PROPOSAL

THE "TUG HILL AQUIFER" --

PROVIDING FOR THE FUTURE OF A CRITICAL WATER RESOURCE

June 7, 1982

Prepared by the Temporary State Commission on Tug Hill at the request of:

- The Oswego County, Oneida County, and Jefferson County Planning Departments
- The Oswego County Department of Health
- The Salmon Rivers Cooperative Planning Board/Conservation Advisory Council (Albion, Orwell, Parish, Williamstown)

TABLE OF CONTENTS

I. Executive Summary - - - - - - - 1

II. The Need and Background - - - - - - 2

III. Project Goals - - - - - - - - 6

IV. Project Approach - - - - - - - - 8

Gathering and Compiling Data - - - - 8

Converting Information into Projects Useful at the Local Level 8

Informing Citizens and Developing Management Strategies 10

V. Tug Hill Aquifer Project, Operations Plan - - - - 12

VI. Budget Summary - - - - - - - - 14

Exhibit A. Participants in Development of This Project - - 15

Exhibit B. Excerpts from Comments Received Concerning Project Needs 17

Exhibit C. Goals Pertinent to Aquifer Project - From Comprehensive Regional Development Plan - Salmon Rivers Cooperative Planning Board / Conservation Advisory Council - 20

Exhibit D. Sample Use of Products for Planning - - - 22

FIGURES

Figure 1. Possible Study Areas - - - - - 4

Figure 2. The Catchment of a Well - - - - - 9

I. EXECUTIVE SUMMARY

This is a request for an appropriation of $97,000 in New York State funds to finance a 24-month project to study a large aquifer (in a sense, an underground lake) that is vital to the economy and quality of life on the southwest portion of the Tug Hill region. (Both the new state salmonid hatchery and Schoeller Technical Papers, Inc. are located in the area because of this aquifer; together they pump over 3 million gallons per day out of it.) The proposal is submitted by the Temporary State Commission on Tug Hill at the request of the three counties in which this aquifer lies and of the four-town Salmon Rivers Cooperative Planning Board.

The project has been designed with the help of some 30 individuals representing local and regional agencies and organizations (Exhibit A). Its broad goals are:

1) To develop information needed to plan for the use and preservation of this critical groundwater resource;

2) To use that information with local communities to aid them in developing appropriate groundwater management strategies.

The principal recipient of the funds is the U.S. Geological Survey which would match its $52,000 share with a federal grant of like amount. The second largest portion of the funding, $30,000, would go to the Center for Environmental Research, Cornell, which would analyze existing and potential contamination problems and convert the technical information into products that can be used readily by the Salmon Rivers board and the municipalities to make management decisions. The commission would act as project coordinator. The three counties would provide basic land use data and help with project guidance.

The project's emphasis on local government action to plan for and protect the future of a large and, as yet, pristine body of groundwater makes it a potentially valuable prototype for those developing policy at the state and federal levels.

II. THE NEED AND BACKGROUND

Along the west and south sides of the central Tug Hill area lies an unusually large aquifer[1]. For the purposes of this project proposal we will title it the "Tug Hill Aquifer." This formation has a large storage capacity and stretches from the Salmon River basin in Oswego County into Jefferson County in the north and Oneida County to the southeast. The new fish hatchery, which is now operational, is pumping about 1.5 million gallons per day. Schoeller Technical Papers has a well field at the lower edge of the aquifer that produces an equivalent amount or more. Both these facilities are vital to the economy of the area, and both were located on the aquifer because of the availability of high quality water.

Previous work by the U.S. Geological Survey (Miller, 1980, and Kantrowitz, 1970) mapped the aerial extent and compiled some well information in Oneida and Oswego Counties. The N.Y. Department of Environmental Conservation conducted seismic surveys and test drilling in parts of the aquifer as part of their hatchery site feasibility investigations.

---

1. An aquifer is an underground body of water within porous rock or deposits of stone and gravel, which can yield water to wells and springs. The "Tug Hill Aquifer" structure was formed by the departing glacier approximately 10,000 years ago.

   The basic purpose of aquifer planning is to provide for future use of land and natural resources in ways that will secure the best uses of the groundwater. Aquifer related uses may be:

   1) withdrawals of water for human consumption.
   2) withdrawals for agricultural or industrial purposes.
   3) the treatment or assimilation of wastewater or waste in the upper layer of the soil.
   4) maintaining base flows to streams and wetlands for fish and wildlife.
   5) acting as a storage reservoir which buffers effects of hydrologic extremes, such as droughts or prolonged periods of wet weather.

