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CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

TOPICAL REPORT NO. 50

LIASON ON HYDROLOGIC STUDIES BY FEDERAL AGENCIES

COMPILED BY

J. S. SCOTT AND L. V. BRANDON

OTTAWA

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Discussion on Hydrologic Networks and Basin Studies

Proceedings of a meeting of representatives of Departments of Agriculture, Transport, Northern Affairs and National Resources, Mines and Technical Surveys held in the board room of the Geological Survey of Canada. January 15, 1962.

Dr. I. C. Brown (G. S. C.), Chairman.

Discussion on Hydrologic Networks and

Basin Studies

January 15th, 1962.

Department of Agriculture

Department of Transport

Department of Northern Affairs and National Resources

Department of Mines and Technical Surveys

10:30 A.M. Board Room
Geological Survey of Canada.

Agenda

1. Introduction

2. Outline of present groundwater programme of Geological Survey

3. Present Basin Studies in progress and their purpose.

    a) Macrobasins
    b) Microbasins

    Information from each federal agency and advice on studies by Provincial and other agencies.

4. Costs of hydrologic data collection. Instrumentation and maintenance.

    a) Meteorology
    b) Water resources
    c) Agriculture
    d) Groundwater

5. Proposed basin studies of each agency. Reasons and costs.

6. Arrangements to be made for integrating data collection networks. (Federal and Provincial).

7. Arrangements for circulating progress data between departments. (Federal and Provincial).

Those present:	Branch	Dept.
Mr. L.V. Brandon	Geological Survey	(M&TS)
Dr. I.C. Brown (Chairman)	Geological Survey	(M&TS)
Mr. J.P. Bruce	Meterological	(D.O.T.)
Mr. J.E. Charron	Geological Survey	(M&TS)
Mr. R.H. Clark	Water Resources	(NA&NR)
Mr. J.H. Day	Research	(Agric.)
Mr. E.F. Durrant	P.F.R.A.	(Agric.)
Mr. R.A. Freeze	Geological Survey	(M&TS)
Dr. P. Meyboom	Geological Survey	(M&TS)
Mr. E.B. Owen	Geological Survey	(M&TS)
Mr. E.R. Peterson	Water Resources	(NA&NR)
Mr. G. Robertson	Research	(Agric.)
Dr. J.S. Scott	Geological Survey	(M&TS)
Mr. R.H. Smith	Economic Research	(D.O.T.)
Dr. W.J. Staple	Research	(Agric.)
Mr. J.J.L. Tremblay	Geological Survey	(M&TS)

Introduction

1. Dr. Y. O. Fortier (Geological Survey) opened the meeting by expressing thanks to members of other departments for coming to the meeting and for their cooperation in hydrologic studies.

He pointed out that the Geological Survey is concerned with the groundwater phase of the hydrologic cycle, but that other phases of hydrology must be considered in all groundwater studies.

The purpose of the meeting is therefore to acquaint each federal agency with the work of other agencies and of our own work. He hoped that the discussions would benefit each department and would lead to closer cooperation wherever necessary.

2. Outline of past and present Groundwater Programmes of the Geological Survey

L. V. Brandon . Groundwater work by the G. S. C. began in the 1870's when borings were carried out and data was obtained and published on wells in the prairies. At the turn of the century a report was published on the artesian wells in the city of Montreal. A more complete memoir on this was published later. In 1915 Dowling pointed out the existense of a good potential aquifer in the Milk River Sandstone of Southern Alberta. The presence of this aquifer was subsequently verified by drilling contracted by the G. S. C. Many other geological reports and maps published on various areas of Canada contain within them data which can lead to conclusions about groundwater potential.

Work was done in the prairies during the 1930's; and following the drought years an extensive inventory of wells was made and published in the form of Water Supply papers. More than 300 of these papers had been published by 1950.

The present aim of the G. S. C. is 1) to publish maps and reports containing more detailed hydrogeologic data and 2) to make various studies leading to the better development of groundwater.

