EVALUATION OF THE NEED FOR UNITED WATER NEW YORK, INC.'S, DEVELOPMENT OF A NEW LONG-TERM WATER SUPPLY SOURCE BASED ON A REVIEW OF ROCKLAND COUNTY, NEW YORK HYDROLOGIC FACTORS

Prepared for
Scenic Hudson Inc.
And
Rockland Water Coalition

Prepared by
Charles F. McLane III, Ph.D.
McLane Environmental LLC
Princeton, New Jersey

November 2013

I. TABLE OF CONTENTS

II. FIGURES

III. APPENDIX A

EXECUTIVE SUMMARY

At the request of Scenic Hudson, Inc. and the Rockland Water Coalition I have reviewed documents and data that provide information regarding the water resources of Rockland County, New York and the United Water New York, Inc. (UWNY) proposed new water supply project for its Rockland County service area. I am a Ph.D. hydrologist with over 25 years of experience in hydrologic and hydrogeologic investigations, including the management, planning, protection, and restoration of water resources. This report presents my findings with respect to UWNY's assertion that a new water supply project is required to meet a projected capacity of an additional 7.5 million gallons per day (mgd). I have concluded that, when considered in the context of reasonable water demand projections, the proposed UWNY long-term water supply project is not needed, and will not be needed, for a time period extending to at least 2025.

In 2006 the New York State Public Service Commission (PSC) was presented with information that led to a ruling that a new long-term water supply project was necessary to meet future water demand in Rockland County. In response, UWNY planned the construction of a desalination (desal) plant to increase the capacity of the water system. Since the 2006 and 2010 PSC Rate Orders, the documents produced by UWNY, including the August 2013 report required by the current proceeding, have failed to adequately address the changes in scientific information, water demand, and public interest related to the water resources of Rockland County. My review of the recent hydrologic information for Rockland County also indicates that many of the concerns that initially lead to the decision to plan a new major water supply source are less critical than previously thought when sufficient data on the Rockland County water resources were not available.

UWNY has not properly incorporated, and appears to not even have properly considered, the substantial benefits of the information provided to them by the U.S. Geological Survey (USGS) in the hydrologic study and groundwater modeling reports published in 2010. Not only has this new information not been adequately addressed, but UWNY has misrepresented the findings of the USGS reports to support the claim that a new water supply project is needed. The USGS reports show that the bedrock aquifer underlying most of Rockland County is a healthy, resilient aquifer that can be sustained at current pumping levels with proper management and has the potential for expanded use. These reports also provide updated aquifer recharge estimates that are higher than those available in 2006 and support a more accurate and more positive view of the aquifer's health and reliability. Use of the bedrock aquifer numerical model, improved understanding of the strengths and limitations of the groundwater system and its interactions with surface water features, and mapped water supply well capture zones should allow UWNY to manage Rockland County's water resources in a manner that enhances the productivity and reliability of the water supply system.

In addition, the system capacity increase that UWNY contends is needed to meet future demand was developed, presented, and applied in a misleading and improper manner. In order to support the claim that a new water supply project is required for Rockland County, UWNY has provided overly conservative demand figures and fabricated a requirement for a 7.5 mgd supply increase (when in fact this number is an engineering estimate of the potential desal plant output, and not an actual water

demand projection). UWNY then improperly held other water supply alternatives up against this false and overblown 7.5 mgd standard (without consideration of reasonable combinations), and then speciously "failed" each alternative when the alternative, standing alone, was unable to "compete" with the desal plant output of 7.5 mgd. To compound the problem, UWNY's alternatives evaluations, in many instances, lack the transparency required for an independent outside review. This methodology, its finding of need for an additional 7.5 mgd, and its rejection of hydrologic resource and management based sources (as opposed to a new major supply project), must be discounted as flawed and blatantly biased in favor of UWNY's selected desal plant solution. This is an important and relevant issue in the current proceeding because several of the alternatives considered options that do not require the development of a new long-term water supply project.

In developing an inflated demand estimate, UWNY planned expensive infrastructure-based water supply increases well in excess of the 2006 95% confidence interval demand projections and well beyond the ten year forecasts. UWNY dismissed their own demand projections that account for minimal conservation and non-revenue water loss reduction, and did not provide demand forecasts which included either a consideration of increased water rates or the additional water conservation efforts proposed by Rockland County (Vanderhoef and Cornell 2011). The current PSC Order Instituting Proceeding (2013) clearly states that future water conservation plans are a required part of a water supply permit application and that water corporations are required to make efforts to reduce and control future demands. Thus, it is unreasonable to plan future demand based on no additional conservation efforts as UWNY has done.

In another failure of its planning process, UWNY has not provided a quantifiable assessment of system capacity or reliability increases that could be achieved by continuing current system efficiency improvements or implementing operational improvements. In the UWNY Draft Environmental Impact Statement (DEIS), these options were compared only to the desalinization plant's maximum capacity of 7.5 mgd and not to actual forecasted demand. In fact, all alternatives in the DEIS were evaluated for their ability to produce a 7.5 mgd increase in safe yield, even though the UWNY's demand projections do not project an increase of 7.5 mgd to be necessary, even when forecast to 2035. The 7.5 mgd increase in safe yield that the proposed project can produce is not an appropriate metric to use in comparing the ability of other water management methods to meet Rockland County's water needs. While the PSC did set system capacity goals through 2015, the 7.5 mgd system capacity increase goal that was fabricated by UWNY is unreasonable, unnecessary, and not explicitly required by the PSC. It appears to be a false demand standard, developed by UWNY, for use in discounting and eliminating water supply alternatives that UWNY found to be less in keeping with their engineering and economic plans.

After careful review of the USGS reports and UWNY's documents, I have come to the conclusion that a new long-term water supply project is not currently needed for Rockland County and UWNY's proposed project is unnecessary at this time. Charting of UWNY's own committed supply and projected demand data show that expected average daily demand will not exceed supply by 2025. Since 2006, UWNY has made considerable improvements to their water supply system, and plan to continue to do so into the future according to the DEIS for the proposed project. The incremental increase in safe yield and

reliability from current system improvements, when taken into consideration with reasonable demand estimates, even those developed by UWNY in the DEIS, negates the need for a new long-term water source.

Continued proper management of the water resources in Rockland County can ensure that those resources will remain productive, and will not be degraded by continued use. Realistic current and future estimates of water demand for Rockland County, coupled with an assessment of the County's water resources based on the most current trends, technology, and hydrologic information, demonstrate that a new water supply project is not needed at the current time. The available information further supports the position that there is adequate time to develop a plan that integrates Rockland County's water resource management in a way that is most advantageous to its current and future residents, as opposed to a plan based solely on increased production that will only exacerbate current Rockland County water problems and costs.

1. INTRODUCTION

This report was prepared at the request of Scenic Hudson, Inc. and the Rockland Water Coalition. The report presents my findings regarding current hydrologic conditions and water resource factors in Rockland County, New York that, when considered in the context of reasonable water demand projections, demonstrate that a new United Water New York, Inc. (UWNY) long-term water supply project to provide an additional 7.5 million gallons per day (mgd) is not needed.

1.1 QUALIFICATIONS

I am the founding Principal of McLane Environmental, LLC, a hydrologic science and environmental consulting firm located in Princeton, New Jersey. My graduate academic training in watershed science at the Master's degree level and groundwater science at the Ph.D. level has provided me with a broad technical background from which to investigate and evaluate hydrologic systems and water resource issues. In my professional work I analyze subsurface hydrologic systems and their interactions with surface water systems, with a special emphasis in groundwater flow system analysis and chemical fate and transport, including the use of computer simulation and data visualization techniques to support water resource evaluation and development, human health and ecological risk assessment, and remedial engineering investigations.

For over 25 years I have provided strategic consulting services to corporate, municipal and governmental clients regarding water resource evaluation and management studies for local and regional governments; investigative and remedial activities at operating industrial facilities; technical direction for site characterization, remediation and groundwater modeling activities at Department of Defense and Department of Energy sites; and quantitative hydrogeologic analyses to support groundwater and wastewater management planning and design. I have advised county and municipal agencies regarding water management planning, new well fields for water supply, and hydrologic resource assessments; and I have published on the topic of sustainable water supply.

I hold a B.A. in Geology from Susquehanna University, a M.S. in Geology from the Earth Resources Department of Colorado State University with an emphasis in watershed hydrology, and a Ph.D. in Environmental Sciences with an emphasis in hydrogeology from the University of Virginia. Prior to forming McLane Environmental, I was a Senior Science Advisor and Manager with ENVIRON International Corporation, Principal Hydrogeologist with Geraghty and Miller Ground Water Consultants, and Senior Engineer with Rockwell International Corporation. I have authored and delivered over two dozen publications and presentations in the areas of groundwater flow and contamination, risk assessment methodologies, and groundwater modeling. On numerous occasions, I have chaired or participated as a lecturer in environmental training seminars and short courses, presented technical papers at scientific meetings, and conducted seminars for groups of regulators and clients on the topics of groundwater flow and contaminant migration, analysis of site investigation data, and the use of computer simulation models. I am a member of the Hydrology Division of the American Geophysical Union and a member of the National Ground Water Association. A copy of my curriculum vitae is provided in Appendix A.

1.2 BACKGROUND

In 2006 the New York State Public Service Commission (PSC) was presented with information that led to a ruling that a new long-term water supply project was necessary to meet future water demand in Rockland County. In response, UWNY planned the construction of a desalination plant to increase the capacity of the water system. Subsequent to the 2006 and 2010 Rate Orders, the New York State Public Service Commission (PSC) recently (July 2013) opened a "proceeding to examine the continuing need for United Water New York Inc.'s (UWNY) proposed development of a new water supply source to satisfy Rockland County's long-term water supply requirements" (PSC 2013b). PSC Commissioner, Gary A. Brown, asserted that the investigation associated with this proceeding will allow the PSC to "account for new information or changed circumstances" relating to the need for Rockland County to develop a "major new water supply source" (PSC 2013b). UWNY was directed to submit a report that addressed new information regarding projected demand, the need for a new water supply source, and concerns raised about the project (PSC 2013a).

In response to previous regulatory requirements and to the more recent PSC request, UWNY produced reports that they contend confirm the need for their proposed new long-term water supply source and address new information and concerns. These documents include:

- *Haverstraw Water Supply Project Draft Environmental Impact Statement*, United Water New York Inc., January 13, 2012.
- *United Water New York Inc.'s Report On The Most Recent Information Relating To Projected Demand And Need For A New Long-Term Water Supply Source In Rockland County*, Response To PSC Order (Case 13-W-0303), United Water New York Inc., August 19, 2013.

I reviewed the UWNY reports, focusing on the hydrologic information presented in the reports, the extent to which UWNY was not rigorous, thorough and or transparent in providing sufficient information to support their determination that a new major water supply source is needed, and the extent to which UWNY appropriately included and addressed recent hydrologic information and concerns.

As part of my work I reviewed the 2010 U.S. Geological Survey (USGS) reports on the water resources of Rockland County to evaluate UWNY's representation of these reports and UWNY's incorporation of the data and tools provided by the reports into their evaluation of Rockland County's water supply needs. The 2010 USGS reports include:

- Water Resources of Rockland County, New York, 2005–07, with Emphasis on the Newark Basin Bedrock Aquifer, U.S. Geological Survey Scientific Investigations Report 2010–5245, Heisig, P.M., 2010.
- Hydrogeology and Simulation of Groundwater Flow in Fractured Rock in the Newark basin, Rockland County, New York, U.S. Geological Survey Scientific Investigations Report 2010–5250, Yager, R.M. and Ratcliffe, N.M., 2010.

1.3 Report Structure

A discussion of my review and my findings regarding key points of interest with respect to Rockland County water resources and the lack of current need for a new water supply project are presented in the remaining sections of this report. Findings regarding the new hydrologic information contained in the 2010 USGS reports are presented in Section 3. Findings regarding the extent to which UWNY incorporated the new hydrologic information in their assessment of the need for a new long-term project are presented in Section 4. A critical evaluation of UWNY hydrologic arguments regarding the need for a new major supply project, and an assessment of the lack of transparency in many of UWNY's determinations, are presented in Section 5. Because Rockland County governance is separate from their water supply company, Section 6 addresses opportunities where the combined efforts of the county and the water company in areas of stormwater, wastewater, and water resource management and infrastructure could provide the most benefit to the residents of Rockland County well into the future.

