File # 0256957

MEMORANDUM

TO: Mr. H.I. Hunter, Chief
Hydrology Division
Water Investigations Branch

FROM: W. Mottram
Hydrology Division
Water Investigations Branch

April 26, 1972

RE: Stream flow - groundwater relationship for the Okanagan River from Penticton to Tonasket

Introduction

This study will attempt to arrive at a relationship between streamflow and ground water for the Okanagan Valley and Okanagan River from Penticton to Tonasket. This will be done by comparing a calculated flow for the Okanagan River against an actual flow for certain areas along the river.

The calculated flows are arrived at by adding the flow of an upstream station plus tributary inflow minus any storage change that occurs in lakes. The storage change is subtracted because of the equation

$$\text{Inflow} = \text{Outflow} + \Delta\text{storage or}$$

$$\text{Outflow} = \text{Inflow} - \Delta\text{ storage}$$

In these calculations, we are calculating the outflow for a certain section on the Okanagan River. The actual flow is taken from a station at the downstream end of the section on the Okanagan River.

Calculations

1. Okanagan River from Penticton to Okanagan Falls

   a) Calculations
      Calculated flow = Okanagan River @ Penticton (8NM-050)
      + Shingle River (8NM-150) + Ellis Creek (8NM-135)
      - Storage change on Skaha Lake (8NM-048)
      Actual flow = Gauge on Okanagan River at Okanagan Falls (8NM-002)

2. Okanagan River from Okanagan Falls to Oliver

   a) Calculations
      Calculated flow = Okanagan River @ Okanagan Falls (8NM-002)
      + Shuttleworth Creek (8NM-149) + Vaseux Creek (8NM-015)
      + Park Rill Creek (8NM-120) - SOLID Diversion
      Actual Flow = Okanagan River @ Oliver (8NM-085)
   b) The SOLID Diversion operates from April to September each year.

3. Okanagan River from Oliver to Oroville

   a) Calculations
      Calculated flow = Okanagan River @ Oliver (8NM-085)
      + Testalinden Creek (8NM-164) - Storage change on Osoyoos Lake (8NM-073)
      Actual flow = Okanagan River @ Oroville (8NM-127)

4. Okanagan River from Oroville to Tonasket

   a) Calculations
      Calculated flow = Okanagan River @ Oroville (8NM-127)
      + Similkameen @ Nighthawk (8NL-022)
      Actual flow = Okanagan River @ Tonasket (8NM-072)

Discussion of Graphical Results

By placing the results of the calculated flows and actual flows on a graph, differences between the two are readily seen. Where the calculated flow is less than the actual flow, the difference would seem to indicate an inflow of ground water. Where the actual flow is less than the calculated flow, an outflow to ground water is indicated.

Since our data is more accurate at low flows, it is better to consider inflow from ground water during the low winter flows than to consider outflow to ground water during high flow periods.

During the winter months, the calculated flows can be subtracted from the actual flows to give us the indicated groundwater contribution.

1. Okanagan River from Penticton to Okanagan Falls - Due to lack of data on tributary streams, this graph does not start until July 1969 but continues on until September 1971. Therefore, we get to study two winter low flow periods.

   For the winter flows, it is found that for:

   December-April 1969-1970 total flow = 91,300 acre-feet
   groundwater contribution = 7,596 acre-feet
   or 8.3% of the total flow.

   November-March 1970-1971 total flow = 29,920 acre-feet
   groundwater contribution = 6,508 acre-feet
   or 21.8% of the total flow.

   The winter flows for 1970-71 are very low due to the lack of runoff and rainfall throughout 1970.

   A large difference between the calculated flow and the actual flow was noted in May 1971. The flows for April, May and June 1971 were rechecked and no faults were found.

   Maximum outflow of water to ground water is noted during August 1969, 1970 and 1971.

2. Okanagan River from Okanagan Falls to Oliver - This section varies from the others as there was a very long groundwater inflow period from July 1969 to April 1970. The usual summer outflow period is missing in 1969 and barely shows in August 1970. However, if we calculate the total groundwater inflows and actual flows we find:

   July 1969-April 1970 total flow = 257,600 acre-feet
   groundwater contribution= 21,766 acre-feet
   or 8.4% of the total flow.

