

**A Health Census
of a Community with
Groundwater Contamination
Jackson Township, 1980**

**Environmental Health
Program**



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Groundwater Contamination
Jackson Township, 1980**

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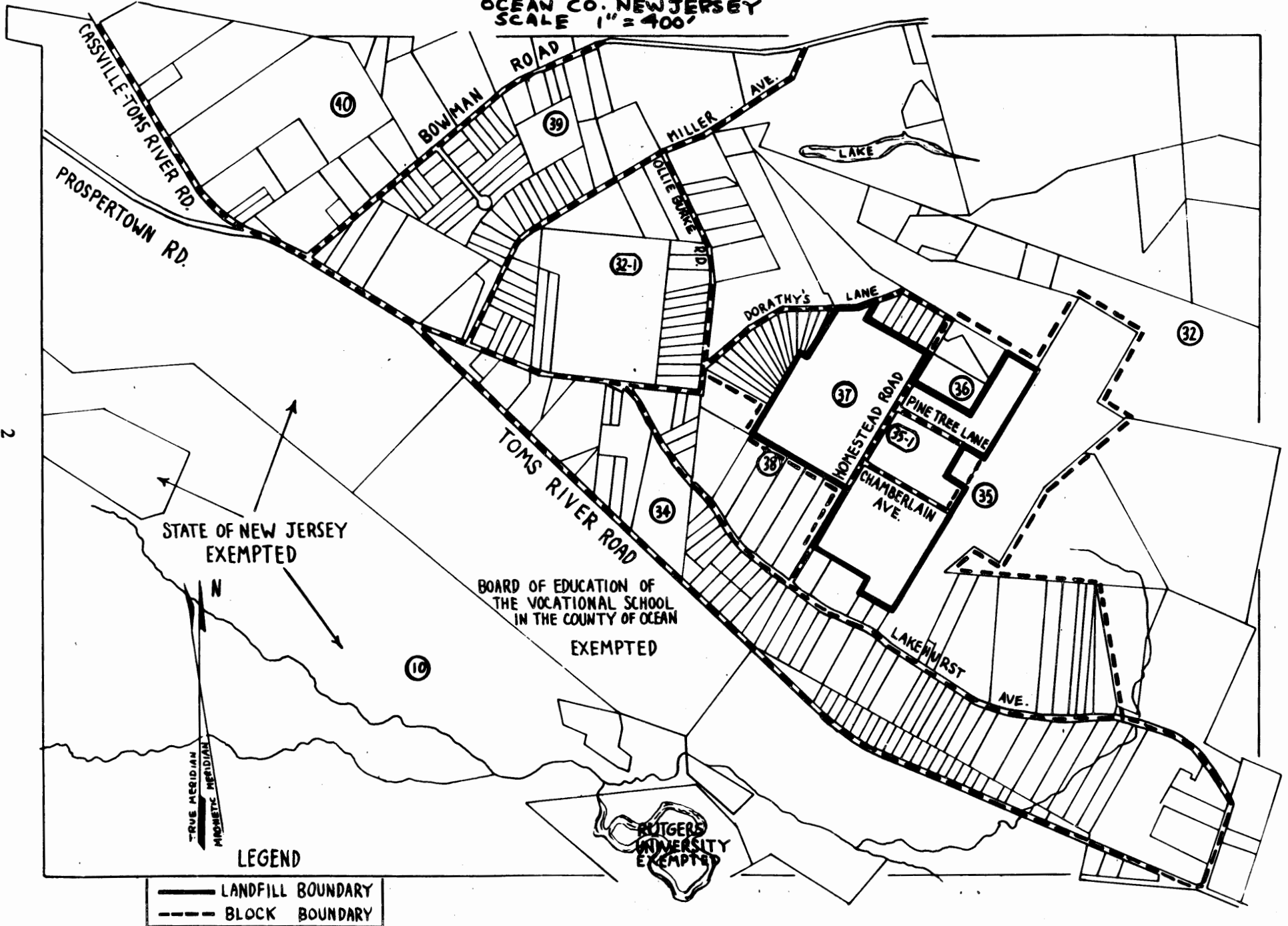
INTRODUCTION

Jackson Township landfill is owned and operated by Jackson Township and is located on and about Homestead Road in the Legler Section in Jackson Township, Ocean County, New Jersey (Map). The landfill overlies the Cohansey aquifer which was the prime source of water for the shallow wells found in residences proximate to the landfill. The landfill had been in operation since approximately April 24, 1972, when it was registered by the Department of Environmental Protection (DEP). Under the condition of the registration, the landfill was prohibited from accepting or disposing of "liquid or soluble industrial materials" such as chemical wastes.

The landfill was not insulated from the underlying groundwaters and/or from surface waters in the area. The landfill was originally located in a relatively undeveloped part of the Township, but many new homes have been built and occupied in the area in recent years. The soil in the area is sandy, and the homes occupied prior to 1979 used water from shallow wells as their potable supply. Complaints about water quality in the summer of 1978 led the DEP to obtain water samples for analysis. The earlier samples were subjected to routine tests, such as for bacteriological contamination and selected inorganic chemicals. By December 1978, more samples had been analyzed (partly in the Department of Health Laboratory), and contamination of the aquifer with a variety of organic chemicals was demonstrated.

In general, there was more contamination near the landfill, but there were variations in test results from the same wells taken at different times.

TAX MAP FOR
JACKSON TOWNSHIP
OCEAN CO. NEW JERSEY
SCALE 1" = 400'



— LANDFILL BOUNDARY
- - - BLOCK BOUNDARY

LEGEND

TRUE MERIDIAN
MAGNETIC MERIDIAN
N

STATE OF NEW JERSEY
EXEMPTED

BOARD OF EDUCATION OF
THE VOCATIONAL SCHOOL
IN THE COUNTY OF OCEAN
EXEMPTED

RUTGERS
UNIVERSITY
EXEMPTED

Despite this limitation, geologists from DEP were able to define an area around the landfill which was subject to the contamination emanating from this dump. The contamination has been ascribed to illegal chemical dumping in the area, and the landfill has been judicially determined to be the repository for much of this waste. Various regulatory actions were initiated in December, 1978, and the landfill has been closed since February, 1980.

The contamination included compounds which are on the federal Environmental Protection Agency (EPA) Priority Pollutant List, and the observed levels were high enough to generate concern about the risk to human health from a long-term consumption of this water. In November 1978, the Board of Health of Jackson Township, in consultation with the State Departments of Health and Environmental Protection, advised families neighboring the landfill not to use water from their wells for potable purposes due to chemical contamination of the aquifer. Since about January, 1979, until June, 1980, local authorities had provided water in tank trucks to area residents for potable purposes. Houses occupied since that time have had their water supplied from deep wells which DEP feels draw from a relatively clean aquifer. All the residents now have an alternative clean source of water supply.

During January of 1980, the Concerned Citizens Committee, comprised of the 94 households involved in a class action lawsuit, completed health surveys, consisting of mailed self-administered questionnaires, similar to one of the surveys administered at Love Canal. The form had a checklist for 148 signs, symptoms and conditions, as well as questions related to medications, occupation, chemical exposure, family history and maternal history. The cover letter to the survey stated that the dual purpose of the survey was to

assist in obtaining federal funds for health purposes, and to assist the Committee's attorney in preparing for litigation by providing information about health problems as they might be related to the groundwater. The completed surveys from 82 households (87% response rate) were evaluated by the New Jersey State Department of Health, and the responses suggested that the only significant complaints were related to skin irritation and, to a lesser extent, eye irritation (Groundwater Contamination and Possible Health Effects in Jackson Township, New Jersey, July 1980).

Since the Health Department had some concern about long-term effects of exposure to the water, it was decided to obtain a census of the community for possible use at a later date. To be useful, such a census should have information about exposure to the water supply, so that detailed information on water supply and usage was obtained. As the census was done by personal interview, it was felt that better data could be obtained on the health of the community than from the self-administered questionnaire analyzed in our first study; and, therefore, health questions were included in the census with particular emphasis on areas which were of concern to the citizens or that came out of the analysis of the first questionnaire. The design of the census permitted an analysis of some health effects compared to exposure to the water. This report largely contains results of this analysis.

In addition, it was decided that the air of a representative sample of homes be tested for possible chemical contamination from the groundwater. It was also felt necessary to test the air in the basements of some homes away from the Legler Section for comparison purposes. This report also gives the results of that investigation.

METHODS

Collection and Analysis of Data

Under the supervision of a physician of the New Jersey State Department of Health, the Community Services Division of the Ocean County Health Department coordinated and completed the Health Survey between the months of August and November, 1980. A letter requesting a personal interview was sent to each residence in the Legler Section of Jackson Township. Appointments were made with the head of the household to be interviewed, and other members of the household were requested to be present.

Interviews were conducted in the home by one of the three trained nurse interviewers. At the time of the interview, the intent of the survey was explained, and the family was advised of the confidentiality of the information and adult members of the family were asked to sign an informed consent. They were also requested to sign a release of medical records, if any health problems were reported. A three-part questionnaire was used. The first part consisted of eight pages of forty-four questions designed to identify all members of the household and collect information considered relevant to the sources of drinking and cooking water while living in the Legler Section of Jackson Township. The second part consisted of thirteen pages of fifty-eight questions asked of each member of the household. An adult member responded for children. Questions were designed to elicit demographic data, residential history, occupational history, smoking history, water use patterns, acute skin problems, and chronic health problems. The third part consisted of six pages of twenty-six questions asked of each female

household member who had ever been pregnant. Responses concerning the four possible mutually exclusive pregnancy outcomes of live births, miscarriages, stillbirths, and therapeutic abortions, as well as birth defects and infant and child deaths, were gathered. Copies of the instructions to the interviewers and the questionnaire are in appendixes 1 and 2, respectively.

Answers were coded and computerized. The results were checked for logical consistency and gross errors. Keypunched data were stored and analyzed on an IBM 370 system, with APL and SAS software. Responses dealing with medical problems were coded by the Eighth Revision of the International Classification of Diseases (ICD-8). All medical problems diagnosed after the start of well water use for drinking and cooking water were included in the analysis. The time between first exposure to the groundwater and the diagnosis of the medical problem may have ranged from a month to more than ten years.

Statistical Methods

The basic hypotheses being tested were that trends exist in health effects, with the highest exposures having the highest percent of respondents reporting health effects, and the lowest exposures having the lowest percent of respondents reporting health effects. Although the onset of disease could be approximately determined from the respondents, based on reported date of diagnosis, it was not possible to definitively determine the onset of exposure to contaminated ground water. Therefore, it was simply assumed that reported date of start of well use was equivalent to the date that exposure began.

The statistical test used was the test for a linear trend in proportions (Snedecor, 1967). In this application, the measures of exposure, years of well use, frequency of showers and/or baths per week, and frequency of dishes washed per week, were each grouped into four categories of increasing exposure, and the assigned scores were the estimated median of each group.

Also, using the information from a DEP Geological Survey (Appendix 3), a dichotomous presentation of high and low exposure areas was possible. The higher exposures were presumed to be on Blocks 34, 37, and 38, and the lower exposures were on Blocks 10, 32, 32-1, 35, 36, 39, and 40. The decision on grouping high and low exposure areas was made after the interview but prior to the analysis of the health data. Criteria used in reaching this decision include:

- 1) The two major sources of groundwater pollution identified were the Jackson Township Municipal Landfill located on Block 37 and the Kenneth Wickham property on Block 38.
- 2) The major groundwater component from the landfill and the Wickham property is toward the southeast (Appendix 3).
- 3) DEP sampling data, which was used to establish the extent of contamination, showed high levels of pollution in Blocks 34, 37 and 38.

The rates of health effects stratified by well water use and residential block were age-adjusted by the direct method of standardization to the 1970

United States standard million population. Because these rates have been age-adjusted to the same standard, these rates may be directly compared with one another.

Relative risk is the rate of illness among those exposed to a given factor divided by the rate of illness among those not exposed to a given factor. Estimates of relative risk (odds ratios) and significance levels were obtained on stratified sets of tables using the Mantel-Haenszel procedure (1959). The classic chi-square test of independence was also used.

RESULTS

Survey Population

In the area identified by geologists as at risk for having a contaminated shallow aquifer, there were 162 households. This is in agreement with the estimate of 165 homes made by the Concerned Citizens Committee. There were 150 households (92.6%) who responded to the survey. Among the households not responding to the survey, members from 9 households (5.5%) refused to be interviewed, and members from 3 households (1.9%) moved from the area and were not contacted.

In the 150 households surveyed, there were 560 persons. Of these people, 50% were male and 50% were female; 97.3% were white, and 2.7% were non-white. Thirty-nine percent were children (19 years of age or younger). The median age group was 25-29. The population's distribution by race, sex, and age is shown in Table 1.

A tax map of the surveyed area is shown in Map 1. For tax purposes, the area is divided into sections called blocks. One of the parameters was determined by residency of different blocks. Of the ten blocks surveyed, approximately 40% of the residents lived on Block 34 (Table 2).

The lifetime cigarette consumption of smokers and exsmokers is shown in Table 3. Sixty percent of the population were non-smokers; this sub-population included children.

Forty percent of the population were employed at the time of the interview. Their occupations may be classified into 9 categories, based on the Occupational Classification System in the 1970 Alphabetical Index of Industries and Occupations (pp X-XIV) published by the U.S. Bureau of the Census. The greatest proportion were craftsmen (Table 4). Eighteen percent of the population were housewives, and twenty-five percent were students. A more detailed description of each category is shown in Table 5. Sixty-six individuals (11.8%) reported chemical exposure on a job; three individuals (0.5%) had chemical exposure at home which was not related to the water supply.

Health Complaints

The sets of questions concerning skin problems and other health problems are to be found on pages 88 through 95. There were ten categories of skin problem questions: acne, psoriasis, excessive dryness, hives, redness, itching, blisters, scaling, sore lips and gums, and other skin problems. The other health problem questions included eye or ear problems during the past three years for which a physician was consulted, hospitalization during the past 10 years excluding pregnancies, kidney illness, liver illness, cancer, neurological illness, and any other medical problem, besides the ones previously mentioned, for which a physician had been visited more than 3 times during the past ten years.

For the purpose of classification, the questions are divided into two groups in the tables: skin effects, which include all categories of skin problems, and systemic effects, which include all the remaining health

problems previously mentioned. The terminology of the specific health problems in the questionnaire is also found in the tables. In addition, the terms used in the questionnaire, were selected as representative of how the respondents expressed their illness. For example, kidney illness was broadly interpreted to mean not only illness related to the kidney, but also to its collecting system, i.e. the ureter and bladder.

Of the ten skin conditions, the most commonly reported effect was itching, followed by other conditions which might be related to or the cause of itching, like dryness, redness, and scaling (Table 6). Of seven chronic variables, the broad categories of other illness, eye and ear problem, and hospitalization were most commonly reported (Table 7). The other illnesses and reasons for hospitalization are shown explicitly in Tables 8 and 9, respectively.

Comparable rates of skin problems were reported by men and women, except for dryness and itching which were reported in excess by women. Rates of systemic effects were similar for men and women, except for kidney illness, and the broad category of other illness which were again reported in significant excess by women (Table 10).

Reported health problems by age are shown in Tables 11-14.

The distribution of systemic illness in the population by pack-year of cigarettes is shown in Table 15.

The small proportion of respondents who reported chemical exposure on the job (12%) reported more acne, skin dryness, hives, and redness. There was no excessive reporting of systemic conditions among the people with chemical job exposures (Table 16).

Among the more serious health complaints the Department of Health was asked to evaluate were reports of kidney, bladder, and urinary tract disease. Therefore, reported illness of these mentioned sites was considered in more detail than other health problems. The thirty-two reports of kidney disease may be divided into two categories based on the time of onset of the disease: acute infections of the kidney, bladder, or urinary tract and chronic kidney conditions.