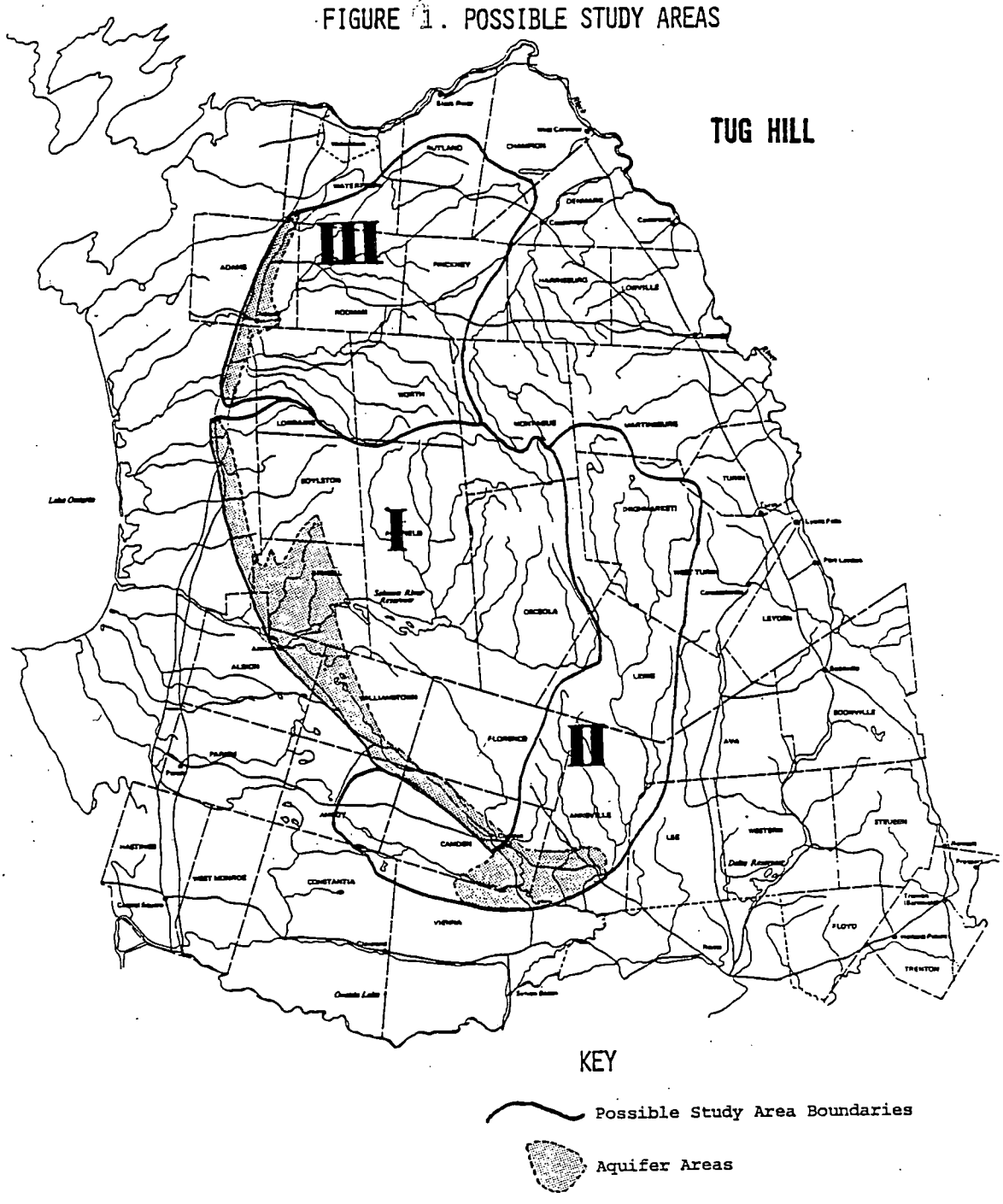
   These uses are either economic or ecological in character. In the case of the fifth use, both purposes may be served. Some or all of these uses can easily be jeopardized by human activities in the catchment of the aquifer. This is particularly so when the uses are close to primary recharge (water input) locations. The water in the underground reservoir, so to speak, moves at a very slow pace and is very difficult, if not impossible, to clean up once it is contaminated.

Figure 1 shows a likely outline of the aquifer and the areas of water catchment (drainage basins) that supply it and, therefore, influence its quality and capacity to provide water. The area is divided into three sections to indicate that there may or may not be connections with underground water deposits further into Jefferson and Oneida Counties.

At the initiation of the Oswego County Planning Board, the Planning Departments of Jefferson County, Oneida County, and Oswego County approached the Temporary State Commission on Tug Hill about the need for more information about this valuable water resource. They suggested that since the aquifer stretches into three counties, it seemed logical that the Tug Hill Commission sponsor the studies, rather than the counties trying to do it piecemeal. The Oswego County Health Department, which is conducting a D.E.C.-financed groundwater study countywide, strongly supports the project. Their funding is limited to collecting existing data in this one county; it is not sufficient to finance the work proposed here for this, the largest and potentially most productive aquifer in the area. The Salmon Rivers Cooperative Planning Board/Conservation Advisory Council, composed of representatives appointed by the Town Boards of Albion, Orwell, Parish, and Williamstown, and the Villages of Altmar and Parish, have long shown a concern for the future of water quality in their communities. They, too, have identified the aquifer as critical to the future of the economy and quality of life for their area. They join the others in supporting the project, but with the condition that the data obtained be put in a form that can be used by town leadership to inform the public and to make decisions.