2. Original Impetus for a New Long-Term Water Supply Source and Subsequent Changed Circumstances

In the 2006 Rate Order and Joint Proposal, the concerns that prompted the search for a new water supply were primarily focused on an immediate need to meet peak demand, as evidenced by UWNY requests for water conservation measures, and occasional air entrainment due to over-pumping in some bedrock wells (PSC 2006). In addition, average annual demand seemed to be approaching the water supply system capacity, efforts to increase supply fell short of estimated gains, and there did not seem to be a concrete plan to address Rockland County's water demand (PSC 2006).

Another concern, that led to the extensive investigation of the bedrock aquifer in Rockland County by the USGS, was Rockland County Department of Health (RCDOH) estimates of withdrawals from the aquifer that were higher than would be sustainable, and possibly greater than the amount of natural recharge to the aquifer (Heisig 2010). Prior to the USGS hydrologic study completed in 2010 to examine water resources in Rockland County, there was little recent hydrogeologic information on which to evaluate the conditions of the bedrock aquifer. The last overall hydrogeologic study of the bedrock aquifer in Rockland County completed by the USGS was in 1959, and the RCDOH evaluation relied on recharge estimates from a 1979 report prepared by a consultant for Spring Valley Water Company Inc.

Since the 2006 Rate Order and Joint Proposal, and UWNY's selection in 2007 of a desalinization plant as the preferred new water supply project, many factors affecting the perceived need for the new water supply project have changed. There have been two USGS reports published about the water resources in Rockland County. UWNY customers have also seen considerable water rate increases; there have been additions to the water supply system capacity through short-term measures (called for in the 2006 Joint Proposal), and there have been numerous letters from elected officials voicing concerns that many new factors may make a major new water supply project unnecessary (PSC 2013a). In addition, projections of average and peak demand have generally decreased, actual demand has continued to decrease, the estimates of recharge to the aquifer have generally increased, and Rockland County has new tools at its disposal for managing its water supply.

The current PSC proceeding recognizes that this new information is important in re-evaluating the water supply system in Rockland County. This report will focus on reviewing the new information from a hydrologic perspective, and will illustrate the extent to which UWNY failed to properly use this new information in it submittals.

2.1 Summary of System Capacity and Demand Projections

The documents produced by UWNY to support the Haverstraw Water Supply Project contain information about the current and planned water system capacity, historic annual average water production, as well as multiple demand projections. Figure 1 provides a summary of this data taken directly from the UWNY August 2013 report, the UWNY 2012 Draft Environmental Impact Statement (DEIS), and the PSC 2006 Rate Order and Joint Proposal. The UWNY system capacity from 2006 to 2012

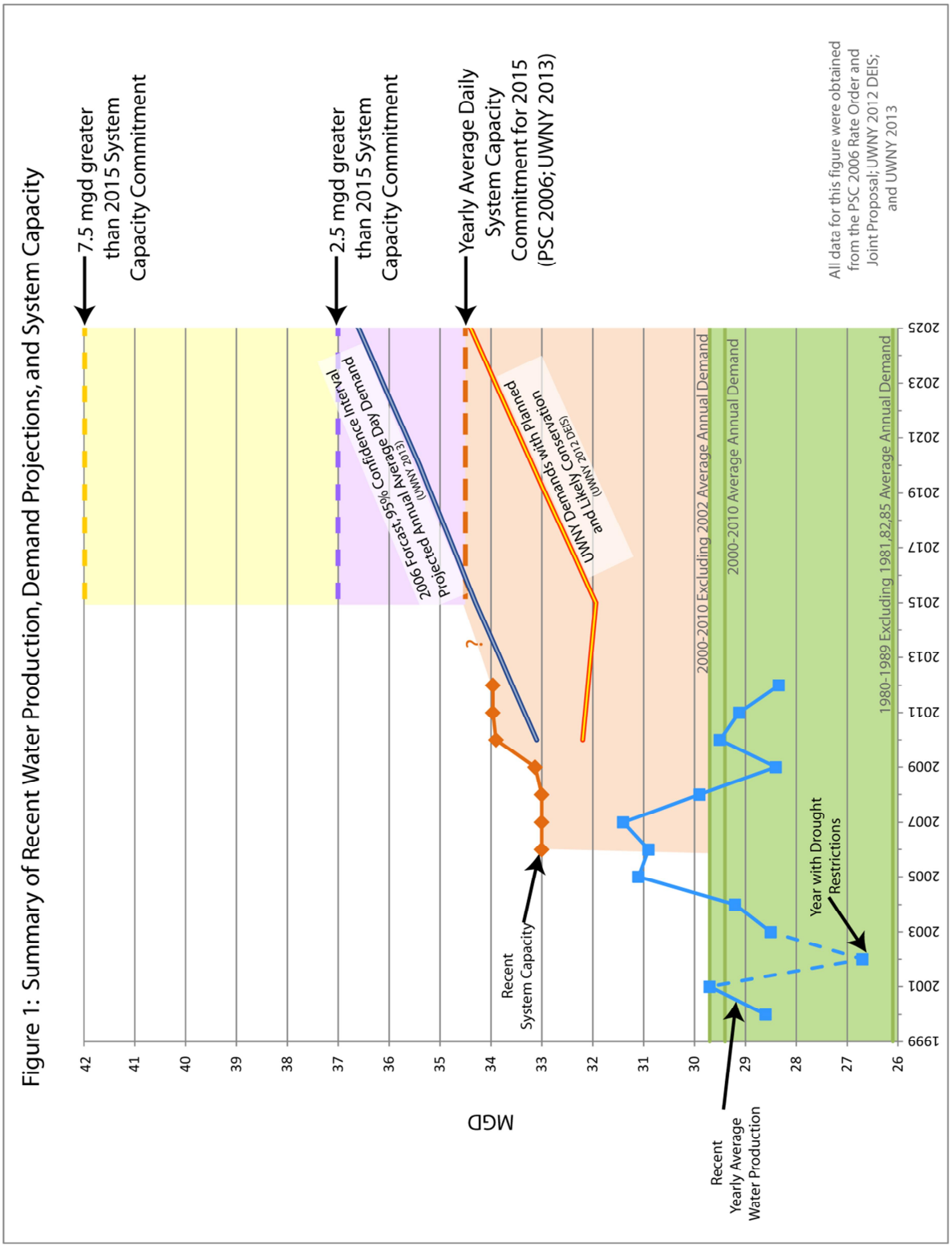
Figure 1: Summary of Recent Water Production, Demand Projections, and System Capacity
7.5 mgd greater than 2015 System Capacity Commitment
2.5 mgd greater than 2015 System Capacity Commitment
Yearly Average Daily System Capacity Commitment for 2015 (PSC 2006; UWNY 2013)
All data for this figure were obtained from the PSC 2006 Rate Order and Joint Proposal; UWNY 2012 DEIS; and UWNY 2013
2006 Forecast, 95% Confidence Interval Projected Annual Average Day Demand (UWNY 2012 DEIS)
UWNY Demand Conservation with Planned and Likely Compensation (UWNY 2012 DEIS)
Recent System Capacity
Recent Yearly Average Water Production
Year with Drought Restrictions
2000-2010 Excluding 2002 Average Annual Demand
2000-2010 Average Annual Demand
1980-1989 Excluding 1981,82,85 Average Annual Demand
MGD
42
41
40
39
38
37
36
35
34
33
32
31
30
29
28
27
26
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
2021
2023
2025

is shown on Figure 1 as well as the 2015 system capacity of 34.5 mgd mandated by the 2006 and 2010 Rate Orders.

UWNY has confirmed that they will be able to meet the 2015 system capacity goals. The figure shows the actual yearly average water production from 2000 to 2013 as well as the annual average demand from 1980-1989 and 2000-2010 with the respective exclusions as calculated by UWNY. The highest annual average productions occurred in 2005 to 2007 (for a maximum of 31.4 mgd in 2007) but have sharply decreased following 2007. It is interesting to note that in Figure 3 of the August 2013 report, the 2006 95% Confidence Interval demand projection is higher than the high 2005-2007 average annual demand, and average annual demand only exceeds this line once in a 33 year record (UWNY 2013). This indicates a very conservative demand estimate. It is shown on Figure 1 of this report to illustrate the demand projection that UWNY continues to defend and to mark an extreme upper bound of demand.

Figure 1 clearly shows that even UWNY's 2006 95% Confidence Interval demand estimate for 2025 is only 2.1 mgd greater than the expected 2015 system capacity. In addition, UWNY's 2006 95% Confidence Interval demand projection does not include any consideration of conservation or rate increases.

The second demand projection shown on Figure 1 of this report represents the UWNY demand projections with the "planned and likely" conservation from fixture replacement and non-revenue water reduction as provided by UWNY in Appendix 1-6 of the 2012 DEIS. This projection (which does not account for any additional conservation efforts that Rockland County could initiate) shows that demand is not expected to surpass the 2015 system capacity through 2025.

Figure 1 also includes the planned system capacity of the proposed new water supply project. A system capacity increase of 7.5 mgd would bring the total system capacity to 42 mgd even if no other improvements to existing sources were made beyond 2015. The UWNY's 2006 95% Confidence Interval demand forecast projected out to 2035 does not exceed 39 mgd. Again, this demand project was made without consideration of any additional conservation, even the conservation that UWNY believes is likely. I will refer back to the importance of this overly-productive (i.e. excessive) supply plan later in the report, and how it biases the UWNY evaluation of the need for the new long-term water supply project.

3. New Hydrogeologic Information From USGS Reports 2010

In 2010, the USGS published two studies that examined the water resources of Rockland County, including the hydrogeology of the bedrock aquifer that underlies most of Rockland County and provides about a third of the County's water supply. These hydrologic investigations found that the aquifer is healthy and resilient. If properly utilized, the scientific information and models provided by the USGS can prove to be powerful tools to help UWNY and Rockland County optimally manage their water resources.

The USGS studies resulted in valuable information for use in Rockland County water supply planning including hydrologic data, improved monitoring, and more accurate estimates of hydrogeologic parameters such as recharge. These data can be used in the evaluation of the need for a new water supply and in management decisions about the UWNY water supply in order to make the system more reliable. It can also help to guide future water supply planning and county development in a way that will be most efficient and protective of the water supplies. Other useful information that was derived from the study include the identification of the most stressed wells, identification of losses from the system, identification of possible ways to make better use of existing water supplies, and the development of a bedrock aquifer model. Continued scientific investigations into the groundwater and surface water resources of Rockland County should be incorporated into any future water management plan, in order to minimize the case where regulatory decisions need to be made without the underlying science to inform them.

3.1 Overall Aquifer Groundwater Level Trend is Not Decreasing

Groundwater levels in Rockland County have remained stable in recent years (Heisig 2010). Groundwater withdrawals are not occurring at a rate greater than the rate of aquifer recharge, as had been previously estimated. The aquifer is producing at a sustainable rate, and may have additional available yield as discussed in Section 4.2. Groundwater levels are drawn down in the summer due to increased withdrawals, but the aquifer rebounds quickly when the well fields are rested. Groundwater levels in the Rockland County aquifer have declined in the past during periods of lower precipitation and recharge, but have always recovered fairly quickly once precipitation amounts returned to normal.

3.2 Aquifer Recharge Greater Than Originally Estimated

Recharge estimates when the 2006 Joint Proposal was constructed were based on very rough estimates from a 1979 study of water resources in Rockland County. While recharge does vary with the amount of precipitation, a range of recharge estimates was established by the USGS 2010 reports, as well as calculations of the percent of recharge being withdrawn at several locations. These estimates of recharge were substantially greater than previously estimated (even when taking into account the wetter period in which they were evaluated). Also, much less of the recharge was being used for water supply than previously suspected based on the older recharge estimates. In addition, previous calculations from the RCDOH estimated that between 88 and 145 percent of recharge was being withdrawn for water supply (Heisig 2010). Estimates from the recent hydrogeologic study by the USGS

found that historically and in 2006, withdrawals for public water supply were only about 12 to 24 percent of recharge in the three watersheds evaluated (Heisig 2010).

3.3 Newark Basin Aquifer Model

The USGS report written by Yager and Ratcliffe (2010) presents a comprehensive hydrogeologic study of the Newark basin aquifer in Rockland County. Several groundwater flow models were produced to simulate groundwater flow to the Spring Valley well field and regional flow through the bedrock aquifer. These models were used to delineate capture zones for Rockland County's well fields, determine groundwater age within the Newark basin aquifer, and to assess the effect of varying recharge and withdrawal rates on water levels within the aquifer and discharge to streams. Important hydrogeologic properties such as recharge rates, aquifer storage properties, and transmissivity were also estimated.

