# COMMENTS ON AQUATIC RESOURCE IMPACTS
# Draft Environmental Impact Statement
# Interstate 93 Improvements Salem to Manchester
# IM-IR-93-1(174)0, 10418-C


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## INTRODUCTION

Community & Environmental Defense Services (CEDS) is assisting the New Hampshire Sierra Club with concerns regarding the proposed widening of I-93. These comments focus on potential effects to the streams, wetlands, ponds and lakes within the project area, which is a 19.8-mile corridor extending from the Massachusetts-New Hampshire state line to Manchester, New Hampshire.

According to data presented in Table 1.1-1, of the Draft Environmental Impact Statement (DEIS), Average Daily Traffic (ADT) volumes on I-93 ranged from 61,800- to 104,400-vehicles per day (vpd) in 1997. By the year 2020 ADT will increase to a range of 73,000- to 137,000-vpd. In the DEIS it was contended that the increasing traffic volume would cause excessive congestion and safety problems. The following was presented in the DEIS as the preferred alternative for resolving these issues:

- add two additional lanes in both directions (increasing the number of lanes from the existing four to eight);
- improve the interchanges at Exits 1 through 5;
- construct three new park and ride lots;
- create Intelligent Transportation Systems, such as variable message boards, radio broadcasts, and website information; and
- construct a bike path within a portion of the project area.

In addition to the DEIS, the documents listed in the references section were reviewed during the preparation of these comments.

## AQUATIC RESOURCE SETTING

According to the DEIS, the following lakes and ponds will be impacted by the project:

- Canobie Lake;
- Cobbetts Pond;
- Crystal Lake;
- Wheeler Pond; and
- two unnamed ponds near North Lowell Road and at Exit 5.

In the DEIS it is contended that Canobie Lake and Cobbetts Pond are the most important of these lakes and ponds. Canobie Lake is the primary water supply for the Town of Salem. Both the lake and pond are highly regarded recreational resources. A large portion of both water bodies lie adjacent to or downgradient of the highway.

According to the DEIS, Canobie Lake is currently enriched with nutrients to a moderate degree (mesotrophic), though at times the enrichment becomes excessive (eutrophic). Nutrient enrichment can lead to excessive algal growth which: depletes oxygen from the water column, prevents light from reaching submerged aquatic grasses, interferes with water treatment processes, and imparts objectionable tastes and odors to the water. Obviously these are major concerns for a lake serving both as a primary water supply and a recreational resource. Cobbetts Pond also suffers from enrichment. Crystal Lake is presently excessively enriched with nutrients.

According to the DEIS 21 streams, rivers, tributaries and other waterways are impacted by the project. The major waterways are:

- Beaver Brook;
- Cohas Brook.
- Little Cohas Brook;
- Policy Brook;
- Porcupine Brook; and
- Spickett River.

These waterways support brook, brown and rainbow trout along with numerous other fish species.

Numerous wetlands are located within the project area. Six of these are considered *prime* wetlands, which are of greater importance and receive a heightened level of protection.

## POTENTIAL AQUATIC RESOURCE IMPACTS

As will be shown in the remainder of these comments, existing I-93 causes a significant, negative impact to aquatic resources. The proposed addition of four lanes will exacerbate these impacts. The DEIS has failed to fully evaluate probable impacts and to explore reasonable alternatives.

### Watershed Impervious Area

Beginning with a study I published in the late 1970s (Klein 1979) a large body of research has shown a consistent relationship between aquatic resource health and the percentage of a watershed covered by buildings, streets, parking lots, sidewalks, and other *impervious* surfaces. These studies are summarized in Table 1.

A number of these studies identified thresholds at which the cumulative effects of watershed development begin to degrade aquatic resources. Wetlands start showing a decline in quality when watershed imperviousness exceeds 2%-4% (Hicks and Larson 1997; Reinelt and Horner 1991). Streams supporting trout, such as those affected by I-93, do best when watershed imperviousness is less than 3% (Roth et al. 1999). Brook trout disappear when watershed imperviousness ranges from 3% to 7% (Roth et al. 1999; Steedman 1988). The Center for Watershed Protection identifies lakes and ponds as being sensitive to increased development when watershed imperviousness exceeds 10%.[1]

[1] See the Center for Watershed Protection *Watershed Vulnerability Analysis* which is available for download from http://www.cwp.org/Vulnerability_Analysis.pdf

**Table 1: Summary of Studies Concerning the Effect of Watershed Development upon Aquatic Communities**

| Geographic Area of Study | Aquatic Systems Studied | Organisms Studied | Nature of Effect of Increasing Watershed Development | Impact Threshold (% Impervious) | Reference |
|---|---|---|---|---|---|
| Connecticut | wetlands | aquatic insects and other macroinvertebrates | A decline in various indicators of aquatic macroinvertebrate community health was observed in wetlands draining watersheds more than 3% impervious. The degradation became significant in most wetlands at an imperviousness of 8%-9%. This degradation was thought to result from physical alterations of the wetlands, sedimentation, nutrients, elevated water temperature, reduced night time dissolved oxygen, elevated pH, and de-icing salts. | 8%-9% | Hicks and Larson. 1997 |
| Delaware | streams | aquatic insects and other macroinvertebrates | Dramatic drop in various indices of health of macroinvertebrate community health which are combined into an index of Biologic Integrity | 8% - 15% | Shaver et al. 1994 |
| Georgia | streams | aquatic insects and other macroinvertebrates | As watershed development increased the number of macroinvertebrates species declined. | | Benke et al. 1981 |
| Maryland | streams rivers | fish, aquatic insects and other macroinverte-brates, and stream baseflow | Fish community Species Diversity Index and stream baseflow declines as watershed imperviousness increases. Most fish species are eliminated when watershed imperviousness reaches 20%. | 10% - 12% | Klein 1979 |
| | streams | brook trout<br>brown trout | Brook trout only occur in watersheds that are less than 2% impervious.<br>Brown trout disappear when watershed imperviousness exceeds 8% and do best when imperviousness is less than 3%. | <2%<br><8%<br><3% | Roth et al. 1999 |
| | streams | aquatic insects and other macroinvertebrates and fish | Combined indexes of macroinvertebrate and fish community health showed decline as watershed development increased. | | Kazyak et al. 1992 |
| | streams | aquatic insects and other macroinvertebrates | As percent urban land use increased indicators of macroinvertebrate community health declined. | 15% | Boward and Hurd 1996 |
| | streams | aquatic insects and other macroinvertebrates and fish | Fish and macroinvertebrate diversity declined as watershed imperviousness increased. | 10% - 12% | Schueler and Galli, 1992 |
| | tidal creeks | fish | Fish assemblages were less diverse in tidal creeks with watersheds dominated by urban land uses when compared to forest and wetland dominated watersheds; dissolved oxygen was lower in creeks draining urban watersheds when compared to forest-wetland dominated watersheds. | | Carmichael et al. 1992 |
| | tidal rivers | fish, macroinvertebrates, and plants | In general, the authors found that tidal tributaries draining more intensely developed watersheds exhibited greater toxicity to fish, benthic macroinvertebrates, and plants. Toxic effects were greatest where developed land uses occupied 25% to 36% of the watershed | | Hartwell et al. 1995 |
| Maryland and Virginia | tidal rivers | benthic macroinvertebrates and water quality | As watershed urbanization increased the health of benthic communities declined; as the proportion of the watershed in forest increased, so did the condition of benthic communities. | | Ranasinghe et al. 1994 |

