GROUNDWATER IN THE METHOW VALLEY

MAZAMA TO WINTHROP

Report prepared by Ernest R. Artim

Department of Natural Resources **May, 1975**

Ground Water in the Methow Valley
Mazama to Winthrop

by

Ernest R. Artim

Division of Geology and Earth Resources
Department of Natural Resources
Olympia, WA 98504

in cooperation with Okanogan County
for
The Okanogan County Planning Department

Introduction

The area of this study extends from approximately Mazama southeast 12 miles to Winthrop along the Methow Valley in Okanogan County, Washington. The valley between Mazama and Winthrop is a northwest-southeast trending u-shaped trough which lies some 1,000 to 2,500 feet below the adjacent mountains. The valley in this area has been glaciated and is partially filled with thick deposits of glacial debris. The resultant landform is a rather steep-sided, broad, flat-bottomed valley approximately 1 mile wide. The valley sides are covered with talus slopes, alluvial fans, and glacial terraces. The alluvial fans and glacial terraces are composed for the most part of sands and gravels.

Purpose

The purpose of this study was to develop a ground-water contour map of the Methow Valley approximately between Mazama and Winthrop. In addition, potential aggregate sources were delineated. The major concern expressed regarding the aggregate sources was that they should lie above the ground-water table and the thickness and horizontal extent be enough to allow economic and efficient operation without extending into or below the ground-water table.

The interpretive map shows:

1. Depth to free ground-water table – showing by use of contours the approximate elevation at which ground water could be expected to occur based upon results obtained in May, 1975.

2. Potential aggregate sources - showing areas of probable major sand and gravel deposits which meet the concerns expressed in the paragraph above.

Field Study

The field study was conducted during the month of May, 1975 utilizing a total of 17 man days. The field study consisted of a visual geological reconnaissance as well as a detailed geophysical investigation. The geophysical investigation was conducted using a portable seismograph and resistivity meter. Twenty four traverses were conducted. The results of these traverses are included in Table 1. Thirty six resistivity traverses were conducted. The approximate resistivity was calculated and plotted and the depth of the approximate break which could indicate the ground-water table was entered on the map beside the traverse location. Air photo interpretations and the calculation, interpretation, and correlation of field data was conducted in the Olympia office of the Division of Geology and Earth Resources.

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Ground-water table as used in this paper is the upper surface of the zone saturated by free ground water. Ground water will rise roughly to the water table and not above it in a shallow well penetrating a free ground-water system. The fact is known that the standing level in a well may register (1) the water table, (2) the pressure surface of a body of confined water, or (3) the highest modified pressure surface of several horizons of confined water. In the Methow Valley few wells are extended below a depth of 90 feet. Existing well logs indicate a probable free ground-water system; therefore, water levels in existing shallow wells probably represent the ground-water table.

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Geophysical methods may furnish direct or indirect information regarding the location of the ground-water table. If ground water is contained in pervious sand and gravel and resistivity measurements are not affected by moist clay layers above the ground-water table, the depth of the water table can be determined. Most curves indicating change in geophysical properties due to saturation are smooth, and, therefore, the zone of saturation is not indicated by a sharp peak (figure 1); thus, the depth to the ground-water table is not indicated with the accuracy obtained from shallow boreholes. The Bison 2350 Resistivity Meter which was used in this survey has an accuracy rating of about ± 10 to 15%; therefore, in shallow measurements the results can be assumed to be fairly close to the actual depth. For instance, if the result of a resistivity sounding indicates the ground-water table at a depth of 10 feet, the actual depth may vary from 8.5 to 11.5 feet, but for the purposes of this survey has been assumed to be accurate at about 10 feet.

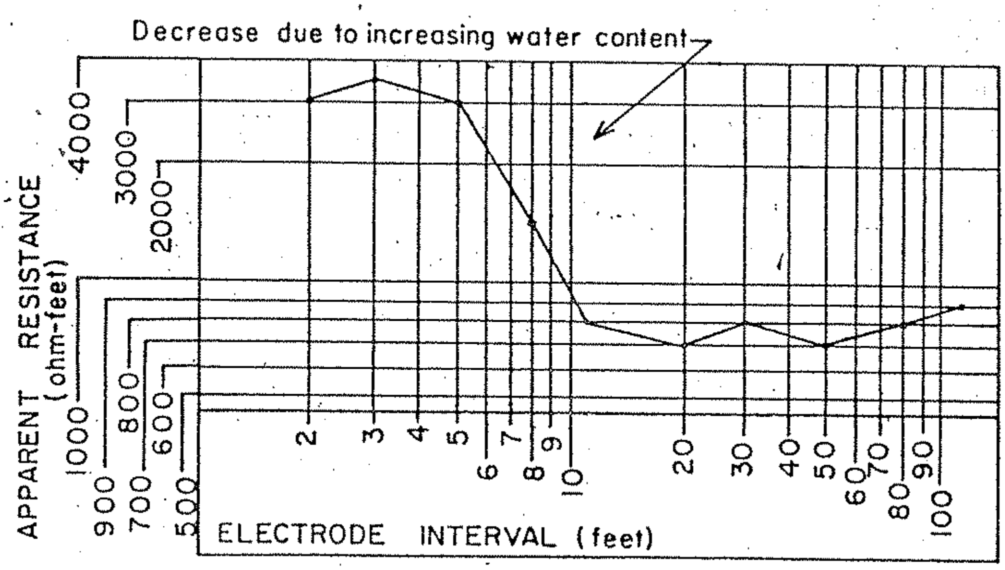

Figure 1: Example of a resistivity curve.

