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Memorandum

TO: City of Piqua

FROM: Hugh Crowell and Ed Pfau, Hull & Associates, Inc.

DATE: January 7, 2010

RE: Human Health Implications of Atrazine Present in Piqua's Community Water System; Hull Doc No. PIQ003.300.0002.

Introduction

Recent national interest in the safety of atrazine in drinking water is captured in an August 2009 Natural Resources Defense Council (NRDC) position paper ('Poisoning the Well: How the EPA is Ignoring Atrazine Contamination in Surface and Drinking Water in the Central United States'). An August 23, 2009 article in the *New York Times* ('Debating How Much Weed Killer Is Safe in Your Water Glass') raised concerns about suspected human health implications of exposures to atrazine in drinking water based on interviews and a literature review. The article expressed the concern that current drinking water standards for atrazine may not adequately protect human populations, a concern echoed by the NRDC position paper. The *New York Times* article discussed atrazine in the City of Piqua's community water supply (CWS) as an example of how atrazine in raw and finished water is monitored and reported in some water supply systems subject to the Atrazine Monitoring Program, mostly in the Midwest. While acknowledging that the City of Piqua's water supply is meeting all atrazine drinking water standards, the article suggests that the frequency of atrazine data collection by the City, and public disclosure of these data, may not be sufficient to answer public concerns about atrazine in drinking water.

Hull was contracted by the City of Piqua to review atrazine data for the raw water supply and for finished drinking water, and to help the City formulate next steps. A meeting with Ohio EPA to discuss atrazine reporting may be indicated, although this has not been scheduled.

Raw Water System Background

Hull conducted a study of the City of Piqua's Raw Water Supply in 2008, summarized in a May 2009 report. The report focused on concerns about lake shallowing due to excessive sedimentation, and consequent aquatic plant and algal growth in areas of passive and active aquatic recreation. The City of Piqua draws its raw drinking water from three sources: a system

of three lakes connected by a hydraulic canal, the Great Miami River, and an abandoned gravel pit on the left bank of the River. One or a combination of these sources may be used at any given time during the year based on seasonal conditions. The report did not focus on or discuss the issue of atrazine in drinking water.

The three-lake system was constructed in the late 1800's to intercept and impound several streams that flow from the west and northwest toward the Great Miami River. The streams feeding the lake system flow through agricultural land in their upper reach and then through limited urban and extensive residential areas that have developed around the lakes. More than 65% of the watershed feeding the lake system is in row crop agriculture, the great majority of which is managed in a regular rotation of corn and soybeans.

Atrazine Data Sources, Reporting, and Standards and Benchmarks

Data on atrazine in the City of Piqua CWS was obtained and reviewed from three sources:

1. The City's monitoring of finished water as required by Ohio EPA. The City reports quarterly atrazine concentrations in finished water to Ohio EPA based on one sample in the 1st, 3rd and 4th quarters and the average concentration of three monthly samples in the 2nd quarter.

2. The national Atrazine Monitoring Program (AMP) administered by the United States Environmental Protection Agency (USEPA), which requires participation by atrazine manufacturers in regular monitoring of raw and finished water as part of the agency's registration of atrazine. Syngenta Corporation monitors atrazine in the City's three sources of raw water, and in finished water, on a weekly basis.

3. The Ohio EPA inland Lakes Monitoring Program in 2008 initiated an extensive study of Swift Run Lake, the largest of the lakes in the three-lake system. Among the parameters they measured were atrazine concentrations in the lake at one to two-week intervals from May to August at the surface and at the bottom of the lake.

Concentrations of atrazine in the City of Piqua water supply may be compared to three concentrations: the Maximum Contaminant Level (MCL) of 3 ppb (*i.e.*, 3 ug/L), an annual rolling average concentration established by USEPA under the Safe Drinking Water Act; the 90-day drinking water level of concern (DWLOC) concentration of total chlorotriazine (TCT) of 37.5 ppb (*i.e.*, 37.5 ug/L), a 90-day rolling average concentration based on a USEPA atrazine risk assessment conducted in 2003; and the one-day DWLOC of 298 ppb,(*i.e.*, 298 ug/L), based on a USEPA atrazine risk assessment conducted in 2003.

