# Appendix F: Additional Atrazine Analyses

# Contents

F-1 Atrazine Maximum Daily Limit Calculation ..... F-2
F-2 Atrazine and Gage Discharge ..... F-3
F-2.1 Spring and Summer 2004 ..... F-5
F-2.2 Spring and Summer 2005 ..... F-5
F-2.3 Spring and Summer 2006 ..... F-5
F-2.4 Spring and Summer 2007 ..... F-5
F-2.5 Spring and Summer 2008 ..... F-5
F-3 Ohio EPA Atrazine Sampling in 2008 ..... F-9

# Figures

Figure F-1. Atrazine concentrations at the PWS intake from April 6, 2004 through September 22, 2008. ..... F-4
Figure F-2. Atrazine concentrations at the PWS intake (April 6 through July 20, 2004). ..... F-6
Figure F-3. Atrazine concentrations at the PWS intake (May 3 through July 26, 2005). ..... F-6
Figure F-4. Atrazine concentrations at the PWS intake (April 5 through July 24, 2006). ..... F-7
Figure F-5. Atrazine concentrations at the PWS intake (April 2 through July 30, 2007). ..... F-7
Figure F-6. Atrazine concentrations at the PWS intake (April 7 through July 28, 2008). ..... F-8
Figure F-7. Atrazine concentrations from May 2008. ..... F-10
Figure F-8. Atrazine concentrations in June 2008. ..... F-11

# F-1 Atrazine Maximum Daily Limit Calculation

The Ohio Environmental Protection Agency (Ohio EPA) decided to use an atrazine target of 35 µg/L as the TMDL target and 3 µg/L as the community action level. The value of 35 µg/L is the maximum daily limit (MDL) for maintaining a 90-day average of 3.0 µg/L. The MDL is briefly discussed in Section 3.1.2.3, and the calculation of the target value (35 µg/L) is presented in this appendix. The MDL equation is as follows:

$$MDL = LTA \times e^{[(z \times \sigma) - (0.5 \times \sigma^2)]}$$

where *LTA* is the long term average, *e* is the base of the natural logarithm, *z* is the z-score associated with the target recurrence interval, and $\sigma^2$ is the natural logarithm of the quantity of the square of the coefficient of variation plus one (U.S. EPA 2007).

The LTA is 3.0 µg/L, which is based on the state standard (Ohio EPA 2008, 3745-1-34(C)(2)(A) and Table 34-1). The z-score of 2.291 was derived from an averaging period of 90 days, which yields a recurrence interval of 98.9 percent (U.S. EPA 2007). The coefficient of variation was calculated using the data from the two stations discussed Section 3.1.2.3 of this subsection, which was 4.17 (for a summary of atrazine sample results, see Section 3.2.5.2). This value was calculated as the division of the mean (6.19 µg/L) of the 94 samples by the standard deviation (25.8 µg/L). Note that in this appendix, values are presented as only three significant digits.

$$MDL = LTA \times e^{[(z \times \sigma) - (0.5 \times \sigma^2)]}$$

where $LTA = 3.0$, $z = 2.291$, and $\sigma^2 = 2.91$

$$MDL = 3.00 \times e^{2.45}$$
$$= 34.9$$

This value was rounded to 35 µg/L to be consistent with the standard of 3.0 µg/L, which has two significant digits.

Ohio EPA has also identified a "Community Action Level" of 3.0 µg/L as a target concentration not to be exceeded because 3.0 µg/L is the de facto daily standard used by the Mount Orab WTP. Maintaining atrazine levels below this target will result in reduced treatment costs for the community, reduced risk to human health, and allowing the drinking water system to fully utilize the Sterling Run water source.

## F-2 Atrazine and Gage Discharge

Atrazine concentrations from samples collected at the Mount Orab water treatment plant (WTP) public water supply (PWS) intake tend to be highest during the spring and summer of each year (Figure F-1). These spikes are likely due to the first spring runoff after applications of atrazine to agricultural fields. The dates of atrazine application are not available nor are continuous discharge data available in the *Sterling Run* subwatershed (HUC 05090201 10 01). Without such data, Tetra Tech cannot absolutely determine if elevated concentrations of atrazine during the spring and early summer are from spring runoff following atrazine application.