The depth of any point is approximately 1/3 of the electrode interval distance. In this example the change occurs between the intervals of 5 and 12 feet; therefore, the apparent ground-water table occurs approximately between the depths of about 2 to 4 feet. Using a conservative approach a depth to the ground-water table of 4 feet will be plotted.

Talus deposits (Qsw) generally contain a high percentage of oversize material, which would require extensive crushing and washing of the material; however, these types of deposits are sometimes utilized as rip-rap sources.

The two types of deposits which come the closest to meeting the concerns expressed in the purpose of this report are the alluvial fan deposits (Qaf) and the older river and glacial terrace deposits (Qt). These deposits generally lie well above the ground water table, and the thickness and horizontal extent should be enough to allow for an economical and efficient mining operation. It should be pointed out that no sampling or testing of the material was performed for this investigation. These opinions are based on the visual geological reconnaissance and the geophysical investigation.

Limitations

The use of this report and map in the evaluation of ground-water conditions is limited by the state of the art, available information in literature, and a practical geological and geophysical field investigation.

The conclusions, data, and opinions made in this report are based on conditions present in May of 1975 and are made for land use preplanning purposes only. This report is not intended to be, nor should it be used as, a geologic or ground-water report for any given site. In all cases, a geologic ground-water report by private consultants is recommended for individual site evaluations and investigations.

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Legend

Qal	Valley fill - mostly sand and gravel with some silts overlying glacial debris.
Qsw	Talus deposits - mostly angular blocks of rock with finer disintegration particles - located along base of steeper valley sides.
Qaf	Alluvial fan deposits - fanglomerate-like material - mostly sand and gravel.
Qrt	Older river and glacial terrace deposits - mostly sands and gravel with large percentages of finer particles.
U	Undifferentiated Pleistocene and pre-Pleistocene deposits - mostly bedrock.
— — —	Approximate location of a geologic contact.
⊗ 6'3" 5-19-75	Approximate water well location used as key wells. Depth to water table and measurement shown.
TR-5 —O— 10'	Approximate location of resistivity traverse - approximate depth to resistivity break shown.
T-1 →	Approximate location and direction of seismic traverse.
2030	Ground-water table contour - based on datum mean sea level (1947), and field data collected in May (1974).

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Seismic Traverse Number	Seismic Velocity (fps)	Depth	Comments
T-1	900	0-3½'	dry, loose earth material
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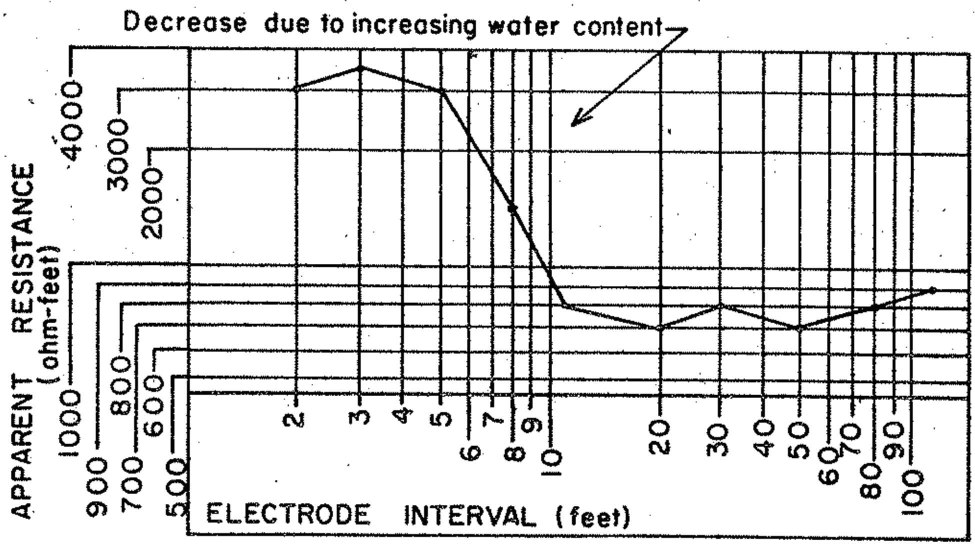

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Findings

Ground Water

The results of the visual geological investigation as well as the geophysical investigation indicate that the ground-water conditions in the Methow Valley between Mazama and Winthrop are not unlike those of other valleys with similar geologic histories and settings. The ground-water table during May, 1975 was at a high stage and was, in effect, "feeding" water to the Methow River. From verbal communications with residents of the valley, the Methow River in late summer and fall very nearly dries up and at that time "feeds" water to the ground-water system.