Recharge rates, estimated with the use of the groundwater flow models, averaged about 19 inches in 2006, are similar to those presented by Heisig (2010), and are generally higher than the 1979 estimates (LBG 1979), again supporting the fact that the Newark basin aquifer is healthy. Three-dimensional capture zones for 30 well fields were delineated using transient simulations with 10 years of extraction data. These models can potentially be used by UWNY and Rockland County to determine the appropriate placement and pumping rates of new water supply wells and to more efficiently manage existing wells. The models in their current form, or with refinements to add local hydrogeologic and surface water features, provide a good representation of aquifer-wide flow, capture zones and water budgets (Yager and Ratcliffe, 2010), and could be an extremely useful tool for Rockland County.

UWNY's review of the USGS modeling study is incorrect. UWNY stated that "The modeling report helps address "groundwater sustainable yield", by including simulations of the historic period that included the drought-of-record."; and that "the historic period simulation efforts provide indications of yield limitations due to severe drought that confirm UWNY assessments pointing to the need for sufficient alternative supply sources." These statements are misleading because the USGS modeling report does not address "groundwater sustainable yield". With additional historical data to better calibrate long term pumping scenarios, UWNY could address the issue of "groundwater sustainable yield" using the USGS models, but the modeling study did not address this issue. These models could be used to great benefit by UWNY to help determine which management practices best maintain water levels in the Newark basin aquifer.

4. UWNY Response to New Information in the 2010 USGS Reports

As part of my review, I evaluated the need for UWNY to develop a new long-term water supply source, particularly in light of the new information presented in the two 2010 USGS reports. UWNY has not established a clear hydrologic need for a new water supply project. While they assert that their operation of the bedrock well fields has been sustainable, UWNY offers no hydrologic discussion of its basis for managing withdrawals from wells that would allow an independent reviewer to evaluate the efficiency and optimization of its well field operations. The USGS report (Heisig 2010) systematically reviews the response of water levels in individual wells to pumping, but UWNY includes no such evaluation in their documents relating to the need for a new long-term water supply project. Instead UWNY disparages the USGS reports and fails to include new and relevant hydrologic data and information into the UWNY planning and evaluation process, as discussed in the sections below.

4.1 Insufficient Representation of Study Benefits

In the August 2013 report that UWNY submitted to fulfill the PSC requirement that they address "the most recent information relating to projected demand and need (PSC 2013a)," a discussion of the 2010 USGS reports was included only in the section titled "Rebuttal of Information Cited by Others as New Evidence Related to Capacity" and "Response to Comments" (UWNY 2013). They did not include any discussion of a proactive assimilation of the valuable scientific data, understanding, and tools provided by these reports into their ability to better manage Rockland County's water resources. To address the concern reported by the USGS (Heisig 2010) regarding aquifer stress during peak pumping periods, a quantifiable management plan, based on the best aquifer and surface water data available, showing that wells and well fields are being operated in a manner to minimize peak stress would be critical to understanding whether an additional supply source is needed. UWNY stated that the 2010 USGS hydrologic study reports were "misleading", "biased", and "unhelpful in providing useful guidance for water planning purposes" (UWNY 2013; UWNY 2012). This characterization of the USGS hydrologic investigations is incorrect and short-sighted, and may indicate a predisposition on the part of UWNY to secure the need for its selected water supply project rather than utilize the recent and potentially very useful hydrologic information. In fact, the August 2013 UWNY report does not even mention that one of the products of the USGS reports was a hydrologic model, a powerful and commonly used tool to evaluate and manage groundwater aquifers, and does not include any discussion that they have attempted to use or adapt the model to evaluate sites for new wells, optimize the timing of withdrawals from groundwater wells, or perform any analysis of aquifer sustainable yield.

UWNY's response to some commenters' suggestions that the information in the 2010 USGS reports would reduce or eliminate the need for a long-term water supply project, is that those suggestions are simply "not correct." When this uninformative statement of denial is coupled with other comments in which UWNY claims that the title of the USGS report "misdirects the reader", that the report's commentary is "misleading", and that the principal author of the report has "implied bias" (UWNY 2012,

Appendix 8A-1), UWNY's review of the USGS studies seems partial and more focused on the defense of the proposed project than on the balanced application of the new data the USGS studies provide.

The fact is, the USGS Rockland County hydrologic study and groundwater modeling study, and their resulting reports, provide a wealth of hydrologic data and insight that UWNY could have used in evaluating options and formulating an integrated approach to future water supply for its customers in Rockland County. UWNY's consultant CDM, in its February 2011 memorandum transmitting to UWNY its review findings on the USGS studies (UWNY 2012, Appendix 8A-1), provided some glowing evaluations of the USGS work, including:

- "These reports provide important and useful foundational information related to comprehensive assessment of the portfolio of water resources available to the County's residents, businesses, and ecosystems."
- CDM calls the "[d]evelopment and calibration of a groundwater flow model for an important portion of the County's overall groundwater system" a "significant product" from the studies.
- CDM notes that "[t]he USGS reports demonstrate the value of the two studies, primarily through the identification of key factors related to short-term and long-term sustainability of the County's water resources."

The USGS reports provide a valuable framework of hydrologic information, as well as a robust well-calibrated hydrologic modeling tool, that are not available to many counties and water companies in the planning stages of a water supply study. These resources should have been better utilized by UWNY in its project planning and alternatives evaluation. In review of the continued need for a major new water supply source, UWNY's evaluation of the "No Action" and "Operational" alternatives in the DEIS which could prevent the need for any new major project, should have been quantified and re-evaluated in consideration of the data and tools from the 2010 USGS studies.

UWNY is contradictory in their comments on the USGS reports and say both that these reports "provide important and useful foundational information related to comprehensive assessment of the groundwater resources available to the County…" and that "The USGS reports alone are not a comprehensive assessment of County water resources…" (UWNY 2012, Appendix 8A-1). UWNY could have considered that providing a "comprehensive assessment" on a county scale is a tall order for any single study performed within the constraints of timeframe and budget, and should have dug deeper into the USGS reports to use the data available there. The UWNY August 2013 report cites three pieces of information they viewed as lacking from the USGS reports including the "average annual amount of water available from selected water basins," "a summary of overall annual recharge," and the land area needed "to balance groundwater withdrawals from a domestic well" (UWNY 2013). UWNY should have recognized that these reports provide the tools and framework for those pieces of information to be calculated by other parties, including UWNY, in a way that would be more useful to their specific goals than generalized averages. Also, surface water resource data, which UWNY says is lacking in the USGS reports, is precisely the kind of information that UWNY could have been compiling as part of its preparation of the DEIS, to merge with the USGS study data to evaluate integrated or operational water supply alternatives that would avoid a need for the new long-term water supply project. To this point,

CDM in its review memo considers the USGS model to be "supplementary (or complementary) to the other documented resource-sustainability assessments of County-wide water resource sustainability." Unfortunately, UWNY presented the least informative view of the USGS work, and did not make the effort to properly incorporate the USGS study information and tools into its re-evaluation of the need for a new major water supply project.

In the DEIS Appendix 8A.1, UWNY suggests that the "...USGS and UWNY should work together to identify the limited number of potential new groundwater source locations and associated yields, which will be useful in support of UWNY's current short-term water supply program." This may sound like an inviting and collaborative statement on UWNY's part. But it may also demonstrate that UWNY, and not the principal author of the USGS report, is the biased party in these hydrologic assessments. Rather than suggesting a full-ranging collaborative technical effort to incorporate a hydrologic-science-based approach to managing water supply in Rockland County, UWNY is in essence saying to the USGS that they would like to collaborate so the USGS could suggest a few places where UWNY might try to put a few new bedrock wells for very limited short-term water supply relief, while UWNY continues to anchor on its large scale long-term engineering water supply project. It would be more productive and more beneficial for the water rate payers of Rockland County, if UWNY were to enter into a dialog with USGS and other independent experts regarding the potential use of the USGS study, its data and findings, and its hydrologic model for Rockland County to support a scientifically based planning and evaluation of water supply project need and alternatives.

UWNY states that "contentions that the USGS study concluded that Rockland's groundwater supply is far healthier than originally reported to the PSC in 2005 are erroneous" (UWNY 2013), but it does not explain why they believe the statement is incorrect. The USGS studies clearly show that recharge to Rockland County aquifers (approximately 18 to 27 inches for 2006) are significantly greater than previously estimated for 2001 and 2002 from the 1979 recharge estimates (Heisig 2010), which is important because these earlier recharge estimates were noted as a reason why the USGS studies were initiated. The USGS studies were not meant to determine whether or not a new water supply project was needed, but to provide the public and any other interested party with the best new scientific information and tools relating to Rockland County's water resources. The August 2013 UWNY report fails to incorporate new data from the USGS study into their re-evaluation of the need for the new long-term water supply project, and thus fails to meet the PSC requirement for a summary of new information related to the need for the proposed project.

4.2 UWNY Presented a Misleading Confirmation of Need

The UWNY 2013 report stated that, "Overall, the [USGS] report confirms that a long-term water solution is needed to meet future demands, because of the uncertainty of current drawdown levels and the constrained opportunity for significant additional yield from the Newark Basin Bedrock Aquifer." This is a misleading statement that appears to be a confusing re-iteration of comments from CDM (UWNY 2012, Appendix 8A-1) submitted to UWNY about the USGS report. There is careful wording on the part of UWNY and CDM on this that needs to be examined closely. UWNY's statements in this regard are a carefully crafted reworking of statements contained in CDM's review of the USGS studies. It is important

to note that UWNY says here that a "water solution" is needed, not a water supply project. The USGS report (Heisig 2010) lists many water issues that will continue to need management, particularly if Rockland County sees increased development, and most of these water issues would not be solved by increased water supply, but might, in fact, result in additional burdensome expenditures by the county and affected municipalities. These issues include stormwater runoff, high flows and groundwater seepage into sanitary sewers, and export of water outside the bounds of Rockland County (USGS 2010).

The two lines of evidence that UWNY presents to assert that the USGS report confirms the need for a "water solution" provide little proof that a new water supply is needed. The "constrained opportunity for significant additional yield from the Newark Basin Bedrock Aquifer" presumably comes from CDM's comment that:

> The potential for development of significant additional yield from the Newark Basin Bedrock Aquifer faces several constraints. Some of them hinge on technical, hydrogeologically-related factors, while others stem from regulatory programs or legal agreements; however, all of them have been addressed in concept or analytically in the USGS studies. The results help confirm UWNY-cited limitations on bedrock aquifer development, which have been reported in project approval related documents. (UWNY 2010, Appendix 8A-1)

While the CDM comments acknowledge that the bedrock aquifer supply has some limitations, this merely suggests that it is not appropriate to expect to produce 7.5 mgd additional from the bedrock aquifer under the current efficiency levels, including leakage to sewer systems, leakage from water pipes and unmetered use of water. However, as shown in Figure 1 and discussed earlier, demand forecasts do not predict an additional 7.5 mgd system capacity will be needed. Additional increases in bedrock aquifer production are expected and will contribute in part to the future water system of Rockland County. UWNY reports that they expect to yield an additional 1 to 1.5 mgd from groundwater sources (UWNY 2012, 18A).

CDM also interprets one of the results of the modeling study (Yager and Ratcliffe 2010) as "valuable indications of likely zones-of-capture for bedrock water supply wells, as well as the basis for mapping-out areas of concern related to potential future aquifer-resource development. The identification of such limitations helps confirm the extensive set of constraints facing the attempted development of new bedrock aquifer supplies" (UWNY 2012, Appendix 8A-1). In terms of the ability to develop new wells, the CDM comment above suggests that the space limitations for new well development could be used as an argument for why UWNY needs to develop a new water source. These limitations should be viewed as an improved understanding that will help UWNY manage the bedrock aquifer in an optimal way, which could potentially allow for more reliable yields and help them more efficiently site location for the development of new wells since they have a better understanding of which areas are under-utilized.

4.3 UWNY Performed an Inadequate Evaluation of Operational and Management Options

UWNY and its consultant CDM contend that UWNY has done a good job of evaluating hydrologic alternatives to meet the water supply requirements of its Rockland County customers. For example, in the August 2013 report, UWNY stated that "During preparation of the DEIS, United Water conducted an extensive evaluation of alternatives and combinations of alternatives, including conservation, to identify whether there are other prudent and feasible alternatives to the Proposed Project that would meet the projected future need for additional water supply in Rockland County in the long-term future" [emphasis added]. UWNY further represents that it has evaluated "all of the alternatives identified in the USGS study." CDM, in its February 2011 memo states that "UWNY has evaluated water resource alternatives at great length in the draft environmental impact statement ("DEIS") for the Haverstraw Water Supply Project ("HWSP")" [emphasis added] (UWNY 2012, Appendix 8A).

