WATER QUALITY
IN
ALASKAN CAMPGROUNDS

Water quality in Alaskan campgrounds
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by

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FOREWORD

The project upon which this report is based was originally begun in 1967 supported by matching funds from the University of Alaska and the Office of Water Resources Research. Extensive field work was accomplished during the summers of 1967 and 1968 and much data, both chemical and economic, was collected. The economic aspects of the data were turned over to Dr. Robert Haring, one of the principal investigators. However, this material became inaccessible with the departure of Dr. Haring from the University of Alaska.

For a time, completion of the project appeared to be thwarted and, in 1972, the Institute of Water Resources contemplated writing a termination report. Fortunately, another option became available to the Institute.

Russell Vizina, a graduate student in the Program of Environmental Health Sciences at the University, felt that the data already collected could form the nucleus of a Master's thesis. He proposed to update and expand the existing data and to this end was financially supported by the State of Alaska. The result of Mr. Vizina's efforts is the completion report which follows.

ABSTRACT

This report presents an evaluation of water quality in Alaskan Campgrounds using laboratory determinations and on-site evaluations. In general, ground water quality was found to be excellent and surface water quality unacceptable for human consumption and total body contact recreation. The most pressing need was found to be the provision of an approved drinking water supply for each campground. The environmental health aspects of campgrounds were found to be largely neglected. Many of the sewage systems are inadequate resulting in pollution of the ground and surface water. Solid waste was found to be stored and disposed of by unacceptable methods. Finally, many campgrounds are located in swampy areas or located in areas subject to annual flooding.

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INTRODUCTION

The tourist-recreation industry is a significant factor in the overall economy of Alaska. In 1971, 125,000 tourists visited Alaska, spending an average of $45 per day and staying an average of 13 days. Approximately 45 per cent, or about 56,000 tourists, used Alaska's campgrounds (ADED, 1971).

Recognizing that the quality of recreational facilities will have a direct effect on the future of tourism in Alaska, various research projects are being directed at the tourist industry. Absent from the program of ongoing research is a survey of water quality problems of present recreational facilities and evaluation of these factors in planning for the construction of new facilities. Therefore, the purpose of this project is to evaluate the chemical and bacteriological quality of water in Alaskan campgrounds.

The major research effort involved in the project was a survey of the various aspects of water quality in public campgrounds in Alaska. The broad objectives of the project are:

1. To survey public recreational facilities along the Alaskan road system, in terms of use and condition of water supply, sewage disposal, site location, and solid waste handling.

2. To estimate the separable costs of facilities involved in acquiring water for human consumption.

3. To indicate environmental quality standards which are appropriate in planning the installation of new recreational facilities. These standards are to include:

    a. Water quality
    b. Sewage disposal
    c. Solid waste handling

Outdoor recreation is becoming the preferred type of leisure for increasing millions of people. Quality, quantity, location, and accessibility of water are prime factors which influence the use of outdoor recreation. A study made by the Outdoor Recreation Resources Review Commission (1962) showed that 90 per cent of all Americans associated their outdoor recreation with water related activities - to gaze at, to swim in, to fish in, to boat on, and to walk alongside. This study further pointed out that boating and camping were among the top outdoor activities.

A water supply intended for human consumption and recreational use should be of high chemical, physical, and bacteriological quality. The public health significance of water quality must be considered when evaluating potential water supplies for recreational areas. Water is a vehicle for transmission of typhoid fever, paratyphoid, amoebic dysentery, infectious hepatitis, bacillary dysentary, cholera, polio, skin diseases, and others.

It is a popular misconception that the extreme low temperatures of Alaskan waters will be detrimental to the survival of pathogenic organisms. Water-borne diseases such as typhoid fever, bacillary dysentary, and infectious hepatitis have been reported in the state (AHRC, 1972).

The collection and sanitary disposal of human waste from recreational areas are necessary to prevent pollution of ground and surface waters. Proper sewage disposal is essential to protect campground users from disease transmitted through sewage. The common method of human waste disposal in Alaskan campgrounds is the pit privy or the vault privy. These facilities, if not carefully constructed and located, will allow untreated sewage to enter the ground and surface water. They also may subject the campground user to direct contact with human feces or indirect contact by exposing the excreta to flies, rodents, cockroaches, and other vermin.

The collection and disposal of solid waste is rapidly approaching the forefront of environmental concerns. The defacing of a recreational environment by the indiscriminate dumping of refuse attracts and harbors disease-carrying rats, flies, and insects; subjects the area to water and air pollution, unpleasant odors; and generally results in a littered and unattractive recreational area (Tilsworth, 1972). The methods of solid waste handling in Alaskan campgrounds vary in effectiveness and will be discussed in detail in the body of this report.

The intimate connection and dependence between water quality and recreational pursuits, coupled with the fact that the Alaska Outdoor Recreation Report (ADP, 1971) projects a 49 per cent deficit of campgrounds by 1975, suggests the need for a study of water quality in Alaskan campgrounds.

All public campgrounds along Alaska's connecting road system were visited to determine bacteriological, physical, and chemical quality of the water supplies, solid waste handling procedures, and adequacy of existing sewage disposal systems.

Suggested standards appropriate for planning recreational facilities are presented in Chapter VII of the report. These were developed from a literature search.

CHAPTER I: LITERATURE REVIEW

This chapter will present a review of the available literature relative to water quality parameters, water quality criteria, and a general discussion of Alaska's water quality. The review of Alaska's surface and ground water quality will emphasize the areas of Alaska in which recreational areas are now located.

Water Quality Parameters

pH:

pH is a measurement of the relative concentration of hydrogen ions in water and indicates the acid or alkaline content. Water in its natural state has a range of pH from 5.5 to 9.0 (USPHS, 1963). The pH of the majority of ground waters is controlled by the relationship between the amount of dissolved carbon dioxide gas and the amount of dissolved carbonate and bicarbonates in the mineral salts. Field determination of pH in ground water is more desirable than laboratory tests due to the escape of carbon dioxide from a reduction in pressure caused by the pumping of a well (Johnson, 1966). Hem (Hanlon, 1964) states that most ground waters in the United States have pH varying from 5.5 to over 8. In surface waters pH levels below 8.0 indicate failure of photosynthesis to utilize completely the amount of carbon dioxide produced. Fish are commonly found in waters with a pH range from 5.0 to 9.0 (MacKenthun and Ingram, 1964). Neel *et al.* (1963) state that decomposition and/or respiration tends to reduce pH and increase bicarbonates and photosynthesis tends to raise pH and reduce bicarbonates. pH measurement is necessary to control corrosion, disinfection, and determination of proper chemical dosages (USPHS, 1963).

Turbidity:

Turbidity, as defined in *Standard Methods* (APHA *et al.*, 1971), is an expression of the optical property of a water sample which causes light to be scattered and absorbed rather than transmitted in straight lines through the sample. Turbidity in water is caused by the presence of suspended material such as silt, clay, plankton, and finely divided organic and inorganic matter (USGS, 1971).

Turbidity and color are often confused. Color is the dissolved substances in water and turbidity is the suspended material in water. True color results from water contacting organic debris such as leaves, wood, weeds, humus, and peat materials producing dissolved substances such as tannins, humic acid, and humates.

Sawyer and McCarty (1967) note that turbidity is an important consideration in public water supplies because of aesthetics, filterability, and disinfection. Laymen have a tendency to associate turbidity in drinking water with possible sewage contamination. Water that is highly turbid is more difficult and expensive to filter and turbidity decreases the effectiveness of disinfectents when the turbidity is caused by sewage solids.

The National Technical Advisory Committee on Water quality Criteria (1968) recommends that turbidity in the receiving water due to a discharge should not exceed 50 Jackson candle turbidimeter units in warm water streams or 10 Jackson candle turbidimeter units in cold water streams. The committee further states that the turbidity of cold water or oligotrophic lakes should not exceed 10 units. McGauhey (1968) recommends a standard of 50 ppm turbidity for bathing, fish life, recreation, and water supplies after treatment.

A turbidity of 5 Jackson candle turbidimeter units is easily detectable in a glass of water and is usually objectionable for aesthetic reasons. For this and other reasons, the United States Public Health Service (USPHS) Drinking Water Standards (1962) for turbidity is 5 Jackson candle units. The Alaska Water Quality Standard (MDPH, 1970) for turbidity is 5 Jackson candle units for drinking water and below 25 units for bathing, swimming, and recreation except when natural conditions exceed this figure. Effluents may not increase the turbidity.

Chloride:

The majority of waters contain some chloride in solution which can be caused by leaching of marine sedimentary deposits, salt water intrusion, and pollution from industrial and domestic waste. Domestic water should contain less than 100 mg/l of chloride (USPHS, 1967). Rainwater contains less than 1 mg/l on the average over the United States. The chloride content of sea water is approximately 19,000 mg/l. Chloride concentration in excess of 250 mg/l usually produces a taste to drinking water and is generally objectionable for municipal water supplies (Johnson, 1966; USPHS, 1963).

Increases in chloride content indicate possible pollution from sewage sources if the normal chloride content is known to be low (USPHS, 1963). Human excreta, particularily urine, has a chloride content about equal to the chlorides consumed with food and water. Prior to the development of bacteriological testing procedures, chloride was used as an indicator of sewage for contaminated ground waters. A high chloride concentration has a deleterious effect on metallic pipe structures and agricultural crops (Sawyer and McCarty, 1967).

Hardness:

Sawyer and McCarty (1967) consider hard waters to be those that require a considerable amount of soap to form a foam or lather, and produces a scale in hot water pipes, heaters, boilers, and other units in which the water temperature is raised significantly. Hardness might also be referred to as the soap-wasting property of water since no suds will be produced in hard water until the minerals causing the hardness have been removed by combining with the soap resulting in the familiar ring on bathtubs (Johnson, 1966).

Hardness is caused by calcium and magnesium metallic cations. It is derived largely from contact with soil and rock formations, with the hard waters originating in areas where the topsoil is thick with limestone formations and soft water originating in areas where the topsoil is thin and limestone formations are sparse or absent (Sawyer, *et al.*, 1967). Total hardness of water may be divided into two types - carbonate and non-carbonate hardness. Carbonate hardness refers to the portion of calcium and magnesium that combines with bicarbonate and carbonate present. Carbonate hardness is also referred to as temporary hardness because it can be removed by boiling the water, precipitating the calcium and magnesium carbonates. Non-carbonate or permanent hardness is the difference between the total and carbonate hardness. It is caused by calcium and magnesium combining with sulfate, chloride, and nitrate ions that are present. This type of hardness cannot be removed by boiling (Sawyer, *et al.*, 1967).

Generally, the biological productivity of water is directly correlated to its hardness, but hardness has little biological significance because productivity is dependent upon the specific combination of elements present (NTAC, 1968).

Sawyer and McCarty (1967) use the following classification for hardness:

0 - 75 mg/l	Soft
75 - 150 mg/l	Moderately hard
150 - 300 mg/l	Hard
300 and up mg/l	Very hard

Temperature:

Drinking waters are most desirable when they are consistently cool and do not have temperature fluctuations of more than a few degrees. Most people find water between 50° - 60°F to be the most palatable (USPHS, 1963).

Temperature can be an important factor in the enjoyment of a recreational area. Excessively high temperatures may reduce pleasure of some water contact sports as well as disrupt the natural processes in the water environment. High temperatures also restrict the dissipation of body heat resulting in possible physiological disturbances. Maximum water temperature that will not induce undesirable physiological effects after prolonged exposure must be less than 90°F (NTAC, 1968).

MacKenthun (1969) notes that temperature determines the aquatic species that may be present; it controls spawning and hatching of young, regulates their activity, and stimulates or suppresses their growth and development. A study by Eschmeyer (1950) noted that the distribution of fish is greatly influenced by water temperature. MacKenthun further states that for every 18°F increase in temperature, the chemical reaction rate is approximately doubled in an organism or in an environment. Also, the synergistic action of pollutants are more severe at higher water temperatures resulting in a more rapid depletion of oxygen, and toxic materials are more toxic at higher temperatures than they are at lower temperatures. Increased water temperatures may cause aquatic plant nuisances under favorable environmental factors (Eschmeyer, 1950).

Iron:

Practically all water supplies contain some iron because of the large amount of iron present in the soil. Iron is objectionable in water because it stains plumbing fixtures, plugs pipes, imparts a brownish color to laundered clothes, affects the taste of beverages, and can advance the spoilage of eggs when washed in water containing iron in excess of 10 mg/l. Some industrial plant processes cannot tolerate an iron content greater than 0.1 mg/l (Johnson, 1966; USPHS, 1967).

Chemically, there are two kinds of iron in water, ferrous iron and ferric iron. Iron in the ferrous state is unstable when exposed to oxygen and changes to the ferric state when natural waters containing iron are exposed to air. The chemical compounds formed by the aeration are iron oxide and iron hydroxide, commonly referred to as rust. Ground waters that contain a large amount of iron always lack dissolved oxygen (Frey, 1969).

Water containing iron also supports the growth of iron bacteria, notably the genus *Chrenothrix*. *Chrenothrix* and other iron bacteria clog water mains, attach to well and pipe walls, infiltration galleries, and the voids of water-bearing material. Iron bacteria live best in the absence of light and are abundant in water containing little or no oxygen with appreciable amounts of carbon dioxide along with dissolved iron (Johnson, 1966). Starkey (1967) noted that iron bacteria may cause turbidity and produce unpleasant tastes and odors.

The U.S.P.H.S. Drinking Water Standards (1962) state that public water supplies should not contain iron in excess of 0.3 mg/l.

Bacteriological Quality:

Water serves as a vehicle for transmission of many disease-producing organisms which can present a hazard to public health. Unfortunately, the specific disease-producing organisms present are not easily identified. Therefore, it has been necessary to develop tests which indicate the relative degree of contamination in terms of an easily defined quantity. The most widely used method involves an estimation of the number of coliform bacteria which are always present in fecal waste (USPHS, 1963).

McKinney (1962) reports that coliform were originally thought to be completely fecal in origin, but it has since been shown that the genera *Aerobacter* and some *Escherichia* can grow in soil. Therefore, the presence of coliforms does not always mean fecal pollution. Coliforms are seldom pathogenic, but most of them live and multiply in the intestinal tracts of man and domestic and wild warm blooded animals (Johnson, 1966).

Freedman (1971) notes that the coliform group includes all of the aerobic and facultative anaerobic, gram negative, nonspore-forming, rod-shaped bacilli which ferment lactose with gas formation within 48 hours at 35°C.

Frobisher (1963) reports that for every typhoid bacillus and polio or hepatitus virus in polluted water supplies, there are usually millions of coliform organisms.

Many years of experience have established the importance of coliform group densities as principal indicators of the suitability of water for domestic, recreational, industrial, and other uses (APHA, *et al.*, 1971).