The most readily available continuous discharge data are from the U.S. Geological Survey (USGS) gage near Georgetown: White Oak Creek at Georgetown, OH (03238500). Atrazine data from samples collected at the PWS intake were compared to gage flow data for April through July of 2004 through 2008. These analyses are presented in the following five subsections. Note that a low head dam is 200 yards downstream of the PWS intake and that Sterling Run flows into Grant Lake near Mount Orab. Additionally, it takes time for flow to reach the gage from the PWS intake. These three factors must be considered when analyzing the relationship between atrazine concentrations at the PWS intake and discharge measurements at the gage.

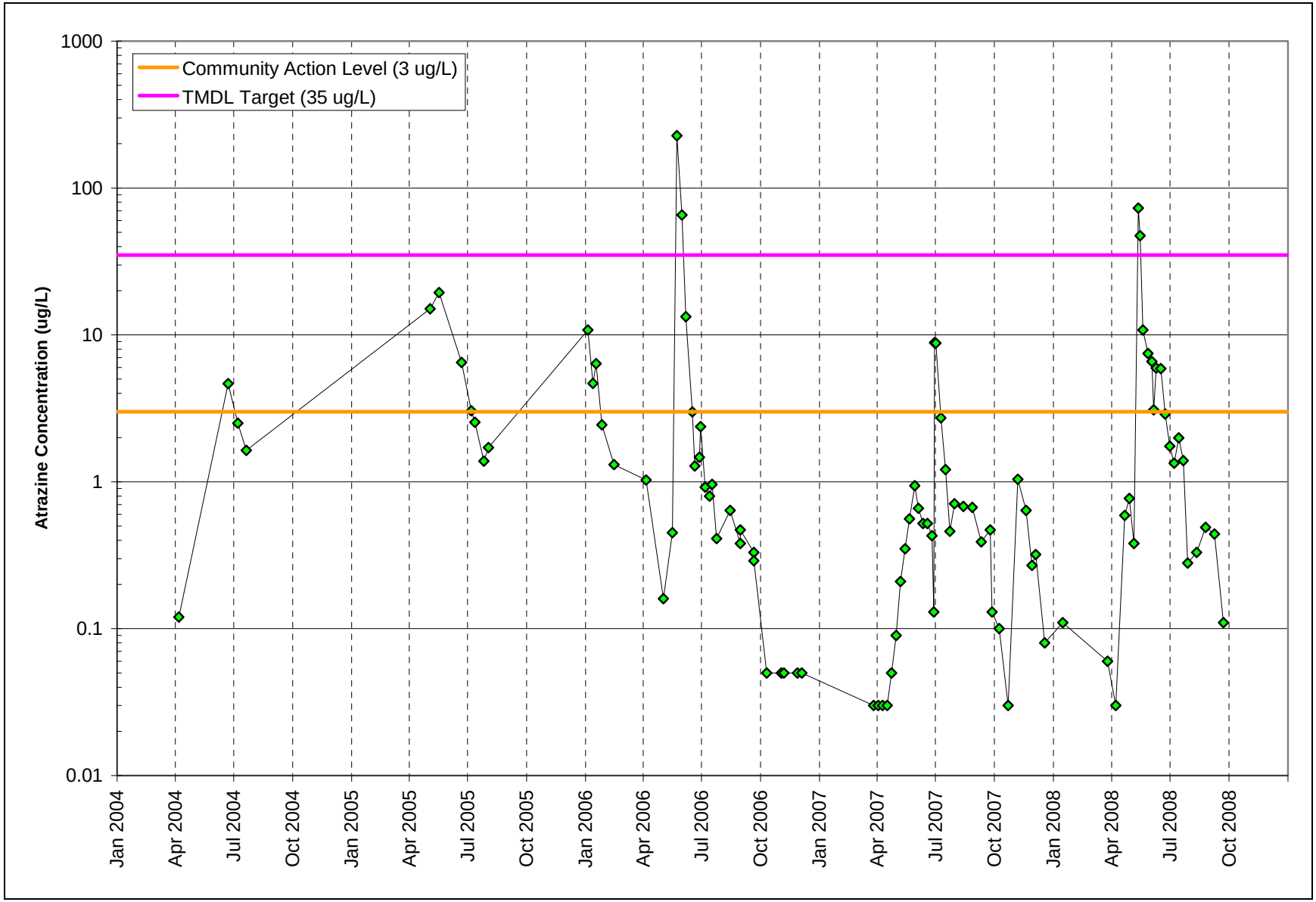


Figure F-1. Atrazine concentrations at the PWS intake from April 6, 2004, through September 22, 2008.

### F-2.1 Spring and Summer 2004

Only four samples were collected at the PWS intake from April through July 2004. The highest concentration was detected on June 22 at 4.66 µg/L. No atrazine data are available near any of the six periods of elevated flow at the USGS gage. A visual analysis shows that atrazine concentrations were decreasing in June and July (Figure F-2).

### F-2.2 Spring and Summer 2005

Only six samples were collected at the PWS intake from April through July 2005. The highest concentration was detected on May 17 at 19.45 µg/L. The atrazine concentration of 15.5 µg/L collected on May 3 might reflect elevated concentrations of atrazine derived from high-flow events on April 23 and 27. A visual analysis shows that atrazine concentrations were decreasing in June and July (Figure F-3).

### F-2.3 Spring and Summer 2006

Fourteen samples were collected at the PWS intake from April through July 2006. The highest concentration was detected on May 23 at 237 µg/L. Increased flow occurred at the gage on May 26 and 27 and again on June 1 through 3. Depending on the time it takes flow to reach the gage from the PWS intake, either high-flow event could have resulted in the elevated atrazine concentration on May 23. A