AN ANNOTATED LISTING OF REPORTS, DATA SETS, CORRESPONDENCE, AND OTHER RESOURCES PERTAINANT TO UNDERSTANDING THE UPPER ESOPUS CREEK AQUATIC ECOSYSTEM

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BACKGROUND

These sources have been compiled and reviewed to serve as a basis in helping to determine the current state of knowledge and need for additional research on the condition of aquatic ecosystem in the upper Espous Creek watershed (source to Ashokan Reservoir) in Ulster County, New York.

The Upper Esopus is in fact two rivers, divided by the inter-basin transfer of water from the Schoharie Reservoir via an ~ 18 mile sub-surface aqueduct. The outfall of the Schoharie Diversion is commonly referred to as the "portal" (see map). The portion upstream of the portal at Shandakan is essentially a natural river with the exception of the diversion in Birch Creek to provide water for snowmaking at the Belleayre Mountain Ski Area. Downstream of the portal the creek is regulated subject to discharges from Schoharie Reservoir at the other end of the aqueduct.

The annotations relate the data presented in the sources to those portions of the creek from which they were obtained as an aid in helping to determine what additional work needs to be done to understand the impacts of those discharges, specifically water temperature, turbidity and velocity.

It is recognized that this listing in not all inclusive and begs to be added to should readers offer other, pertinent information. It is, however, thought to be complete enough to provide direction in developing and conducting further work as needed.

ANNOTATED LISTING: BIOLOGICAL

Baldigo, Barry P. USGS, Troy, NY. 2006. Data generated and sent to New York City Department of Environmental Protection on CD in partial fulfillment of USGS – DEP contract titled: NYCDEP-USGS Agreement (DEL – 188): Channel Geomorphology & Biology for Stable and Unstable Streams of the Catskill Mountain Region (NYC Registration No.: CTC 82620020003708).

Biological and physical habitat sampling was done for analysis of stream restoration work in Broadstreet Hollow and Stony Clove, both entering Esopus Creek downstream of the portal. Seven transmitted tables include fish, habitat and macroinvertebrate data for control (C), reference (R) and treatment (T) reaches on Broadstreet Hollow and Stony Clove and for R reaches only on Warner Creek, tributary to Stony Clove. Population and biomass estimates are listed, by species for C, R, and T during 1999-2000 and 2002-4 for Broadstreet Hollow and

2002-3 for Stony Clove along with community summaries of species richness. Population and biomass estimates are given for the fishes of the 2 Warner Creek R for 2002 and 2004. Fish population and biomass estimates/area are included for 10 R in the New York City West of Hudson watershed (WOH) for 2004. Average and overall characteristics of C, R and T are listed for Broadstreet Hollow for 2002 and 2004 and Stony Clove for 2002 and 2004 including an additional R during 2003. Average and overall characteristics are described for Warner Creek, 2002 and 2004. Average habitat suitability variables (17) Are listed for Broadstreet Hollow, Stony Clove and Warner Hollow R for 2002 and 2004. Significant correlations among habitat variables numbering 6, are listed for 10 R in the WOH for 2002 and again for 9 R streams with an outlier excluded from the analysis, increasing the correlations to 8. Marcoinvertebrate data, including abundance, richness and diversity/evenness measures, community and functional group composition, biotic indices and Karr BIBI and NYSDEC PMA metrics are listed for C, R and T for Broadstreet Hollow for 2002 - 2004 and Stony Clove for 2002 and2003. Macroinvertebrate data for both Warner Creek R included species, EPT, Ephemeroptera, Plecoptera and Trichoptera and intolerant taxa richness, percents of those and functional groups (6 plus unclassified), 4 indices, weighted and weighted average fine sediment biotic indices for 2002 and 2004. Pearson correlation coefficients relating fish community metrics to habitat variables at 10 WOH stream R are given for 2002 and again for 2002 for 9 R streams after R outlier was removed.

Baldigo, B. P., A. S. Gallagher-Ernst, W. Keller, D. R. Warren, S. J. Miller, D. Davis, T. P. Baudanza, D. DeKoskie, and J. R. Buchanan. 2006. Restoring geomorphic stability and biodiversity in streams of the Catskill Mountains, New York, USA. Pages 587-600 in Proceedings of 4th World Fisheries Congress, Reconciling Fisheries with Conservation: The Challenge of Managing Aquatic Ecosystems. American Fisheries Society, Vancouver, B. C., Canada.

Reports on natural channel design stream channel restoration impacts on fish populations in treatment reaches of 3 streams including Broadstreet Hollow Brook (BSH) which enters Esopus Creek downstream of the portal. Findings from BSH fish surveys during 1999-2000 and 2002-2003 show significant increases in mean community density, 0.91 fish /m2, and biomass, 14.34 g/m2, at the treatment reach after restoration. "The observed responses indicate that fish communities were affected by the restorations, and by normal year-to-year variations in uncontrolled factors such as temperature, precipitation, and stream discharge." BSH responses of community richness and equitability were not significant.

Baldigo, B. P. and D. R. Warren. In press. Response of fish populations to natural-channel design restoration in streams of the Catskill Mountains, New York. Can. J. Fisheries Aquat Sci. NA

Reports on restoration of fish populations in treatment reaches of 3 streams including Broadstreet Hollow Brook (BSH) which enters Esopus Creek post portal. Findings from BSH fish surveys during 1999-2000 and 2002-2003 showed treatment reach total fish density and biomass increased in the (BSH) treatment reach, by 0.96 fish/m2 and 14.98 g/m2, but declined in the treatment reaches in 3 other, out-of-watershed streams. Salmonid density increases were only significant in BSH, means of 0.35 trout/m2 and 9.30 g/m2, of which 0.25/m2 were comprised of brown trout. Brown trout increased only significantly in BSH, at 0.25fish/m2 6.17

g/m2. Brook trout decrease was significant at -0.02 fish /m2 while rainbow trout increases were not significant at 0.144 fish/m2 and 2.94 g/m2. Brook trout increases of 0.18/gm2 were not significant. Neither density nor biomass changes were significant for other fishes at BSH.

