislature in Laws of Minnesota 2007, Chapter 37, Section 1.

Based upon a review of the written submissions and filings, Minnesota Statutes, Minnesota Rules, and for the reasons set forth in the Memorandum that follows below:

**IT IS HEREBY ORDERED:**

1. The rules were adopted in compliance with the procedural requirements of Minn. Stat. Chap. 14 and Minn. R. Chap. 1400.
2. The amendments to Minnesota Rules, parts 4717.7200, 4717.7500, and 4717.7650 are **APPROVED**.

Dated: August 17, 2007

  
ERIC L. LIPMAN  
Administrative Law Judge

## MEMORANDUM

On May 4, 2007, Governor Tim Pawlenty signed, and deposited with the Secretary of State, Chapter 37 of the 2007 Laws of Minnesota. In addition to other requirements, this legislation directed the Commissioner of Health to:

develop and adopt by rule, pursuant to Minnesota Statutes, section 14.388, subdivision 1, clause (1), health risk limits, as defined in Minnesota Statutes, section 103H.005, subdivision 3, for perfluorooctanoic acid, and perfluorooctane sulfonate. The commissioner shall develop and adopt the health risk limits according to Minnesota Statutes, section 144.0751, and ensure that the health risk limits are based on currently available toxicity and exposure data.<sup>1</sup>

Chapter 37 was effective on the day following final enactment.<sup>2</sup>

The legislation has a number of noteworthy features that are relevant to the later legal review of the proposed rules. First, the state legislature's directive that "the commissioner shall develop and adopt by rule" health risk limits for perfluorooctanoic acid (PFOA), and perfluorooctane sulfonate (PFOS) "pursuant to Minnesota Statutes, section 14.388, subdivision 1, clause (1)," makes two points clear: the Legislature concluded that the ordinary rulemaking procedures of Chapter 14 are "unnecessary, impracticable, or contrary to the public interest," and that the sought-after health risk limits are needed to "address a serious and immediate threat to the public health, safety, or welfare."<sup>3</sup> Minn. Stat. § 14.388 provides an abbreviated rulemaking procedure where an agency can show good cause for use of that provision. In this instance, however, the Legislature has determined (and specified in Chapter 37) that good cause is present.<sup>4</sup>

Second, section 14.388 provides that the agency must satisfy the requirements of Minn. Stat. § 14.386(a)(1)-(4) in order to adopt a rule. Under those provisions the Revisor of Statutes must approve the form of the rule, the agency head must adopt the rule, the Office of Administrative Hearings must approve the rule as to its legality and the rule must be published in the State Register.

The legality determination by OAH is governed by Minn. Rule pt. 1400.2400, subp. 3, which states that in reviewing a filing the judge must decide

<sup>1</sup> See, 2007 Laws of Minnesota, Chapter 37, Section 1.

<sup>2</sup> *Id.*

<sup>3</sup> See, Minn. Stat. § 14.388 (1)(1) (2007).

<sup>4</sup> Compare, e.g., *In the Matter of the Adoption of Rules Governing Voter Registration, Minnesota Rules, Chapters 8200 and 8210*, OAH Docket No. 70-3500-16046-1 (2004) (<http://www.oah.state.mn.us/aljBase/350016046.or.htm>).

whether the rule meets the standards of part 1400.2100, Items A and D to G. Those standards of review provide as follows:

A rule must be disapproved by the judge or chief judge if the rule:

A. was not adopted in compliance with procedural requirements of this chapter, Minnesota Statutes, chapter 14, or other law or rule, unless the judge decides that the error must be disregarded under Minnesota Statutes, section 14.15, subdivision 5, or 14.36, subdivision 3, paragraph (d);

...

D. exceeds, conflicts with, does not comply with, or grants the agency discretion beyond what is allowed by its enabling statute or other applicable law;

E. is unconstitutional or illegal;

F. improperly delegates the agency's powers to another agency, person or group;

G. is not a "rule" as defined in Minnesota Statutes, section 14.02, subdivision 4, or by its own terms cannot have the force and effect of law. . . .

Minn. Stat. § 14.388, subd. 2 provides that interested parties have five business days after the date of the Notice of Adoption to submit comments to the Office of Administrative Hearings. The comment period ended on August 10, 2007 at 4:30 p.m. OAH received four timely-submitted comments regarding this rule.