   This compares favourably with the flow for the previous section for this year.

3. Okanagan River from Oliver to Oroville - The winter groundwater inflow period and the summer outflow period are very apparent on the graph for this section of the Okanagan River. The summer outflows peak in August 1969 and July 1970. A comparison of the flows for the winter period gives us:

   December-April 1969-1970 total flow = 110,200 acre-feet
   groundwater contribution = 11,537 acre-feet
   or 10.5% of the total flow.

   This section of the river contains the Inkaneep River, a major tributary which is ungauged.

4. Okanagan River from Oroville to Tonasket - Flows for this section are very high because of the inflow of a major tributary, the Similkameen River. However, summer groundwater outflow is still apparent and peaks in August during both 1969 and 1970. Groundwater inflow during the winter is visible from November 1969 to March 1970. The total flows for this period are:

   November-March 1969-1970 total flow = 265,890 acre-feet
   groundwater contribution = 17,630 acre-feet or
   6.3% of the total flow.

Conclusions

Due to the fact that some major tributaries such as Dutton Creek and the Inkaneep River are ungauged, that there are many smaller ungauged tributaries and that streamflow data on some of the gauged tributaries is seasonal, I feel that it is impossible to arrive at any definite conclusions regarding a relationship between streamflow and ground water. However, some trends are apparent and they are:

1. The Okanagan River loses water from April to September. This is during the freshet and during the dry summer months. The maximum loss usually takes place in late July or August.

2. The Okanagan River gains water from late September to sometime during the spring, usually April or May. This gain is fairly even throughout and accounts for 6-10% of the total flow during this period.

W. Mottram

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WM/ls

26-4-72

27-4-72

Okanagan River Monthly Flows

------ Calculated Flows
—— Actual Flows

for: Okanagan River @ Okanagan Falls

Calculated Flows = Σ Ok. R. @ Penticton + Shingle Cr. + Ellis Cr. - Storage @ Shuha
Actual Flows = Ok. River @ Ok. Falls

Flows x 1000 c.f.s.

100
90
80
70
60
50
40
30
20
10
0

Month End Dates

Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.

1969 | 1970 | 1971 | 19____

100
90
80
70
60
50
40
30
20
10
0

Flow
x 1000 cu. ft.

OKANAGAN RIVER MONTHLY FLOWS

---- CALCULATED FLOW
—— ACTUAL FLOW

for: OKANAGAN RIVER @ OLIVER

CALCULATED FLOWS : Σ OK. R. @ OK. FALLS + SHUTTLEWORTH CR + VASEUX R. + PARK HILL CR - S.O.I.D. DIVERSION.

ACTUAL FLOW : OKANAGAN RIVER @ OLIVER

MONTH END DATES

Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.

19 | 19 69 | 19 70 | 19

Flow
x 1000 ac. ft.

100
90
80
70
60
50
40
30
20
10
0

Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.