Baudanza, Thomas P. 2000. Letter to Christopher von Schilgen. NYCDEP, Kingston, NY. 1 p. with 40 p. Attachments.

Cover letter with data summery of Summer 1999 electrofishing catches from tribs of Esopus Creek and Ashokan Reservoir, for stream reclassification. Twenty-two samples were collected from tribs entering Esopus Creek upstream of the portal (U), downstream of the portal (D) or Ashokan Reservoir (R) and identified by name and DEC stream number, including: Bushkill, lower reach H-171-P848-5R, Bushkill Maltby Brook H-171-P848-5-2R, Bushkill, upper reach H-171-P848-5R, Unnamed H-171-P848-5-2-2R, Willow Brook H-171-43-7D, Mink Hollow Brook H-171-43D, Panther Kill H-171-46-2D, Silver Hollow Brook H-171-45-2D, Unnamed H-171-47-1D, McKenley Hollow Brook H-171-55U, Fox Hollow Brook H-171-49U, Muddy Brook H-171-46-1D, Elk Bushkill H-171-56U, Dougherty Brook H-171-46-4D, Unnamed H-171-P848-1R, Kenozia Lake Outflow H-171-848-11R, Unnamed H-171-848-10R, Butternut Brook H-171-P848-9R, Beaver Kill H-171-43D, Beaver Kill H-171-43D, Little Beaver Kill H-171-42D and Little Beaver Kill H-171-42D. Of 16 tribs to the reservoir or the creek downstream of the portal with trout, 13 had trout under 100 mm total length, 4 with brown trout (BT) only, 1 with rainbow (RT) trout only, 6 with both BT and RT and 2 with brook trout (ST) only. Composition of populations of trout under 100 mm total length in 3 tribs upstream of the portal were RT, BT and RT and RT and ST, respectively. An additional 3 tribs downstream of the portal had trout over 100 mm total length only. Water data including temperature, pH, specific conductivity and dissolved oxygen are given for 17 sites for one date each during late Fall, 1999, most for tribs entering Esopus Creek downstream of the portal.

Bierhorst, John. THE ASHOKAN CATSKILLS, A NATURAL HISTORY. 1995. The Catskill Center for Conservation and Development, Arkville, NY. 117 p.

Presents a checklist of 33 fishes found in the Esopus watershed, upstream of the reservoir. Discusses the past history of the comely shiner, a minnow species last seen in the Bushkill in 1936 but found again by members of the Olive Natural Heritage Society in a survey below the reservoir in 1994. DEC protected wetlands (12.4 acres or larger), 18 in number, are mapped for the Town of Olive.

Bode, Robert W., Margaret A. Novak, Lawrence E. Abele. 1993. BIOLOGICAL STREAM ASSESSMENT, Lower Esopus Creek, 1993 Survey. NYSDEC, Albany, NY. 38 p.

Reports on water quality analysis based on rapid biological assessment of macroinvertebrate collections from kick sampling. The only sample from the upper Esopus, just upstream of the reservoir, was dominated by mayflies and caddisflies. That sampling was done in September for comparison with those downstream of the reservoir. Sample “indices at this site were within the range of non−impacted water quality”.

Bode, Robert W., Margaret A. Novak, Lawrence E. Abele. 1995. BIOLOGICAL STREAM ASSESSMENT, Esopus Creek, 1995 Survey. NYSDEC, Albany, NY. 40 p.

Reports on water quality analysis based on rapid biological assessment of macroinvertebrate collections from kick sampling. Water quality based on 4 assessment criteria, was non-impacted at 2 sites upstream of the portal and 3 sites downstream. The assessment of slightly impacted for the upstream most site was upgraded to non-impacted because of "lower richness in nutrient-poor headwaters and high contributions by intolerant species". Includes field data summary listing physical and chemical characteristics and biological attributes of sample sites.

Bode, Robert W., Margaret A. Novak, Lawrence E. Abele. 1996. BIOLOGICAL STREAM ASSESSMENT, Esopus Creek, 1996 Survey. NYSDEC, Albany, NY. 33 p.

Reports on water quality analysis based on rapid biological assessment of macroinvertebrate collections from kick sampling. Water quality based on 4 assessment criteria, was non-impacted at 2 sites downstream of the portal and 1 upstream. Includes field data summaries listing physical and chemical characteristics and biological attributes of the sample sites.

Bode, Robert W., Margaret A. Novak, Lawrence E. Abele, Diana L. Heitzman, Sophia I. Passy, Alexander J. Smith. 2001. Upper Esopus Creek, Biological Assessment, 2000 Survey. NYSDEC, Albany, NY. 43 p.

Reports on water quality analysis based on rapid biological assessment of macroinvertebrate collections from kick sampling. Water quality at the upper most of 3 sites upstream of the portal was assessed as slightly impacted but that was attributed to headwater effect. Water quality at the middle of the 3 sites downstream of the portal was found to be slightly impacted. Remainder of sites had non-impacted water quality. Includes field data summaries listing physical and chemical characteristics and biological attributes of the sample sites.

