RESEARCH COUNCIL OF ALBERTA

REPORT 68-1

BEDROCK TOPOGRAPHY AND SURFICIAL AQUIFERS, EDSON AREA, ALBERTA

by

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ILLUSTRATIONS

BEDROCK TOPOGRAPHY AND SURFICIAL AQUIFERS, EDSON AREA, ALBERTA

Abstract

The surficial deposits in the Edson area have a complex origin. Potential surficial aquifers are found in buried-valley deposits, glacial meltwater channel deposits, glacial outwash sands, aeolian deposits, and alluvial deposits. The most significant surficial aquifer — a buried-valley aquifer consisting mainly of gravel — has been extensively investigated. The estimated 20-year safe yield of a single well located in the southeast section of Edson and completed in this gravel is 225 imperial gallons per minute; average safe yields for individual wells in a well-field development would be reduced from this figure, partly because of interference among wells and partly because the aquifer appears to have a lesser potential at other locations. The Edson buried-valley aquifer is, nevertheless, potentially a major source of water for the area.

INTRODUCTION

This investigation was undertaken as an aid to the town of Edson in its groundwater exploration program. Primary objectives were (a) delineation of course and dimensions for a major, northeast-trending, buried preglacial valley — the Edson Valley — and (b) determination of extent and thickness of permeable deposits contained in the valley. Test drilling in the east and southeast portions of the town had first demonstrated the existence of these deposits; subsequent aquifer testing had established that they had a considerable water-supply potential. If geologic and hydrologic conditions could be shown to be equally favorable for other sections of the buried valley, the availability of this supply might furnish an incentive for the establishment of light industry in the Edson area.

Shot-hole logs, which represent the great bulk of the information on which this report is based, were available for a considerable area surrounding Edson and it was thus possible to extend considerably the scope of the investigation. These shot-hole data and the knowledge gained by one of the authors (MAR) in a separate study of the surficial geology permitted the location of permeable deposits other than those contained in the preglacial Edson Valley. The result is a preliminary evaluation of groundwater potential in the surficial deposits for a relatively large area surrounding the town of Edson.