The standard tests for the coliform group described in *Standard Methods* (APHA, *et al.*, 1971) are designed for the quantitative determination of the coliform group. The standard tests are:

1. Multiple Tube Fermentation Technique

   a. Presumptive Test - (Based on gas production from lactose within a 48-hour period) A negative reaction excludes the coliform group and a positive test indicates coliform bacteria may be present.
   b. Confirmed Test - (Based on a 48-hour period) This test demonstrates gas production from lactose in the presence of brilliant green lactose bile broth or eosin methylene blue agar. The presence of typical coliform colonies on the agar plate or gas formation in the brilliant green lactose broth bile tubes is a positive confirmed test.
   c. Completed - The coliform are isolated in pure culture, reaffirming the gas-producing characteristic of the bacteria.

2. Membrane Filter Technique: The sample is filtered through a membrane flter, coliform colonies are cultivated with *Standard Methods* (APHA, *et al.*, 1971). M-Endo medium, and a count of coliform colonies is made.

The results of the tests are stated in terms of the Most Probable Number (MPN) which is an index of the number of coliform bacteria that more probably than any other number gives the results shown in the tests. Geldreich (1966) points out that these tests do not distinguish between the various types of coliform bacteria, nor do they yield any information as to the possible source or origin of the coliforms.

The recent trend has been to differentiate between fecal and non-fecal coliform organisms. The multiple-tube dilution technique and membrane filter method have been modified to provide estimates of the density of fecal coliforms (APHA, *et al.*, 1971). As Geldreich (1966) states, fecal coliforms may be considered indicators of recent fecal pollution and indicative of dangerous contamination from human or animal origin.

A U.S.P.H.S. Manual (1963) emphasizes that the presence or absence of coliforms in a water sample is indicative of quality only at the time of collection.

Water Quality Requirements for Recreational Areas

Water quality in recreational areas is essential for domestic use, recreation, aquatic life, and aesthetic considerations. This section of the literature review will review various standards and recommended criteria which are directed at the uses of water for recreation, aquatic life, aesthetics, and domestic use.

Aesthetics:

The National Technical Advisory Committee on Water Quality Criteria (1968) made the following recommendations:

1. All surface water should be capable of supporting life forms that have aesthetic value.

2. Surface waters should be free of the following substances:
   a. Materials that will settle to form objectionable deposits.
   b. Floating debris, oil, scum, and other matter.
   c. Substances producing objectionable color, odor, taste, or turbidity.
   d. Materials in concentrations or combinations which are toxic or which produce undesirable physiological responses in humans, fish and other animal life and plants.
   e. Substances which produce undesirable aquatic life.

3. The aesthetic values of unique or outstanding waters should be

recognized and protected.

The Alaska Department of Environmental Conservation (1972) states that water quality may not be impaired by the presence of materials or their effect which are offensive to the sense of sight, smell, taste, or touch.

Domestic Use:

The Public Health Service Drinking Water Standards (1962) have been universally accepted as reasonable criteria throughout much of the United States and Canada. They are, in part, as follows:

Parameter	Limit
pH	no criteria
Iron	0.3 ppm
Chloride	100 ppm
Turbidity	5 Jackson candle units
Hardness	no criteria
Temperature	no criteria
Bacteriological	
10 ml standard portions	Not more than 10 per cent in any month shall show the presence of the coliform group.
100 ml standard portions	Not more than 60 per cent in any month shall show the presence of the coliform group.
Membrane Filter Technique	The arithmetic mean coliform density of all standard samples examined per month shall not exceed one per 100 ml.

The National Technical Advisory Committee (1968) on Water Quality criteria recommend the following standards for surface water prior to treatment:

Parameter	Limit
pH	6.0 to 8.5
Iron	0.3 ppm
Chloride	250 ppm
Turbidity	no criteria
Hardness	no criteria
Temperature	no criteria

Bacteriological	
Coliform organisms	10,000 per 100 ml
Fecal Coliform	2,000 per 100 ml

The advisory committee did not establish fixed criteria for temperature because of the variance with geographical location and climatic conditions. However, they point out that the following conditions detract from domestic water quality:

1. Water temperature higher than 85°F.
2. More than 5°F increase in excess of ambient conditions.
3. More than 1°F hourly variation of ambient conditions.
4. Any water temperature change which adversely affects the biota, taste, odor, or chemistry of the water.
5. Any water temperature change that decreases the acceptance of the water for cooling and drinking purposes.

The State of Alaska Water Quality Standards (1972) for domestic use is broken down into two classifications:

Water Classification A: Water supply, drinking, culinary, and food processing without the need for treatment other than simple removal of naturally present impurities:

Parameter	Criteria
pH	6.5 to 8.5
Iron	no criteria
Chloride	no criteria
Turbidity	Less than 5 Jackson candle units
Hardness	no criteria
Temperature	Below 60°F
Organisms of the Coliform Group	Mean of 2 or more samples in any month less than 50/100 ml.

Water Classification B: Water supply which needs advanced treatment. Same as Classification A, except the coliform criteria is a mean of 2 or more samples in any month less than 1000 per 100 ml and not more than 20 per cent of samples during one month may exceed 1000 per 100 ml.

McGauhey (1968) notes that water for domestic use should meet Public Health Service Drinking Water Standards. Also, the recommended, but not obligatory, standards should be exceeded only as a result of the characteristics of natural water.

Michigan's Water Quality Criteria (1967) differ in that the monthly average for the coliform group of organisms shall not exceed 2000 per 100 ml nor shall 20 per cent of the samples exceed 2000 per 100 ml. Also, the maximum natural water temperature shall not be increased by more than 10°F.

Recreational Use:

Recreational water uses are such things as boating, swimming, water skiing, skin diving, hunting, and fishing. Water uses are sometimes divided into total body contact and partial body contact (MWRC, 1967). Stevenson (1967) classifies recreational waters as follows:

1. Swimming and bathing in natural or impounded waters.
2. Fishing in natural or impounded waters.
3. Boating on or camping along bodies of water solely used for boating activities.

The National Technical Advisory Committee (1968) notes the following general requirements:

1. Surface waters should be suitable for human use not involving significant risks. The committee suggests an average not to exceed 2000 fecal coliforms per 100 ml.
2. Surface waters should be of a quality to provide for the enjoyment of recreational activities, utilizing fishes, waterfowl, and other forms of life.

3. Species available for harvest should be fit for human consumption.

McGauhey (1968) reports that, in general, recreational waters should be free of obnoxious floating or suspended material, objectionable color, foul odors, and substances which are dangerous to swallow.

Recreational waters appear to fall into two general catagories: primary contact or total body contact for waters used in swimming, water skiing, and skin diving. The recommended requirements for this type of use are quite variable. Stevenson (1967) states the pH should range from 6.0 to 8.5, coliform index of 1000 per 100 ml, and a turbidity limitation of 250 mg/l. McGauhey (1968) limits the temperature to 85°F, pH range of 6.5 to 9.0, and a coliform index of 1000 per 100 ml. The National Technical Advisory Committee (1968) states that the microbiological suitability of waters used in primary contact recreation should be determined by fecal coliforms based on a minimum of not less than five samples for any 30-day period of the recreational season. The fecal coliform index shall not exceed a log mean of 200 per 100 ml. Freedman (1971) reports that waters safe for primary contact recreation should have a satisfactory environmental survey, satisfactory epidemiological experience, and a coliform average not in excess of 1000 per 100 ml.

Partial body contact or secondary contact is a classification for waters used for boating, fishing, hunting, and trapping. The published literature reveals little information about this classification. Exceptions are an average fecal coliform density of 2000 per 100 ml (NTAC, 1968). Michigan Standards (1967) state that the average of any series of 5 consecutive samples shall not exceed 5000 coliforms nor shall 20 per cent of the samples examined exceed 10,000 coliforms per 100 ml sample.

Aquatic Life:

Wildlife require water quality adequate to maintain their health and produce beneficial biota in their environment. MacKenthun (1969) reports that different species of aquatic life require different temperatures. The National Technical Advisory Committee on Water Quality Criteria (1968) recommends a pH range of 6.0 to 9.0 for fresh water organisms or a pH range of 6.7 to 8.5 for marine and estuarine organisms. McGauhey (1968) suggests a pH range of 6.5 to 8.5 for fresh water and 6.5 to 9.0 for salt water.

Standards for aquatic life in recreational waters are not applicable to the Alaskan situation. Most recreational areas in Alaska are presently not located in areas which would subject them to major pollution sources. Therefore it would not be practical to recommend standards where natural conditions exist that are not influenced by campground users.

Water Quality in Alaska

Information on the surface and ground water of Alaska is mostly available through publications of the United States Geological Survey. It varies in substance from area to area, with the Anchorage, Juneau, Kenai, and Fairbanks areas having the most comprehensive compilation of data. This review of water quality in Alaska will consider pH, iron, chloride, hardness, turbidity, and temperature. These are the water quality parameters considered for this research project. Other parameters will be illustrated in tables or indicated in a general way.

Due to its large size and diversity, the state has been divided into six sub-regions by the Inter-Agency Technical Committee of Alaska (WRC, 1970). The six sub-regions are the Arctic Slope, Northwest, Yukon, Southwest, Southcentral, and Southeast (Fig. 1).

Permafrost and glaciers are important factors in determining water quality in Alaska. Permafrost is found in the majority of the state except for a strip about 25 to 125 miles along the coast where only a few patches exist (USGS, 1971a). Because of its impermeable nature, permafrost restricts discharge, recharge, and the movement of ground water. It also prevents the downward percolation of water, increases direct runoff, and creates numerous lakes and swamps.

Glaciers in the State of Alaska cover a total of about 17,000 square miles and contribute as much as 2,000 mg/l of suspended sediment in streams compared to 100 mg/l for nonglacial streams in the summer. Glacier fed streams are characterized by a very fine sediment referred to as glacial flour (USGS, 1971a).

Glaciers markedly influence water quality in Alaskan campgrounds. Glacial fed streams experience their highest runoff with corresponding heavy suspended sediment loads in the summer months when campground use is highest. Thus, surface waters in the majority of the campgrounds can be expected to contain appreciable amounts of suspended sediments limiting their use for domestic and recreational purposes.

As illustrated on a map of Alaska (Fig. 1), the majority of the campgrounds are located in the Yukon, Southcentral, and Southeast subregions. The water quality of these areas is discussed in detail, whereas the water quality of the Arctic Slope, Northwest, and Southwest subregions will be presented in tabular form using selected locations from each subregion. The quality of surface and ground waters will be considered separately because of their wide variations.

This literature review of water quality in Alaska will be largely directed at the areas which receive highest recreational usage.

Surface Water:

It is estimated that 900 thousand cubic feet per second is the average amount of runoff in Alaska. Surface waters within the influence of the Gulf of Alaska experience high runoffs with little seasonal variation. In contrast, northern areas of the state have low runoff rates with large seasonal variations. Alaska has more than 3 million lakes. Twenty of these are known to be 250 feet deep and 94 lakes each has a surface area of more than 10 square miles.

The chemical quality of surface water is quite variable from area to area.

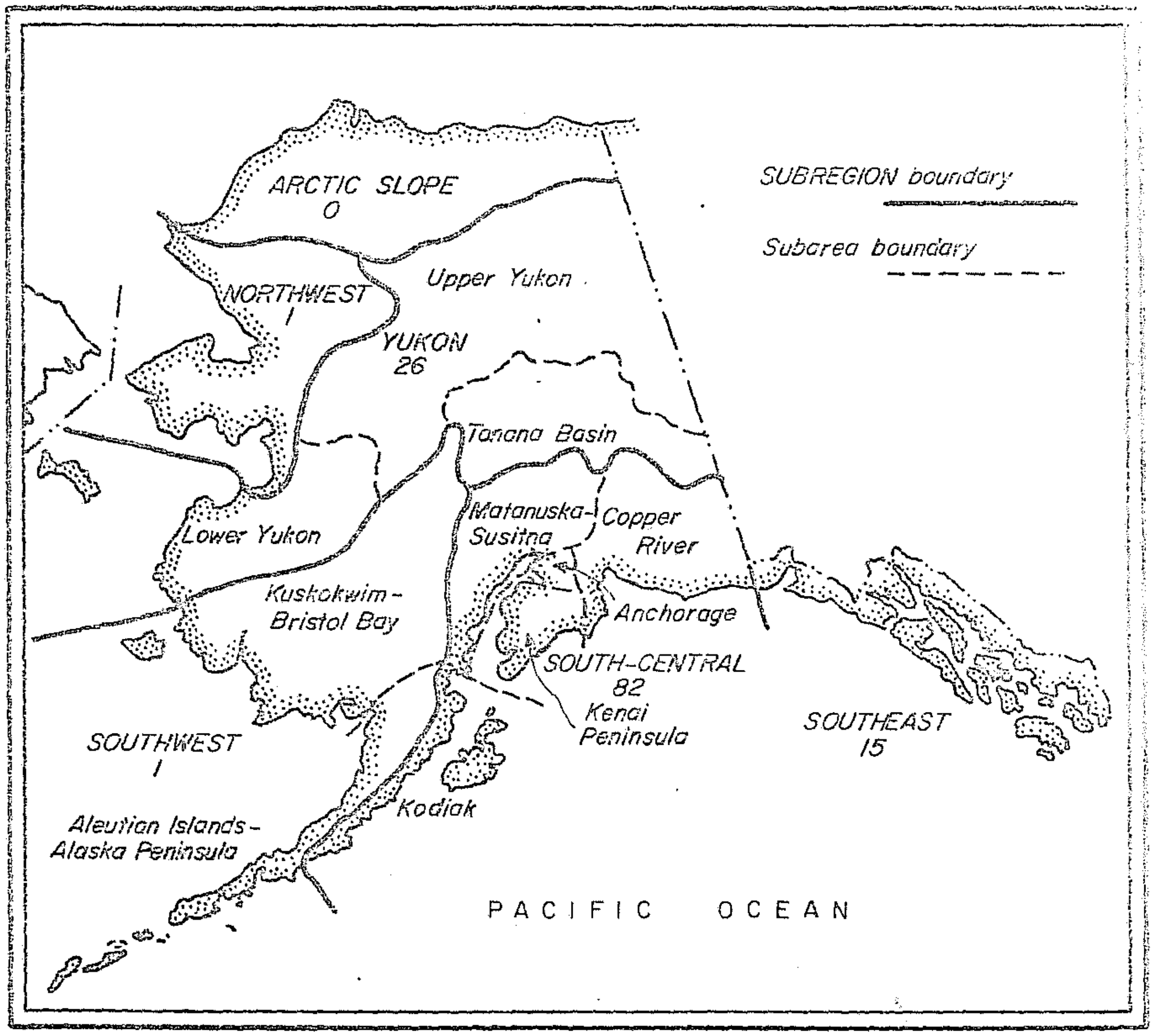

Figure 1: Hydrologic Subregions. Numbers represent number of campgrounds in each subregion.

The streams draining lowlands usually contain harder water than the streams in the higher mountains. The water of lakes and large adjacent rivers in the lowlands remote from the ocean have similar chemical quality (USGS, 1971a). Alter (1969) reports that streams and lakes may have considerable color and turbidity and are subject to ready contamination.

