OF 53-257

13

July 21, 1953

Acting General Manager
The Alaska Railroad
United States Department of the Interior
Anchorage, Alaska

Dear Sir:

In response to a request from Col. J. P. Johnson, General Manager of The Alaska Railroad, dated November 25, 1952, Mr. F. W. Trainer of the Ground Water Branch of the U. S. Geological Survey made a brief examination of the geology, with particular respect to water supply, at several sites along the railroad. The localities mentioned by Col. Johnson were Hunter, Portage, Girdwood, McKinley Park, and Dunbar. Information regarding a sixth locality, Bird, was later requested informally. Mr. Trainer accompanied Mr. John Fouch of The Alaska Railroad Engineering Department to Portage, Girdwood, and Bird on June 1, 1953. Other field visits were made as follows: Girdwood, April 11; Dunbar, May 21-22; McKinley Park, May 22-23; Hunter, June 3-4; and Bird, June 7.

As noted in the attached memorandum by Mr. Trainer, information obtained during these field visits suggests that pure and adequate water supplies are readily available at Hunter and Girdwood, where drilled wells will probably be most suitable, and at Dunbar, where the existing source can be improved. It is believed that the existing surface supply at McKinley Park can be improved, at least as a temporary measure, but that test-drilling for a ground-water supply is justified. Drilling at Portage is considered justified, as is digging or drilling at Bird Point.

The courtesy and help extended by all railroad personnel during the course of this brief investigation is greatly appreciated.

Very truly yours,

R. J. Cederstrom
District Geologist

Encl. 1

WATER SUPPLY AT SIX LOCALITIES ON THE ALASKA RAILROAD [1]

By

Frank W. Trainer
Geologist
Ground Water Branch
U. S. Geological Survey

INTRODUCTION

In response to a request from the General Manager of The Alaska Railroad, a brief investigation of water-supply problems at six localities along the railroad was made by the Ground Water Branch of the Geological Survey. The present memorandum describes these localities briefly and suggests possible solutions to the water-supply problems

DUNBAR

The section house at Dunbar (Mile 431.6 on The Alaska Railroad, or about 39 miles southwest of Fairbanks) is situated on the north edge of the valley floor of Goldstream Creek. The valley floor is here 1½ to 2 miles wide. Low hills flank the valley on the north and south; the hill north of (behind) the section house rises about 1,000 feet above the general level of the valley floor. The area surrounding Dunbar is drained by Goldstream Creek, which flows within a few hundred feet of the section house, and by small tributaries from the hills. The tributary closest to the section house is about 1-3/4 miles to the east.

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[1] Open-file report. Not reviewed for conformance with editorial style of the Geological Survey.

A cut behind the section house exposes 25 to 35 feet of tan silt which contains a few angular fragments of schist. Silt of a similar appearance but containing more organic material is exposed in the banks of Goldstream Creek, where it was frozen below a depth of 1 to 2 feet (May 21, 1953). Bedrock is reported to have been encountered at a depth of a few feet in an excavation for a privy at the east end of the section-house area, where blasting was necessary, and in two 1- to 2-foot auger holes north of the bunkhouse. The writer observed the rock in the auger holes, but failed to find rock nearby in two other auger holes 2 to 3 feet deep. However, because of the occurrence of bedrock in many railroad cuts along the edges of the hills farther south, near Nenana, it is reasonable to assume that the rock found at Dunbar is bedrock in place rather than transported rock fragments

Permafrost occurs in the valley of Goldstream Creek and probably extends some distance up the slopes of the adjacent hills. The maximum thickness of the permafrost here is not known. A shaft near Standard, about 7 miles east-northeast of Dunbar, is reported to have penetrated about 180 feet of frozen gravel and sand before striking frozen bedrock.