In response to all this interest, the commission convened two sessions at the Altmar Fish Hatchery to discuss, first, the need for the project, then the form it should take. The commission also contracted with the Center for Environmental Research, Cornell, to prepare a discussion paper that was then used by this group in shaping the total

FIGURE 1. POSSIBLE STUDY AREAS



project. (Exhibit A lists the parties that have been involved to date. Also, in Exhibit B are letter excerpts from various parties of interest supporting the project and indicating their specific concerns about the future of the aquifer.)

It was pointed out during the group effort to design this project that we are at the early, but very active, stages of a new national interest in the future of underground water resources. Many strategies will emerge to protect these vulnerable, hidden resources from overuse and contamination. The Tug Hill Aquifer project would represent an effort for a relatively pristine area, that as yet has no known major contamination problems. More importantly, it is aimed at maximizing local decision making on these matters, and could be a beneficial process prototype.

It is fitting that this prototype occur in the Tug Hill area, where there is a track record for grassroots participation and cooperation between small rural communities. Although the state groundwater program gives first priority to heavy use areas, where contamination problems already exist, there is also real value in having a prototype that involves planning for the future of an essentially pristine water supply.

III. PROJECT GOALS

In the past, Jefferson, Oneida, and Oswego Counties have identified water related goals in county planning documents. The Tug Hill Commission in 1976 recommended areawide goals and actions based on extensive public participation (The Tug Hill Region - Preparing for the Future). Finally, and most important, towns or groups of towns have worked out goals expressed in their own planning documents. (See Exhibit C, "Goals and Objectives" from the Comprehensive Regional Development Plan prepared by the Salmon Rivers Cooperative Planning Board/Conservation Advisory Council.) These documents all attempt to balance environmental and quality-of-life aims with the goal of a healthy local economy. The following project goals are in harmony with these local and area-wide goals that have been stated in the past.

1. To define the "Tug Hill Aquifer," the boundaries and dimensions of the saturated zone and the quantity and quality of water available. Top priority will be given to defining the central part of the aquifer, Section I, shown on Figure 1.
2. To develop from appropriate data bases information describing how meteorology, topography, soil, land use, and waste management practices may influence the quality and quantity of the recharge which replenishes the groundwater reservoir. From the understanding provided by this information, it will be possible to determine reasonable withdrawals and loadings of contaminants that would still allow the various sections of the aquifer to be preserved for ecological and human needs.
3. To ascertain the direction and rate of flow within the saturated zone and define the relationship between streams and the groundwater system. Given these flow patterns, it will be possible to determine vulnerability of wells or streams to incidents of contamination. If at some time groundwater contamination is observed, knowing the flow pattern will allow

that contamination to be traced back through the system to the approximate time and place of the original release of the substance concerned.

4. To determine the patterns of uses of the aquifer and to suggest limits on future use based on potential quantity and quality stresses to the system. These uses will be the primary outputs or withdrawals of water from wells for human and industrial purposes, and ecological uses such as flows to wetlands and streams.

5. To work with local governments and area citizens in order to use the information being produced to develop both aquifer management strategies and a "kit of tools" that can be used for future problem diagnosis and correction. This means packaging technical information so that the layman can put it to use, for both educational and decision-making purposes. Town planning board representatives point out that citizen education throughout the project is critical if there is to be cooperation with data collection and if local governments are to make informed decisions.

6. To foster cooperation and communication between local governments and county and state agencies concerned with the future of this aquifer. Past work and current parallel efforts, such as the Oswego County Groundwater Study, will continue to be integrated with this project.

7. To communicate the process used and the lessons learned to federal, state, and local government people concerned with groundwater policy and management; thereby serve as a prototype study of a pristine aquifer which emphasizes action through involvement at the local level.

IV. PROJECT APPROACH

The project will require 24 months to complete. During that time there will be three arenas of activity: gathering and compiling data, converting information into products useful at the local level, and informing citizens and developing management strategies. Each effort will require coordination with the others.

Gathering and Compiling Data

The U.S. Geological Survey (U.S.G.S.) will first collect and compile existing geologic, hydrologic, and water quality data. Preliminary maps and cross sections will be prepared to show aquifer characteristics such as thickness, direction of groundwater movement, water table, and areas of recharge and discharge. Possible sources of existing contamination will be identified, as well. This information will be used to determine what additional data is needed, to plan where drilling should be conducted in order to measure aquifer depth and thickness and collect water samples, and to determine what other ground and surface water measurements should be made.