**Table 1: Summary of Studies Concerning the Effect of Watershed Development upon Aquatic Communities**

| Geographic Area of Study | Aquatic Systems Studied | Organisms Studied | Nature of Effect of Increasing Watershed Development | Impact Threshold (% Impervious) | Reference |
|---|---|---|---|---|---|
| Minnesota | streams | aquatic insects and other macroinvertebrates | As watershed development increased, macroinvertebrate community diversity decreased. | | Richards and Host 1994 |
| New York | nontidal and tidal streams | fish | Alewife herring egg and larval densities decreased as the extent of watershed development increased; dissolved oxygen was more variable in streams draining urbanized vs. undeveloped watersheds. | | Limburg and Schmidt 1990 |
| New Jersey | wetlands | plants | As watershed development increased indigenous plant species declined due to water quality changes and invasion by upland and exotic species. | | Ehrenfeld and Schneider 1991 |
| | wetlands | plants | Runoff from developed land killed sphagnum moss is two wetlands. | | Vedagiri and Ehrenfeld 1991 |
| | stream | aquatic insects and other macroinvertebrates | Diversity and abundance declined dramatically as a stream flowed through a heavily developed area. | | Garie and McIntosh 1986 |
| Ontario, Canada | streams | fish | Index of macroinvertebrate community health and brook trout declined as the degree of watershed development increased. Using data presented in Steedman 1988, Booth and Reinelt (1993) calculated that brook trout begin declining when watershed imperviousness reaches 7% - 10%. | 7% - 10% | Steedman 1988 Booth & Reinelt 1993 |
| Virginia | streams | aquatic insects and other macroinvertebrates | As watershed development increased pollution sensitive macroinvertebrates became less abundant. | 14% | Jones and Clark 1987 |
| | | fish | Comparisons of fish communities in a stream over a 32-year period showed that watershed development resulted in a significant decline in species diversity. | | Weaver and Garman 1994 |
| | | aquatic insects and other macroinvertebrates and algae | Macroinvertebrate diversity s and algal species decrease as watershed development increased. | | Mangun 1988-89 |
| Washington (state) | streams | fish habitat | Quality of fish habitat declines with increasing watershed development. | 8% - 10% | Booth and Jackson 1994 |
| | streams | fish and aquatic insects and other macroinvertebrates | As watershed development increases indices of salmonid health declines, zinc concentrations increase, 2-year peak discharge increases, stream baseflow decreases along with dissolved oxygen. This investigation also documented that stormwater management measures - mostly ponds - did not significantly reduce the adverse impacts of watershed development. | 5% | May et al. 1997 |
| | streams | aquatic insects and other macroinvertebrates | Macroinvertebrate community in a rural stream was twice as diverse when compared to a stream draining an urbanized watershed. | | Pederson and Perkins 1986 |
| | wetlands | amphibians, water-level fluctuations, and water quality | Significant decline in the number of amphibian species as the degree of watershed development increased; significant increase in water-level fluctuations; conductivity, suspended solids, and fecal coliform bacteria were higher in wetlands draining most developed watersheds. | 4% - 14% | Reinelt and Horner 1991 |

Table 4.4.1, on pages 4-32 to 4-35 of the DEIS, shows that the project will increase watershed imperviousness of all 21 tributaries impacted by the proposed widening of I-93. The increase in imperviousness ranges from 2% to 171%. The project will cause watershed imperviousness to exceed 3% in the following brook trout streams: tributary to Porcupine Brook, south tributary to Beaver Brook, and north tributary to Beaver Brook . The project will exacerbate the impact of existing impervious area in all other streams.

The DEIS did not address the cumulative effects of increased watershed imperviousness upon trout nor the many other aquatic species inhabiting the streams impacted by the project.

The DEIS did not contain a wetland version of Table 4.4-1. In other words, the DEIS failed to address the cumulative effects of the project upon wetland ecosystems.

The DEIS did not analyze existing and post-project imperviousness for the lakes and ponds impacted by widening of I-93. Thus, the DEIS failed to address the cumulative effects of the project upon lakes and ponds.

Table 2 lists 16 specific factors identified in 28 studies as causing the degradation of aquatic systems associated with watershed development. All 16 specific impacts will be caused by the proposed widening of I-93.

Table 3 presents the sections of the DEIS in which each specific impact was addressed. Table 3 shows that only seven of the 16 impacts were addressed. In other words, the DEIS failed to address more than half of the specific impacts I-93 widening will cause.

The use of the term *address* should not be construed to mean *fully* addressed. The degree to which these seven impacts were addressed ranged from poor to fair. Following is a description of the shortcomings for two of the seven impacts.

**Road Salt:** A detailed analysis of road salt effects upon aquatic resources was presented in the DEIS. However, this analysis suffers from a very serious shortcoming.

On page 4-39 the DEIS states that the acute aquatic life protection standard for chloride is 230 milligrams per liter (mg/l). The actual fresh water acute chloride standard is 860 mg/l.[2]

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[2] See TABLE 1703.1 in the New Hampshire *Surface Water Quality Regulations* which is available for download at http://www.des.state.nh.us/wmb/env-ws1700.pdf

**Table 2: Specific Land Development Impacts Associated with Degradation of Aquatic Communities**

| Specific Factor Causing Significant Degradation | References |
|---|---|
| Sediment released from construction sites and road surfaces | 5, 12, 13, 14, 23, 24, 25, 26, 27 |
| Hydrologic and habitat modifications | 1, 5, 8, 12, 14, 26, 27 |
| Loss of recharge; diminished groundwater inflow to streams and wetlands | 5, 13, 25, 27 |
| High fluctuations in water level | 6, 15, 25, 27 |
| Erosion/scour due to increased flood flows | 1, 2, 5, 9, 10, 13, 14, 23, 27 |
| Elevated water temperature due to reduced riparian shading | 5, 8, 27 |
| Thermal impact of runoff from heated impervious areas | 5, 17, 26 |
| Organic pollution (sewage, other oxygen demand) | 5, 8, 11, 12, 25, 26 |
| Dissolved oxygen deficiency | 3, 6, 11, 12, 26 |
| Elevated nutrient inputs | 5, 6, 11, 15, 26 |
| Toxicity of an undefined nature. | 22 |
| Metals | 5, 10, 12, 13, 19, 20, 21, 28 |
| pH changes | 10, 12, 26 |
| Road salt | 5, 13, 15, 16, 18, 19 |
| Oil | 5, 20, 28 |
| Reduced inputs of food materials due to loss of riparian forest | 5, 13, 21, 23 |
| No specific factor identified as causing degradation | 4, 7 |