The present source of water for the Dunbar section house is a spring modified by the construction of a timbered well. The spring well measures about 7 by 6 feet in diameter at the ground surface but narrows downward because of caving of the timber cribbing. The depth of the well, as measured by steel tape, is 13.25 feet (below the top of the well cover, which is about 1 foot above the original ground w level), but probing with a pole suggests that the well was at least 1 to 2 feet deeper before being silted in.

The static water level in the well is 59 inches below the top of the well cover, or 9.5 feet above the water surface of Goldstream Creek 90 feet away (May 21, 1953). Mr. Johnson, the foreman of the Dunbar section, states that this observed static level is typical of conditions the year around.

A simple test was made by pumping water from the well into the elevated storage tank. After pumping for 40 minutes the water level declined from 4 feet 11 inches to 10 feet (below the top of the well cover). The estimated volume of the well from which the water was removed, corrected for the inward slope of the walls downward and for the volume of ice and planks in the water, is 1,300 gallons. The volume of water actually pumped into the tank, corrected for leakage of the tank, is 3,700 gallons (a pumping rate of about 93 gallons per minute). Forty-five minutes after pumping had ceased the water level had recovered to within 7 inches of static level. These facts indicate a fairly strong flow of water into the well. The writer believes that the water could not be transmitted through the silt at such a rate, and that the water is probably derived from fissures in bedrock beneath the hill. The observed temperature of the water, 35°F., is consistent with this interpretation. The high gradient of the water table from the well to the stream is attributed to the (presumed) low permeability of the silt between the hill and the stream.

Mr. John Fouch, of the Engineering Department of the Alaska Railroad, reports that in some years high water from Goldstream Creek floods the well, leading to contamination and silting. He states that two methods of improvement of the water supply have been considered: (1) construction of a second well on higher ground north of the track; and (2) construction of a concrete shaft to replace the timber cribbing of the existing well. It is possible that the location of the original spring was determined by structural conditions in the bedrock, and that an excavation to bedrock at another spot would not obtain water. It might, therefore, be necessary to drill or blast a hole into the rock to obtain water at another location, and even then obtaining water would be dependent upon intersecting fissures in the rock. The writer believes that improvement of the existing supply is preferable, and that an adequate and satisfactory water supply is readily available here.

The timber cribbing should be replaced because it is beginning to collapse and because it is not sanitary. Installation of concrete pipe (with the joints tightly sealed), followed by removal of the existing timber cribbing and by back-filling of the outer part of the hole, should be satisfactory. Mr. Johnson states that tentative plans have been made for the extension of a water line from the well to the new section house, and for a sewage-disposal line. One desirable result which would follow from the construction of new sewage facilities would be the removal of the existing privies in the section-house area. The privy at the east end of the area, for example, is only about 120 feet from the well, and is between it and the hill. If the ground water here moves through fissures in the rock, as has been suggested above, the generally-accepted minimum distance of 100 to 150 feet between a well and a cesspool or privy may not be sufficient to protect the well from contamination.

McKINLEY PARK

The McKinley Park Hotel and station (Mile 347.9 on The Alaska Railroad; about 122 miles south of Fairbanks or 234 miles north of Anchorage) are on one of several gravel-covered benches that stand above the Nenana River;

This bench is west of the river and about 200 feet above it. Mountain slopes rise west and northwest of the hotel.

Brief reconnaissance suggests that the gravel on the bench upon which the hotel is situated is locally 100 feet or more thick. At other places, however, bedrock is exposed at the surface; rock exposed about a quarter of a mile southwest of the hotel is a moderately-fractured quartzitic schist.

Permafrost is known to occur in the valleys near McKinley Park and on some of the mountain slopes, but its distribution and thickness are poorly known.

The existing water-supply installation for the hotel and other railroad facilities at McKinley Park consists of a low dam of timber and earth in a ravine west of the hotel; a 50,000-gallon concrete reservoir buried in the hill about 400 feet above the hotel; a pipeline, several hundred feet long, leading from the dam to the reservoir; and a pipeline, about 1,000 feet long, leading from the reservoir to the power plant. Water to be used as cold water continues directly into the distribution system without treatment. Water for the hot-water taps or for laundry use is softened in Permutit units. Boiler water is also chemically treated.

