Post Office Box 2857
Raleigh, North Carolina 27602

August 14, 1985

Mr. Robert E. Alexander
Environmental Engineer
United States Marine Corps
Office of the Assistant
Chief of Staff Facilities
Camp Lejeune, North Carolina 28542

Dear Mr. Alexander:

Per your request when Ron Coble and I met with you and other staff members at Camp Lejeune on July 23, 1985, we have prepared a project proposal describing an investigation of the ground-water resources of the base and its environs. Four copies of the proposal are attached for your review and consideration. The cost of test drilling is high, but we feel the drilling is necessary to better insure the reliability of the data and, therefore, of the computer model. The estimated total cost of the project ($417,000) could be divided evently over a four year period to make the annual funding level more constant.

Please let us know if you have any questions, suggestions, or comments about the proposal. We are looking forward to working with you toward the solution of the water-supply problems at Camp Lejeune.

Sincerely,

Orville B. Lloyd, Jr.

Orville B. Lloyd, Jr.
Hydrologist

Encl.

OBL:ceh

PROJECT PROPOSAL

AN APPRAISAL OF THE GROUND-WATER RESOURCES OF CAMP LEJEUNE MARINE CORPS BASE, NORTH CAROLINA

U. S. Geological Survey
Raleigh, North Carolina

August 14, 1985

Revised August 22, 1985

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ILLUSTRATIONS

PROJECT PROPOSAL

TITLE AND LOCATION: An appraisal of the ground-water resources of Camp Lejeune Marine Corps Base, North Carolina.

Camp Lejeune Marine Corps Base, an area of about 170 square miles, is located southeast of the city of Jacksonville in Onslow County, North Carolina. The Base is bounded on the north by N.C. Highway 24, the east by N.C. Highway 172 and Bear Creek, the southeast by the Atlantic Ocean, the southwest by the New River and an irregular line that roughly parallels N.C. Highway 172, and on the west by U.S. Highway 17 (see fig. 1).

PROBLEM: Camp Lejeune plays an essential role in training many Marine Corps men and women for jobs that are necessary to preserve our national security. The Base is the only military training center in the eastern United States where joint amphibious training exercises can be carried out with all branches of the Armed Services.

A plentiful and good-quality water supply is vital for Camp Lejeune to carry out its mission and to maintain the operational readiness of the Fleet Marine Forces. Because it would be very difficult to impound large supplies of fresh water on the surface of the land in the area, Camp Lejeune relies on large amounts of ground water for water supply.

Since Camp Lejeune was first opened in the late 1930's, water supply has been derived from wells that tap freshwater-bearing aquifers (sands and limestone) which occur between land surface and about 400 feet below land surface in the area (see figs. 2 and 3). Clay and silty clay-confining beds are interlayered with the aquifer material but are estimated to be thin and discontinuous beneath the Base. Salty water occurs in the deep sand aquifers that underly the area and in the shallow aquifer material adjacent to the Atlantic Ocean and the tidal reaches of the New River and its tributaries.

Over the years, more than 100 wells have been drilled and operated to satisfy increasing demands for water as the Base functions and population grew. At present, ground-water withdrawals rank amoung the largest in the State and are estimated at 8 million gallons per day. The Base presently supports a population of about 100,000.

An increase in the amount of waste generated by Base operations accompanied the growth. As a result, significant amounts of several kinds of wastes containing hazardous and toxic organic compounds have been disposed of or spilled at numerous sites on the Base (see fig. 4).

PROBLEM: continued

Most of the disposal and spill sites are directly underlain by sand and lack natural or synthetic barriers to contain the wastes and prevent them from moving downward into the ground-water system. Consequently, some of the wastes have infiltrated to the water table and contaminated some of the ground water in the shallow and supply aquifers. Many of the waste-disposal and spill sites are near water-supply wells (see fig. 4), and the use of a number of supply wells has been discontinued recently because organic compounds have been detected in the well water.

Ground-water withdrawals from wells that are near the tidal reaches of the New River and its tributaries may cause salty water in these drainage-ways to move into and through the shallow sand and limestone aquifers toward the pumping wells (see figs. 2 and 3). It is also possible that salty water could be drawn upward from deeper parts of the aquifer system by wells pumping large amounts of ground water from the deep sand aquifers or the lower parts of the limestone aquifer.