Two men and twenty-two women had reported infections of the kidney, bladder, or urinary tract. The ages at diagnosis ranged from 4 to 70. Well use experience ranged from 0.5 to 18 years. The majority of cases (54%) resided on Block #34. The median reported year of diagnosis was 1978, although the most frequently reported year of diagnosis was 1980 (Table 17).

Two men and six women reported chronic kidney conditions. The ages at diagnosis ranged from 8 to 59. Well use experience ranged from 1 to 51 years. The majority of cases (75%) resided on Block #34. The median and most frequently reported year of diagnosis was 1979 (Table 18).

The 8 reports of chronic kidney conditions included kidney stones, reflux-flowing back, pain in right kidney, right kidney removed, left kidney removed, total kidney failure, kidney operation and kidney 40% function. A medical record review was conducted for the latter six reported chronic renal illnesses to clarify the specific diagnoses. For three individuals, it was not possible to obtain medical records. The individual who reported "pain in right kidney" had never consulted a physician. Neither the person who reported "right kidney removed" nor the person who reported "left kidney removed" had signed a Release of Medical Records form.

Three physicians were contacted and responded to corroborate the remaining reported diagnoses. The individual who reported "total kidney failure" indeed had chronic renal failure, diagnosed as secondary to diabetic nephropathy with hypertension and nephrotic syndrome and diabetic retinopathy. The individual had had juvenile-onset diabetes, diagnosed in 1948, prior to moving to Jackson. The individual who reported "kidney operation" had a left extended pyelolithotomy, i.e. an operation for a kidney stone. The individual who reported "kidney 40% function" has chronic renal disease, of unknown etiology. In addition, the individual has coronary atherosclerotic heart disease, diabetes mellitus, and hypertension.

Skin and Systemic Effects of groundwater according to proximity to the landfill

With the exception of redness, a higher proportion of residents on Blocks 34, 37, and 38 than elsewhere in the Legler section reported experiencing each skin problem, although only itching and blisters show statistically significant differences. In addition, with the exception of hospitalization and neurological illness, a higher proportion of systemic effects were reported, although none showed a statistically significant difference (Table 19).

Skin and systemic effects of groundwater according to length of time of well use and depth of well.

The length of time and depth of well which these respondents reported using for drinking and cooking were used as measures of their ingestion exposure to groundwater. Two assumptions were made. First, the longer the well usage, the greater would be the exposure and therefore the percent of the population experiencing health effects. Second, the shallower the well (less than 100 feet), the more contaminated the water (Appendix 3), the greater would be the exposure and the percent of the population experiencing health effects. A significantly increasing trend with increasing years of well water use was observed for reports of hospitalization and kidney illness at all well depths combined, and the subgroup of well depth less than 100 feet. Overall, the percentage of respondents reporting health problems was higher among shallow well users than among deep well users. However, the validity of the deep well users' data is limited because of the relatively small number

of respondents using deep wells. The frequencies with which health effects were reported according to years and depth of well use are shown in Table 20.

Skin effects and eye and ear effects according to frequency of skin exposure.

The frequency with which the respondents reported using well water for showers and/or baths and dish washing was used as a measure of their skin contact exposure to groundwater, as shown in Tables 21 and 22, respectively. The interpretation of increasing exposure levels was limited, since most people reported bathing seven or more times a week or washing dishes less than seven times per week.

The highest proportion of people reporting acne did not shower or bathe. Psoriasis was reported least among those who showered most. Of the remaining symptoms, the reports increased from zero use, but not necessarily in a linear fashion. Dryness, hives, scaling and sore lips were reported most by those who showered or bathed four to six times a week. At the highest exposures (7+), a higher proportion of people reported redness, itching, blisters, other skin problems, and eye or ear problems. Significant positive trends were detected for reports of redness, itching, and other skin problems.

Increasing exposure to groundwater by dish washing did not result in increased reports of skin symptoms in a significant positive trend, except for one condition, hives. Seven symptoms, acne, dryness, hives, itching, blisters, scaling, and sore lips and gums showed more reports among those who washed dishes than among those who did not. Three symptoms, psoriasis, redness,

and other skin problems, showed more reports among those who did not wash dishes. In fact, increasing dishwashing was associated with decreasing reports of redness in a significant negative trend.

Reproductive effects of groundwater

Residence in the study area during pregnancy was used as a measure of the 141 mother's, and hence fetus's exposure, to groundwater in Jackson. That is to say, mothers' pregnancy outcomes prior to moving to Jackson was compared to the same mothers' pregnancy outcomes while living in Jackson. All reported adverse pregnancy outcomes, miscarriages, abortions, stillbirths and low birth weight, did not occur in a substantial excess in Jackson, in either the total or specific age groups, except for miscarriages in the "under 20" age group. However, it is difficult to interpret the rate of 40%, since the numbers representing this percent are small (2/5) (Table 23 and 24).

The birth defect reported after 3½ years of parental exposure to groundwater was described as multiple congenital anomalies. The infant subsequently died one day later of congenital heart disease, as reported on a death certificate. The mother had occupational exposure to anesthesia which has been associated with developmental defects at birth (Pharoah, 1977). The second infant death, reported after approximately 5 years of parental exposure to groundwater, was in an 8-month old and the reported cause was Wilm's tumor. A child death, reported after approximately one year of the household's exposure to ground water (there was no fetal exposure), occurred at the age of one year and five months and the cause, reported on a death certificate, was anoxic-ischemic encephalopathy.

In addition, the sixty-six pregnancy outcomes which occurred while the women were living in Jackson, were stratified on the basis of various gradients of groundwater exposure, specifically, by residence block and depth and years of well use. No statistically significant differences between high and low exposure blocks were observed (Table 25); nor was any statistically significant trend evident from depth and years of well use (Table 26).

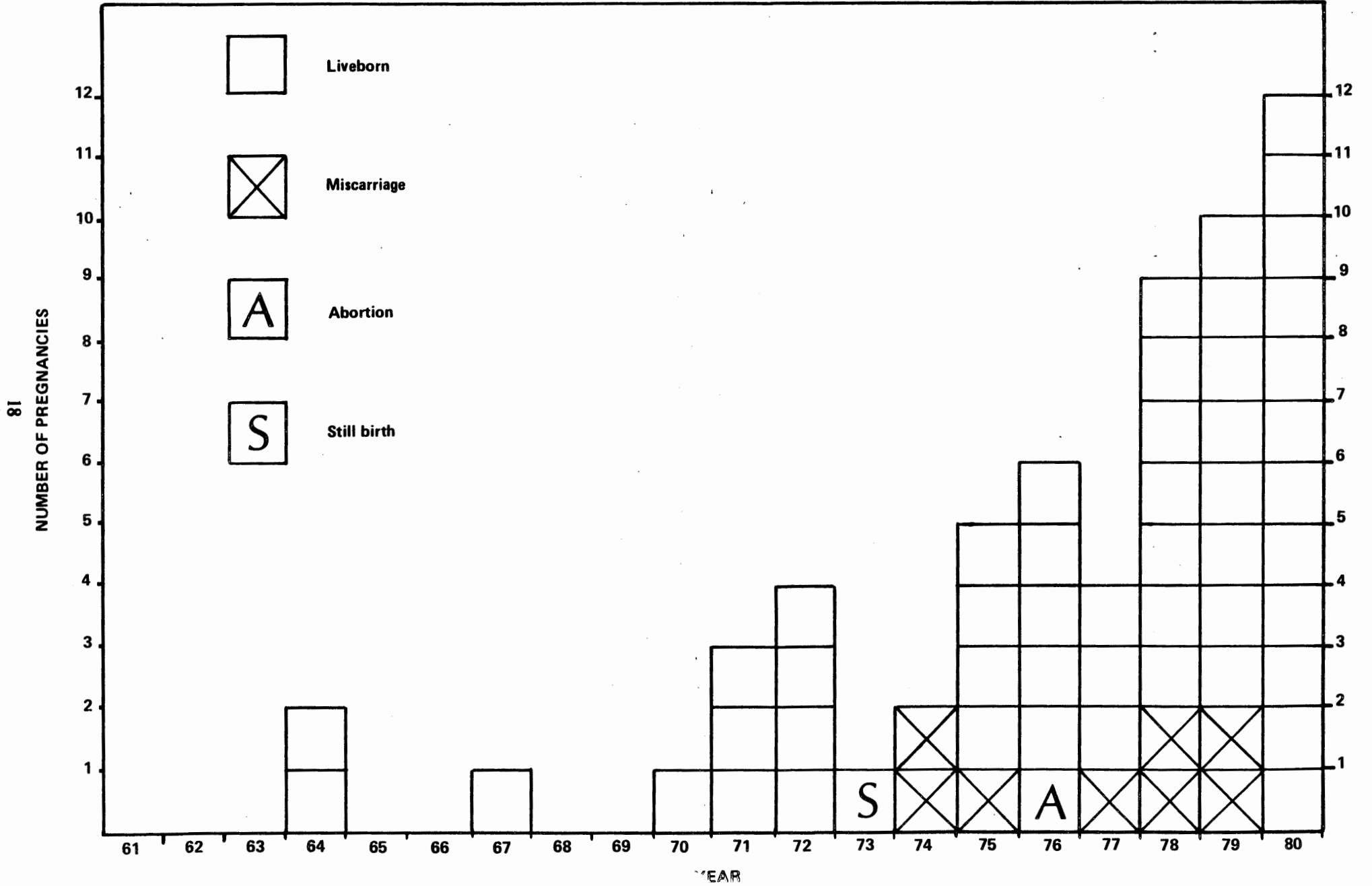
Graph 1 plots the year of pregnancy after moving to Jackson Township, and is similar in format, but not information, to Figure 2, presented in the first report of Groundwater Contamination and Possible Health Effects in Jackson Township, New Jersey, page 33. Six of the sixty-six reported pregnancies occurred prior to 1961. From 1970 to 1980, there was an almost linear increase in the number of reported pregnancies, from one in 1970 to twelve in 1980. Miscarriages, stillbirths and abortions were reported between the years of 1973 to 1979. No more than two of these outcomes occurred in any one of those years.

Air Sampling Measurements

During the week of August 18 and 22, 1980, the New Jersey State Department of Health (DOH) conducted air sampling inside a selected group of homes in the Legler section of Jackson Township. The purpose was to determine whether basement contamination by volatile organics, resulting from groundwater pollution, had occurred.

The presumed exposed population consisted of 15 households located in five different blocks as designated by municipal tax maps. Of these

GRAPH 1
REPORTED YEAR AND OUTCOME OF PREGNANCIES COMPLETED FOLLOWING MOVE TO JACKSON TOWNSHIP
1980



households, three had at least one member with a history of reported kidney disorders. Five homes were still utilizing water from shallow domestic wells and, at the time of sampling, had not yet been connected to the new, deeper municipal system. A summary of the presumed exposed households is presented in Table 27.

Between February 2 and 6, 1981, an unexposed group composed of volunteers from the local Rotary Club were similarly sampled. The ten control households similarly utilized water from the Cohansey aquifer but were located in the northwest section of Jackson Township and were not exposed to the alleged point source of contamination.

The specific occurrence and concentration of organic compounds in air in the basements of Legler and non-Legler homes is presented in Table 28. As shown in the table, several different compounds were usually at low levels in varying concentrations in both study and control homes. Ten of the 15 case homes (66.7%) showed at least one organic compound while six of the 10 controls (60%) were similarly positive. As such, there was no significant difference in the number of positive air results between cases and controls ($p = 0.31$, Fisher's exact test). Toluene was the most frequently detected organic compound in the Legler homes.

Table 29 summarizes data on all of the organic chemicals detected in these air samples; mean, minimum and maximum concentrations are presented for each of these organic chemicals.

It appears that there were no significant differences in constituents or concentrations of detectable organic compounds between Legler and non-Legler households. Unfortunately, the air samplings in the Legler and control homes were done during different seasons. These seasonal differences may mask any slight increase in air levels in the Legler homes as compared to the control homes. The individuals whose homes were sampled were notified of the findings, and it was recommended that any household chemicals, pesticides and materials used for hobbies, etc., be stored in a cool place, preferably outside their homes, such as in sheds.

DISCUSSION

The reported health effects and exposures afforded us the opportunity to assess if possible relationships exist between adverse health effects and exposure to toxic materials present in a landfill site. To this end, 560 individuals from 150 households were interviewed. This was a response rate of 92.6% of the potentially exposed households. With this high a response rate, the results obtained can be considered to be representative of reported health problems in this community.

One of the major difficulties in assessing the health effects of toxic waste dumps is to be able to assess the differing levels of exposures individuals have had. Since there is no information available to quantitate previous exposure, four methods were used to estimate individuals' exposure: 1) for skin and systemic problems: residence in the area suspected of having the highest contamination; 2) for systemic problems: years of well use; 3) for systemic problems: use of shallow wells which were felt to have higher levels of contamination than deep wells; and 4) for skin problems: number of showers or baths per week, and number of times an individual washed dishes per week.

If health complaints are related to toxic contaminants in the water, one would expect increased symptoms to be associated with increased measures of exposure. Of the ten categories of skin complaints recorded (Table 6), the report of blisters was statistically increased among residents in the presumed more highly contaminated area (Table 19). Redness, itching and other skin problems were statistically associated with increased showering or bathing

(Table 21), and hives were statistically associated with number of times an individual washed dishes per week (Table 22). The results were not totally consistent across the three measures of exposure used. For example, although redness was increased among individuals who reported increased showering or bathing, there were less reports of redness in individuals who reported washing the dishes frequently and in individuals living on the presumed higher contaminated blocks than the less contaminated blocks. Various halogenated organic compounds have been found in the well water. At higher concentrations in occupational settings, these compounds have been associated with similar skin symptoms. We, therefore, see the occurrence of these skin symptoms and their relationship, although not totally consistent, with measures of water exposure to be biologically plausible.

The percentage of individuals who reported systemic problems is shown in Table 7. The "other illnesses" are classified in Table 8. There were no particular diseases that were reported in excess. Besides skin rashes, common illnesses like bronchitis, hypertension or sore throat were the most frequently reported illness. The reasons for hospitalization are reported in Table 9. Again, there was no single cause for hospitalization reported in excess. The most common reasons for hospitalization were cystitis/urinary infection, uterine dilatation and curettage, concussion and tonsillitis acute/removal.

No systemic illness was statistically associated with living in the presumed more highly contaminated area (Table 19). When systemic illness was correlated with years of well use, both kidney illness and hospitalization were reported with highly significant increasing frequency with increased

years of well use (Table 20). This trend was seen only in individuals using shallow wells (Table 20). This association with years of well use and, in particular, shallow wells is consistent with a dose-response relationship.

Hospitalization also increased with years of well use (Table 20). Like kidney illness, this was seen only in individuals using shallow wells (Table 20). There was, however, no increase in hospitalization in individuals living in the presumed high exposure area (Table 19). The absence of any one particular cause for hospitalization makes the association found between water use and hospitalization to be of questionable biologic significance. It is hard to imagine that exposure to water was associated with the wide range of conditions for which individuals were hospitalized.

The majority of kidney illnesses were diagnosed to be of infectious origin (Table 17). Urinary tract infections are known to be very common. They are rarely seen in males before the age of 50 years and are much more prevalent in females (Rubin, 1982). In Jackson, more women than men reported urinary tract infections. The age distribution of reported urinary tract infections in Jackson, was similar to the age distribution shown in a compilation of published incidence rates (Table 30).

The chronic kidney problems were diverse. One individual reported pain and had not seen a physician, two had kidney stones, one had reflux, which is generally considered to be congenital, two individuals with kidney failure had diabetes and hypertension and two individuals, who had had nephrectomies, did not sign medical release forms.

With our present understanding of the etiology of chronic kidney disease and urinary infections, as well as the absence of similar problems in the occupational settings at higher exposures to the same compounds found in the contaminated wells, the association between well use and kidney disease found in this study does not make biologic sense. Further studies of other similarly exposed groups will be necessary to replicate these findings before these results can be accepted as more than a statistical coincidence.