Yukon Sub-region: In the Yukon River Basin all surface waters on which information is available are of the calcium bicarbonate type and generally of acceptable quality. An anaylsis of the Yukon River sampled at Ruby had a dissolved-solids content of 103 mg/l and a hardness of 96 mg/l. A few of the streams have excessive iron content during some parts of the year. Iron is the only constituent that seems to be present in excessive amounts. Lakes may be either higher or lower than streams in iron content, but the hardness of lake waters sampled is less than in most streams. The normal temperature range is 44°F to 50°F (USGS, 1971a). In the Yukon sub-region, the Yukon River and streams in the Tanana Basin are heavily loaded with sediments in the summer with concentrations ranging from 400 mg/l in the Yukon River to 2000 mg/l in the Tanana Basin (USGS, 1971a). A study by Frey (1969) of the Chena River near Fairbanks showed a pH which ranged from neutral to basic in 1953-54 and a neutral to acidic range in 1967-68. Table 1 illustrates a random selection of water resources data (USGS, 1970) for the Yukon sub-region.

South Central Sub-region:

Anchorage area: A study made by the US Geological Survey (1972) showed stream water generally to be of excellent quality. Water from Ship Creek had an iron concentration of 0.03 mg/l, chloride content of 0.4 mg/l, and a total hardness of 64 mg/l. The temperature of Ship Creek water ranged from 32°F in mid-winter to 59°F in July. Records on the South Fork Campbell Creek and Eagle River, also in the Anchorage area, indicate water of a similar excellent quality. The water quality of lakes is of sufficient quality for recreational uses. A few shallow lakes and streams draining these lakes are high in color and a few are

TABLE 1: SURFACE WATER QUALITY, YUKON SUB-REGION

Source	Date	Iron mg/l	Chloride mg/l	Total* Hardness mg/l	Dissolved Solids mg/l	pH	Temp. °F
Chena River at Fairbanks	3/70	3.2	2.1	165	119	6.6	--
Chena River at Fairbanks	7/70	.49	.5	103	84	7.7	54
Yukon River at Ruby	5/69	----	1.2	103	86	7.8	--
Gulkana River at Paxson	7/70	.01	.4	55	44	8.0	36
Porcupine River near Fort Yukon	6/70	----	.7	52	49	7.2	44
Chandalar River near Arctic Village	3/70	.15	.0	228	217	8.0	--
Lake at Arctic Village	3/70	.05	.4	154	154	8.0	--
Boulder Creek near Central	5/70	.79	.1	16	17	5.9	--
Tanana River at Nenana	10/69	.74	.4	164	133	8.2	39
Koyukuk River near Wiseman	9/70	----	.1	192	179	8.1	--
Yukon River near Kwiguk	6/70	.41	.7	90	77	7.4	54

*as $CaCO_3$

high in iron content (USGS, 1971a). The Greater Anchorage Borough Health Department conducted a bacteriological survey of Campbell Creek in 1966-67 (USGS, 1972) which showed coliform densities with ranges of 100 coliforms per 100 ml to 3900 coliforms per 100 ml.

Table 2 is a random selection of Water Resources Data (USGS, 1970) for the South Central Sub-region, Anchorage area.

Copper River area: The Copper River basin shows ranges in dissolved solids content from 21 mg/l at Power Creek near Cordova to 177 mg/l at the Copper River at Chitina. Total hardness ranges from a low of 15 mg/l at Power Creek near Cordova to a high of 146 mg/l at Willow Lake, Mile 88.4, Richardson Highway. The observed temperature range is from 32°F to 37°F. The Copper River below Chitina has had a suspended sediment concentration of about 1700 mg/l for a 9 year period (USGS, 1971a). It appears from available data that the chemical quality of the water in the Copper River basin is acceptable for most uses. The results of the chemical quality of various surface waters in the Copper River basin are shown in Table 3 (USGS, 1970).

Kenai Peninsula: On the basis of reports from Water Resources Data and Hydrologic Data of Kenai-Soldotna area (USGS, 1970), the range of dissolved solids appears to be from 18 mg/l at Kasilof River to 140 mg/l at the Swanson River near Sterling. The range of temperature for surface water on the Kenai peninsula is from 32°F to 59°F at Beluga Lake. Beluga Lake at Homer also experiences the greatest concentration of observed hardness (1185 mg/l) on the Kenai peninsula. In contrast, the Kasilof River has a reported hardness concentration of 12 mg/l.

Chloride does not appear to be a problem with the exception of Beluga Lake which has a reported concentration of 596 mg/l. Iron content of surface water on the Kenai peninsula appears variable with a notable high concentration of 2.0 mg/l at Beaver Creek (USGS, 1970). Table 4 represents a random selection of data on the Kenai Peninsula (USGS,

TABLE 2: SURFACE WATER QUALITY, SOUTH CENTRAL SUB-REGION, ANCHORAGE AREA

Source	Date	Iron mg/l	Chloride mg/l	Total* Hardness mg/l	Dissolved Solids mg/l	pH	Temp. °F
Glacier Creek at Girdwood	3/70	----	1.8	68	48	7.4	35
South Fork Campbell Creek near Anchorage	10/69	.02	0.0	50	37	7.8	33
Ship Creek near Anchorage	4/70	----	.4	90	70	7.6	32
Eagle River at Eagle	10/69	----	.7	68	51	7.7	39
South Fork Chester Creek near Anchorage	5/70	----	.4	84	68	7.2	--

*as $CaCO_3$

TABLE 3: SURFACE WATER QUALITY, SOUTH CENTRAL SUB-REGION, COPPER RIVER AREA

Source	Date	Iron mg/l	Chloride mg/l	Total* Hardness mg/l	Dissolved Solids mg/l	pH	Temp. °F
Sourdough Creek at Sourdough	7/70	----	12.0	99	74	7.7	--
Gulkana River at Gulkana	5/70	.08	15.0	103	78	7.9	55
Tazlina River near Glenallen	5/70	.11	8.9	87	64	7.8	36
Squirrel Creek near Tonsina	4/70	----	6.0	131	97	7.5	32
Copper River near Chitina	4/70	----	24.0	177	117	8.2	32
Little Tonsina River at Mile 74, Richardson Highway	9/70	.06	.3	73	42	7.7	37
Lowe River at Valdez	9/70	----	.6	69	54	7.3	35
Power Creek near Cordova	2/70	.04	2.1	30	21	7.1	35
Spruce Creek near Seward	2/70	----	10.0	54	41	7.6	34
Klutina River at Copper Center	9/70	----	1.1	54	44	7.4	--

*as $CaCO_3$

TABLE 4: SURFACE WATER QUALITY, SOUTH CENTRAL SUB-REGION, KENAI PENINSULA

Source	Date	Iron mg/l	Chloride mg/l	Total* Hardness mg/l	Dissolved Solids mg/l	pH	Temp. °F
Fish Creek near Seldovia	7/70	----	3.2	32	18	7.4	48
Bradley River near Homer	6/70	----	1.4	36	27	7.6	38
Beluga Lake at Homer	7/70	.03	596.0	---	185	7.4	59
Beaver Creek near Homer	7/70	----	2.8	78	28	7.5	46
Anchor River near Anchor Point	8/70	----	2.8	83	36	7.5	50
Ninilchik River at Ninilchik	5/70	----	2.1	54	23	8.2	37
Kenai River at Copper Landing	3/70	----	.7	.44	33	7.6	33
Kenai River at Soldotna	10/69	----	.0	36	21	7.6	41
Kasilof River near Kasilof	10/68	1.24	0.4	24	12	7.1	39
Bishop Creek near Kenai	9/70	.70	3.2	66	42	7.4	42
Ressurection Creek near Hope	8/70	.36	2.5	52	.39	7.8	43
Beaver Creek near Kenai	1/70	2.00	2.1	114	66	7.3	55

*as $CaCO_3$

1970, 1971a).

Matanuska-Susitna: The surface water sampled is of the calcium carbonate type in the Matanuska-Susitna area. Iron appears to be a problem in most streams of the area with ranges from 0.1 mg/l to 0.8 mg/l, which is considerably higher than the PHS Drinking Water Standards (U.S.P.H.S., 1962). In studies made by U.S. Geological Survey (1960, 1970, 1971a), the dissolved solids content ranged from 24 mg/l at the Cakachatna River near Tyonek to 234 mg/l at Caribou Creek at Sheep Mountain. Refer to Table 5 (1970) for further details.

Kodiak area: Table 6 (1970) reveals that the dissolved solids content for Kodiak Island varies only from 19 mg/l to 35 mg/l. The other constitutents vary only slightly and appear to be of acceptable chemical quality for public use.

Southeast Sub-region: The Southeast sub-region has an observable range of dissolved solids content from 3 mg/l to 120 mg/l. Waters in the southern part of the sub-region have lower dissolved solids content than waters in the northern part. It appears that iron has the most effect on water quality in this area. Hardness, chloride, or dissolved solids do not appear to present any chemical quality problems in this sub-region (Table 7) (USGS, 1970).

Arctic Slope, Northwest and Southwest Sub-regions: The chemical analysis of a random selection of surface waters is illustrated on Tables 8, 9, and 10 (USGS, 1970).

Ground Water:

Ground water conditions in Alaska are highly variable from region to region. The principal aquifers are bodies of water-sorted sands and gravel incorporated within the glacial drift that covers the uplands, and in the glacial outwash and other alluvial deposits that extend from the uplands into lowlands.

TABLE 5: SURFACE WATER QUALITY, SOUTH CENTRAL SUB-REGION, MATANUSKA - SUSITNA AREA

Source	Date	Iron mg/l	Chloride mg/l	Total* Hardness mg/l	Dissolved Solids mg/l	pH	Temp. °F
Knik River at Palmer	4/70	.10	.7	93	70	8.0	34
Susitna River near Cantwell	7/70	.07	4.3	80	58	8.1	49
Chulitna River near Talkeetna	3/70	.49	25.0	110	58	7.6	--
Susitna River near Susitna	2/70	----	12.0	122	87	7.6	--
McArthur River near Tyonek	2/70	.23	9.2	84	44	7.8	--
Drift River near Tyonek	2/70	.80	21.0	139	76	7.2	--

*as $CaCO_3$

TABLE 6: SURFACE WATER QUALITY, SOUTH CENTRAL SUB-REGION, KODIAK

Source	Date	Iron mg/l	Chloride mg/l	Total* Hardness mg/l	Dissolved Solids mg/l	pH	Temp. °F
Uganik River near Kodiak	6/70	----	3.0	35	20	7.2	37
Unnamed Creek near Old Harbor, Kodiak	6/70	.05	2.1	19	10	7.1	44
Unnamed Creek north of Old Harbor Creek	6/70	.05	3.2	21	10	7.2	45
Myrtly Creek near Kodiak	4/70	----	5.0	22	7	6.7	--
Middle Fork Pillar Creek near Kodiak	4/70	----	8.5	32	14	6.5	34

*as $CaCO_3$

TABLE 7: SURFACE WATER QUALITY, SOUTHEAST SUB-REGION

Source	Date	Iron mg/l	Chloride mg/l	Total* Hardness mg/l	Dissolved Solids mg/l	pH	Temp. °F
Davies Creek near Auke Bay	10/70	1.20	1.4	16	10	7.4	42
Wheeler Creek near Douglas	5/70	.45	1.4	57	48	7.8	40
Hook Creek near Tenakee	7/70	----	2.8	44	32	7.7	--
Salmon River near Hyder	8/70	.50	.4	32	24	7.4	36
Harding River near Wrangell	4/70	.12	.7	20	10	7.3	37
Sheep Creek near Juneau	1/70	.01	.7	56	44	7.6	38
Lemon Creek near Juneau	4/70	.06	1.1	45	30	7.4	38
Duck Creek near Auke Bay	5/70	----	3.9	79	58	8.4	--
Taiya River near Skagway	11/69	.23	.7	35	26	7.8	36
Whipple Creek near Ward Cove	7/70	.30	2.5	14	6	6.2	32
Gunnuk Creek near Kake	9/70	.49	.4	22	15	6.8	--
Big Boulder Creek near Haines	7/70	.08	3.0	54	56	7.5	--

*as $CaCO_3$

TABLE 8: SURFACE WATER QUALITY, ARCTIC SLOPE SUB-REGION

Source	Date	Iron mg/l	Chloride mg/l	Total* Hardness mg/l	Dissolved Solids mg/l	pH	Temp. °F
Kaparuk River near Prudhoe Bay	6/70	.16	2.5	21	26	6.7	--
Putuligayuk near Prudhoe Bay	6/70	.32	21.0	79	107	7.5	--
Big Lake near Prudhoe Bay	6/70	----	16.0	53	69	7.2	--
Saganavirtok River at Sagwon	8/70	.10	.0	87	93	8.1	55
Colville River near Umiat	5/70	.23	.0	164	140	8.0	32

*as $CaCO_3$

TABLE 9: SURFACE WATER QUALITY, NORTHWEST SUB-REGION

Source	Date	Iron mg/l	Chloride mg/l	Total* Hardness mg/l	Dissolved Solids mg/l	pH	Temp. °F
Snake River near Nome	3/70	----	15.0	129	103	7.1	53
Kobuk River at Ambler	3/70	----	.4	115	98	7.5	--
West tributary Oakpisoorok Stream near Kivalina	8/60	.03	320.0	646	386	8.0	--
Stream, 3 1/4 Mile S.E. of Cape Thompson (sea water intrusion)	6/60	.00	4880.0	9020	3160	7.1	--
Emmikroak Creek near Cape Thompson	8/60	.00	6.0	156	152	7.5	--

*as $CaCO_3$

TABLE 10: SURFACE WATER QUALITY, SOUTHWEST SUB-REGION

Source	Date	Iron mg/l	Chloride mg/l	Total* Hardness mg/l	Dissolved Solids mg/l	pH	Temp. °F
Limpet Creek on Amchitka Island	10/69	.18	30.0	18	84	7.2	--
Fall Creek on Amchitka Island	10/69	.023	30.0	22	96	6.9	--
Jones Lake on Amchitka Island	10/69	.49	39.0	17	140	7.9	--
June Lake on Shemya Island	9/70	.22	40.0	45	116	7.0	--
Grace Lake on Shemya Island	9/70	.75	61.0	36	127	5.5	--
Nuyakuk River near Dillingham	5/70	----	.4	28	36	7.6	40
Goodnews Bay Tributary at Goodnews	3/70	.19	4.3	19	36	7.6	--
Kuskokwim River at Crooked Creek	3/70	----	2.5	108	137	7.9	--

*as $CaCO_3$

Ground water availability is complicated by the widespread presence of permafrost (permanently frozen ground). Ground water may occur above the permafrost, in thawed zones within the permafrost, or below the permafrost (Johnson, 1966). Thawed zones near large bodies of water and aquifers under the regional body of permafrost are the most reliable source of large amounts of water. The easiest ground water to develop is the active zone during the summer and early winter. These supplies are generally poor producers and cannot be depended upon for any large quantities of water. Alter (1969) notes that this type of ground water supply is easily contaminated because it receives water from subsoil, where cesspools and other waste disposal systems are usually placed at the same depths to avoid seasonal frosts and yet not be in the permafrost.