Growing water-supply needs coupled with the threat of present and future contamination of existing wells (by disposed wastes or brackish and saline water) has prompted the Marine Corps to request the U.S. Geological Survey to study the geohydrology of the Base and environs and determine ground-water use and management practices that will reduce the chances of further contamination and help assure that future water-supply needs are met.

OBJECTIVES: The objective of this study is to describe the ground-water resources of the Base and environs and to construct an appropriate ground-water flow model that will be used to evaluate alternative ground-water use and management practices that will reduce chances for further contamination and help assure that future water-supply needs are met.

SCOPE: The study area will include the Marine Corps Base and environs. Study elements will include determining (1) the lateral extent, thickness, and hydraulic characteristics of aquifers and confining beds, (2) the potentiometric surfaces of the aquifers, (3) the amounts of ground-water recharge and discharge, (4) the quality of freshwater contained by the aquifers, and (5) the relationship between the freshwater and saltwater in the aquifers. The data collected during these study elements will be used to construct a fine-grid, finite-difference ground-water flow model.

SCOPE: continued

Water-level and water-quality data obtained from more than 50 wells that were drilled during the second phase of the Navy Assessment and Control of Installation Pollutants (NACIP) program at the Base will be used in conjunction with data to be collected during the USGS study. The NACIP data will help define the hydrology and any potential and existing water-quality problems. The wells drilled for the NACIP program are designed to test the ground-water quality to a depth of about 10 feet below the water table and are located adjacent to 22 waste-disposal or spill sites at the Base. Analyses of soil, rock, and water samples collected from these wells are being used to confirm whether or not the shallow ground-water and aquifer material have been contaminated. Confirmation of contamination in the shallow part of the ground-water system will provide an alert to potential contamination in the deeper supply aquifer.

APPROACH:

1. Water-resources budget--Data on precipitation, evapotranspiration, runoff, water levels and water use will be collected, compiled and analyzed to estimate ground-water recharge and discharge in the area.

2. Geohydrologic framework--The depth to and thickness and lateral extent of the aquifers and confining beds will be determined and mapped from a study of geophysical and lithologic logs made from existing wells and new wells that will be constructed for the study.

3. Ground-water movement through the geohydrologic framework--Data from geophysical and lithologic logs will be used in conjunction with aquifer-test data from existing and new wells to determine and map the water transmitting and storage capabilities (hydraulic conductivity and storage coefficient, respectively) of the aquifers and confining beds. In addition, water-level data collected from existing and new wells will be used to determine and map the potentiometric surfaces of the aquifers. The water-level data indicate the hydraulic gradient throughout the aquifer systems. The hydraulic gradient, hydraulic conductivity and storage coefficient are needed to determine the direction and rate of ground-water movement in the area.

4. Quality of ground water--Water samples will be collected from existing and new wells and analyzed for concentrations of major ions, including chloride, and organic compounds, heavy metals, and other appropriate chemicals that can be associated with the work or waste disposal at the Base. The water-quality data will be used to identify, quantify, and determine the source of chemical constituents in the fresh ground water and to help determine the position of the freshwater-saltwater interface in the Base area.

APPROACH: continued

5. Ground-water flow model--The compiled and analyzed data will be used to construct and calibrate the fine-grid, finite-difference ground-water flow model. The model will be the basic tool with which to analyze the effects of alternative ground-water supply development scenarios for the Base. It will be run on the USGS PRIME computer in the North Carolina District office in Raleigh; however, the model can be transferred to other computer(s) on the Base or elsewhere.

6. Test drilling--A major part of the study can be implemented with data that is either presently available or can be collected from existing wells. However, some new test drilling will be needed to better define the geohydrologic framework, the factors that control ground-water movement through the framework, and the ground-water quality. It is estimated that about four test wells (500 to 600 feet deep) will be needed to investigate the water-quality and water-bearing characteristics of the deep sand aquifers and the limestone aquifer in the base area. Also, about three or four observation wells (200 to 400 feet deep) will be needed to make an aquifer test in the supply aquifer, and an additional four to six observation wells (50 to 100 feet deep) will be needed to investigate the position of the freshwater-saltwater interface and its relation to supply-well pumping.