The ground-water contours run at approximately 90 degree angles to the axis of the valley and form a subshadow of the existing ground surface contours. The ground-water contours form a uniform slope downstream, except where the river cuts across the valley and intercepts the ground-water table. It was noted that Goat Canyon, Wolf Canyon, and several other tributary drainages apparently form ground-water "highs" near their confluence with the Methow Valley. The result is that, instead of the ground-water contours running almost perpendicular to the axis of the valley, on the influenced side of the valley the ground-water contour bends down valley. Actual depths to the ground-water table are dependent upon surface elevations; however, the interpretation is rather straight forward. To estimate depth to the ground-water table locate a point on the map and obtain the approximate ground surface elevation, for instance, 2,085 feet. Next obtain the approximate ground-water contour elevation, for instance, 2,030 feet. Subtract 2,030 feet from 2,085 feet to obtain the approximate depth of 55 feet to the ground-water table.

Sand and Gravel

Four Quaternary units were mapped: valley fill (Qal), talus deposits (Qsw), alluvial fan deposits (Qaf), and older river and glacial terrace deposits (Qt). All of these units are composed of various percentages and forms of aggregate materials.

The valley fill (Qal) is composed of river sand and gravel deposits with some silt layers. Units such as this generally contain, and are generally utilized as, excellent local deposits of sand and gravel; however, in the Methow Valley the shallow ground-water table would usually cause this unit to be excluded as a potential source of aggregate. This exclusion is based on the concerns stated in the purpose of this specific investigation.

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JOHN SPELLMAN
Governor

DONALD W. MOOS
Director

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
3601 West Washington • Yakima, Washington 98903 • (509) 575-2800

M E M O R A N D U M

WRIA ~~38~~ 49
WANNACUT LAKE

TO: Glen Fiedler
John Spencer

THROUGH: Bruce Cameron

FROM: Mike Wilson MW
John Hodgson

SUBJECT: Wannacut Lake

DATE: February 8, 1984

A field examination of Jamison, Wannacut, Blue and Alta Lakes was made on February 2nd and 3rd. This memo will deal with the Wannacut/Blue Lakes situation. More will follow on the other two.

We held a meeting regarding the Wannacut/Blue water levels at the Whitestone Church on the evening of February 2nd. This followed our field exam of that afternoon. Present at the meeting were property owners on Wannacut Lake, land owners in "Whiskey Draw" to the south, owners of property around Whitestone Lake and representatives of the Whitestone I.D. that controls Whitestone Lake, a property owner of land riparian to the Whitestone Lake outlet and a land owner of orchard land east of Blue Lake. No owners of property around Blue Lake were present. Paul Inlow of the Cattleman's Association, Ken Williams of WDOG and Barry Nelson of Okanogan County Health were also present. A copy of the attendance sheet is attached.

We approached the meeting as a fact finding mission and tried not to offer solutions nor promise assistance.

PUBLIC CONCERNS:

John Donahue, spokesman for the Wannacut L. Property Property Owners Association and the owner of Sun Cove Resort, led off with a brief history of the problem. Briefly, lake levels are available back to the '30's with some historical accounts prior to that. They show fluctuating lake levels in high/low cycles, but no levels as high as present. June, 1982, to present has been a period of unusually high inflow. A three foot increase over 1982 was recorded, and a 10 foot rise in 1983. There is no outlet stream. Mr. Donahue claims a total of $500,000 damage to all owners, to date, with another $500,000 in property threatened. He has estimated the lake has increased in surface area from 420 to 550 acres.

The property owners are looking for county, state and/or federal funds to do feasibility studies and/or construction of works to pump water from the lake to reduce the lake level to pre-1982 levels. Three basic pumping solutions were proposed. They were: (1) pump water from Wannacut into Blue Lake to the north; (2) pump water to the Okanogan River via Blue Lake and an unnamed drainage; and (3) pump water to Whitestone Lake via "Whiskey Draw".

Additional "testimony" was offered by the Heisermans, a retired couple whose home is flooded to within one foot of the wood structure. The concrete basement is totally submerged. They estimate they will have to spend $15,000 to move the home to higher ground. Mrs. Heiserman made thinly veiled mention of a suit against the state because "the water belongs to the State".

Concerns of the landowners over which the pumped water might go seemed to be nearly the same. Open discharge of water would probably damage land over which water does not currently flow, and the intermittent channels with seasonal flow might not be adequate for the increased flow.

THE PLANS:

Blue Lake

Although no representatives of Blue Lake landowners were present, it seems that there would be several drawbacks to using Blue Lake as the terminal site for pumped water. Blue Lake itself is much higher than previous levels, and, although no homes are involved, much land has been inundated. Any additional water added would cause a loss of the established riparian habitat, about one mile of county road and additional range land. It is unlikely that the Blue Lake area could accept the quantity of water necessary from Wannacut. Water quality in Wannacut could be better than that in Blue. Rights of way over several ownerships would also have to be obtained.