visual analysis shows that atrazine concentrations were decreasing in both April and May through July (Figure F-4). The decrease in April corresponds to a spike in January 2006, which may be the result of a fall application of atrazine in 2005 (Van Harlingen, Mount Orab WTP, telephone conversation and email correspondence, August 2008).

### F-2.4 Spring and Summer 2007

Twenty samples were collected at the PWS intake from April through July 2007. The highest concentration was detected on June 29 at 8.85 µg/L. Increased flow occurred at the gage on June 29 (Figure F-5). A spike amidst decreasing atrazine concentrations and an increase in flow during a dry summer on the same day likely indicates a precipitation event throughout the watershed. The increase of atrazine concentrations in April and May and stagnation of concentrations in June, before the spike, likely mean that no large precipitation events occurred to wash atrazine off the field and into Sterling Run.

An additional spike in atrazine concentrations occurred on November 5 at 1.04 µg/L (Figure F-5). No high-flow events were recorded at the USGS gage near November 5. Because fall application of atrazine is not permitted, the cause of this spike is unknown. It is possible that a localized precipitation event occurred in the upper reaches of the Sterling Run subwatershed above Lake Grant with the increased flow absorbed by Lake Grant and not reaching the USGS gage.

### F-2.5 Spring and Summer 2008

Seventeen samples were collected from the PWS intake from April through July 2008. The highest concentration was detected on May 12 at 72.99 µg/L. High-flow events began on May 12, 15, 16, and 20 (Figure F-6). It is likely that the May 15 spike in streamflow corresponds to the atrazine spike on May 12. It is also noteworthy that atrazine concentrations decreased from the spike on May 12 through July and did not spike again despite the high-flow events on May 16 and 20. Thus, it is likely that only one precipitation event of sufficient volume is necessary to remove the majority of residual atrazine from agricultural fields.