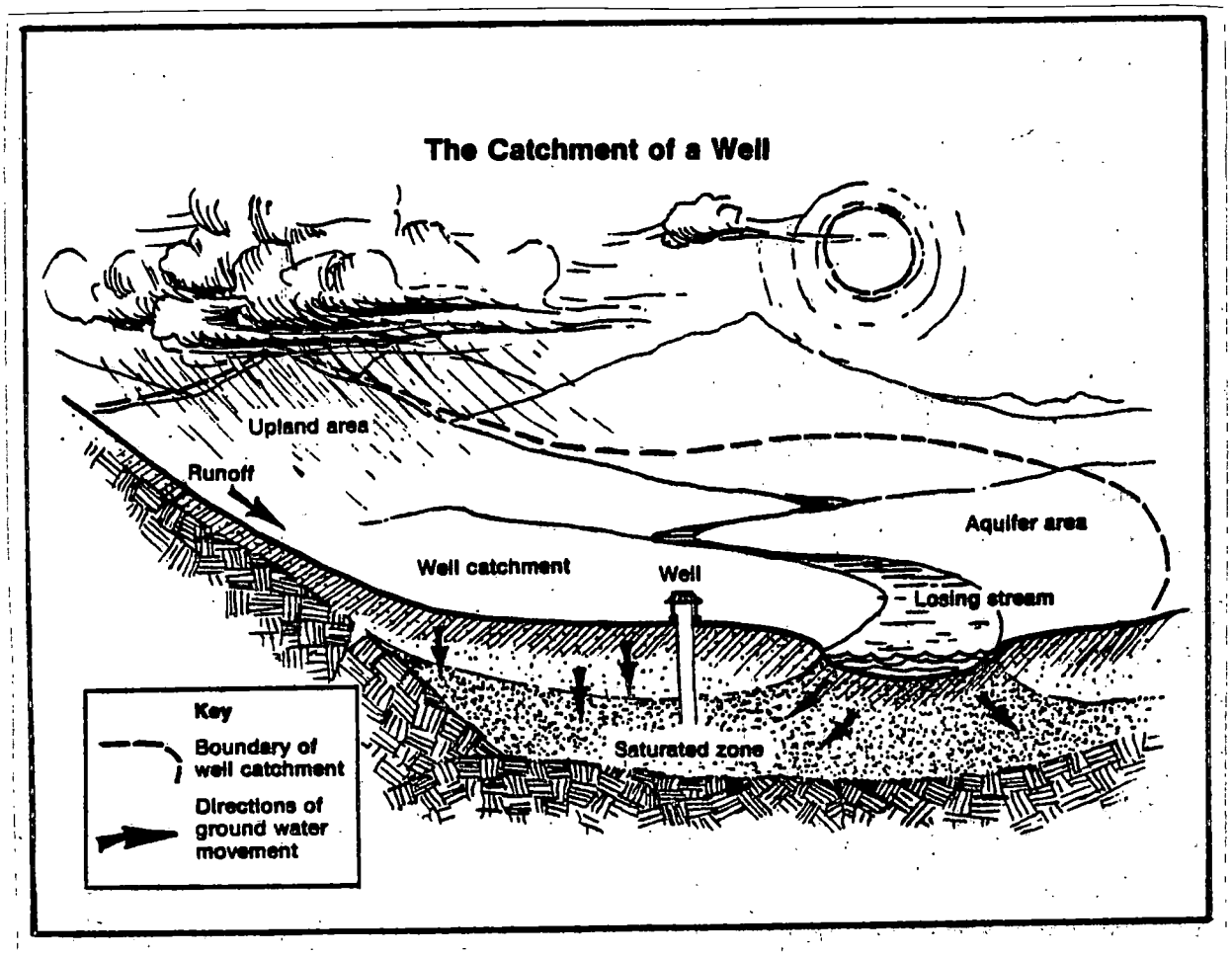
County planning departments with the Tug Hill Commission will assemble and update land use information. All parties involved will contribute to identifying landfills, exploratory gas drilling sites and other potential sources of contamination.

Converting Information into Products Useful at the Local Level

Using the preliminary data obtained by U.S.G.S., the counties and others, Cornell's Center for Environmental Research and U.S.G.S. will prepare an overall description of the hydrologic system. This will include "budgets" showing inputs and withdrawals to

possible sources of contamination, will be combined with what is known about the soils and the water movement through the aquifer in order to describe instructive scenarios or case studies. These can then be used to understand the nature of future risks to the resource. The cases will be modified and refined as more detailed information is obtained by U.S.G.S. Cornell's existing capability for computer modeling will be used.

A manual will be prepared showing how to use the budgets, maps, and other information to analyze proposed land developments or diagnose and cure problems. Exhibit D, Sample Use of Products for Planning, taken from the Cornell discussion paper entitled, The Tug Hill Aquifer, Planning and Educational Needs, describes three possible scenarios for case studies.