The difficulties encountered in using the existing water-supply system include the following: (1) icing of the stream and of the impounded water during the winter, as a result of which the water flows over or around the dam; (2) freezing of water lines between the dam and the storage reservoir, between the reservoir and the power plant, and at the overflow from the storage reservoir; and (3) poor quality of water during the period of thawing and heavy runoff in the spring. Because of the difficulty and expense of maintaining this system during the winter and particularly during very cold weather, the Railroad is desirous of finding an alternative water supply.

The only alternative to a surface supply such as that now in use is a ground-water supply from a well. It is impossible, on the basis of available information, to assess the practicability of drilling for water in the hotel area. Mr. Fouch obtained at second hand a verbal report which states that a well drilled near the power plant during the 1930's reached a total depth of about 200 feet but was dry; another report states that permafrost was encountered during drilling. The reliability of these reports could not be determined, but it seems reasonable to assume that a well drilled near the hotel might be several hundred feet deep and extend into the bedrock. A test well is the only means of determining whether a ground-water supply can be obtained. We believe that test-drilling here is justified; the Railroad has both the drill and the well-casing, and the risk would consist essentially of the cost of the labor. The disadvantages inherent in the existing water-supply system are such that a well-water supply, if it could be obtained, would be highly desirable.

Our observations do not suggest that any particular spot near the hotel would be more desirable than others as the site of a test well. In general it would appear that the chances of success become greater as the site is moved downslope from the hotel, toward the river. Against this factor must be balanced the increase of maintenance and operating costs for a well supply and distribution system at greater distance downslope from the hotel. Should drilling be carried out the following procedure might be reasonable: drill a well at the most convenient spot in the hotel area; if this well is unsuccessfull, use the geologic data and cost figures obtained from the drilling to determine whether another test well, located as far downslope from the hotel as appears possible from a consideration of probable maintenance and operating costs, is justified.

Well water should be free of silt and organic contamination, but it would probably be as highly mineralized as the water now used, or more so.

Improvement of the existing water-supply system appears to be practicable as a temporary measure. The improved supply might prove suitable as a permanent one, although the difficulties of winter operation probably could not be completely overcome.

The two chief problems in winter operation of the existing system are: (1) preventing freezing of the water lines and storage reservoir between the dam and the hotel area; and (2) maintaining a supply behind the dam.

The ideal water-distribution system in a cold environment seems to consist of a closed system in which the temperature of the water is kept above freezing and the water is circulating continuously.

The continual addition of steam to the water in the pipeline throughout the cold months should prove helpful in preventing freezing. Under existing conditions the ground in contact with the line probably freezes by late autumn; any extremely cold period thereafter is likely to cause freezing of the line unless immediate thawing is begun. We believe that keeping the water temperature a few degrees above freezing, beginning in the autumn, would keep a sufficient thickness of unfrozen ground around the line to give a margin of safety during very cold weather.

A thicker gravel fill over the pipeline and reservoir might prove helpful in protecting them from freezing. (It appears from observation that the fill over the reservoir is not more than 3 to 5 feet thick.) It is possible, however, that this added fill might be undesirable if it created a bare hill from which the wind could remove the insulating snow cover. The importance of this possibility could best be estimated by someone closely familiar with the area.

Because of the difference in altitude between the storage reservoir and the hotel area it is probably impracticable to attempt to circulate water from the power plant back to the reservoir. It would appear helpful, however, to move the waste outlet from the storage reservoir to the power plant. This would serve the dual purpose of removing a trouble spot from the reservoir (where reported freezing of the waste outlet undoubtedly effects the water in the reservoir) and of making possible at least a small continual flow through the water line below the reservoir.