It is assumed that the drilling and sampling of the NACIP program will describe and define the nature and extent of ground-water contamination from hazardous-waste sites on the Base. Therefore, drilling done for the USGS study will be located away from the hazardous-waste sites, as much as possible, to reduce the expense of required and special drilling and safety procedures (like those needed at Cherry Point Marine Corps Air Station).

REPORTS: A report will be written for the USMC describing the results of each completed phase of the investigation (see TIME FRAME for phase descriptions). The completion of the study will result in an interpretative report entitled, "An appraisal of the ground-water resources of Camp Lejeune Marine Corps Base, North Carolina." Additional interpretative reports may be written on various technical aspects of the study. Written progress reports will be prepared and submitted to the USMC quarterly.

RELATION TO LONG-RANGE PLAN: This study relates directly to the North Carolina District's long-range plan (dated May 12, 1980) concerning the quality and availability of ground water in the Coastal Plain.

RELATION TO STATE AND WRD PROGRAMS: The North Carolina Department of Natural Resources and Community Development and the Department of Human Resources are interested and involved in classifying, mapping, and regulating water-use, waste-disposal, and land-use practices throughout the State.

The USGS has a mandate from the U.S. Congress to study and report on the quality and availability of water resources throughout the United States. Ground-water quality is of high national priority for the USGS.

TIME FRAME: The study is tentatively planned for four years and will be divided into three phases. The second phase is extended over a two-year period because of the cost of the work tasks. A brief description of work tasks for each phase follows:

Phase 1 (Fiscal Year 1986[?]) - Collect, compile and analyze all available data on water budget, water use, geohydrologic framework, hydraulic characteristics of aquifers and confining beds, and head and quality of water in aquifers. Prepare a report that describes the available data and new data needs.

Phase 2 (Fiscal Year 1987[?] and 1988[?]) - To fill data needs described in Phase 1 report, design and construct new test wells and new observation wells, and make geohydrologic and chemical tests on new and pre-existing wells. Prepare a report that describes test- and observation-well construction, and the new geohydrologic and chemical data.

Phase 3 (Fiscal Year 1989[?]) - From the analysis of data collected in Phases 1 and 2, construct and calibrate a finite-difference model of ground-water flow through the aquifer and confining-bed materials that underlie the Base area. Determine alternative ground-water use and management practices that will reduce chances for further ground-water contamination and help assure that the future water-supply needs of Camp Lejeune are met effectively and efficiently with the least amount of environmental impact. Recommend a long-term water-level and water-quality monitoring system that will help assure the quality and quantity of the Base water supply. Prepare a report describing the results of Phase 3.

MANPOWER:

Project chief:	Hydrologist	GS-12/13	Full time
Project staff:	Hydrologist	GS- 7/ 9	Part time
	Hydrologic technician	GS- 7/ 9	Part time

COSTS: Estimated costs for each phase of the project are summarized below:

Phase 1 (Fiscal Year 1986[?])	
Data collection and compilation.	$ 20,000
Data analysis and synthesis.	30,000
Report preparation	30,000
Fiscal Year 1986(?) Subtotal	$ 80,000
Phase 2 (Fiscal Year 1987[?] and 1988[?])	
Construction and equipment	
Well drilling, construction, sampling and testing (4600 feet at an estimated $25/foot)	$115,000
Water sampling equipment.	3,000
Geophysical logging (10 days @ $1000/day).	10,000
Laboratory services (40 samples @ $500/sample) . .	20,000
Data collection, analysis, interpretation, and report preparation	80,000
Fiscal Years 1987 and 1988 Subtotal	$228,000
Fiscal Year 1987. . . . .$114,000	
Fiscal Year 1988. . . . .$114,000	
Phase 3 (Fiscal Year 1989)	
Computer time and support personnel.	$ 29,000
Data preparation, analysis, interpretation, and report preparation	80,000
Fiscal Year 1989 Subtotal	$109,000

COST SUMMARY

U. S. Marine Corps Funds

Phase 1 (FY 1986[?]).	$ 80,000
Phase 2 (FY 1987[?]).	114,000
Phase 2 (FY 1988[?]).	114,000
Phase 3 (FY 1989[?]).	109,000
GRAND TOTAL	$417,000