Bode, Robert W., Edward Kuzia, Lawrence E. Abele, Diana L. Heitzman, Alexander J. Smith, Nicole D. Wright, Margaret A. Novak. 2005. Birch Creek, Biological Assessment, 2004 Survey. NYSDEC, Albany, NY. 36 p.

Reports on water quality analysis based on rapid biological assessment of macroinvertebrate collections from kick sampling. Water quality at all 4 sites was found to be non-impacted. Includes field data summaries listing physical and chemical characterisitics and biological attributes of the sample sites.

Clattenburg, Will. 2006. Norman Turner, Catskill Mountain Chapter, New Paltz, New York. (article in Trout, page 50). Trout Unlimited, Arlington, VA.

Article names Norman Turner "Stream Champion" for his work to install facilities for fish passage on Birch Creek, tributary to the upper Esopus above the portal.

Elliot, Wayne. 1984. MEMORANDUM to Bob Bathrick. Proposed Snowmaking Facilities at Birch Creek. NYSDCE, New Paltz, NY. 4 p.

Expresses concerns about snowmaking proposal supported by tables of monthly averages of mean daily discharge at Shandaken USGS gauge (1963-83) and predicted monthly discharges in Birch Creek at trib 3.

Flaherty, Michael J. 1992. Esopus Creek Angler Diary Cooperator Program Summary Report For The 1990 Fishing Season. NYSDEC Region 3 Fisheries Unit, New Paltz, NY. 36 p.

Presents trout catch statistics from 14 anglers, representing 193 trips and over 1200 hours of fishing, through a season with "good' fishing conditions, 1990, and compares it to those from 1974-1976 (diary program) and 1975-1978 (creel census) . Angler caught brown trout and rainbow trout averaged 9.1 and 8.9 inches total length, respectively. Species composition angler catch (rainbow trout: brown trout) was 57:43 and 39:61 (average for years 1973-75 and 1990), upstream and downstream from the portal, respectively. Rainbow trout predominated in the catch upstream during the mid-70's, brown trout were more abundant in the catch upstream in 1990. The catch rate was over 1 trout/hour during the 4 years of the diary program.

Flaherty, Mike. 1996. MEMORANDUM to Wayne Elliot. Natural Impacts of Floods to Esopus Creek Watershed Trout Streams. NYSDEC Region 3, New Paltz, NY. 3 p.

Compares pre (1988) and post flood (1996) brown and rainbow trout populations in Birch Creek, an upstream the portal trib to Esopus Creek. Young of the year (YOY) brown trout were 83% of the YOY trout in 1988 and only 5% in 1996. YOY trout were reduced by 61% in 1996 while yearling or older trout were diminished by 28%. Total trout biomass was reduced by 42%, for year 1996 divided by year 1988.

Flaherty, Mike. 1998. MEMORANDUM to Pat Festa. Esopus Creek Pressure Estimates. NYSDEC Region 3, New Paltz, NY. 4 p. (including tables and figures).

Compares aerial angler count estimates of angling pressure in Esopus Creek during 1960 – 1963, 1974 – 1978 and 1991 – 1997, upstream and downstream of the portal. Shows averageannual diminishment of roughly 5K angler trips from the previous era downstream of the portal. Upstream the pressure increased about 1K angler trips yearly from the first series of counts to the middle era but diminished about 2.5K from the middle to the most recent era.

Flaherty, Michael. 2003. Letter to Norman Turner. NYSDEC, New Paltz, NY. 1 p.

Letter supports work done by recipient and Trout Unlimited in providing fish passage on Birch Creek.

Flaherty, Mike. 2006. MEMORANDUM to Esopus Creek File. Requested recreation whitewater releases to Esopus Creek from 1993 – 2006. 1 p.

Lists the dates requested by whitewater enthusiasts for the NYSDEC Reservoir Release Manager, Division of Water for releases from Schoharie Creek to Esopus Creek for years 1993 - 2006. There are 4 dates listed/year, beginning in early June and ending in late September or early October. The dates listed do not necessarily reflect actual releases.

Gann, Michael C. 1976. 1976 Fisheries Survey, Ashokan Reservoir, P848 – LH. NYSDEC, New Paltz, NY. 83 p.

Describes reservoir design and water distribution through the reservoir. Values for water temperature, pH, dissolved oxygen and methyl orange alkalinity for both basins are presented for four days in the spring and summer, surface to near bottom. Warmwater fish species investigations targeted walleye, yellow perch, smallmouth and largemouth bass, chain pickerel,

rock bass, black crappie, bluegill, pumpsinseed, redbreast sunfish and brown bullhead. Population estimates are provided for walleye and relative abundance indices are shown for other warmwater species along with age and growth data. Fish species abundance is compared between basins. Parasites are described for smallmouth bass. Some sex, maturation and stomach content data are presented for most warmwater fishes. Ichthyoplankton tow data are presented for cisco, yellow perch and walleye. Coldwater fishes investigated included cisco, brown trout and rainbow trout. Catch per unit effort provide measures of relative abundance. Age and growth data are given along with sex, maturation and stomach content information for some fish. Comparisons are made between populations in the respective basins.
Forage base collections included plankton from Esopus Creek near the portal and in both basins. Emerald shiner was identified as the most important trout food but the presence of alewives was noted and described as a recent introduction. The young of other fish species were also identified as forage fishes.
Creel census findings are presented and the census is described.
Study findings are applied to a discussion of the "Prattsville Alternative", a New York Power Authority proposal to construct and operate a pump-storage electrical generation facility making use of Schoharie Reservoir as part of that facility.