The problem of maintaining stream flow into the reservoir during the winter is a more difficult one. The water that forms the icings in and along the pond and the stream above the dam probably comes from two sources: part is stream water that breaks through the ice as a result of increased hydrostatic pressure beneath the ice; part is spring water that emerges along the banks of the stream. Growth of ice in the pond and in the stream begins along the banks, and on the bottom in shallow water. It is impossible to prevent this growth of ice, but enlarging the pond in depth and area by means of a somewhat higher dam might make it easier to keep the water at the pipeline intake from freezing. Steam-thawing of ice in the pond, as has been done, might still be necessary, however. Blasting and steam-thawing of ice upstream, carried out in the past to keep water flowing in the channel, would probably also have to be continued.

It appears that chlorination of the water is most desirable because contamination is difficult to prevent in a surface supply of this sort.

The chemical quality of the water obtained from this stream cannot be improved except by filtration or chemical treatment. Clear water from springs along the banks of the stream would be an excellent substitute for the stream water even if the spring water were carried by a temporary pipeline laid on the surface and extending to the present intake, and which therefore could be used only during the late spring and summer months. The writer searched unsuccessfully for springs near the upper end of the pond, however. Springs probably do occur along the banks farther upstream, but a comparison of the length of the stream and its observed flow suggest that it is unlikely that one spring or even several together would yield a flow sufficient to supply the need.

BIRD

The Bird section house is located on the west side of Bird Point, a small peninsula on the north side of Turnagain Arm about 35 miles southeast of Anchorage. Water is now brought to the section house by railroad water car. It is reported that tentative plans had been made to move the section house and to combine this section with another, but that it is now considered desirable to keep the section house at Bird Point if a satisfactory water supply can be developed.

The bedrock at Bird Point consists of graywacke, argillite, and slate. The strike or trend of the rock beds here is about 45° east of north; the beds dip about 70° to 80° toward the northwest. The rock is moderately to conspicuously jointed and fractured. On Bird Point and on the mountain slope above it the rock on ridges and knolls has been ground smooth by glacial abrasion and now bears little or no cover of soil or other loose material. Shallow ravines that extend down the slope to Bird Point, along the strike of the rock beds, are floored with broken rock and soil whose thickness is not evident from surface inspection but which may be relatively thin. It seems likely that the ravines were eroded along the more fractured rock beds, but evidence of this was not observed in the field.

Two possibilities of developing a ground-water supply at Bird Point appear reasonable, and either or both can be tested at a relatively low cost in time and materials. A dug well can be constructed in the fill in one of the ravines at Bird Point, or a well can be drilled into the bedrock.

Of the three ravines that extend out upon the point the one at the section house appears to be the least favorable for the development of a ground-water supply. The other ravines, farther east, are larger and have more extensive areas upslope to receive moisture. This factor may not be important, however, if the fill in the lower ends of the ravines receives water from fractures in the rock. The thickness of the fill and the strength of any flow of water into it from the rock beneath or beside the ravine will probably be the determining factors in the success of a properly-constructed dug well. If none of the water in the fill comes from the adjacent rock the supply may prove inadequate during the winter and early spring. Moreover, it may be difficult to select a location for a shallow well in one of the ravines that will be satisfactory from the standpoint of sanitation, because each is crossed by the highway and the railroad. Near the present section house, for example, a dug well might have to be placed some distance southeast of the house, near the "Y" in the track. For these reasons a dug well is considered the less desirable alternative.

Small seeps observed north of the track on the east side of the point suggest that water from fractures in the rock emerges near tide level. The purpose of a well drilled into the rock here would be to intersect enough water-bearing fractures to yield an adequate supply of water, or to provide reservoir space that would accumulate water from a slower flow. It is likely that water could be obtained from the rock beneath any part of the point. Because of the possibility that the rock beneath the ravines is more fractured than that beneath the knolls and ridges, however, it appears that the most favorable location for a drilled well is along the west side of one of the ravines and a short distance uphill from the level of the floor of the ravine fill. Such a location would take advantage of the northwestward dip of the rock beds, and also should prove more satisfactory, from the standpoint of sanitation, than a location on level ground. It would therefore appear reasonable to locate a drilled well at the present site of the section house, but uphill from the house and as far as practicable from the privy.