Okanogan River

To pump water via the Blue Lake drainage and the unnamed draw to the east of Blue Lake into the Okanogan River also has some drawbacks. This draw is very intermittent. It appears that unless large flows occur that the water usually disappears into the alluvial fan at the base of the draw. There is no established channel over this fan, and it is planted to well established orchard. Unpiped water of any significant volume would damage this orchard. There is also the water quality effects on the Okanogan River to address particularly during low flow months. Wannacut water in the river could potentially exacerbate the Okanogan milfoil problem by literally fertilizing it. There is also the question of acceptance by the Tribe, a Corps permit for a discharge structure and rights of way across several ownerships, and compliance with 90.48 RCW, 173-201 WAC and the FWPCA.

Whitestone Lake

Property owners in "Whiskey Draw" are very concerned about erosion or other damage due to open flow through this intermittent channel. The question of the adequacy of culverts under roads to the east and west of Whitestone Lake was raised. Also of concern is the fact that Whitestone Lake cannot receive more water without spilling a like quantity. The outlet channel is not now adequate to handle the existing quantity and could conceivably do property damage downstream. The Game Department is concerned about the quality of Wannacut water and its impact on the spiny ray species in Whitestone. Dilution in Whitestone should eliminate adverse impact on the ultimate receiving water (the Okanogan). The provisions of 90.48 RCW, 173-201 WAC and the FWPCA would apply, and rights of way would have to be obtained.

Also not considered in any of the above plans is the necessity of setting a lake level on Wannacut Lake if asked to do so by the Game Department.

TECHNICAL DATA:

The following is preliminary data on watershed and system requirements to complete the various plans for pumping from Wannacut lake as prepared by Bob Barwin:

Watershed area = 16.2 mi^2 = 10364 acres

Surface area = 0.64 mi^2 = 411 ac @ 1850 msl

Mean annual precipitation = 20 in/yr = 508 mm/yr

Mean annual temperature = 45°F = 7.2°C

From Castany, 1967:

$$L = 300 + 25(7.2) = 0.05(7.2)^2 = 483$$

$$\overline{P} - ET = 508 - \frac{508}{\left[0.9 + \frac{508^2}{483^2}\right]^{\frac{1}{2}}} = 149 \text{ mm/yr} = 5.88 \text{ in/yr}$$

Average annual watershed yield = excess moisture - lake evaporation

$$= 10364 \frac{(5.88)}{(12)} - 450(3)$$

$$= 3730 \text{ ac-ft/yr}$$

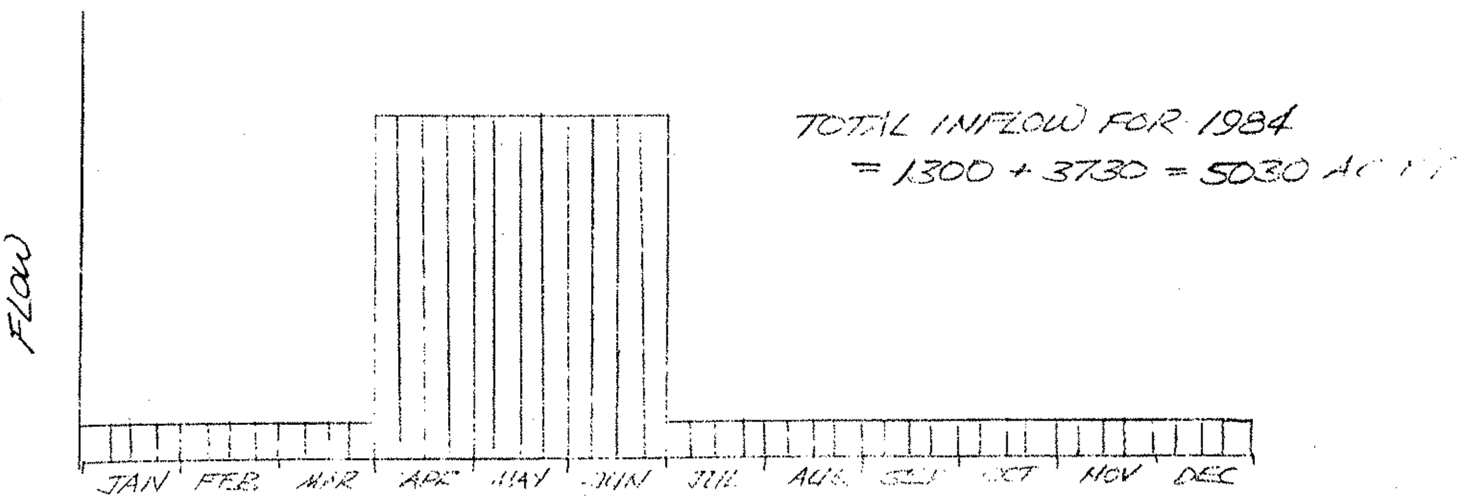
$$= 5.1 \text{ cfs}$$

John Donahue reports that the 13 foot lake level increase experienced in the 1982-1983 water years has increased the lake surface area from 420 ac. to 550 ac. This 6300 ac-ft. change in storage (neglecting the increase in aquifer water levels adjacent to the lake) is the amount by which the watershed yield for 1982 and 1983 would have exceeded the long-term average. Approximately 3 ft. (1300 ac-ft.) of the lake level increase occurred during 1982 and 10 ft. (5000 ac-ft.) occurred during 1983. In order to cause a meaningful lake level decline, it would be necessary to pump an amount of water on an annual basis which exceeds any amount of inflow to the lake that is greater than the long-term average plus a fraction of the long-term average.