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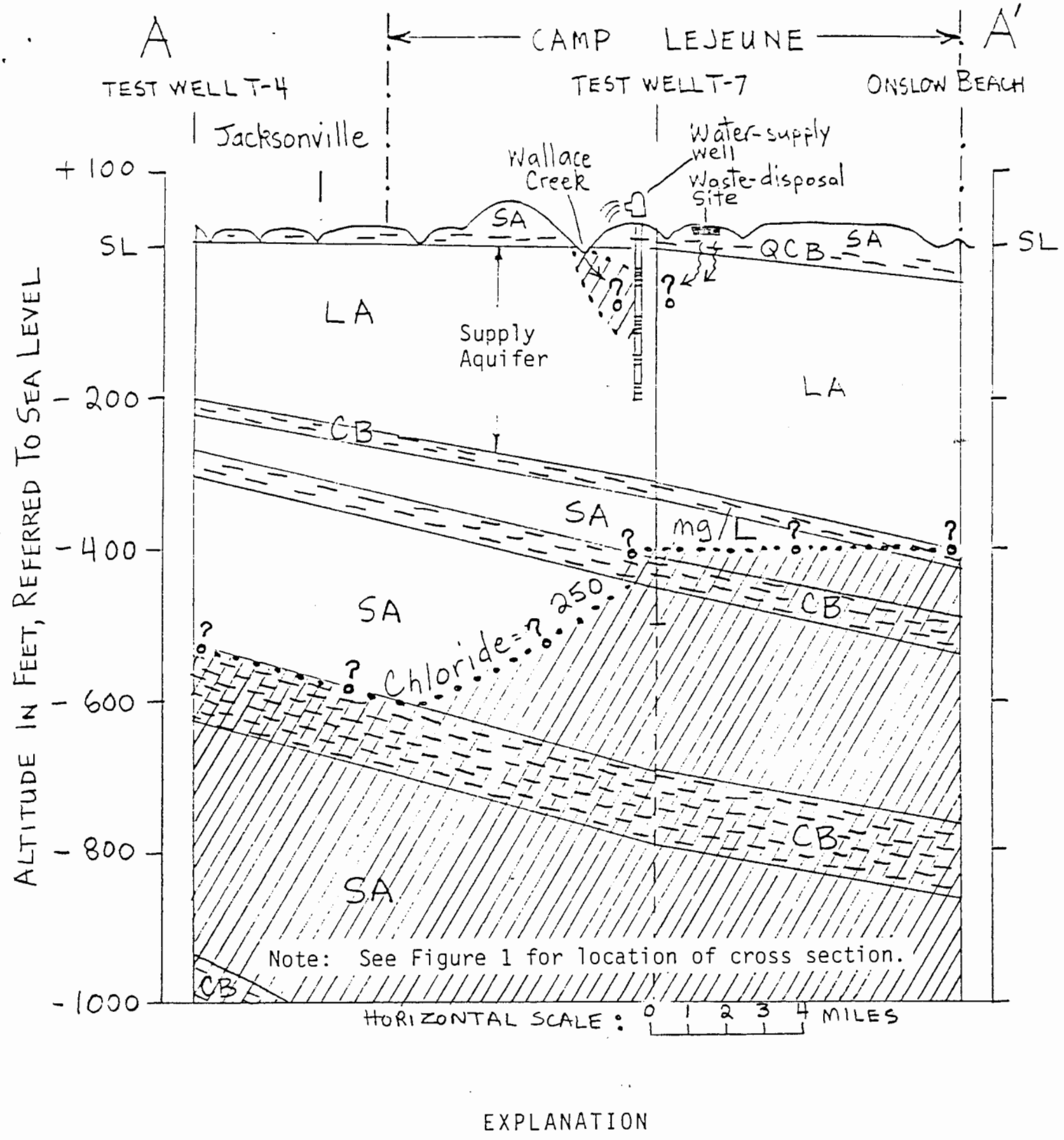

EXPLANATION

CB - Confining Bed

QCB - Questionable Confining Bed

LA - Limestone Aquifer

SA - Sand Aquifer

SL - Sea Level

mg/L - milligrams per liter

- Rock containing water with more than 250 mg/L Chloride

Figure 2.--Diagrammatic geologic and hydrologic cross section A-A', through Camp Lejeune Marine Corps Base, North Carolina.

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