**References**

1. Booth and Jackson 1994
2. Boward et al. 1995
3. Carmichael et al. 1992
4. Kayzak 1992
5. Klein 1979
6. Reinelt and Horner 1991
7. Shaver et al. 1994
8. Steedman 1988
9. Booth and Reinelt 1993
10. Vedagiri 1989
11. Ranasinghe et al. 1994
12. Limburg and Scmidt 1990.
13. Jones and Clark 1987
14. Mangun 1988-89
15. Ehrenfeld and Schneider 1991
16. Crowther and Hynes 1977
17. Yetman 1991
18. Wilcox 1986
19. Kszos et al. 1990
20. Roper et al. 1988
21. Garie and McIntosh 1986
22. Hartwell et al. 1995
23. Pedersen and Perkins 1986
24. Richards and Host 1994
25. Weaver and Garman 1994
26. Hicks and Larson, 1997
27. Pitt and Bissonnette, 1984
28. Cooke et al. 1994

**Table 3: DEIS Sections in Which Specific Land Development Impacts Were Addressed**

| Specific Factor Causing Significant Degradation | DEIS Section Where Impact Was Addressed |
|---|---|
| Sediment released from construction sites and road surfaces | 4.4.1.4 |
| Hydrologic and habitat modifications | 4.4.2 and 4.6.2.2 |
| Loss of recharge; diminished groundwater inflow to streams and wetlands | |
| High fluctuations in water level | |
| Erosion/scour due to increased flood flows | |
| Elevated water temperature due to reduced riparian shading | 4.4.2 and 4.6.2.2 |
| Thermal impact of runoff from heated impervious areas | |
| Organic pollution (sewage, other oxygen demand) | |
| Dissolved oxygen deficiency | |
| Elevated nutrient inputs | 4.4.1.2 and 4.4.1.3 |
| Toxicity of an undefined nature. | |
| Metals | 4.4.1.2 |
| pH changes | |
| Road salt | 4.4.1.2 and 4.4.1.3 |
| Oil | |
| Reduced inputs of food materials due to loss of riparian forest | 4.4.2 and 4.6.2.2 |

DEIS Table 4.4-3 presents the results of an analysis of chloride concentrations in receiving waters. Unfortunately, the analysis shows *average* concentrations, not the three-year *maximums* required by U.S. Environmental Protection Agency (EPA) guidance on evaluating acute chloride toxicity in freshwater aquatic systems.[3]

The scientific literature shows that chloride concentrations in runoff from salt treated roads can reach 17,200 mg/l (Cherkauer and Ostenso 1976). Therefore, the analysis presented in the DEIS failed to determine if road salt washed from the widened I-93 will create conditions toxic to aquatic organisms inhabiting the streams, wetlands, lakes and ponds impacted by the project. Since the project would double the impervious area requiring road salt applications it seems logical to assume that road salt releases into receiving waters would double. This could also double the extent of streams, wetlands, lakes and ponds exposed to toxic chloride levels.

**Phosphorus:** A fairly detailed analysis of phosphorus loadings was presented in Section 4.4.1.2 of the DEIS.

On page 4-28 of the DEIS the following text appears:

> *For each of the project alternatives, a total phosphorus concentration of 0.4 mg/l was used, which represents the runoff concentration observed on 50 percent of the urban highways that had average daily traffic levels above 30,000 vpd (Driscoll 1990).*

Driscoll (1990) did not present 0.4 mg/l as the *total phosphorus* concentration observed on 50% of the urban highways with ADT greater than 30,000 vpd. Instead, 0.4 mg/l was the concentration for *phosphate* ($PO_4$). Driscoll presented the following total phosphorus range for highway runoff 0.113 - 0.998 mg/l or a mid-point value of 0.556 mg/l. In other words, the DEIS phosphorus load analysis used the wrong concentration; one which is 28% lower than the correct value. This is the first serious flaw in the phosphorus loading analysis presented in the DEIS.

It was assumed that proposed extended-detention ponds would remove 60% of the phosphorus entrained in I-93 runoff. It was also assumed that grass swales would remove 40% of the phosphorus in runoff conveyed along these channels. The DEIS references a 1996 New Hampshire Department of Environmental Services (NHDES 1996) publication as the source for these removal rates.

Since the NHDES document was released in 1996, a more thorough analysis of stormwater pollutant removal rates was published by the Center for Watershed Protection (Winer 2000). The CWP document was based upon a review of all the reliable studies of stormwater facility pollutant removal rates. It shows that extended-detention ponds remove 20% to 55% of

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[3] See *Ambient Aquatic Life Water Quality Criteria for Chloride-1988* available for download at http://www.epa.gov/ost/pc/ambientwqc/chloride1988.pdf

the total phosphorus load; not the 60% claimed in the DEIS. The CWP document also shows that grass swales remove 29% of the phosphorus load; not the 40% claimed in the DEIS.

In the DEIS it was assumed that the erroneous phosphorus removal efficiencies would apply to 100% of the runoff. But the extended-detention ponds will only provide water quality treatment for the first half-inch of runoff. CEDS analyzed precipitation records for the Manchester station covering the period of 1948-1999. This analysis showed that 71% of all impervious runoff would be treated with a facility designed for the first half-inch of runoff.

In summary, the proposed extended-detention ponds and grass swales will not remove 60% and 40% of the phosphorus load. Instead 20%-55% of the phosphorus will be removed from 71% of the runoff from the widened I-93. In other words, the facilities will remove 14%-39% of the phosphorus load. The portion of the DEIS addressing phosphorus impacts to downstream waters should be revised using more realistic assumptions.

Road salt and phosphorus are just two of the many pollutants entrained in highway runoff. The DEIS cited a study by Driscoll (1990) as being the source of the phosphorus concentration used in estimating I-93 loads. Table 4a and 4b, from Barrett et al. 1995, is based on Driscoll (1990). These two tables show that road salt (chloride) and phosphorus are just two of many pollutants present in highway runoff. A number of these pollutants are quite toxic to aquatic organisms. Yet the DEIS only dealt in detail with chloride and phosphorus. This is another serious flaw in the DEIS.

**Thermal Impacts**

While the DEIS did contain a discussion of the thermal effects of riparian canopy removal, no mention was made of heated water discharged from the proposed extended-detention ponds. The lethal temperature for brook and brown trout is 72°F and 75°F, respectively (Galli 1990).