1. Hydrogeologic maps and reports are to be classified in the following manner:

a) Groundwater probability maps. These can be prepared by office studies which involve the interpretation of existing geologic, water well and oil exploration data. Their purpose is to advise on the best aquifer to develop in any one area. The maps will be on 4 mile to the inch scale.

b) Hydrogeology of basins. Groundwater basins have essentially the same configuration as surface drainage basins and quantitative studies of hydrology require basin wide studies. These studies can be divided into macrobasin studies and microbasin studies. A discussion of selected basin studies would be reserved for a later part of the agenda.

It is hoped that a hydrogeologic map of Canada will be compiled by the end of 1962.

c) Groundwater Availability maps. A complete hydrogeologic basin study would eventually lead to a map showing the available

groundwater supplies, and such maps may soon be needed in areas where industrial, irrigation or municipal wells are being developed.

2. Groundwater use has not been undertaken in some places because of failure to solve some particular phase of development.

The development of groundwater is a fourfold problem similar in analogy to a run in baseball in that there is no score until the batter has successfully rounded all four sides of the diamond. The four phases are: a) Location of aquifer - i.e. outlining it in depth and area.

b) Quantitative testing of aquifer.

c) Chemical testing of aquifer and determining if treatment is necessary.

d) Well construction. This involves the use of the correct type of drilling technique to develope a permanent well.

Further research is required and is being done in each of these phases of development. e.g. Testing and development of geophysical instruments is being carried out by the Geophysical division in depth location studies. More studies are being carried out to develop better methods of assessing the safe yield of aquifers. The delineation of chemical regions is being studied. Contracts have been let to compare and test the effectiveness of various types of wells. The introduction of new drilling methods is making possible better construction techniques.

It should be pointed out that various Provincial agencies are also doing extensive groundwater work. Some of the Provincial studies are done in close cooperation with the Geological Survey. The main agencies are:

Ontario (Ontario Water Resources Commission)

Quebec (Department of Mines)

Saskatchewan (Research Council and Water Rights Branch)

Alberta (Research Council)

Manitoba and British Columbia also have groundwater personnel

The matter of groundwater level records is often referred to the G. S. C. and at the Resources for Tomorrow conference reference was made to the lack of these records. In fact there is much published data on water levels and there is probably more data available on provincial files. The water levels themselves are only important in that they indicate areas of recharge and discharge, what is more important is the fluctuation in level. A number of factors produce water level fluctuations and these are as follows:

1. Seasonal; often of the order of 10-15 feet.

2. Climatic; about 2-4 feet.

3. Pumping by high capacity wells. Excessive pumping of well fields is a matter of Provincial Water Rights legislation.

4. Barometric, tidal and seismic fluctuations are also recorded on continuous water level recorders.

Continuous water level recorders in wells and periodic water

level measurements are carried out at some places by the Geological Survey and also by the Ontario Water Resources Commission and the Alberta Research Council. No consistent groundwater level recording procedure data has been worked out with each Province but in general it may be said that levels within aquifers being pumped are the concern of Provincial authorities. The G. S. C. is concentrating observation wells across river valleys for better information in basin studies and groundwater discharge to streams.

One of the purposes of this meeting is to find out which areas are at present being studied by government departments and which areas need more water level or other studies.

3. Present Hydrologic Studies in Progress and their Purpose

Dr. I. C. Brown. Taking each location from west to east across Canada current groundwater studies are:

1. Southeast part of Vancouver island a groundwater study is being undertaken at the same time as pleistocene geology mapping.

2. The Research Council of Alberta has several groundwater projects in progress and the G. S. C. is not doing any work there.

3. Date collection in the Saskatoon Prince Albert region has been completed. Thus concluding all federal inventory work. Some aquifer testing studies were carried out last year and geophysical studies in cooperation with the S. R. C. were also made. A drainage basin study of the Assiniboine basin has been started. The S. R. C. has several projects underway for pleistocene and groundwater mapping.