Third, while the ordinary review of rules under the "good cause exemption," specifically excludes assessments of the reasonableness of the proposed rules,<sup>5</sup> in this instance the enabling legislation reintroduces some inquiry into the reasonableness of the Department's selections when issuing health risk limits. Chapter 37 requires that the adoption of health risk limits for PFOA and PFOS be made "according to Minnesota Statutes section 144.0751," and so as to "ensure that the health risk limits are based on currently available toxicity and exposure data."<sup>6</sup> Minn. Stat. § 144.0751 further provides that:

(a) Safe drinking water or air quality standards established or revised by the commissioner of health must:

<sup>5</sup> Compare, Minn. R. 1400.2400 (3) (2005) with Minn. R. 1400.2100 (B) (2005).

<sup>6</sup> See, 2007 Laws of Minnesota, Chapter 37, Section 1.

(1) be based on scientifically acceptable, peer-reviewed information; and

(2) include a reasonable margin of safety to adequately protect the health of infants, children, and adults by taking into consideration risks to each of the following health outcomes: reproductive development and function, respiratory function, immunologic suppression or hypersensitization, development of the brain and nervous system, endocrine (hormonal) function, cancer, general infant and child development, and any other important health outcomes identified by the commissioner.

(b) For purposes of this section, "peer-reviewed" means a scientifically based review conducted by individuals with substantial knowledge and experience in toxicology, health risk assessment, or other related fields as determined by the commissioner.<sup>7</sup>

In this circumstance, therefore, in order to complete an assessment of whether the proposed health care limits "exceeds, conflicts with, does not comply with, or grants the agency discretion beyond what is allowed by its enabling statute or applicable law,"<sup>8</sup> some inquiry into the agency's choices of data, "margins of safety" and "peer-reviewed information" is needed.

When Chapter 37 and Minn. Stat. § 144.0751 are read together, three essential requirements are presented. The Commissioner is to develop health risk limits for PFOA and PFOS that:

- (1) reflects scientifically acceptable, peer-reviewed information;
- (2) includes a reasonable margin of safety to protect the health of infants, children and adults from health outcomes that are specified in statute and by the Commissioner; and
- (3) are based on currently available toxicity and exposure data.

Because the health risk limits developed by the Department meet each of these statutory standards, approval of the proposed rules is warranted.

At the core of the controversy over the proposed health risk limits, is a dispute over the integers that should be used in an important equation. The founding blocks of both the Department's assignment of health risk limits, and the sharp critiques of the commentators who timely responded to the proposed limits,

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<sup>7</sup> See, Minn. Stat. § 14.388 (1)(1) (2007).

<sup>8</sup> Compare, Minn. R. 1400.2100 (B) and (D) (2005) with Minn. R. 1400.2400 (3) (2005).

are the numerical values that should be used to complete the following calculation:

$$\begin{array}{l} \text{Health Risk Limits} \\ \text{(in micrograms per liter)} = \end{array} \frac{\begin{array}{l} \text{(Reference dose) (Weight of the subject)} \\ \text{(Relative source contribution) (1,000)} \end{array}}{\begin{array}{l} \text{(time weighted water intake in units of liters} \\ \text{per kilogram of human body weight per day)} \end{array}}$$

The Department's calculations for PFOA and PFOS revise and supplement the values stated in its earlier regulation "Health Risk Limits for Systemic Toxicants."<sup>9</sup>

Minnesota Mining and Manufacturing (3M), the Minnesota Center for Environmental Advocacy and Dr. David Gray all urge different values to be placed into the Department's health risk limit equation. Yet, the claim that another integer represents a better choice does not establish that the Department's selections fail to provide "a reasonable margin of safety," as those terms are used in Chapter 37. Particularly instructive in this regard, is the summary that Administrative Law Judge Bruce D. Campbell made on a similar question, nearly fifteen years ago. Judge Campbell observed:

The word "reasonable" is perhaps one of the most relative and generic terms used in the law and it is difficult to formulate an adequate or all-encompassing definition. The word "reasonable" has been defined in the law as "ordinary or usual", "not immoderate or excessive", "not capricious, arbitrary, or confiscatory." When employed to describe the means which are used to achieve a legitimate end, it suggests not necessarily the best or only method but one fairly appropriate, at least under all circumstances. It has been said that conduct is reasonable if it is consistent with that of a prudent person in like circumstances. The word has also been held to be the equivalent of the words "adequate", "moderate", and "ordinary".