(Courtesy, Cornell Water Resources Center)

A manual will be prepared showing how to use the budgets, maps, and other information to analyze proposed land developments or diagnose and cure problems. Exhibit D, Sample Use of Products for Planning, taken from the Cornell discussion paper entitled, The Tug Hill Aquifer, Planning and Educational Needs, describes three possible case studies.

Informing Citizens and Developing Management Strategies

Community involvement has already begun in part. A summer intern has been assigned by the commission to the Salmon Rivers Cooperative Planning Board to work with that board and its member municipalities to develop an agenda for discussing the questions surrounding groundwater planning and management. General educational materials on the subject will be collected and tested.

With this pre-project activity the Salmon Rivers cooperative board will be prepared to assume leadership in inviting surrounding communities to participate in the efforts to inform the citizenry about the project and start the discussion of the needs, opportunities and risks. The commission will coordinate assistance to the communities through the existing network of circuit riders covering the following three areas: Salmon Rivers area, four towns (central portion of aquifer); Northern Oneida County Council of Governments area (Camden and perhaps several other towns on south and east); Cooperative Tug Hill Planning Board area (uplands draining into the aquifer). Eastern Ontario coast towns of Richland, Sandy Creek, Ellisburg and perhaps others more inland such as Adams will be invited to participate through either county contact or through the St. Lawrence - Eastern Ontario Commission. Some of the educational tools being considered, in addition to the case studies, are field trips to observe aquifer study

activities, physical models of the aquifer built and operated by area students, and use of video disk and simulated computer displays to show what takes place in an aquifer.

Through these kinds of educational efforts understanding and appreciation of the resource and its vulnerability will be fostered.

The thirty people listed in Exhibit A constitute those who have been interested in the development of this project. All who wish have been invited to serve on an overall project steering committee. A member of the staff of the Temporary State Commission on Tug Hill will serve as coordinator and will be responsible for regularly communicating project status and receiving feedback. The commission would receive the state funds and be responsible for accounting for, and monitoring expenditures by, U.S.G.S, Cornell, and others.

V. TUG HILL AQUIFER PROJECT, OPERATONS PLAN

Project Element	Details	Lead Agency	Time Frame Months from Start	Cost Estimate In Kind	Federal	State
1. Project Management and Coordination	• General Management and Accounting	Tug Hill Commission	1-24	3,000		
	• Project Management 10% Dir., Natural Resources Policy					6,000
	• Field Management 10% Dir., Comm. Assistance			6,000		
2. Community Involvement and Education	Involve citizens in monitoring the project, education and development of management strategies. Includes preparation of materials for education. Video-tape, slide shows, etc.	Salmon Rivers Coop. Planning Board/Tug Hill Comm./Cornell and others	1-24	10,000		9,000
3. Preliminary Investigation	Collect and analyze existing data, collect well logs, construct prelim. maps	U.S.G.S.	1-4		7,100	7,100
4. Update Land Use Data	Update land use maps, especially for area above saturated zone of aquifer	County Planning Depts. and Tug Hill Commission	1-6	6,000		
5. Construct Water Budget for Study Area	Use existing land use, soils and climate data. Divide study area into hydrologic units. Compute water budget for each. Report describing aquifer as a whole using U.S.G.S. prelim. data, prepared for citizen use.	Cornell and U.S.G.S.	7-11	1,000		8,000

6.	Drill Test Wells	Determine where observation wells are needed, drill wells, measure water levels, update maps	U.S.G.S.	5-17		18,600	18,600
7.	Collect Samples for Baseline Quality	Collect and analyze samples	U.S.G.S.	10-18		3,600	3,600
8.	Analyze Present and Future Risks Using Water and Contaminant Budgets. Select Scenarios for Analysis and Presentation.	Use land use data, investigate chemical usage; Select and analyze budgets; define problems, risks, and possible prevention steps.	Cornell or others with S.R.C.P.B.	1-24	2,000		12,000
9.	For Scenarios of Use or Contamination, Do Site-specific Physical and Chemical Analyses.		U.S.G.S.	12-24		5,000	5,000
10.	Gain Loss Streamflow Measurements	On 4 or 5 major streams	U.S.G.S.	11-16		2,300	2,300
11.	Produce Maps and Reports About Saturated Zone and Interactions With Streams	A set of maps, and a report from which rate and direction of movement, etc., can be determined	U.S.G.S.	12-24		15,400	15,400
12.	Produce Manual for Evaluating Situations of Opportunities or Potential Threats	A manual describing use of water and contaminant budget and saturated zone information in planning situations.	Cornell or others with S.R.C.P.B.	12-24	2,000		10,000
					30,000	52,000	97,000

VI. BUDGET SUMMARY

Summarized by organization and funding source the budget is as follows:

	IN KIND	STATE	FEDERAL
U.S.G.S.		52,000	52,000
Cornell and Others	5,000	30,000	
Tug Hill Commission Salmon Rivers Coop. Pl. Bd. County Planning Departments	25,000	15,000	
	30,000	97,000	52,000

EXHIBIT A

PARTICIPANTS IN DEVELOPMENT OF THIS PROJECT

Oswego County Planning Department
Alman Hawkins, Director
Martin Weiss, Planner assigned to Tug Hill towns

Oswego County Health Department
Robert Shearer - Coordinates Oswego County groundwater study funded through D.E.C.