4. Work is progressing in the Red River basin in Manitoba, preliminary reports have been published on N. T. S. map areas.

5. The most recent G. S. C. work in Ontario was a report on the Ottawa region. The Ontario Water Resources Commission are making field studies for municipal supplies.

6. Groundwater studies have been made on the Vaudreuil area west of Montreal and the Chateauguay area south of Montreal. Preliminary reports have been published. The Quebec Department of Mines has a Hydrology Division making many reports on municipal groundwater supplies.

7. Work is being done in the Moncton area, N. B., which will probably be finally published as a study of the Petitcodiac basin. Preliminary reports have been published.

8. A reconnaissance has been made of groundwater problems in the North in areas of mines and settlements and a report has been published.

Various other groundwater studies based on requests by other government departments have been made by the G. S. C. Results of these have been published in Topical reports.

F. Durrant

Experimental work on hydrology west of the Great Lakes consists mainly of the following:

1. Wilson Creek Watershed, (Manitoba)

   This study is aimed at the determination of the causes and control of erosion in a steep sloped watershed, but it includes studies of the proper location of rain gauges and variations in precipitation with elevation.

2. Dalton Creek, Regina: A study is being made by the experimental farm of the physical characteristics of the hydrograph related to snowmelt. This project has been in operation since 1950 but nothing has yet been published.

3. Swift Current: The effect of cultural practices on runoff is being studies on a small watershed (approx. 1/4 section).

4. Saskatoon: The Saskatchewan Research Council plans to study all of the aspects of the hydrologic cycle in a small area near Saskatoon. The aim is to be able to extrapolate these data so that inferences about the hydrologic cycle can be made in other areas where only precipitation and runoff data are available.

5. Eastern Rockies Forest Conservation Board: This organization has an advisory committee which enlists the aid of various government departments in the work of the Board.

6. Saskatchewan Research Council: is undertaking a study of the permanency of sloughs related to vegetation. This work is similar to the pothole studies being done in North Dakota.

7. City of Victoria: The city has established a complete watershed management program of a 30 square mile area.

8. Vancouver: A similar study to that at Victoria is being done here.

9. Range Experiment Station, Kamloops, B.C.: Precipitation and runoff measurements are the main work done with an aim to managing grazing in order to control erosion.

10. Summerland, B.C.: Work is being done on the variation in chemistry of water with elevation.

J. Bruce

In Ontario the best microbasin study is being done at O.A.C. by Ayers and Witherspoon. The project covers only a few acres but is concerned with the effect of snowmelt on soil moisture and groundwater recharge. Work is also being done on the problems of stream flow measurement in winter.

The Conservation Authority Branch of the Ontario Government is conducting runoff studies for flood forecasting. Data collected from the Thames Valley are available on punched cards but nothing has been

published on this project. Groundwater levels are generally not considered in these studies.

Some studies are also being done in Ontario in the water balance of swamp lands.

Discussion

Brown. Has D. O. T. done anything in the St. John, N. B. area?

Bruce. Some work has been done in the Loch Lomond area where there is an indication that more water can be pumped from the lake than runoff would indicate.

The Meteorological Branch has no project of the micro-basin type because it considers itself a support agency in such studies.

Clark. The Associate Committee of Hydrology will be holding a symposium on experimental watersheds to be held at O. A. C., Guelph in June 1964.

Meyboom. Does any watershed study on the prairies take groundwater into account?

Durrant. Marmot Creek is probably the only one; groundwater is generally an unknown quantity.

G. Robertson. The Department of Agriculture is mainly interested in the effect of soil moisture on plant growth and therefore on evapo-transpiration. Evapo-transpiration studies based on lysimeter methods and/or improved Thornthwaite calculations are being done

at the following places: Ottawa, Swift Current, Beaverlodge, Harrow, Guelph, Saskatoon.