The frequency of reported adverse reproductive outcomes among mothers exposed to groundwater contamination did not increase with presumed increased exposure to contaminated groundwater, as observed by three different measures: pregnancies in Jackson compared to pregnancies before moving to Jackson (Tables 23-24), residence in the presumed more contaminated area by block (Table 25), and years of well use (Table 26). As a further observation, the frequency of reported adverse reproductive outcomes among the fifty-seven pregnancies which occurred between 1970 and 1980, were compared to the expected frequency, as published in the literature (Table 31). The Stein reference does not show original data, but is a compilation of many studies. Once again, no excessive frequency was observed among the pregnancies in Jackson.

In this type of study, the investigators are always concerned about differential reporting of health effects in the exposed individuals who are more aware and concerned about the issue than the control or less exposed group. This type of bias, which epidemiologists call respondent or recall bias, may have contributed to the results found in this study. However, all

individuals interviewed in this study considered themselves exposed. All comparisons in the analysis are made between the presence of greater exposed versus lesser exposed individuals. In order for the associations found between measures of increasing exposure and our estimates of health complaints to be based merely on respondent bias, individuals interviewed would have needed to have associated living in a certain area, shallow wells, and frequent or long use with health problems. This may have been true, and there may have been different levels of concern throughout the community interviewed. However, we do not believe that respondent bias explains all our results as the measures of exposure were set up after the study.

Air levels found in the basements of homes around the landfill were generally low and comparable to levels found in control group of houses. The data do not support an unusual exposure to chemicals subsequent to the replacement of contaminated well water.

In summary, an association was found between various skin symptoms, hospitalizations, kidney disease and exposure to well water. Based on previous studies done on exposure to similar toxins, only the findings related to skin symptoms are consistent with the known effects of the chemicals found in the drinking water, although the concentrations found are much lower than levels found to cause similar problems in the occupational setting. These findings are not consistent with current medical knowledge on the etiology of these diseases. Further work will need to be done on similarly exposed individuals to replicate the findings that these conditions are associated with exposure to low levels of chemicals in the water.

REFERENCES

1. Groundwater Contamination and Possible Health Effects in Jackson Township, New Jersey. Division of Epidemiology and Disease Control. New Jersey State Department of Health, Trenton, 1980.
2. International Classification of Diseases. Manual of the International Statistical Classification of Diseases, Injuries and Causes of Death. Eighth Revision. Geneva: World Health Organization, 1967.
3. Mantel N. Haenszel W. Statistical Aspects of the Analysis of Data From Retrospective Studies of Disease. Journal of the National Cancer Institute, 1959; 22:719-748.
4. Pharoah, P.D.D., Alberman, E. and Doyle, P. Outcome of Pregnancy Among Women in Anesthetic Practise. Lancet, 1977, I:34-36.
5. Snedecor, G. W. and Cochran, W.G.: Statistical Methods, 6th edition, Ames, Iowa State University Press, 1967, pages 246-248.
6. United States Department of Commerce, Bureau of the Census: 1970 Census of Population, Alphabetical Index of Industries and Occupations. Library of Congress, 74-612012.

TABLES

TABLE 1
 DISTRIBUTION OF POPULATION SAMPLED BY AGE, SEX, AND RACE
 JACKSON, 1980

Age Group	<u>Males</u>				<u>Females</u>				<u>Total</u>	
	<u>White</u>		<u>Nonwhite</u>		<u>White</u>		<u>Nonwhite</u>		<u>N</u>	<u>%</u>
	<u>N</u>	<u>%</u>	<u>N</u>	<u>%</u>	<u>N</u>	<u>%</u>	<u>N</u>	<u>%</u>		
< 1	6	2.2			5	1.8			11	2.0
1-4	34	12.4	1	14.3	19	7.0	1	12.5	55	9.8
5-9	31	11.4	1	14.3	39	14.3	1	12.5	72	12.9
10-14	17	6.2			26	9.6	1	12.5	44	7.9
15-19	22	8.1			15	5.5	1	12.5	38	6.8
20-24	20	7.3	1	14.3	18	6.6	1	12.5	40	7.1
25-29	28	10.3			46	16.9	1	12.5	75	13.4
30-34	51	18.7			35	12.9			86	15.4
35-39	17	6.2	1	14.3	17	6.2	1	12.5	36	6.4
40-44	11	4.6	1	14.3	14	5.1			26	4.6
45-49	7	2.6			9	3.3			16	2.9
50-54	11	4.0	2	28.6	7	2.6	1	12.5	21	3.7
55-59	5	1.8			3	1.1			8	1.4
60-64	3	1.1			5	1.8			8	1.4
65-69	1	0.4			5	1.8			6	1.1
70-74	5	1.8			1	0.4			6	1.1
75-79					3	1.1			3	0.5
80-84	2	0.7			4	1.5			6	1.1
85+	2	0.7			1	0.4			3	0.4
<u>Total</u>	<u>273</u>	<u>100.0</u>	<u>7</u>	<u>100.0</u>	<u>272</u>	<u>100.0</u>	<u>8</u>	<u>100.0</u>	<u>560</u>	<u>100.0</u>

TABLE 2
DISTRIBUTION OF RESPONDENTS AMONG THE TEN BLOCKS
JACKSON, 1980

<u>Block Number</u>	<u>No. of Respondents</u>	<u>% of Total</u>
34	221	39.5
39	107	19.1
32-1	67	12.0
37	59	10.5
38	26	4.6
10	25	4.5
32	24	4.3
35	18	3.2
40	9	1.6
<u>36</u>	<u>4</u>	<u>0.7</u>
Total	560	100.0%

TABLE 3

DISTRIBUTION OF POPULATION SAMPLED BY LIFETIME CIGARETTE CONSUMPTION
JACKSON, 1980

<u>PACK-YEARS*</u>	<u>RESPONDENTS</u>	
	<u>N</u>	<u>%</u>
Nonsmoker	338	60.4
<1	26	4.6
1-9	65	11.6
10-19	62	11.1
20-29	27	4.8
30-39	15	2.7
40-49	6	1.1
50-59	4	0.7
60+	14	2.5
Don't Know	3	0.5
	<u>560</u>	<u>100.0</u>

*1 pack-year = 365 packs of cigarettes

TABLE 4
 CLASSIFICATION OF RESIDENTS BY CURRENT OCCUPATION
 JACKSON, 1980

<u>Occupation</u>	<u>N</u>	<u>%</u>
Professional, Technical and Kindred Workers	35	6.2
Managers and Administrators	19	3.4
Sales Workers	9	1.6
Clerical and Kindred Workers	38	6.8
Craftsmen and Kindred Workers	54	9.6
Operatives, except Transport	17	3.0
Transport Equipment Operatives	18	3.2
Laborers	9	1.6
Service Workers	<u>22</u>	<u>3.9</u>
Total Employed	<u>221</u>	<u>39.3</u>
Not Currently Employed:	<u>339</u>	<u>60.6</u>
Housewife	101	18.0
Student	140	25.0
Children Under 5	74	13.2
Unemployed	7	1.3
Retired	15	2.7
Disabled	1	0.2
Unknown	1	0.2
Total Population	<u>560</u>	<u>99.9</u>

TABLE 5

COMPREHENSIVE LISTING OF OCCUPATION TITLES
JACKSON, 1980

1.	Professional, Technical and Kindred Workers	35
	Accountant	1
	Architect	1
	Computer programmer	1
	Computer systems analyst	1
	Computer specialist	1
	Industrial engineer	1
	Engineer	3
	Chemists	1
	Life and physical scientist	1
	Registered Nurse	7
	Clinical Laboratory Technologists and Technicians	1
	Psychologists	2
	Social Workers	1
	Elementary School Teacher	4
	Secondary School Teacher	2
	Teachers, except college and university n.e.c.	2
	Chemical Technicians	1
	Draftsmen	3
	Painters and sculptors	1
2.	Managers and Administrators	19
	Assessors, controllers, treasures, local public admin.	1
	Bank Officers and financial managers	2
	Managers and superintendents, building	1
	Office managers	1
	Restaurant, cafeteria and bar managers	2
	Sales manager and dept. heads, retail trade	1
	Sales manager, except retail trade	1
	Managers and administrators	9
	Farm manager	1
3.	Sales Workers	9
	Insurance agents, brokers, and underwriters	2
	Newsboy	1
	Salesmen and sales clerks	6

TABLE 5 (CONTINUED)

4.	Clerical and Kindred Workers	38
	Bank Tellers	3
	Bookkeepers	4
	Cashiers	2
	Clerical supervisors	1
	Counter clerks, except food	1
	Estimators and investigators	3
	Expeditors and production controllers	2
	Mail carriers, post office	2
	Computer and Peripheral equipment operators	1
	Key Punch operators	1
	Postal clerks	1
	Receptionists	3
	Secretaries, legal	1
	Secretaries, medical	1
	Secretaries	3
	Shipping and receiving clerks	3
	Telephone operators	1
	Ticket station, and express agents	1
	Not specified clerical workers	4
5.	Craftsmen and Kindred Workers	54
	Blacksmiths	1
	Carpenters	10
	Electricians	3
	Electric power linemen and cablemen	1
	Excavating, grading and road machine operators	2
	Floor layers, exc. tile setters	1
	Foreman	4
	Inspectors	1
	Air Conditioning, heating, and refrigeration	1
	Automobile body repairmen	3
	Automobile mechanics	1
	Heavy equipment mechanics, in. diesel	2
	Radio and Television	1
	Miscellaneous mechanics and repairmen	7
	Not specified mechanics and repairmen	6
	Painters, construction and maintenance	1
	Photoengravers and lithographers	1
	Plumbers and pipe fitters	1
	Plumber and pipe fitter apprentices	1
	Pressmen and plate printers, printing	1
	Sheetmetal workers and tinsmiths	1
	Stationary engineers	2
	Structural metal craftsmen	1
	Tool and die makers	1

TABLE 5 (CONTINUED)

6.	Operatives, except transport	17
	Garage workers, and gas station attendants	3
	Meat cutters and butchers	1
	Meat wrappers, retail trade	1
	Packers and wrappers, except meat and produce	1
	Stationary firemen	2
	Welders and flame-cutters	1
	Machine operatives, miscellaneous specified	2
	Machine operatives, not specified	2
	Miscellaneous operatives	2
	Not specified operatives	2
7.	Transport Equipment Operations	18
	Bus drivers	3
	Deliverymen and routemen	11
	Forklift and tow motor operatives	2
	Railroad switchmen	1
	Truck driver	1
8.	Laborers, except farm	9
	Animal caretakers, exc. farm	1
	Gardeners and groundkeepers, exc. farm	3
	Stockhandlers	1
	Miscellaneous laborers	4
9.	Service workers, exc. private Household	22
	Bartenders	3
	Waiters	6
	Health aides, exc. nursing	1
	Nursing aides, orderlies and attendants	2
	Attendants, personal service	2
	Hairdressers and cosmetologists	1
	Housekeepers, exc. private household	1
	Policemen and detectives	6

TABLE 6
REPORT OF NOTICING SKIN PROBLEMS
FOLLOWING BATHING OR SHOWERING AMONG 560 RESIDENTS
JACKSON, 1980

<u>Skin Problem</u>	<u>No.</u>	<u>(%)</u>
1. Itching	229	(40.9)
2. Excessive Dryness	187	(33.4)
3. Redness	158	(28.2)
4. Other Skin Problems	130	(23.2)
5. Scaling	114	(20.4)
6. Sore Lips, Gums	62	(11.1)
7. Acne	48	(8.6)
8. Hives	45	(8.0)
9. Blisters	28	(5.0)
10. Psoriasis	19	(3.4)

TABLE 7

REPORT OF SYSTEMIC PROBLEMS AMONG 560 RESPONDENTS WHOSE ONSET
WAS AFTER START OF WELL USE
JACKSON, 1980

1.	Other Illness*	141	(25.2)
2.	Eye or Ear Problem**	123	(22.0)
3.	Hospitalization	102	(18.2)
4.	Kidney Illness***	32	(7.8)
5.	Neurological Illnesss***	14	(2.5)
6.	Cancer***	4	(0.7)
7.	Liver***	1	(0.2)

*Individual had to report to have visited a physician 3 or more times for the same medical problem.

**Individual had to report that he/she had consulted a physician.

***Individual reported he/she had these conditions.

TABLE 8

CLASSIFICATION OF "OTHER ILLNESSES"* REPORTED IN TABLE 7
 (CLASSIFICATION ADAPTED FROM
EIGHTH REVISION, INTERNATIONAL CLASSIFICATION OF DISEASES)
 JACKSON, 1980

<u>Disease</u>	<u>No. of Respondents</u>
Infective and Parasitic Diseases	
Tuberculosis, pulmonary	1
Staph infection, unspecified	2
Mononucleosis	1
Warts, unspecified	1
Neoplasms	
Vocal cord nodule	1
Endocrine, Nutritional, and Metabolic Diseases	
Goiter, simple/hyperthyroidism	1
Low blood sugar	1
Weight loss	1
Diseases of the Nervous System and Sense Organs	
Seizure disorders	1
Ear infection, unspecified	1
Diseases of the Circulatory System	
Mitral valve disorder, unspecified	1
Hypertension	9
Angina pectoris	1
Arrhythmia	1
Phlebitis	1
Diseases of the Respiratory System	
Colds	3
Sinusitis, acute	2
Tonsillitis	4
Laryngitis	1
Pneumonia, unspecified	5
Bronchitis, unqualified	10
Emphysema	1
Asthma	5
Allergies	4
Hay Fever	1
Epistaxis	1
Shortness of breath	2
Diseases of the Digestive System	
Gastritis/duodonal ulcer	1
Hernia, hiatal	1
Colitis, ulcerative	1
Gall bladder problems	1

*Individual had to report to have visited a physician 3 or more times for the same medical problem.