Streams draining developed watersheds average a water temperature 8°F to 10°F warmer than rural waterways (Pluhowski 1970; Galli 1990). Part of the elevated temperature is due to the loss of shade along streams. Another part is due to heated stormwater runoff from road surfaces

During a sunny, summer day a road surface can heat to a high temperature. When rain falls on the road heat is transferred to runoff. The temperature of summer road runoff can range from 80°F to 85°F (Bahr 1996; Galli 1990; Yetman 1991). The widening of I-93 would double the amount of road surface generating heated runoff to the trout waters impacted by the project. The mileage of trout waters degraded by existing heated I-93 runoff could double if the project is built as proposed. This impact was not addressed in the DEIS.

**Table 4a: Constituents of Highway Runoff** ***(Source Barrett et al. 1995)***

| Constituent | Concentration (mg/L unless indicated) | Load (kg/ha/year) | Load (kg/ha/event) |
|---|---|---|---|
| **SOLIDS** | | | |
| Total | 437 - 1147 | | 58.2 |
| Dissolved | 356 | 148 | |
| Suspended | 45 - 798 | 314 - 11,862 | 1.84 - 107.6 |
| Volatile, dissolved | 131 | | |
| Volatile, suspended | 4.3 - 79 | 45 - 961 | .89 - 28.4 |
| Volatile, total | 57 - 242 | 179 - 2518 | 10.5 |
| **METALS** (totals) | | | |
| Zn | .056 - .929 | .22 - 10.40 | .004 - .025 |
| Cd | ND - .04 | .0072 - .037 | .002 |
| As | .058 | | |
| Ni | .053 | .07 | |
| Cu | .022 - 7.033 | .030 - 4.67 | .0063 |
| Fe | 2.429 - 10.3 | 4.37 - 28.81 | .56 |
| Pb | .073 - 1.78 | .08 - 21.2 | .008 - .22 |
| Cr | ND - .04 | .012 - 0.10 | .0031 |
| Mg | 1.062 | | |
| Hg, x $10^{-3}$ | 3.22 | .007 | .0007 |
| **NUTRIENTS** | | | |
| Ammonia, total as N | .07 - .22 | 1.03 - 4.60 | |
| Nitrite, total as N | .013 - .25 | | |
| Nitrate, total as N | .306 - 1.4 | | |
| Nitrite + nitrate | 0.15 - 1.636 | .8 - 8.00 | .078 |
| Organic, total as N | .965 - 2.3 | | |
| TKN | 0.335 - 55.0 | 1.66 - 31.95 | .17 |
| Nitrogen, total as N | 4.1 | 9.80 | .02 - .32 |
| Phosphorus, total as P | .113 - 0.998 | .6 - 8.23 | |

**Table 4b: Constituents of Highway Runoff** *(Source: Barrett et al. 1995)*

| Constituent | Concentration (mg/L unless indicated) | Load (kg/ha/year) | Load (kg/ha/event) |
|---|---|---|---|
| **MISCELLANEOUS** | | | |
| Total coliforms organisms/100 mL | 570 - 6200 | | |
| Fecal coliforms organisms/100 mL | 50 - 590 | | |
| Sodium | | 1.95 | |
| Chloride | | 4.63 - 1344 | |
| pH | 7.1 - 7.2 | | |
| Total Organic Carbon | 24 - 77 | 31.3 - 342.1 | .88 - 2.35 |
| Chemical Oxygen Demand | 14.7 - 272 | 128 - 3868 | 2.90 - 66.9 |
| Biological Oxygen Demand (five day) | 12.7 - 37 | 30.60 - 164 | 0.98 |
| Polyaromatic Hydrocarbon (PAH) | | .005 - .018 | |
| Oil and Grease | 2.7 - 27 | 4.85 - 767 | .09 - .16 |
| Specific conductance (µS at 25 C) | 337-500 | | |
| Turbidity (JTU) | 84 - 127 | | |
| Turbidity (NTU) | 19 | | |

Table 4.4-1 indicates that 52 extended-detention stormwater management basins would be constructed as part of the I-93 widening. Several studies have shown that while stormwater resides in an extended-detention pond, such as those proposed for the I-93 project, it will adjust to the temperature of air overlying the water surface (Galli 1990 and 1992; Bahr 1996; Hicks and Larson 1997). If the overlying air temperature is in the 80-90°F range then the water sitting in the pond will adjust to 80-90°F.

The proposed extended-detention ponds will discharge into a number of streams supporting trout. During the summer months the temperature of the discharge will be well in excess of the lethal temperature range for trout. Again, this issue was not addressed in the DEIS.

**Induced Growth**

Table 4.12-4, on page 4-160 of the DEIS, shows that the proposed widening of I-93 would induce 19, 356 acres of residential development which would otherwise not occur.

Assuming an average lot-size of one-acre, which would be 20% impervious[4], this would mean an additional 3,871 acres of impervious area. In a September 5, 2002 letter to Commissioner Carol Murray, of the New Hampshire Department of Transportation, EPA Regional Administrator Robert Varney put the induced growth figure in the range of 50,000- to 100,000-acres. The additional impervious area attributable to induced growth could be as high as 20,000 acres.

DEIS Table 4.4.1 shows that the existing roadway area is 283 acres. If I-93 is widened as proposed then another 300 acres of roadway will be created. Thus the impervious area created by widening I-93 is only 8% of that created by the induced growth caused by the project. This much larger impervious area was not factored into the analysis of aquatic resource impacts presented in the DEIS. Obviously, the cumulative aquatic resource impacts of I-93 widening plus induced growth is far greater - by a factor of 13 to 67 - compared to that of just of adding four lanes. In other words, loadings of road salt, heated runoff and other pollutants could be 13- to 67 times greater than presented in the DEIS. This is a very serious flaw in the DEIS.

**MTBE**

DEIS Table 1.1-1 indicates that widening of I-93 would allow traffic volume to increase by about 30% by the year 2020. The DEIS lacks a discussion of how this action would affect the likelihood of a hazardous material spill into the affected waterways.

Of greatest concern would be the spill of a contaminant into Canobie Lake, which is the primary water supply for Salem. For example, gasoline sold in the area is treated with methyl tertiary butyl ether (MTBE). One gallon of MTBE treated gasoline can contaminate four million gallons of drinking water (Kiner 2001). The DEIS states that Canobie Lake has a surface area of

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[4] An imperviousness of 20% for a one-acre lot is based upon Table 2-2a in *Urban hydrology for small watersheds* (SCS, 1986).

373 acres and a maximum depth of 44 feet. Assuming an average depth of 20 feet then the lake has a volume of 2.4 billion gallons. It would take just 608 gallons of MTBE treated gasoline to contaminate the entire lake. A single tanker truck carries 10,000 of gasoline. An accident in which a sports utility vehicle tank ruptures could release 28 gallons, enough gasoline to contaminate 5% of Canobie Lake.