Bruce. In the summer of 1962 Campbell (?) and King plan to carry out lysimeter studies in cooperation with Meteorological Branch, D. O. T.

Brown. How much work is being done in measuring evaporation from the water table up?

Robertson. About 5 neutron meters are being used in Canada for measuring soil moisture.

Meyboom. The G. S. C. is not trying to get everything and give nothing. The aim of our studies are to completely understand the processes of the hydrologic cycle. e.g. The relation of phreatophytes in the hydrologic cycle; evapo-transpiration from such plants are direct losses to groundwater. We also want to learn of the processes leading to the formation of playas. Subsurface waste disposal is also an important subject for study.

Bruce. I am delighted to learn that groundwater geologists are interested in other aspects of hydrologic studies.

Clark. What microbasins are under study by the Survey?

Meyboom. There are none in Canada at present apart from a small one near Regina.

Brown. At present we are trying to get a reconnaissance picture of groundwater in Canada. The microbasin studies will follow.

Clark. The O. A. C. and Marmot Creek studies appear to be the only ones relating to groundwater. It seems the Survey is mainly interested in macrobasin studies. Considerable data on macrobasins are available from both the Water Resources Branch and P. F. R. A.

What does one do when no base flow exists in a basin?

Durrant. There are places in the prairies where negative base flow exists i. e. there are conveyance losses. P. F. R. A. has worked up hydrologic data from existing records for 18 water beds on the prairies.

Clark. Our branch has similar data on the relationship of precipitation and runoff for other streams on the prairies. Similar work has been done in Quebec but mainly for hydro development. The Souris River basin study was done in 1950 and there are many other basins on which the study of surface water supply has been completed.

Meyboom. Can we get a list of these projects?

Clark. Yes.

Owen. What work has been done in the Yukon?

Clark. Some data are available.

Brandon. What reasons determine the location of stream gauging stations?

Clark. They are set up for various purposes.

Costs of Hydrologic Data Collection, Instrumentation and Maintenance Meteorologic Data

J. Bruce

Costs of meteorological equipment vary considerably e.g. a simple rain gauge costs from 8 to 10 dollars whereas a recording gauge costs about 400 dollars. Costs also vary depending upon the area being measured. e.g. The cost of meteorological instruments alone for the Marmot Creek Basin study was about 10,000 dollars.

Approximately two thirds of labour for reading precipitation and temperature measurements is obtained on a voluntary basis, however, schedules of payment up to $170 per year have been established where both rainfall and temperature readings are obtained.

In the Marmot Creek project one permanent meteorological technician is on the staff (salary approx. 5,000 per year) to service one permanent station and 8 satellite stations.

Before selecting a basin for study the G. S. C. should consult with D. O. T. for an assessment of existing meteorologic stations. Any new stations would probably be supplied by D. O. T. but any special instruments would probably have to be supplied on a cost sharing basis.

Discussion

Durrant. In the Assiniboine basin the runoff over the area is about 1/2 inch annually. If the accuracy of precipitation data is required

therefore to 1/2 inch then a very close network of rain gauges would be required. A loose network of gauges could be used, however, if an index approach was used. As an example of the variability of precipitation on the prairies a 2 inch annual difference has been recorded in rain gauges spaced only 300 feet apart.

Bruce. Rain gauges in a basin give an indication of precipitation but not an absolute quantity of the rainfall.

Durrant. In the prairies 50 per cent of summer rainfall occurs as thunder-showers thus great variation in precipitation between stations can occur.

Bruce. Over longer periods of time the effect of individual storms smooths out.

Clark. What accuracy is required in groundwater quantity estimates?

Brown. There is no absolute accuracy figure; at present we can only hope to continue studying the problem with the aim of increasing the accuracy.

Meyboom. Is there any tie between the placing of meteorological and stream flow stations?

Clark. An attempt is being made to do this particularly in Northern areas.

Bruce. The Survey must define the degree of accuracy required then the Meteorological Branch can give a good idea of the density of stations required.