I disagree with the assessments of UWNY and its consultant regarding the quality of UWNY's alternatives evaluation. UWNY has not conducted a proper evaluation of the ability of integrated hydrologic alternatives to meet the actual future demand of its Rockland County service area. UWNY's evaluations are incomplete, improperly founded, and misleading; and they lack the transparency required for an independent outside review of the UWNY evaluation methods, data, assumptions, and findings.

From my review, there are several glaring deficiencies and inaccuracies in the water supply need and alternatives evaluations reported by UWNY in its August 2013 report and in its DEIS. First, the 7.5 mgd increase in safe yield that the proposed project (the desalinization plant) can produce in the long-term is not an appropriate metric to use in comparing the ability of other methods to meet demand and avoid the need for a major new water supply source, particularly when those alternatives could demand far less capital and/or provide additional benefits to the county and ecological systems. Demand projections, even those produced by UWNY, do not predict the need for an additional 7.5 mgd above the expected 2015 capacity in the next twenty years extending to 2035. Comparing all the water supply alternatives, including those that do not include the necessity of developing a new water supply source, falsely gives the impression that whatever alternative or alternatives are evaluated and selected must be able to compete, volume-wise, with the potential output of a large engineered water treatment plant. In doing this UWNY has unfairly biased the evaluations against conservation and hydrologic system management based alternatives.

The second major deficiency in the UWNY approach is the unnecessary requirement, incorrectly imposed by UWNY in some of its evaluations, that the particular alternative being evaluated must meet ALL of the 7.5 mgd demand. Claiming that combining two infrastructure-based alternatives might be less feasible and more expensive than one larger infrastructure-based project, is not a valid approach for evaluating the hydrologic system management and operational based approaches. If a combination of conservation, improved operational efficiency, improved management and better integration with other county needs such as storm water and wastewater management could negate the need for a major new

water supply source, these options should be combined and utilized to their fullest before a new source is developed. In fact, UWNY states that this is part of their mandate, to "undertake all reasonable efforts to reduce and control future demands to bring them into balance with supply" (UWNY 2012, Chapter 1). While it might make sense to plan an engineering project much larger than required, measures that would prevent the need for it should not be compared to the same yield.

UWNY also fails to provide support for several of its key assertions and fails to provide the necessary information in its various evaluations to allow an outside review to check or assess the UWNY conclusions. For example, in terms of this PSC proceeding to determine the need for a new long-term water supply source, the most important alternatives listed in the DEIS are the "No Action" and "Operational Alternatives" because these are the options UWNY should pursue with or without a new water source, and they are the options that could make the new water source unnecessary.

From a hydrologic perspective, one of the most important options mentioned was the Integrated Water Resources Management Program. UWNY provides only a short paragraph mentioning that they are pursuing this management option. The language also suggests that the water system has not been operated in a methodical, integrated optimal way in the past, and integrated water management is only now being pursued. The 2010 USGS reports support the idea that some wells are more stressed than others and respond differently to stresses than others. While there is no data provided to evaluate this question, it would be important to understand if water shortages in the past could have been avoided if UWNY had better information about the hydrogeology of its well system and could have managed pumping in a more optimal way. This lack of transparency, and lack of data or explanation about important water supply management issues, obviously works to the advantage of UWNY in supporting the project it has already selected, and works very much to the disadvantage of those attempting to evaluate the need for the project and available alternatives.

Combining several of the operation alternatives mentioned in UWNY's DEIS could eliminate the need for a new long-term water supply. Although the DEIS gives the impression that UWNY considered all of these options, crucial information that would allow for an informed decision is missing and the presented information is misleading. An in-depth evaluation of several of these alternatives was not conducted, or if so, was not presented in the DEIS. For example, spill skimming from Lake DeForest was listed as an operational alternative, yet no information was provided as to how much water spills over the Lake DeForest dam on average, or how much water this could add to Rockland County's water supply. UWNY considers this a valid option, and is pursuing it, yet spill skimming is not considered part of the long-term water supply project. Why not?

Aquifer storage and recovery (ASR) is also considered part of a short-term plan, but this could be a significant part of a larger plan with combined alternatives. The DEIS lists ASR as an option, but does not provide necessary information regarding the amount of water that could be added to the aquifer to be extracted when needed. UWNY states that the safe yield derived from a combined alternative approach would be "unlikely to reach 7.5 mgd" and that "implementation of these alternatives is far from certain, in that they each involve extensive capital investment that would be cost-prohibitive and far beyond the

costs of the Proposed Project", yet no information is provided as to the possible cost of a combined alternative.

Additionally, in evaluating the wastewater alternative, wastewater treatment plants were excluded if they did not have enough effluent to produce the full 7.5 mgd. There was not an appropriate discussion or evaluation of the cost or feasibility of allowing a smaller wastewater treatment plant to be integrated into the existing system or of the additional benefits to Rockland County by integrating wastewater and stormwater management with the water supply system to reduce redundancy of infrastructure. A fair evaluation of these alternatives could show that a new long-term water supply project is not necessary.

5. CRITICAL EVALUATION OF UWNY ARGUMENTS REGARDING THE NEED FOR A NEW LONG-TERM WATER SUPPLY SOURCE

The use of 7.5 mgd as the increase in safe yield that an alternative option is required to provide inappropriately applies an inflated value based on the production capabilities of a desalinization plant and not the projected demand in Rockland in the next twenty years. UWNY defends the use of 7.5 mgd as a goal because of the need to apply a safe margin (UWNY 2012, 1-47), but planning a water system to the 95% Confidence level already takes a safe margin into account. As of December 2012, UWNY had increased the total average system capacity from 33 mgd in 2006 to 33.96 mgd. UWNY's own 2010 demand projections for 2035 are only 3.1 mgd (lower growth rate) or 4.1 mgd (higher growth rate) higher than the capacity they expect to have in 2015 (UWNY 2012, 1-45). UWNY compares each alternative to the Proposed Project and eliminates each by claiming that they will not increase safe yield by 7.5 mgd. While this may be true, there is no need for an additional 7.5 mgd. The PSC 2006 Rate Case Order calls for UWNY to plan a new long-term water supply project to meet future demand, but does not specify what increase in system capacity is needed beyond the 2015 commitments (PSC 2006). UWNY's demand projections through 2035 do not show water demand increasing by 7.5 mgd. Eliminating each alternative based on this number is inappropriate.

5.1 WATER SYSTEM LIMITATIONS

Limitations have been identified for various components of the UWNY water supply system. A major limitation identified by UWNY and other investigators is related to the ability of the water supply system to meet peak demand during seasonal periods of increased water use and during low precipitation conditions. The Ramapo Valley Well Field is limited by flow conditions in the Ramapo River and some of the other supply wells have experienced air entrainment when pumped continuously for too long.

UWNY estimates that new bedrock wells will each add 0.2 to 0.5 mgd additional capacity to the water supply system. They list the possibility of identifying suitable land in a sufficiently productive part of the aquifer and the time required to bring new wells on line as the primary constraints to developing new wells (UWNY 2012, pg.1-28). In regard to the ability of the aquifer to support additional wells, UWNY claims that the answer is unknown, an answer that is not particularly informative after a lengthy and costly planning study has been conducted by UWNY, and in light of the costly long-term water source decisions that must be made. UWNY does state that the USGS reports were initiated because concerns were raised about the sustainability of how the aquifer was being used and that, while the main concern was increased peak pumping, the aquifer has been able to recharge during normal pumping rates. UWNY has plans to continue to expand their groundwater yield by 1 to 1.5 mgd (UWNY 2012, pg. 1-29).

Additional improvements that UWNY intends to pursue in addition to the long-term water supply and groundwater resource development include an Underground Infrastructure Renewal Program, an Integrated Water Resources Management Program, and others, but they do not provide any quantitative combined estimate on the improvements to reliability, yield or efficiency of these projects (UWNY 2012, pg. 1-29). Because of this failure on the part of UWNY to provide information on its own

system for use in the planning process, these factors were not properly evaluated by UWNY, and cannot be evaluated by independent reviewers.

In the DEIS, UWNY addresses the possibility of not developing a new long-term water supply source in two of the listed alternatives. In the No Action Alternative, UWNY lists how it will operate the Rockland County water system if a new major water source is not developed. In the Operational Alternatives, UWNY includes water supply management options that would address Rockland County's water needs without a major new infrastructure project. As discussed in Section 4.3, the evaluation of these alternatives that could possibly allow Rockland County to avoid the need for a major new water supply source were not fully evaluated nor evaluated under the context of a reasonable water demand projection. UWNY does not supply any quantitative conclusions about the increase to the system capacity that could be realized by pursuing these options.

5.2 How Well Has UWNY Used New Information?

As initially discussed in Section 1.2, in 2013 the PSC requested that UWNY provide a statement of how it was incorporating new information into its assessment of the need for a new long-term water supply project and into its evaluation of alternatives. From my review, I have determined that much new information has been developed since the original 2006 impetus for this water supply planning process. I have further concluded that UWNY has done a poor job of incorporating new information in a number of areas including hydrogeologic data, factors affecting demand, and the better utilization of surface water sources, as discussed in the sections below. This failure to employ new information at its disposal is one of the major failings of the UWNY DEIS and August 2013 status reports.

5.2.1 Bedrock Aquifer

According to UWNY, Rockland County's water system's total average capacity will be 34.5 mgd and peak system capacity will be 52.6 mgd based on the "development of additional groundwater capacity" and as of January 2013, they had reached a total average capacity of 34 mgd and peak capacity of 51.8 mgd[26]. In the UWNY August 2013 report, section 3.0 and 3.1 (PROJECTED WATER DEMAND AND NEED: United Water's Rockland County System Capacity) and section 4.0 (UPDATED SYSTEM CAPACITY AND AVAILABLE SUPPLY) UWNY makes no reference to improving the utilization of sources based on new information, only their capacity increase. In section 4.3 of the UWNY 2013 report, instead of attempting to reconcile some of the concerns expressed about their plan and to incorporate plans for additional capacity, they devalue the information they should be using.

5.2.2 Peak Demand

In 2009 testimony to the PSC, Rockland County hydrologist Dr. Daniel Miller presented a graph showing that maximum day demand would likely reach 44.9 mgd in 2020 (slightly lower than his 2006 analysis result of 45.9 mgd) (Miller 2009). The 2015 system peak capacity is required to be 52.6 mgd by 2015 (UWNY 2013). Using the regression equation presented on the graph (Miller 2009), the predicted

maximum day demand for 2035 would only be 48.1 mgd. If the peak demand commitment of 52.6 mgd, which UWNY in its August 2013 report re-affirmed it will meet by 2015, is used as a comparison, Miller's upper limit of 90% confidence in Exhibit DMM-1 would not be exceeded in the 2020 projection (Miller 2009). For a reference point, from 1970 to 2009, the upper 90% confidence bound was exceeded only twice. UWNY does not provide an analysis to update their peak demand estimates in the UWNY August 2013 report even though these were a primary reason for planning a new long-term supply project. UWNY asserted that their 2006 average annual demand projections were confirmed by updated estimates, although all but one method predicted lower demand, but there is no discussion of any re-evaluation of the peak demand (UWNY 2013, UWNY 2012).

5.2.3 LAKE DEFOREST

While much of the discussion about Lake DeForest has addressed the technical aspects of the permitting associated with it, UWNY has not provided, in the reports produced for the planning of the new long-term project, a comprehensive accounting of the water that enters and leaves Lake DeForest. While the safe yield of the reservoir is an important limitation in the worst drought, a very rare occurrence, the normal operations of the reservoir should not be limited by the safe yield as long as a sufficient amount of water is maintained in the reservoir. In order to understand how to efficiently manage the water resources in Rockland County, it is important to understand the water balance in Lake DeForest, one of its largest resources. It is simply not good management to put increased stress on the groundwater aquifers when there is water available from an existing surface water reservoir. While the permitting discussion is out of the scope of this review, an important first step for all who may need to decide on permitting decisions and the need for new water sources is to understand the true water availability from Lake DeForest.