To size such a pump facility it is necessary to make an assumption about the watershed yield during the pumping period. For the purposes of the following analyses, it will be assumed that the lake is at its January 1984 level (surface area = 550 ac.) and that the 1984 climatic conditions will result in a watershed yield equal to that of 1982. It is also assumed that 75% of the watershed yield reaches the lake during the period from April 1 to June 30.

The attached pages discuss the effects of pumping Wannacut Lake and attempt to approximate the resulting water level changes.

INFLOW TO WANNACUT LAKE (PROJECTED)

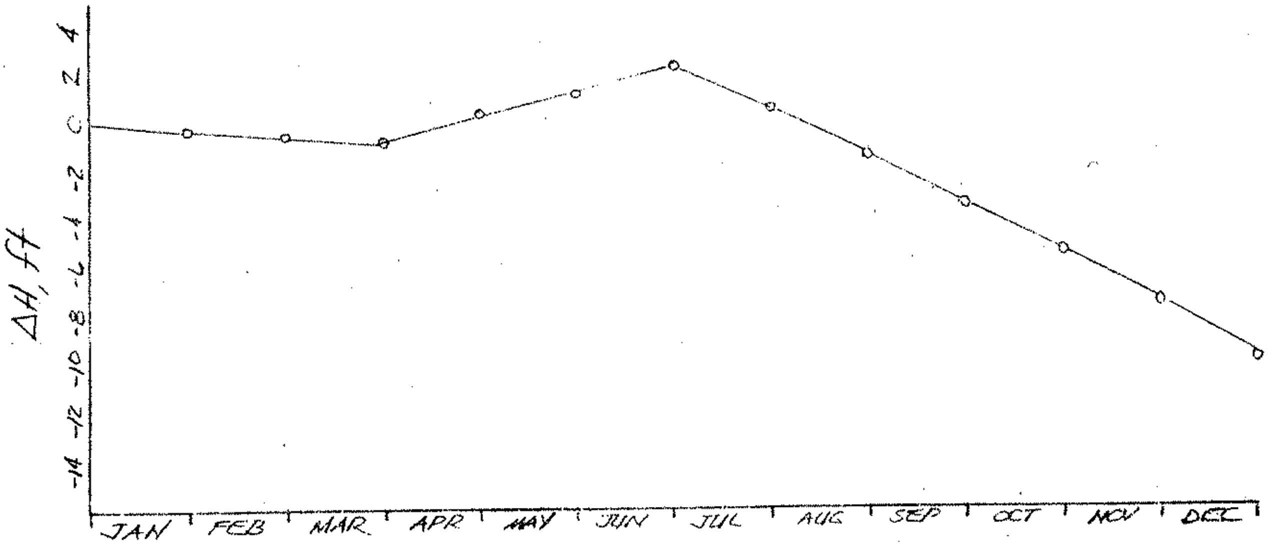


Desired Objective: To cause a lake level decline of 10 feet from the January, 1984, level by puming from April 1, 1984 to December 30, 1984.

Total Volume of Water to be Pumped: 6300 acre-feet.

Pumping Rate: $\frac{6300}{2 \times 270}$ = 11.67 ft³3/s = 5240 gpm

PROJECTED 1984 LAKE LEVEL FLUCTUATION
PUMPING 11.67 cfs FROM 4/1 TO 12/31



As can be seen from the graph, even if pumping were to begin on April 1, 1984, at a rate sufficiently high to cause a 10-foot decline from present levels, the lake will still rise approximately two feet from its present levels before it will begin a decline in mid-summer. The following table has been prepared to illustrate the resulting water levels due to higher pumping rates, but it should be kept in mind that higher pumping rates will result in larger water quality impacts on receiving waters (and perhaps in Wannacut Lake), larger capital costs, and, depending on the means of conveyance, higher liability and difficulty obtaining easements.