TABLE 8 (CONTINUED)

<u>Disease</u>	<u>No. of Respondents</u>
Diseases of the Genital System	
Hypospadias	1
Menstrual cycle irregularity	1
Erosion of cervix	1
Vaginitis	6
Endometriosis	1
Complications of Pregnancy and Childbirth	
Infertility	1
Diseases of the Skin and Subcutaneous Tissue	
Acne	1
Ringworm	1
Pityriasis roseola	1
Psoriasis	1
Urticaria	1
Skin rash, unspecified	9
Diseases of the Musculoskeletal System and Connective Tissue	
Vertebrogenic pain syndrome	1
Muscle tone problems, unspecified	1
Congenital Anomalies	
Dislocated hip, congenital	1
Symptoms and Ill-defined Conditions	
Sore throat	19
Upper Gastrointestinal symptoms, unspecified	7
Lower Gastrointestinal symptoms, unspecified/diarrhea	3
Headaches	1
Fever/FUO	1
Fainting/syncope	1
Accidents	
Fracture, metatarsal, unqualified	1
Back injury, unspecified	1
Accidents, motor vehicle	3
Operations and Surgical Procedures	
Shunt for cerebral fluid	1
Dilation and curettage	1

TABLE 9

CLASSIFICATION OF HOSPITALIZATION REPORTED IN TABLE 7
 (CLASSIFICATION ADAPTED FROM
 EIGHTH REVISION, INTERNATIONAL CLASSIFICATION OF DISEASES)
 JACKSON, 1980

<u>Disease</u>	<u>No. of Respondents</u>
Neoplasms	
Neoplasm of large intestines, malignant	1
Neoplasm of breast, unspecified	1
Nutritional Diseases	
Malnutrition	1
Mental Disorders	
Schizophrenia	1
Diseases of the Nervous System and Sense Organs	
Neurological Evaluation/workup	1
Tear duct opening	1
Cataracts	1
Ear infection, unspecified	2
Diseases of the Circulatory System	
Myocardial infarction	3
R/O cardiac problems	1
Pericarditis	1
Ruptured blood vessel in eye	1
Phlebitis	1
Hemorrhoids	1
Diseases of the Respiratory System	
Tonsillitis, acute/removal	4
Influenza	1
Pneumonia, viral	1
Pneumonia, unspecified	2
Bronchitis, unqualified	2
Asthma	2
Allergies	1
Deviated Nasal Septum	2
Pneumothorax, unspecified	1
Diseases of the Digestive System	
Gastritis/duoditis	1
Appendicitis, acute/removal	1
Ruptured intestine	1
Anal fissure	1
Retrocele	1
Gall bladder problems	2
Diseases of the Genitourinary System	
Kidney infection, unspecified	3
Kidney stones	2
Cystitis/urinary tract infection	5
Meatal stenosis	1
Pelvic Inflammatory Disease	1

TABLE 9 (CONTINUED)

<u>Disease</u>	<u>No. of Respondents</u>
Complications of Pregnancy, and Childbirth	
Complications of Pregnancy, unspecified	1
Infertility	1
Diseases of the Musculoskeletal System and Connective Tissue	
Disc ruptured	1
Muscle tone problems, unspecified	1
Congenital Anomalies	
Crossed eyes, congenital	1
Symptoms and Ill-defined Conditions	
Upper gastrointestinal symptoms, unspecified	2
Falling spells	1
Fainting/syncope	1
Accidents, and Violence	
Fracture, pelvis, unspecified	1
Fracture, shoulders, unspecified	1
Fracture, elbow, unspecified	1
Fracture, femur, unspecified	1
Fracture, unspecified bones of lower limb	2
Knee injury, unspecified	1
Back injury, unspecified	1
Concussion	5
Accident, motor vehicle	3
Burns, electrical, unspecified	1
Operations and Nonsurgical Procedures	
Lymph node excision	1
Cyst removal, jaw, unspecified	1
Myringotomy	3
Tooth extraction	2
Hernia repair, unspecified	4
Dialysis	1
Kidney removal	1
Surgical vaginal examination	1
Tubal ligation	3
Dilation and curettage	5
Knee cartilage removal	1
Splenectomy	1

TABLE 10
 PROPORTION OF MALES AND FEMALES REPORTING SKIN AND
 SYSTEMIC EFFECTS
 JACKSON, 1980

	Sex			
	Male		Female	
	280	(100%)	280	(100%)
<u>Skin Effect</u>				
Acne	24	(8.6)	24	(8.6)
Psoriasis	10	(3.6)	9	(3.2)
Excessive Dryness	77	(27.5)	110	(39.3)
Hives	15	(5.4)	30	(10.7)
Redness	79	(28.2)	79	(28.2)
Itching	101	(36.1)	128	(45.7)
Blisters	9	(3.2)	19	(6.8)
Scaling	51	(18.2)	63	(22.5)
Sore Lips	26	(9.3)	36	(12.9)
Other Skin Problems	64	(22.9)	66	(23.6)
<u>Systemic Effect</u>				
Eye or Ear Problem	60	(21.4)	63	(22.5)
Hospitalization	46	(16.4)	56	(20.0)
Kidney Illness	6	(2.1)	26	(9.3)
Liver Illness	1	(0.4)	0	(0.0)
Cancer	1	(0.4)	3	(1.1)
Neurological Illness	4	(1.4)	10	(3.6)
Other Illness	55	(19.6)	86	(30.7)

TABLE 11

PERCENT AGE DISTRIBUTION OF MALES REPORTING SKIN PROBLEMS
AFTER SHOWERING OR BATHING WITH WELL WATER
BY AGE AT INTERVIEW AND TYPE OF SKIN PROBLEM
JACKSON, 1980

	Age Group (In Years)								
	Total	<1	1-9	10-19	20-29	30-39	40-49	50-59	60+
Number of Respondents	280	6	67	39	49	69	19	18	13
Acne	8.6	0.0	0.0	20.5	18.4	4.3	10.5	5.6	7.7
Psoriasis	3.6	0.0	0.0	2.3	6.1	4.3	15.8	0.0	0.0
Excessive Dryness	27.5	0.0	22.4	25.6	24.5	29.0	57.9	22.2	38.5
Hives	5.4	0.0	6.0	5.1	6.1	1.4	5.3	11.1	15.4
Redness	28.2	0.0	25.4	30.8	20.4	27.5	57.9	33.3	30.8
Itching	36.1	0.0	20.9	41.0	30.6	43.5	63.2	50.0	38.5
Blisters	3.2	0.0	4.5	2.6	0.0	4.3	5.3	0.0	7.7
Scaling	18.2	0.0	10.4	17.9	16.3	20.3	47.4	27.8	7.7
Sore Lips + Gums	9.3	0.0	2.3	17.9	6.1	7.3	26.3	11.1	15.4
Other Skin Problems	22.9	0.0	17.9	20.5	24.5	23.2	26.3	38.9	30.8

TABLE 12

PERCENT AGE DISTRIBUTION OF FEMALES REPORTING SKIN PROBLEMS
AFTER SHOWERING OR BATHING WITH WELL WATER
BY AGE AT INTERVIEW AND TYPE OF SKIN PROBLEM
JACKSON, 1980

	Age Group (In Years)								
	Total	<1	1-9	10-19	20-29	30-39	40-49	50-59	60+
Number of Respondents	280	5	60	43	66	53	23	11	19
Acne	8.6	0.0	1.7	20.9	13.6	7.6	4.3	0.0	0.0
Psoriasis	3.2	0.0	0.0	2.3	4.6	5.7	0.0	18.2	0.0
Excessive Dryness	39.3	20.0	15.0	34.9	45.5	56.6	56.5	54.6	31.6
Hives	10.7	0.0	5.0	11.6	12.1	7.6	17.4	18.2	21.1
Redness	28.2	0.0	26.7	27.9	27.3	28.3	43.5	36.4	21.1
Itching	45.7	0.0	35.0	44.2	47.0	56.6	56.6	54.6	61.5
Blisters	6.8	0.0	3.3	7.0	6.1	3.8	17.4	18.2	10.5
Scaling	22.5	0.0	11.7	13.9	21.2	34.0	47.8	36.4	15.8
Sore Lips + Gums	12.9	0.0	1.7	20.9	10.6	15.1	30.4	18.2	10.5
Other Skin Problems	23.6	0.0	18.3	20.9	24.2	26.4	34.9	27.3	26.3

TABLE 13

PERCENT AGE DISTRIBUTION OF MALES REPORTING SYSTEMIC PROBLEMS
SINCE START OF WELL USE
BY AGE AT INTERVIEW AND TYPE OF HEALTH PROBLEM
JACKSON, 1980

	Age Group (In Years)								
	Total	<1	1-9	10-19	20-29	30-39	40-49	50-59	60+
Number of Respondents	280	6	67	39	49	69	19	18	13
Eye or Ear Problem	21.4	0.0	44.8	23.1	10.2	13.0	5.3	22.2	15.4
Hospitalization	16.4	0.0	19.4	20.5	8.2	13.0	10.5	38.9	23.1
Kidney Illness	1.8	0.0	0.0	0.0	2.0	2.9	5.3	11.1	0.0
Liver Illness	0.4	0.0	0.0	0.0	0.0	0.0	0.0	5.6	0.0
Cancer	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.7
Neurological Illness	1.4	0.0	1.5	5.1	0.0	0.0	0.0	5.6	0.0
Other Illness	19.6	0.0	32.8	25.6	10.2	11.6	26.3	22.2	7.7

TABLE 14
DISTRIBUTION OF FEMALES REPORTING SYSTEMIC PROBLEMS
SINCE START OF WELL USE
BY AGE AT INTERVIEW AND TYPE OF HEALTH PROBLEM
JACKSON, 1980

	Age Group (In Years)								
	Total	<1	1-9	10-19	20-29	30-39	40-49	50-59	60+
Number of Respondents	280	5	60	43	66	53	23	11	19
Eye or Ear Problem	22.5	0.0	36.7	25.6	15.1	18.9	21.7	18.2	15.8
Hospitalization	20.0	0.0	13.3	18.6	18.2	17.0	30.4	54.6	31.6
Kidney Illness	6.4	0.0	11.7	4.6	9.1	7.5	17.4	0.0	15.8
Liver Illness	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cancer	1.1	0.0	0.0	0.0	1.5	0.0	0.0	9.1	5.3
Neurologic Illness	3.6	0.0	6.7	0.0	3.0	1.9	13.0	0.0	0.0
Other Illness	30.7	0.0	30.0	34.9	27.3	34.0	34.8	36.4	26.3

TABLE 15
 DISTRIBUTION OF RESPONDENTS REPORTING SYSTEMIC PROBLEMS
 BY SMOKING HISTORY
 JACKSON, 1980

		Total	Non-Smoker	Pack-Years					Smoker Don't Know
				<1	1-19	20-39	40-59	60+	
No. of Respondents		560	338	26	127	42	10	14	3
Eye or Ear Problem	Yes	123	86	3	25	5	2	1	1
	%	22.0	25.4	11.5	19.7	11.9	20.0	7.1	33.3
Hospitalization	Yes	102	53	6	23	7	5	8	0
	%	18.2	15.7	23.1	18.1	16.7	50.0	57.1	-
Kidney Illness	Yes	32	17	2	8	2	1	2	0
	%	5.7	5.0	7.7	6.3	4.8	10.0	14.3	-
Liver Illness	Yes	1	0	0	0	1	0	0	0
	%	0.2	-	-	-	2.4	-	-	-
Neurological	Yes	14	9	0	5	0	0	0	0
	%	2.5	2.7	-	3.9	-	-	-	-
Other Illness	Yes	141	91	4	25	9	4	6	2
	%	25.2	26.9	15.4	19.7	21.4	40.0	42.9	66.7
Cancer	Yes	4	1	1	2	0	0	0	0
	%	0.7	0.3	3.8	1.6	-	-	-	-

TABLE 16

PROPORTION OF RESPONDENTS REPORTING LOCAL AND SYSTEMIC EFFECTS
BY CHEMICAL EXPOSURE ON THE JOB
JACKSON, 1980

No. of Respondents=558 ¹	Chemical Exposure On the Job		Chemical Exposure On the Job	
	<u>Yes</u>	<u>(%)</u>	<u>No</u>	<u>(%)</u>
	<u>66</u>	<u>(100%)</u>	<u>492</u>	<u>(100%)</u>
<u>Skin Effect</u>				
Acne*	11	(16.7)	37	(7.5)
Psoriasis	1	(1.5)	18	(3.7)
Excessive Dryness**	34	(51.5)	152	(30.9)
Hives**	12	(18.1)	33	(6.7)
Redness	26	(39.4)	132	(26.8)
Itching	33	(50.0)	196	(39.8)
Blisters	2	(3.0)	25	(5.1)
Scaling	17	(25.8)	96	(19.5)
Sore Lips	12	(18.2)	49	(10.0)
Other Skin Problem	21	(31.8)	108	(21.9)
<u>Systemic Effect</u>				
Eye or Ear Problem	16	(24.2)	107	(21.7)
Hospitalization	11	(16.7)	91	(18.5)
Kidney Illness	2	(3.0)	29	(5.9)
Liver Illness	0	(0.0)	1	(0.2)
Cancer	2	(3.0)	2	(0.4)
Neurological Illness	2	(3.0)	12	(2.4)
Other Illness*	9	(13.6)	131	(26.6)

¹Two individuals did not know if they were exposed to chemicals on the job.

*Chi-square test significant at the 5% level (One degree of freedom).

**Chi square test significant at the 1% level (One degree of freedom).

TABLE 17

DISTRIBUTION OF REPORTED ACUTE INFECTIONS OF THE KIDNEY, BLADDER,
OR URINARY TRACT AFTER START OF WELL USE
JACKSON, 1980

Block	Number Reported Infections of the Kidney, Bladder or Urinary Tract	Median Year of Diagnosis	Median Age at Diagnosis	Median Years of Well Use Prior to Illness
32-1	1	1979	26	0.5
32	3	1979	45	0.4
34	13	1977	26	4
35	1	1977	31	3
36	1	1980	29	1
38	2	1972	26	11.5
39	3	1980	5	0.5

TABLE 18

DISTRIBUTION OF REPORTED CHRONIC KIDNEY CONDITIONS
AFTER START OF WELL USE
JACKSON, 1980

Block	Number of Reported Chronic Kidney Conditions	Median Year of Diagnosis	Median Age of Diagnosis	Median Years of Well Use Prior to Illness
32	1	1979	8	0.2
34	6	1978	36.5	8.5
35	1	1979	30	7

TABLE 19

AGE-ADJUSTED RATES PER 100 OF RESPONDENTS REPORTING
LOCAL AND SYSTEMIC EFFECTS BY BLOCK
JACKSON, 1980

	<u>Blocks 34,37,38</u>	<u>Other Blocks</u>	<u>Age-adjusted Odds Ratio</u>	<u>95% Confidence Interval</u>
Total No. Of Respondents	306	254		
<u>Skin Effect</u>				
Acne	9.4	8.0	1.1	0.6-2.2
Psoriasis	4.6	2.1	1.8	0.7-4.7
Excessive Dryness	37.4	30.6	1.1	0.7-1.5
Hives	11.9	6.4	1.3	0.7-2.5
Redness	27.9	29.0	0.9	0.6-1.3
Itching	48.8	33.9	1.7*	1.2-2.4
Blisters	9.4	1.6	4.0*	1.6-9.7
Scaling	21.9	22.0	1.1	0.7-1.7
Sore Lips	17.6	10.0	1.8	1.0-3.1
Other Skin Problems	28.3	20.4	1.1	0.8-1.7
<u>Systemic Effect</u>				
Eye or Ear Problem	25.3	17.9	1.4	0.9-2.2
Hospitalization	21.2	29.1	0.6	0.4-1.0
Kidney Illness	8.1	3.1	1.8	0.9-4.0
Liver Illness	0.7	0.0		
Cancer Illness	2.0	0.9	1.2	0.2-7.8
Neurological Illness	2.4	3.2	1.0	0.3-1.6
Other Illness	26.9	23.3	1.1	0.7-1.6

*Significant at the 5% level.

TABLE 20

AGE-ADJUSTED RATES PER 100 FOR RESPONDENTS REPORTING SYSTEMIC EFFECTS
SINCE START OF WELL USE FOR DRINKING AND COOKING
BY DEPTH AND YEARS OF WELL USE
JACKSON, 1980

Systemic Effect	Depth of Well	Years of Well Use			
		0	<1	1+	5+
Eye or Ear Problem	All Well Depths	24.6	28.2	14.5	27.2
	Less than 100 ft.		31.9	18.4	27.5
	More than 100 ft.	-	15.9	1.6	19.2
Hospitalization	All Well Depths*	10.4	18.0	15.9	28.2
	Less than 100 ft.*		18.5	17.9	29.4
	More than 100 ft.	-	11.8	6.4	0.0
Other Illness	All Well Depths	11.1	24.4	26.8	22.3
	Less than 100 ft.		21.9	30.9	21.0
	More than 100 ft.	-	21.9	12.0	19.2
Neurological Illness	All Well Depths	0.0	1.7	3.8	2.3
	Less than 100 ft.		1.8	4.3	2.5
	More than 100 ft.	-	0.0	0.8	0.0
Kidney Illness	All Well Depths*	8.1	3.0	5.9	13.0
	Less than 100 ft.*		3.2	6.5	13.4
	More than 100 ft.	-	0.0	4.2	0.0
Number of Respondents	All Well Depths	17	161	261	121
	Less than 100 ft.	17	131	190	115
	More than 100 ft.	0	30	71	6

*Normal deviate Z for testing trend significant at 1% level.

TABLE 21

AGE-ADJUSTED RATES PER 100 OF RESPONDENTS REPORTING SKIN PROBLEMS AND EYE OR EAR PROBLEMS BY USUAL NUMBER OF SHOWERS AND/OR BATHS PER WEEK JACKSON, 1980

	Number of Showers and/or Baths			
	0	1-3	4-6	7+
Number of Respondents	10	55	119	375
Acne	23.1	7.6	4.7	9.8
Psoriasis	0.0	7.4	7.1	2.6
Excessive Dryness	5.6	32.0	37.7	32.9
Hives	0.0	5.8	10.7	8.8
Redness**	1.7	21.8	16.6	32.7
Itching*	13.5	33.4	33.5	42.6
Blisters	0.0	5.0	4.4	6.5
Scaling	0.0	15.5	23.1	22.4
Sore Lips and Gums	5.6	12.1	16.9	13.1
Other Skin Problems**	5.5	16.1	19.8	27.9
Eye or Ear Problems	13.9	19.8	19.2	22.8

*Normal deviate Z for testing trend significant at 5% level.