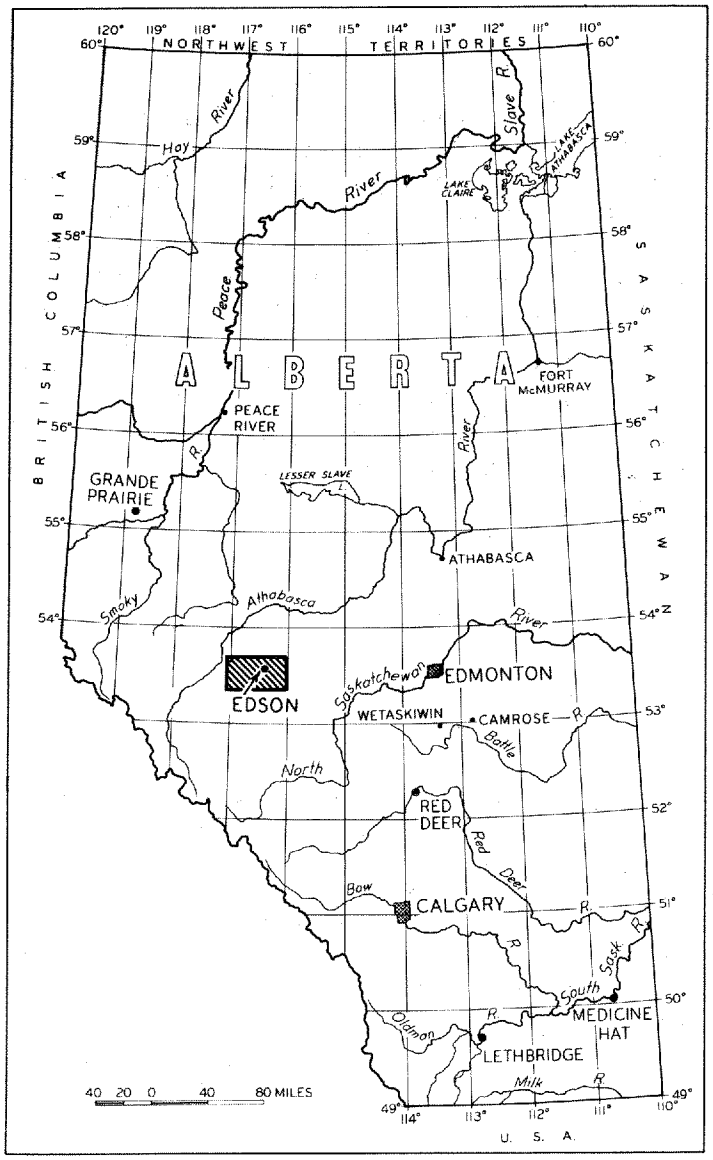

Figure 1. Location of the Edson area

The report includes two maps which indicate what are believed to be the most promising areas to explore for groundwater supplies in the surficial deposits of the Edson area. A map of the bedrock topography (Fig. 2) drawn with a 50-foot contour interval locates the main valleys on the bedrock surface. The location and interval below surface at which coarse granular deposits were encountered during drilling are also plotted on this map. The shot-hole data suggest large areas of surficial gravels. Field investigations, however (Roed, 1968), indicate that these "gravels" are, in many cases, stony tills and more information will be required to evaluate groundwater availability in these areas.

For some parts of the study area, comparison of bedrock and surface contours indicates the bedrock surface to be higher than the present-day land surface. This is particularly noticeable along the course of the Sundance Glacial Meltwater Channel (Fig. 3) where the bedrock contours (Fig. 2) should be taken to represent the preglacial position of the bedrock surface. In other parts of the study area, mapping of the bedrock surface at a higher elevation than the present-day land surface reflects the existence of large differences between shot-hole elevations as measured by oil company survey crews and as indicated by the surface contours taken from the National Topographic Series (NTS) 1:50,000 map-sheets. Bedrock contours were adjusted where this type of discrepancy was particularly serious but some anomalous areas remain.

Figure 3 shows the locations of buried valleys, glacial meltwater channels, and glacial outwash sands in the Edson area. These locations indicate important areas for exploration for groundwater supplies in the surficial deposits. The locations of glacial meltwater channels and glacial outwash sands are based on field investigation of the surficial geology of the Edson-Hinton area (Roed, 1968).

Location of Area

The area covered by this report includes townships 51 to 54 and ranges 15 to 21, west of the fifth meridian (Fig. 1). This area is part of National Topographic System map-area 83F.

Source of Information and Acknowledgments

The majority of the information used in drawing the bedrock topography map consists of seismic shot-hole logs supplied by Hudson's Bay Oil and Gas Company Limited. Supplementary data were supplied by water-well drillers' reports. Field investigations of the buried-valley aquifer at Edson provided detailed information about surficial materials and potential groundwater availability of the aquifer. This work was carried out by the Town of Edson under the direction of

W. A. Meneley and D. H. Lennox of the Groundwater Division, Research Council of Alberta.

SURFICIAL DEPOSITS

Surficial deposits in the Edson area comprise a complex assemblage of deposits which can be divided into a lower, a middle, and an upper group. A brief description of the deposits in each group is given below.

Lower Group

Deposits in the lower group, comprising mainly gravel, underlie deposits of the middle group and overlie the bedrock of the area. These gravel deposits can be divided into two units on the basis of occurrence and lithologic composition: (a) terrace gravel and (b) buried-valley gravel.

Terrace gravel is found overlying bedrock in isolated patches between the major valleys on the bedrock surface. These gravels are composed mainly of chert and quartzite pebbles with numerous pebbles of petrified wood at some localities.

Buried-valley gravel is found in the bottoms of valleys which have been eroded into the bedrock surface at bedrock surface elevations ranging from 2,700 feet in the eastern portion of the map-area to 3,350 feet in the western portion. This gravel is typically composed of a variety of sandstone, siltstone, quartzite, and limestone pebbles derived from the Rocky Mountains to the west. These gravel deposits are near the surface in areas where the present-day rivers coincide with the buried-valley locations shown on figure 2. Elsewhere they are buried by the middle and upper groups of deposits.

Middle Group

The middle group of deposits can be divided into till, glacial outwash, and glacial lake sediments. The till was deposited from two extensive ice-sheets originating in the Rocky Mountains (Cordilleran) to the west and the Canadian Shield (Continental) to the east. The Edson area is located in the junction area of these two great ice-sheets (Fig. 3). The glacial outwash and glacial lake sediments were laid down by meltwaters from these two glaciers.