Ohio EPA performs two regulatory compliance checks on atrazine data submitted by the City of Piqua:

1. Ohio EPA computes the annual rolling average atrazine concentration and compares it to the MCL. The annual rolling average is the average of the current test result (which is itself an average in the 2nd quarter) and the results from each of the previous three quarters. Test results in which atrazine was not detected are assigned a value of zero.

2. Ohio EPA also checks for individual test results that exceed four times the MCL (i.e., 12 ppb).

Exceedance of the MCL by the rolling annual average or four times the MCL for an individual event is a non-compliance event. Ohio EPA has not adopted the 90-day and one-day DWLOCs for atrazine and compliance with these benchmarks are not required.

Atrazine Data Trends

According to the AMP data base incorporating data collected by Syngenta, peak concentrations of atrazine are reached in Swift Run Lake and the Great Miami River in late April, May or early June each year, a time period corresponding to the peak atrazine application period in the region's agricultural fields (Figure 1). Peak concentrations in the gravel pit are much reduced in comparison to the other sources and tend to be reached in mid to late June, facts attributable to the gravel pit's groundwater-only connection to the Great Miami River. In each year since 2003, atrazine levels have reached a peak within a two-week period which decreases significantly by the next sample. Although interim peaks higher than those actually measured could be reached between sampling events in any given year, over the seven years of data available the magnitude of the atrazine peaks is assumed to have been accurately captured.

The USEPA AMP web site reports maximum 90-day rolling average values for TCT in Swift Run Lake for 2003 through 2007; these values ranged from 5.54 ppb in 2006 to a high of 20.10 ppb in 2005. Each of these concentrations was below the 90-day DWLOC of 37.5 ppb. The maximum 90-day rolling average values for TCT had not yet been posted for 2008 or 2009 as of the date of this report.

With one exception in 2008, atrazine concentrations in finished water were uniformly lower than the corresponding Swift Run Lake raw water concentration on the same day, reflecting a degree of removal of atrazine during treatment. For example, the peak atrazine concentration in raw water from Swift Run Lake reached 84.80 ppb in 2005, while the concentration in finished water was 59.57 ppb (a reduction of 30%). In 2006, 2007, and 2008, the atrazine peaks in finished water were 3.83 ppb, 4.83 ppb, and 45.00 ppb, respectively.

According to the City's reporting of atrazine in finished water obtained from Ohio EPA, a peak 2nd quarter concentration of 11.6 ppb was obtained in 2005. Maximum concentrations of 2.4 ppb and 3.35 ppb were reached during 2nd quarter in 2007 and 2008, respectively, and atrazine was not detected in the second quarter of 2009 (Table 1). Atrazine concentrations obtained and reported by the City in finished water were comparable although somewhat lower than the Syngenta concentrations obtained from finished water samples within the same time period.

The Ohio EPA Inland Lakes Monitoring Program data for Swift Run Lake is available for 2008 only (Figure 2). Data were obtained for atrazine concentration at the surface and at the bottom of the lake. Atrazine concentration peaked at the surface and at depth on the same day (June 16), with the concentration at depth exceeding that for the surface. The surface atrazine concentration (24 ppb) roughly corresponded with that obtained by Syngenta during the same time period (26.8 ppb).

In comparison to applicable standards and benchmarks, the data show that:

1. The data for atrazine in finished water reported by the City have not exceeded the MCL;

2. In 2005, a single sample concentration of 11.6 ppb approached but did not exceed four times the MCL;

3. The maximum 90-day rolling average concentration of TCT in the City of Piqua raw water supply in each of the years from 2003 through 2007 was below the level of concern of 37.5 ppb; and

4. No peak concentration of atrazine exceeded the one-day drinking water level of concern (DWLOC) of 298 ppb.

Review of Atrazine Risk Assessments Announced by USEPA in Fall 2009

The USEPA has commenced "a comprehensive re-evaluation of the science associated with atrazine human health and ecological risk assessments" and will include advice from the Science Advisory Panel (SAP) for the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), under which atrazine is registered as a pesticide.[1] This process will include a total of four public meetings, which commenced in November 2009 and will be followed by meetings in February 2010, April 2010 and September 2010[2].