UWNY states that:

> …the permit for Lake DeForest allows an annual average withdrawal of 10 mgd, and United Water's approach to meet water demands is to withdraw 10 mgd as an annual average from Lake DeForest with the remainder of the water being supplied by the other sources. In other words, United Water maximizes the use of Lake DeForest to the extent allowed by its permit and the amount of its safe yield that is reserved for Rockland County (10 mgd). (UWNY 2012)

Since the removal of the clause in the NY Department of Health permit for the Lake DeForest treatment plant that limited the annual production average to 10 mgd, the above statement from UWNY is no longer true. The safe yield during the worst drought conditions is still 20 mgd (with 9.75 mgd of that reserved for downstream uses), but in all other conditions, greater than 10 mgd average should be able to be withdrawn sustainably from Lake DeForest while still maintaining the required 9.75 mgd flow in the Hackensack River for downstream users.

6. Rockland County's Next Steps Toward Maintaining a Sustainable Water Supply Well into the Future

Realistic current and future estimates of water demand for the UWNY Rockland County system, coupled with an assessment of the County's water resources based on the most current trends, technology, and hydrologic information demonstrate that a new water supply project is not needed, and will not be needed for a period of time extending to at least 2025. This information also supports the position that there is adequate time to develop a superior, more robust, more sustainable water supply solution for Rockland County that may allow it to avoid a costly new major water supply project in the future beyond 2025.

An evaluation of UWNY's operation of existing well fields could identify additional supply via better operational procedures and management. The fact that UWNY would have to work a little harder to both identify these efficiencies and to adhere to the newly developed operating guidelines should not be an impediment to their implementation. Other hydrologic system analysis software tools could also be used to plan an appropriate solution for Rockland County's water future. For example, IRAS-2010 developed by Dr. Daniel Loucks at Cornell University in Ithaca New York, provides a platform for sophisticated analyses of water resource systems. The model is capable of examining water management given hydrologic inflows, evaporation rates, water allocation rules, reservoir release rules, consumptive water demands and minimum environmental flows, surface and groundwater storage, energy use and operating costs, and other important elements and constraints.

Rockland County is fortunate to have available for its use a high resolution, well calibrated, hydrologic model developed by the US Geological Survey. The model, which was designed for the express purpose of examining Rockland County water supply issues, includes aquifer recharge, stream discharges, well field extraction, and other key components of the hydrologic system. This model could be used by UWNY to explore hydrologic system based options (integrating all parts of the water system) for water supply and water management

To address the water demand increase of approximately 25 % during the summer season, several actions that adhere to a hydrologic system based solution will reduce the stress on the county's aquifer systems, making them more reliable during peak production.

- Year-round demand reduction
- More efficient operation of existing well fields
- Incorporation of withdrawals from additional existing wells that are currently out of service or underutilized
- A distributed well network allowing well cycling and well field rest throughout the summer to improve recovery
- Addition of wells in strategic locations to provide additional supply and support the concept of distributed withdrawals
- Increased use of surface water sources to reduce stress on the aquifers
- Aquifer storage and recovery

- A well planned and managed program of conjunctive surface water and groundwater use
- Supplementing surface sources with routed storm water and/or treated wastewater

In the DEIS (Chapter 18A, page 18A-3) UWNY claims that "A combination or composite of more than one alternative would be less efficient, inherently more energy-intensive, more costly, and more prone to disruption and repair. A combination of alternatives would also require substantially more management by United Water to oversee both construction and operations of these multiple systems." However, UWNY does not support the claim that combining alternatives would be more difficult or costly to Rockland County. Making the most efficient use of limited natural resources may require management and using all the possible resources in conjunction with each other. UWNY has not done a comprehensive evaluation of the benefits to the current and future rate payers of Rockland County in terms of water supply, treatment, waste and infrastructure costs associated with combined hydrologic system management versus a supply only solution to their water needs.

One of the added benefits of an integrated approached to county-wide water resource management is that solutions can solve more than one problem and not exacerbate other problems. As discussed earlier, the recent USGS reports (Heisig 2010) highlight many of the water issues besides supply that Rockland County will face in the future. Among these issues are stormwater runoff, high flows and groundwater seepage into sanitary sewers, and the export of water outside the bounds of Rockland County. Additionally, any increases in water supply demand will also create large volumes of wastewater that the county treatment plants and infrastructure will need to accommodate.

If development increases without planning for appropriate stormwater management, Rockland County could experience increased flooding. An integrated plan for water resource might tie future stormwater management and wastewater treatment to the water supply system, such that the expense would solve multiple problems at once.

UWNY has argued that many of its surface water withdrawal permits are limited by the amount of flow or volume that must be maintained in surface waterbodies. They have also argued that they examined all possibilities of using wastewater or stormwater to increase the water system safe yield. However, as I have discussed above, all alternatives that would not result in 7.5 mgd increases to safe yield were excluded. A proper analysis of integrated water resource planning is UWNY's duty to the rate payers of Rockland County, and has the potential to support a finding that a costly new large-volume water supply project will not be needed in the future.

7. CONCLUSION

A thorough review of the available information regarding Rockland County's hydrologic conditions and projected water supply, including documents released by UWNY and reports published by the USGS, has shown that there is no need through 2025 for a new long-term water supply source in Rockland County. The assertions by UWNY to the contrary are incorrect, are based on outdated assumptions and data, and in many instances are based on determinations by UWNY that lack sufficient information and data to allow an independent external review.

The UWNY increased average daily supply "requirement" of 7.5 mgd is a phantom, based on the potential output of their selected desal plant option, and not on their actual demand projections through 2035. Expected demand, as projected by UWNY's own data through the standard ten year planning interval to 2025, are far less than 7.5 mgd (see Figure 1 of this report) and, when "planned and likely" conservation is considered, DO NOT EXCEED UWNY's committed supply numbers through at least the year 2025 (and likely beyond if UWNY's data were brought into line with more reasonable estimates).

UWNY's use of the 7.5 mgd increased supply "yardstick" against which to evaluate hydrologic system based alternatives (e.g. additional groundwater withdrawals, quarry storage, surface water replenishment of well fields, greater reliance on surface water to rest well fields thereby increasing their yield in periods of greater demand, etc.) was improper on many counts.

First, as stated above, projected demand requires much less than a 7.5 mgd increase in supply, will not exceed expected supply by 2025, and does not support the need for a new long-term water supply project. Thus, the evaluation of alternatives for an unnecessary future supply does not provide decision makers with useful information (especially in the way UWNY did it; see second and third items below).

Second, an evaluation of hydrologic-system-based water resource alternatives against a "goal" of 7.5 mgd safe yield increase is improper and appears designed to exclude any alternative that is not a desal plant. Various components of the hydrologic system in Rockland County are capable of providing additional supply in ways that can contribute positively and substantially to meeting demand; but any of these sources taken alone cannot be expected to provide as much water as a large engineered treatment plant. This, however, is not a proper basis for completely excluding a particular hydrologic alternative.

Third, the proper supply alternatives evaluation, which would include an assessment of combinations of hydrologic alternatives against a more realistic demand estimate, was never performed by UWNY. Such an evaluation would likely show that one or more of the operational and management alternatives supplementing the UWNY committed 2015 supply would comfortably meet demand through 2025. This evaluation finding, as I have stated above, would further support the conclusion that a new long-term water supply source for Rockland County is not needed.

What is also troubling from my review, in addition to the inflated system capacity goals and improper weighing of alternatives, is the lack of support for many of the determinations submitted by UWNY in its

reports. In some instances this is caused by a failure on the part of UWNY to include new information into their previous findings; a strategy, deliberate or not, that allowed them to continue to assert the need for a new water supply and allowed them to continue to favor a desal plant alternative. For example, UWNY disparaged the USGS reports that contained valuable new hydrologic information, and failed to include that new information that was clearly requested by PSC in UWNY's August 2013 report.

In other instances UWNY made assertions or stated conclusions with no apparent quantitative analysis or support. This makes it virtually impossible for an external reviewer to evaluate the validity of the UWNY statements and underlying analyses (if analyses were in fact performed). For example, UWNY stated that additional supply from the bedrock would be limited, but provided no hydrogeologic study data to support the conclusion. UWNY also determined that the many system enhancements and management improvements listed in the "No Action" and "Operational" alternative sections of the DEIS could not meet the purpose of the proposed project but provided no reviewable basis for its statement. One example of this is UWNY's discussion about Lake DeForest spill skimming where they indicate that they could use the excess water and allow bedrock wells to rest. However they include no quantitative estimate of the amount of water that could be used in an average year.

In summary, my review of the current and projected Rockland County New York hydrologic conditions, water demand, and water resource factors, including supply alternatives and management actions, has led me to conclude that a new long-term water supply project for the UWNY water system in Rockland County for the period through 2025 is not needed.

REFERENCES

Heisig, P.M., 2010, Water resources of Rockland County, New York, 2005–07, with emphasis on the Newark basin bedrock aquifer: U.S. Geological Survey Scientific Investigations Report 2010–5245, 130 p., at http://pubs.usgs.gov/sir/2010/5245.

Leggette, Brashears & Graham, Inc., 1979, Hydrogeologic assessment of Rockland County, New York: 72 p., 5 pls.

Miller, D.M., 2009, County of Rockland direct testimony of Dr. Daniel M. Miller, Exhibit DMM-1: P.S.C. Case No. 09-W-0731 at http://documents.dps.ny.gov/public/MatterManagement/CaseMaster.aspx?MatterCaseNo=09-W-0731&submit=Search+by+Case+Number.

Perlmutter, N.M., 1959, Geology and groundwater resources of Rockland County, New York: State of New York Department of Conservation, Water Power and Control Commission, Bulletin GW–42, 133 p., 4 pls.

State of New York Public Service Commission (PSC), 2006, Case 06-W-0103 – Proceeding on motion of the Commission as to the rates, charges, rules and regulations of United Water New York Incorporated for water service: Order approving merger and adopting three-year rate plan (Issued and Effective December 14, 2006) at http://documents.dps.ny.gov/public/MatterManagement/CaseMaster.aspx?MatterCaseNo=06-W-0131&submit=Search+by+Case+Number.

State of New York Public Service Commission (PSC), 2013a, Case 13-W-0303 – Proceeding on motion of the Commission to examine United Water New York, Inc.'s development of a new long-term water supply source: Order Instituting Proceeding (Issued and Effective July 19, 2013) at http://documents.dps.ny.gov/public/MatterManagement/CaseMaster.aspx?MatterCaseNo=13-W-0303&submit=Search+by+Case+Number.

State of New York Public Service Commission (PSC), 2013b, Case 13-W-0303 – Proceeding on motion of the Commission to examine United Water New York, Inc.'s development of a new long-term water supply source: Study of Rockland County's water needs gets underway - Commission proceeding to examine development of new water supply sources: Press Release at http://documents.dps.ny.gov/public/MatterManagement/CaseMaster.aspx?MatterCaseNo=13-W-0303&submit=Search+by+Case+Number.

United Water New York Inc., 2012, Haverstraw water supply project Draft Environmental Impact Statement.

United Water New York Inc., 2013, United Water New York Inc.'s report on the most recent information relating to projected demand and need for a new long-term water supply source in Rockland County: Response to PSC Order (Case 13-W-0303).

Vanderhoef C.S., and Cornell H.D., 2011, Rockland tomorrow: Rockland County comprehensive plan: at http://rocklandgov.com/files/4513/5067/1656/Rockland_Tomorrow.pdf

Yager, R.M., and Ratcliffe, N.M., 2010, Hydrogeology and simulation of groundwater flow in fractured rock in the Newark basin, Rockland County, New York: U.S. Geological Survey Scientific Investigations Report 2010–5250, 139 p., at http://pubs.usgs.gov/sir/2010/5250/

APPENDIX A
CURRICULUM VITAE OF CHARLES F. MCLANE III, PH.D.