Canobie Lake is, of course, not the only water body threatened by an increased risk of MTBE contamination should the widening occur. Obviously, this is one of the more serious potential impacts of widening I-93 and allowing traffic volume to increase within the watershed of Canobie Lake and other important aquatic resources. That the DEIS is virtually silent on this issue is a very serious flaw.

**PAH**

A study of lakes throughout the United States found a relationship between traffic volume and the concentration of polycyclic aromatic hydrocarbons (PAH) in bottom sediments (Van Metre et al. 2000). The authors expressed serious concern about the level of PAH in the lakes and water quality. The DEIS made no mention of this issue.

**REFERENCES**

Bahr, R.P., 1996. A temperature study of discharges from three extended detention/wetland stormwater management basins in Maryland. Chesapeake Biological Laboratory, University of Maryland, Solomons, MD 20688.

Benke, A.C., G.E. Willeke, F.K. Parrish, and D.L. Stites, 1981. Effects of urbanization on stream ecosystems. Environmental Resources Center, Georgia Institute of Technology, Atlanta, GA 30332.

Booth D.B. and C.R. Jackson. 1994. Urbanization of aquatic systems - degradation thresholds and the limits of mitigation. Proceedings Annual Summer Symposium of the American Water Resources Association - Effects of Human-Induced Changes on Hydrologic Systems, pp 425-434.

Booth D.B. and L.E. Reinelt. 1993 Consequences of urbanization on aquatic systems - measured effects, degradation thresholds, and corrective strategies. *Proceedings Watershed 93 - A National Conference on Watershed Management*, pp. 545-550.

Boward, D. and M. Hurd. 1996. DRAFT Evaluation of Maryland's benthic rapid bioassessment program: Relationships between cumulative land use impacts and non-tidal stream ecological conditions. Resource Assessment Service, Maryland Department of Natural Resources, Tawes State Office Building, Annapolis, MD 21401.

Boward, D., P. Kayzak, S. Stanko, M. Hurd, and A. Prochaska, 1999. From the mountains to the Sea: The state of Maryland's freshwater streams. Maryland Department of Natural Resources, Tawes State Office Building, Annapolis, MD 21401.

Carmichael, J.T., B.M. Richardson, M. Roberts, and S.J. Jordan, 1992. Fish assemblages and dissolved oxygen trends in eight Chesapeake Bay tributaries during the summers of 1989 - 1991: A data report. Chesapeake Bay Research and Monitoring Division, Maryland Department of Natural Resources, Tawes State Officer Building, Annapolis, MD 21401.

Cherkauer, D.S. and N. A. Ostenso, 1976. The effect of salt on small, artificial lakes. Water Resources Bulletin 12(6):1259-1266.

Cooke, T., D. Drury, R. Katznelson, C. Lee, P. Mangarella, and K. Whiteman, 1994. Storm water NPDES monitoring in Santa Clara Valley. In: Proceedings of an Engineering Foundation Conference - Stormwater NPDES Related Monitoring Needs, American Society of Civil Engineers, 345 East 47th Street, New York, NY 10017-2398.

Crowther, R.A. and H.B.N. Hynes, 1977. The effect of road deicing salt on the drift of stream benthos. Environmental Pollution 14:113-126.

Driscoll, E.D., Shelley, P.E., and Strecker, E.W., 1990a, Pollutant Loadings and Impacts from Highway Stormwater Runoff, Vol. I: Design Procedure, Federal Highway Administration, Office of Research and Development Report No. FHWA-RD-88-006.

Ehrenfeld, J.G. and J.P. Schneider, 1991. *Chamaecyparis thyoides* wetlands and sururbanization effects on hydrology, water quality and plant community composition. Journal of Applied Ecology 28:467-490.

Galli, J. Department of Environmental Programs, Metropolitan Washington Council of Governments, 777 North Capitol Street, N.E., Washington, D.C. 20002. (202) 962-3200

1990. Thermal impacts associated with urbanization and stormwater management best practices.

1992. Analysis of urban BMP performance and longevity in Prince George's County, Maryland: Final report.

Garie, H.L. and A. McIntosh, 1986. Distribution of benthic macroinvertebrates in a stream exposed to urban runoff. Water Resources Bulletin 22(3):447-455.

Hartwell, S.I., C.E. Dawson, E.Q. Durell, D.H. Jordahl, S.J. Jordan, M.R. McGinty, A.S. Ives, D.A. Randle, B.S. Rodney, R.W. Alden, P.C. Adolphson, D.A. Wright, G.M. Coelho, J.A. McGee, M.S. Illstock, and C.M. Norman, 1995. Integrated measures of ambient toxicity and fish community diversity. Chesapeake Bay Research and Monitoring Division, Maryland Department of Natural Resources, Tawes State Officer Building, Annapolis, MD 21401.

Hicks, A.L. and J.S. Larson. 1997. Aquatic invertebrates as an index for estimating the impacts of urbanization on freshwater wetlands. The Environmental Institute, University of Amherst, MA. Report submitted to U.S. Environmental Protection Agency, Corvallis, OR.

Jones, R.C. and C.C. Clark, 1987. Impact of watershed urbanization on stream insect communities. Water Resources Bulletin 23(6):1047-1055.

Kazyak, P.F., 1992. Assessment of the relationship between land use patterns and biotic indices in the Gwynns Falls watershed. Maryland Save Our Streams, 258 Scotts Manor Drive, Glen Burnie, MD 21061.

Kiner, N.E. 2001. Fate, Transport and Remediation of MTBE. Civil/Environmental Engineering, University of New Hampshire, Durham, NH.

Klein, R.D., 1979. Urbanization and stream quality impairment. Water Resources Bulletin 15(4):948-963.

Kszos, L.A., J.D. Winter, and T.A. Storch, 1990. Toxicity of Chautauqua Lake bridge runoff to young-of-the-year sunfish *(Lepomis macrochirus)*. Bulletin of Environmental Contamination & Toxicology 45:923-930.

Limburg, K.E. and R.E. Schmidt, 1990. Patterns of fish spawning in Hudson River tributaries: Response to an urban gradient. Ecology 71(4):1238-1245.

Mangun, W.R., 1989. A comparison of five northern Virginia watersheds in contrasting land use patterns. Journal of Environmental Systems 18(2):133-151.

May, C.W., E.B. Welch, R.R. Horner, J.R. Karr, and B.W. Mar, 1997. Quality indices for urbanization effects in Puget Sound lowland streams. Department of Civil Engineering, University of Washington, Box 352700, Seattle, WA 98195-2700.

NHDES 1996. Best Management Practices for Urban Stormwater Runoff. Prepared by Water Supply and Pollution Control Division, New Hampshire Department of Environmental Services, 6 Hazen Drive, Concord, NH 03302-0095

Pedersen, E.R. and M.A. Perkins, 1986. The use of benthic invertebrate data for evaluating impacts of urban runoff. Hydrobiologica 139:13-22.