This process will mark the most recent in a series of evaluations that the USEPA has conducted on atrazine over the past two decades. These evaluations include the following:

1. Development of the Maximum Contaminant Level (MCL) for atrazine by USEPA under the Safe Drinking Water Act in 1992[3];

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[1] U.S. EPA, October 7, 2009. *Atrazine Science Re-evaluation: Potential Health Impacts* (EPA-HQ-OPP-2009-0759), p. 1. Available on-line at: http://www.epa.gov/opp00001/reregistration/atrazine/atrazine_update.htm#atrazine

[2] U.S. EPA,. October 7, 2009. Press Release, available on-line at: http://www.epa.gov/opp00001/reregistration/atrazine/atrazine_update.htm#atrazine

[3] U.S. EPA. *Consumer Fact Sheet on Atrazine.* Available on-line at: http://www.epa.gov/ogwdw000/pdfs/factsheets/soc/atrazine.pdf

2. Development of an oral Reference Dose (RfD) for atrazine by EPA under the Integrated Risk Information System (IRIS) on October 1, 1993[4];

3. Atrazine Interim Registration Eligibility Decision (IRED), including the 2003 atrazine risk assessment, by the EPA's Office of Pesticide Programs (OPP), January 31, 2003; and the Memorandum of Agreement (MOA) between USEPA and the atrazine registrants, which implemented the Community Water System (CWS) monitoring program in 2003[5];

4. The Triazine Cumulative Risk Assessment conducted by USEPA's Office of Prevention, Pesticides and Toxic Substances (OPPT) on March 28, 2006[6,7];

5. The Atrazine Registration Eligibility Decision (RED) by USEPA's OPPT on April 6, 2006[8]; and

6. USEPA OPP's Status Updates for Atrazine Monitoring in CWS, annually from 2003 through 2009[9].

USEPA's evaluations to date have supported the determination that the MCL of 3 parts per billion (ppb) in drinking water (*i.e.*, 3 ug/L) is protective of long-term daily drinking water exposures to atrazine; that intermediate-term exposures to concentrations below the 90-day drinking water level of concern (DWLOC) of 37.5 ppb of TCT in raw water do not pose a risk to human health ; and that concentrations below the one-day DWLOC of 298 ppb do not pose a risk to human health[10].

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[4] U.S. EPA, October 1, 1993. Integrated Risk Information System (IRIS); on-line database most recently updated on 02-09-2004, available at: http://www.epa.gov/ncea/iris/subst/0209.htm

[5] U.S. EPA, January 31, 2003, revised October 31, 2003. *Interim Registration Decision Document for Atrazine, Case Number 0062.* Available on-line at: http://www.epa.gov/oppsrrd1/REDs/atrazine_combined_docs.pdf

[6] U.S. EPA, March 31, 2006. *Cumulative Risk from Triazine Pesticides.* Available on-line at: http://www.epa.gov/oppsrrd1/REDs/triazine_cumulative_risk.pdf; and U.S. EPA, June 22, 2006.

[7] U.S. EPA, March 31, 2006. *Triazine Cumulative Risk Assessment and Atrazine, Simazine and Propazine Decisions: Fact Sheet*. Available on-line at: http://www.epa.gov/oppsrrd1/cumulative/triazine_fs.htm

[8] U.S. EPA, April 6, 2006. *Atrazine: Finalization of Interim Reregistration Eligibility Decision and Completion of Tolerance Reassessment and Reregistration Eligibility Process*. Available on-line at: http://www.epa.gov/oppsrrd1/REDs/atrazine_combined_docs.pdf

[9] U.S. EPA. August 2009. *Status update of Atrazine Monitoring Data*. Available on-line at: http://www.epa.gov/opp00001/reregistration/atrazine/atrazine_update.htm#cws

[10] *Ibid.*

***New York Times* Atrazine Article and Referred Studies**

The CWS monitoring conducted by the City of Piqua was featured in a newspaper article about exposures to atrazine in drinking water, which cited "five epidemiological studies published in peer-reviewed journals" that "found evidence suggesting that small amounts of atrazine in drinking water, including levels considered safe by federal standards, may be associated with birth defects[11]. Upon request, Charles Duhigg, the author of the *New York Times* article, provided a list of thirteen references that were used in the article. From the list of 13 references provided by the *Times*, twelve complete articles and one abstract were reviewed.