19 | 1969 | 1970 | 19

OKANAGAN RIVER MONTHLY FLOWS

---- CALCULATED FLOW
—— ACTUAL FLOW

for: OKANAGAN RIVER @ OROVILLE

CALCULATED FLOW : Σ OK. RIVER @ OLIVER + TESTALINDEN CR - STORAGE @ OSOYOOS

ACTUAL FLOW : OK. RIVER @ OROVILLE

MONTH END DATES

OKANAGAN RIVER MONTHLY FLOWS

CALCULATED FLOW
ACTUAL FLOW
for: OKANAGAN RIVER @ TONASKET

CALCULATED FLOW = Σ OK. RIVER @ OROVILLE + SIMILKAMEEN RIVER @ NIGHTHAWK
ACTUAL FLOW = OK. RIVER @ TONASKET

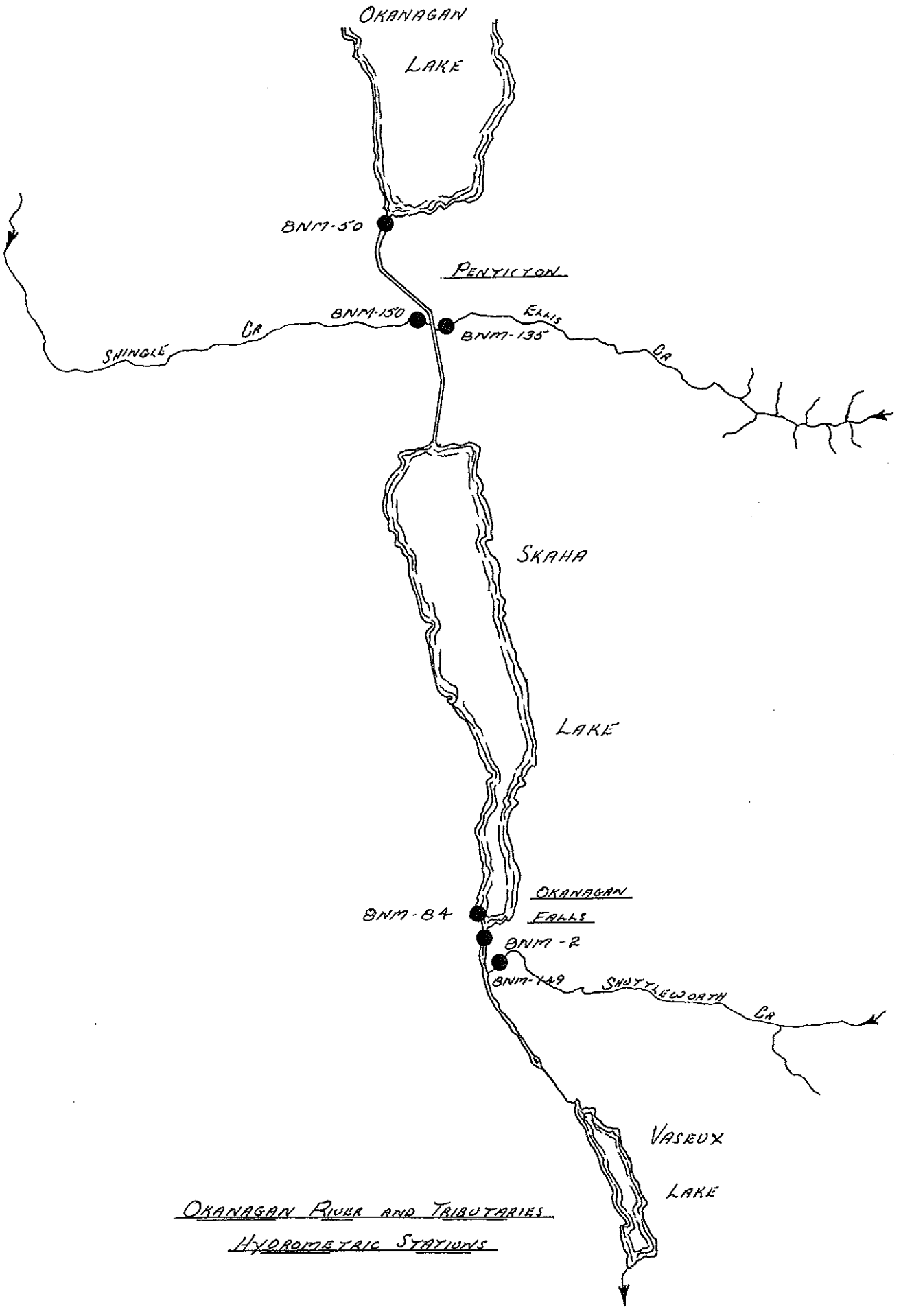
FLOW
X 10,000 cu. ft.