Pitt, R. And P. Bissonnette, 1984. Bellevue Urban Runoff Program Summary Report, Storm and Surface Water Utility, City of Bellevue, Washington.

Pluhowski, E.J., 1970. Urbanization and its effects on the temperature of the streams of Long Island, New York. U.S. Geological Survey Professional Paper 627-D, Reston, VA.

Ranasinghe, J.A., S.B. Weisburg, J. Gerritsen, and D.M. Dauer, 1994. Assessment of Chesapeake Bay benthic macroinvertebrate resource condition in relation to water quality and watershed stressors. Tidewater Administration, Maryland Department of Natural Resources, Annapolis, MD 21401.

Reinelt, L.E. and R.R. Horner, 1991. Urban storm water impacts on the hydrology and water quality of palustrine wetlands in the Puget Sound region. In: Puget Sound Research '91 Proceedings, Puget Sound Water Quality Authority, Vol. 1, pp. 33-42.

Richards, C. And G. Host, 1994. Examining land use influences on stream habitats and macroinvertebrates: A GIS approach. Water Resources Bulletin 30(4):729-738.

Roper, D.S., S.F. Thrush, and D.G. Smith, 1988. The influence of runoff on intertidal mudflat benthic communities. Marine Environmental Research 26:1-18.

Roth, N.E., M.T. Southerland, G. Mercurio, J.C. Chaillou, P.F. Kazyak, S.S. Stranko, A.P. Prochaska, D.G. Heimbuch, and J.C. Seibel, 1999. State of the Streams: 1995-1997 Maryland Biological Stream Survey Results. Maryland Biological Stream Survey, Department of Natural Resources, Tawes State Office Building, 580 Taylor Avenue, Annapolis, Md 21401 Available for download at: http://www.dnr.state.md.us/streams/pubs/ea-99-6.pdf

Schueler, T.R. and J. Galli, 1992. Environmental impacts of stormwater ponds. In Watershed Restoration Sourcebook, Metropolitan Washington Council of Governments, 777 North Capitol Street, N.E., Washington, D.C. 20002.

SCS, 1986. Urban hydrology for small watersheds. Technical Release 55, U.S. Soil Conservation Service, Post Office Box 2890, Washington, D.C. 20013.

Shaver, E., J. Maxted, G. Curtis, and D. Carter. 1994. Watershed protection using an integrated approach. Delaware Department of Natural Resources and Environmental Control.

Steedman, R.J. 1988. Modification and assessment of an index of biotic integrity to quantify stream quality in southern Ontario. Canadian Journal of Fisheries & Aquatic Sciences 45:492-501.

Van Metre, P., B. Mahler and E. Furlong. 2000. Urban sprawl leaves its PAH signature. *Environmental Science Technology*. 34(19): 4064-4070.

Vedagiri, U. 1989. Behaviour of lead in pristine and urbanized acid wetlands in the New Jersey Pinelands with special reference to the role of Sphagnum moss. Doctoral thesis. Graduate School - New Brunswick, Rutgers, The State University of New Jersey.

Weaver, L.A. and G.C. Garman, 1994. Urbanization of a watershed and historical changes in a stream fish assemblage. Transactions of the American Fisheries Society 123:162-172.

Wilcox, D.A., 1986. The effects of deicing salts on vegetation in Pinhook Bog, Indiana. Canadian Journal of Botany 64:865-874.

Winer, R., 2000. National Pollutant Removal Performance Database for Stormwater Best Management Practices, 2nd Edition. Center for Watershed Protection, 8391 Main Street, Ellicott City, MD 21043. (410) 461-8323.

Yetman, K., 1991. Study of non-point source thermal pollution in Jabez Branch. Power Plant & Environmental Review Division, Maryland Tidewater Administration, Annapolis, MD 21401.

# COMMUNITY & ENVIRONMENTAL DEFENSE SERVICES

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## QUALIFICATIONS LAND DEVELOPMENT IMPACTS UPON AQUATIC SYSTEMS

**RICHARD D. KLEIN**

### EMPLOYMENT HISTORY

**COMMUNITY & ENVIRONMENTAL DEFENSE SERVICES**

| | | |
|---|---|---|
| 1987-Present | | President |

**MARYLAND DEPARTMENT OF NATURAL RESOURCES**

| | | |
|---|---|---|
| 1977-1987 | Save Our Streams Program | Conservation Associate<br>Natural Resources Manager |
| 1973-1977 | Water Quality Services Division | Conservation Associate |
| 1969-1973 | Anadromous Fish & Stream Survey Project | Conservation Aide<br>Conservation Associate |

### EXPERT TESTIMONY ON THE EFFECTS OF LAND DEVELOPMENT UPON AQUATIC SYSTEMS

Though I am not certified as a biologist, chemist, engineer, or any other specific professional classification, my 30 years of experience in evaluating the effects of land development upon aquatic systems has allowed me to qualify as an expert in circuit court, the Maryland Court of Special Appeals, and the following administrative bodies:

| Decision-Making Body | Case |
|---|---|
| Anne Arundel Co., MD | |
| Board of Appeals | Back Bay Beach Project |
| | Chesapeake Terrace Rubble Landfill |
| | Woods Landing II |
| Baltimore Co., MD | |
| Board of Appeals | Eck Property |
| | Georges Transfer |
| | Greystone Golf Course |
| | Villa Julie College |

| | |
|---|---|
| Baltimore Co, MD *continued* | |
| Zoning Commissioner/Hearing Officer | Bridle Ridge |
| | Glyndon Meadows |
| Glyn Garth | Greystone Golf Course |
| | Honeygo Rubble Landfill |
| | Locksley Conserve |
| | Magers Landing |
| Cecil Co., MD | |
| Board of Appeals | Old Line Village |
| Charles Co., MD | |
| Board of Appeals | St. Peters Church mining site |
| Board of County Commissioners | Chapmans Landing |
| District of Columbia | |
| Zoning Commission | Arkenderry Mews |
| Dorchester Co., MD | |
| Board of Appeals | Hunting Creek rubble landfill |
| Howard Co., MD | |
| Board of Appeals | Greenwood Place |
| | Prince Property |
| Planning Board | Covenant Baptist Church |
| Kent Co., MD | |
| Board of Appeals | Eastern Shore Bible Church |
| Planning Board | Eastern Shore Bible Church |
| | Bramble Contractor Yard |
| King George Co., VA | |
| Board of Supervisors | Hopyard Farm |
| Circuit Court | Guest et al v. Board of Supervisors |
| Department of Environmental Quality | King George landfill |
| King County, WA | |
| Hearing Examiner | Beaver Lake Estates II |
| | Bordeaux at Beaver Crest |
| | Greens At Beaver Crest |
| | Norris Estates |
| Louisa Co., VA | |
| Board of Supervisors | Edgemar Rezoning Request |
| Martha’s Vineyard Commission, MA | Meeting House Golf Club |
| Maryland Office of Administrative Hearings | Villa Julie College |
| Maryland Wetlands Administration | Baldwins Choice |
| | Riddle Farm |
| Montgomery Co., MD | |
| Planning Board | Marriott/Milestone Project |
| | Residences at Great Falls |