The availability of ground water throughout Alaska is quite variable with the best producing areas being along valleys of the Yukon and Susitna Rivers. Iron in excessive amounts probably affects the chemical quality of ground water more than any other constituent, especially the water from shallow wells. The iron content ranges from 47 mg/l at Galena to 0.0 mg/l at several areas. The dissolved solids content has a reportable range of 21,200 mg/l at Kotlik, near Point Romanof, to 4 mg/l at Murphy Dome near Fairbanks, with most of the ground water sampled containing less than 250 mg/l of dissolved solids. Hardness also shows a wide range from 3,010 mg/l at Kotlik to a low of 5 mg/l at Cape Romanzof. Chloride is generally low in concentration except for some of the coastal areas (Kim, *et al.*, 1969).

Yukon Sub-region: In the Yukon sub-region, the dissolved solids content ranges from 18 mg/l at Cape Romanzof to 7,700 mg/l at Savoonga on Saint Lawrence Island. Wells inland generally have calcium bicarbonate type water, whereas the coastal water is either sodium bicarbonate or sodium chloride type. Ground water from the deeper zones beneath and adjacent to the Yukon River is high in iron content and contains objectionable amounts of organic matter. Water from beneath thick permafrost, as at Campion (Table 11), is high in iron content.

In the Tanana Basin, wells along the boundaries are drilled to bedrock

TABLE 11: GROUND WATER QUALITY, YUKON SUB-REGION

Source	Date	Iron mg/l	Chloride mg/l	Total* Hardness mg/l	Dissolved Solids mg/l	pH
Andreafski	1/59	.05	11.0	83	100	---
Beauport	6/67	.08	16.0	216	262	---
Campion	11/59	12.00	3.0	296	355	---
Cape Romanzof	10/58	.07	3.0	5	18	---
Clear AFS	9/63	.03	2.0	173	1194	---
Donnelly Flats	9/67	.06	0.0	187	225	---
Eagle	8/61	.05	1.0	220	303	---
Fort Yukon	8/67	.71	0.0	151	184	---
Fox	2/61	.20	8.0	266	295	---
Galena	1/65	9.60	2.0	212	248	---
Manley Hot Springs	11/61	.05	64.0	44	254	---
Murphy Dome	9/67	.00	1.0	20	32	---
Northway	11/61	.10	1.0	220	269	---
Fairbanks	4/51	8.80	15.0	284	312	7.1
Tanacross	10/61	.10	4.0	190	420	---
Savoonga	8/66	.06	4100.0	1320	7700	---

*as $CaCO_3$

yielding water high in magnesium bicarbonate or magnesium sulfate.

Ground water in this area is generally of acceptable chemical quality except for high iron concentration. A U.S.G.S. Report (1970) notes that the Yukon sub-region has probably a greater potential for developing large supplies of ground water than any other sub-region in Alaska.

South Central Sub-region:

Anchorage area: Ground water from the alluvial and glacial deposits in this area is predominantly of the calcium bicarbonate type. The majority of the wells from the glacial deposits yield water containing about 150 mg/l dissolved solids. Water from bedrock wells in the area has somewhat higher dissolved solids content. Reports by U.S. Geological Survey (1964, 1968, 1971a, 1972) indicate that the chemical quality of ground water is generally excellent. Iron is generally a localized problem with the normal iron concentration being low, with fewer than 5 per cent of the samples showing concentrations greater than 0.5 mg/l. Hardness ranges from 39 mg/l to 330 mg/l (Table 12).

Confined ground water in the Anchorage area, protected by nearly impermeable layers, is generally free from pollution. In contrast, shallow wells in unconfined aquifers have been reported as being contaminated, probably as a result of on-site sewage disposal system failures. In 1962-63, the Greater Anchorage Health District (1963) conducted a water supply survey which showed coliform contamination in 22 per cent of samples from individual wells less than 50 feet in depth.

Copper River: Information on ground water in this area is sketchy. Water obtained from wells shallower than 150 to 200 feet is generally of a calcium bicarbonate type. Ground water from wells sampled in the coastal lowlands is generally low in dissolved solids content. Ground water from deep wells and from mineral springs exceeds the suggested limit set by the US Public Health Service (U.S.P.H.S., 1962) for chloride.

TABLE 12: GROUND WATER QUALITY, SOUTH CENTRAL SUB-REGION, ANCHORAGE AREA

Source	Date	Iron mg/l	Chloride mg/l	Total* Hardness mg/l	Dissolved Solids mg/l	pH
Greater Anchorage Area	1/68	.30	2.5	41	113	8.1
Greater Anchorage Area	1/68	.30	2.5	39	141	8.0
Greater Anchorage Area	1/68	.08	5.7	132	164	8.1
Greater Anchorage Area	2/68	1.60	33.0	330	394	7.5
Greater Anchorage Area	2/68	.02	17.0	163	209	7.9
Greater Anchorage Area	2/68	.09	3.5	---	---	7.9
Greater Anchorage Area	2/68	.27	.7	109	136	8.0
Greater Anchorage Area	2/68	.14	3.2	95	117	7.9
Fire Island	8/67	.11	140.0	197	443	---

*as $CaCO_3$

Water from shallow wells and wells on the southern slope of Kenai-Chugach Mountains is normally low in iron and other mineral content. Water from wells on the Paxson and Denali Highways shows iron in excess of 0.3 mg/l (PHS Standards), traces of chloride, an average concentration of dissolved solids of 150 mg/l, and an average hardness of 94 mg/l (USGS, 1968). The temperature of ground water in this area ranges from 37°F to 39°F (USGS, 1971a).

Kenai Peninsula: Table 13 represents only a small fraction of the 723 wells and test borings included in a study by US Geological Survey of the Kenai Borough (1970). Most of the ground water sampled has approximately 140 to 150 mg/l of dissolved solids. Water containing the highest dissolved solids is along the western and southeastern edges of the area. The greatest iron concentration, 10 mg/l to 30 mg/l, is found in some wells in the Homer and Kenai areas. A few wells near Homer also contain methane gas. The ground water temperature in the area ranges from 37°F to 42°F (USGS, 1971a).

Matanuska-Susitna: The ground water sampled in the Matanuska-Susitna area ranged in dissolved solids content from 54 mg/l at Talkeetna to 652 mg/l in the Matanuska Valley (Table 14). Water containing the highest dissolved solids content is normally found in the eastern part of the area. Some wells near Palmer reportedly yield water of high nitrate content, and many wells and springs in the area also contain boron. One well at Palmer, for example, yields 2.5 mg/l of boron. Ground water temperatures in the area range from 37°F to 44°F. Iron also appears in excessive amounts throughout most of the area with a high of 7.2 mg/l in the Matanuska Valley (USGS, 1971a).

Kodiak: The dissolved solids content ranges from 29 mg/l to a reported 1,500 mg/l on Woody Island. The iron concentration appears to be uniformly high (Table 15) throughout the island, with hardness reportedly low. The temperature of ground water in the Kodiak area ranges from 35°F to 55°F. Ground water is utilized for domestic use only

TABLE 13: GROUND WATER QUALITY, SOUTH CENTRAL SUB-REGION, KENAI PENINSULA

Source	Date	Iron mg/l	Chloride mg/l	Total* Hardness mg/l	Dissolved Solids mg/l	pH
Kenai Peninsula Borough	1/68	.30	2.5	41	113	8.1
Kenai Peninsula Borough	2/68	.14	3.2	95	117	7.9
Kenai Peninsula Borough	10/66	.48	2.1	81	167	7.3
Kenai Peninsula Borough	7/69	.30	11.0	77	185	7.6
Kenai Peninsula Borough	3/70	.18	2.5	87	111	7.9
Kenai Peninsula Borough	4/69	.66	400.0	73	845	7.7
Kenai Peninsula Borough	9/69	.80	60.0	83	273	8.0
Kenai Peninsula Borough	9/55	2.60	9.0	131	190	8.0

*as $CaCO_3$

TABLE 14: GROUND WATER QUALITY, SOUTH CENTRAL SUB-REGION, MATANUSKA-SUSITNA

Source	Date	Iron mg/l	Chloride mg/l	Total* Hardness mg/l	Dissolved Solids mg/l
McKinley Park	6/63	.10	113.0	297	330
Matanuska Valley	8/66	.00	1.0	140	159
Matanuska Valley	9/66	.51	2.0	144	178
Matanuska Valley	8/49	.02	74.0	490	652
Palmer	11/67	.04	6.0	49	190
Talkeetna	9/66	5.43	6.0	52	87
Talkeetna	7/67	.69	3.0	25	54
Wasilla	8/66	.08	1.0	113	141
Wasilla	8/67	.12	0.0	114	172
Tyonek	7/67	7.00	1.0	136	177

*as $CaCO_3$

TABLE 15: GROUND WATER QUALITY, SOUTH CENTRAL SUB-REGION, KODIAK

Source	Date	Iron mg/l	Chloride mg/l	Total* Hardness mg/l	Dissolved Solids mg/l	pH
Kodiak Island Borough	9/68	.19	1.7	24	34	7.0
Kodiak Island Borough	9/68	.54	1.6	22	41	6.9
Kodiak Island Borough	9/68	.01	2.2	20	29	---
Kodiak Island Borough	9/68	1.80	3.8	25	44	7.1
Kodiak Island Borough	9/68	.15	1.8	23	37	7.0
Kodiak Island Borough	9/68	.84	8.6	21	49	7.0
Kodiak Island Borough	9/68	.15	7.0	30	56	6.7
Kodiak Island Borough	9/68	.36	5.6	15	57	6.8

*as$CaCO_3$

from a few individual wells. No large supplies from ground water are known to exist (USGS, 1971a).

Southeast Sub-region: Chemical analysis of 301 water samples from the Juneau Borough shows that most of the samples are of the calcium carbonate type which is typical for the southeast area. Five per cent of the 301 water samples in the Juneau study (USGS, 1971b) exceeded the Public Health Service's (USPHS, 1962) recommended upper limit of 500 mg/l of dissolved solids. The range of dissolved-solids was from 20 to 936 mg/l. Most of the ground water sampled is of acceptable chemical quality although generally high in iron content (Table 16). The temperatures of ground water range from 35°F to 42°F.

Arctic Slope, Northwest and Southwest Sub-regions: Tables 17 and 18 represent ground water characteristics in the Northwest and Southwest sub-regions. High chloride concentrations at Nome and Teller indicate salt water intrusion into the ground water. Greenwood and Murphy (1972) report that in the Arctic Slope sub-region, water suitable for human use appears to be found only in isolated areas.

TABLE 16: GROUND WATER QUALITY, SOUTHEAST SUB-REGION

Source	Date	Iron mg/l	Chloride mg/l	Total* Hardness mg/l	Dissolved Solids mg/l	pH
Juneau	9/65	.60	1.0	98	136	---
Juneau	9/65	2.31	3.0	84	119	---
Juneau	4/68	7.20	220.0	160	470	8.4
Juneau	6/68	.15	.7	92	115	7.2
Glacier Bay National Monument	10/67	.07	4.3	110	123	7.2
Sitka Borough	6/67	4.70	27.0	74	152	7.2
Gustavus Area	6/67	2.10	4.6	278	317	7.7
Haines	3/66	.04	5.0	112	145	---

*as $CaCO_3$

TABLE 17: GROUND WATER QUALITY, NORTHWEST SUB-REGION

Source	Date	Iron mg/l	Chloride mg/l	Total* Hardness mg/l	Dissolved Solids mg/l	pH
Elim	2/65	.00	396.0	340	911	---
Koyuk	unk.	.02	1620.0	849	3112	---
Nome	7/60	.05	312.0	456	1130	---
Nome	7/60	5.00	2.0	120	110	---
Nome	7/62	.03	2860.0	1176	5390	---
Teller	5/60	.05	502.0	453	1395	---
Tin City	9/66	.24	7.0	28	40	---
Unalakleet	10/64	.22	5.0	89	101	---
Unalakleet	7/60	.00	4.0	87	90	---
Point Hope	10/60	.05	14.0	45	----	---

*as $CaCO_3$

TABLE 18: GROUND WATER QUALITY, SOUTHWEST SUB-REGION

Source	Date	Iron mg/l	Chloride mg/l	Total* Hardness mg/l	Dissolved Solids mg/l	pH
Akiachuk	8/60	1.00	10.0	65	140	---
Akiak	8/60	.20	28.0	259	390	---
Bethel	9/60	1.90	3.0	107	154	---
Bethel	1/63	39.00	4.0	105	123	---
Bethel	9/67	.14	13.0	124	185	---
Goodnews Bay	5/62	.07	6.0	90	101	---
Kasiglook	unk.	.02	44.0	101	242	---
Napaskiak	10/60	18.00	5.0	55	240	---
Mekoryuk on Nunivak Island	10/68	.05	119.0	261	456	6.3
Napakiak area (Kuskokwim River)	10/68	.86	3.0	192	230	7.4
Shemya	7/67	.06	59.0	112	241	---

*as $CaCO_3$

CHAPTER II: PROJECT DESCRIPTION

This report is based on an evaluation of water quality in 101 campgrounds and 7 picnic waysides. This is approximately 80 per cent of the total number of campgrounds in the state (USBLM, 1971). Only the campgrounds which are not readily accessible by road were excluded from the project. The connecting highway system of Alaska was used for traveling from campground to campground.