It is possible that a well on Bird Point, and particularly a drilled well extending below tide level, would obtain salt water. We believe that the deposits of silt and clay in Turnagain Arm seal the bottom sufficiently to prevent the flow of salt water into the rock beneath the point, particularly as it is anticipated that only small quantities of water would be pumped. In the last analysis, however, it would be necessary to pump a well here in order to show that it is not affected by the salt water nearby.

GIRDWOOD

Girdwood (Mile 74.8 on the Alaska Railroad, or about 40 miles southeast of Anchorage) is on a low terrace of Glacier Creek, on the northeast side of Turnagain Arm. Glacier Creek is tidal near its mouth, and very high tides crossing the flat bordering Turnagain Arm also reach almost to the community. Observations and well logs show that the ground surface is underlain by gravel and sand. Mr. Joseph Danich states that in his well this gravel and sand is 24 feet thick; it is underlain by 8 feet of clay that contains no stones, and beneath the clay the well penetrates gravel and sand to its total depth of 45 feet. Several other wells, reported by Mr. Danich to be 30 to 40 feet deep, also supply water to the inhabitants.

Mr. Denich also reports that in three wells the static water level is above the ground surface. Mr. Feusch and the writer observed a fourth well, at the school, in which the water also stands above the surface. The artesian pressure responsible for these high water levels is reasonably explained by the confinement of water beneath the layer of clay encountered in Mr. Denich's well. This clay may have been deposited at a time when Turnagain Arm extended somewhat farther up its tributary valleys than it does at present.

It is possible that the area immediately surrounding Girdwood is underlain, not by a single layer of clay lying between layers of gravel and sand, but by a more complex sequence of clay layers interbedded with layers, lenses, and stringers of gravel and sand. Another well drilled at some distance from the existing wells might, therefore, penetrate a different sequence of materials. There seems no reason to doubt, however, that ground water in quantity sufficient for a section house is available generally in the vicinity of Girdwood.

Although the specific location of a well might be determined on the basis of convenience, it appears desirable that it be placed some distance from Glacier Creek in order to minimize the danger of inducing the inflow of salt water from the stream during very high tides.

Chemical analysis of water from Mr. Denich's well, a copy of which is attached, shows that the water is only moderately mineralized and that it contains only a trace of chloride, 3 parts per million.

PORTAGE

Portage (Mile 64.2, or about 50 miles southeast of Anchorage) is on a wide flat where the valleys of Twentymile River and Portage Creek merge at the head of Turnagain Arm. The railroad station and yards lie about half a mile south of Twentymile River, and almost as far north of Portage Creek. The ground surface near Portage is poorly drained and there are many marshy areas.

Gravel and sand are exposed in gravel pits near Portage Creek about 2 miles southeast of the station. Fine-grained material, probably chiefly silt and clay, forms the flat along Turnagain Arm to the northwest. Mr. Fouch states that, according to a verbal report whose reliability cannot be determined, a "dry hole" about 100 feet deep was drilled at Portage prior to 1935; and that, according to another report, the well passed through a considerable thickness of blue clay. These reports, together with brief observation of the area and analogy with conditions in the vicinity of Anchorage, suggest that the flat near Portage is underlain by thin deposits of gravel and sand (a few feet, or at most a few tens of feet, thick) that rest upon estuarine clay and silt laid down at a time when Turnagain Arm extended farther into its tributary valleys than it does at present.

Gravel is present beneath estuarine clay in several wells at Anchorage. One of the deeper of these wells penetrates nearly 200 feet of the clay. It is possible that deeply-buried gravel is present also in the valleys in the Portage area, because the recent geologic history here and at Anchorage have undoubtedly been similar.