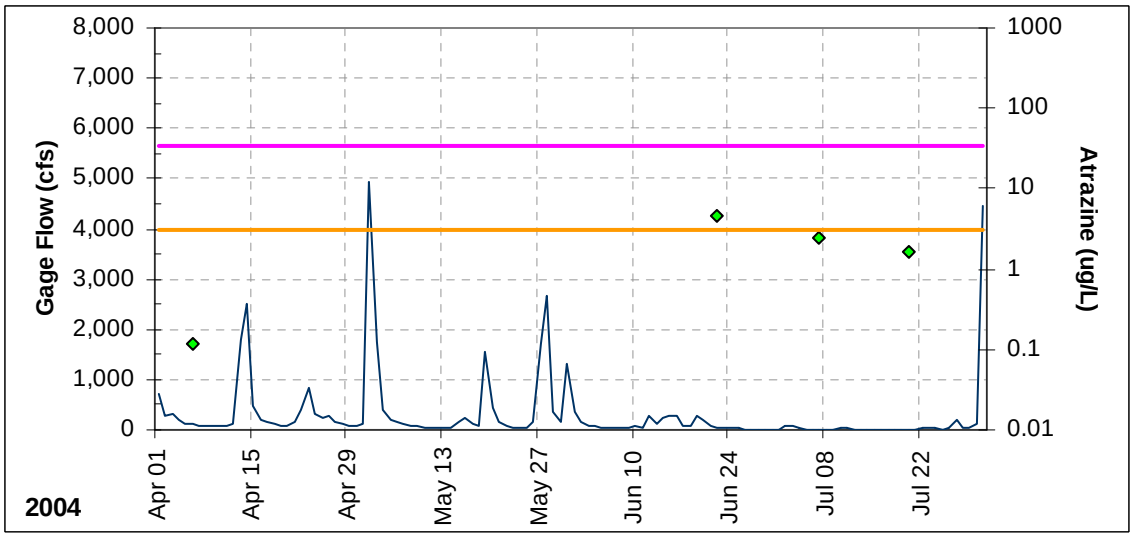


Figure F-2. Atrazine concentrations at the PWS intake (April 6 through July 20, 2004).

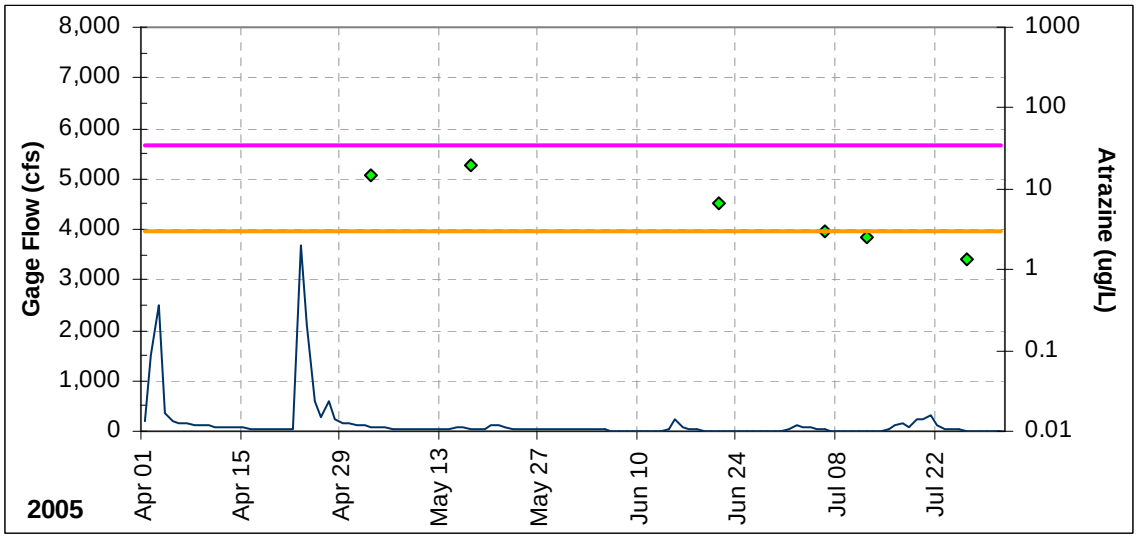


Figure F-3. Atrazine concentrations at the PWS intake (May 3 through July 26, 2005).