Grim, John s. 1952. ESOPUS CREEK, 1950-1951 Investigation. NEW YORK STATE CONSERVATION DEPARTMENT, Southern Fisheries District, Poughkeepsie, NY. 24 p. (plus anonymous notes)

Reports on some stocking of trout and results of electro-fishing at 42 sites in some tributaries and in 10 main stem Esopus Creek sites upstream of the portal. Fish are listed by sample site, species, numbers and age classes for trout. Diminishment of numbers of 34% non-trout and 31% trout between years of sampling is attributed to flooding from a hurricane in the Fall of 1950 and flooding in the Spring of 1951. Turbidity to the creek and tributaries from clay lenses, some located, is described. Depth and pool grade of 37 of 47 sites improved or remained unchanged from the flooding. Change in insect population is described with recovery noted during second summer post flooding.

Homa, John Jr., 2005. Memo to Steven P. DiBenedetto. Good Water Company, Response to DEIS, Project Effects Fish Population Woodland Valley Creek (APPENDIX C, DRAFT ENVIRONMENTAL IMPACT STATEMENT, GOOD WATER CORPORATION SPRING WATER COLLECTION PROJECT, TOWN OF SHANDAKEN, ULSTER COUNTY, NEW YORK. Ichthyological Associates, Ithaca, NY. 8 p.

Addresses effects of water withdrawal on the fish population of Woodland Valley Creek by describing the proposed ground water diversion and the fishery of the creek and assessing the effects of the project, concluding that "diversion of approximately 11K gpd of spring water would have no measurable impact on the fish population in Woodland Creek". Includes Winter and Summer low flow estimates and summaries of fish collections from Woodland Creek.

Kelly, William H. 1976. 1975 ESOPUS CREEK CREEL CENSUS STUDY. NYSDEC Region 3, NY. 24 p.

Reports angler trips and hours of use at 2 sections downstream of portal and 1 upstream. Estimated angler catch was about 22.3K (4.5K upstream/17.8K downstream) yearling hatchery

brown trout, 9.8K (1.6K/8.2K) wild rainbow trout, 4.6K (1.1K/3.5K) wild brown trout and 0.7K (0.1K/0.6K) hatchery holdover brown trout. Catch is further reported by study section. Age and growth data from creel census and an 1974 electrofishing sample show that both brown and rainbow trout of similar age were generally larger downstream of the portal. Angler use by section estimates are 20.6K angler trips downstream and 4.4K upstream of the portal. Recommendations include monitoring changes in flow from portal, "address the effect of turbidity" and natural turbidity " on the natural aquatic environment", prohibit the stocking of rainbow trout upstream from Ashokan Reservoir and "review proposals for change in land/and or water use management which might effect environmental quality in the Esopus Watershed."

Kelly, William H. 1976. 1976 ESOPUS CREEK CREEL CENSUS STUDY. NYSDEC Region 3, NY. 29 p.

Reports angler trips and hours of use in 2 sections downstream of the portal and 1 upstream. Is a continuation of the study started in 1975. Estimated angler catch was about 22.3K (2.6K upstream of the portal/19.7K downstream of the portal) yearling hatchery brown trout, 7.6K (1.4K/6.2K) wild rainbow trout, 1.2K (0.3K/0.9K) wild brown trout and 0.9K (0.1K/0.8K) hatchery holdover brown trout.
Catch is further reported by study section. Age and growth data from creel census and an 1976 electrofishing sample show that both brown and rainbow trout of similar age are generally larger at ages 0+ through 2+ upstream of the portal. Age 3+ and 4+ rainbow trout were larger upstream of the portal than downstream, however those fish have spent part of their life in the reservoir. Age 3+ brown trout downstream of the portal were generally larger than those upstream. No age 4+ or 5+ brown trout were taken upstream of the portal. Angler use estimates are about 20.2K trips downstream and 3.1K upstream of the portal.

Release flows are discussed relative to "good" and "bad" fishing and noted as "bad relative to excessive releases. Recommends additional work to determine turbidity affects on aquatic biological community and/or the angling community, life history patterns of rainbow trout and monitoring of flow temperature and turbidity regimes in 1977.

Kelly, William H. 1978. ESOPUS CREEK INVESTIGATIONS 1975 – 1978, PART I THE ESOPUS CREEK SPECIAL REGULATIONS AREA, PART II THE SHANDAKAN AGREEMENT, PART III THE "PRATTSVILLE ALTERNATIVE". NYSDEC Region 3, NY. 42 p.

Reports angler trips and hours of use in 2 sections below the portal and 1 above. Is a continuation of a study started in 1975. Estimated angler catch for 1977 and 1978, respectively, was about 10.6K (1.3K upstream from the portal/9.3K downstream from the portal) and 10.2K (0.9K/9.3K) hatchery brown trout, 5.3K (0.6K/4.7K) and 3.0K (0.4K/2.6K) wild rainbow trout, 2.2K (0.03K/2.2K) and 0.1K (0.03K/0.09K) hatchery holdover brown trout. During 1978, 27 brook trout were caught above the portal. Catch is further reported by study section. Age and growth data from electrofishing during 1976 – 1978 show that wild brown trout and rainbow trout are larger at age, on average, downstream of the portal than upstream. Angler use estimates are about 13.7K trips downstream and 2.0K upstream of the portal during 1977 and 12.4K and 2.7K, respectively during 1978. The Shandakan Agreement is discussed relative to avoiding fish kills, stabilizing flows, reducing turbidity and maintaining aquatic productivity. Study findings are applied to a discussion of the "Prattsville Alternative", a New York Power

Authority proposal to construct and operate a pump-storage electrical generation facility making use of Schoharie Reservoir as part of that facility.