The recreational sites visited are located in the Interior, Kenai Peninsula, and the Anchorage-Palmer areas as designated by the Alaska Recreational Guide (USBLM, 1971). As can be seen from Table 19, the breakdown of campgrounds evaluated based on area designation is as follows:

Area	Number of Campgrounds and Picnic Waysides
Interior	50
Anchorage - Palmer	18
Kenai	40

This report includes only those campgrounds in Alaska which are publicly owned and operated. Private campgrounds contribute only a small number to the total number of campgrounds. A breakdown of campgrounds by agency is as follows:

Agency	Number of Campgrounds and Picnic Waysides
Alaska Division of Parks	47
Bureau of Sport Fisheries and Wildlife	17
U. S. Forest Service	16
Bureau of Land Management	15
Alaska Highway Department	5
City	8

The major field work involved in this project was accomplished in June, July, and August of 1972. Each campground was visited once and evaluated for water quality. The normal procedure when visiting the campgrounds was to

TABLE 19: LIST OF CAMPGROUNDS AND PICNIC WAYSIDES SURVEYED

Campground	Area[1]	Agency[2]
Anchorage River Wayside	Kenai	ADP
Beaver Pond Campground	Kenai	FS
Bedrock Creek Campground	Interior	BLM
Bernice Lake Wayside	Kenai	ADP
Bertha Creek Campground	Kenai	FS
Big Delta	Interior	BLM
Big Lake Campground East	Anchorage-Palmer	ADP
Big Lake Campground South	Anchorage-Palmer	ADP
Bird Creek Wayside	Anchorage-Palmer	ADP
Black Bear Campground	Kenai	FS
Blueberry Lake Campground	Interior	ADP
Bonnie Lake Wayside	Anchorage-Palmer	ADP
Bottinentnin Lake Campground	Kenai	BSFW
Brushkana Creek Campground	Interior	BLM
Chatanika River Wayside	Interior	ADP
Chena River Wayside	Interior	ADP
Chitina Campground	Interior	AHD
Circle City Campground	Interior	City
Clearwater-Alcan Campground-Wayside	Interior	ADP
Cooper Creek Campground	Kenai	FS
Crescent Creek Campground	Kenai	FS
Deadman Lake Wayside	Interior	ADP
Deep Creek Campground	Kenai	ADP
Dolly Varden Campground	Kenai	BSFW
Donnelly Creek Wayside	Interior	ADP
Dry Creek Wayside	Interior	ADP
Eagle Campground	Interior	BLM
Eagle River Campground	Anchorage-Palmer	ADP
Eagle Trail Campground	Interior	ADP
Eklutna Recreational Area	Anchorage-Palmer	ADP
Engineer Lake Campground	Kenai	BSFW
Fielding Lake Wayside	Interior	BLM
Finger Lake Wayside	Anchorage-Palmer	ADP
Gardiner Creek Campground	Interior	ADP
Granite Creek Campground	Kenai	FS
Harding Lake Recreation Area	Interior	ADP
Hidden Lake Campground	Kenai	BSFW
Homer Campground	Kenai	City
Igloo Creek Campground	Interior	NPS
Johnson Lake Recreation Area	Kenai	ADP

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TABLE 19: LIST OF CAMPGROUNDS AND PICNIC WAYSIDES SURVEYED, Continued:

Campground	Area[1]	Agency[2]
Kasilof Campground	Kenai	ADP
Kelly Lake Campground	Kenai	BSFW
Ketchum Creek Campground	Interior	BLM
Lakeview Wayside	Interior	ADP
Liberty Campground	Interior	BLM
Liberty Falls Campground	Interior	BLM
Little Nelchina River Campground	Interior	ADP
Little Tonsina Wayside	Interior	ADP
Long Lake Picnic Wayside	Anchorage-Palmer	ADP
Manley City Campground	Interior	City
Matanuska Glacier Wayside	Interior	ADP
Matanuska River Campground	Anchorage-Palmer	ADP
Moon Lake Campground	Interior	ADP
Moose Creek Campground	Anchorage-Palmer	ADP
Nancy Lake Wayside	Anchorage-Palmer	ADP
Nenana City	Interior	City
Nine Mile Picnic Wayside (Valdez)	Interior	City
Ninilchik Wayside	Kenai	ADP
Lower Ohmer Lake Campground	Kenai	BSFW
Upper Ohmer Lake Campground	Kenai	BSFW
Paxson Lake Wayside	Interior	BLM
Peter Creek Wayside	Anchorage-Palmer	ADP
Petersen Lake Campground	Kenai	BSFW
Porcupine Campground	Kenai	BSFW
Porcupine Creek Campground-Wayside	Interior	ADP
Primrose Campground	Kenai	FS
Ptarmigan Creek Campground	Kenai	FS
Quartz Creek Campground	Kenai	FS
Rainbow Lake Campground	Kenai	BSFW
Riley Creek Campground	Interior	NPS
Rocky Lake Wayside	Anchorage-Palmer	ADP
Russian Jack Springs Campground	Anchorage-Palmer	City
Russian River Campground	Kenai	FS
Sanctuary River Campground	Interior	NPS
Savage Creek Campground	Interior	NPS
Seward Highway Campground	Kenai	City
Lower Skilak Campground	Kenai	BSFW
Upper Skilak Campground	Kenai	BSFW
Soldotna City Campground	Kenai	City
Sourdough Creek Wayside	Interior	BLM
Squirrel Creek Wayside	Interior	ADP

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TABLE 19: LIST OF CAMPGROUNDS AND PICNIC WAYSIDES SURVEYED, Continued:

Campground	Area[1]	Agency[2]
Stariski Wayside	Kenai	ADP
Swanson River Campground	Kenai	BSFW
Tangle Lakes	Interior	BLM
Upper Tangle Lake Boat Launching	Interior	BLM
Teklanika	Interior	NPS
Tenderfoot Creek Campground	Kenai	FS
Tern Lake Campground	Kenai	FS
Tolovana River Campground	Interior	BLM
Tolsona River Wayside	Interior	ADP
Tok River Campground	Interior	ADP
Trail River Campground	Kenai	FS
Tustumena Campground	Kenai	BSFW
Twelve Mile Picnic Site (Valdez)	Interior	City
Valdez Glacier Road Wayside	Interior	ADP
Walker Fork Campground	Interior	BLM
Watson Lake Campground	Kenai	BSFW
Williwaw Campground	Kenai	FS
Willow Creek Wayside	Anchorage-Palmer	ADP
Wonder Lake Campground	Interior	NPS
Worthington Glacier Wayside	Interior	ADP

Picnic Waysides	Area[1]	Agency[2]
Chena Pump Wayside	Interior	AHD
Fox Wayside	Interior	AHD
Johnson Lake Rest Area	Kenai	AHD
Lake Louise Rest Area	Anchorage-Palmer	AHD
McHugh Creek Wayside	Anchorage-Palmer	ADP
Mirror Lake Picnic Wayside	Anchorage-Palmer	ADP
Salcha River Wayside	Interior	ADP

Notes:

[1] Alaska Recreational Guide, Bureau of Land Management, U. S. Department of Interior

[2] BLM: Bureau of Land Management
ADP: Alaska Division of Parks
NPS: National Park Service

TABLE 19: LIST OF CAMPGROUNDS AND PICNIC WAYSIDES SURVEYED, Continued:

Notes, Continued:

FS:	U. S. Forest Service
AHD:	Alaska Highway Department
BSFW:	Bureau of Sport Fisheries and Wildlife

first determine the water quality of the water source, followed by a thorough inspection of the campground relative to water source, sewage disposal, solid waste, site location, and condition of individual sites. The data collected was then transcribed to report forms, illustrated by the examples included in Appendix II.

The broad objective of this project is to evaluate the various factors which influence water quality in Alaskan campgrounds. To accomplish this objective the following procedures were implemented to collect the necessary data:

1. The chemical quality of the water source in the campgrounds was determined. The parameters used to accomplish this were, pH, temperature, iron, turbidity, hardness, and chloride.

2. Sampling all drinking water - wells and springs - for bacteriological quality using the coliform index as the parameter.

3. The sewage disposal systems were evaluated relative to their effects on water and aesthetic quality of the campground.

4. The solid waste handling practices were evaluated to determine their influence on the quality of campgrounds.

5. The collection of data also included the following general information which could markedly influence campground quality:

   a. site location
   b. condition of individual camp sites
   c. number of camping sites
   d. number of campers and types of recreational vehicle.

Appendix I represents the data collected at the origination of this project in the summer of 1968. Unfortunately, before the project was completed, but after some of the data collection had been accomplished, the principal investigator left the University of Alaska and the state. The data then collected was based on information received from 76 parties at 22 campgrounds. The forms included in Appendix II of this report, are directed at obtaining information from campground visitors on water quality requirements for recreational uses.

This report also includes recommendations for environmental standards which would be appropriate in programming future campgrounds. The standards, which are included in Chapter VII, are directed at water quality, sewage disposal, and solid waste storage, collection, and disposal. These standards were developed from a review of the literature and the author's experience. Chapter VI presents an economic comparison of acquiring water for campgrounds using a well, infiltration gallery, or hauling water.

CHAPTER III: EXPERIMENTAL PROCEDURES

The experimental procedures used in the determination of water quality are based on the recommendations of U. S. Public Health Service, the Fairbanks laboratory of the Alaska Department of Health and Social Services, and the methods manual of the HACH model DR-EL. The sampling procedures for surface and ground waters were those suggested by the U. S. P. H. S. and the Fairbanks laboratory of the Alaska Department of Health and Social Services. The procedure as outlined in the methods manual of HACH model DR-EL was used in determining pH, total hardness, iron, chloride, turbidity, and temperature. The chemical and bacteriological quality of the water sources was determined by using the following procedure:

Chemical Quality

All analyses for chemical quality were performed in the field using the HACH model DR-EL, Engineers Laboratory, Methods Manual, Fifth Edition, Hach Chemical Company, Ames, Iowa.

Sampling Procedure:

Well or Spring Water:

1. Each well was pumped for several minutes to thoroughly flush the system.
2. The sample was then collected in a clean 100 ml Erlenmeyer flask.
3. All tests were then immediately performed in a pick-up camper vehicle to eliminate any outside contamination.

Surface Water:

1. Each sample was collected in a clean 100 ml Erlenmeyer flask by holding the flask in a slanting position and sweeping it below the surface in such a manner to eliminate collecting surface scum

and bottom sediment.

2. All tests were then immediately performed in the pick-up camper vehicle. The camper vehicle provided facilities to properly clean glassware and store distilled water.

Bacteriological Quality

All analyses for bacteriological quality were performed by the Fairbanks laboratory of the Alaska Department of Health and Social Services. The total coliform index was used for this purpose.

The bacteriological quality of the drinking water from wells and springs was determined by using the multiple-tube dilution technique.

Sampling Procedure:

1. Each water sample was taken with an approved sample bottle furnished by the Alaska Department of Health and Social Services.

2. Prior to sampling, water was pumped for several minutes to thoroughly flush the system.

3. Each water sample was carefully collected so as not to contaminate the water, bottle, or cap.

4. Immediately after collection, the water samples were stored under refrigeration.

5. The water samples were kept under refrigeration until they were delivered to the laboratory in Fairbanks. The minimum time between sampling and delivery to the lab was two days and maximum elapsed time between sampling and delivery to the lab was seven days.

CHAPTER IV: RESULTS AND DISCUSSION

The results of the evaluation of water quality in Alaskan campgrounds will be presented and discussed in the following sequence:

1. ground water quality
2. surface water quality
3. sewage disposal
4. solid waste storage, collection, and disposal
5. miscellaneous

Chemical Quality of Ground Water in Alaskan Campgrounds

Chloride:

The chloride content of well water ranged from 4 mg/l at Harding Lake campground to 25 mg/l at Well #2, Tern Lake campground. These concentrations are well below the U. S. Public Health Service Drinking Water Standards of 100 mg/l. Table 20 shows the chloride concentration in well water for each campground.

Iron:

The iron content ranged from 0.0 mg/l at the Fox spring near Fairbanks to 5.5 mg/l at Petersen Lake campground, Soldotna city campground, and Manley city campground. It's readily noted from Table 20 that 32 of 58 wells tested had iron concentrations in excess of 0.3 mg/l, which is the U. S. Public Health Service's limit for drinking water. Iron in excess of 0.3 mg/l is not hazardous to health, but it is objectionable from the standpoint of taste, has a deleterious effect on clothing, corrodes and stains plumbing fixtures, promotes the growth of iron bacteria, affects the taste of beverages, and is aesthetically displeasing. The high concentration of iron in Alaskan ground water is one of the major water quality problems.

TABLE 20: CHEMICAL ANALYSIS - WELLS, SPRINGS

Campground	Chloride mg/l	Total* Hardness mg/l	Iron mg/l	pH	Turb. JTU	Temp. °F
Chena River	10	150	5+	7.5	50	51
Manley	20	155	5.5	6.7	2	44
Circle	20	300	0.15	7.2	0	54
Harding Lake	4	60	2.4	7.2	35	--
Tok River	6	260	0.25	8.4	35	--
Delta	5	118	0.08	8.4	0	42
Wonder Lake	30	110	0.3	7.7	18	--
Riley Creek	10	260	0.0	8.3	0	--
Teklanika	20	230	0.1	7.3	0	50
Savage Creek	5	170	0.05	8.2	2	54
Nancy Lake	20	110	1.1	8.3	0	40
Eagle Trail	5	150	0.1	8.0	0	--
Matanuska River	20	170	0.22	8.3	0	--
Finger Lake	10	170	0.1	8.3	0	50
Peters Creek	20	98	0.15	8.5	2	40
Eagle River	10	100	0.2	8.3	0	36
Bird Creek	15	85	0.2	8.3	2	40
Beaver Pond	15	50	4.5	7.0	1	36
Black Bear	20	50	0.3	7.7	0	40
Willawa						
Well #1	10	90	0.05	7.7	0	37
Well #2	12	70	0.1	8.1	0	38
Picnic Area	7	80	0.1	8.0	0	38
Tenderfoot Creek	5	70	0.2	8.0	2	36
Crescent Creek	15	40	0.4	7.9	3	39
Quartz Creek	5	60	0.05	7.2	2	48
Bertha Creek	10	50	0.4	7.4	5	36
Tern Lake						
Well #1	15	40	1.3	7.3	22	35
Well #2	25	40	0.4	7.3	5	36
Ptarmigan Creek						
Well #1	10	50	1.4	7.9	30	39
Well #2	15	60	0.08	8.5	12	40
Seward Highway C. G.	5	62	0.1	8.3	0	50
Porcupine						
Well #1	5	80	0.1	7.8	0	38
Well #2	20	95	0.4	7.8	5	37
Cooper Creek						
Well #1	5	85	0.7	8.4	0	37
Well #2	20	60	0.3	7.1	0	38

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TABLE 20: CHEMICAL ANALYSIS: WELLS, SPRINGS, Continued:

Campground	Chloride mg/l	Total* Hardness mg/l	Iron mg/l	pH	Turb. JTU	Temp. °F
Russian River	5	30	0.1	6.7	2	50
Lower Skilak	13	105	0.4	8.6	3	38
Engineer Lake	10	70	4.0	8.0	70	38
Upper Skilak	5	150	3.0	9.8	40	39
Hidden Lake						
Well #1	10	90	4.0	7.5	5	38
Well #2	5	120	0.06	8.3	0	39
Trail River						
Lakeside	5	88	0.4	8.0	2	37
Riverside	15	50	1.0	7.1	70	36
Sprucewoods						
Well #1	20	60	1.0	7.1	25	36
Well #2	20	40	2.5	8.3	90	38
River Terrace	10	40	0.8	8.4	25	37
Dolly Varden	10	130	0.5	8.5	25	38
Swanson River	10	140	1.3	8.6	25	39
Rainbow Lake	15	120	1.0	8.4	75	40
Bottinentnin Lake	12.5	120	3.3	8.2	38	38
Petersen Lake	5	90	5.5	7.7	30	37
Watson Lake	5	90	1.4	8.6	7	--
Kelly Lake	10	88	1.9	8.3	30	40
Tustumena	10	80	0.9	8.5	7	39
Kasilof	20	110	0.9	8.5	2	46
Soldotna City						
Well #1	15	80	5.5	6.9	3	48
Well #2	10	100	5.5	7.0	5	47
Fox	7	190	0.0	7.6	0	34

*as $CaCO_3$

Turbidity:

Turbidity is caused by suspended materials such as clay, silt, and other inorganic particles as well as plankton and finely divided organic material. Table 20 shows that the turbidity range for Alaskan campgrounds ground water source is from a low 0.0 JTU at numerous locations to a high of 90 JTU at Well #2, in the Sprucewoods section of the Trail River campground on the Kenai Peninsula. The high concentration in this particular well is probably due to the well's not having been used since the previous summer. The US Public Health Drinking Water Standard (USPHS, 1962) for turbidity is 5 Jackson Turbidimeter Units (JTU). It is apparent from Table 20 that approximately 33 per cent of the wells tested exceeded this limit. Turbidity may not adversely affect health, but high turbidity units are important because of aesthetics, filterability, and disinfection. Also, variations in ground water turbidity following a rainfall may indicate surface pollution.