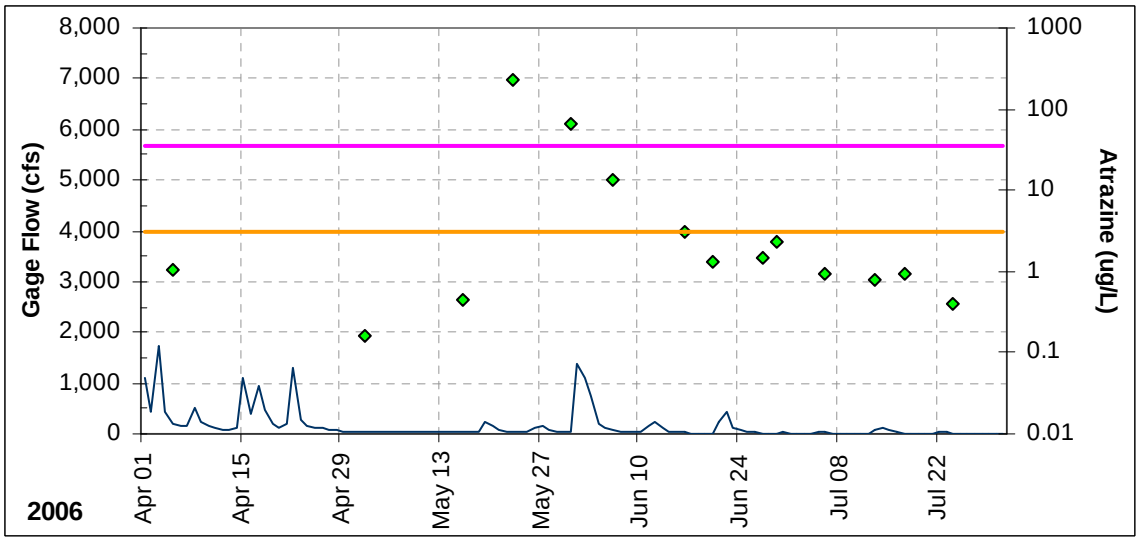


Figure F-4. Atrazine concentrations at the PWS intake (April 5 through July 24, 2006).

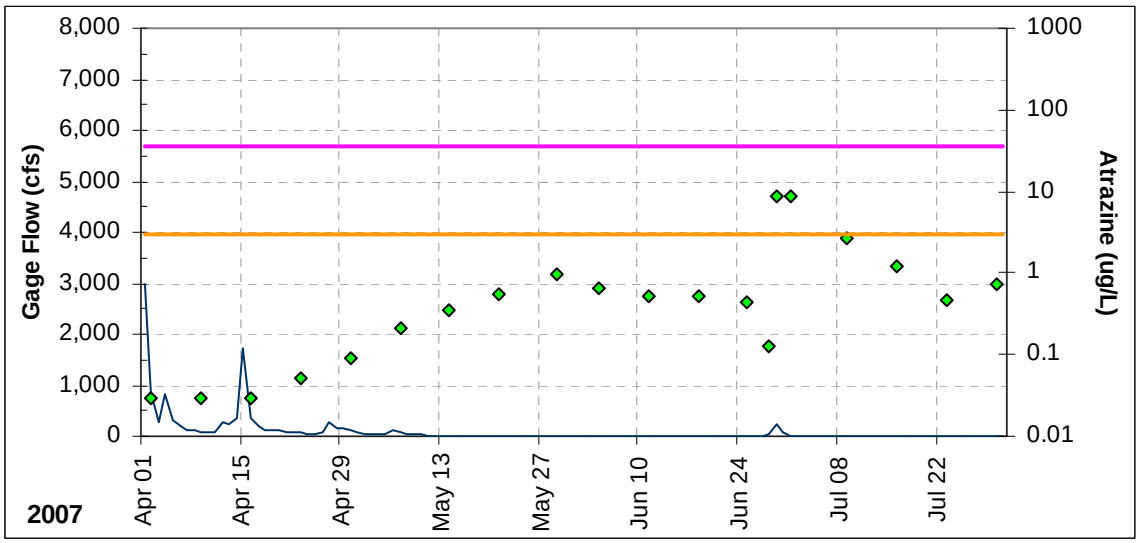


Figure F-5. Atrazine concentrations at the PWS intake (April 2 through July 30, 2007).

