SALMON ARM TERTIARY

TREATMENT ALTERNATIVES

CONTRIBUTING AUTHORS:

E. R. Haughton, P. Eng.
Waste Management Branch
Ministry of Environment

R. N. Nordin, Ph. D. (Section 2.0)
Environmental Studies Division
Ministry of Environment

P. Epp (Portfolio and Section 3.2)
Resource Analysis Branch, Kelowna
Ministry of Environment

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1.0 INTRODUCTION

Mayor Lund of Salmon Arm wrote to the Minister of Environment in October, 1978, seeking assistance in resolving Salmon Arm's effluent disposal problems. The present STP discharge is to the Salmon Arm of Shuswap Lake. The treatment is biological, without nutrient removal. Previous reports have recommended spray irrigation and exfiltration (1, 2). Unfortunately the sites recommended in the reports were not acceptable for various reasons, such as high water tables and groundwater contamination at the spray irrigation site.

The Resource Recovery Section was assigned the task of looking at possible spray irrigation sites, and of presenting spray irrigation costs and in-plant phosphorus removal costs. The sites selected for spray irrigation are the most favourable locations available (excluding reservation land), based on information provided by the Resources Analysis Branch. The area evaluated falls within the boundaries of the Resources Analysis land evaluation maps appended. A complete explanation of the method of land evaluation is included with the maps.

The preliminary costs for developing the spray irrigation sites are for comparative purposes. Capital costs are conservative; however, annual costs are based on interest rates of 12% and may require readjustment, particularly considering the extreme fluctuation in interest rates in recent weeks.

The Salmon River mixing patterns vary with the seasons and furthermore the density current formed by the river after entering Salmon Arm cannot be controlled with regard to mixing and diffusion. The STP discharge can be either diffused into the epilimnion (upper mixed zone) or the hypolimnion (deep non-mixed zone). Both have serious drawbacks. If the nutrients flow into the epilimnion, extensive mixing takes place and the nutrients are more available to phytoplankton than if they flowed into the hypolimnion. If the treated effluent is directed into the hypolimnion, oxygen depletion may be encountered if the inflow has significant amounts of material with biological oxygen demand.

The levels of nutrient loading which are acceptable is difficult to comment on. Several schemes relating water quality to major uses have been based on chlorophyll a content of the water, (an index of algal growth), water clarity, or oxygen content. Minimum chlorophyll and maximum water clarity are advantageous for drinking water supplies or recreation, but a more productive lake system is advantageous in terms of fisheries production (as is shown by the lake fertilization projects of the Salmonid Enhancement Program), and absolute levels are difficult to establish. However, a situation of very high productivity characterized by algal blooms, poor water clarity and hypolimnetic oxygen depletion is unfavourable for most human uses, and obviously should be avoided.

Some information from the literature is available on which to base estimates of changes in phosphorus loading. It is difficult to speculate what the historical productivity of Tappen Arm has been. A report by the International Pacific Salmon Fisheries Commission and the Department of Fisheries Canada (I.P.S.F.C.) documents the very large sockeye runs which existed on the Salmon River in the pre-Hell's Gate slide period (pre 1912). Estimated runs in peak years was 150,000 fish. This number of spawners would certainly contribute a large amount of nutrients to the lake system, but unfortunately other relevant limnological data is lacking, so it is difficult to speculate if Tappen Bay has historically been more productive than the rest of the lake.

There has been good current information collected by Dr. Jim Bryan of the Waste Management Branch, Vernon, on which to assess the present water quality of Tappen Arm. The most significant feature of Tappen Arm is the relatively high productivity compared to other areas of Shuswap Lake. The mean chlorophyll a for Tappen Bay (1978 - 79) is 4.8 mg/m^3 as compared to the main body of the lake, where the comparative value is 1.0 mg/m^3

A number of calculations can be made (see Appendix E) to estimate the response magnitude of Tappen Arm to different phosphorus loadings and the response time involved in these changes.

The spring overturn total phosphorus concentration for Tappen Arm in 1979 was about 17 µg/L. Therefore, the loading to the water body would be 7.3 metric tonnes of phosphorus per year. Another estimate of loading, PE-1251 memo of February 26, 1979, was 8.4 tonnes per year using inflow volumes and concentration. Normally the loading calculated from lake concentration would be lower because of loss to, and dilution by, the main lake.

On this basis, some theoretical estimates can be made of the effects of changes in the phosphorus loading on the algal growth and water clarity of Tappen Arm. For instance, if the STP discharge were cut back by 90%, the loading to Tappen Arm would be reduced by about 3 tonnes per year (about 35 - 40% of the total load). With a phosphorus load of 5 tonnes per year, the overturn phosphorus would be reduced from the present 17 µg/L to 11.7 µg/L.

What this means in terms of algal growth and water clarity is that the theoretical mean summer chlorophyll would be reduced from 4.4 mg/m^3 to 2.7 mg/m^3, and the average water clarity increased from about 2.8 metres to about 3.7 metres. The decrease in loading results in a disproportionately higher water clarity reading because the relationship of phosphorus to chlorophyll is a logarithmic one (Appendix A).