**Normal deviate Z for testing trend significant at 1% level.

TABLE 22

AGE-ADJUSTED RATES PER 100 FOR RESPONDENTS REPORTING SKIN PROBLEMS
 BY NUMBER OF TIMES DISHES WASHED BY HAND PER WEEK
 WHEN WELL WATER WAS USED
 JACKSON, 1980

	Number of Times Washed Dishes Per Week			
	0	1-7	8-14	15+
Number of Respondents	325	126	33	76
Acne	8.0	13.1	7.7	5.5
Psoriasis	4.3	1.2	2.6	4.2
Excessive Dryness	34.8	29.9	18.6	37.5
Hives**	5.2	8.7	7.0	16.7
Redness*	33.1	24.7	15.8	24.3
Itching	40.8	46.5	22.5	45.9
Blisters	4.0	4.3	1.6	6.0
Scaling	21.2	20.8	14.7	33.1
Sore Lips, Gums	10.0	23.8	2.2	18.8
Other Skin Problems	25.9	21.2	11.0	18.6

*Normal deviate Z for testing trend is significant at 5% level, but direction of trend is opposite to that hypothesized.

**Normal deviate Z for testing trend is significant at 1% level.

TABLE 23

DISTRIBUTION OF REPORTED PREGNANCY OUTCOMES BY RESIDENCE DURING PREGNANCY
JACKSON, 1980

Pregnancy Outcome	Residence During Pregnancy				Unadjusted Odds Ratio	95% Confidence Interval
	Jackson		Before Jackson			
	N	(%)	N	(%)		
Total Live births	56	(84.9)	258	(83.8)	1.0	0.9-1.1
Total Abortions	1	(1.5)	14	(4.5)	0.3	0.1-2.5
First Trimester	1	(1.5)	12	(3.9)		
Second Trimester	0	(0.0)	2	(0.6)		
Total Stillbirths	1	(1.5)	5	(1.6)	0.9	0.1-7.9
Total Miscarriages	8	(12.1)	31	(10.1)	1.2	0.6-2.5
First Trimester	7	(10.4)	24	(7.7)		
Second Trimester	1	(1.5)	4	(1.3)		
Third Trimester	0	(0.0)	3	(0.9)		
Total Number of Pregnancies	66	(100.0)	308	(100.00)		
<hr/>						
Live birth outcome						
Birthweight less than 2501 grams ²	5	(8.9)	23	(8.9)	1.0	0.4-2.5
Birth Defects	1	(1.8)	6	(2.3)	0.8	0.1-6.5
Infant Deaths	2	(3.6)	4	(1.6)	2.4	0.4-12.6
Total Number of Livebirths	56		258			

¹Odds ratio is the ratio of affected to unaffected pregnancies among those exposed divided by the ratio of affected to unaffected pregnancies among those not exposed.

²Weight unknown for 13 live births

TABLE 24

PERCENT DISTRIBUTION OF REPORTED PREGNANCY OUTCOMES BY RESIDENCE
DURING PREGNANCY (JACKSON (J) AND BEFORE JACKSON (BJ))
AND MATERNAL AGE AT PREGNANCY
JACKSON 1980

Pregnancy Outcome	Residence During Pregnancy	Maternal Age (Years)					
		Less than 20	20-24	25-29	30-34	35-39	40+
Live births	% J	60.0	85.7	81.5	100.0	100.0	-
	% BJ	91.2	84.6	83.8	75.6	75.0	100.0
Abortions	% J	0.0	4.8	0.0	0.0	0.0	-
	% BJ	9.7	4.3	4.0	4.9	0.0	0.0
Stillbirths	% J	0.0	0.0	3.7	0.0	0.0	-
	% BJ	0.0	1.7	1.0	2.4	8.3	0.0
Miscarriages	% J	40.0	9.5	14.8	0.0	0.0	-
	% BJ	0.0	9.4	11.1	19.5	16.7	0.0
Total number of pregnancies	J	5	21	27	11	2	0
	BJ	34	117	99	41	12	5
Live birth outcome							
Birthweight less than 2501grams ¹	% J	33.3	16.7	0.0	9.1	0.0	-
	% BJ	13.3	10.4	4.8	13.8	0.0	40.0
Birth Defects	% J	0.0	4.8	0.0	0.0	0.0	-
	% BJ	3.2	3.0	1.2	3.2	0.0	0.0
Infant Deaths	% J	0.0	4.8	3.7	0.0	0.0	-
	% BJ	0.0	1.0	2.4	3.2	0.0	0.0
Total number of live births	J	3	18	22	11	2	0
	BJ	47	95	77	27	9	3

¹ Represent the percentage of live births with known birth weights.

TABLE 25
 RATES PER 100 OF REPORTED PREGNANCY OUTCOMES BY BLOCK
 JACKSON, 1980

	Blocks 34,37,38	Other Blocks	Relative Risk	95% Confidence Interval
Pregnancy Outcome				
Live births	83.3	87.5	0.7	0.2-3.1
Abortions	2.4	0.0		
Stillbirths	2.4	0.0		
Miscarriages	11.9	12.5	0.9	0.2-4.4
Total number of Pregnancies	42	24		
Live birth outcome				
Birthweight less than 2501 grams	11.4	4.8	2.6	0.3-23.6
Birth defects	2.9	0.0		
Infant deaths	5.7	0.0		
Total number of live births	35	21		

TABLE 26

RATES PER 100 OF REPORTED PREGNANCY OUTCOMES SINCE START OF WELL USE
BY DEPTH AND YEARS OF WELL USE
JACKSON 1980¹

	Depth of Well	Years of Well Use			
		0	<1	1+	5+
Pregnancy outcome					
Live births	All Well Depths	88.9	93.7	74.1	92.9
	Less than 100 ft.	87.5	92.9	69.6	92.9
	More than 100 ft.	100.0	100.0	100.0	-
Abortions	All Well Depths	0.0	0.0	3.7	0.0
	Less than 100 ft.	0.0	0.0	4.3	0.0
	More than 100 ft.	0.0	0.0	0.0	-
Stillbirths	All Well Depths	0.0	0.0	3.7	0.0
	Less than 100 ft.	0.0	0.0	4.3	0.0
	More than 100 ft.	0.0	0.0	0.0	-
Miscarriages	All Well Depths	11.1	6.3	18.5	7.1
	Less than 100 ft.	12.5	7.1	21.7	7.1
	More than 100 ft.	0.0	0.0	0.0	-
Number of Pregnancies	All Wells	9	16	27	14
	Less than 100 ft.	8	14	23	14
	More than 100 ft.	1	2	4	0
Live birth outcome					
Live births less than 2501 grams ²	All Well Depths	12.5	6.7	5.0	15.4
	Less than 100 ft.	14.3	7.7	6.3	15.4
	More than 100 ft.	0.0	0.0	0.0	-
Birth Defects	All Well Depths	0.0	0.0	5.0	0.0
	Less than 100 ft.	0.0	0.0	6.3	0.0
	More than 100 ft.	0.0	0.0	0.0	-
Infant Deaths	All Well Depths	0.0	0.0	5.0	7.7
	Less than 100 ft.	0.0	0.0	6.3	7.7
	More than 100 ft.	0.0	0.0	0.0	-
Number of Live births	All Wells	8	15	20	13
	Less than 100 ft.	7	13	16	13
	More than 100 ft.	1	2	4	0

¹No normal deviate Zs for testing trend were significant.

TABLE 27
 CHARACTERISTICS OF LEGLER HOUSEHOLDS
 SELECTED FOR AIR SAMPLING
 JACKSON, 1980

<u>Block</u>	<u>No. Households Sampled</u>	<u>No. Households with a History of Reported Kidney Illness</u>	<u>No. Households Sampled by Type of Water Supply</u>	
			<u>New</u>	<u>Old</u>
10	1	0	1	0
32-1	2	1	2	0
34	7	2	4	3
37	4	0	2	2
38	<u>1</u>	<u>0</u>	<u>1</u>	<u>0</u>
	15	3	10	5

TABLE 28

SPECIFIC OCCURRENCE AND CONCENTRATIONS (PARTS PER BILLION)
OF ORGANIC COMPOUNDS IN SELECTED LEGLER AND NON-LEGLER BASEMENTS
JACKSON, 1980

Household Chemical	LEGLER															NON-LEGLER										
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4*</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>	<u>10</u>	<u>11</u>	<u>12*</u>	<u>13*</u>	<u>14*</u>	<u>15*</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4*</u>	<u>5*</u>	<u>6*</u>	<u>7*</u>	<u>8</u>	<u>9</u>	<u>10</u>	
Acetone	<1																									
Benzene	7	37	3	<1				4								<10	80	20					20	<10	20	
Chloroform	<1																									
n-Decane	2					26			154							20	20									
Ethyl acetate																	90									
Ethyl benzene																<10	20									
Ethyl ether	3		3		6																					
n-Hexane	26		11		7			3	28	20																
Methanol																									12	
n-Nonane									41							<10	<10									
n-Octane									76	17																
n-Pentane	54		16		3																					
2-Propanol	4																	30								
Tetrachlor- ethylene	<1		<1			13																				
Toluene	94	381	25		3	12	3	3	78	387	14					70	80	10					20		<10	
Xylene(s)		81				8			130							20	50						<10			

*No organic compounds were detected at the limit of detection for total organics (10ppb).

NOTE: Concentrations that are reported as "less than" a value indicate the limit of detection for that specific organic compound.

TABLE 29
 CONCENTRATION OF MEASURED CHEMICALS
 IN LEGLER AND NON-LEGLER HOUSEHOLDS
 JACKSON, 1980

Chemical Group	Legler Households Concentration					Non-Legler Households Concentration				
	Number of Positive Results	(%)	Mean	Min	Max	Number of Positive Results	(%)	Mean	Min	Max
Alcohols										
Methanol	0	(0.0)	-	-	-	1	(10.0)	12.0	-	-
2-Propanol	1	(0.0)	4.0	-	-	1	(10.0)	30.0	-	-
Aliphatics										
n-Petane	3	(20.0)	24.3	3.0	54.0	0	(0.0)	-	-	-
n-Hexane	6	(40.0)	15.8	7.0	28.0	0	(0.0)	-	-	-
n-Octane	2	(13.3)	46.5	17.0	76.0	0	(0.0)	-	-	-
n-Nonane	1	(6.7)	41.0	-	-	2	(20.0)	10.0	10.0	10.0
n-Decane	3	(20.0)	60.7	2.0	154.0	2	(20.0)	20.0	20.0	20.0
Aromatics										
Benzene	5	(33.3)	10.3	1.0	37.0	6	(60.0)	25.0	10.0	80.0
Ethylbenzene	0	(0.0)	-	-	-	2	(20.0)	15.0	10.0	20.0
Toluene	10	(66.7)	100.0	3.0	387.0	5	(50.0)	36.0	10.0	80.0
Xylene(s)	3	(20.0)	73.0	8.0	130.0	3	(30.0)	25.0	10.0	50.0
Chlomethylenes										
Tetrachloro-ethylene	3	(20.0)	7.7	1.0	13.0	0	(0.0)	-	-	-
Esters										
Ethylacetate	0	(0.0)	-	-	-	1	(10.0)	90.0	-	-
Ethers										
Ethylether	3	(20.0)	4.0	3.0	6.0	0	(0.0)	-	-	-
Halomethanes										
Chloroform	1	(6.7)	1	-	-	0	(0.0)	-	-	-
Ketones										
Acetone	1	(6.7)	1	-	-	0	(0.0)	-	-	-

TABLE 30
 INCIDENCE OF URINARY TRACT INFECTION
 ACCORDING TO AGE AND SEX
 JACKSON, 1980

Age Group	Published Incidence Per 100 ^a	Published Approximate Sex Ratio Male:Female ^a	Jackson Incidence Per 100 Person Years Of Observation	Jackson Approximate Sex Ratio Male:Female
Neonatal (<1)	1	1.5:1	0.0	0:0
Preschool age (1-4)	1.5-3	1:10	2.5	0:2
School age (5-14)	1.2	1:30	1.7	0:5
Reproductive age (15-54)	2.5	1:50	1.2	2:13
Geriatric (55+)	10-30	1:1	0.5	0:2

^aSOURCE: Rubin, Robert H. "XXIII: Infections of the Urinary Tract," in Chapter 7, Infectious Diseases Scientific American Medicine, 1982: Table 2, p. 3.

TABLE 31
 FREQUENCY OF SELECTED REPRODUCTIVE ENDPOINTS
 JACKSON, 1980

<u>Event</u>	Jackson 1970-1980 Frequency Per 100	Published Annual Frequency Per 100 ^a	<u>Unit</u>
Spontaneous abortion within 8-28 weeks of gestation	1.3	10-20	Pregnancies
Stillbirths	0.2	2-4	Stillbirths and livebirths
Birthweight less than 2501 grams	1.0	5-15	Livebirths
Birth defects	0.2	2-3	Livebirths
Infant deaths	0.4	1.3 ^b	Livebirths

^aSOURCE: Z. Stein, M. Hatch, J. Kline, P. ShROUT, and D. Warburton, "Epidemiologic Considerations in Assessing Health Effects at Toxic Waste Sites" from Assessment of Health Effects at Chemical Disposal Sites, proceedings of a symposium held on June 1-2, 1981 at The Rockefeller University, New York City. Edited by William W. Lowrance. (New York: The Rockefeller University, 1981), Table 2, p. 131.

^bSOURCE: Mortality 1979, Health Data Services, Health Planning and Resources Development, New Jersey State Department of Health, VSIO-8105.

APPENDIX 1
INSTRUCTIONS TO INTERVIEWERS

INSTRUCTIONS TO INTERVIEWERS

A. Household Information

Cover Page --

Complete Block/Lot # and address from records before interview

- Q1. If address same as front write "same".
- Q2. If address same as front or Q1., write "same".
- Q3. Be sure to record complete 10 digit number.
- Q4. The address refers to the current Jackson Township address?
- Q5. You must compute how long the respondent has lived in the current address by subtracting answer to #4 from the current date. Then confirm this with P.
- Q6. & 7. We want to make sure that we know the entire period of time P lived in Jackson Township.
- Q8. This may be rephrased to say "From whom did you buy your house"
If R is original owner (moved into house when new), write "none".
If R does not know former owner, circle 9.
- Q9. We, at some later time, may want to contact families who have moved from Jackson Township.
- Q10. This refers to those in household while living in Jackson Township

If everyone has the same last name, record once and use ditto marks.
Be sure to probe for boarders, deceased family members, and those who have moved out of household.
Mark the individual answering this question with an asterisk (*).
- Q11. The designated head of household does not have to be R. Responses include wife, sibling, son, daughter, mother, father etc.
- Q12. This question includes date of birth, sex, race, and social security number. Use dash if family member does not have a social security number.