Total Hardness as Ca CO_3:

The total hardness of ground water quality varied from a low of 30 mg/l at the Russian River to a high of 300 mg/l at Circle City campground. Using Sawyer and McCarty's (1967) classification of hardness, 34 per cent of the water samples tested were soft, 52 per cent were moderately hard, and 14 per cent of the samples were classified as hard. Hardness of water is a personal judgement depending on individual experience. Alaskan waters may be very hard for some individuals and soft for others. The hardest ground waters are observed to be in the Interior and the lowest on the Kenai Peninsula. As a whole, the total hardness of well water in campgrounds does not seem to be a major quality problem.

Temperature:

The temperatures of samples tested ranged from 34°F at the Fox spring to 54°F at the Circle City campground. The average observable temperature (summer) of ground water for all campgrounds was 40°F. This is somewhat below the 50° to 60°F temperature that people find to be most palatable (USPHS, 1963), but it should have a minimal significance for users' preference

pH:

The pH range for ground water in Alaskan campgrounds varied from 6.7 at the well at Manley Hot Springs campground to 9.8 at Upper Skilak campground on the Kenai Peninsula. Only 4 out of the 58 wells and springs sampled were not within the prescribed limits set by the Alaska Water Quality Standards (ADEC, 1972).

Bacteriological Quality of Ground Water in Alaskan Campgrounds

Forty-nine water samples were submitted for analysis to the Fairbanks laboratory, Alaska Department of Health and Social Services. All samples were judged to be satisfactory. Only four samples showed evidence of coliform organisms. Two samples showed coliform indexes of 1/100 ml at Lower Skilak Lake and Petersen Lake Campgrounds. Russian River Campground on the Kenai had a coliform index of 3/100 ml and Dolly Varden Campground had an index of 7/100 ml. These indexes are well below the Alaska State Standard of 50/100 ml. The low coliform counts are probably due to surface contamination. All 49 of the wells surveyed had isolation distances greater than 100 feet between the well and the sewage disposal systems. This distance is enough to prevent any contamination of the wells from the sewage systems.

Chemical Quality of Surface Water in Alaskan Campgrounds

Chloride:

The chloride content of surface water ranged from 0.5 mg/l at Brushkana Creek campground near Denali to 100 mg/l at Ketchum Creek campground near Circle Hot Springs. This does not include the one campground adjacent to the Pacific Ocean which had too high a concentration to register on the Hach test kit. It is readily apparent from Table 21 that the chloride concentration of surface waters in Alaskan campgrounds is not objectionable for human consumption or recreational pursuits.

TABLE 21: CHEMICAL ANALYSIS - SURFACE WATER

Campground	Chloride mg/l	Total* Hardness mg/l	Iron mg/l	Turb. JTU	pH	Temp. °F
Porcupine Creek	0.5	90	0.1	3	8.5	--
Tolsona River	9	60	0.4	85	8.2	52
Little Nelchina River	8	60	0.6	260	8.5	44
Long Lake	50	110	0.05	0	8.6	46
Bonnie Lake	6	70	0.4	30	8.4	54
Paxson Lake	15	50	0.1	19	8.5	42
Walker Fork	20	50	0.3	60	7.2	42
Moon Lake	--	50	0.7	50	8.4	60
Liberty	5	55	0.3	40	8.6	34
Deadman Lake	15	100	0.4	5	7.5	69
Lake View	30	140	0.6	30	8.4	69
Gardiner Creek	12	100	0.5	55	5.5	48
Clearwater - Alcan	--	140	0.4	5	8.7	41
Chatanika River	20	60	0.1	2	8.2	54
Bedrock Creek	35	20	0.3	30	6.6	47
Ketchum Creek	100	50	2.5	500	8.4	48
Fielding Lake	5	40	0.2	9	8.0	42
Little Tonsina	5.5	---	0.3	11	8.2	50
Igloo Creek	15	90	0.03	100	8.5	47
Sanctuary Creek	10	90	0.6	210	8.2	47
Nenana	10	130	0.2	0	8.4	68
Tolovana	5	70	0.2	5	7.6	67
Chena Pump Wayside	5	100	1.6	500	8.2	54
Bruchkana Creek Campground	0.5	30	0.2	15	7.5	45
Upper Tangle Lakes Boat Launching	0.5	50	0.2	15	7.1	40
Tangle Lakes	2.5	10	0.1	20	7.5	39
Bernice Lake	10	15	0.3	0	8.0	58
Primrose	15	20	0.03	0	7.5	42
Donnelly Creek	5	222	0.2	2	8.5	49
Sourdough Creek	4.5	40	0.3	30	8.0	52
Lower Ohmer Lake	5	60	0.1	5	8.5	53
Nine Mile Picnic Wayside	4	30	0.04	0	8.3	42
Anchor River	8	35	0.8	15	8.5	53
Deep Creek	-----	---	0.1	16	8.6	38
Johnson Lake	8	110	0.9	2	8.5	46
Willow Creek	15	25	0.3	10	7.5	48
Big Lake - East	15	50	2.4	15	7.5	62
Big Lake - South	15	50	0.1	5	8.1	60
Rocky Lake	25	10	0.03	0	8.1	60
Dry Creek	4	75	0.2	20	8.7	52

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TABLE 21: CHEMICAL ANALYSIS - SURFACE WATER, Continued:

Campground	Chloride mg/l	Total* Hardness mg/l	Iron mg/l	Turb. JTU	pH	Temp. °F
Squirrel Creek	5	58	0.05	47	8.4	48
Liberty Falls	2.0	40	0.02	2	7.9	39

*as $CaCO_3$

Iron:

The iron content of the surface water in campgrounds ranged from 0.02 mg/l at Liberty Falls campground near Chitina to a high of 2.5 mg/l at Ketchum Creek near Circle Hot Springs. Although these limits are acceptable for recreational and aesthetic uses, some do not meet the criteria for drinking water. Sixty-five per cent of the surface waters sampled have iron contents which meet the 0.3 mg/l limit set by U. S. Public Health Standards (USPHS, 1962) and 35 per cent of the surface waters in campgrounds exceed that limit.

Turbidity:

Turbidity as measured in Jackson Candle Units ranged from 0.0 JTU at several campgrounds (Table 21) to 500 JTU at Ketchum Creek and at Chena Pump Wayside on the Tanana River. About 35 per cent of the surface water in campgrounds exceed the Alaska Water Quality Standards (ADEC, 1972) of 25 JTU for bathing, fishing, and recreation. Roughly 20 per cent would exceed the 50 JTU limit for recreation, fish life, and bathing recommended by McGauhey (1968). Approximately 60 per cent of the surface waters in campgrounds where wells or springs are not available exceed the 5 JTU limit recommended by U.S. Public Health Service's Drinking Water Standards (1962). Approximately 56 per cent of the campgrounds and picnic waysides surveyed rely on surface water as the only source of water for human consumption.

Total Hardness as $CaCo_3$:

The total hardness of the surface waters sampled ranged from 10 mg/l at Rocky Lake and Tangle Lakes Campgrounds to 222 mg/l at Donnelly Creek campground. The average total hardness for all samples was 66 mg/l. Total hardness is not a problem in surface water. All concentrations are below recommended limits.

Temperature:

The temperature range for surface waters sampled is 38°F at Deep Creek campground on the Pacific Ocean to 69°F at Deadman Lake Campground near

Northway Junction. The average summer temperature was 50°F in the samples tested. There are no temperature limits that would be applicable to Alaskan surface waters. Approximately 54 per cent of the surface waters sampled had temperatures below the 50° to 60°F which is most palatable for individuals to drink (USPHS, 1963). Roughly 10 per cent of the samples had temperatures above 60°F.

pH:

The pH of the surface waters sampled ranged from 5.5 at Gardiner Creek near the Alaska-Canada border on the Alaskan highway to 8.7 at Dry Creek campground near Gulkana. The pH for drinking and recreational water is 6.0 to 8.5 recommended by the National Technical Advisory Committee (NTAC, 1968) and 6.5 to 8.5 in the Alaska Water Quality Standards (ADEC, 1972). About 14 per cent of the samples showed a pH out of these ranges, but they are so close to the acceptable ranges that they do not appear to be a water quality problem.

Sewage Disposal

The sewage disposal facilities observed in the 108 campgrounds and picnic waysides are as follows:

Type	Number of Campgrounds
Pit Privies	77
Vault Privies	18
Vault and Pit Privies	6
Septic Tanks and Pit Privies	4
Septic Tanks and Vault Privies	1
No Sewage Disposal System	1

The sewage disposal systems were evaluated subjectively based on the author's experience in environmental health. The systems were evaluated as good, fair, or poor. The "good" rating was given to those sewage disposal systems which were of good construction, well maintained, clean, ventilated, and did not pollute the ground or surface water. The "fair" rating was given to those systems which were odorous, poorly ventilated, and not well maintained. The "poor" rating was given to those systems which needed pumping, were in disrepair, poorly maintained, and located where they possibly are polluting the ground and/or surface water. Forty-seven of the campgrounds received a good rating. Thirty-one of the campgrounds received a fair rating, and 29 of the sewage systems in campgrounds received a poor rating. Also, the sewage disposal systems in 21 campgrounds are possibly polluting the ground or surface water and 13 sewage systems were located within 10-50 feet of a lake or stream.

Unfortunately, many of the pit privies are in such a poor condition as to exemplify the thinking of a rural Thai as reported by Hanlon (1964):

> He said: "You Americans are strange. Before you came here, if I felt like relieving myself, I found a quiet spot in the open with gentle breezes and often a pleasant vista. Then you came along and convinced me that this material that comes from me is one of the most dangerous things with which people can have contact. In other words, I should stay away from it as far as possible. Then the next thing you told me was that I should dig a hole, and not only I, but many other people should concentrate this dangerous material in that hole. So now, I have even closer contact, not only with my own, but everyone else's and in a dark smelly place with no view at all. Frankly, I wondered, and I still wonder, which of us was the more logical."

After visiting some of the pit privies in Alaskan campgrounds, the author also wondered which would be the best place to relieve oneself if given the two alternatives.

Solid Waste Storage, Collection, and Disposal

The storage, collection, and disposal of solid waste was evaluated by noting the type of storage for solid waste in campgrounds in conjunction with the water quality survey. The methods of collection and final disposal were determined from personal communication with personnel of the U. S. Forest Service, Bureau of Land Management, and Alaska Division of Parks.

The storage facilities for solid waste were evaluated by distinguishing between correct and incorrect storage.

Correct Storage:

According to a U.S.P.H.S. report (USPHS, 1966), correct storage is storage in durable, watertight, nonabsorbent, easily cleanable containers with close-fitting lids. The containers should be placed on concrete pads or in a storage rack off the ground. The storage containers should be effectively anchored to prevent scattering by bears and dogs.

Incorrect Storage:

Incorrect storage applies to containers without lids, not easily cleanable or durable, directly on ground, and not anchored.

The method of storing refuse in campgrounds is surprisingly clear-cut between correct and incorrect storage. Fifty-seven per cent of the campgrounds and picnic waysides have correct storage of refuse. There are two common methods of storage in Alaskan campgrounds which illustrate correct storage. The U.S. Forest Service uses metal cans with liners and lids. The cans are stored off the ground and secured with a wooden frame. The State Division of Parks and the Highway Department use metal cans with lids and liners. The cans are attached to a metal rod which anchors the container and keeps it off the ground.

The incorrect storage of refuse is practiced in 43 per cent of the campgrounds. The most common method to illustrate this type of storage is the use of 55 gallon drums with and without liners stored directly on the ground without any lids or anchored in any way. This not only attracts bears, rodents, and dogs, but it also serves as a breeding ground for flies and insects. Open refuse containers promote littering and cause nuisance problems.

Solid waste from campgrounds in Alaska is basically collected in two ways. The method most often used is collection with an open pickup or stakebed truck. Another method, which is primarily employed by the Alaska Division of Parks personnel, is collection of solid waste with a packer-type truck.

Both of these methods are satisfactory if liners are used to prevent scattering of refuse. The packer-type truck is more advantageous than the open pickup or stakebed truck because it does compact the refuse, thereby reducing the volume, and it completely encloses the refuse, eliminating scattering of refuse.

Administratively, collection is handled by private contractors and/or personnel of the responsible agency. The Alaska Division of Parks is under contract to collect solid waste for Highway Department rest areas along the Alaska, Richardson, Glenn, Denali, and Edgerton Highways.

The normal frequency of collection is twice weekly except on holidays and in heavy use areas. Solid waste is then collected three times a week. Observations by the author indicate that the collection frequency of solid waste in Alaskan campgrounds is adequate for normal use. Campgrounds generally were not littered nor were the collection containers overflowing.

The solid waste from campgrounds is almost without exception disposed of in open dumps. Some of the dumps are operated by local government units, others are operated by personnel from the Federal and State agencies involved, and a few are privately operated. Personnel of these agencies admit to frequent fires at these dump locations which is, of course, a violation of air pollution laws. This method of solid waste disposal in Alaskan campgrounds is probably the major solid waste problem. Disposing of solid waste in open dumps is not recognized by either state or federal laws as an approved method of disposal. Responsible officials in the agencies involved with campgrounds should initiate solid waste management programs which meet existing requirements.

Disposal of solid waste in open dumps from recreational areas operated by the state, federal, and local agencies sets an unacceptably bad example. A study conducted by the Environmental Protection Agency (Spooner, 1971) in National Forest Recreation areas found no land disposal sites that conformed to local standards where they existed. The study further reported that an average of less than 4 per cent of the money appropriated for solid waste was used to finance final disposal. About one-half of 22 National Forest Districts surveyed reported no expenditure for final disposal.

Miscellaneous

Individual Sites:

Individual sites in campgrounds were evaluated relative to location, size, drainage, surfacing, and general layout. On this basis, 44 per cent were rated as excellent; 35 per cent were rated as fair; and 21 per cent were rated as poor.

Drainage:

The drainage characteristics of the campgrounds were evaluated with respect to slope of land and nearness to flood plain. About 65 per cent of the campgrounds surveyed are located on high, well drained ground and not in proximity to a flood plain. There are 26 per cent of the campgrounds located in areas subject to flooding, with high ground water tables and poor drainage. Approximately 9 per cent of the campgrounds are located in swampy areas or in a definite flood plain. Some of these campgrounds suffer yearly flooding resulting in sewage systems polluting ground and surface waters.

Sanitary Station:

A sanitary station is defined by Michigan Campground Regulations (MDPH, 1970) as a facility where recreational units equipped with fresh water storage tanks and sewage holding tanks can be serviced. The author found only two such facilities located in Alaskan campgrounds. Since approximately 50 per cent of the recreational vehicles noted in this survey had holding tanks for sewage, it indicates a substantial need to increase the number of these facilities. The present situation promotes the indiscriminate dumping of sewage along highways, in recreational areas, and in lakes and streams.