"Reasonably", when used as a qualifying adverb likewise has many shades of meaning, depending in a particular case on the context or attendant circumstances. It is defined as meaning in a "reasonable manner", "consistently with reason", "fairly", "in moderate degree", "measurably", "moderately", "tolerably", "not extravagantly, excessively, or fully."<sup>10</sup>

<sup>9</sup> Compare, Minn. R. 4717.7100 through 4717.7800 (2007) and Minn. Stat. § 103H.005 (3) (2006) with 3M's Exhibits 2 and 3 (February 26, 2007 Memoranda of Helen Goeden).

<sup>10</sup> See, *In the Matter of the Application of Northern States Power Company for Reissuance of the Air Emission Permit for the Allen S. King Generating Plant*, OAH Docket No. 2-2200-7921-2 (1993) (citing 75 C.J.S. 635 and 75 C.J.S. 638 omitted) (<http://www.oah.state.mn.us/aljBase/22007921.93.htm>).



By any fair reading of the February 26, 2007 memoranda which underlie the Department's PFOA and PFOS health risk limits, the promulgated standards are "moderate" and "consistent with reason."

Moreover, in accordance with the statutory mandates, the proposed health risk limits: (1) reflect scientifically acceptable, peer-reviewed information;<sup>11</sup> (2) include a reasonable margin of safety to protect the health of infants, children and adults from specified health outcomes;<sup>12</sup> and (3) are based on currently available toxicity and exposure data.<sup>13</sup>

Lastly, if the commentators (or others) are not persuaded by the analyses that appear in the February 26, 2007 memoranda, and believe that other numerical values should represent the "reference dose,"<sup>14</sup> "relative source contribution"<sup>15</sup> or "intake values,"<sup>16</sup> their best remedy is to present these views directly to the Minnesota Legislature. Just as the Legislature directed the Commissioner of Health to render her best judgment on the question of health risk limits, and to work within specified parameters, the Legislature is at liberty to revise those directives or to substitute other health risk limits as it sees fit.

#### CONCLUSION

Pursuant to Minnesota Statutes, sections 14.386 and 14.388, subdivision 1, clause 1, the amendments to Minnesota Rules, parts 4717.7200, 4717.7500, and 4717.7650 are approved as to legality.

With the approval of the adopted rules, our office has closed its file and will return the rule record to the Minnesota Department of Health. Our office will file four certified copies of the rules with the Secretary of State. The Department may publish a copy of the amendment in the State Register pursuant to Minn. Stat. § 14.386(a)(4). The amendments will be effective upon publication.

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<sup>11</sup> See, Attachment to 3M's Exhibit 2 at 2 through 7; Attachment to 3M's Ex. 3 at 2 through 7.

<sup>12</sup> See, Attachment to 3M's Ex. 2 at 1 through 3; Attachment to 3M's Ex. 3 at 1 through 3.

<sup>13</sup> See, Attachment to 3M's Ex. 2 at 1 through 7; Attachment to 3M's Ex. 3 at 1 through 7.

<sup>14</sup> See, Comments of 3M at 13 through 17; Comments of David Gray at 4.

<sup>15</sup> See, Comments of 3M at 12 and 13; Comments of D. Gray at 2.

<sup>16</sup> See, Comments of MCEA at 2; Comments of 3M at 11 and 12.

## **Appendix E**

### **PFOA and PFOS Health Risk Limits Rules**

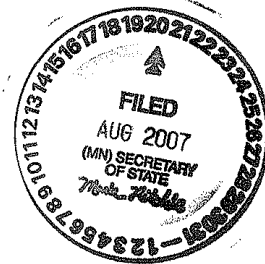
**Office of the Revisor of Statutes  
Administrative Rules**



**TITLE:** Adopted Exempt Temporary Rules Relating to Health Risk Limits for Perfluorochemicals

**AGENCY:** Department of Health

**MINNESOTA RULES:** Chapter 4717



**RULE APPROVED**

**OFFICE OF ADMINISTRATIVE HEARINGS**

*August 17, 2007*

DATE

*Eric M. King*

ADMINISTRATIVE LAW JUDGE.