- Q13-15. We are interested in knowing of anyone in the household who had a residence or lived away from the household for an extended time. This includes living at a second residence or summer home. This does not consider vacations, unless they were for longer than 4 months.
- Q16-21. Occupational history.
- Q16. As for the current occupation of each family member, that is what is he/she doing at the present time? If a family member is a student, and is not employed, record this information in chart, but do not ask Q's 17 & 18.
- Q17 & 19. Current occupation may not always be the same as usual occupation. An individual may retain the same occupation even if he has changed employers.
- Q18 & 21. Job activities and duties should explain exactly what he/she does. Probe for as much specificity as possible.
- Q22. This answer should be as specific as possible. Responses "shallow" or "deep" are not sufficient. Probe for depth in feet.
- Q23. Deep wells may be used by more than one household.
- Q24. Ask only if more than R's household uses well.
- If R cannot provide block and lot #'s record addresses, complete block and lot #'s after interview by consulting map in office.
- Q25. Each corrective measure should re read. If R mentions another measure, not listed, record in margin.
- Q26. Be as specific as possible concerning date of installation.
- Q27. The measures may have only been temporary, and not used the entire time since installation.
- Q28. We would like a rough estimate of the cost of installation.
- Q29. This question refers to laundry while household was using original well water.
- Q30. We would like to know if this household was represented in the previous survey.
- Q31. This question refers to problems which the individual completing the previous questionnaire may have had in interpreting questions, etc.
- Q32. This is a broad, open-ended question to record any other problems or comments R has concerning water supply.

B. INDIVIDUAL HEALTH HISTORY

We must have a general consent form signed for each respondent. A parent or guardian must sign for minors or those otherwise unable to sign.

Q1. Include full name of respondent. The respondent code is the 2-digit number of the individual as listed in Section A, Q10.

Be sure Section B is completed for all household members listed in Section A. Q10. including deceased and those who are no longer living there.

Q2. We are interested in frequent contact, not just using a chemical once a year. Do not include ordinary household cleaning products, unless something unusual was used.

This question does also refer to chemical exposure on the job.

Q3-6. If R did not smoke cigarettes, Q4-6 remain blank.

We are not interested in cigar or pipe smoking.

Q4. R may tell you his/her age when he/she started smoking. Record this in the margin, calculate the year, and confirm it with R.

Q5. If R started and stopped smoking, try to get him/her to estimate the total number of years smoked.

Q6. This answer calls for cigarettes per day. Convert packs to # of cigarettes, i.e., one pack = 20 cigarettes.

Q7-11. Hospitalizations.

Q8. Ask R to be as specific as possible concerning diagnosis.

Q9. If R in New Jersey hospital, record name and city. If out-of-state hospital, record name, city and state.

Q12-16. The medical conditions listed are very general. Be sure and probe for specific diagnosis.

Space is left to record information on 2 conditions per block. For example, if R had 2 kidney diseases, list both and then asks Q13-16. for each. Then go on to liver disease, etc.

Q17-20. We are interested in any medical condition serious enough to consult a physician at least 3 times. Do not include medical problems already discussed in Q12-16.

- Q.21-30 These questions all concern conditions or problems during the time the original well water source was in use. Be sure and emphasize the appropriate time period.
- Q.21 This should be an average number of times R took a shower in a week. If R never takes a shower, record 0. If less than once a week, record in right margin number of times per month.
- Q.22 This question refers to the average number of times per week R took a bath. If less than once a week, record in right margin number of times per month.
- Q.23 This is an average number of times the individual was exposed to water by washing dishes, by hand. Don't count if R used rubber gloves, or if a dishwasher was used.
- Q.24 This question considers all bathing or showering with water other than the original Jackson Township well. If showering at someone else's home involved same water supply, don't consider.
- Do consider using bottled or other water sources in R's own home, or showering or bathing at someone else's home with another water supply.
- Q.25 The list of skin problems should be read. Emphasize that this means problems which occur during or after bathing or showering with original well water.
- Q.26 R should choose an answer of usually, often or sometimes. If R is more specific, ask him/her to choose an answer.
- Q.27 Read the complete list of responses for time of occurrence after each problem which occurred.
- Q.28 Record specific season, i.e., Winter, Spring, Summer, or Winter, or record "Year round".
- Q.29 This means that when an alternate water source was used, did the problem improve.
- Q.30 Probe to see whether there are any other skin problems which R feels are due to showering or bathing with well water.
- Q.31-34 This includes only conditions for which R consulted a physician. Probe for specific diagnosis
- Q.35 This refers to health problems occurring while living in Jackson Township which R feels are serious.

COMPLETE MEDICAL CONSENT FORM

We may want to obtain medical records on some of the health problems listed. This consent form is different from the general consent form which is consent to take part in the study.

C. REPRODUCTIVE HISTORY

This section is to be completed for any female household member who has ever been pregnant. This includes pregnancies which ended in a birth, a miscarriage, or an abortion. We are interested in all pregnancies whether they occurred before or after R's move into Jackson Township.

Q1. Record R's full name, first and last.

Obtain R's code # from Section A, Q10. and enter in area indicated
R_____.

Q2. Again, this refers to all pregnancies including births, miscarriages, or abortions.

Q3. Record code letter of outcome:

live birth - LB
miscarriage - N
stillbirth - SB
abortion - A
currently pregnant - P

Q4. Refers to date of outcome.

Q5. We are interested in whether R lived in Jackson Township at any time during pregnancy. If R lived there during the entire time, circle yes. If R lived there only part of the time, either because she moved in during the pregnancy or because she spent part of her time while pregnant at another address.

Q6. Record duration of pregnancy in weeks.
full term = 36 weeks.

Q7. Refers only to still births or live births. Record whether the birth was single, twins, triplets, or more.

Q8. Birth weight is to be recorded for live births in pounds or ounces.

Probe to be sure we have all pregnancies including children by another husband or children who are no longer living with R.

Q9. We need information on any child who may have died since birth.

Q10. Record # of birth from pregnancy history chart and complete question questions 11 and 12.

Q11. Record date of death.

Q12. Record cause of death. Probe for specific cause.

Q13-17. Refers to children with birth defects.

- Q14. Record # of birth from pregnancy history chart and complete questions 15 & 17.
- Q15. Probe for specific medical diagnosis of birth defect.
- Q18. Amniocentesis refers to a surgical procedure to obtain a sample of amniotic fluid.
- Q19. If procedure performed during more than one pregnancy, record all dates.
- Q20-21. Probe for R to be as specific as possible.
- Q22-23. If more than 1 physician or hospital involved, record all.
- Q26. Read list and ask R to choose most appropriate answer.

COMPLETE MEDICAL CONSENT FORM

If no medical consent form was completed earlier, complete one at this time if there were medical problems involved with birth, any birth defects reported, or amniocentesis performed.

APPENDIX 2
COMMUNITY SURVEY QUESTIONNAIRE:
JACKSON TOWNSHIP 1980

Family Consent Form

You have been invited to participate in a health study of residents of the Legler section of Jackson Township. The study is being conducted by the New Jersey State Department of Health and the Ocean County Health Department.

You will be asked to provide information about _____
_____'s
residence, occupation, and health, and sources of water for drinking, cooking, and bathing.

If you agree, and should it be necessary, we may contact you again.

Your participation in this study is completely voluntary and you are free to discontinue participation at any time. All information that is obtained in connection with this study and that could identify you will remain confidential.

Your signature indicates that you have read and understand the information provided above and that you agree to participate.

Signature

Relationship

Date

Interviewer

Now I'm going to ask you about individuals who have lived in your household. First I'll ask about current household members. Then we'll talk about anyone else who lived with you in Jackson Township.

6. Please list for me the names of everyone who currently lives in your household, starting with the head of the household.

STAR (*) RESPONDENT. ASK Q.7 FOR EACH HOUSEHOLD MEMBER.

BEGIN NEW CARD FOR EACH R

cc 7-8

9-33

R	Q.6 Current Household Members LAST, FIRST, MI	Q.7 Relationship to Head of Household
01		34 35 <input type="checkbox"/> <input type="checkbox"/>
02		34 35 <input type="checkbox"/> <input type="checkbox"/>
03		34 35 <input type="checkbox"/> <input type="checkbox"/>
04		34 35 <input type="checkbox"/> <input type="checkbox"/>
05		34 35 <input type="checkbox"/> <input type="checkbox"/>
06		34 35 <input type="checkbox"/> <input type="checkbox"/>
07		34 35 <input type="checkbox"/> <input type="checkbox"/>
08		34 35 <input type="checkbox"/> <input type="checkbox"/>

7. What is (NAME)'s relationship to the head of the household?

BEGIN CARD $\frac{0}{1}$ $\frac{5}{2}$ $\frac{0}{3}$

Household : $\frac{\quad}{4}$ $\frac{\quad}{5}$ $\frac{\quad}{6}$

8. Now please tell me anyone who lived in your household in Jackson Township for four months or more since 1970 but who is no longer living here. This includes anyone who is away at college or who moved out to get married or for some other reason, and any household member who is deceased.

LIST ON CHART AND ASK Q.9 & 10 FOR EACH HOUSEHOLD MEMBER.

BEGIN NEW CARD FOR EACH R. 66-75

CC 7-8	9-33	Q.9	36-65	EACH R. 66-75
R	Q.8	Relationship To Head of Household	Q.10	Telephone Number
Former Household Member LAST, FIRST, MI			Current Address	
51				()
		34 35		
52				()
		34 35		
53				()
		34 35		
54				()
		34 35		
55				()
		34 35		
56				()
		34 35		
57				()
		34 35		
58				()
		34 35		

9. What is _____ relationship to the head of the household?
NAME

10. What is _____ current address and telephone number?
NAME

BEGIN CARD 060

1-3

Household : 4 5 6

Now I'd like to know all of your sources of drinking and cooking water while you lived in the Legler section.

11. Did you use well water for drinking and cooking?

Yes..... 1(Q.12-16 COMPLETE CHART) 9
 No..... 2(Q.18)
 Don't Know..... 9(Q.18)

12. During what years did you use this well for drinking and cooking?
 (PROBE FOR MONTHS AND YEARS)

13. What was the depth of this well?

14. How many households used water from this well for drinking and cooking?

15. Where was this well located?

16. Is this the only well you ever used for drinking and cooking water?

IF MORE THAN ONE WELL USED, ASK Q.12-17 FOR ANY NEW INSTALLATIONS, NEW HOOK-UPS OR WATER FROM ANY OTHER WELL IN THE AREA

17. What was the cost of installing a new well or hook-up?

Q.12 USE From MO / YR To MO / YR	Q.13 Depth in feet	Q.14 # Households Using Well	Q.15 Location Address & Family Name	Q.16 Only Well?
1.				Yes ...1 No2
10-17	18-20	21-22		23
				Q.17 Cost
2.				\$
24-31	32-34	35-36		37-41
3.				\$
42-49	50-52	53-54		55-59

BEGIN CARD 070
1-3

Household _____
4 5 6

18. Did you use bottled or trucked-in water as a source of water for drinking and cooking?

yes...1 (Q.19 & 20 COMPLETE CHART) 9
no....2 (Q.21)
DK....9 (Q.21)

19. During what years did you use bottled water for drinking and cooking?

20. What was your approximate cost per week for using the water?

Bottled or
Trucked-in
Water

	Q.19 Use		Q.20 Approximate Cost \$	
	From MONTH/YEAR	To MONTH/YEAR		
1	_____	_____		10-22
2	_____	_____		23-35
3	_____	_____		36-48

21. Have you hooked into the new community water source?

yes...1 (Q.22) 49
no....2 (Q.23)

22. When did you hook into this supply?

MONTH/YEAR

50-53

23. Were there any other sources of water you regularly used for drinking and cooking, such as going to the home of a relative or friend for water?

yes...1 (Q.24) 54
no....2 (Q.26)

24. What was the source of the water? (SPECIFY Location)

55-56

25. During what time period did you use water from this source?

_____ to _____
MONTH/YEAR MONTH/YEAR

57-64

26. Did you use well water for bathing or showering while living in the Legler area?

yes...1 (Q.27)
no....2 (Q.28)
DK....9 (Q.28)

9

27. During what years did you use well water for bathing or showering?
[PROBE FOR MONTH & YEAR]

_____ to _____
MONTH/YEAR MONTH/YEAR

10-17

28. Did you use bottled or trucked-in water for bathing or showering while living in the Legler area?

yes...1 (Q.29)
no....2 (Q.30)
DK....9 (Q.30)

18

29. During what years did you use bottled or trucked-in water for bathing or showering? [PROBE FOR MONTH & YEAR]

_____ to _____
MONTH/YEAR MONTH/YEAR

19-26

30. Did any household member regularly use another source of water for bathing or showering, such as going to the home of a relative or friend?

yes...1 (Q.31)
no....2 (Q.33)
DK....9 (Q.33)

27

31. What was the source of this water? SPECIFY _____

28-29

32. During what time period did this occur?

_____ to _____
MONTH/YEAR MONTH/YEAR

30-37

HOUSEHOLD _____

33. Did you launder your clothes at home, at a laundromat, or someplace else while you were getting your water from the wells in question?

At home.....1

At laundromat

IS THIS BECAUSE OF
water problems.....2
or some other reason.....3

38

At a friend or relative's home

IS THIS BECAUSE OF
water problems.....4
or some other reason.....5

Other location (Specify)6

34. Did you install a water softener to improve the quality of your water?

yes...1 (Q.35)
no....2 (Q.38)
UnK...9 (Q.38)

39

35. When was it installed? _____

40-43

MONTH/YEAR

36. During what time period did you use a water softener?

_____ to _____

44-51

MONTH/YEAR

MONTH/YEAR

37. What was your approximate cost for installing a water softener?

\$ _____

52-56

38. Did you install a home water filter to improve the quality of your drinking water?

yes...1 (Q.39)
no....2 (Q.42)
UnK...9 (Q.42)

57

39. When was it installed? _____

58-61

MONTH/YEAR

HOUSEHOLD _____

40. During what time period did you use a water filter?

_____ to _____ 62-69
MONTH/YEAR MONTH/YEAR

41. What was your approximate cost for installing a water filter?

\$ _____ 70-74

42. Did a member of your household previously complete the questionnaire supplied by the Concerned Citizens Committee?

yes...1 (Q.43) 75
no....2 (Q.44)

43. Did you/he/she have difficulties with the Concerned Citizens Committee questionnaire?

yes...1 (EXPLAIN) 76
no....2

44. Do you have any other comments about your past water supply?

77

GO TO SECTION B, AND COMPLETE A QUESTIONNAIRE FOR EACH HOUSEHOLD MEMBER.

BEGIN CARD 1 0 0
 1 2 3

Household :
 4 5 6

R :
 7 8

COMPLETE GENERAL CONSENT FORM

B. INDIVIDUAL HEALTH HISTORY

1. Name: _____ 9 - 33
 LAST FIRST MI
2. What is your date of birth? _____ 34 - 39
 MONTH DAY YEAR
3. Sex: Male..... 1 40
 Female..... 2
4. Race: White..... 1 41
 Black..... 2
 Oriental..... 3
 Other (SPECIFY) 4
5. What is your Social Security Number?
 _____ - _____ - _____ 42 - 50

WE MAY NEED TO FOLLOW-UP JACKSON TOWNSHIP RESIDENTS AND CAN USE SOCIAL SECURITY NUMBER AS A WAY TO DO THIS.

BEGIN CARD 1 1 0
 1 2 3
 Household :
 4 5 6
 R :
 7 8

6. Where was the (FIRST/NEXT) place you lived in Jackson Township since January 1, 1970?

BE AS SPECIFIC AS POSSIBLE. IF NO HOUSE NUMBER, PROBE FOR LOCATION SUCH AS CROSS STREETS

7. What is the block and lot number of this residence?

8. During what years did you live at this residence?
 (PROBE FOR MONTH AND YEAR)

REPEAT Q.6 to 8 FOR ALL RESIDENCES IN JACKSON TOWNSHIP.
 BE CERTAIN TO INCLUDE ALL RESIDENCES IN JACKSON TOWNSHIP INCLUDING THE CURRENT RESIDENCE (PART A).

Q.6 Street Address in Jackson Township	Q.7 Block # Lot #		Q.8 Years of Residence				
			From		To		
			Month	Year	Month	Year	
1.	-----	-----	-----	-----	-----	-----	9-22
2.	-----	-----	-----	-----	-----	-----	23-36
3.	-----	-----	-----	-----	-----	-----	37-50
4.	-----	-----	-----	-----	-----	-----	51-64
5.	-----	-----	-----	-----	-----	-----	65-79

CARD 1 2 0

Household : _____

R : _____

15. Have you had any jobs on which you handled or were exposed to chemicals?

Yes.....	1(Q.16)	
No.....	2(Q.17)	31
Don't Know.....	9(Q.17)	

16. What chemicals did you handle?

_____	_____	32 - 35
_____	_____	36 - 39
_____	_____	40 - 43

17. Do you have frequent exposure to chemicals in your home? This doesn't include exposure to the chemicals in your water supply, or ordinary household cleaners.