CHAPTER V: ECONOMIC CONSIDERATIONS

The acquisition of a potable water supply for campgrounds in Alaska is difficult due to the variability in quality and quantity of water throughout the state. The remoteness of the majority of campgrounds in Alaska necessitates this acquisition by a system which does not require a power source. Therefore, the alternatives for acquiring water are limited to shallow wells, infiltration galleries, and hauling water. Although a water treatment plant would give the best quality water, it would not be practical because of power needs, operation requirements, high cost, and extensive maintenance.

Table 22 gives an analysis of the expected capital and operation cost for acquiring water by wells, infiltration galleries, and hauling water.

The cost analysis for a typical well was largely obtained from information supplied by the Alaska Division of Parks. Information on the cost of infiltration galleries was not so easily obtained. The requirements for infiltration galleries were largely acquired from Feulner (1964) and personal communication with Guymon (1972). The cost data used for constructing this analysis were acquired from Fairbanks merchants.

The cost data for hauling water was estimated using prices quoted by Pioneer Wells in Fairbanks. Pioneer Wells does not haul water beyond 20 miles from Fairbanks, therefore, it was necessary to estimate the additional cost incurred for greater distances.

It is readily seen from Table 22 that hauling water for campgrounds is not an economical alternative. The comparable cost between wells and infiltration galleries is such that infiltration galleries should be given increased attention as a method of obtaining potable water for campgrounds.

Feulner (1964) notes that infiltration galleries cost appreciably less to maintain than surface water intakes, and are easy to construct, require small capital outlay, and can be expanded with ease to meet additional vol-

TABLE 22: SEPARABLE COST OF ACQUIRING WATER

Well	
Initial Capital Cost:	
Mobilization and Demobilization	$ 250.00
Drilling Hole - 110 ft. @ $11.50/ft	1,265.00
Steel Casing - 110 ft. @ $4.00/ft	440.00
Test Pumping and Developing, 7 hours @ $25.00/hr	175.00
Installation of Hand Pump and Assembly and Grouting	525.00
Miscellaneous and Contingencies	700.00
Total Capital Cost	$ 3,355.00
Annual Operating Cost:	
Maintenance	$ 500.00
10-Year Amoritization @ 6% per annum	456.00
Total Annual Operating Cost	$ 956.00
Infiltration Gallery	
Initial Capital Cost:	
Galvanized, perforated steel pipe, 30 feet long by 2 feet diameter @ $5.10/ft	$ 153.00
22 cubic yards of graded gravel @ $4.55/yd	100.00
Installation of Hand Pump and Assembly with Concrete Base	600.00
Backhoe - $25.00/hr for 6 hours	150.00
Labor - 24 hours @ $6.00/hr	144.00
Miscellaneous and Contingencies	600.00
Total Capital Cost	$ 1,747.00
Annual Operating Cost:	
Maintenance	$ 500.00
5-Year Amortization @ 6% per annum	415.00
Total Annual Operating Cost	$ 915.00

continued on next page

TABLE 22: SEPARABLE COST OF ACQUIRING WATER, Continued:

Hauling Water

Initial Capital Cost:	
3000-gallon Steel Storage Tank	$ 775.00
Pump Installation and Assembly	500.00
Miscellaneous and Contingencies	400.00
Total Capital Cost	$ 1,675.00
Annual Operating Cost:	
Maintenance	$ 500.00
Hauling Cost - 3000 gallons twice per month @ $.05/gal	1,200.00
10-Year Amortization @ 6% per annum	230.00
Annual Operating Cost	$ 1,930.00

Cost Comparison

	Capital	Annual
Well	$ 3,355.00	$ 956.00
Infiltration Gallery	$ 1,747.00	$ 891.00
Hauling Water	$ 1,675.00	$ 1,873.00

ume requirements

In computing the economic analysis for a well, infiltration gallery, and hauling water, it was necessary to make several assumptions. The depth of the well, feet of casing, and hours of pumping and developing time were based on information supplied by the Alaska Division of Parks. The typical well used for the cost analysis represents the average characteristics from 20 wells. The 10-year amortization for a well is based on personal observation and communications with campground personnel.

The assumptions made for computing cost data for an infiltration gallery were volume requirements and a 5-year amortization. The assumption on volume requirements was made after consulting with Guymon (1972). The 5-year amortization period is based on Feulner's report (1964) and the unpredictability of winter conditions on infiltration galleries.

The only assumption used in the cost analysis for hauling water is the 10-year amortization period on the steel storage tank and pump assemblage. This is based on personal observation and communications with campground operators and Fairbanks merchants.

CHAPTER VI: PROPOSED STANDARDS FOR RECREATIONAL AREAS

Generally, standards for environmental quality are not always applicable to the unique situations in recreational areas. It is the author's intent to indicate the type of standards which are appropriate for recreational areas in Alaska. These standards are to include water quality, sewage disposal, and solid waste handling.

Water Quality

Water quality in recreation areas is important for aesthetics, domestic use, recreational use, and aquatic life.

Aesthetics:

1. Water quality should not be impaired by the presence of materials, or their effects, which are offensive to the sense of sight, smell, taste, or touch (ADEC, 1972).

2. The aesthetic values of unique or outstanding water should be recognized and protected (NTAC, 1968

Domestic Use:

Water quality for domestic purposes should meet the U.S. Public Health Service Drinking Water Standards (USPHS, 1962) except for the following additions from the Alaska Water Quality Standards (ADEC, 1972):

1. Color - true color less than 15 color units (ADEC, 1972)
2. Temperature (°F) - below 60°F
3. Dissolved Inorganic Solids - total dissolved solids from all sources should not exceed 500 mg/l.

Recreational Use:

There are only a limited number of Alaskan lakes and streams that are suitable for total body contact. Therefore, recreational water quality standards should be classified as total body contact or partial body contact.

Total Body Contact: Classification for activities such as swimming, water skiing, and skin diving:

pH	6.0 to 8.5 (NTAC, 1968).
Turbidity	below 25 JTU, except when natural conditions exceed this figure, effluents may not increase the turbidity (ADEC, 1972).
Fecal Coliform	log mean of 200/100 ml based on 5 samples per month (NTAC, 1968).
Toxic Substances	below concentrations found to be of public health significance (ADEC, 1972).

Partial Body Contact: Classification for boating, fishing, hunting, and trapping:

1. Waters for this use should be free from obnoxious floating or suspended material, foul odors, and the water should be free of substances which are dangerous to swallow (McGauhey, 1968).

2. An average fecal coliform density not to exceed 2000 fecal coliforms per 100 ml (NTAC, 1968).

Aquatic Life:

Standards for aquatic life in recreational areas are not applicable to the Alaskan situation except that species available for harvest should be fit for human consumption (NTAC, 1968).

Sewage Disposal Standards

As stated previously in this report, the primary methods of sewage disposal are the pit privy, vault privy, and a few septic tank systems.

Pit Privy:

1. The pit should be of such capacity that it may be used for several years, unless pumping of pit contents is planned.

2. The privy should be designed and constructed so that the pit can be maintained fly tight and rodent proof.

3. The pit privy should be located to minimize the danger of contaminating surface or ground water sources. The unit should be located a minimum of 100 feet from a well, spring, or cistern and 50 feet from a lake or stream. The bottom of the pit shall not be less than 2 feet above the high ground water table (MDPH, 1970).

4. The privy should be constructed of such material as to prevent rapid deterioration.

5. The unit should be properly vented to provide for a continuous escape of odors.

6. A privy for each sex should be provided for every 15 camping units.

Vault Privy:

1. The vault privy should be constructed of concrete materials.

2. Vaults must be made water-tight to keep ground water from entering or leakage of the contents into the ground water.

3. A readily accessible clean-out trap should be provided for scavenger operators to pump the contents of the vault.

4. Vault privies should be frequently checked to prevent overflowing

and pumped prior to the development of a nuisance condition.

5. The pumped contents of a vault privy shall be disposed of in a public sewer system, or in such a manner approved by the appropriate authorities.

Septic Tanks:

All septic tank systems should conform to the guidelines set forth in the "Manual of Septic Tank Practices," U.S. Public Health Service (USPHS, 1967). The permafrost conditions in Alaska are a governing factor as to whether or not this system should be used.

Solid Waste

Standards for the storage, collection, and disposal of solid waste are common in the United States. Alaska has a proposed state-wide standard which is expected to be implemented. The following proposed standards are not new or unique, but they do need increased emphasis in recreational areas as evidenced by the findings of this project.

Storage:

1. Storage of solid waste should be in water-tight, durable, easily cleanable containers with handles and tight-fitting lids.

2. Containers should be off the ground on a rack or on a cement slab.

3. Containers should be effectively anchored to discourage bears, dogs, and other animals.

4. Containers should be of adequate capacity and of sufficient numbers to hold the solid waste that accumulates between collections.

5. It is highly recommended that plastic liners be used in conjunc-

tion with the storage container. Liners increase collection efficiency and reduce the time spent in cleaning of storage containers.

Collection:

The normal frequency of collection in Alaskan campgrounds is twice weekly. The author observed this to be adequate for the Alaskan situation. Therefore the following standards are recommended:

1. Twice weekly collection.
2. Trucks with dump or fixed-type water-tight bodies that can be easily loaded (USPHS, 1966).
3. Trucks can be of open stakebed type provided plastic liners are used.
4. Packer-type trucks shall be used when plastic liners are not used, and are highly recommended when volume of solid waste is large or the hauling distance is such to justify the increased cost of equipment.

Disposal:

The method most used in Alaskan recreational areas and one of the most unsatisfactory methods of solid waste disposal is the open dump. Open dumps should be avoided due to problems of air pollution, odors, fly breeding, rodent infestation, water pollution, fire hazard, smoke problems, and depreciation of the value of adjacent property. It is the author's understanding that the State of Alaska is currently developing regulations for solid waste disposal which would eliminate the open dump. In lieu of concrete regulations, the following recommendations are made which would be applicable to Alaskan recreation areas:

Municipal System: If a satisfactory system exists in the nearby community, it is probably the most economical approach to the problem.

Sanitary Landfill: In contrast to the open dump, a sanitary landfill is a method of disposing of solid waste on land without nuisance, fire, or public health hazard.

The general requirements for a sanitary landfill are:

1. An engineering survey made in order to provide data for the planning of access roads and ground and surface water drainage and control. The study should also determine soil characteristics and lift height and should estimate the life of the site.

2. An all-weather road on the site and a vehicle turn-around, if necessary.

3. An all-weather road to the site.

4. Measures to prevent paper scattering.

5. Appurtenances for aesthetic reasons, such as earth berm or solid fence around the site to screen the activities.

6. Facilities for storing and servicing equipment.

7. Facilities for workmen.

8. Scales to weigh refuse in determining cost and improving management practices.

9. Utilities, communications, and fire fighting equipment.

10. Continual compaction and covering with a minimum of a six inch blanket of compacted earth daily.

11. Final cover should be a minimum of two feet of compacted earth.

Modified Landfill: For most recreation areas, the requirements of maintenance, equipment, and personnel for a sanitary landfill are economically prohibitive. A variation of a sanitary landfill, sometimes referred to as a modified landfill, is recommended for most recreational areas. The modified version of a sanitary landfill requires less maintenance, personnel, and equipment than does a sanitary landfill.

A modified landfill operation normally does not require daily maintenance, facilities for equipment and personnel, and daily earth cover. An earth cover is required only a few times a year or probably two or three times in the course of a recreational season. Any solid waste management plan should always have the approval of the Alaska Department of Environmental Conservation.

CHAPTER VII: RECOMMENDATIONS AND CONCLUSIONS

The following recommendations and conclusions are based on the results obtained from evaluating the water quality in Alaskan Campgrounds:

1. It is the opinion of the author that further research on water quality in Alaskan campgrounds is unnecessary. The research effort involved in this project pointed out inadequacies in campgrounds which do not need further research. Information on water supplies, sewage systems, and solid waste disposal is more than adequate to correct the deficiencies found in the campgrounds.

2. It is further recommended that campground operators and regulatory authorities cooperate in the planning and development of further campgrounds.

3. The most pressing need is the provision of a drinking water supply to all campgrounds.

4. Water which generally meets the U.S. Public Health Service Drinking Water Standards is found at only 42 per cent of the campgrounds and picnic waysides surveyed.

5. The water quality of wells and springs is generally acceptable for domestic uses, except for the problems caused by excessive concentrations of iron in most well water.

6. The surface water quality in campgrounds is unacceptable for drinking water and the streams are generally unacceptable for total body contact recreation.

7. Many of the sewage disposal systems are inadequate, poorly maintained, and polluting the ground and surface water.

8. Only two sanitary stations are located in Alaskan campgrounds.

9. The majority of the solid waste generated from campgrounds is disposed of in unacceptable open dumps.

10. The solid waste storage practices in many campgrounds are unacceptable.

11. The location and condition of many campgrounds does not conform to recognized environmental health practices.

12. Enforcement of state standards relative to well construction, water quality, sewage disposal, and solid waste is often lacking.

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APPENDICES

APPENDIX I - QUESTIONNAIRE RESULTS

Appendix I represents the data collected at the origination of this project in 1968. The content and interpretation of this data is largely the work of Joseph E. Hoffman (1971).

Campgrounds

Name	Region[1]	Administering Agency[2]	No. of Interviews
Auke Village Campground	Southeast	FS	1
Chilkoot Lake Wayside	Southeast	ADL	9
Circle City Campground	Interior	City	6
Dry Creek Wayside	Interior	BLM	1
Eagle River Wayside	Anchorage-Palmer	ADL	3
Fielding Lake Wayside	Interior	BLM	3
Ketchum Creek Campground	Interior	BLM	2
Liberty Falls Wayside	Interior	BLM	4
Little Nelchina Wayside	Interior	BLM	1
Long Lake Wayside	Anchorage-Palmer	ADL	1
Matanuska Glacier Wayside	Interior	ADL	1
Matanuska River Wayside	Anchorage-Palmer	ADL	4
Mendenhall Lake Campground	Southeast	FS	3
Moose Creek Wayside	Anchorage-Palmer	ADL	1
Morino Campground	Interior	NPS	2
Ohmer Creek Campground	Kenai	BSFW	1
Sanctuary River Campground	Interior	NPS	4
Savage River Campground	Interior	NPS	3
Settlers Cove Campground	Southeast	FS	7
Signal Creek Campground	Southeast	FS	10
Wonder Lake Campground	Interior	NPS	7
Wrangell Picnic Ground	Southeast	City	2

[1] *Alaska Recreation Guide*. Bureau of Land Management, U.S. Department of the Interior.

[2] BLM: Bureau of Land Management
ADL: Alaska Division of Lands
NPS: National Park Service
FS: U. S. Forest Service
BSFW: Bureau of Sport Fisheries and Wildlife

APPENDIX I

Summary of Campgrounds

Region	Number of Campgrounds	Number of Interviews	Average Number of Interviews per Campground
Anchorage-Palmer	4	9	2.25
Interior	11	34	3.09
Southeast	6	32	5.33
Kenai	1	1	1.00
Total	22	76	3.45
Agency			
Alaska Division of Lands	6	19	3.17
U. S. Forest Service	4	21	5.25
Bureau of Land Management	5	11	2.20
National Park Service	4	16	4.00
City	2	8	4.00
Bureau of Sport Fisheries and Wildlife	1	1	1.00
Total	22	76	3.45

Interviews and Interviewee Residence

The first interview was made on June 18, 1968 and the last interview on August 16, 1968. Almost half of the interviews were in August. Friday and Saturday were the biggest interview days, with 24 and 25 parties interviewed respectively.