Tills of both Continental and Cordilleran origin are the most common glacial deposits in the Edson area. Till of Cordilleran origin contains many more pebbles and boulders than till of Continental origin and in some cases approaches gravel in composition. The tills are mantled, however, by widespread lacustrine deposits.

Major areas of glacial outwash deposits are mapped on figure 3. Other fairly extensive deposits of outwash sand and gravel are found in the area of Sundance Creek in township 53, range 19, west of the 5th meridian.

Upper Group

The upper group of deposits is composed of aeolian sand and alluvial silt, sand, and gravel. The aeolian sand is fine to medium grained in texture and forms U-shaped dunes occupying extensive stable dune fields southwest, south, and east of the town of Edson. The sand is commonly underlain by relatively impermeable lacustrine silty clay. Alluvial silt, sand, and gravel are found mainly in abandoned terraces and abandoned meanders adjacent to the McLeod River.

MAIN POTENTIAL AQUIFERS IN THE SURFICIAL DEPOSITS

Buried-Valley Deposits

Saturated gravels in buried valleys on the bedrock surface are potentially excellent aquifers where they are extensive and at considerable depth below the surface, where the pressure head of water is high, and where their permeability is not reduced by clay lenses or the presence of large amounts of fine material.

The town of Edson presently obtains part of its water supply from one of these aquifers – the buried Edson Valley aquifer. A cross section of the materials encountered during drilling across this valley at Edson is presented in figure 4. Figure 5 is a plan view of the locations of the test holes in the cross section. The original estimated 20-year single-well safe yield* for Edson well No. 8 was 120 imperial gallons per minute based on a projection of the drawdown trend observed during the final stages of a prolonged aquifer test. Subsequent computer analysis of the test data indicated that the buried Edson Valley aquifer behaved as a bounded leaky-artesian aquifer and led to a precise estimate of the leakage factor, as well as to values for the transmissibility and storage coefficients. With these results and the geologic information concerning boundary locations, Vanden Berg and Lennox (1968) made a digital-computer calculation of the 20-year single-well safe yield for well No. 8, arriving at a figure of 225 igpm. They also calculated average safe yields for various groups of similar wells located at 1,000-foot intervals along the axis of the

*The 20-year single-well safe yield is defined as the rate at which a well uninfluenced by pumping from other wells completed in the same aquifer can be pumped continuously for 20 years without lowering the water level in the well below the top of the aquifer.