Four of the articles included an epidemiological evaluation of atrazine concentrations in surface water, ground water or drinking water[12,13,14,15]. None of these studies reported any causality between atrazine concentrations and an adverse effect. Mattix *et al.* reported correlations between abdominal wall defects (AWD) and atrazine and nitrate levels from locations in the Midwestern United States; however, no causality was demonstrated and the authors stated that "(a)dditional study is needed to further investigate a possible causative relationship of surface water pesticides and AWD."[16]

Although Ochoa-Acuña *et al.* reported to find "a significant association between atrazine concentration in drinking water and prevalence of SGA" (small-for-gestational age) in several Indiana communities, the authors stated that "it is not clear at present whether this association represents a true cause-effect relationship, as other co-occurring chemicals in drinking water were significantly correlated with atrazine"[17].

In a similar study in Finistère, a district in the Brittany region of France, Villanueva *et al.* reported no association between atrazine levels and low birth weight or SGA, and a slight association between atrazine and prematurity[18]; the authors state that "we cannot conclude that atrazine levels in drinking water explain the seasonal pattern we observed"[19].

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[11] Charles Duhigg, "Debating How Much Weed Killer Is Safe in Your Water Glass", *New York Times*, August 23, 2009.

[12] Mattix, K.D., Winchester, P.D., and Scherer, L.R. 2007. Incidence of abdominal wall defects is related to surface water atrazine and nitrate levels. *Journal of Pediatric Surgery* **42**:947-949.

[13] Ochoa-Acuña, H., Frankenberger, J., Hahn, L., Carbajo, C. 2009. Drinking-water herbicide exposure in Indiana and prevalence of small-for-gestational-age and preterm delivery. *Environmental Health Perspectives* **117**(10):1619-1624.

[14] Villaneuva, C.M., Durand, G., Coutté, M-B, Chevrier, C., and Cordier, S. 2005. Atrazine in municipal drinking water and risk of low birth rate, preterm delivery, and small-for-gestational age status. Occupational and Environmental Medicine **62**:400-405.

[15] Winchester, P.D., Huskins, J., and Ying, J. 2009. Agrichemicals in surface water and birth defects in the United States. *Acta Pædiatrica* **98**:664-669.

[16] Mattix *et al.* 2007. p. 949.

[17] Ochoa-Acuña *et al*. 2009. p. 1624.

[18] Villanueva *et al*. 2005. p. 400.

[19] *Ibid.*, p. 405.

Winchester *et al*. compared concentrations of atrazine, nitrates and "all other pesticides" from the U.S. Geological Survey National Ambient Water Quality Assessment (NAWQA) between 1996 and 2002 to monthly pregnancy and birth outcome data from the Centers for Disease Control mortality database for the same years[20]; the NAWQA data from "186 stream sites representing 51 hydrological systems"[21] were assumed to be a proxy for human exposures nation-wide[22]. The authors reported that the "log odds of birth defects are positively correlated with atrazine, nitrate and other pesticide concentrations"[23], although the authors state that "(a) causal link between birth defects and environmental nitrates/pesticides is plausible but not proven"[24] from the study, which "has many limitations"[25].

The abstract of a study conducted in Italy[26] stated that "(t)he results of the case-control study suggest an increased risk" for non-Hodgkin's lymphoma and leukemia "and some chemical classes of pesticides, although few are statistically significant and some are based on few exposed cases"[27].

Summary of Current Knowledge about Atrazine Risk

The limitations of the epidemiological studies and described above are clear; EPA states that "epidemiology data and human incident reports contain valuable information about human exposure and response to pesticides", and that such data also "pose challenges with respect to characterizing human health risks"[28]. A review of the epidemiological data, along with "the best available science on mode of action, exposure, pharmacokinetics, animal and human data from both *in vivo* and *in vitro* studies in addition to models such as physiologically-based pharmacokinetic models when available" will form the basis of EPA's re-evaluation of atrazine[29]. Therefore, the observations in the epidemiological studies do not, by themselves, provide any basis for determining a dose-response relationship between atrazine and human health effects or revising EPA's current risk assessment based on acute and chronic exposures[30].