The attached rules are approved as to form

*Sandra Glass-Sirany*

Sandra Glass-Sirany  
Senior Assistant Revisor

0800504

1 Department of Health

2 Adopted Exempt Temporary Rules Relating to Health Risk Limits for  
3 Perfluorochemicals

4 4717.7200 HEALTH RISK LIMITS FOR SYSTEMIC TOXICANTS.

5 Subpart 1. Scope. This part establishes the method for determining the health risk  
6 limit for a systemic toxicant.

7 Subp. 2. Equation for systemic toxicants other than nitrate (as nitrogen),  
8 perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), or possible human  
9 carcinogens. The equation for determining the health risk limit for a systemic toxicant  
10 other than nitrate (as nitrogen), perfluorooctane sulfonate (PFOS), perfluorooctanoic  
11 acid (PFOA), or a possible human carcinogen is:

12 
$$\text{HRL} = \frac{(\text{RfD})(70)(\text{RSC})(1,000)}{(2)}$$

13  
14  
15 Where:

- 16 A. HRL is expressed in microgram or micrograms per liter.
- 17 B. (70) is the standard weight of an adult expressed in kilograms.
- 18 C. The RSC for substances or chemicals not listed in item D shall be 0.2.
- 19 D. The RSC for the following substances or chemicals is:

20 Name	CAS RN	RSC
21		
22 (1) antimony	7440-36-0	0.4
23 (2) barium	7440-39-3	0.8
24 (3) cadmium	7440-43-9	0.25
25 (4) chromium III	16065-83-1	0.7
26 (5) chromium VI	18540-29-9	0.7
27 (6) manganese	7439-96-5	0.8

28 E. (1,000) is a factor used to convert the units of concentration from milligrams per  
29 liter to micrograms per liter. There are 1,000 micrograms per milligram.

30 F. (2) is the standard amount of water ingested by an adult expressed in liters per  
31 day.

4717.7200

1 [For text of subp 3, see M.R.]

2 Subp. 3a. Equation for perfluorooctane sulfonate (PFOS). The equation for  
3 determining the health risk limit for perfluorooctane sulfonate (PFOS) is:

4 
$$\text{HRL} = \frac{(\text{RfD})(\text{RSC})(1,000)}{(0.048)}$$

7 Where:

8 A. HRL, RSC, and (1,000) have the meanings given in subpart 2.

9 B. (0.048) is the time weighted average water intake (in units of liters per kilogram  
10 human body weight per day) of an upper-end consumer (95th percentile of water  
11 intake) over the first 27 years of life; a period of time corresponding to the longer  
12 half-life of the chemical in the human body.

13 Subp. 3b. Equation for perfluorooctanoic acid (PFOA). The equation for determining  
14 the health risk limit for perfluorooctanoic acid (PFOA) is:

15 
$$\text{HRL} = \frac{(\text{RfD})(\text{RSC})(1,000)}{(0.053)}$$

18 Where:

19 A. HRL, RSC, and (1,000) have the meanings given in subpart 2.

20 B. (0.053) is the time weighted average water intake (in units of liters per kilogram  
21 human body weight per day) of an upper-end consumer (95th percentile of water  
22 intake) over the first 19 years of life; a period of time corresponding to the longer  
23 half-life of the chemical in the human body.

24 [For text of subp 4, see M.R.]

25 **4717.7500 TABLE OF HEALTH RISK LIMITS.**

26 [For text of subps 1 to 70, see M.R.]

27 Subp. 70a. Perfluorooctane sulfonate (PFOS). Perfluorooctane sulfonate (PFOS):

28 1763-23-1      0.000075      =      0.3

4717.7500

1     Subp. 70b. Perfluorooctanoic acid (PFOA). Perfluorooctanoic acid (PFOA):

2         335-67-1           0.00014           =           0.5

3

4

[For text of subps 71 to 90, see M.R.]

5     **4717.7650 TOXIC ENDPOINTS.**

6

[For text of subps 1 to 57, see M.R.]