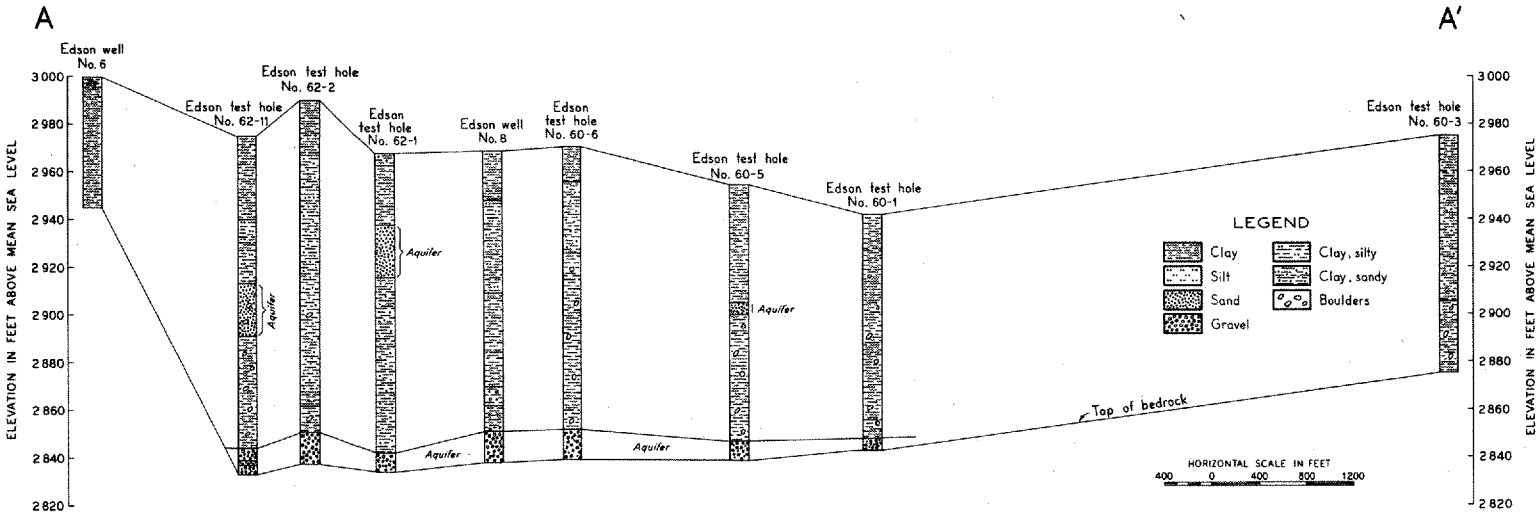

Figure 4. Buried Edson Valley cross section A–A'

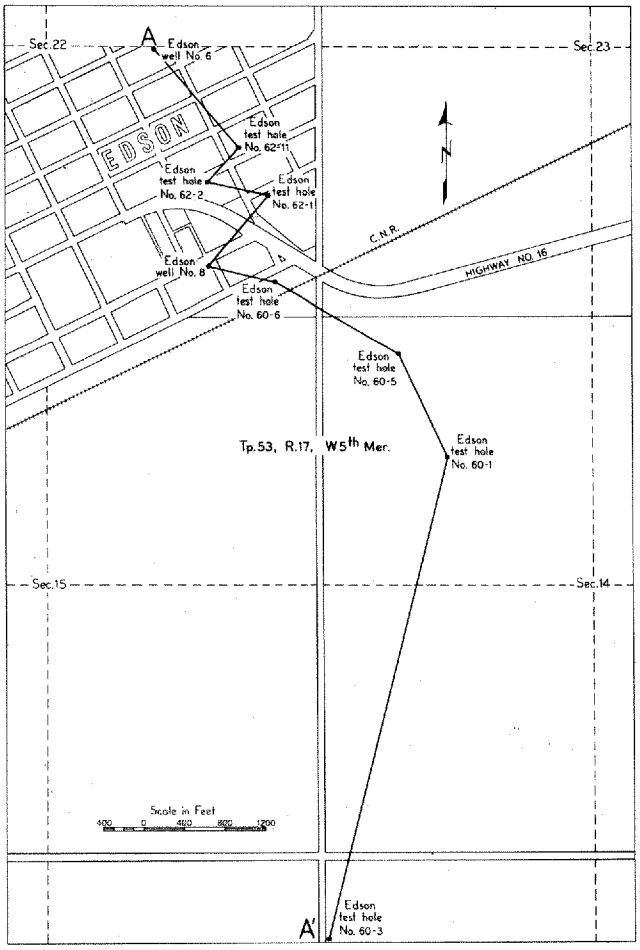

Figure 5. Plan view of test hole locations in cross section A-A'

buried-valley aquifer. These results are shown on figure 6. They are based on the assumptions that aquifer and leakage characteristics do not vary markedly from place to place and that well completions for all wells are as efficient as that for well No. 8. Test results for wells other than No. 8 suggest that the first assumption probably does not hold true. The estimated single-well safe yields for town wells Nos. 9 and 10 are 100 and 45 igpm, respectively (Fig. 3). Both estimates are based on projection of drawdown trends and the low value for No. 10 is probably influenced to some extent by a somewhat conservative well design. Another well, located in section 11, township 53, range 18 (Fig. 3), has an estimated safe yield of 65 igpm. Thus, the yield figures suggested by figure 6 are tentative and might have to be revised downward by a factor of two or more.

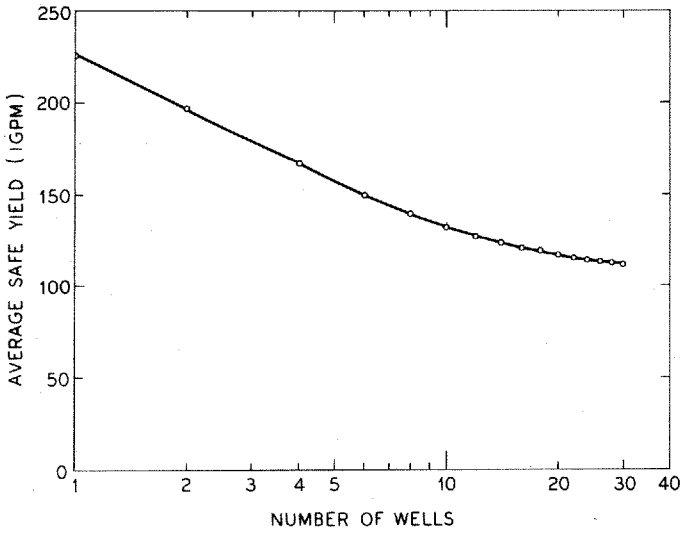

Figure 6. Preliminary estimates of average safe yields for well-field development of the buried Edson Valley aquifer