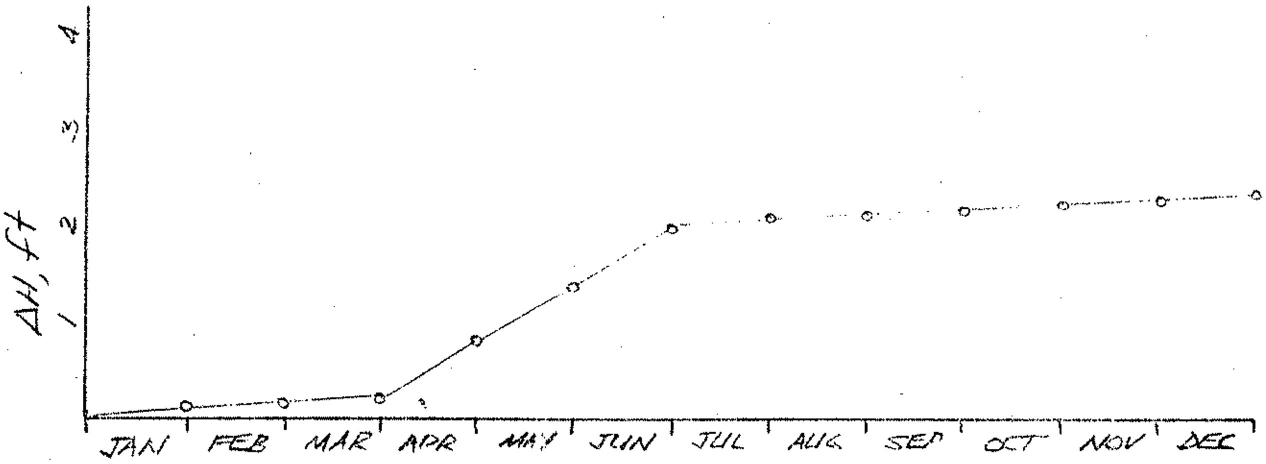
Pumping Rate	Pumping Duration*	Highest Level**
11.67 cfs	270 days	+2.1 ft
15	210 days	+1.0 ft
20	158 days	present
30	105 days	present
40	79 days	present

*Duration required to achieve a 10-foot decline from 1/84 to 1/85.

**Relative to 1/84 lake level.

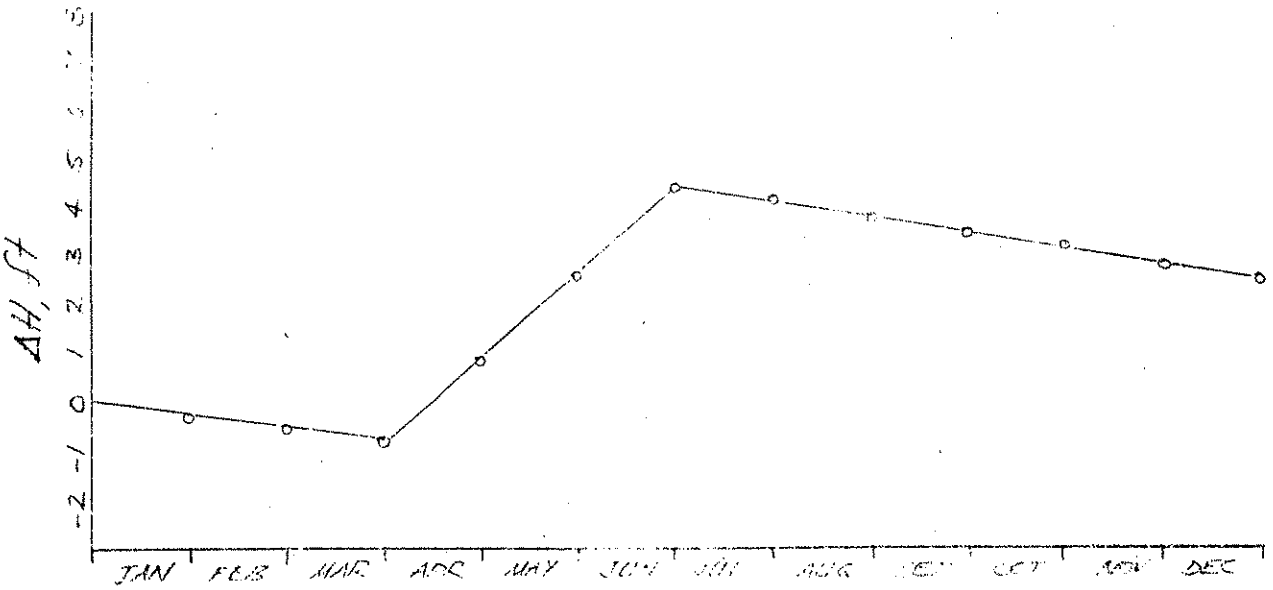
To Glen Fiedler, John Spencer
Through Bruce Cameron
From Mike Wilson, John Hodgson
Wannacut Lake
February 8, 1984
Page Five -