Lemmon, David. 2005. E-mail transmittal forwarding Bio Sustainability Project to Amanda LaValle @ ALaValle@dep.nyc.gov. 1p. w/attachment (6 p.). Attachments are also at web link http:www//sunyulster.edu/bio/

Attachment includes raw data from fish collections at 6 main stem Esopus Creek sites, 3 upstream of the portal, during Fall 2002 electrofishing collections and 2 indices of biotic integrity for fish, based on those data. Macroinvertebrate sampling data from 5 sites, 2 upstream of portal, for the months of May, July and September, 2002, are listed by order and family or class and are summarized by site by percent relative abundance by family. Periphyton collection data are listed by the same 3 months of sampling, for the same 5 sites, by family and genus and are used for the diversity/abundance index shown on a separate table. Periphyton were not sampled at 2/5 sites in May nor 1/5 sites in July. The above are from the Ulster County Community College Biodioversity 225 Class, taught by Dr. Ted Wohnseidler during 2002.

New York State Department of Environmental Conservation. 2005. NEW YORK STATE FRESHWATER FISHING REGULATIONS , 2004-2006 REVISED. Albany, NY. 81 p.

Includes sport fishing regulations for Esopus Creek including 5 trout/day creel limit, April 1- November 30 open fishing season, any size length limit and bait or lures as method of take. References New York City requirement for special permit to fish city reservoirs, including Ashokan, and provides fishing regulations for Ashokan including an April 1 – November 30 season, a 12" total length (TL) size limit and a 3 fish/day limit for trout. Additional special fishing regulations for Ashokan Reservoir walleye include a 1st Saturday in May – March 15 season, a 12" TL size limit and a 3 fish/day limit. State-wide, general fishing regulations apply to those species found in the reservoir but not specially listed. The guide reiterates The New York State Department of Health advisory listing for consumption of fish which includes Ashokan Reservoir smallmouth bass > 16" TL and walleye, suggesting consumption of < 1 meal/month except for women of childbearing age and children under the age of 15, who should not eat any fishes from any of the listed waters. The guide further advises against the consumption of >1 meal (0.5 pounds)/week by the remainder of the human population for those fishes not listed.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION. 2005. Draft State Pollutant Discharge Elimination System (SPDES) DISCHARGE PERMIT, Special Conditions (Part 1), DEC Number: 3-5150-00420/00001. 27 p.

Spells out water quality permit limits, levels and monitoring definitions for the discharge, either as totals for the day for units of mass or the average daily discharge for pollutants, expressed in other units of measurement. The draft permit addresses turbidity, water temperature, phosphorus, settleable and total suspended solids and the volume of cold water in Schoharie Reservoir and requires samples be taken at the "South Portal discharge point of tunnel prior to admixture with the Esopus Creek". Conditions of the draft permit require that "re-evaluation shall occur on five year intervals beginning at the years from the effective date…" as structural and non-structural measures are implemented. Compliance with structural measures requires, at least, a multi level intake structure and turbidity curtain and "any alternative

identified and implemented in accordance with the Comprehensive Analysis of Potential Alternatives at Schoharie Reservoir that will be developed by the permittee and approved by the EPA in fulfillment of requirements contained in the November 2002 FAD". Nonstructural programs include a filtration avoidance determination schedule, stream restoration (repair of 5K linear feet of stream in seven years), local implementation program [at least $2 million for implementation of stream management plan (SMP) recommendations in Schoharie Reservoir Basin SMP under current development], all within 36 months of completion of Schoharie Basin SMP or the effective date of the permit, whichever is later. Additionally, "The Permittee shall conduct projects and/or establish contract(s) with one or more local entities to implement this local program." An average flow rate of 160 million gallons per day is required by the permit and turbidity ranges of from 7.5-13.8 and maxima of 85-300 nephelometric turbidity units permitted, varying seasonally. Cold water needs (70 F) during May-September are to be provided by releases of "adequate cold water volume". Phosphorus effluent limits are set at 7,980 kg/year as a 12 month rolling average. Neither Ashokan or Schoharie Reservoir had algae bloom issues at that phosphorus level.

Under special circumstances the draft exempts New York City Department of Environmental Protection from temperature and turbidity limits to manage their water supply and to protect the biota of the Ashokan and Schoharie watersheds, subsequent to consultation with the permitting agency.

New York State Department of Health. 2005. Chemicals in Sportfish and Game, 2005-06 Health Advisories. Albany, NY. 25 p.

Lists all the waters of New York State for which fish have been tested against chemical standards for human consumption and found to contain toxic substances harmful or thought to be harmful to humans. Ashokan Reservoir is listed for smallmouth bass > 16" total length and for walleye, mercury is the contaminant of concern. The advisory for human consumption of those species and sizes is no more than 1 meal (0.5 pound)/month except for children <15 years old or women of childbearing age who should eat none, nor any other Ashokan Reservoir fishes. The advisory further suggests that the non-excepted portion of the human population further consume < 1 meal (0.5 pounds)/week of those fishes not listed.

The LA group, Landscape Architecture and Engineering, P. C.; Delaware Engineering, P. C.; Whitman Osterman & Hanna; Creighton Manning Engineering, P. C.; Allee King Rosen & Fleming, Inc.; HVS Consulting Services; Alpha Geoscience; Hartgen Archeological Associates, Inc.; Rettew Engineering and Surveying, P. C.; SE Group; ENSR International; Love Enterprises and Associates; Emilio Ambasz, Hart Howerton/Robert Lamb-Hart; and Blue Dog Design. 2003. Draft Environmental Impact Statement For: Belleayre Resort at Catskill Park, Towns of Shandaken and Middletown, Ulster and Delaware Counties, New York. Executive Summary and TABLE OF CONTENTS. 51 P.