There are several areas in the country where close networks of rain gauges have been established from which rainfall indices can be computed.

Robertson. There are other factors affecting the interpretation of precipitation data such as the infiltration capacity of the soil, slope, moisture conditions at the time of precipitation and so on.

Stream Flow Data

Clark

Many of the river level recording stations have been installed on a cooperative basis. There are about 1,500 stations in Canada of which about 1/3 have automatic recorders.

The cost of gauges ranges from about 50 dollars for a manually read gauge to between 400 and 2,500 dollars for an automatic recording gauge. If well installations are required these range in cost from 1,000 to 50,000 dollars.

In the Marmot Creek study 20,000 dollars was expended on installation of instruments exclusive of the cost of the instruments.

In southern areas most of the stations were installed on a co-operative basis on which 1/2 of the cost of construction and maintenance was charged to the agency requesting the station; thus the Survey could expect to pay 1/2 the cost of construction and maintenance of any stations requested.

The cost of the station will vary greatly depending upon requirements e.g. if summer readings only are needed the costs will be much less than $5,000 per station at Marmot Creek. If only one reading per day is required from a staff gauge this could probably be obtained for $50 or less but a station requiring a cableway would be much more; the cableway at Barrie cost $3,700.

Discussion

Brown. What payment is made to gauge readers?

Clarke. Generally $10 per month depending upon proximity to the gauge. Automatic recorder servicing is paid at the rate of about $5 per visit or from $10 to $40 per month.

Durrant. I would like to point out that measurements of low flow of rivers on the prairies are generally inaccurate because of flow conditions.

Meyboom. Are there any places where the Water Resources Branch are reading water wells as well as stream gauges?

Clark. This is being done in the Souris River area but at the request of G. S. C. and not as a part of our own program.

Water Resources Branch have gauge stations on international and interprovincial streams to provide basic data but other stations on these streams may be put in by request.

Freeze. Are data published for all stations?

Clark. Yes.

Meyboom. Is there any program for correlating one station with another?

Clark. Such a program has been started but there is nothing published nor much progress on this work.

Brandon. Does the Water Resources Branch have a problem in obtaining personnel for the gauging programs?

Clark. There are 6 branch offices and 27 sub offices within the Water Resources Branch. A new man is generally required if about 10 new stations are installed in one of the office areas. Money is not so great a problem as personnel thus if 10 new stations were installed, at a cost of 30,000 dollars, no assurance could be given of having a man available to service these stations and to analyse the records.

Evaporation and Infiltration Data

Robertson

Lysimeters vary in cost from a few dollars to thousands of dollars and a neutron moisture probe costs about $5,000. The neutron probe has the advantage, however, that it can be used in a number of localities within the basin under study.

Discussion

Staple. Considerable soil moisture measurements have been made at Swift Current mainly from soil samples obtained by an auger. The neutron probe may not give good results if there is flow through

the unsaturated zone.

In southwestern Saskatchewan data are available on evapotranspiration from wheat crops. Measurements in this area indicate that in 3 years out of 10 years water is not moving past the root zone during the growing season.

I would like to see a meter capable of measuring flow in the unsaturated zone.

Meyboom. Is there any supply of moisture to plants by capillarity?

Staple. Probably not in southern Saskatchewan but there may be in periods of wet years.

Durrant. Olafson has studies fluctuations of the water table under irrigation conditions at Maple Creek.

Robertson. The Ontario Research Foundation has done work on capillarity and the water balance of swamps particularly in the Holland Marsh area.

Groundwater Level Recorders

Brown

The cost of instruments for observation wells varies from no cost for voluntary observations on existing weeks to $10,000 for a 6 inch diameter well about 700 feet deep. Automatic water level recorders used by the Survey cost about $150 each.

One of the Survey's projects at present is the establishment of a net of observation wells across the country from which weekly

readings will be made. The Survey hopes to have at least 10 wells in those provinces without groundwater level programmes as a start with readings being made on a voluntary basis.