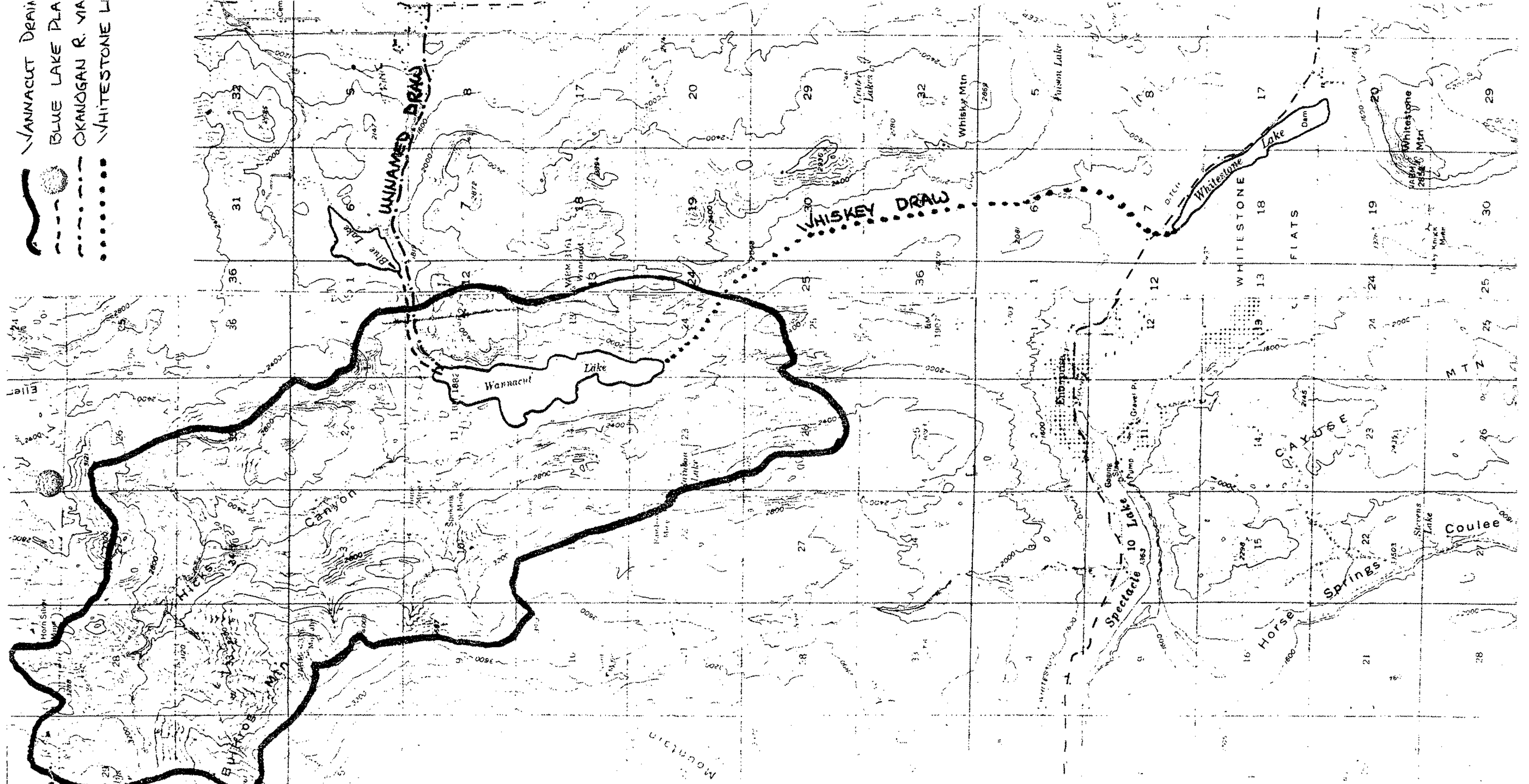
LAKE LEVEL FLUCTUATION DUE TO 1300 AC-FT
OF INFLOW ABOVE LONG-TERM AVERAGE (NO PUMPING)



The above graph depicts the additional lake level fluctuation due to a better-than-average water year, like 1982. If the estimate of the watershed yield is reasonably accurate, the expected lake level fluctuation for the 1984 year will be as shown in the following graph:

PROJECTED 1984 LAKE LEVEL FLUCTUATION
No Pumping





WANNACUT DRAI
BLUE LAKE PLA
OKANOGAN R. VIA
WHITESTONE L
UNNAMED DRAW
Blue Lake
WHISKEY DRAW
Wannacut Lake
Whisky Mtn
Whitestone Lake
Dam
Whitestone Mtn
WHITESTONE FLATS
CAYUSE MTN
Spectacle Lake
Horse Springs Coulee
Stevens Lake
Canyon
Hicks
Burros Mtn
Mountain

ACUT LAKE OKANOGAN COUNTY

LATITUDE 48*52' 5" LONGITUDE 119*30'54" T39N-R26E-24
OKANOGAN RIVER BASIN

PHYSICAL DATA

DRAINAGE AREA	20.0 SQ MI
ALTITUDE	1880. FT
LAKE AREA	410. ACRES
LAKE VOLUME	23000. ACRE-FT
MEAN DEPTH	55. FT
MAXIMUM DEPTH	160. FT
SHORELINE LENGTH	5.4 MI
SHORELINE CONFIGURATION	1.9
DEVELOPMENT OF VOLUME	0.35
BOTTOM SLOPE	3.3 %
BASIN GEOLOGY	IGNEOUS
INFLOW	INTERMITTENT
OUTFLOW CHANNEL	ABSENT

CULTURAL DATA

RESIDENTIAL DEVELOPMENT	8 %
NUMBER OF NEARSHORE HOMES	11
LAND USE IN DRAINAGE BASIN	
RESIDENTIAL URBAN	0 %
RESIDENTIAL SUBURBAN	0 %
AGRICULTURAL	8 %
FOREST OR UNPRODUCTIVE	89 %
LAKE SURFACE	3 %
PUBLIC BOAT ACCESS TO LAKE	YES

WATER-QUALITY DATA (IN MG/L UNLESS OTHERWISE INDICATED)