Table of contents indicates an extensive and exhaustive presentation of aspects of the relationship of construction, development and maintenance of the resort to the ecosystem, in illustration, tables and narrative.

No author listed. 1965. SEVENTH ANNUAL REPORT ON CREEL CENSUS IN REGION 8, ESOPUS CREEK CREEL CENSUS –1965. NEW YORK STATE CONSERVATION DEPARTMENT, Poughkeepsie, NY. 2 p.

Tabular summary of creel census data for the entire Upper Esopus Creek for 1962 – 1965. Brown trout dominated the fishery during all years, hatchery brown trout during 1962, 1964 and 1965 when they represented about 52% (15.7K), 56% (15.4K), and 75% (17.5K) of the catch, respectively. Brook trout made up more than 2% of the catch during 1962 and 1964 and rainbow trout contributed about 40% of the catch during 1962 and more than 23% of the catch during the other 3 years. Angler trips totaled about 14.9K, 10.7K, 12.4K and 15.9K during the years 1962-1965, respectively. Stocking was delayed during 1965 to correspond with warmer water temperatures at time of stocking. An angler catch rate goal of 0.5 trout/hour and annual harvest of about 25K trout was exceeded in 1962 and 1964. Total catch in 1963 and 1965 were about 21K and 23K, respectively. A 1965 drought is referenced.

No author listed. 1965. INSTRUCTIONS FOR 1965 CREEL CENSUS, ESOPUS CREEK. NEW YORK STATE CONSERVATION DEPARTMENT, Poughkeepsie, NY. 3 p.

Instructions suggest that data for the 1965 report may be broken down somewhere to reflect catch statistics for pre and post-portal stream sections.

Pierce, Ronald. 1996. ESPOUS CREEK ELECTROFISHING SURVEY. NYSDEC, New Paltz, NY. 23 p.

Electrofishing catch breakdown for upstream and downstream of the portal collections during September, 1996 were 89 and 85% wild rainbow non-fingerlings downstream of the portal (2 sites) and 76% (1 site) upstream. Brown trout wild non-fingerlings were 9 and13% downstream of the portal vs10% upstream. Hatchery brown trout comprised 2% at both sites downstream of the portal and 14% upstream. No hatchery holdovers were caught. Fingerling catch composition was 94% rainbow trout at the only downstream site where fingerlings were caught and 67% above the portal. Size at age favored trout of both species downstream of the portal. Rainbow trout were larger at any given age than brown trout. More larger brown were caught upstream of the portal, on average per site. No rainbow trout larger than 10 inches were caught upstream of the portal.

Parasiewicz, Piotr, Sarah Beth Ehmann and Piper Corp. 2003. Fish Habitat Assessment on Stony Clove Creek, NY using MesoHABSIM. Cornell Uinversity, Ithaca, NY. 52 p. with 42 p. Attachments.

Reports on mapping of habitat in nine miles of stream 3 times with flows from 0.1 – 1.0 cubic feet/second/mile2 and comparing the habitat to fish collections from about 300 fish collection grids. All the following are reported conclusions: Fish populations are characterized as low density, dominated by slimy sculpins and dace species with abundant brown and rainbow trout and minimal brook trout. The majority of brown and rainbow trout were stocked, with very low winter survival rates. Trout nursery habitat is available as required. Brown trout presence negatively impacted brook trout habitat availability. Brook trout habitat conditions would be improved with woody debris, boulders and pools. The MesoHABSAIM model simulates and evaluates channel improvements and quantifies major habitat deficits, providing guidance for stream management.

Turner, Norman. 2003. E-mail to Wayne Elliot and Mike Flaherty. 1 page with attached figures, plans and article.

Describes and illustrates proposed fish passage facilities for Birch Creek.

Wich, Kenneth. 1967. ASHOKAN RESERVOIR, 1966 Investigation. NEW YORK STATE CONSERVATION DEPARTMENT, Poughkeepsie, NY. 8 p.

Reports July water temperature for the surface to near the bottom for 10' increments, dissolved oxygen (good to near bottom in both basins) and methyl orange alkalinity for some similar depths for 2 stations in the east basin and 1 station in the west basin. Fish collections included 15 species from the east basin and 17 species from the west basin. Trout were taken only in the west basin. Length at age data are combined for both basins.

ANNOTATED LISTING: CHEMICAL, PHYSICAL AND OTHER

Arscott, David B., Anthony K. Aufdenkampe, Thomas L. Bott, Charles L. Dow, John K. Jackson, Louis A Kaplan, J. Denis Newbold, Bernard W. Sweeney. 2004. Water Quality Monitoring in the Source Water Areas for New York City: An Integrative Watershed Approach, A Report on Year 4 (203) Monitoring Activities. Stroud Water Research Center, Avondale, PA. 221 p.

Reports on a synoptic study of the entire NYC watershed including 1 station each in main stem Esopus Creek and 2 tribs upstream of the portal and 1 main stem and trib station downstream. Broadscale landscape analysis shows the watershed for all 5 sites as predominantly forest. Total suspended solids in Esopus Creek were almost 3X downstream of the portal than above and greater in Warner Creek than Bushnelville Creek (Warner is tributary to Stony Clove Creek which enters the Esopus downstream of the portal, Bushnelville enters upstream of the portal). Percent suspended organic matter at the upstream sites, both main stem and trib, was about 2X that for the corresponding sites downstream of the portal. Data are graphed for summer baseflow stream water concentrations of polycyclic aromatic hydrocarbons with some compared to Environmental Protection Agency criteria and do not idicate anything exceptional. Macroinvertebrate samples indicate very high water quality for Warner Creek and corresponding species richness. Water quality was better in the upstream main stem station as was species richness. Dissolved organic carbon (DOC) concentrations at both Esopus Creek stations were relatively similar with a slightly higher DOC concentration at the downstream station but a greater concentration of biodegradable DOC at the upstream station, about 4 %.