Yes.....	1 (Q.18)	
No.....	2 (Q.19)	44
Don't Know.....	9 (Q.19)	

18. What chemicals did you handle?

_____	_____	45 - 48
_____	_____	49 - 52
_____	_____	53 - 56

Household _____

R _____

30. When did you change to (LEVEL IN Q. 29)?

23 - 26

_____ MO / YR

31. How many times a week did you wash dishes by hand?

27 - 28

_____ # TIMES PER WEEK

32. Has your pattern of washing dishes changed over the past two years?

Yes...1 (Q.33)

29

No....2 (Q.35)

DK....9 (Q.35)

33. How did your use change? (EXPLAIN)

Increased to _____ times per week

#

Decreased to _____ times per week

#

No change(00)

30 - 31

Changed to using rubber gloves....98

34. When did you change to (LEVEL IN Q. 33)?

32 - 35

_____ MO / YR

BEGIN CARD $\frac{1}{1}$ $\frac{5}{2}$ $\frac{0}{3}$

Household #: $\frac{\quad}{4}$ $\frac{\quad}{5}$ $\frac{\quad}{6}$

R: $\frac{\quad}{7}$ $\frac{\quad}{8}$

35. Did you notice any of the following skin problems following bathing or showering with water from your well?

READ LIST. FOR ANY "YES" RESPONSE,
ASK Q.36-39 AND COMPLETE CHART.

36. Would you say this problem usually, often, or sometimes occurred?

37. Now please look at the handcard and tell me how soon after showering or bathing this problem occurred.

HAND
CARD

38. Did this problem occur in any particular season(s)? (SPECIFY)

39. Has this problem improved by stopping the use of well water for bathing or showering?

40. Were there any other problems which occurred? (RECORD ON CHART)

SKIN PROBLEMS AFTER SHOWERING OR BATHING

Q.35 SKIN PROBLEMS	Q.36 USUALLY, OFTEN SOMETIMES, OCCUR?	Q.37 TIME OF OCCURRENCE? (HAND CARD)	Q.38 SEASON(S)	Q.39 IMPROVE WHEN STOP WATER USE?
ACNE Yes.....1 No.....2 Unk.....9	Usually....1 Often.....2 Sometimes..3 Unk.....9	<input type="checkbox"/>	<input type="checkbox"/>	Yes....1 No.....2 Unk....9
PSORIASIS Yes.....1 No.....2 Unk.....9	Usually....1 Often.....2 Sometimes..3 Unk.....9	<input type="checkbox"/>	<input type="checkbox"/>	Yes....1 No.....2 Unk....9
EXCESSIVE DRYNESS Yes.....1 No.....2 Unk.....9	Usually....1 Often.....2 Sometimes..3 Unk.....9	<input type="checkbox"/>	<input type="checkbox"/>	Yes....1 No.....2 Unk....9
HIVES Yes.....1 No.....2 Unk.....9	Usually....1 Often.....2 Sometimes..3 Unk.....9	<input type="checkbox"/>	<input type="checkbox"/>	Yes....1 No.....2 Unk....9
REDNESS Yes.....1 No.....2 Unk.....9	Usually....1 Often.....2 Sometimes..3 Unk.....9	<input type="checkbox"/>	<input type="checkbox"/>	Yes....1 No.....2 Unk....9
ITCHING Yes.....1 No.....2 Unk.....9	Usually....1 Often.....2 Sometimes..3 Unk.....9	<input type="checkbox"/>	<input type="checkbox"/>	Yes....1 No.....2 Unk....9
BLISTERS Yes.....1 No.....2 Unk.....9	Usually....1 Often.....2 Sometimes..3 Unk.....9	<input type="checkbox"/>	<input type="checkbox"/>	Yes....1 No.....2 Unk....9
SCALING Yes.....1 No.....2 Unk.....9	Usually....1 Often.....2 Sometimes..3 Unk.....9	<input type="checkbox"/>	<input type="checkbox"/>	Yes....1 No.....2 Unk....9
SORE LIPS, GUMS Yes.....1 No.....2 Unk.....9	Usually....1 Often.....2 Sometimes..3 Unk.....9	<input type="checkbox"/>	<input type="checkbox"/>	Yes....1 No.....2 Unk....9
Other (SPECIFY) Yes.....1 No.....2 Unk.....9	Usually....1 Often.....2 Sometimes..3 Unk.....9	<input type="checkbox"/>	<input type="checkbox"/>	Yes....1 No.....2 Unk....9
Yes.....1 No.....2 Unk.....9	Usually....1 Often.....2 Sometimes..3 Unk.....9	<input type="checkbox"/>	<input type="checkbox"/>	Yes....1 No.....2 Unk....9

9-1

15-2

21-2

27-3

33-3

39-4

45-5

51-5

57-6

63-6

69-7

LESS THAN 1 MINUTE

BETWEEN 1 AND 10 MINUTES

BETWEEN 10 MINUTES AND A HALF AN HOUR

BETWEEN HALF AN HOUR AND AN HOUR

BETWEEN 1 AND 8 HOURS

BETWEEN 8 AND 24 HOURS

MORE THAN 24 HOURS

BEGIN CARD 1 6 0
 1 2 3

Household :
 4 5 6

R :
 7 8

41. Have you had an eye or ear problem during the last 3 years for which you consulted a physician?

Yes..... 1(Q.42)
 No..... 2(Q.45) 9
 Don't Know..... 9(Q.45)

42. What was/were the problem(s). (BE SPECIFIC)

RECORD EACH PROBLEM OF CHART AND ASK Q.43-44

43. When did this problem first occur? (PROBE FOR MONTH & YEAR)

44. Who was your attending physician? (PROBE FOR NAME & ADDRESS)

Q.42 EYE/EAR PROBLEM	Q.43 DATE OF ONSET MO./YR.	Q.44 PHYSICIAN NAME & ADDRESS					
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BEGIN CARD 1 7 0
 1 2 3
 Household : 4 5 6
 R : 7 8

45. Have you been hospitalized at any time during the last 10 years, excluding pregnancies?

Yes..... 1(Q.46)
 No..... 2(Q.50)
 Don't Know..... 9(Q.50)

9

ASK Q.46-49 FOR EACH HOSPITALIZATION AND COMPLETE CHART.

- 46. What was the reason for your hospitalization?
- 47. In which hospital were you?
- 48. In what year did this hospitalization occur?
- 49. Who was your attending physician?

HOSPITALIZATION

Q. 46 Reason	Q.47 Hospital Name/Address	Q.48 Year	Q.49 Attending Physician/ Address
		19__ __	
		19__ __	
		19__ __	
		19__ __	

10 - 17

18 - 25

26 - 33

34 - 41

CARD 1 8 0
 1 2 3

Household :
 4 5 6

R:
 7 8

50. Have you had any of the following illnesses?

READ LIST. FOR ANY "YES" RESPONSE, ASK Q.51-53 AND COMPLETE CHART. THE ILLNESSES LISTED ARE VERY GENERAL. PROBE FOR SPECIFIC CONDITION.

51. When did this problem first occur? (PROBE FOR MONTH AND YEAR)

52. Did you see a physician about this condition?

53. Who was your physician? (INCLUDE NAME AND ADDRESS)

DISEASE	Q.50 Specify Diagnosis	Q.51 Date of Onset MONTH/YEAR	Q.52 Consult Physician	Q.53 Physician's Name & Address
KIDNEY	1.	---	Yes....1 No.....2 Unk....9	9-17
	Yes..1 No...2 Unk..9	2.	---	18-25
LIVER	1.	---	Yes....1 No.....2 Unk....9	26-34
	Yes..1 No...2 Unk..9	2.	---	35-42
CANCER (SPECIFY 1 ^o SITE)	1.	---	Yes....1 No.....2 Unk....9	43-51
	Yes..1 No...2 Unk..9	2.	---	52-59
NEUROLOGICAL (SPECIFY)	1.	---	Yes....1 No.....2 Unk....9	60-68
	Yes..1 No...2 Unk..9	2.	---	69-76

CARD 1 9 0
 1 2 3

Household :
 4 5 6

R :
 7 8

54. Have you visited a physician more than 3 times during the past 10 years for the same medical problem, other than those we've just discussed?

Yes..... 1(Q.55)

No..... 2(Q.58)

Don't Know..... 9(Q.58)

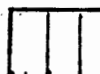
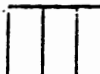
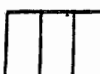
9

IF YES, ASK Q.55-57 AND COMPLETE CHART PROBE FOR ALL CONDITIONS.

55. What was the medical problem?

56. When did this problem first occur?

57. Who was your attending physician?

Q. 55	Q. 56	Q. 57
MEDICAL PROBLEM (BE SPECIFIC)	DATE OF ONSET MO./YR.	PHYSICIAN NAME & ADDRESS
10 - 12 	13 - 16	
17 - 19 	20 - 23	
24 - 26 	27 - 30	

CARD 190 cont.

Household _____

R _____

58. Please tell me about any other health problems of particular concern which we have not discussed.

31
32 33 34
35 36 37

COMPLETE MEDICAL CONSENT FORM
IF R REPORTS ANY MEDICAL PROBLEMS

C. REPRODUCTIVE HISTORY

**THIS SECTION MUST BE COMPLETED FOR EACH FEMALE
HOUSEHOLD MEMBER WHO HAS EVER BEEN PREGNANT.**

Card 200
1 - 3

Household _____
4 - 6
R _____
7 8

C. REPRODUCTIVE HISTORY

Now I'd like to complete this section of the questionnaire for anyone who has ever been pregnant, including births, miscarriages, and abortions. Please tell me which family members that would be.

1. Name _____
LAST, FIRST MI

2. How many times have you been pregnant?

PREGNANCIES

9-10

ASK Q.3-8 FOR EACH PREGNANCY & RECORD ON CHART

3. What was the outcome of the first/next pregnancy? Was it a live birth (LB), a miscarriage (M), a still birth (SB), or an abortion (A)?

4. When did this _____ occur?
OUTCOME

5. Did you live in the Legler section of Jackson Township during the pregnancy?

6. What was the duration of the pregnancy?

ASK Q.7 FOR LIVE BIRTHS & STILL BIRTHS ONLY.
ASK Q.8 ONLY FOR LIVE BIRTHS

7. How many children were born? That is, was it a single birth, twins, or triplets?

8. What was the birth weight of this child?

Household _____

PREGNANCY HISTORY

R _____

Q.3 Q.4 Q.5 Q.6 Q.7 Q.8

PREG- NANCY ORDER	OUTCOME	DATE OF OUTCOME MO./YR.	LIVE IN LEGLER	WEEKS DURATION	TYPE	BIRTH WT. LB/OZ
1			yes....1 no.....2 pt.....3			11-25
2			yes....1 no.....2 pt.....3			26-40
3			yes....1 no.....2 pt.....3			41-55
4			yes....1 no.....2 pt.....3			56-70

BEGIN CARD 201

1-3

Household

4 5 6

R

7 8

5			yes....1 no.....2 pt.....3			9-23
6			yes....1 no.....2 pt.....3			24-38
7			yes....1 no.....2 pt.....3			39-53
8			yes....1 no.....2 pt.....3			54-68

RECORD BELOW FOR ANY STILL BIRTH, MISCARRIAGE, OR ABORTION WHICH OCCURRED WHILE YOU LIVED IN JACKSON TOWNSHIP

For the (MISCARRIAGE, STILL BIRTH, ABORTION) which occurred while you were living in Jackson Township, who was/were your attending physician(s)?

Pregnancy
Order #

Physician
NAME & ADDRESS

BEGIN CARD 210
1 - 3

Household
 4 5 6
R
 7 8

ASK Q. 9 ONLY IF ONE OR MORE PREGNANCIES RESULTED IN A LIVE BIRTH
IF NO LIVE BIRTHS, GO TO Q.13

9. Are all of these children still living?
 yes..... 1 (Q.13)
 no..... 2 (Q.10)
 don't know... 9 (Q.13) 9

10. What was the name(s) of the child (children) who was/were deceased and which pregnancy was that?

RECORD NAME & PREGNANCY ORDER FROM Q.3 & ASK Q.11 & 12
RECORD ANSWERS ON CHART BELOW

11. When and where did he/she die? (FOR PLACE OF DEATH, RECORD STATE ONLY.)

12. What was his/her cause of death?

	Q.10	Q.11	Q.12	
PREG- NANCY ORDER #	FULL NAME	DATE OF DEATH MO./YR.	STATE OF DEATH	CAUSE OF DEATH
				10-18 <div style="border: 1px solid black; width: 100px; height: 20px; margin-left: auto;"></div>
				19-27 <div style="border: 1px solid black; width: 100px; height: 20px; margin-left: auto;"></div>
				28-36 <div style="border: 1px solid black; width: 100px; height: 20px; margin-left: auto;"></div>
				37-45 <div style="border: 1px solid black; width: 100px; height: 20px; margin-left: auto;"></div>

BEGIN CARD 220
1-3

Household _____
4-6
R _____
7 8

13. Have you ever given birth to a child with birth defects?

yes..... 1 (Q.14)
no..... 2 (Q.18)
don't know... 9 (Q.18)

9

14. What was the name of that child and which birth was that?

RECORD FULL NAME & PREGNANCY ORDER #
FROM Q.3 & ASK Q.15-17.
COMPLETE CHART BELOW

15. What is the precise name of the birth defect?

16. Who was the child's attending physician? (SPECIFY NAME & ADDRESS)

17. In which hospital was the child seen? (SPECIFY NAME & CITY & STATE)

Q.14 PREG- NANCY ORDER #	FULL NAME	Q.15 DEFECT	Q.16 PHYSICIAN NAME & ADDRESS	Q.17 HOSPITAL NAME CITY & STATE

10-17

18-25

26-33

18. Have you ever had amniocentesis performed?

yes..... 1 (Q.19)
no..... 2 (Q.24)
don't know... 9 (Q.24)

34

19. When was this test performed? (SPECIFY MONTH & YEAR)

MO/YR

35-38

MO/YR

39-42

4

Household _____

R _____

20. What was/were the reason(s) for this test?

43-45
46-48

21. What was/were the result(s) of this test?

49-51
52-54

22. Who was the physician who performed the amniocentesis? (SPECIFY NAME & ADDRESS)

Physician: _____

23. In which hospital was this test performed?

Hospital _____
CITY/STATE _____

58-60

24. Have you decided not to have more children, in part because of the water problem?

yes..... 1
no..... 2
don't know... 9

61

25. Have you decided to delay childbearing in part because of the water problem?

yes..... 1
no..... 2
don't know... 9

62

Household _____

R _____

IF R ANSWERED "YES" TO EITHER Q.24 OR 25, ASK Q.26.
FOR "NO" RESPONDERS, COMPLETE MEDICAL CONSENT FORMS,
IF NECESSARY, & END INTERVIEW.

26. How large an influence did the water problem have in your decision?
Was it [READ LIST]

- the only consideration 1
- a major factor..... 2
- a moderately important factor..... 3
- a minor factor..... 4
- least important of all considerations... 5
- not a factor..... 6
- don't know..... 9

63

COMPLETE MEDICAL CONSENT FORM

Release of Medical Records

To whom it may concern:

You are hereby authorized to furnish the New Jersey State Department of Health all information and copies of any and all records you may have pertaining to _____, including, but not limited to, medical history, progress notes, physical reports, laboratory reports, pathological materials, radiology reports and films, and nuclear medicine reports and scans.

A photocopy of this release has the force of and is as effective as the original.