SAMPLE SITE	1	
DATE	7/22/74	
TIME	1135	1140
DEPTH (FT)	3.	131.
TOTAL NITRATE (N)	0.00	0.14
TOTAL NITRITE (N)	0.00	0.09
TOTAL AMMONIA (N)	0.40	52.
TOTAL ORGANIC NITROGEN (N)	0.60	17.
TOTAL PHOSPHORUS (P)	0.008	7.2
TOTAL ORTHOPHOSPHATE (P)	0.003	3.7
SPECIFIC CONDUCTANCE (MICROMHOS)	5500	35000
WATER TEMPERATURE (DEG C)	20.6	11.1
COLOR (PLATINUM-COBALT UNITS)	15	--
SECCHI-DISC VISIBILITY (FT)	15	
DISSOLVED OXYGEN	9.0	0.0

LAKE SHORELINE COVERED BY EMERSED PLANTS	11- 25 %
LAKE SURFACE COVERED BY EMERSED PLANTS	NONE OR <1 %

DATE	7/22/74
TIME	1204
NUMBER OF FECAL COLIFORM SAMPLES	5
FECAL COLIFORM, MINIMUM (COL./100ML)	<1
FECAL COLIFORM, MAXIMUM (COL./100ML)	6
FECAL COLIFORM, MEAN (COL./100ML)	2

REMARKS

A SLIGHTLY SALINE LAKE. THE LAKE HAS SEVERAL RESORTS AND RECREATIONAL USE IS HEAVY. HYDROGEN SULFIDE WAS DETECTED IN THE HYPOLIMNION. IN 1975 THE U.S. GEOLOGICAL SURVEY WILL SAMPLE THE LAKE FOUR TIMES. THE LIMNOLOGY OF WANNACUT LAKE WAS DESCRIBED BY BENNETT (1962) AND WALKER (1974). A COLOR DETERMINATION OF THE DEEP WATER SAMPLE WAS NOT MADE.

Property owners discussed three alternative proposals to remove water from Wannacut Lake:

1. Pump water to Blue Lake.

2. Pump water to Okanogan River via Blue Lake.

3. Pump water to Whitestone Lake via Whiskey Creek.

Each of the alternatives share the following elements:

1. Easements will be required for conveyance facilities.

2. Owners from whom easements will be required are not enamored with the prospects of an open discharge into Whiskey Creek or the draw below Blue Lake. As a result, I will only consider the alternative projects as being piped from Wannacut Lake to the receiving water.

Alternative No. 1:

Pipeline Length	= 7000 ft
Elevation Diff.	= -70 ft
Pumping Rate	= 11.67 cfs
Pipeline Dia.	= 14 in
Total Dyn. Head	= 140 ft
Horsepower Req'd	= 265 hp

The surface area of Blue Lake is 111 acres at elevation 1183 MSL. Problems associated with the alternative include limited storage capacity (it would not contain all 6300 acre-feet required to be pumped from Wannacut Lake), the possibility of seepage from Blue Lake forming a creek and inundation of a county road.

Alternative No. 2:

Pipeline Length	= 2400 ft
Elevation Diff.	= -930 ft
Pumping Rate	= 11.67 cfs
Pipeline Dia.	= 14 in
Total Dyn. Head	= 100 ft (minimum discharge head to avoid excessive negative pressure)
Horsepower Req'd	= 190 hp

Alternative No. 3

Pipeline Length	= 30,000 ft
Elevation Diff.	= -450 ft
Pumping Rate	= 11.67 cfs
Pipeline Dia.	= 16 in
Total Dyn. Head	= 80 ft (minimum discharge head to avoid excessive neg. pressure)
Horsepower Req'd	= 150 hp

In addition to conveying water from Wannacut Lake to Whitestone Lake, this alternative may require improvement of the Whitestone Lake outlet stream channel which is reported to be flowing at or near its bank-full capacity at this time.

It should be kept in mind that the pipeline and horsepower estimates are very preliminary and would vary greatly for different pipeline routes along the general paths described.

WATER QUALITY:

The existing water quality data on Wannacut Lake would tend to show that any receiving water could potentially be adversely impacted. Reconnaissance Data on Lakes in Washington, Vol. 5 (USGS, 1976), describes Wannacut Lake as a slightly saline lake with conductivity of 35,000 micromhos. (See also the attached sheet for additional physical, cultural and water quality data from that source.)

Pumping of 11.67 cfs could generate up to 7.6 million gallons of wastewater per day containing 3296 lbs of ammonia nitrogen, 1078 lbs of total organic nitrogen and 456 lbs of total phosphorous. Such quantities of fertilizer could pose toxicity and/or enrichment problems in a receiving water given a 270-day pumping period.

A comprehensive limnological investigation would be necessary to firmly establish the water quality of Wannacut Lake and determine from what level water could be pumped, given expected stratification, to minimize receiving water impact. Also to be considered is the quality of remaining water and its impact on aquatic life.

MAW:JH:RFB:mjj

Attachments

Paper oversized drawing/map enclosed

MAZAMA to WINTHROP MAP