Arscott, David B., Anthony K. Aufdenkampe, Thomas L. Bott, Charles L. Dow, John K. Jackson, Louis A. Kaplan, J. Denis Newbold, Bernard W. Sweeney. 2004. Water Quality Monitoring in the Source Water Areas for New York City : An Integrative Watershed Approach, A Report on Phase I of Monitoring (2000-2002). Stroud Water Research Center, Avondale, PA. 653 p.

Reports on nutrients and major ions in transport, molecular tracer analysis, macroinvertebrates, organic particle, dissolved organic carbon (DOC) and biodegradable dissolved organic carbon (BDOC) dynamics, nitrogen, phosphorus and DOC spiraling, stream metabolism, reservoir primary productivity and ecosystem structure and function relationships. Includes data from one or more stations in Esopus Creek near Big Indian and Allaben, upstream

from portal and near Mt Tremper downstream, and in Stony Clove and the Beaver Kill, tribs downstream of the portal. Cation and anion profiles are relatively similar with lowest values at the uppermost station on the creek and the lowest main stem station showing values less than its tributary station upstream. Average values for three years of data are below the Environmental Protection Agency criteria for the most toxic measured polycyclic aromatic hydrocarbons but some readings are at or above the criteria for year one of the study. Summer lowflow streamwater concentrations of sewage input tracers are generally similar for all stations. Average fecal input tracers are relatively similar for steroids but only about half as much coprostanol was found in Stony Clove as at the other stations, on average, and coprostanol was below the recreational contact level at all stations. All fecal contamination was human rather than from other animals. Summer and winter concentrations and baseflows versus stormflows are compared. Based on macroinvertebrate samples, the downstream most site had the lowest water quality score (WQS) while the Beaver Kill station had the highest. WQS differences were not statistically significant. Water quality in Stony Clove and in the main stem near Mt. Tremper were slightly impacted. Total suspended solid concentrations (TSS) averaged 4.08 mg/L and ranged from 1.58 to 6.48 mg/L. The highest TSS values recorded for the Esopus watershed were 11.28 mg/L during 2001. TSS were mostly in the size range of 0.5-10micrometers, 59 to 92 % at stations near Mt. Tremper and Allaben, respectively. Volatile suspended solid (VSS) concentrations averaged 0.93 mg/L and ranged from 0.50 at Big Indian 1.68 near Allaben. VSS of 0.5 to 10 micrometers were dominant and ranged from 58 percent at Mt Tremper to 94 percent at Allaben. Average DOC and BDOC values for the watershed were 1171 micrograms of C/L of which 16.6% was BDOC. DOC increased downstream, between stations within years. BDOC did not follow the same pattern.

Spiraling of nitrogen, phosphorous and DOC was modeled with surrogates and compared with water quality scores. At Allaban nutrient (ammonium and phosphate) uptake occurred at velocities of about 0.085 and 0.21 mm/s with a corresponding water quality score of 8. The chlorophyll *a* concentrations were about 55 mg/m2 for 2001 and 2002 and 50 mg/m2 for all years. Plots of photosynthetically active radiation against gross primary productivity are high for the Allaben station during 2001 and 2002 but relatively low for 2000 and community respiration was also high for those 2 years.

Butch, G. K., P. M. Murray, R. Lumia, M. D. Corse. 2004. Water Resources Data, New York Water Year 2003, Volume 1. Eastern New York Excluding Long Island, Water-Data Report NY-03-1. USGS, Troy, NY. 579 p.

Annual report for the water year (Oct – Sept) listing mean daily discharge in cfs, at least, for 10 sites on Esopus Creek or its tributaries upstream of the reservoir, including (starting year) those at Panther Mtn trib near Oliveria (2001) , Birch Creek at Big Indian (1998), Esopus Creek at Allaben (1963), the diversion from Schoharie Reservoir at the portal (1924), Hollow Tree Brook near Lanesville (1997), Stony Clove Creek near Phonecia (1996), Beaver Kill trib (2000), Little Beaver Kill near Mt Tremper 1997), Esopus Creek at Cold Brook (1914) and Bush Kill (2000). Includes information on where data for previous water years may be found and specifically locates gauging station for particular years.

Effler, S. W., M. G. Perkins, N. Ohrazdda, C. Brooks, B. A. Wagner, D. L. Johnson, F Peng. And A. Bennett. 1997. Turbidity and Particle Signatures Imparted by Runoff Events in Ashokan Reservoir, NY. Lake and Reserv. Manage. 14 (2-3): 254-265.