The locations of the observation wells will be plotted on a drainage basin map and ultimately data collected from the wells will form the subject of an annual report.

It should be pointed out here that both the provinces of Ontario and Alberta have extensive observation well networks of their own which have been operating for some time.

Discussion

Brown. Can we get a copy of the numbering system used by the Water Resources Branch for stream gauge stations?

Clark. Yes, this information is available. Many of the stream gauge stations in the prairies are farm management stations. i.e. in irrigation ditches and thus of no value in groundwater studies.

Bruce. If the Survey is thinking of an extensive net of stations then the records should be placed on punched cards or some similar method of filing.

Brown. We are presently selecting stations pretty much on the availability of existing wells suitable for use as observation well.

Bruce. It would be a good idea to put in a rain gauge at each observation well. The Meteorological Branch would be happy to have our employees read well levels near our gauging stations if that would be of help.

Proposed Basin Studies of Each Agency

Geological Survey of Canada

Brandon

Climate and geology form the basis of our selection of typical macrobasins for future study but consideration is also given to the availability of existing data such as precipitation and stream flow records.

From west to east the proposed basins are as follows:

1. Yukon River Basin. The study would be confined to a part of the drainage basin where stream flow records are available. The aim here is to relate groundwater to studies of the hydrology of a permafrost region. It is realized that the cost of instrumentation in the region might be large.
2. Chilcotin Basin, western B.C. This is a dry area in which gound-water is moving through a basalt plateau as evidenced by the presence of springs at the base of the basalt. A good type basin may be selected there shortly.
3. Frenchman Creek, Saskatchewan. This is a dry area in which the Tertiary and Cretaceous rocks may contain important aquifers. It is a type area for this geology and climate.
4. Assiniboine River Basin. This study of a basin in a semiarid to subhumid area covered by Pleistocene deposits was chosen for a present study because of the availability of precipitation and stream flow records.

5. Old Wives Lake, Sask. The lake is within an internal drainage basin and thus affords the opportunity to study the movement of groundwater under conditions of internal drainage. It is a type area for much of Saskatchewan.

6. Ottawa Valley. Here groundwater is moving through Palaeozoic and crystalline rocks in a humid area.

7. Thames Valley. This basin is not given much priority for our work because it is thought that considerable work has been done here by the Ontario Government.

8. Richilieu River, Quebec. This would be a type study of the movement of groundwater in Pleistocene and Palaeozoic deposits in a humid climate.

9. Moncton, N. B. Salt water intrusion would form a part of the study of groundwater in Carboniferous rocks in a humid area.

11. Annapolis Valley, N. S. A study of groundwater movement in a uniform sequence of Mesozoic rocks in a humid area.

12. Prince Edward Island. The entire province would be treated as a hydrogeologic entity because of the relatively homogeneous nature of the geology and climate.

The Survey is therefore interested in learning how these proposed macrobasin studies fit with the proposed projects of other departments.

Discussion

Bruce. The programs proposed appear to be sound.

Meyboom. Do these basins accord with climatic variations?

Brandon. The Yukon basin is climatically very variable and we have some doubts about selecting an area there.

Bruce. The climatic variations within the various basins may be great but they should not be prohibitive.

Durrant. The greatest need for water on the prairies is in areas of no streams.

Clark. On the prairies it is often very difficult to find the drainage divide and it is therefore difficult to define the drainage area.

Meyboom. The effect of a shift in the drainage divide may be greater for a microbasin than a macrobasin.

Clark. The Water Resources reports are based only on the gross drainage area and this area can vary. Many of the areas have been computed from early maps which may not be too accurate.

Durrant. I think the gross area figures are not reliable for quantitative studies.

Clark. If runoff data are available over a long period of time the gross area figures may well be useful.

Meyboom. The minimum flow figures give a fairly good picture of groundwater discharge.

Clark. What is the contribution from one basin to another?