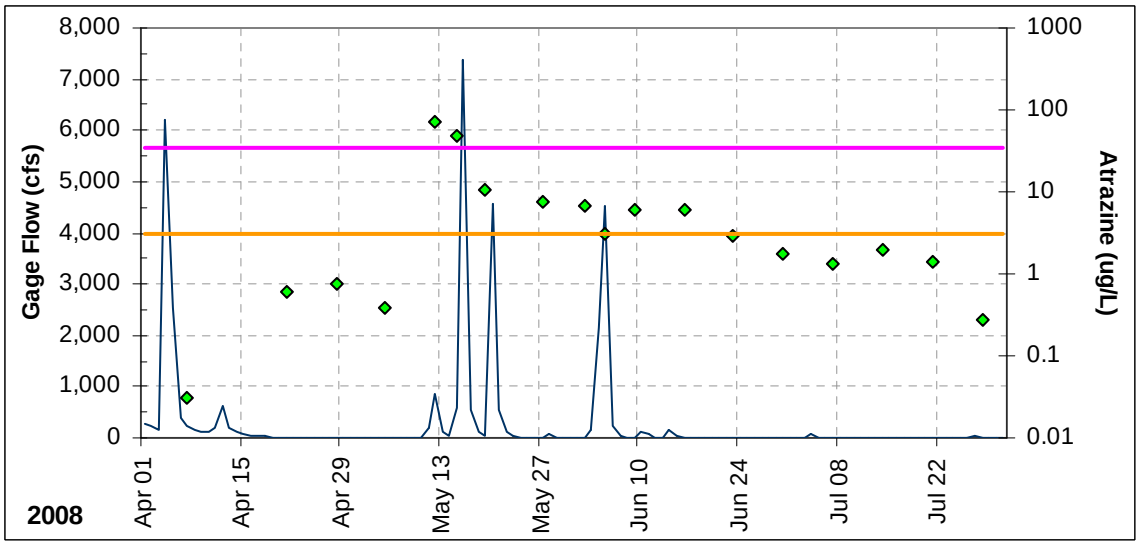


Figure F-6. Atrazine concentrations at the PWS intake (April 7 through July 28, 2008).

## F-3 Ohio EPA Atrazine Sampling in 2008

Ohio EPA sampled three locations for atrazine on May 15, 2008 and June 5, 2008. Per the MOA, Mount Orab WTP personnel sampled at the PWS intake on May 12, 2008, and June 2, 2008, and the samples were analyzed by a laboratory contracted by Syngenta. The Ohio EPA and Sygenta atrazine data for May 2008 and June 2008 are displayed in Figure F-7 and Figure F-8, respectively.

All four samples collected between May 12 and May 15, exceeded both the 35 µg/L TMDL target and the 3 µg/L community action level. It appears that the atrazine concentration increased between May 12 and May 15, assuming that Ohio EPA's RM 6.74 station (X02W05), which is only 555 yards upstream of the PWS intake (RM 6.47), is essentially the equivalent of the PWS intake sample station.

None of the samples collected between June 2 and June 5 exceeded the 35 µg/L TMDL target, and only the two samples of stations near and at the PWS intake exceeded 3 µg/L. Similar to May, it appears that atrazine concentrations increased between June 2 and June 5 on the basis of data at the PWS intake and station X02W05.

A future analysis that includes additional atrazine sample stations with data regarding, but not limited to, recent weather, atrazine application, local farming patterns, might result in a better understanding of the atrazine in the Sterling Run subwatershed.