Oneida County Planning Department and Environmental Management Council
Hans Arnold, Principal Planner
Jeff Gregg

Jefferson County Planning Department
Robert McNary, Director
Bruce Armstrong

Salmon Rivers Cooperative Planning Board/Conservation Advisory Council
S. Arthur Mattison, Chairman
Victor Waggoner, Vice Chairman
Kermit Hayford, Aquifer Committee
Paul Baxter, Local Government Consultant (circuit rider)

Temporary State Commission on Tug Hill
James M. McMahon, Chairman
Benjamin P. Coe, Executive Director
C. Waring Blackburn, Director, Community Assistance
Donald J. Beevers, Director, Natural Resources Policy

St. Lawrence - Eastern Ontario Commission
Daniel Palm, Executive Director

Northern Oneida County Council of Governments (NOCCOG)
Linda Bush, Local Government Advisor (circuit rider)

Cooperative Tug Hill Planning Board
Betty Adler, Coordinator (circuit rider)

D.E.C. Region VI
John Kenna
Joseph Kuta

D.E.C. Region VII
David Files, Real Property Services
Robert Torba, Groundwater Project
Barry Borrow, Groundwater Project

D.E.C. Altmar Fish Hatchery
Robert Maynard, Resident Manager

D.E.C. Albany

C. Thomas Male III, Director, State Groundwater Program
Fred VanAlstyne, Geologist

Center for Environmental Research, Cornell University

Keith Porter
Henry Hughes

United States Geological Survey, Ithaca

Richard Novitzki, Sub-District Chief
Todd Miller, Geologist

McFarland - Johnson, Engineers

Mark Szymkowicz, Engineer (has contract for Oswego Co. groundwater study)

Schoeller Technical Papers, Inc.

Charles W. Osburn, Plant Engineer

EXHIBIT B

Excerpts from Comments Received

Concerning Project Needs

From Schoeller Technical Papers:

"We at Schoeller Technical Papers are vitally interested in this aquifer; we selected this site mainly because of an ample supply of water suitable for the manufacture of our photographic base papers. These requirements are totally in agreement with or more stringent than those for human consumption - namely the absence of heavy metals, radioactive materials, or other chemically active compounds. The size of the aquifer is perceived as being large and therefore conceivably more vulnerable to contamination and this is believed to span several counties and only an agency such as yours could easily insure its protection. We would therefore encourage the Tug Hill Commission to pursue funding on the state or federal levels for this further study. We use approximately 1.7 million gallons of water per day. We are obviously concerned in maintaining the supply in quantity."

From the Jefferson County Department of Planning:

"It is our consensus that the study of the aquifer should determine the quality of the water, the potential sources of contamination, the quantity, and the potential rates for use without detrimental impact."

From the Jefferson County Department of Planning:

"In Jefferson County, 55% of the county's population is totally dependent on groundwater as their sole water source. Little information on the quantity, quality, and location of major sources is known. Knowledge of this kind is extremely important in stabilizingexisting

development as well as providing an incentive in promoting new development and facilities. Secondly, we must protect our existing development (i.e., homes, industry, agriculture) as well as evaluate the potential that exists for an expanded base. Therefore, increased awareness and comprehensive information of potentially significant sources is important to us."

From the Oneida County Environmental Management Council:

"The Environmental Management Council supports and applauds the actions of the Temporary State Commission on Tug Hill and the U.S.G.S. in their preparation of a proposal to study the extent, composition and the availability of water within the Tug Hill aquifer. Such a study and its findings will have a multitude of benefits. They include: protection of the resource for future use, identification of the current and perpetual threats to the resources, utilization of the resource by municipalities needing improvement to their water systems, attraction or expansion of business and industry, understanding of the water cycle, particularly the relationship between surface water and groundwater and the role that the relationship has on the ecosystem composition."

From the Oswego County Public Health Department:

"Following our February 3rd meeting on the "Tug Hill Aquifer" I felt it important to pass on some background information regarding natural gas exploration and production in Oswego County. Gas well development in the northeastern portion of the county poses a potential threat to groundwater resources if improperly conducted. Contamination of this type usually results in improper disposal of brine solution or other fluids produced during drilling operations. We at the local level have

little prior knowledge or any drilling operations and no review powers. While such exploration poses a potential threat to groundwater resources, if conducted properly the two resources together present tremendous incentives for future industrial growth. As we attempt to develop a groundwater management program at the county level, natural gas exploration will be an activity we will have to monitor in a more effective manner. Any extension of the knowledge of the "Tug Hill Aquifer" obtained through the proposed U.S.G.S. study would be invaluable for environmental assessment of proposed activities within the northeastern portion of Oswego County."