"ABSTRACT"

"The occurrence, temporal and spatial patterns, and origins of turbidity events, and their linkage to runoff events, are documented for a water supply impoundment with two separated basins, Ashokan Reservoir, NY. The analysis is supported by a comprehensive 6-week study of the major inflow and the reservoir during the summer of 1996, that captured the effects of a single runoff event, and turbidity (T) measurements made in the reservoir and the water supply intakes for the entire year. Measurements supporting the short-term study include: temperature, specific conductance, beam attenuation coefficient, electronic particle counts, Secchi disc transparency, T, up- and downwelling cosine irradiance, chlorophyll, microscopy-based individual particle size and chemistry, and total suspended solids (TSS) on sediment trap collections. The external load of mostly quartz and clay particles delivered by the principal tributary as an interflow, during the summer runoff event imparted distinct signatures in T and deposition within the epilimnion of the receiving basin; the other basin remained unaffected by comparison. The deposition rate of TSS and T increased in the receiving basin in response to the runoff-based loading; decreasing gradients in both parameters were observed within this basin downstream of the entry point of the tributary. More than 85% of T in the receiving basin during the 6-week study is attributed to inorganic tripton particles of terrigenous origins. Analysis of the longer-term data indicates elevated T values (maximum of 150 nephelometric turbidity units) occur routinely in the receiving basin following runoff events, and that this effect extends to the other basin, including the water supply intake(s), during intervals other than summer stratification."

Galusha, Diane. 1999. Liquid Assets, A history of New York City's Water System. Purple Mountain Press, Fleischmanns, NY. 303 p.

Narrative of construction of NYC water system.

Kappel, Jason C. 2002. Letter to Andrew Zweben. (APPENDIX B, DRAFT ENVIRONMENTAL IMPACT STATEMENT, GOOD WATER CORPORATION SPRING WATER COLLECTION PROJECT, TOWN OF SHANDAKEN, ULSTER COUNTY, NEW YORK) Spectra Environmental Group, Inc. 4 p.

Addresses thermal loading of Woodland Creek from proposed water diversion piping and storage. Concludes negligible thermal impact on water temperature.

Kappel, Jason C. 2002. Letter to Andrew Poncic (APPENDIX B, DRAFT ENVIRONMENTAL IMPACT STATEMENT, GOOD WATER CORPORATION SPRING WATER COLLECTION PROJECT. Spectra Environmental Group, Inc. 8 pp.

Addresses water budget for Woodland Creek. Project watershed is described as 5.8% of 13,184 acre Woodland Creek watershed. Water collection would use 0.4% of available recharge water in spring basin.

Mast, M. A., and J. T. Turk. 1999. Esopus Creek at Shandakan, New York (Station 01362198). 17 p. in Environmental characteristics and water quality of Hydrologic Benchmark Network stations in the Eastern United States, 1963-95: U.S. Geologic Survey Circular 1173-A. 158 p.

Describes the watershed basin and presents and discusses historical water quality data and time-series trends. Samples numbered 2/year until 1968 and 12/year (monthly) after. Synoptic water quality data include specific conductance, pH, calcium, magnesium, sodium, potassium, alkalinity, sulfate, chloride, nitrate for 11 sites in the watershed upstream of the portal are listed by station for October, 1991. Major ion concentrations, ion balance, pH and discharge are graphed.

New York State Department of Environmental Conservation, in cooperation with New York State Department of Transportation. 1999. Catskill Forest Preserve Public Access Plan. 101 p.

Reports that the 1996 Clean Water/ Clean Air bond Act included $1 for the NYSDEC purchase of public fishing rights on 7 Catskill waters including Esopus Creek and discusses construction of easy access fishing sites and sites that are more easily accessible for disabled people. Suggests that fisherman groups such as Trout Unlimited and Theodore Gordon Flyfishers might be willing to work with NYSDEC operations staff to accomplish the afore mentioned proposed actions of the plan.

Part 862.2, New York Codes, Rules and Regulations (6NYCRR), items 523 – 675. NYS07/11/06EC, Albany, NY.18 p.

Includes standards which indicate presence of trout (T) or young of year trout (TS) which are evident of trout spawning. Each of those standards are associated with specific water quality criteria including temperature, dissolved oxygen and pH.

USGS web site for NY State: http:// waterdata.usgs.gov/ny/nwis/current/?type=flow

Shows discharge and stage data for Esopus Creek and tributary stations.

Help contact for USGS Esopus Creek data.

Margaret Phillips: askny@usgs.gov
USGS, WRD
425 Jordan Road
Troy, NY 12180-8349
Voice: (518) 285-5602
Fax: (518) 285-5601
New York District Website: http://ny.usgs.gov

Yeates – Thomas, David. No date. Mountain Water for a City. Blaine Associates, Kennett Square, PA. 82 p.

Narrative history of New York City water supply and the Stroud Water Research Center monitoring of the city watersheds.

ACKNOWLEDGEMENTS

Special thanks go to Jeremy Magliaro, Cornell Cooperative Extension of Ulster County, Michael Flaherty, New York State Department of Environmental Conservation, Thomas Baudanza and Dan Davis with New York City Department of Environmental Protection and Amanda LaValle and Sarah Tarallo, Ulster County Community College, for providing most of the included documents to me.

NOTES ON THIS STUDY

This research is being coordinated by Cornell Cooperative Extension of Ulster County, and is part of a larger effort of developing a multi-objective management plan for the upper Esopus Creek. More information about the upper Esopus Creek Management Plan can be found at the project website: http://www.esopuscreek.org.

The development of this comprehensive annotated bibliography is the first step in characterizing the status of the aquatic ecosystem condition of the upper Esopus Creek. Further research will describe and characterize trends, limitations, and information gaps in the existing body of research. Finally, recommendations for additional study will be identified through a multi-stakeholder process. A final report with recommendations is anticipated by December 1, 2006.

We are interested in your comments and opinions about this document, and/or further insight that you could provide about aquatic ecosystem conditions in the upper Esopus Creek (above Ashokan Reservoir). Most importantly, if you know of additional literature or data sources that should be included in this bibliography, please contact us.

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