7         Subp. 57a. Perfluorooctane sulfonate (PFOS). Perfluorooctane sulfonate (PFOS),  
8         1763-23-1, hepatic (liver) system, thyroid.

9         Subp. 57b. Perfluorooctanoic acid (PFOA). Perfluorooctanoic acid (PFOA), 335-67-1,  
10         hepatic (liver) system, hematopoietic (blood) system, developmental, immune system.

11

[For text of subps 58 to 69, see M.R.]

## **Appendix F**

### **Studies on PFCs**

## **Available Studies on PFCs**

### **Chemical names:**

PFBS - Perfluorobutane sulfonate C<sub>4</sub>F<sub>9</sub>SO<sub>3</sub>

PFHxS - Perfluorohexane sulfonate, C<sub>6</sub>F<sub>13</sub>SO<sub>3</sub>

PFPeA - Perfluoropentanoic acid, C<sub>5</sub>HF<sub>9</sub>O<sub>2</sub>

PFHxA - Perfluorohexanoic acid, C<sub>6</sub>HF<sub>11</sub>O<sub>2</sub>

### **Half-life study information that the department is aware of:**

PFBS - mice NA; rats NA; monkeys (3.5 to 4 days); and humans (approximately 30 days).

Manuscript for publication under preparation and anticipated to be available late 2007.

PFHxS - mice NA; rats NA; monkeys (87 to 141 days); and humans (approximately 8.7 years).

PFPeA - mice NA; rats NA; monkeys NA; and humans NA.

PFHxA - mice NA; rats 0.5 days; monkeys 0.8 - 1.45 days); and humans NA.

### **Toxicity study information that the department is aware of:**

PFBS - 2 generation reproductive/developmental study in rats; 90 day oral study in rats; and genotoxicity data.

PFHxS - a 28 day study with a screening evaluation of developmental endpoints and genotoxicity data

PFPeA - no studies

PFHxA - screening 28 day study (only 1 dose level). Asahi Glass Company (Japan) in a presentation to EPA reported data from a 28 day study with a screening evaluation of developmental endpoints and a 90 days study. These studies have not been published. The department has a copy of the 28 day report summary but does not have access to the 90 day study report.



## **Appendix G**

### **PFC Water Values from the United Kingdom and Germany**

## United Kingdom

The United Kingdom Drinking Water Inspectorate has developed a series of values for drinking water supplies

Tier	PFOS (ug/L)	PFOA (ug/L)
1 (monitor levels)	> 0.3	> 0.3
2 (take action to reduce levels as soon as practicable)	> 1.0	> 10.0
3 (take action to reduce levels as soon as possible)	> 10.0	> 90.0

Note: > means “greater than”

Source:

Guidance on the Water Supply (Water Quality) Regulations 2000/01 specific to PFOS (perfluorooctane sulphonate) and PFOA (perfluorooctanoic acid) concentrations in drinking water

May 2007

<http://www.dwi.gov.uk/regs/infolett/2007/info0507.pdf>

## Germany

The Drinking Water Commission in Germany has developed maximum guidance values for evaluating composite PFOA and PFOS water concentrations.

Type of maximum value	PFOA/PFOS composite (ug/L)
Health-based precautionary value	0.1
Strictly health-based for safe lifelong exposure	0.3
Precautionary action level for infants	0.5
Precautionary action level for adults	5.0

Source:

Provisional evaluation of PFT in drinking water with the guide substances perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) as examples

Assessment of PFOA in the drinking water of the German Hochsauerlandkreis. Statement by the Drinking Water commission (Trinkwasserkommission) of the German Ministry of Health at the Federal Environment Agency

June 21, 2006/revised July 13, 2006

<http://www.uba.de/uba-info-presse-e/hintergrund/pft-in-drinking-water.pdf>

## **Appendix H**

### **North Carolina PFOA Water Value**

**[Only the first page of the memo and the PFOA table entry of the memo are displayed]**

June 20, 2007

TO: Requesting Parties

FROM: Dr. Luanne K. Williams, Toxicologist  
Dr. Kenneth Rudo, Toxicologist  
NC Occupational and Environmental Epidemiology Branch (NC OEEB)  
NC Division of Public Health  
NC Department of Health and Human Services