Buried-valley gravel deposits are near the surface in areas where the present-day rivers coincide with the buried-valley locations shown on figure 2. The possibility for developing induced infiltration supplies of water at these sites appears to be good but careful exploration and proper aquifer testing are required to demonstrate the existence of the geologic and hydrologic conditions necessary for the success of this type of development. These conditions include: (a) the presence of extensive deposits of granular material of high permeability, (b) thickness of granular materials ranging from at least 15 feet to a few tens of feet below the river bed, (c) a perennial flow of water in the river associated with the aquifer material, and (d) a good hydraulic connection between the aquifer materials and the river.

Two potential sites for induced infiltration are found near Edson in Sec. 4, Tp. 54, R. 16, W. 5th Mer. and Sec. 36, Tp. 52, R. 18, W. 5th Mer.

Glacial Meltwater Channel Deposits and Glacial Outwash Sands

Glacial deposits are generally capable of yielding only small quantities of water (a few imperial gallons per minute or less) to single wells completed in them, because their average permeability

is low. The more promising areas for groundwater supplies in these deposits are at the locations of the main glacial meltwater channels and glacial outwash sand deposits as shown on figure 3. These aquifers consist of unconsolidated granular meterials which can be near the surface or buried by less permeable glacial deposits.

Aeolian and Alluvial Deposits

Aeolian deposits are found at the surface in the dune areas to the southwest, south and east of Edson and can yield considerable amounts of water (possibly 1 to 10 igpm) if their saturated thickness is sufficient and their permeability not too low. Permeable alluvial sand and gravel deposits associated with the major rivers in the area might be suitable for large groundwater withdrawals by means of induced infiltration techniques. As in the case of the buried-valley gravels, however, certain geologic and hydrologic conditions would have to be satisfied for induced infiltration to be successful.

REFERENCES CITED

Roed, Murray A. (1968): Surficial geology of the Edson-Hinton area, Alberta; unpublished Ph.D. thesis, University of Alberta, Edmonton,

Vanden Berg, A. and Lennox, D. H. (1968): Safe yield of a well-field in a leaky-artesian strip aquifer; Ground Water, Vol. 6, No. 2, p. 30-36.

To accompany Research Council of Alberta Report 68-1

LEGEND

Bedrock contours:

good control 3200

poor control 3200

(Contour interval 50 feet; elevations in feet above mean sea level)

Reported interval in feet below surface of sand and / or gravel in the surficial deposits

Gravel ..... ● 10-40

Sand ..... ○

Sand and gravel ..... ◒

WEST OF FIFTH MERIDIAN

SCALE 1:50,000

1.25 inches to 1 mile approximately

1 0 1 2 3 Miles

1000 500 0 1000 2000 3000 4000 Metres

1000 500 0 1000 2000 3000 4000 Yards

Base map compiled from National Topographic Series sheets 83F/6E, 83F/7E & 7W, 83F/8E & 8W, 83F/9E & 9W, 83F/10E & 10W, 83F/11E published by Department of Energy, Mines and Resources, Ottawa

R.18 116°35′ 30′ R.17 25′ 20′ R.16 15′ 10′ R.15 116°05′

Tp.54 53°40′ Tp.53 35′ 30′ Tp.52 53°25′ Tp.51

Edson Wolf Creek Rosevear Pinedale Yates Ansell Jang Lake

CANADIAN NATIONAL RAILWAYS

McLEOD RIVER WOLF CREEK

3000 2950 3050 3100 2900 3200 3150 3300 3250 3400 3350

77-86 34-37 15-35 10-20 0-20 10-12 0-25 65-85 32-37 10-30 0-8 73-77 40-45 0-30 0-15 44-65 123-133 90-100 107-116 82-85 73-87 60-80 110-117 94-99 123-126 108-116 118-120 119-131 118-137 120-130 127-134 15-24 10-12 50-65 21-28 35-39 55-65 17-24 50-60 32-41 37-43 25-29 25-40 15-55 60-63 34-43 40-55 44-46 25-32 37-39 10-15 8-14