Meyboom. It is probably negligible.

Bruce. Has any study been made of the residence time of groundwater?

Meyboom. We hope to have age determinations of samples done.

Brandon. Tritium is useful for dating up to 30 years but carbon 14 dates may be more useful. We have had a few Tritium counts made.

Meyboom. The downstream variations in quality of water may be a function of groundwater flow.

The Survey has at present a man working on the scaling relations of small basins to large basins.

Brown. Are P.F.R.A. or Agriculture considering any basin studies?

Durrant. Most of P.F.R.A. work is done in the office using published data but our office in Vauxhall has done work on the fluctuations of groundwater levels in irrigation areas.

Bruce. The work done on the Thames Valley has not really been a thorough study.

Durrant. Our organization has a great need for a study of water losses in stream channels (influent seepage).

Brandon. In the Regina area considerable hydrologic data are available thus this might be a good place for a microbasin study. There is a need for more stream gauges on Boggy Creek but this would seem to be mainly a municipal affair.

Durrant. I can't see any objection against doing such a study; the province also has an interest in this problem.

Clark. A federal-provincial board has been established for the Ottawa River. The terms of reference of the board are not yet approved by the various governments but this should be completed in the near future. The river is fairly well metered by various government departments. It is hoped the study, which will be for several purposes such as power, recreation etc., will get underway within a month or so.

Owen. Is there any possibility of a similar project being done for the Richilieu River?

Clark. There is a possibility but it would not be to the same extent as for the Ottawa River.

If any thought is given to a study in the Mackenzie Valley the Water Resources Branch would be willing to expand their stream gauging network into that area.

Arrangements to be Made for Integrating Data Collection Networks

Discussion

Brandon. The G. S. C. has contracted to establish stations for measuring water level fluctuations in wells across river valleys. e.g. piezometers are to be installed across the Assiniboine River at Carberry. Man. and at a number of other places. It seems desirable to relate these data to measurements of precipitation and stream

flow and I therefore, would like to hear the views of others on the placing of these stations.

Clark. I would like to propose the idea of using common gauge readers thus the Water Resources Branch could instal a gauge at a place where the Meteorological Department has a good gauge reader and vice versa. The Meteorological Branch has submitted to us a list of stations where they have good readers.

Bruce. The readers are paid by the department concerned but arrangements have been worked out to reimburse say Water Resources for services of their gauge readers in reading our instruments. The system of using combined readers has been successfully applied to 40 stations north of parallel 54. This scheme could be applied to expand the network.

Brown. The Survey should start their program on the same basis i.e. find a list of meteorological and stream gauging stations and fit the water level stations to this network.

Durrant. Perhaps the Meteorological Branch could supply the Survey with a list of rain gauge stations operated by individuals and not reported because of non-standard operating conditions.

Bruce. We could supply the Survey with a list of agencies (grain companies, forestry departments etc.) which operate non-standard stations. These stations are operated generally only during the summer.

Durrant. P.F.R.A. has abstracts of all the grain company precipitation records and these data could be made available to the Survey.

Brown. Who does snow surveys?

Bruce. The Meteolological Branch does a fair amount but the Water Resources Branch and the power companies are also doing this work. The Branch hopes to publish snow survey information in the future.

Robertson. The experimental farms in western Canada do a soil moisture in the fall and the following spring. These data are not standardized or coordinated but they could be obtained from each farm. There is of course no indication of when moisture is added to the soil.

Durrant. It seems soil moisture may be recharged over the winter. The moisture equivalent of snow decreases over the winter but the losses cannot be accounted for by evaporation alone thus recharge may well occur.

Staple. It is difficult to measure the permeability of soil at any time of the year but it is particularly so when the soil is frozen.

Durrant. Swift Current seems to be the only place on the prairies where soil permeability work is being done.

Bruce. The Meteorological Branch has a list of agencies which are doing snow survey work in Canada.