| | |
|---|---|
| Zoning Hearing Examiner | VanGrack/McNeil Project |
| | Miller Property |
| Prince George's Co., MD | |
| Planning Board | The Woodlands Project |
| | Schelford North Farm |
| Zoning Hearing Examiner | Cross Road Trail rubble landfill |
| | Villages of Belmont |
| Prince William Co., VA | |
| Planning Board | Waverley |
| Queen Anne' County, MD | |
| Board of Appeals | Days Cove Rubble Landfill |
| Board of County Commissioners | Rubble landfill zoning text amendments |
| Planning Board | Rubble landfill zoning text amendments |
| Saint Mary's Co., MD | |
| Board of Appeals | Cedar Cove Marina Boatel |
| | Persimmon Rubble Landfill |
| | Renie Quade Property |
| Board of County Commissioners | County solid waste plan |
| | First Colony |
| Planning Commission | First Colony |
| | Willowbrook |
| Tinicum Township, PA | |
| Board of Supervisors | Quarry Valley Country Club |
| Worcester Co., MD | |
| Board of Appeals | Captains Pointe |
| Board of County Commissioners | Captains Pointe |
| | Lighthouse Sound |

## EDUCATION

In 1973, I began pursuing a degree in environmental science so I could engage in professional level work within the Department of Natural Resources (DNR). After completing my first year of college it became apparent that DNR would permit me to perform professional level work regardless of academic credentials. At that point I elected to expand my knowledge of environmental science through independent study and the training provided through the Department. I did not complete a degree program.

## EXPERTISE GAINED THROUGH EXPERIENCE & OBSERVATION

### TRAINING

While working under the supervision of DNR chemists, biologists, engineers, and other professionals, I acquired expertise in a wide range of methods for assessing the physical, chemical, and biological characteristics of aquatic systems. These systems included freshwater streams and rivers, ponds, lakes, reservoirs, wetlands, tidal waters, and groundwater. Following is a summary of the specific assessment methods I learned how to employ:

- Collection of water samples for chemical and bacteriological analysis; operation of various water quality meters including those designed to measure dissolved oxygen, stream flow, tidal currents, specific conductance, turbidity, pH, chlorine, chloride, fluorescence, and water/air temperature. I also learned how to operate weather monitoring equipment, well sampling equipment, data loggers and recorders, and robot water quality monitors. I spent several months analyzing water samples for chemical and bacteriological parameters in the DNR laboratory.

- I was instructed in procedures for surveying streams, rivers, tidal waters, and lakes for factors which may effect fishery resources. These factors included pollution, discharges, stormwater runoff, erosion and sedimentation problems, fish migration barriers, sources of thermal pollution, stream shade and buffer deficiencies, livestock grazing effects and other agricultural impacts, construction site impacts, physical destruction of aquatic habitat, and a number of other factors. I employed these procedures in surveying nearly a thousand miles of Maryland streams, rivers, tidal waters and impoundments.

- I was also instructed in procedures for collecting and identifying fish, aquatic insects, crustaceans, aquatic plants (including algae), shellfish, and other aquatic organisms. I was taught how to assess the condition of individual organisms and to use aquatic communities to assess the health and condition of streams, lakes, tidal waters, and other aquatic systems.

- I learned how to study groundwater systems through monitoring wells and other methods. My responsibilities included sampling monitoring wells at landfills, sewage sludge disposal sites, wastewater treatment facilities, and other locations.

- I was also instructed on proper procedures for designing and conducting various studies of aquatic systems. This included sampling station selection, quality control/quality assurance, data analysis, and interpretation of data results based upon Maryland water quality standards and various other criteria. I was also instructed on the preparation of reports on the findings of studies of aquatic systems.

**PROFESSIONAL RESEARCH & ACTIVITIES-DNR**

While I was with the Water Quality Services Division I studied the quality of stormwater runoff from developed lands. This experience included sample collection, laboratory analysis, study design, and interpretation of the results. In 1978, I conducted my first independent professional study, which focused on the relationships between land development and the health of aquatic systems. The paper addressed the effect of land development upon groundwater recharge and base flow, water temperature, pollutant loadings, channel erosion, and the overall relationship between percent impervious area and the health of fish and macroinvertebrate communities. The results of my study were published in the scientific journal *Water Resources Bulletin* (15(4):936-

952) under the title of *Urbanization and Stream Quality Impairment*. This paper serves as the primary basis for percent impervious area limits found in the Maryland Chesapeake Bay Critical Areas law and many local land use laws. My paper also served as one of the primary justifications for the two-acre lot exemption contained in the Maryland Stormwater Management regulations.

I developed a method for quickly assessing the health of freshwater streams and rivers using aquatic insects, crustaceans, and other macroinvertebrates.

I managed 15 major DNR investigations of the effects of developed lands upon the quality of aquatic systems. These investigations utilized the macroinvertebrate assessment technique I developed.

I designed and managed a study of the effects of Savage River Reservoir upon the Savage River, in Garrett County, Maryland. The study was designed to assess the effects of the reservoir upon channel morphology (stream bed particle size distribution, channel width and depth), base flow, water depth and velocity distributions, and various facets of stream ecology, including effects upon aquatic insects, crustaceans, and fishery resources. I interpreted the data generated through the study and prepared the report of findings.

I conducted a study of the effects of Prettyboy and Loch Raven Reservoirs upon the temperature, chemistry, aquatic insects, and fishery resources of Big Gunpowder Falls.

I conducted studies of the temperature regime of streams and the effects of the following factors upon stream temperature: stormwater runoff from developed lands, absence of shading vegetation, effects of varying amounts of shade upon stream temperature, discharges of heated water from industrial activities, and impoundment effects.

I conducted a study of fish migration barriers formed by highway crossings in Maryland.

I managed a study of the effects of existing stormwater management ponds and lakes upon stream channel erosion. The study was carried out by DNR staff under my supervision.

I developed a program for training citizens to evaluate the quality of erosion and sediment control measures on construction sites. I supervised a number of large citizen inventories of erosion and sediment control quality at the county and watershed level.

I developed and managed the Gwynns Falls Restoration Campaign. This was the first attempt to restore a degraded suburban-urban stream in Maryland. It was a joint project of Baltimore County, the City of Baltimore, and the Maryland Department of Natural Resources. My duties included developing a watershed restoration plan, overseeing a $100,000 study to establish "before" conditions in the stream system, and managing the staff assigned to the project. I chaired the joint city, county, and DNR committee overseeing the campaign.