SUBJECT: North Carolina Public Health Goals (NCPHGs)

The North Carolina Public Health Goals (NCPHGs) are North Carolina Division of Public Health health-based drinking water levels. These levels are used by NC OEEB for evaluating the safety of private well drinking water. The basis for each NCPHG is provided in the table that follows. New or updated NCPHGs are also provided including the basis for the new NCPHGs. Questions regarding the calculation of the NCPHGs can be directed to the two state toxicologists, Dr. Luanne K. Williams at 919-707-5912 or Dr. Ken Rudo at 919-707-5911.

NCPHGs are not regulatory levels but provide guidance on the safety of North Carolina private wells. When NC OEEB receives private well sampling results, these results will be compared to the health-based NCPHGs to determine if the water is safe to drink. A “Guide for Interpreting Private Well Water Lab Results” and “Information and Recommendations for Uses of Private Well Water” will be provided to the health department responsible for collecting the private well samples. When the NCPHG is less than the practical quantitation limit, the detection of that substance at or above the practical quantitation limit, shall be considered an unsafe level.

The list of NCPHGs is subject to change and will be reviewed every year or sooner if new scientific and toxicological data become available. When a NCPHG is revised, we will send an electronic file to those that have requested to be placed on our list of individuals to receive the revised tables.

The following references shall be used in order of preference in establishing the NCPHGs.

1. US EPA Integrated Risk Information System Database <http://www.epa.gov/iris/index.html>
2. EPA latest Edition of the Drinking Water Standards and Health Advisories [www.epa.gov/waterscience/criteria/drinking/dwstandards.html](http://www.epa.gov/waterscience/criteria/drinking/dwstandards.html)
3. US EPA Region 9 Preliminary Remediation Goals <http://www.epa.gov/region09/waste/sfund/prg/files/04prgtable.pdf>
4. US EPA Region 3 Risk-Based Concentration Table <http://www.epa.gov/reg3hwmd/risk/human/rbc/RBCapr07.pdf>
5. US EPA 1997 Health Effects Assessment Summary Tables
6. Centers for Disease Control and Prevention ATSDR chronic oral minimum risk level <http://www.atsdr.cdc.gov/mrls.html> and cancer risk evaluation guide for  $1 \times 10^{-6}$  excess cancer risk (CREG)
7. California EPA Public Health Goals (PHGs) <http://www.oehha.ca.gov/water/phg/allphgs.html>
8. National Primary Drinking Water Regulations <http://www.epa.gov/safewater/mcl.html>
9. Other health risk assessment data published by US EPA and states

**[Table entry for PFOA in the North Carolina Public Health Goals (NCPHG) June 20, 2007 memo]**

<p>Perfluorooctanoic acid (PFOA)</p>	<p>NCPHG 0.00063 mg/L (<b>subject to change following the completion of the NC SAB toxicological review</b>)          (reference dose 0.00009 mg/kg-day generated by CIIT at RTP based on lower bound 10% benchmark plasma concentration response for monkeys associated with increased liver weight at 23,000 ng/ml, safety factors 3 for animal to human and 10 for human variability, pharmacokinetic modeling data that administered dose is 0.12 times serum 10% lower bound effect level which is 90 ng/kg-day or 0.00009 mg/kg-day; 0.20 relative source contribution; due to half life differences between rats of 2.8 to 202 hours and humans 38,281 hours or 4.37 years (difference of as high as 13,671). Applying traditional safety factors to an administered effect dose is not a scientifically valid approach for determining a safe dose for humans because the corresponding serum level for humans at a given administered dose would be significantly higher than for animals such as rodents. Instead, EPA, EPA's Scientific Advisory Board, CIIT, and NC DHHS recommend the use of pharmacokinetic modeling to predict safe dose in humans based on serum effect levels.</p> <p>Odor threshold level not available          Taste threshold level not available          IMAC 0.002 mg/L (0.0003 mg/kg-day based on decreased body weight in rats and safety factor of 3000 based on 10 animal to human, 10 human variability, 10 Lowest Observed Adverse Effect Level to No Observed Adverse Effect Level, and 3 data gaps)          MCL not available</p>
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