Alaska resident parties comprised 39 per cent of the total number. The other parties were fairly evenly divided between 23 other states, the District of Columbia, and Canada, with the exception of California, which furnished 13 per cent of the parties.

Interviews by Day of Week

Sunday	16
Monday	0
Tuesday	2
Wednesday	1
Thursday	8
Friday	24
Saturday	25

APPENDIX I

Interviews by Month and Day

June:		July:		August:	
Sunday	3	Sunday	11	Sunday	2
Monday	0	Monday	0	Monday	0
Tuesday	0	Tuesday	0	Tuesday	2
Wednesday	0	Wednesday	0	Wednesday	1
Thursday	0	Thursday	3	Thursday	5
Friday	2	Friday	3	Friday	19
Saturday	12	Saturday	9	Saturday	4
Total	17	Total	26	Total	33

Place	Number of Parties
Alaska	30
California	10
Illinois	3
Washington	3
Colorado	3
Arizona	2
Indiana	2
Missouri	2
New Jersey	2
Connecticut	2
Canada	2
Oregon	2
Minnesota	2
New Mexico	1
New York	1
Maine	1
District of Columbia	1
Utah	1
Maryland	1
Pennsylvania	1
Ohio	1
Wisconsin	1
Michigan	1
Florida	1
Total	76

Purpose of Trip

A large majority of the parties were on vacation. Other reasons given by Alaskans for purpose of trip were fairly evenly scattered between work, picnic, and day off, with the exception of 10 per cent who were in the process of moving. For visitors, other reasons for the trip were associated with their work.

Alaskans

Purpose	Number of Parties	Percent
Vacation	21	70
Moving to Alaska	3	10
Business Trip	1	3
Work	1	3
Picnic	1	3
Day Off	1	3
Live Here	1	3
Birthday Party	1	3
Total	30	

Visitors

Purpose	Number of Parties	Percent
Vacation	41	89
Army	1	2
Research	1	2
Field Work	1	2
Work	2	4
Total	46	

Length of Trip in Alaska

Most Alaskans did not answer the question on length of trip in Alaska. Of the eight parties that did answer, half traveled 600 miles or less and the other half traveled from 1,000 to 2,000 miles. Most visitors answered the question and the average was 2,067 miles. Over half the parties, however, traveled 1,500 miles or less in Alaska. Only five parties traveled more than 3,500 miles.

	Number of Parties	
Miles	Visitors	Alaskans
no answer	11	22
less than 700	11	4
700 to 1,500	9	2
1,501 to 2,000	4	2
2,001 to 3,500	6	--
greater than 3,500	5	--
Total	46	30

APPENDIX I

Nights Spent in Commercial Lodgings this Trip

Only 13 visitor parties (non-Alaskans) reported they stayed in commercial lodgings on this trip. Over half of the parties stayed three nights or less. All but one party stayed only seven nights or less. Average number of nights, excluding the 60 night party, is 3.3 nights.

Number of Nights	Number of Parties
1	3
2	3
3	1
4	1
5	1
6	2
7	1
60	1
	13

Total Time Spent at Alaskan Campgrounds

Alaskans stayed in campgrounds just over half as long as visitors, 13 days compared with 22 days. For visitors, 39 per cent of the parties spent 30 days or more in campgrounds while, for Alaskans, 20 per cent of the parties spent that much time in Alaskan campgrounds.

	Number of Parties	
Number of Days	Visitors	Alaskans
1	1	8
2	0	1
3	1	2
4	1	1
5	3	0
6	1	1
7	3	2
8	1	0
9	1	0
10	3	4
12	2	0
14	2	1
15	2	2
18	1	0
20	3	1

APPENDIX I

Number of Days	Number of Parties: Visitors	Number of Parties: Alaskans
21	2	1
25	1	0
30	10	3
35	0	1
40	4	0
45	2	1
60	1	1
90	1	0
Total Parties	46	30
Average Stay	22 days	13 days

Nights Spent in Campgrounds on This Trip

Visitors stayed in campgrounds an average of 22.7 nights and Alaskans stayed an average of 4.3 nights, not including one party which stayed 200 nights. All but one party of Alaskans stayed less than two weeks while over half the visitors parties stayed 20 nights or more.

Visitors: No. of Nights	Visitors: No. of Parties	Alaskans: No. of Nights	Alaskans: No. of Parties
1	2	1	2
2	1	2	6
3	1	3	1
4	3	6	2
6	1	7	2
7	2	10	1
9	1	12	1
10	2	200	1
11	1		16
14	2		
15	1		
16	1		
18	1		
20	2		
21	1		
27	1		
28	1		

Visitors

No. of Nights	No. of Parties
30	5
40	2
43	1
60	2
62	1
90	1
	36

Total Nights Away from Home This Trip

For visitors the average trip was 31 nights. For Alaskans, the average trip was 18 nights, but when one party who spent 200 nights away from home is excluded, the average drops to 6 nights. Half of the Alaskan parties were away 3 nights or less. Half of the visitors were away from home less than 30 days.

Visitors

No. of Nights	No. of Parties
1	1
2	1
4	2
6	2
7	1
13	1
21	4
28	2
34	1
35	2
42	1
45	1
60	5
62	1
75	1
No answer	20
	46

Alaskans

No. of Nights	No. of Parties
1	2
2	5
3	1
6	1
7	3
10	1
12	1
30	1
200	1
No answer	14
	30

APPENDIX I

Total Time at This Campground

Most Alaskans did not stay over three nights at the campground where the interview took place. The average stay (not counting those who did not answer) was 3.5 days. Visitors stayed longer with an average stay of 6.5 days at that campground. One night stays were the most popular, being twice as common as two night stays.

	Number of Parties	
Number of Days	Visitors	Alaskans
1	4	7
2	14	3
3	7	6
4	6	6
5	4	1
6	3	1
8	3	--
9	1	--
11	--	1
15	--	1
21	1	--
45	1	--
80	1	--
No answer	1	4
	46	30

Purpose for Using Campground

As expected, both visitors and Alaskans used campgrounds primarily for sleeping places. Picnicking and rest stops were the second and third most popular reasons for staying in the campground for both visitors and Alaskans.

	Number of Parties	
Purpose	Visitors	Alaskans
Picnicking	13	10
Rest Stop	13	7
Base for Fishing	8	4
Base for Hunting	--	--
Base for Boating	4	--
Sleeping Place	31	13
Other	11	3

APPENDIX I

Camping Facilities Used

Tents were the most common facility used by Alaskans, followed by campers. However, approximately one-sixth of the parties used no facilities. For visitors a camper was the most popular facility, closely followed by tents and trailers.

	Number of Parties	
Type	Visitors	Alaskans
Tent	13	12
Camper	16	7
Trailer	13	2
Car Equipped	8	1
None	--	5
No Answer	--	3
Other	2	--

Sources of Water

A majority of the parties, both visitors and Alaskans, carried their own drinking and cooking water. For visitors who carried their own drinking water, the two greatest sources were gas stations or another campground. For Alaskans, the greatest source was from home.

	Number of Parties	
	Visitors	Alaskans
Drinking water obtained		
From well at campground	2	8
From lake at campground	0	1
Carrying own water	28	19
Other	0	1
If carrying water, obtained		
Gas station	14	7
Lodge	2	0
From home	8	14
Other campground	13	3
Other	4	0
Cooking water obtained		
Are you cooking at campground?		
Yes	45	25
No or no answer	1	5

	Number of Parties	
	Visitors	Alaskans
If cooking, water was obtained		
From well at campground	16	7
From lake at campground	0	1
From stream at campground	8	4
Carrying own water	23	17
Other	2	0

Facilities Used or Needed at Campgrounds

The standard facilities found in campgrounds, such as tables, trash cans, rest rooms, camping space, and water were either in short supply, inadequate, or totally missing for some parties. Water for consumption was the facility most often missing. Forty three per cent of the visitor parties and twenty seven per cent of the Alaskan parties said water facilities were needed. For visitors, firewood and cooking shelters were next on the list of facilities needed. For Alaskans, firewood, cooking shelters, boat ramps, and camping space all tied for the second most needed facility.

	Number of Parties	
	Visitors	Alaskans
Facilities Needed		
Fireplace	3	1
Firewood	9	2
Water for consumption	20	8
Boat ramp	3	2
Cooking shelter	8	2
Camping space	1	2
Restrooms	3	1
Picnic table	1	--
Showers	2	--
Facilities Used		
Picnic table	35	18
Trash barrel	39	20
Restrooms	34	26
Camping space	37	16
Fireplace	28	15
Firewood	30	10
Water for consumption	27	8
Boat ramp	3	0
Cooking shelter	0	0
Parking space	1	3

APPENDIX II - DATA COLLECTION FORMS

RECREATION WATER QUALITY SURVEY
UNIVERSITY OF ALASKA
COLLEGE, ALASKA

DO NOT WRITE IN THIS SPACE

Campground name and location:______________________________

____

Agency:______________________________

Date of Interview: Month______________ Day______________
Day of Week______________ Year______________ Time______________

By:______________________________

(BEGIN COMPLETINN QUESTIONNAIRE AT THIS POINT)

How many people are in your party?
Male Adults______________ Male Children______________
Female Adults______________ Female Children______________
Total______________

What is the occupation of the head of your party?______________
Employer:______________ Position:______________

Where is your permanent residence?
City:______________ State or Province:______________

What is the purpose of your trip?
1. Vacation:______
2. Primarily to visit friends or relatives in Alaska:_____
3. Moving to Alaska:________
4. Other (please.specify):______________________________

APPENDIX II

What is the total time you plan to spend at Alaskan Campgrounds this year? (Include time you have already spent):________________(days)

What is the total time you plan to spend at this campground? (Include time you have already spent).

Not spending the night:________

One night or more (number of days):________________

What will be the total length of your trip in Alaska?________(miles)

What type of camping facilities are you using?

1. Tent:_____
2. Camper:_______
3. Trailer of camping trailer:_______
4. Car equipped for sleeping:_______
5. None:_____
6. Other (please specify):_______

How many nights have you spent on this trip?

1. In commercial lodging:________
2. In campgrounds:_______
3. Total away from residence:________

Please rank your purpose or purposes for using this campground. (1 for the most important, 2 for a lesser purpose, etc.)

1. Picnicking:_______
2. Rest stop:_______
3. As a base for fishing:_______
4. As a base for hunting:_______
5. As a base for boating:_______
6. Sleeping place:_______
7. Other (please specify:_______

APPENDIX II

Place an X next to the facilities listed below that you used at this campground. (Some of the below may not be present at this location.)

1. Picnic table:______
2. Trash barrel:______
3. Restrooms:_____
4. Camping space:_____
5. Fireplace:_____
6. Firewood:______
7. Water for consumption:_______
8. Boat ramp:_____
9. Cooking shelter:____

Place an X next to the facilities listed below that you believe are needed, but not present at this campground.

1. Picnic table:______
2. Trash barrel:______
3. Restrooms:_____
4. Camping space:_____
5. Fireplace:_____
6. Firewood:______
7. Water for consumption:_______
8. Boat ramp:_____
9. Cooking shelter:____

Where did you obtain the water you are using for drinking purposes?

1. From well at campground:______
2. From lake at campground:______
3. From stream at campground:____
4. Carrying our own water:______
5. Other (please specify):______

If you are carrying your own water, where did you obtain it?

1. Gas station:_______

2. Lodge:________
3. From home:_____
4. Other campground:________
5. Other (please specify):_______

If you are carrying your own water, in what type and size container are you transporting it?____

Are you cooking at the campground?

Yes:________________________________ No:________________________________

If you are cooking at the campground, where do you obtain the water used for cooking?

1. From well at campground:______
2. From lake at campground:______
3. From stream at campground:____
4. Carrying own water:______
5. Other (please specify):_______

Place an X next to the work that best describes the quality of the water that you are using.

1. Excellent:_____
2. Good:_____
3. Adequate:______
4. Fair:_____
5. Poor:_____

If you are using water from campgrounds, please estimate the distance of the water source from where you are located. ________________________________

Do you think the water source is near enough?

Yes:________________________________ No:________________________________

APPENDIX II

Non-residents only: How did you come to Alaska?

1. Alaska Highway:_____
2. Inside Passage:_____
3. Air:_____

APPENDIX II

UNIVERSITY OF ALASKA
INSTITUTE OF WATER RESOURCES
FAIRBANKS, ALASKA

Date:______________________ Agency:______________________

Campground Name:____

Location:____

No. of Units:____________________ Weather:____________________

Body of Water:__________________ Investigator:________________

Number of Campers: Tent____________, Travel Trailers:___________

Pick-Up Camper:_________, Motorhome:_________, Bus Type:_________

Other:____

Water Supply: Yes:____________ No:____________ (for consumption)

Type:______________________ Isolation:______________________

Depth:_____________________ Construction:___________________

Toilet Facilities: Type_______________ Location:______________

Number: (Men):__________ (Women):__________ Construction:________

______________________ Maintenance:___________________________

Final Disposal:____

Garbage and Rubbish: Storage:_________________________________

Maintance of Storage Containers:______________________________

Final Disposal:____

Site: Picnic Table:________ Firewood:________ Trash Barrel:________

Fire Place:__________ Other:___________________________________

Condition of individual sites:________________________________

____

General: Picnic Area:_______________ Condition:_______________

Roads:______________________ Drainage:_______________________

Boat Ramp:__________________ Other (specify):________________

Remarks:____

____

APPENDIX II

CAMPGROUND WATER SUPPLY
CHEMICAL ANALYSIS

Name of Campground: ______________________________

Date: ______________ Investigator: ______________

Type: ______________ Source: ______________

Distance to Nearest Source of Pollution: ______________

Chloride (ppm as Cl): ______________

Total Hardness (ppm as $CaCo_3$): ______________

Iron (ppm): ______________

pH: ______________

Turbidity: ______________

Temperature: ______________

APPENDIX II

CAMPGROUND - SURFACE WATER

Name of Campground: ____________________

Source: ____________________ Date: ____________________

Time: ____________________ Location: ____________________

Investigator: ____________________

Water Temperature: __________ Depth: __________ Width: __________

Turbidity: Turbid Slightly turbid Clear Evidence of Sewage Septic

Color: ____________________ Odor: Offensive Strong Light None

Bottom: Sand Gravel Silt Clay Rocky Sludge

Vegitation: Weeds Algae Fungi

Fish Life: Yes: _____ No: _____ Species: ____________________

Weather: Clear Partly cloudy Cloudy Rain

Nearest Source of Pollution: ____________________

Distance to Source of Pollution: ____________________

Use of Frontage: Water supply Public parking Bathing Fishing