I was the author of the DNR handbooks entitled *The Preservation & Enhancement of Stream Quality* and *The Restoration of Urban Streams*. I also wrote DNR publications on the use of the Universal Soil Loss Equation and Manning's equation for calculating land development effects upon flood water volumes.

I designed and supervised the installation of eight stormwater infiltration structures. These were the first stormwater infiltration structures installed in an existing developed area in Maryland.

I compiled a review for DNR of the scientific literature of the effects of sediment pollution from agriculture, logging, mining, and construction activity upon aquatic systems.

I compiled another review of scientific literature for DNR entitled Effects of Urbanization Upon Aquatic Resources.

I was assigned the responsibility by DNR's Tidewater Administration to develop habitat protection criteria for all of Maryland's fish and shellfish resources. This responsibility included review of the scientific literature as well as coordinating research conducted by most of the agency's other professional staff. The criteria covered physical habitat requirements along with temperature preferences and the lethal-sublethal effects of temperature, toxic substances, and all other environmental contaminants.

**PROFESSIONAL RESEARCH & ACTIVITIES: CEDS**

Since starting Community & Environmental Defense Services (CEDS) in 1987, I have evaluated the environmental effects of thousands of land development projects. Though most of these evaluations were performed at the request of citizen organizations, my clients have included development companies as well as local and state government.

I prepared watershed management plans for the following Maryland waterways: Cuckold Creek, Middle River, Town Creek, and the Saint Mary's River. Much of the plans are devoted to the effects of current and future watershed development.

In 1990, I conducted a survey of 90 construction sites in the Chesapeake Bay watershed on behalf of the Chesapeake Bay Foundation. The purpose of the survey was to assess erosion and sediment control quality along with stormwater management measures. The results of the survey were presented in a book entitled *Turning The Tide* (Island Press).

Methods for assessing and minimizing the effects of land development upon aquatic systems were included in my book, *Everybody Wins: A Citizen's Guide to Development*, which is published by the American Planning Association.

I prepared a guidance publication entitled *Protecting The Aquatic Environment From The Effects of Golf Courses*. The publication begins with a review of a study I conducted of 11 golf courses in Maryland and Pennsylvania. Next, the scientific literature regarding the environmental effects of golf courses in reviewed. I then presented a number of recommendations for siting, designing, and managing golf courses to enhance the aquatic environment. The findings presented in my publication were cited in a literature review commissioned by the U.S. Golf Association, *Environmental Issues Related to Golf Course Construction and Management*. I wrote a chapter in the second edition of *Handbook of Integrated Pest Management for Turf and Ornamentals*, which is published by the U.S. Environmental Protection Agency. The chapter is entitled Siting and Design Considerations to Enhance the Environmental Benefits of Golf Courses. The chapter is based upon my publication *Protecting the Aquatic Environment From The Effects of Golf Courses*. I presented by findings at a 1991 conference sponsored by the U.S. Golf Association and the Golf Course Superintendents Association of America. I also presented a paper at the 1991 New York State Turfgrass Conference and the 1991 conference on golf courses held in Honolulu, Hawaii. A paper I wrote appeared in the March/April 1991 issue of the Green Section Record, which is published by the U.S. Golf Association. In 1991, I was retained by the Office of State Planning, State of Hawaii, to evaluate the potential environmental effects of three golf courses proposed for construction on the island of Oahu. I have conducted assessments of more that one hundred golf courses located throughout the United States.

I conducted a review of the scientific literature regarding the effects of boating activity and boating facilities upon the aquatic environment. The results of this review were presented in my publication *The Effects of Boating Activity & Related Facilities Upon Tidal Creeks*. Recommendations contained in this publication were incorporated into a U.S. EPA guidance document entitled *Guidance specifying management measures for sources of nonpoint pollution in coastal waters*. The State of Maryland also adopted my recommendations as part of the marina regulations administered by the Tidal Wetlands Division of the Department of the Environment.

## PROFESSIONAL COMMITTEES

I served as the County Executive's representative on the Baltimore County Soil Conservation District.

I served as a representative of the Department of Natural Resources on:

- the 208 Technical Advisory Committee which oversaw the Nationwide Urban Runoff Project administered by the former Baltimore Regional Planning Council.
- the subcommittee of the General Assembly that drafted the Maryland Stormwater Management Act.
- the Instream Flow Committee of the Interstate Commission on the Potomac River Basin.
- I served on the Acid-Rain Task Force convened by Trout Unlimited.

I served on the Golf and Environment Roundtable convened by the National Golf Foundation, the U.S. Golf Association other national golfing organizations, and a number of national environmental organizations.

I served on two committees formed by the Maryland Department of the Environment-the Solid Waste Accord and the Rubble Landfill Workgroup .

## HONORS & AWARDS

Environmental Excellence Award - Maryland Department of the Environment.
Maryland Governor Schaefer's Salute To Excellence.
Outstanding Conservationist; Maryland State Game & Fish Protective Association.
Conservation Award; Izaak Walton League of America.
Certificate of Commendation; Tawes Award for a Clean Environment.
The Joe Brooks Conservation Award; Maryland Chapter - Trout Unlimited.
Outstanding Water Conservationist; Maryland Wildlife Federation.
Gurney Godfrey Award; Maryland Fly Anglers.
Certificate of Appreciation; Maryland Classified Employees Association.
Outstanding Individual; American Planning Association - Maryland Chapter.

## PUBLICATIONS

Urbanization and stream quality impairment. *Water Resources Bulletin* 15(4):948-963

*Everyone Wins: A Citizen Guide to Development*. Planners Press, American Planning Association, .Chicago, Illinois.

Siting and design considerations to enhance the environmental benefits of golf courses. In: *Handbook of Integrated Pest for Turf and Ornamentals*, edited by Anne R. Leslie, U.S. Environmental Protection Agency, Washington, D.C.

*Protecting the aquatic environment from the effects of golf courses*. Community & Environmental Defense Services, Post Office Box 206, Maryland Line, MD 21105.

Enhancing the environmental benefits of golf courses. *U.S. Golf Association Green Section Record* March/April 1991 and presented at the 1991 Golf Course Superintendents Conference in Las Vegas, Nevada.

*Effects of sediment pollution upon the aquatic environment*. Maryland Tidewater Administration, Tawes State Office Building, Annapolis, MD 21401.

*Effects of urbanization upon aquatic resources*. Maryland Tidewater Administration, Tawes State Office Building, Annapolis, MD 21401.

*The effects of boating activity and related facilities upon tidal creeks in Maryland*. Community & Environmental Defense Services, Post Office Box 206, Maryland Line, MD 21105.

*Restoration of Urban Streams* Maryland Tidewater Administration, Tawes State Office Building, Annapolis, MD 21401

*Preservation & Enhancement of Stream Quality* Maryland Tidewater Administration, Tawes State Office Building, Annapolis, MD 21401.

Numerous reports assessing the potential environmental effects of proposed development projects.