CHARLES F. McLANE III **MCLANE ENVIRONMENTAL, L.L.C.**
Principal

Education

1984 Ph.D., Environmental Sciences (Hydrogeology), University of Virginia
1978 M.S., Geology (Hydrology), Colorado State University
1974 B.A., Geology, Susquehanna University

Experience

Dr. McLane is a Principal and founder of McLane Environmental, L.L.C. He has over 25 years of diverse experience in environmental regulatory matters, investigations, and analyses. Dr. McLane specializes in groundwater flow system analysis, and in the fate and transport of chemical contaminants in the subsurface, including the use of computer simulation and digital graphic techniques to support risk assessment and remedial engineering investigations. Dr. McLane has assisted numerous corporate clients and their counsel in responding to hazardous waste regulatory program requirements, and in developing the technical portions of complex litigation strategies. He has been called upon to serve as a technical expert in cases involving private party cost recovery, insurance claims, toxic tort, and environmental remediation issues. Examples of Dr. McLane's project and case experience are provided below:

Water Supply, Wastewater Disposal, Regulatory Compliance and Site Assessment Investigations

- Performed groundwater modeling investigation to support permitting of a new wastewater treatment plant for a cranberry processing facility in New England. Reviewed regional and site-specific groundwater studies, evaluated hydrogeologic data, and directed the development and application of an analytic element groundwater model of wastewater infiltration beds to assure proper location of monitoring wells under the permit. Discussed results with regulatory agency and submitted technical report summarizing approach and findings.
- Provided hydrogeologic expertise to a township in northeastern Pennsylvania in reviewing portions of a rock quarry application. The application included plans for groundwater extraction and reinfiltration based on a three-dimensional groundwater flow developed for the proposed quarry site. The review included site geology and hydrogeology reports, the results of bedrock aquifer pumping tests, studies of surface water streams and wetlands, and groundwater modeling analyses performed by the mining company. Findings were presented in an expert report and in testimony presented before the township zoning board.
- Managed groundwater modeling project to evaluate environmental impacts associated with upgrade of an existing wastewater disposal system for a recreational facility in New England. Project included groundwater flow and nitrate transport modeling within the shallow aquifer and to a nearby lake, and preparation of model summary report to accompany project engineering firm's permit application submittal to the State.
- Provided expert witness services on behalf of an industrial client in New Jersey whose facility was named as one of the potential contributors to organic chemical contamination at a small municipal well field. Analyzed site hydrogeologic and contaminant sampling data, well field water testing data, and operational history and sampling data for nearby landfill and other

potential sources. Prepared expert report and provided deposition testimony prior to the case settling.

- Served as consulting team leader and groundwater expert for a project designed to support water resource and land use planning decisions for a rapidly growing Florida county. Reviewed existing environmental science and engineering reports, and prepared a 300-page report summarizing key environmental information, and presented findings to Board of County Commissioners.
- Conducted technical peer review of a complex three-dimensional finite-element model to support design of a wastewater disposal system as part of a former defense installation development project in New England. Reviewed site hydrogeologic data, site conceptual model, and groundwater flow and mounding model, and prepared summary report for client.
- Oversaw the development of a groundwater flow model to support a water allocation permit application for an operating industrial facility in New Jersey. The model was designed to explore future configurations of production wells that were to be operated in a complex a multi-layered dipping bedrock aquifer near a major surface water body. Potential future drawdown was calculated, and particle tracking was employed to examine possible hydraulic effects on nearby facilities and surface water bodies.
- Managed a ground water modeling investigation to examine hydrologic impacts associated with proposed increased withdrawals at an operating municipal well field on Cape Cod. Obtained existing USGS aquifer model to provide for a highly cost-effective analysis of the proposed withdrawals, performed sensitivity analyses and engaged in technical discussions with USGS to guide model modification, simulated impacts of withdrawals on ecologically sensitive nearby surface water bodies, and presented results to client.
- Provided ground water consulting services for landfill Superfund site in New England. Performed ground water flow and plume transport modeling study for two-year remedy performance review, developed recommendations for site data collection, assisted in responding to regulatory agency recommendations contained in five year review, oversaw data management and analysis tasks including development of a comprehensive site data base and evaluation of monitored natural attenuation parameters for the site, and participated in planning of subsequent phases of site remediation.
- Conducted analyses of aquifer yield and potential saltwater intrusion to assist Cape Cod municipality with water management planning and identification of new source alternatives; engaged in technical exchange with U.S. Geological Survey regarding freshwater aquifer modeling analyses; presented findings to town leadership to support decisions regarding future plans.
- Served as hydrogeology and ground water modeling expert on an external advisory panel for a large southwestern Department of Energy facility. Reviewed technical information; met with installation management, staff and consultants; participated in meetings with regulators and public Stakeholders; prepared reports summarizing findings and recommendations, and performed external peer review for final project Hydrogeologic Synthesis Report.
- Performed analyses to support design and permitting of wastewater treatment facility for Cape Cod town. Developed computer model for Pilgrim Lens aquifer and conducted ground water flow, mounding height, flow path (particle tracking), and nitrogen loading analyses.

Participated in meetings with representatives of regulatory, governmental, and environmental oversight agencies, and provided testimony at public hearing.

- Conducted nitrate loading analyses for proposed residential development in sensitive ecological area. Developed analytical model for existing and proposed residential sources, and examined various loading scenarios. Prepared report for submittal to regulatory agency and responded to agency requests for supporting information.
- At the request of a PRP steering committee, reviewed technical documents describing site investigation and remediation activities for ground water contamination at a Superfund site in Pennsylvania resulting from injection well disposal into a fractured bedrock aquifer in the vicinity of a large municipal drinking water source. Prepared and submitted recommendations regarding additional work to be performed to support a proposed modification of the operating ground water remedy.
- Directed ISRA preliminary assessment for former pharmaceutical processing and packaging facility in central New Jersey. Negotiated approach with NJDEP, performed site inspection, and oversaw preparation of report that resulted in No Further Action letter.
- Assisted Cape Cod municipality in developing a comprehensive water management plan. Reviewed previous hydrogeologic investigations, conducted modeling analyses for proposed well fields, summarized information regarding previous saltwater intrusion modeling studies, and analyzed saltwater interface upconing as one of the primary limiting factors in establishing safe yields for the well fields.
- Directed ground water modeling investigation for well field on Cape Cod, Massachusetts to examine potential benefit of switching from central suction pump to distributed submersible pumps. Developed analytical element model of Pamet Lens section of the Cape and simulated effects of selected pumping schemes for various hydrologic conditions. Conducted analysis of potential saltwater upconing for various pumping schemes and saltwater interface depths corresponding to average and drought conditions.
- Served as project manager for a three-dimensional ground water flow simulation and particle-tracking analysis for an abandoned agricultural chemical processing facility in a northern Florida city. Analyzed potential impact of site releases on city water supply wells and nearby surface water to support a petition to exempt the site from listing as a Superfund site on the National Priorities List (NPL).
- Served as technical advisor to a township municipal utilities authority (MUA) in southeast New Jersey regarding ground water modeling conducted by a large energy company in support of a water diversion permit application. Performed review of modeling studies and recommended additional analyses that would lend stronger support to the preliminary finding that large withdrawals for steam generation would not adversely impact the ground water aquifer. Worked with energy company's consultants to modify model and improve analyses, and presented testimony before New Jersey Department of Environmental Protection at public hearing.
- Provided hydrogeologic assistance to engineering firm tasked with sitting and permitting a treated wastewater disposal basin for a proposed residential development in New England. Consulted on field data collection program, developed program analyses consistent with state

regulations, and performed geologic and computer modeling analyses to support permitting effort.
- Performed groundwater mounding analyses for a proposed municipal wastewater disposal system for a town in Massachusetts. Evaluated field testing results, performed mounding calculations and sensitivity analyses, and prepared report to support permit application.
- Directed Phase I assessments for commercial and industrial facilities and residential properties in New Jersey to identify conditions that may represent an environmental concern. Provided post-assessment assistance in obtaining air permits for a pharmaceutical production, packaging and shipping facility in central New Jersey.
- Managed an Alternate Concentration Limit (ACL) demonstration for a southeastern U.S. Department of Energy (DOE) hazardous waste facility subject to RCRA regulations. Compiled site-specific hydrogeologic, demographic, ecosystem, and waste-disposal history data pursuant to EPA ACL guidelines; prepared and submitted preliminary ACL report to Tennessee Department of Health and Environment.
- For U.S. Department of Energy (DOE), conducted a stochastic (Monte Carlo) modeling study of radionuclide migration from containers in a proposed northwestern US high-level nuclear waste repository in fractured crystalline basalt using finite-element transport code. The simulation technique was based on a statistical failure distribution for population of containers and a statistical assessment of subsequent releases relative to EPA and NRC guidelines.
- Prepared RCRA Part B Post-Closure Permit Applications for hazardous waste management units at a southeastern U.S. Department of Energy (DOE) facility. Compiled required waste disposal and environmental sampling information, and prepared plan for post-closure monitoring and maintenance.
- Assisted a midwestern corporation in evaluating environmental issues at several manufacturing facilities throughout the United States. Reviewed relevant site documents, met with headquarters and plant environmental staff and on-site consultants to review status of investigation and remediation efforts, and prepared reports of findings to support corporate decisions regarding future actions.

Remediation and Risk Assessment

- Directed development and application of a groundwater flow model to evaluate remedial alternatives for a landfill Super Fund site in Vermont. Analyzed conceptual designs for extraction trench and well array conceptual designs for capturing a mixed chlorinated solvent groundwater plume. Prepared model results and presented to remediation engineering firm.
- Provided groundwater modeling and hydrogeologic technical support services to a New York consulting firm who was assisting a local printing facility in complying with environmental regulations regarding investigation and cleanup of organic chemical contamination in soil and groundwater beneath and surrounding its property. Performed State-requested modeling analyses; prepared report summarizing data, methods and findings; and participated in conference call with prime consulting firm and State regulators to discuss results of analyses.
- Assisted major engineering contractor with soil remediation program for a portion of US Department of Energy facility in Oak Ridge, Tennessee. Built on system of calculated soil

trigger levels by performing soil zone modeling analyses incorporating vertical profile soil sampling results to establish chemical-specific soil cleanup levels. Prepared and submitted modeling analysis reports to project management team to guide remedial decisions.

- Managed the modeling portion of a focused feasibility study to examine likely influent rates and capture effectiveness of several conceptual trench designs for a landfill Superfund site in New England. Modified the existing site model to incorporate a trench design. Calculated flow to the model trenches, and employed particle tracking to examine the effectiveness of the various designs in capturing the known extent of VOC contamination. Worked with the client to redefine and retest selected designs, and prepared modeling report for submittal to EPA as part of overall focused feasibility study.
- Reviewed PRAP, and supporting RI and FS, for a New Jersey Superfund site contaminated with arsenic and VOCs. Examined technical basis for EPA proposed remedy, and performed data analyses to examine estimated ground water cleanup time and effectiveness of natural attenuation processes for VOCs. Assisted PRP committee in preparation of response comments for submittal to EPA prior to ROD issuance.
- Provided oversight and technical peer review for two ground water modeling studies of petroleum refineries located along the Delaware River. Modeling included the development of regional ground water flow models of the Potomac-Raritan-Magothy aquifer system in the vicinity of the sites, and refinement of the models to the site scale to support remedial design analyses.
- Performed technical review of ground water flow and contaminant fate and transport models for New York landfill Superfund site. Reviewed information on background hydrogeology and site conceptual model, examined model design and parameter values, and prepared technical report.
- Assisted the Los Alamos office of DOE, by serving as an independent expert in a review of ongoing and planned ground water modeling studies that were intended to provide support for ground water remediation studies and field data collection and integration activities. Attended a modeling program review meeting with other experts and DOE and LANL staff to receive information on site-specific and regional modeling activities. Prepared recommendations report and submitted to DOE LAOO.
- Directed engineering analyses of remedial alternatives for nitrate and uranium plume at DOE facility in Colorado. Reviewed and assessed adequacy of existing data, prepared conceptual model report and analysis program plan, and presented project plan to regulatory agencies. Reviewed site-specific uranium adsorption test data, and factored into analysis program. Developed ground water flow and transport models, analyzed alternatives including trench capture and phytoremediation, and assisted in the evaluation of reactive barrier technology to support selection of final ground water remedy.
- Assisted the US Army by serving as a Subject Matter Expert in the areas of hydrogeology, karst hydrology, and ground water modeling for independent technical reviews of ground water investigation and remediation programs at numerous installations. Participated in site tours and meetings with installation staff, contractors and regulators to discuss pending issues and ongoing and planned activities. Prepared recommendations to assist Army in streamlining investigation, remediation, and closure of installations.