From Sarah J. Meyland, Co-Executive Director, N.Y.S. Legislative Commission on Water Resource Needs of Long Island:

Planning for a water supply, especially a groundwater supply requires more than a 20 or40 year planning cycle -- it is, in a sense, planning for forever. I feel that the Tug Hill Commission's leadership role in this effort deserves full support for this important undertaking. As a prototype for the protection of rural and upstate woodland aquifers, the Tug Hill Aquifer Project is unmatched."

EXHIBIT C

GOALS PERTINENT TO AQUIFER PROJECT - FROM COMPREHENSIVE REGIONAL DEVELOPMENT PLAN

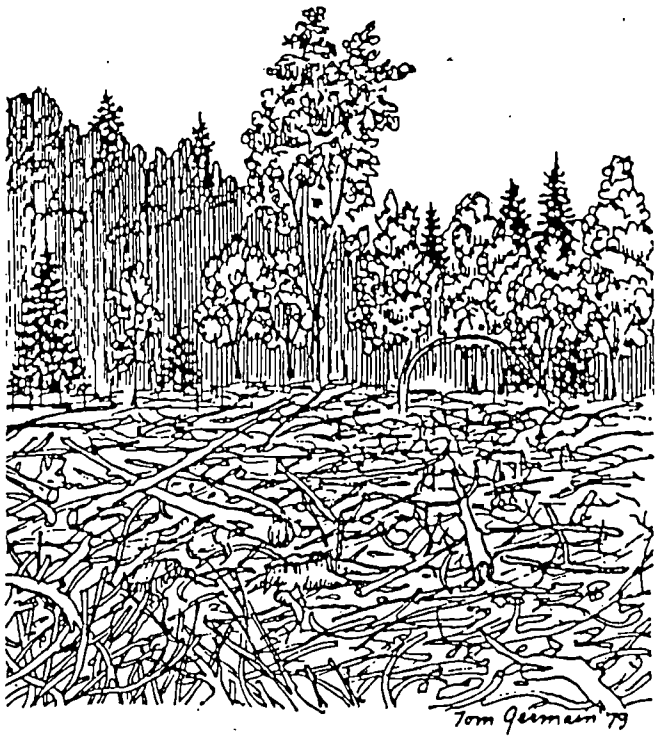
SALMON RIVERS COOPERATIVE PLANNING BOARD/CONSERVATION ADVISORY COUNCIL

GOALS and OBJECTIVES

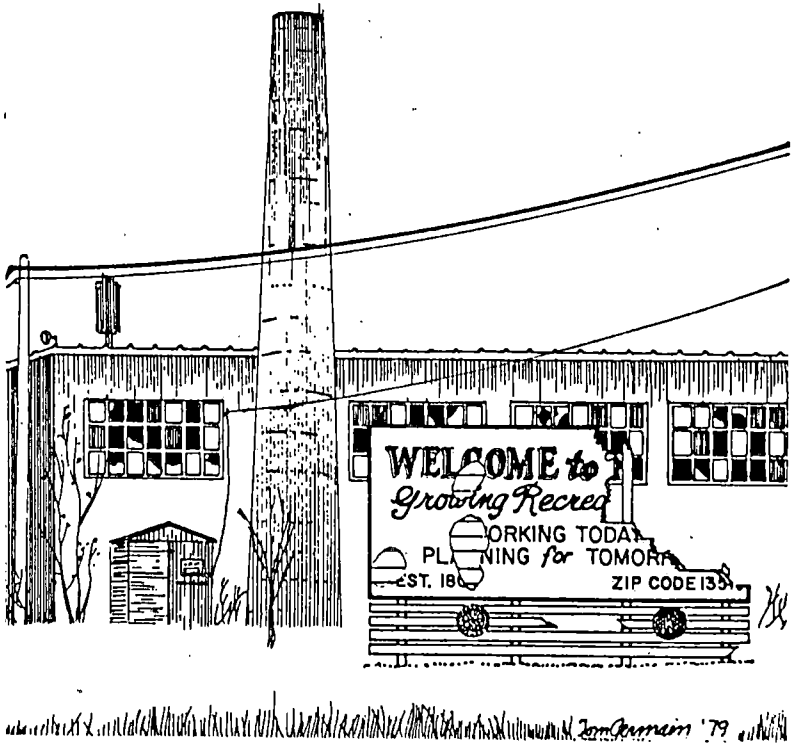
Natural resource and social and cultural considerations present the community with a list of possibilities for the area's growth and development. Only by determining community goals can a plan be developed, however, because a plan depicts a certain direction out of the many possibilities suggested by the earlier work. This section sets forth these community goals and the means for achieving them. A goal may be distinguised from an objective by considering an objective as one of the short-term steps toward achieving the goal. To give a contemporary example, if you decide your goal is to become more physically fit, your first objective may be to walk or jog a mile three times a week.