The current EPA evaluation of atrazine is regarded as highly protective, based on a determination that "change in hormonal levels is the most sensitive health effect observed in an

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[20] Winchester *et al*., 2009, p. 665.
[21] *Ibid.*, p. 664.
[22] *Ibid*., p. 668.
[23] *Ibid*., p. 666.
[24] *Ibid*., p. 667.
[25] *Ibid*., p. 668.
[26] Miligi, L., *et al*., 2003. Non-Hodgkin's lymphoma, leukemia, and exposures in agriculture: Results from the Italian multicenter case-control study. *American Journal of Industrial Medicine* **44**(6):627-636.
[27] *Ibid.*
[28] *Federal Register*, Vol. 74, No. 221, Wednesday November 18, 2009. p. 59535.
[29] *Ibid.*
[30] U.S. EPA, October 7, 2009. *Atrazine Science Re-evaluation: Potential Health Impacts* (EPA-HQ-OPP-2009-0759), pp. 4-6, and Table 1. Available on-line at: http://www.epa.gov/opp00001/reregistration/atrazine/atrazine_update.htm#atrazine

extensive battery of atrazine toxicity tests"[31]. Under EPA's atrazine risk assessments, the acceptable levels for short-term exposures (*i.e.,* the one-day DWLOC of 298 ppb), intermediate-term exposures (*i.e*., the 90-day rolling average DWLOC of TCT in raw water of 37.5 ppb) and long-term exposures (*i.e*., the MCL of 3 ppb) are based upon a "300-fold margin of safety to help ensure that an exposure will not affect hormone levels, and a 1000-fold margin of safety to help protect against long-term or chronic effects. In other words, the exposure that the Agency allows is at least 300 to 1000 times more protective than the level where the Agency saw no adverse effects in the most sensitive animal species tested."[32]

Impairment of Public Drinking Water Supply Beneficial Use

The OEPA's 2008 and draft 2010 Integrated Water Quality Monitoring and Assessment reports (currently in public comment until February 8, 2010) list Swift Run Lake as impaired for the Public Drinking Water Supply (PDWS) beneficial use. The lake is listed as impaired because the annual average atrazine concentration in lake water in 2005 (5.03 ppb) and 2008 (3.62 ppb) exceeded the MCL (3 ppb). These concentrations were calculated by Ohio EPA from the AMP/Syngenta raw water data set based on the average of the results from the four quarters of the calendar year, as opposed to the rolling average calculated for the finished water data. The MCL has been adopted as the surface water criterion for atrazine by Ohio EPA.

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Summary

Through its compliance with all atrazine monitoring requirements of the Safe Drinking Water Act, the City of Piqua is protecting public health. In addition, CWS monitoring conducted by Syngenta in the city's raw water sources, in accordance with the requirements of RED and the MOA, indicates that the 90-day rolling average concentrations are protective of human health.

In Hull's opinion, there is no scientific basis for voluntarily increasing the frequency of monitoring for atrazine in finished drinking water. The multiple years of monitoring data taken together allow a solid understanding of the magnitude of the variation of atrazine concentrations in raw and finished water over time, and permit the conclusion that undetected excursions of atrazine concentrations above established benchmarks are very unlikely.

The most recent atrazine review recently announced by USEPA may lead to changes in required reporting or possibly a change in the DWLOCs or the MCL; any such changes would be reflected in Ohio EPA reporting requirements for water supplies under the Safe Drinking Water Act, or in the requirements for pesticide registrants under the AMP.

[31] U.S. EPA, August 2009. Pesticide Programs' Monitoring in Community Water Systems. Atrazine Updates. Available on-line at: http://www.epa.gov/opp00001/reregistration/atrazine/atrazine_update.htm#cws

[32] *Ibid.*

Recommendations

In response to public interest in atrazine in the public water supply, Hull recommends that a web page be established on the City website containing a description of the City's atrazine monitoring program and links to relevant publicly available data on atrazine, its sources and environmental fate, and the new USEPA atrazine reevaluation currently underway. Hull can provide a set of links which the City may wish to post.

The City may also wish to begin posting the annual and 90-day average concentrations and one-day maxima for atrazine in finished water obtained under the City's monitoring program, which would give the public ready access to this information in real time.

Finally, the City may wish to enumerate publicly the steps it is taking to address the beneficial use impairment of Swift Run Lake, including establishment of the Community Advisory Committee. Through the CAC, the City hopes to develop strategies for reducing the amount of atrazine that enters the lake system from agricultural fields.

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