COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS
DIVISION OF ADMINISTRATIVE LAW APPEALS

IN THE MATTER OF
DEPARTMENT OF CONSERVATION AND RECREATION
Docket No. DEP-04-919
DEP FILE #233-547
NATICK

TESTIMONY OF RICHARD F. YURETICH, Ph.D.

I, Richard F. Yuretich, do hereby swear and affirm the following:

1. I am a professor of Geosciences at the University of Massachusetts in Amherst, MA. I received my Bachelor of Arts from New York University in 1971, my Masters of Arts from Princeton University in 1973, and my Ph.D. in Geology from Princeton University in 1976.

2. I have been a professional geologist for nearly 30 years, and I am a specialist in the geochemistry of the Earth's surface environment. Geochemistry includes the study of the behavior of chemical elements and compounds, both natural and contributed by humans, in rocks, water, soil, and the atmosphere. In this connection, I have conducted numerous research projects involving the chemistry of rivers, lakes, and groundwater, including an investigation of the potential effects of acid rain on the water quality of the Quabbin Reservoir. This project determined that groundwater entering into the reservoir from the surrounding watershed contributed a significant fraction of the dissolved substances to the water in the reservoir. In this case, dissolved ions from the surrounding soils and bedrock served to neutralize the acidity of the rainfall, thus reducing the effects of the acid rain.

3. I have been retained by the Petitioners in this matter to determine the likelihood of migration of the pesticides diquat dibromide ("Reward") and dipotassium endothall ("Aquathol K") from Lake Cochituate to ground water, and the public water supply for the Town of Natick, and the effect of the application of these pesticides on surface water quality. I have undertaken this work on a *pro bono publico* basis. My opinions, as set forth herein, are stated to a reasonable degree of scientific certainty.

4. I have examined several documents pertaining to this matter. These include:

1. Pesticide Information Profile concerning diquat dibromide, available from the Extension Toxicology Network (http://extoxnet.ordst/edu/pips/diquatdi.htm)

2. Pesticide Information Profile concerning endothall available from the Extension Toxicology Network (http://extoxnet.ordst/edu/pips/endothal.htm)

3. Excerpts from "Final Risk Assessment for Diquat Dibromide," Washington State Department of Ecology, November 2002

4. Excerpts from "Occurrence Summary and Use Support Document for the Six-Year Review of National Primary Drinking water Regulations," U.S. EPA. March, 2002

5. U.S. EPA Technical Factsheet on: DIQUAT, (http://www.epa.gov/safewtaer/dwh/t-soc/diquat.html)

6. Notice of Intent Application , Aquatic Management Program, Lake Cochituate, Natick, MA, April, 2003, Aquatic Control Technology

7. Massachusetts DEP Superseding Order of Conditions 233-47, Issued March 9, 2004.

8. "Pond-Aquifer Interaction at South Pond of Lake Cochituate, Natick, Massachusetts" U.S. Geological Survey Water-Resources Investigation Report 01-4040, Northborough, MA, 2001.

9. "Herbicide Risk Assessment for the Aquatic Plant Management Final Supplemental Environmental Impact Statement" Appendix D, Volume 2, Endothall, Washington State Department of Ecology, February 2001, Scection 4, Environmental Effects (http://www.ecy.wa.gov/biblio/0010044.html)

10. Lake Cochituate Long-Term Vegetation Management Plan, Aquatic Control Technology, May 2004

Hydrogeology of Lake Cochituate

5. Lake Cochituate is comprised of four connected water bodies: North Pond, Middle Pond, South Pond, and Small Pond. As approved by the Massachusetts Department of Environmental Protection, diquat is proposed to be applied to the Lake around the perimeter near the shore of South Pond, except for a 1,000 foot "no treatment" setback distance from the point of land containing the Town's Springvale well field; and endothall is proposed to be applied to the Lake near the shore of Middle Pond, in the area of the State Beach (6, 7). Lake Cochituate formed as the glaciers receded after the last ice age, leaving behind depressions that filled with sand, gravel, mud, and water. Geophysical surveys of South Pond show that fine-grained sediments occupy the deeper parts of the lake basin, and that the shoreline is comprised of coarser sand and gravel. The shallow-water north end of South Pond is mostly sand and gravel (8).