Only by setting goals and working toward them can communities control their own future.

GOALS	OBJECTIVES	MEANS OF ACHIEVEMENT
Maintain a high quality environment.	1. Monitor & maintain air and water quality. 2. Understand the impact of man's activities. 3. Relate this to citizens to develop awareness and understanding.	1. Enforce existing regulations. 2. Land use regulations. 3. Open space and natural resources plan. 4. Programs on environmental topics. 5. Special studies.



GOALS	OBJECTIVES	MEANS OF ACHIEVEMENT
Maintain and encourage rural lifestyle.	1. Control rate and type of growth. 2. Encourage support of local civic organizations. 3. Develop means of expressing local concerns.	1. Public meetings. 2. Communications with other groups. 3. Provide aid in securing sources of funding for community projects. 4. Land use program.
Encourage local employment opportunities.	1. Existing business support. 2. Maintain healthy agricultural sector. 3. Develop area strengths: a. recreation b. clean air & water c. open space d. location on transportation network	1. Business expansion incentives (tax and other). 2. Economic development plan. 3. Capitol budgeting for facilities. 4. Good local services and facilities. 5. Agricultural districts.
Provide adequate housing	1. Located in areas best suited from town maintenance and physical standpoints.	1. Building code. 2. Land use program. 3. Provide information on grants and aid for housing construction.



6. SAMPLE USE OF PRODUCTS FOR PLANNING

The way the products of this project might be used can be illustrated by describing specific possibilities which might confront a planner. The following three scenarios cover the basic range of possibilities:

1. What if a food processing industry wanted to locate in Tug Hill?

Suppose this food processing industry needed abundant clean water and a low cost way to dispose of its wastes, which consisted of nonhazardous biodegradable by-products, but which contained large concentrations of nitrogen. The problem is finding an area where there is enough water available for the industry's needs and to devise a way to dispose of the waste without causing excessive nitrate contamination of the ground water.

Determining how much water is available for a given use is the first planning step.

Locating areas where abundant water is available can be done using the map which shows well yields to select some candidate well sites. Each of these sites should then be evaluated further by using the potentiometric surface maps to calculate what the well catchments would be. Calculating the water budget for each well catchment would show how much water was available for that well and would allow a rough estimate of what effect the well might have on other users in the area and on wetlands and streams.

Disposal of waste products can be beneficial (as fertilizer) or detrimental (as contamination).

Since the organic loading in the waste would be too great to discharge directly to a stream or to ground water, and because it is high in nutrient content, the company may propose disposing of the waste on nearby cropland with a spray irrigation system. A water and nitrogen budget could be used to calculate the concentration of nitrate in the recharge water from such a

scheme and the amount of recharge water it would generate. The loading thereby calculated would be compared with the permissible loading defined by ground water standards or criteria. The map of the potentiometric surface could be used to determine where the water from the disposal system would go in the aquifer and consequent potential threats to downstream water supplies. These techniques could be used to test a variety of schemes using different locations and different areas of land that the waste could be spread over to identify the best site and management practices that wouldn't adversely affect any water supply or degrade the overall aquifer quality.

2. What if benzene were found in a well used for drinking water?

Tracking down the source is the basic approach to contamination.

Suppose a person with a private well notices that the water from the well suddenly has a highly unpleasant taste and odor. Upon having it tested, it is found that benzene is the cause. The procedure outlined in Section 5.3 could be applied specifically to this well to track down the source of the benzene.

Possible sources of benzene would be gasoline stations or sites where petroleum products had been disposed of. Testing would have to be done at other wells within the catchment of the original well and at the possible sources of the contamination to track down the exact source.

3. What if a residential housing development using septic systems were proposed for a site overlying the aquifer?

Residential housing developments are sources of nitrates from septic systems, domestic animals, and lawn fertilizers. Also

trace amounts of other more hazardous chemicals found in consumer products may be released in recharge water after their use.

Leaching of excess nitrates or hazardous chemicals can contaminate ground water.

The contaminant budgets would estimate the likely concentrations of the contaminants in the recharge water from the proposed development. Also the potentiometric surface map could be used to determine whether any water supply wells would be affected by recharge from the development.

Because of the need to allow for any uncertainties involved in doing contaminant budgets for hazardous chemicals in consumer products, a planner might suggest modification to a plan for a major development in a well catchment of a water supply well. If the development is outside any well catchments, the plan may be more acceptable if the contaminant loadings calculated showed that there would be no resulting general degradation of ground-water quality.

Other possible applications of the products are to evaluate the effects of: (1) the fish hatchery in Altmar and, (2) the consequences of a locally lowered water-table and consequences for adjacent wetlands or streams.