100
90
80
70
60
50
40
30
20
10
0

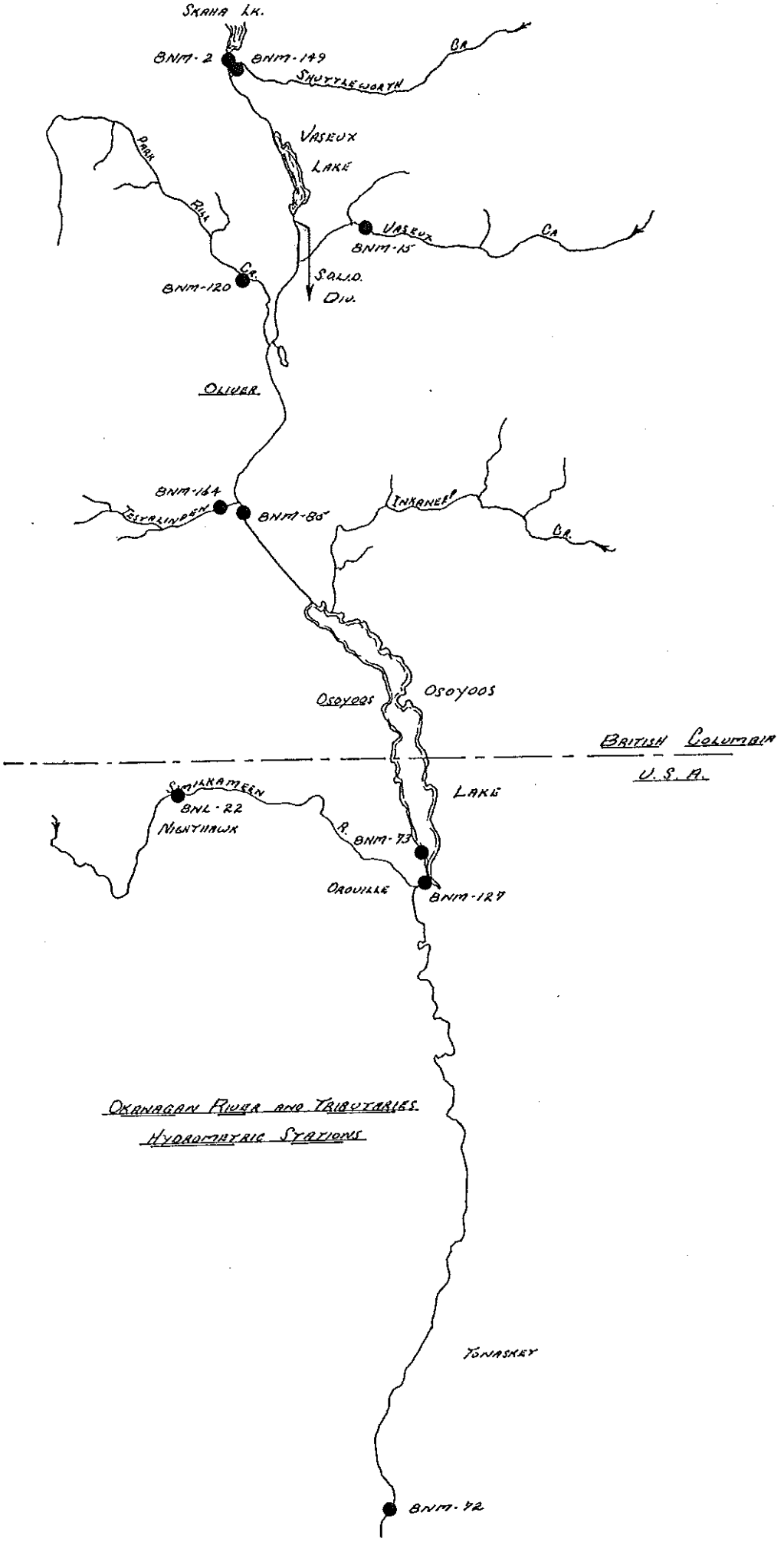
MONTH END DATES

Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.

19 | 1969 | 1970 | 19



OKANAGAN RIVER AND TRIBUTARIES
HYDROMETRIC STATIONS



OKANAGAN RIVER AND TRIBUTARIES.
HYDROMETRIC STATIONS