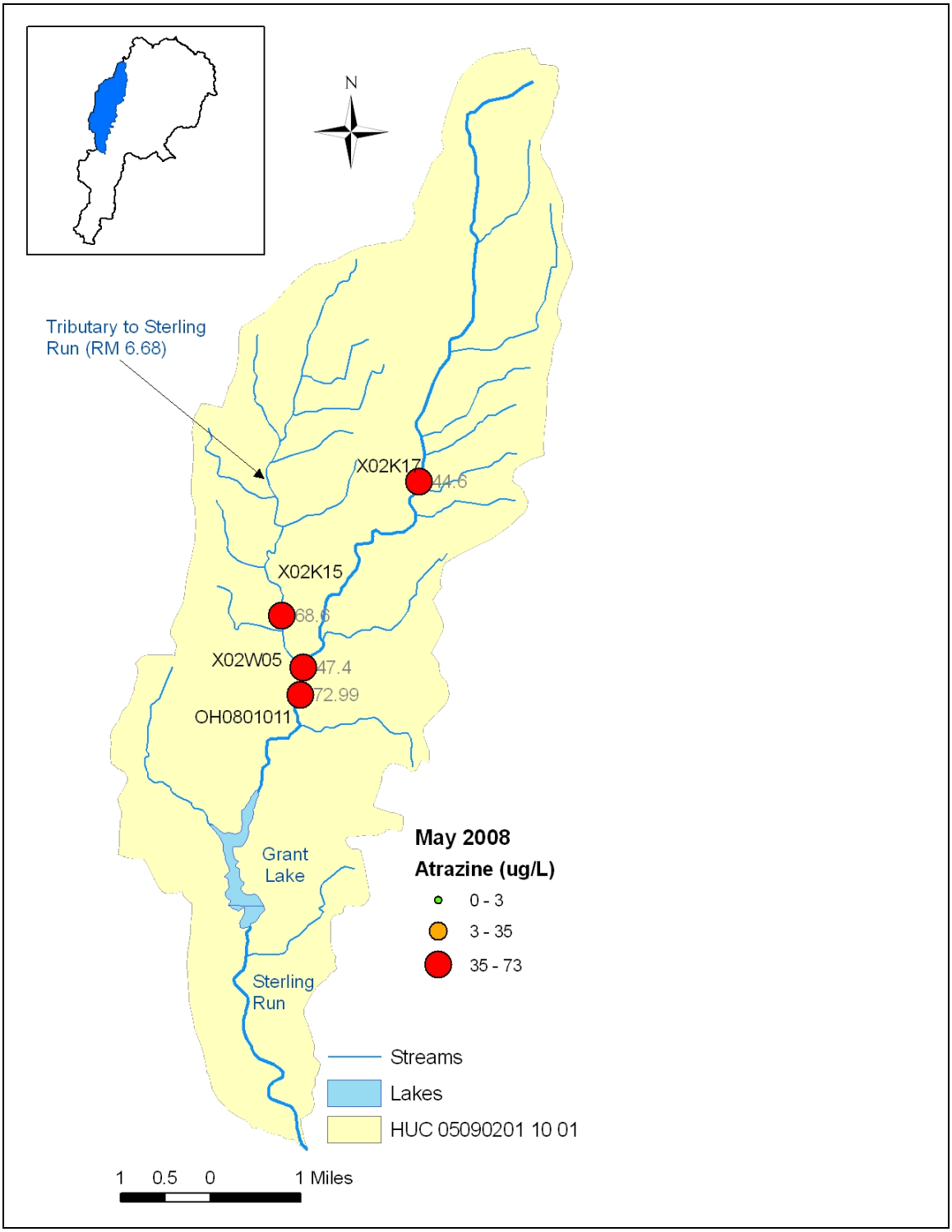


Figure F-7. Atrazine concentrations from May 2008.