- Conducted ground water to surface water discharge calculations to set safe soil cleanup levels for a lead and tetraethyl lead disposal basin at a waste disposal facility. Presented plans for extending the approach to other on-site SWMUs to the New Jersey Department of Environmental Protection and Energy.
- Managed a project for the development of three-dimensional ground water flow and contaminant transport models for RCRA hazardous waste surface impoundment at Department of Energy facility in eastern Tennessee. Utilized MODFLOW and SWIFT and employed grid-refinement approach to move from valley-scale model to site-scale model. Used model results in a risk assessment to establish safe cleanup goals for the site.
- Analyzed data for a mixed petroleum product release from an aboveground tank terminal in Virginia and performed modeling simulations of soil leaching, dissolved plume migration, and sediment desorption to establish ground water, soil and sediment cleanup goals for the facility.
- Developed the soil and ground water portion of a RCRA clean closure strategy for a group of automobile manufacturing facilities in Ohio. Reviewed relevant RCRA regulations, developed an innovative approach for calculating potential soil leaching impacts to ground water, and presented the proposed approach to Ohio EPA.
- Directed the preparation of a preliminary cost estimate for remediating 55 gas pipeline compressor stations at which PCBs, metals, and hazardous substance list (HSL) contaminants have been detected in soils, ground water, and surface water.
- Served as principal investigator for the ground water portion of a multimedia probabilistic (Monte Carlo) risk assessment for the hypothetical release of hazardous materials from a 20,000-drum landfill located near a major eastern river.
- Authored a report comparing the results of a large aquifer testing field program (8 tests, 18 pumping wells, over 200 observation wells) with the predictions of a three-dimensional numerical ground water flow model developed for a Superfund site in New Jersey.
- Conducted a technical review of the contaminant transport modeling portion of a risk assessment performed by consultants for a pesticide production facility in Louisiana. Recommended revisions prior to submittal to State Department of Environmental Resources.
- Assisted in developing technical strategy and served as peer reviewer for modeling studies of potential ground water health risks and remedial alternatives for a southwestern Superfund site.
- Reviewed contaminant transport modeling results performed for a California manufacturing facility along with supporting hydrogeologic, water quality, and waste disposal data to provide an opinion regarding the possible presence of DNAPL contamination and to estimate the potential length of remediation. Presented a cleanup time estimate in cumulative probability form for inclusion in statistical analysis of potential cleanup costs.

Litigation Support Activities

- Provided expert assistance in an environmental insurance matter involving release of petroleum from a pipeline in the southeastern US. Reviewed site hydrogeology data and information describing the nature of the release to form the basis for analyses of the fate and transport of petroleum compounds from the point of release to groundwater. Developed opinions regarding

the timing of the release, prepared an expert report, and presented testimony in mediation proceedings.

- Served as an environmental expert on behalf of a major communications corporation in a dispute regarding allocation of remediation costs for a former electric lighting and uranium processing facility in northern New Jersey. Reviewed information regarding historical operations, nature and extent of contamination, and remediation costs to assist counsel if developing a cost allocation scheme that led to a successful resolution between the parties.
- Provided expert witness services for a generator defendants group seeking to resolve cost allocation litigation with numerous other parties for a large municipal landfill in central New Jersey. Analyzed site hydrogeologic and contaminant sampling data and operational history information, as well as operational history and sampling data for nearby potential sources. Prepared expert report and provided deposition testimony prior to case settling.
- Served as a testifying expert in cost recovery litigation brought by the owner of an industrial facility in northern New Jersey. Reviewed site hydrogeologic and operational information, and assisted counsel for the US Government in preparing technical defenses to claims that war time operations by a small defense contractor contributed to site contamination. Prepared expert report and presented testimony in deposition and at trial.
- Assisted the US Government in complex mediation regarding historical operations and releases, and past and future remedial response actions and costs, for a major automobile and steel manufacturing facility in the Midwest. Compiled and reviewed information regarding site investigation and remediation activities performed and costs claimed by the private party, and participated in mediation sessions with the parties to achieve resolution.
- Assisted an industrial client in evaluating a Natural Resource Damage claim by the State of New Jersey for resources impacted by releases from two former disposal sites in the ecologically sensitive Pine Barrens area of the state. Reviewed data describing the past and current extent of contamination, evaluated the State's calculations regarding damages, and assisted client in preparing for settlement discussions.
- Provided assistance to the US Government in the early discovery stages of Natural Resource Damage litigation brought by the State of New Jersey for chemical releases to the environment at a US Navy installation in central New Jersey. Compiled and reviewed information, met with installation staff and counsel to identify relevant data and information from facility records, and provided advice to counsel for USDOJ regarding case issues.
- Reviewed information regarding environmental contamination and remedial response activities and costs for insurance litigation matter involving a printing facility in northern New Jersey. Prepared expert report regarding the source and timing of soil and groundwater contamination, the portions of the remedy that were associated with off-site soils, and the reasonableness of response costs; assisted in settlement negotiations.
- Served as ground water expert of behalf of the U.S. Government in a case involving perchlorate contamination and response costs at a facility located in the western U.S. Reviewed site hydrogeologic and perchlorate sampling data; reviewed facility process, ownership, and operations information, and developed attribution of released perchlorate mass to support response cost allocation.

- Reviewed BTEX and MtBE soil and ground water sampling data for a gasoline service station in Pennsylvania, examined site operations information and water testing data for surrounding community, and assisted major petroleum company in responding to a legal action filed to attempt to certify a class of impacted residential properties.
- Examined historic releases and response actions at three medical equipment manufacturing facilities and served as expert on behalf of manufacturer in insurance litigation. Identified discharge, spill, and release events from on-site sources at the various facilities, examined the response action in light of the governing state or federal regulatory program, and estimated the nature and timing of impacts to environmental media at the facilities.
- Served as expert in insurance litigation involving response cost claims by a commercial property owner against an on-site dry cleaning facility and nearby food processing facility. Examined site geologic, soil, and ground water data, and evaluated plaintiff's expert's opinions regarding a postulated fate and transport link between the food processing facility and the impacted property.
- Reviewed historic site information and hydrogeologic and environmental sampling data related to gasoline and MtBE groundwater contamination at a former gasoline service station in eastern New Jersey. Prepared expert report describing timing and extent of contamination and evaluating groundwater modeling results and other analyses performed by opposing groundwater expert.
- Served as expert in litigation involving a large Natural Resource Damage claim by the State of New Mexico for impacts associated with releases from multiple facilities at a southwestern Superfund site. Compiled, reviewed and analyzed site data; reviewed analyses including groundwater modeling and kriging performed by Plaintiff's experts to estimate damages; and provided testimony regarding assessment of nature and extent of contamination, potential loss of services, and duration of impacts.
- Served as testifying expert for toxic tort litigation involving historic release of crude oil and gas from a leak in a deep production well in Harris County, Texas. Reviewed ground water flow and chemical transport analyses performed by plaintiffs' expert, conducted rebuttal modeling analyses to examine likelihood of potential impacts to downgradient municipal water supply well, and presented testimony regarding findings.
- Served as ground water expert in insurance litigation involving releases, contamination, and cleanup at a large western petroleum refinery; compiled information on the nature and timing of release events and response action costs, and developed program of analyses to estimate impacts of sudden and accidental releases.
- Served as ground water expert in cost allocation litigation involving historic perchlorate releases from a western rocket fuel processing facility. Reviewed data and information pertaining to site hydrogeologic conditions, plant operational data, and locations and timing of perchlorate releases. Evaluated ground water flow and transport modeling analyses and reports prepared by opposing experts.
- Assisted counsel for eastern chemical and plastics manufacturing company by preparing technical portions of insurance litigation relating to chemical release timing, migration, and remediation. Performed data analyses and computer modeling to support testimony of ground

water expert, oversaw preparation of complex courtroom graphics including digital animations, and assisted counsel in preparing for trial.

- For a litigation matter involving the release and remediation of gasoline from a transmission pipeline in the mid-west, reviewed and analyzed discharge event data and hydrogeologic information to evaluate the size and location of the proposed class certification area. Examined data describing the migration and distribution of petroleum compounds including MtBE in a fractured bedrock aquifer and evaluated information related to other petroleum sources in the vicinity of the point of release.
- Served as nontestifying ground water expert in toxic tort litigation involving historic organic solvent releases from electronics manufacturing facilities and other industrial sources at a southwestern Superfund site. Reviewed information on solvent handling and disposal practices that had resulted in potential DNAPL sources and deep dissolved phase contamination in a complex alluvial basin aquifer system. Worked with counsel, industrial client, and on-site consultants to compile data, to perform hydrogeologic analyses of ground water flow and contaminant transport, and to oversee development of technical information to support litigation effort.
- Served as ground water expert in insurance litigation involving releases from tanker truck dispatch terminal at a Superfund site in southern New Jersey. Reviewed site documents describing facility operations, site investigation activities, and remedial action program. Analyzed environmental releases, performed lagoon seepage and contaminant plume migration calculations, and presented testimony at trial.
- Assisted a PRP at a Superfund site in California in developing a cost allocation scheme for interim and final ground water remedies aimed at recovering and treating intermingled volatile organic chemical plumes from dozens of PRP facilities in a large valley aquifer system.
- Served as nontestifying consultant on behalf of a private party in a cost recovery suit involving the contamination of a municipal well field by organic solvents and chlorofluorocarbon refrigerants from nearby commercial and industrial facilities.
- For a PRP at a Superfund site in Michigan, developed a cost allocation scheme for investigation and remediation costs that were to be divided among approximately one dozen PRPs. Prepared a matrix of facility-specific and cost-item-specific weighing factors for facilities that had been operated by multiple successive owners over a thirty-year period.
- Assisted PRP group for former lead smelting facility in Pennsylvania in developing information to support a challenge to EPA ROD and proposed remedy. Directed modeling analysis of lead leaching impacts to ground water for various remedial scenarios, including an analysis of the infiltration rate through RCRA cap that addressed EPA concerns regarding minor liner installation defects, and presented findings to regulators.
- Assisted counsel for major U.S. petroleum company in a case involving contamination of a sole source aquifer in the U.S. Virgin Islands. Reviewed opposing experts' computer modeling studies linking contamination of potable wells in a fractured bedrock aquifer to releases from numerous gasoline stations, dry cleaning facilities and other industrial sources of petroleum and chlorinated hydrocarbons. Evaluated opposing experts' calculations, performed production well capture zone analyses, and presented expert testimony.

- Served as nontestifying hydrogeological expert in cost allocation litigation on behalf of the past owner of a manufacturing facility in northern New Jersey. Allocation scheme was developed based on length of ownership, operating practices, known releases, and the fact that activities by current owner's technical consultant had contributed to the contamination problem.
- Provided technical litigation support in a cost recovery case involving contamination by pentachlorophenol and other chemicals at neighboring wood processing facilities in California. Assisted counsel for of one of the industries in developing arguments to limit EPA's ability to recover excessive costs, and developed an allocation scheme to fairly divide the remaining costs between the two private parties.
- Assisted attorneys for an insurance carrier in reaching a successful settlement with other carriers in a cost recovery case involving multiple releases of degreasing solvents at a southern manufacturing facility.
- Assisted counsel for U.S. Department of Justice in a suit brought by PRP over proposed remedy for zinc smelting wastes and environmental contamination at a Superfund site in eastern Pennsylvania. Reviewed site documents and opposing expert report regarding remediation of leachate from waste slag pile, and worked with counsel and hydrogeologic expert to develop plans for field data collection program to support preparation of response report.
- Presented expert witness testimony on behalf of a southeast Florida city in a cost recovery case involving VOC contamination of municipal water supply wells. Conducted a peer review of ground water flow and transport modeling that was performed by the city's engineering consultant. Prepared preliminary present-cost estimates for remediation, and presented testimony at a trial.
- Provided litigation support, and presented expert testimony in a case involving the release of gasoline product from a northern New Jersey service station. Reviewed information pertaining to facility operation, inventory records, tank and pump upgrades and testing, and BTEX and MTBE environmental sampling data. Performed contaminant transport modeling to support the development of opinions regarding allocation of investigation and remediation costs for past releases.

Professional Communication and Instruction

- Dr. McLane served as Chairperson for the Hydrogeology I: Water Resources and Water Balances session of the Geological Society of America Annual Meeting, October 9, 2011 in Minneapolis, MN.
- From 2003 to present, Dr. McLane has lectured each May at a Fundamentals of Hydrogeology short course for environmental professionals offered by Rutgers - Cook College, where he presents lectures on ground water modeling software and methods, data visualization, analysis of uncertainty, and uses of models in water supply, wastewater engineering, and remedial design.
- In 2007 and 2008, Dr. McLane served on the faculty of the ALI-ABA advanced course in Environmental Litigation held each June in Boulder, Colorado. Dr. McLane assisted in the

preparation of attorney-expert demonstrations for the course and participated in the environmental litigation mock trial, and various demonstrations and panel discussions.