6. The Natick Springvale public water-supply wells are adjacent to South Pond of Lake Cochituate, where much of the proposed spraying will occur. These wells supply their water from the same glacial sand and gravel that underlies Lake Cochituate. The Town of Natick receives about 50% of its water from these wells during the summer months, and about 30% during the remainder of the year (8). Groundwater is derived from recharge areas that can be some distance from the wells themselves. This water flows both vertically and horizontally towards the pumping wells. The recharge area for the Springvale public water supply wells includes the northern half of South Pond, and the southern half of Middle Pond (6). An evaluation by the U.S. Geological Survey examining the temperature profiles and water composition of monitoring wells show that

about 64% of the water in these wells is derived via recharge of the groundwater aquifer directly from South Pond (8). In general, dissolved solids in the lake will be transported with the water to the wells, although absorption and degradation along the way can reduce the concentration of some dissolved components.

7. The shoreline of South Pond comprises coarse-grained sand and gravel, with finer-grained and organic-rich sediments in the middle of the pond. According to the US Geological Survey study, "pond water infiltrates the aquifer mainly through these shoreline areas" (8). The hydraulic conductivity of these gravels is very high, which means that water can move very rapidly from the lake into the groundwater. Estimates of average travel time from the lake to the wells are on the order of 1 month to 8 months, but this can be much shorter depending upon specific hydrologic conditions.
Studies of the temperature and composition of both groundwater and lake water show that water from different parts of the lake mixes together before arriving at the water-supply wells, and water entering the groundwater aquifer nearest the well field will have the shortest travel times. Travel time will also be much shorter when the wells are being pumped at high rates, such as typically occurs during the summer months when demand for water is high. Depending upon the exact point of recharge, "travel times of pond-derived water could range from days to more than a year" (8). The lower end of the estimate is much shorter than the inferred degradation time of endothall (2).

8. The proposed area of application of the herbicide diquat (Reward) is concentrated around the entire shoreline perimeter of South Pond, with the exception of the area within 1000 feet of the water-supply wells. Application of diquat has also been proposed near the area known as State Beach, approximately 2 acres in size, and in certain other areas along the shoreline in the north and south of Middle Pond. The herbicide endothall (Aquathol-K) is to be applied to the area of State Beach in Middle Pond (6, 10). In both South Pond and Middle Pond, sand and gravel are the dominant sediment types underlying the sites of proposed spraying.

Properties of diquat dibromide (Reward) and endothall (Aquathol K)

9. Diquat dibromide has been shown to be absorbed readily by vegetation, and generally binds firmly to soils when used in agricultural settings (1). However, it is "highly persistent, with reported field half-lives of greater than 1000 days" (1). Diquat persisted in the soil in laboratory experiments for 9 months (4).In other words, although this chemical is not easily leached from the soil to which it is bound, it remains in said soil for long periods of time.

10. This binding action requires that the soils contain considerable amount of clay or organic matter, which have a high exchange or adsorption capacity. Sandy soils have a much reduced capacity for binding these substances. Available data indicate that sand and gravel have binding capacities for diquat that is hundreds or even thousands of time lower than clay, with an adsorption coefficient ($Kd_{abs)}$ =30, compared to up to 100,000 for clays (4). An adsorption coefficient is determined by the amount found on the soil divided by the amount remaining in the water, so the higher the number, the more that

will be retained on the soil, and the less that will be mobilized in the water. The diquat adsorption studies have been conducted on unsaturated sediments and soils, such as those typically found in agricultural areas or lawns. They are exposed to oxygen and have a relatively low water content. The sediments at the bottom of a lake are saturated with water and have a much reduced oxygen content. Consequently, the potential for significant amounts of diquat to remain in the water is much larger in areas of sandy, water-saturated sediment.

11. The solubility of diquat dibromide in water is very high (700,000 mg/l) (1). A laboratory study using purified sand showed that 75% of diquat applied to the sand migrated through the column (4). The comprehensive analysis for diquat dibromide by the Washington State Department of Ecology notes that in a 'scenario of a sand/gravel sediment with little or no clay or silt, that diquat would not adsorb and be inactivated, and could, with a very heavy and continuous pumping of water, contaminate the ground water" (4).