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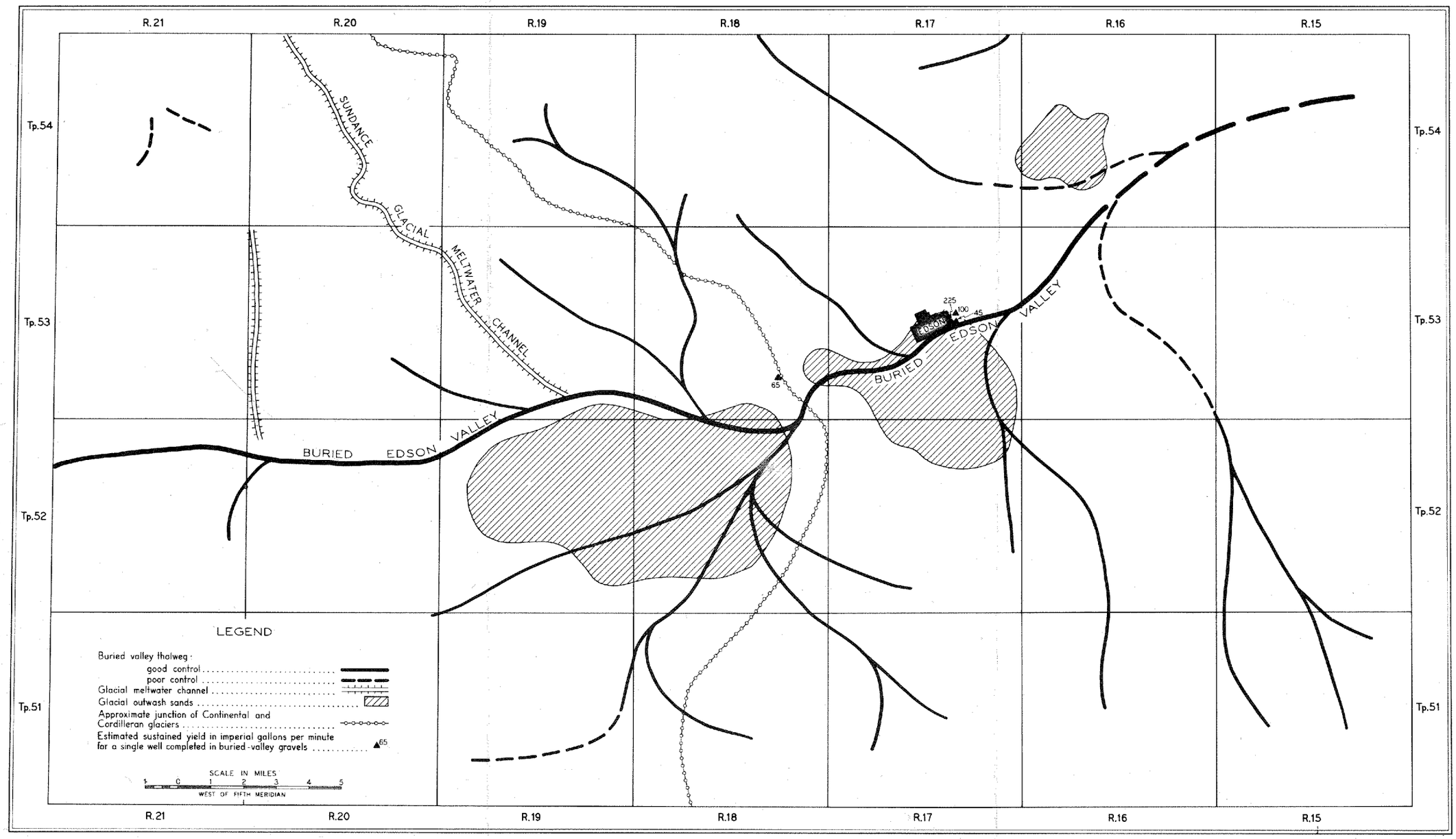

Figure 3. Locations of buried valleys, glacial meltwater channels, and glacial outwash sands.