- From 2004 through 2007 Dr. McLane co-developed and served as one of the primary lecturers for the Environmental Forensics short course offered by the National Ground Water Association. The course explored forensic methods in ground water science and analytical chemistry as they are applied in environmental litigation and regulatory actions; the role of science and the scientific expert in the courtroom; and the nature of specific technical issues associated with the various types of environmental litigation.
- In the Spring of 2004, Dr. McLane served as a lecturer for a series of Navy-sponsored Remediation Innovative Technology Seminars at various installations across the country. The seminar topic was optimization of site characterization and remediation, and Dr. McLane presented information regarding various field equipment and software tools (including statistics, geochemical analyses, ground water flow and transport modeling, Geographic Information Systems, and data visualization to streamline and optimize remedial response activities.
- Dr. McLane was invited to speak at the 1999 Theis Conference sponsored by the National Ground Water Association. The conference assembled presentations and poster sessions on the topic "Remediation of Subsurface Contaminants: The Meaning and Measures of Success". Dr. McLane's presentation was entitled "Probabilistic Risk Assessment and Uncertainty Analysis in Defining Cleanup Goals."
- For a period of over ten years from the early 1990s to the early 2000s, Dr. McLane lectured twice each year at a short course sponsored by the National Ground Water Association to introduce environmental professionals to computer software designed for use in ground water modeling, remediation, and risk assessment. Dr. McLane lectured on ground water modeling and risk assessment, and directed a computer laboratory exercise on the application of Monte Carlo statistical techniques to environmental risk assessment calculations.
- For several years in the early 1990s Dr. McLane chaired and lectured at a short course offered under the auspices of Government Institutes to provide environmental professionals a broad overview of ground water flow, contaminant fate and transport, site investigation, risk assessment, ground water modeling, and site remediation.
- In 1990 and 1991, Dr. McLane served as project manager and co-instructor for a national series of Wellhead Protection training workshops sponsored by EPA Office of Ground Water Protection (OGWP). The first three-day course presented an overview of wellhead protection policy and guidelines, and focused on the prescribed half dozen or so technical methods and hydrogeologic bases for delineating Wellhead Protection Areas. The second course was aimed at getting computer modeling technology into the hands of environmental professionals involved in water management issues. The course provided instruction in basic hydrogeology and ground water modeling and provided course participants with hands-on experience in the use of the EPA WHPA computer model for delineating Wellhead Protection Areas.
- In the late 1980s, while a Principal Hydrogeologist with Geraghty & Miller Ground Water Consultants, Dr. McLane lectured at a ground water seminar presented to Bureau of Reclamation personnel in Denver, Colorado, presenting portions of the course dealing with ground water flow modeling, transport modeling, and uses of models in artificial recharge

system design and management. Also, as part of G&M's "Fundamentals of Ground Water Contamination" seminar for attorneys, environmental managers, and hydrogeologists he presented an overview of ground water modeling technology and methodology, and discussed potential applications to ground water supply and contamination problems.

- Other presentations, seminars and workshops include a two-day course on ground water hydrology and hydraulics to representatives of the Virginia State Office of Surface Mining. Introduced hydrogeologic terminology and concepts relating to ground water recharge and discharge, flow in aquifer systems, and effects of pumping.

Prior to forming McLane Environmental, L.L.C., Dr. McLane was a Manager and Senior Science Advisor with ENVIRON International Corporation. In addition, Dr. McLane has practiced environmental consulting as a Principal Hydrogeologist with Geraghty & Miller Ground Water Consultants, and served as a Senior Engineer with Rockwell International Corporation.

Professional Memberships

Member, American Geophysical Union (AGU).
Member, National Ground Water Association (NGWA).
Member, Geological Society of America (GSA).

Publications and Presentations

Walton, W.C. and C.F. McLane. 2013. Aspects of Groundwater Supply Sustainable Yield. *Ground Water* Vol. 51 No. 2: 158-160.

Metheny, M.A. and C.F. McLane. 2012. Investigating Sustainable Development of Groundwater Resources for a Lower Cape Cod Fresh-Water Lens Using SEAWAT. Presented at the GSA Northeastern Section Meeting, March 18 – 20, 2012, Hartford, CT.

McLane, C.F. 2012. AnAqSim: Analytic Element Modeling Software for Multi-Aquifer, Transient Flow. Software Spotlight, *Ground Water*, Vol. 50, No. 1: 2 – 7.

McLane, C.F. 2011. Analytic Element Modeling of Transient Saltwater Interface Response in a Layered Freshwater Lens Aquifer. Presented at the GSA Annual Meeting, October 9-12, 2011, Minneapolis, MN.

Cecan, L. I., J. F. Guarnaccia, C. F. McLane, and R. T. Simon. 2010. Environmental Modeling: A Site Characterization Tool. Presented at the NGWA 2010 Ground Water Summit and 2010 Ground Water Protection Council Spring Meeting, April 11 – 15, 2010, Denver, CO.

Nelson, G., L. Cecan, C. F. McLane and M. Metheny. 2009. Estimating Fresh Water Lens Aquifer Parameters Using Automated Parameter Estimation and Axisymmetric Flow and Transport Modeling. Presented at the PEST Conference, November 2 – 4, 2009, Potomac, MD.

Luchette, J., G. Nelson, C. F. McLane and L. Cecan. 2009. Unlimited Virtual Computing Capacity using the Cloud for Automated Parameter Estimation. Presented at the PEST Conference, November 2 – 4, 2009, Potomac, MD.

Gillespie, T. and C. F. McLane. 2009. Modeling structural controls on groundwater flow and solute transport in fractured consolidated rock aquifers (Poster). GSA Annual Meeting, October 18-21, 2009, Portland, OR.

McLane, C. F. and L. Cecan. 2009. Discussion of Paper - ''MODALL: A Practical Tool for Designing and Optimizing Capture Systems.'' *Ground Water*, March-April 2009, Vol. 47, No.2: 172-175.

Cecan, L., G. Nelson, C.F. McLane and M. Metheny. 2008. Pumping Test Analyses in an Aquifer with Fresh Water/Salt Water Interface. Presented at the 20th Salt Water Intrusion Meeting, June 20 – 22, 2008, Naples, FL.

Nelson, G., L. Cecan, C.F. McLane and M. Metheny. 2008. Evaluating Safe Yield for Supply Wells in an Aquifer with Fresh Water / Salt Water Interface. Presented at the 20th Salt Water Intrusion Meeting, June 20 – 22, 2008, Naples, FL.

Cecan, L., M. Metheny and C.F. McLane. 2008. Analytical Modeling versus Numerical Modeling for Determining Source Water Protection Areas. Presented at the MODFLOW and More 2008 - Ground Water and Public Policy Conference, May 18 – 21, 2008, Golden, CO.

Cecan, L., J. Peterson and C.F. McLane. 2008. Modeling Bedrock Aquifer to Permit Water Supply Wells. Presented at the MODFLOW and More 2008 - Ground Water and Public Policy Conference, May 18 – 21, 2008, Golden, CO.

McLane, C.F. and R. D. Magelky. 2006. Dispersion, Plumes and Darcy's Law. Presented at the Annual Meeting of the National Ground Water Association 2006 NGWA Ground Water and Environmental Law Conference, July 6 – 7, 2006, Chicago, IL.

Lasse, A.D., R.D. Magelky, C.F. McLane and J.O. Rumbaugh. 2006. Particle-Tracking Optimization for Designing and Evaluating Well-Field Extraction Systems. Poster Presented at the Fifth International Conference on Remediation of Chlorinated and Recalcitrant Compounds May 22-25, 2006, Monterey, CA.

Coppola, Jr., E.A., C.F. McLane, M.M. Poulton, F. Szidarovszky, and R.D. Magelky. 2005. Predicting conductance due to upconing using neural networks. *Ground Water* Vol. 43 No. 6: 827-836.

Henley, J.J., D.R. Sieling, D.C. Shafer, and C.F. McLane. 2003. Effect of aquifer anisotropy and layering on estimated yields from pumping wells in a coastal setting (Poster). NGWA 2003 AGWSE Annual Meeting, December 9 – 12, 2003, Orlando, FL.

McLane, C.F., R.A. Magelky, and D.R. Sieling. 2002. Effect of withdrawals from a simulated island freshwater lens aquifer system: An analytic element modeling approach (Poster). GSA 2002 Annual Meeting, October 27 – 30, 2002, Denver, CO.

Magelky, R.A., C.F. McLane, and M.N. White. 2002. Modeling of wastewater infiltration in a freshwater lens system using analytic elements. GSA 2002 Annual Meeting, October 27 – 30, 2002, Denver, CO.

McLane, C.F. 1999. Probabilistic risk assessment and uncertainty analysis in defining cleanup goals. Presented as an invited speaker at the National Ground Water Association 1999 Theis Conference. Nov. 12 – 15, 1999, Amelia Island, FL.

McLane, C.F., J.A. Whidden, and J.K. Hopkins. 1998. Hydrogeologic Analysis of Remedial Alternatives for the Solar Ponds Plume, Rocky Flats Environmental Technology Site (RFETS). Spectrum '98: International Conference on Decommissioning and Decontamination and on Nuclear and Hazardous Waste Management, September 13-18, 1998, Denver, CO. pp. 950-957.

McLane, C.F. 1994. Ground water modeling and risk assessment. Presented as special guest lecture at NGWA-sponsored short course *IBM-PC Applications in Ground Water Pollution and Hydrology*, January 1994 , San Francisco, CA.

Dielman, S.A., Y.M. Sternberg, and C.F. McLane. 1993. Design and evaluation of ground water monitoring well network. In *Proceedings of the Superfund XIV Conference and Exhibition,* December 1993, Washington, D.C.

Harris, R.H., C.F. McLane, and S.W. Washburn. 1991. Monte Carlo risk assessment for a hazardous waste drum landfill. Presented at the Annual Meeting of the Society for Risk Analysis, December 1991, Baltimore, M D.

McLane, C.F., S.A. Dielman, and M.F.N. Mohsen. 1991. A simple analysis of landfill drum corrosion and waste release to ground water. Presented at the National Ground Water Association Conference, October 1991, Washington, D.C.

Harris, R.H., C.F. McLane, and S.W. Washburn. 1991. Use of Monte Carlo techniques in risk assessment. Seminar presented to the State of New Jersey Interagency Risk Assessment Committee, September 1991, Trenton, NJ.

McLane, C.F. 1990. Uncertainty in wellhead protection area delineation. In *Proceedings of the 1990 Cluster of Conferences,* February 20-21, Kansas City, MO. National Water Well Association, Dublin, OH.

McLane, C.F., and G.M. Duffield. 1990. Ground-water flow and contaminant transport modeling in wellhead protection. In *Water resources in Pennsylvania: Availability, quality and management*. eds. S.K. Majumdar, E.W. Miller, and R.R. Parizek, The Pennsylvania Academy of Science, pp. 291-300.

McLane, C.F., D.R. Buss, and R.A. Mace. 1989. Quantitative techniques applicable to protection of water supply wells in the Chesapeake Bay area. In *Proceedings of NWWA Conference on Ground Water Issues and Solutions in the Potomac River Basin/Chesapeake Bay Region,* March 14-16, 1989. National Water Well Association: Dublin, OH, pp. 495-516.

Rumbaugh, J.O., G.M. Duffield, D.R. Buss, and C.F. McLane. 1988. The role of groundwater modeling in hazardous waste management. *Hazardous Waste Management Magazine*, March, pp. 8-11.

Howard, A.D., and C.F. McLane. 1988. Erosion of cohesionless sediments by ground water seepage. *Water Resources Research* 24(10):1659-1674.

McLane, C.F., M.F. Weiner, and G.L. Underberg. 1986. Effects of model dimensionality and material properties on release of radionuclides from waste packages in a geologic repository in basalt. *EOS Trans. of Amer. Geophys. Union* 67:284, abstract.

Kochel, R.C., A.D. Howard, and C.F. McLane. 1985. Channel networks developed by groundwater sapping in fine-grained sediments: Analogs to some Martian valley networks. In *Models in geomorphology*. ed. M.J. Woldenberg, Allen & Unwin, Inc.: Winchester, MA. pp. 313-341.

McLane, C.F. 1984. An experimental and theoretical study of seepage-induced erosion in non-cohesive sediments. Ph.D. dissertation, University of Virginia, Charlottesville, VA, 193 pp.

Howard, A.D. and C.F. McLane. 1982. Groundwater sapping in sediments: Theory and experiments (abstract). *Reports of Planetary Geology Program - 1981*, NASA Tech. Memo. 84211.

Adams, J., G.L. Zimpfer, and C.F. McLane. 1978. Basin dynamics, channel processes, and placer formation: A model study. *Economic Geology* 73:416-426.

McLane, C.F.. 1978. Channel network growth: An experimental study. M.S. Thesis, Colorado State University, Fort Collins, CO, 100 pp.