12. The chemical properties of endothall are even more uncertain (2). However, the indications are that it has a greater tendency to dissolve in water and not bind to soils and sediments. Reported adsorption coefficients range from 0.426 to 2.12, which are far lower than for diquat (9). This indicates that most of the endothall that is applied in the water will remain in water as it enters the sediments of the lake. Total solubility of endothall is extremely high, 100,000 mg/l (2). Most sources report that the compound is rapidly degraded in water and soil, with a half-life ranging from 4 days to 7 days (2). In other words, after 4 to 7 days, half of the amount of endothall that was applied will still be in the water. After 8 to 14 days, there will still be one-quarter left, and so on. However, studies of persistence in sediments indicate that the residence times until disappearance are longer, up to 62 days in some instances, and that conditions of reduced oxygen, which limit the metabolic breakdown of the compound, could extend this time (9). Reduced oxygen conditions are normal in the sediments at the bottom of a lake. Clearly, the threat to groundwater from endothall is reduced if the time from recharge area to pumping well is much longer than 62 days.

Groundwater Quality Impacts

13. As noted above, the shoreline of South Pond and Middle Pond comprises coarse-grained sand and gravel. The sand and gravel will minimize the amount of herbicides that are adsorbed by the sediment as the water makes its way to the wells. Given the ease that diquat migrates through this material, and the relatively short time that it takes for the water to reach the public wells, it is my opinion that detectable amounts of herbicides are likely to appear within the drinking water within weeks of herbicide application. Specifically, with the proposed treatment concentration of approximately 0.20 – 0.30 ppm (10), as much as 75% of this amount may enter the sand and gravel aquifer.

14. The various reports (3, 9) mention that under conditions of reduced oxygen the persistence of both diquat and endothall will be extended. Reduced oxygen in the

deeper waters of Lake Cochituate occurs regularly during the summer months (10).After spraying an extensive area such as is proposed for South Pond, the dying vegetation on the lake bottom will serve to lower the oxygen levels at the point where water is recharging the aquifer. It is my opinion, based upon the facts I have reviewed, that this would permit greater abundances of the herbicides to infiltrate into the groundwater. The information on the degradation of these herbicides generally applies to soil environments where easy access to atmospheric oxygen can stimulate the microbial degradation of the herbicides (1, 2, 9). It is my opinion that, in the oxygen-poor environment of the lake bottom and sediments, the breakdown of these products will be much slower and the products will travel in an unaltered state to Springvale well field.

Surface Water Quality Impacts

15. Killing the milfoil in large quantities with these herbicides will create an extensive area of dead and decaying vegetation along the lake shoreline. This mat of vegetation will further consume oxygen from the lake water, affecting the quality of the surface water. In addition, this low-oxygen environment will further encourage the persistence of the both diquat and endothall in the bottom water that infiltrates into the groundwater aquifer. The only effective solution to this problem is to remove the dead and decaying vegetation by hand or other mechanical means, since natural degradation is a slow process that could last many years.

Conclusion

16. It is my opinion that applying diquat to the proposed areas along the shoreline of Lake Cochituate will have a negative impact upon the quality of the drinking water at the Town of Natick Springvale well field. Diquat will not be adsorbed by the sand and gravel underneath these areas and will not be degraded appreciably before being drawn into the wells within a few months time.

17. It is my opinion that endothall will also quickly infiltrate into the underlying sand and gravel at State Beach in Middle Pond. Owing to the smaller area of application, and the greater distance from the Springvale Well Field, I do not see that this procedure poses a high risk to this groundwater. However, groundwater wells nearer to the State Beach will be at risk of contamination, owing to the ability of endothall to migrate quickly and unaltered through saturated sand and gravel.

18. It is my opinion that these herbicides will create additional low-oxygen conditions along the shorelines where the spraying occurs. In addition to the negative effects upon living organisms, such conditions inhibit the breakdown of the herbicides, and could lead to a greater infiltration of contaminants into the groundwater aquifer. Harvesting the decayed vegetation will be required to prevent these conditions.

19. Based on the above, I recommend against using herbicides to control the invasive vegetation here.

Signed under the pains and penalties of perjury this 28th day of April, 2005.

Richard F. Yuretich, Ph.D.