The existing water supply at Portage is obtained from a small tributary of Portage Creek about a quarter of a mile southeast of the station. The water is open to contamination and, in addition, is reported by Mr. Fouch to be undesirable as boiler water. Rusty sludge observed in pools and small streams near Portage suggests that iron is being precipitated from the water on the surface.

The only alternative to an improvement of the present source is the development of a ground-water supply from a well. Test-drilling would be required to determine whether deep ground water is available and to permit determination of its chemical quality. It is impossible to predict with assurance the most promising site for drilling. The Portage station is near the axis of the valley, however, and appears to be as likely a site as any other nearby. It is also impossible, on the basis of available information, to predict the thickness of any clay in the Portage area, but it may well be even thicker than that found at Anchorage. Experience at Anchorage has shown, however, that drilling in the clay is not difficult even where a well is somewhat deeper than the average for the area.

HUNTER

Hunter (Mile 40.0, or about 74 miles southeast of Anchorage) is on a low terrace a few feet above Trail Creek. The valley floor, which is about three-quarters of a mile wide here, consists of the active alluvial plain of the stream and of terraces representing several of its older, higher levels. Mountains north and south of the valley rise 3,000 to 5,000 feet above its floor.

Trail Creek is a glacial stream. The material observed in here in its channel and in the low terrace on which the section house is built consists of sandy pebble- and cobble-gravel.

Ground water should be readily available at shallow depth almost anywhere near the section house. The water table is within a few feet of the land surface in the terrace near the house. The level of the water table here is controlled by that of Trail Creek; at present (June, 1953), the stream is high and water stands in many low spots on the terrace. Artificial springs were made by bulldozers that opened ditches and borrow pits along the track at the section house and for some distance to the west.

Water now used at Hunter is obtained from a small tributary of Trail Creek. The water is diverted from a pond in the stream by a sump and pipeline that lead to another sump beneath an elevated storage tank. Water is piped to the section house by gravity flow from the tank. The water has been reported to be contaminated on several occasions. It is unlikely that contamination of a surface-water supply here can be prevented; in spring the melt water from snow carried organic debris into the pond; during the summer and autumn debris is also present, and the pond and stream are fully exposed.

It should be practicable to develop a ground-water supply at any convenient location at Hunter. Of the two alternatives, a dug or a drilled well, the drilling well is considered much the better. Because of the high permeability of the gravel, the high ground-water level, and the possibility of flooding by Trail Creek, it would be difficult to construct a safe dug well. A drilled well could readily be sunk to a sufficient depth to afford protection from surface contamination. It is probably desirable that a drilled well be at least 20 feet deep, and preferable that it be 30 to 40 feet deep if the water-bearing gravel continues to that depth.

The most desirable location for a well is on the slightly higher ground west of the section house, because drainage from the existing cesspools and privy at the house is toward the west. A well site near the storage tank should be suitable, and would be convenient because the tank and the existing w water line to the house could be used.

UNITED STATES DEPARTMENT OF THE INTERIOR, GEOLOGICAL SURVEY
WATER RESOURCES BRANCH

ANALYTICAL STATEMENT

Location *Girdwood, Alaska*

Source *Joseph Danielsell*

Aug 11, 1953

Date of collection *April 11, 1953*			
Use		SiO_2	*7.1*
Temperature		Fe	
Color *5*	pH *6.7*	Ca	*24*
Suspended matter		Mg	*3.4*
Hardness as $CaCO_3$		Na	*2.3*
N.C. *8*	Total *74*	K	*0.8*
[illegible]		CO_3	*0*
[illegible]		HCO_3	*80*
[illegible]		SO_4	*10*
[illegible] *146*		Cl	*3.0*
TA[illegible]		F	
		NO_3	*0.4*

[illegible] A [illegible]