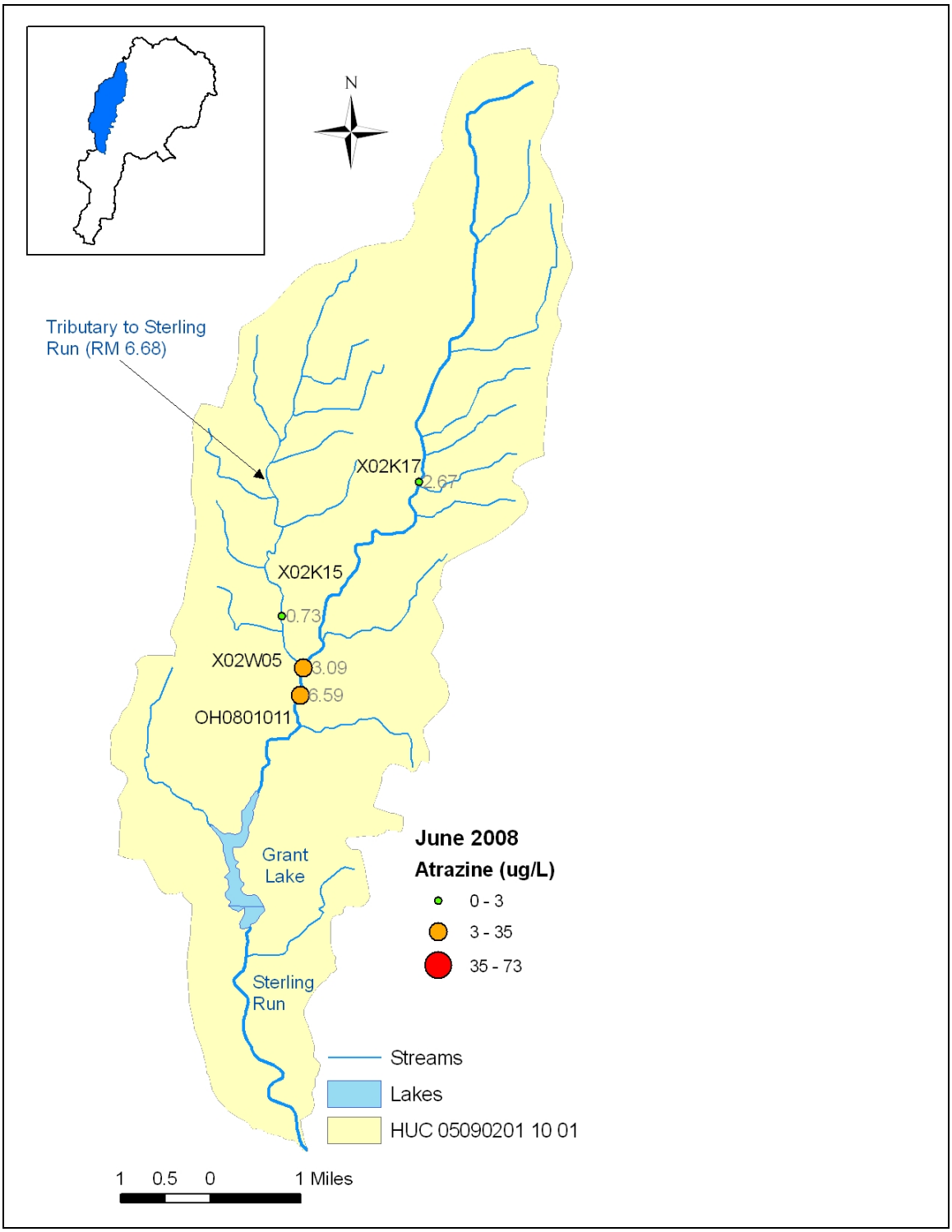


Figure F-8. Atrazine concentrations in June 2008.

## F-4 References

Ohio EPA (Ohio Environmental Protection Agency). 2008. Rule 32: Ohio River Standards, in *State of Ohio Water Quality Standards* (OAC-3745-1) Ohio Environmental Protection Agency, Division of Surface Water, Columbus, OH.

U.S. EPA (U.S. Environmental Protection Agency). 2007. *Appendix B: Identifying Daily Expressions for Non-daily Concentration-based TMDLs* in the draft report of *Options for Expressing Daily Loads*. U.S. Environmental Protection Agency, Office of Wetlands, Oceans, and Watersheds, Washington DC. June 22, 2007.