Signature

Date

Witness

APPENDIX 3

MEMO ON GROUNDWATER CONTAMINATION

MEMONEW JERSEY STATE DEPARTMENT OF ENVIRONMENTAL PROTECTION

TO Nate Edelstein, Deputy Attorney General

FROM Wayne R. Saunders, Principal Geologist (through) Haig Kasabach, Acting Chief, Bureau of Water Quality Planning & Management DATE November 2, 1979

SUBJECT Jackson Township, Ground-Water Contamination, Legler Section

The following report is based on inquiries you made at our meeting on September 24, 1979, on the above-referenced problem.

Two (2) major sources of ground water pollution have been identified in this area. These two sources are the Jackson Township Municipal Landfill located on Block 37; Lots 2-13, and the Kenneth Wickham property located on Block 38; Lots 17-18. The aforementioned sources were identified by an extensive investigation by the Ground-Water Section of this Bureau. This investigation employed the following methods in its determination of these sources:

Monitoring/Observation Wells and Private Wells

- Ten (10) wells were installed in this study. Three (3) of the ten (10) wells were constructed by the ground-water section for the direct investigation of the Jackson Township Landfill, since the Kenneth Wickham property was not a suspected source at the time of the installation. The remaining seven (7) wells were installed by well-drillers during the investigation of the Kenneth Wickham property. The purposes of these 10 wells were to establish that contaminants existed in the upper aquifer (Cohansey) and to establish ground-water flow directions for the origin and movement of these contaminants (see overlay).

- Ninety-six (96) ground water samples were taken during the investigation of both major sources. A total of 67 samples were taken from thirty-four (34) private home wells and tested for volatile organics. The 10 observation/monitor wells and four (4) previously installed landfill monitor wells (total 14 wells), were sampled 29 times. The attached sheets indicate the location of the sampling points by block and lot, the date the sampling took place, the group responsible for sampling and the laboratory who performed the analysis, and the result of that analysis.

- The overlay, over the tax map, indicates the location of the monitor wells installed by the Ground-Water Section, Diamond Drilling, Inc., and Craig Testing. Attached sheets also indicate all soil logs and construction of these wells.

- The ten (10) observation/monitoring wells were surveyed by the Bureau of Geology and Topography to ascertain their elevation for the water table map. Two (2) wells, Monitor Well #3 and Landfill Well #3, were surveyed by the Ground-Water Section of the Bureau of Water Quality Planning and Management. Water levels from the wells were taken by the Ground-Water Section and a contour map constructed (see overlay).

- A survey resistivity survey was initiated in the Legler section to ascertain the viability of this geophysical method for delineation of a contaminated area. The basic principle of surface resistivity is to place an electrical current through the subsurface and measure the resistance of the current to flow through the subsurface. The current movement is dependent on the amount of free ions in the saturated zone (i.e. clays, low resistance; clean sand and gravels, high resistance). Varying depths of exploration may be achieved using different electrode configurations.

The organic contaminants which were found in the landfill monitoring wells, showed that the organic chemicals exhibited electrical properties of high resistance, relative to the "natural" (clean) ground water in the area. It was assumed that these contaminants would be in the upper portion of the shallow aquifer and would travel in a plume through that aquifer.

The resistivity survey was started near the landfill, parallel to the assumed ground water flow direction. These first measurements exhibited extremely high resistance, as anticipated. (Measurements were attempted on the landfill itself, but the extremely clean, dry material acted as an insulator and would not conduct a current.) A resistivity profile was started on Lakehurst Avenue (see overlay) near Ollie Burke Road and proceeded in a southeasterly direction approximately $\frac{1}{4}$ mile past the entrance of the landfill. This profile revealed that areas of higher resistance occurred just past the Kenneth Wickham property and the landfill entrance. As the profile proceeded toward the southeast, the resistivity readings became significantly lower, therefore, the assumption was made that the ground water in this area was significantly less contaminated or even clean.

Another resistivity profile was run on Route 571. This profile revealed that very little change in resistance took place throughout the survey. Readings in the area of the McCarthy and White homes were only slightly higher than the surrounding readings of that profile which may indicate that the contaminant concentration levels have decreased due to the dilution within the aquifer.

Additional surveys were conducted in other areas of the Legler Section (see overlay). These surveys did not reveal any additional zones of contamination.

- Aerial photographs of the area were examined and revealed no obvious areas of pollution.

- USGS quadrangles (Lakehurst/Cassville) and State Atlas sheets #28 and 29, showed that the area where the landfill and Wickham properties are located are within three (3) water sheds. One drainage area is north, toward the Long Brook (FW-1) and Maple Root Branch of the Toms River. The other drainage areas to the south are controlled by the Ridgeway Branch and an unnamed tributary to the Ridgeway, which at one time extended within the landfill area. The aforementioned watersheds are shown on the attached map (copy of USGS quadrangel).

Identification of Source(s):

- The landfill became an immediate suspect due to the fact that since 1972, it had accepted large volumes of septage, and the area which is used for disposal was a former mining area (Glidden Corp.). The former mining operation had used a dredging technique where ilmenite, a titanium bearing mineral, was removed from both above and below the water table. Included in this removal was all fines (silts and clays, peat?). The fines, ilmenite and heavy minerals were separated from the parent material and the clean quartz sand was returned to the excavation. Therefore, liquid waste material deposited had a direct route through the unsaturated zone to the water table with little or no intervention. Borings submitted by the township engineer (Ernst, Ernst and Lissiden, December 10, 1972) to the Solid Waste Administration (SWA) show that intervening clay layers did exist prior to mining operations, which do not exist at the present or at the time of landfilling operations. As data was collected from the various wells, the analyses were shown to Dr. Robert Tucker of the Toxic Substances Program. Dr. Tucker notified the Jackson Township Health Department that residents (in the delineated area) should not consume the water and to limit skin exposure (bathing).

The area for non-use of the shallow aquifer for potable purposes was defined by using existing surface water boundaries. The entire landfill site was taken into account as the source. Since the landfill is situated on a drainage divide the area bounded by the Maple Root, Long Brook and Ridgeway Branch, were used as boundaries to the north, west and south. The unnamed tributary and the mining operation area was used toward the east. The boundary was later extended to the east along the entrance road to the old Glidden operation. This was due to the fact that the Glidden wells were proposed as a potable water source for the Legler section and it was felt that since the supply line would be adjacent to these homes that they should be included in the potable water system. The assumption was that the surface water would act as a barrier to the contaminants in the water table which would not flow underneath these streams from the landfill.

- The Kenneth Wickham property became involved as another major source when Mr. Wickham allegedly dumped wastes on his property at 11:50 PM on March 1, 1979. A sample taken from Mr. Wickham's tank truck by Robert Gogatz, Health Officer, was taken to the N.J. Department of Health for analysis with the following results:

Sample #C 11436	Benzene	67 ppb
	Toluene	40 ppb
	Xylene	50 ppb
	Butyl-Benzene	20 ppm (off scale)
	3-unknown peaks	

On March 8, 1979, this unit investigated the Wickham property, as requested by the Office of Hazardous Substance Control. The results of that investigation are documented in the file.

The site (shown on overlay) was an illegal dump and analyses of the material found in the excavation by the State Health Department is also documented in the files (see attached memo). The Wickham property was identified as a major source for contaminants, with the contaminants continuing to pollute the groundwater.

OTHER SOURCES:

- When the two (2) major sources (landfill and Wickham) were identified and the geohydrologic data had been compiled, other wells which were not in the ground water flow direction of the landfill or Wickham property showed contamination. Therefore, other sources of contamination were thought to exist. These other possible (minor) sources are as follows:

- 1) The Jackson Estates (Trailer Park) - this site has a package treatment plant. The method of disposal of treated wastewater is through rapid infiltration beds. (Analysis of Observation Well #5 showed that chloroform existed in the ground water. This chloroform may be due to excessive chlorination of the wastewater.)
- 2) Promiscuous dumping - when the Jackson Township Municipal Landfill began limiting its intake of liquid wastes to 20,000 gallons daily, many haulers were not permitted to use the landfill. These haulers may have dumped on the many roads in the area. The area was sparsely populated until recently and illegal dumping could go almost undetected. Residents have noticed numerous tank trucks throughout the area over a period of years.

An example of this problem is that homes located on Bowman Road have (Cole, Cope) had their wells analyzed and have shown various levels of contamination (see attached sheets). These wells are not influenced by the two (2) major sources, since ground water flow direction is away from this area (Bowman Road). This leads us to suspect that illegal dumping has taken place in the area at some time. No surface evidence was noticed in regard to illegal dumping.

- 3) Septic Systems - Except for Jackson Estates and Maple Glenn Estates, there is no public sewer system in the Legler Section of the township. Private residents employ individual subsurface disposal systems for treatment of their wastes. Since the disposal systems rely on the soil medium for treatment, the soil matrix becomes clogged over a period of time if the property septic tank maintenance procedures are not followed. Individuals will then employ different types of septic system cleaners to alleviate this problem. These cleaners contain different organic chemicals (degreasers). I have enclosed two reports entitled "Control of Organic Chemical Contaminants in Underground Source of Drinking Water, Nassau County, New York", and "Report on Survey of Consumer Products Containing or Suspected of Containing Harmful Organic Chemicals and Having the Potential of Contaminating the Groundwater of Nassau County, New York". These two reports indicate that many of the contaminants found in the ground water in the Legler section at Jackson are contained in several solvent type septic system cleaners. These organic chemicals are transmitted to the ground water via the septic system and will also be present within the septic tank. As the septic tank cleaner/hauler pumps out the septage, these organic chemicals will be transported to the disposal area, either a licensed landfill or illegal discharge point. The Legler section had both the Jackson Township Landfill and the Wickham property. However, not all of the contaminants found in the ground water are from septic system cleaners. I have attached a list of the organic chemicals found in this area with their toxic levels, where applicable, and their origins and uses.

CONCLUSIONS:

The two (2) major sources of ground-water contamination in the Legler section of Jackson Township are:

- 1) Jackson Township Municipal Landfill
- 2) Kenneth Wickham Property

Some of the organic chemicals were introduced into the landfill by septage haulers, who dumped septage containing degreasing agents and/or household products. Other chemicals may have been brought in illegally by haulers under the guise of septage.

- The Kenneth Wickham property is an illegal landfill (dump). Many of the liquid materials found on this property are trapped above the water table. The liquid materials contain organic chemicals which are harmful to humans. These materials are in contact with the ground water.

- The major ground water flow component from the landfill and the Wickham property is toward the southeast.

- Minor sources of contamination exist in the area, with individual septic systems a likely suspect. Other suspects are the Jackson Estates Trailer Park and promiscuous dumping.
- The geology of the area dictates that the upper aquifer, approximately 65 - 80 feet in thickness, cannot be used for potable purposes. The next viable (production and potability) aquifer for potable purposes is the Mt. Laurel Formation, which is approximately 340 feet deep.
- The landfill area has been reworked by mining operations and contains only clean sands and gravels to the ground water table. This material has little or no renovative capacity.

RECOMMENDATIONS:

1) A public supply water system should be installed in the delineated area. (The Jackson Township Municipal Authority has proposed to use the Glidden Wells, which are 1600 feet deep in the Magothy-Raritan Formation.) The overlying geology (various formations of clay, marl or sands) would prevent contamination of these wells from the water table (Cohansey) in this area. The individual potable wells should be sealed to prevent their use.

2) Remedial Measures

Many remedial (clean-up) actions are possible at this site. These actions range from doing nothing at all, to an entire decontamination of the aquifer. Since the spectrum of measures is very broad, I will attempt to discuss major points only:

a) Aquifer Decontamination/Containment

To ascertain what clean-up or containment measures should be taken, a complete geohydrologic study would have to be undertaken. A study of this magnitude would be best performed by a private consultant due to the fact that the Ground-Water Section does not have the manpower to devote itself to this case for such an in-depth study. The Ground Water Section would review any data and recommendations developed by the consultant. The feasibility study would entail the following:

1) Measurement of Aquifer Properties

- a) hydraulic conductivity
- b) transmissivity
- c) specific yield
- d) storage coefficient

2) Flow-System Analysis

- a) movement of the contaminant
- b) infiltration rate
- c) surface water interaction
- d) saturated and unsaturated flow

This study would entail the installation of large capacity wells (6 - 8") and the performance of several pump tests. Additional observation wells may have to be installed to perform these tests. An estimated cost of \$150,000.00 would be needed to perform such a study by a consultant. This data would then be integrated with any clean-up of the ground water, such as the number of wells needed to stop the flow of the contaminant from the major sources and the proper treatment of the contaminant.

Advantages: This program would devoid the aquifer of most of the contaminants and possibly make the aquifer usable for potable purposes.

Disadvantages: The cost for such a project could go to the millions of dollars. The treatment of these contaminants is unknown by this office. A treatment plan would have to be built on site to take care of these contaminants and operate on a 24-hour basis.

The wastewater for the pump test would have to be discharged since there is no sewer system nearby, this would be a major difficulty.

Since the contaminants appear to be volatile, part of the treatment may be spraying of the wastewater into the atmosphere. This could cause a major air pollution problem (see attached sheets on contaminants).

CONTAINMENT:

The two (2) major sources could be contained by the use of a cut-off wall and covering with an impervious cover. Since the upper clay layer was removed in the Glidden mining operation, it would necessitate that the cut-off wall be constructed to a depth of 65 - 80 feet to the Kirwood Formation. This wall would contain the organics for either treatment or for non-movement.

Advantages: The contaminants would be contained and movement of the contaminants within the aquifer would be almost nil. The aquifer (where the potable wells are located) would clean itself naturally. (The contaminants outside the containment wall would move through the aquifer to the surface water bodies.) This would speed-up the process of having the aquifer returned to potable levels since the source(s) would be cut-off.

Disadvantages: The construction of such a clay wall would be a major engineering feat at such depths. The cost of such an undertaking would be in the millions of dollars.

Impermeable Cover Without Cutoff:

The two sources could be covered with an impermeable cover such as a clay. This would stop any infiltration of precipitation onto the source area and therefore would reduce the movement of the contaminants through the aquifer. The cost of a 2 foot clay cap would be approximately \$10.00/cu. yard or approximately \$2,000,000.

Advantages: The clay cap would stop the infiltration (driving force) into the sources. With the elimination of the infiltration, the concentration of the contaminants hopefully would be reduced and the "slugging" effect of the contaminants would be abated.

Disadvantages: The cost of such an operation would be prohibitive in conjunction with the benefits. The contaminants would still be present at lower concentrations. This would not make the aquifer acceptable for potable usage. The contaminants would move at a slower velocity and would be present for a longer period of time than if the following remedial action is taken.

Non-Action:

This remedy would allow the precipitation to infiltrate the source area (especially for ~~landfill~~) and move the contaminants away from the sources and be diluted in the ground water regime, as is being done presently. A ground water monitoring network would be instrumented to ascertain water quality over a period of time.

Advantages: The cost of the implementation of the system is very small, except for the monitoring wells and analyses. The aquifer is not being used at the present, so the public water system plan is essential for potable water.

Disadvantages: The aquifer (Cohansey) in this area is "written off" for use as a potable source for an undeterminable period of time.

Recommendations:

The aforementioned remedial actions appear either to be very costly or condoning pollution of a viable aquifer. It is the opinion of this section that the following minimal action be taken as a first step:

The landfill should be thoroughly investigated by the installation of large diameter monitoring wells within the landfill (these wells may later be used for the extraction of contaminated ground water). These wells would be used to determine the exact location and amount of contaminated ground water at the landfill. Grab sampling at strategic depths would determine "thickness" of the grossly contaminated ground water, and the wells would also determine the aerial extent of the contaminants. Additional steps of curtailing the source could be determined after the amount was determined.

The Wickham property should be excavated and the contaminated material above the ground table removed. A well should be placed on this property to ascertain its relative involvement in the ground-water contamination problem.

This recommendation should be carried out by a private consultant with data reviewed by this office.

The most important aspect is that the public water supply system be constructed immediately for the health and safety of the affected people.