Precipitation over ungauged area may be obtained by radar in

the future but the method probably won't work for rainfall from an individual storm.

It seems to me that groundwater data may well be used to complete evapo-transpiration.

Brandon. Evapo-transpiration from a potato crop has been measured by fluctuations of water levels obtained by a groundwater recorder set up in the potato field.

Clark. A Joint United States/Canada study has been initiated for surface waters of the Pembina River, Man. Some groundwater studies should be done in this area because of the water supply problem.

Charron. There are a number of observation wells in the Pembina River area.

Brandon. Where specifically in the country are groundwater data inadequate?

General consensus. Everywhere.

Brandon. What is the time lag between the request for a new gauge station and the fulfilment of the request.

Bruce. If the request is for a station required for the general network then the Meteorological Branch can supply the station from our own budget and it would be installed within 6 to 8 months. Any unusual requests, i.e. location or special equipment, would require a longer period of time. Requests for new stations should

be directed to Director, Meteorological Branch, Department of Transport, Bloor Street Toronto.

Robertson. The Department of Agriculture is essentially a research organization and I do not know of any procedure for handling such requests by other departments.

Staple. Most of the infiltration studies done in the past have been on a comparative basis i.e. bare fields vs. cropped fields. It is probable that request work could be done on a cooperative basis dependent upon the kind of request.

We have found lysimeters are generally a useful method for infiltration studies.

Clark. If the request is modest and could be fitted to our overall project then possibly a month or so is all the time that would be required for fulfilment of the request.

If gauging is required for a larger project then the request should be made at least a year in advance because of funds appropriations.

Requests can be made either directly to the Branch offices or to headquarters in Ottawa. The kind of readings required will have to be specified in the request because these will affect the type and cost of station installed.

Robertson. The Agriculture Department will not accept service work but if the project is of a research nature then it might be set up on a cooperative basis.

If the Survey has such a research project they should draw up their program and submit it to the Director General who would then decide upon the disposition of the request.

Brown. The Survey is often asked to advise other government departments and we are willing to assist other departments in their projects. Personal contact with the Survey staff member concerned is probably the best way to affect cooperation but requests can also be made through the Director of the Geological Survey.

Staple. Some progress has been made on the use of computer to determine the conductivity of unsaturated flow but the whole problem is a large one.

Arrangements for Circulating Progress Data Between Departments

Discussion

Brandon. Information re the location of observation wells and recorded fluctuations can be distributed annually perhaps on April 1 of each year.

Clark. Water Resources are essentially a provincial responsibility except for international, navigible and other such streams thus the network of stream gauge stations has not expanded as rapidly as it might otherwise have done. In the prairies there is a greater network of gauge stations because of former Federal administration of this area.

Brown. The Survey is trying to have groundwater service work handled by the provinces. The Survey will, however, do other work where the provinces do not have the necessary facilities.

Bruce. Do sections of the Survey publish monthly reports of their work?

Brown. No, but there is an annual report covering the work of the Survey as well as a public release each fall.

Clark. Is the Survey aware of the water supply study of Lake Ontario reported in the A. S. C. E. transactions in 1959? The study is based mainly on runoff data and groundwater is not considered. A similar study is being done for Lake Erie.

Brude. There is also a report on the water balance of the Great Lakes which was presented at an American Association for the Advancement of Science meeting in Chicago in 1959.

Clark. Has any work been done on groundwater in N. W. T. ?

Brandon. Yes. A recorder has been installed at Pine Point Mine and a Topical report on Mackenzie District is available.

Durrant. Has any thought been given to repeating a well survey such as was done in the 1930's?

Meyboom. Alberta and Saskatchewan are collecting these data from well drillers and will probably publish this information in the future.

Durrant. It is much easier to collect these data from one agency rather than from several agencies.

Brown. The old water supply papers published as a result of the well inventory work on the prairies are being reprinted.

Dr. Brown concluded the meeting by thanking everyone for coming and contributing to a useful exchange of ideas.