The other possibility to examine is what would occur if a 25% increase in phosphorus loading were to occur. In this case the overturn phosphorus would increase to 21.2 µg/L, resulting in a mean summer chlorophyll of 6.0 mg/m^3 and a water clarity of about 2 metres.

2.0 TAPPEN ARM PHOSPHORUS CONCENTRATIONS

The amount of phytoplankton (algal) growth in lakes is dependent on two predominant factors: the amount of nutrients entering the water body (loading) and the bulk water residence (flushing) time.

The nutrient loading to the lake determines the concentrations which are directly related to the amount of algal growth. The two major nutrients are nitrogen and phosphorus, and in the case of Tappen Arm, phosphorus is the limiting factor to algal growth.

The major sources of phosphorus to the Tappen Arm of Shuswap Lake at Salmon Arm are the Salmon River and the Salmon Arm Sewage Treatment Plant (STP). The STP contributes a larger portion of biologically available phosphorus. Considering that the Salmon River Valley is presently extensively farmed, the Salmon River phosphorus loading to the lake is unlikely to increase significantly. The population of the municipality of Salmon Arm will increase, and the phosphorus loading to Salmon Arm from the STP will increase in proportion to the rate of population growth, assuming of course that the plant design is not altered.

The phosphorus concentration (spring overturn) in the shallow Tappen Arm is approximately 16 - 17 µg/L; in the main channel, 5 µg/L. The difference is largely due to the excess phosphorus loading from the Salmon River and the treatment plant.

The second factor which has an effect on phytoplankton growth is water residence time. The volume of Tappen Arm is approximately 768 million cubic metres. The discharge from the Salmon River is 196 million cubic metres per year. Thus the theoretical time to replace the lake volume would be 3.9 years. However actual residence time, may be somewhat less because of other inflows and mixing with the main lake body. Relative to other lakes, the Tappen Arm has a relatively long residence time and therefore the Arm is susceptible to increased phytoplankton growth as compared to a body of water which is well flushed.

The question of response time of the water body can also be considered. If a change in phosphorus loading takes place, the time to reach the new equilibrium lake concentration is a function of the water exchange time and the lake volume. In the case of Tappen Arm, with a fairly long water exchange time and large volume, the response time is calculated to be between 3.7 and 6.2 years.

Because of the large number of factors involved in affecting lake productivity, it is emphasized that these calculations have been very much simplified. The estimates give some idea of both magnitude and timing of changes involved with the modification of phosphorus loading.

A level of certainty can be indicated based on experience with some of the relationships described. Some idea of the range of possible responses is shown on the graph (Appendix A) which indicates the 50% and 95% confidence interval for the phosphorus-chlorophyll relationship.

If phosphorus input to Tappen Arm is reduced, when will change occur? The response time of the water body, in this case, is an important point. If a reduction is affected, the results will only be evident some years later. However, to delay any reduction means that loadings will continue to increase and consequently the improvements in water quality will be delayed.

The key question is whether or not the present water quality is acceptable; the answer to this, however, is not within the bounds of scientific speculation. How much of a reduction should be carried out and on what schedule is a managerial decision, and the scientific data provided here will, it is hoped, provide some guidance.

3.0 SEWAGE DISPOSAL

The Pollution Control Permit (PE-1251) stipulates maximum concentrations of Biochemical **Oxygen** Demand (BOD) 30 mg/L and Total Suspended Solids (TSS) 40 mg/L to the lake and BOD 45 mg/L and TSS 60 mg/L to the ground. All effluent presently is discharged to the Salmon Arm of Shuswap Lake without nutrient removal.

According to Dayton and Knight, (2), 1975:

> "Planning studies predict the year 2020 population to be served equal to 25,000 persons generating an average dry weather flow of 2.5 MGD of sewage. It is anticipated that an average dry weather flow of 625,000 gpd will be generated in 10 to 15 years. It is for this quantity of flow, at today's per capita flows corresponding to a population equivalent 7,500 to 10,000 people, that the first stage facilities were constructed. Conduits were designed for the ultimate population; pumping station and the treatment works for 625,000 gpd with provision for doubling and redoubling the capacity.
>
> Metered flows in the 1972 survey showed an average dry weather per capita contributions of about 0.21 m^3pd (55 gpd) increasing during periods of freezing weather to about 0.30 m^3pcpd (80 gpcpd). The ultimate design average dry weather contribution is 0.38 m^3pcpd (100 gpcpd) with 4.7 m^3phapd(500 gpapd) allowed for infiltration. Peak design flows are calculated at peak dry weather flows plus peak infiltration. For design, therefore, the peak flow to the treatment plant in stage one is 6 600 m^3pd (1.75 mgd), and the average dry weather flow is 2 344 m^3pd (0.62 mgd)."

MGD - million gallons per day
m^3pd - cubic metres per day
gpd - gallons per day
m^3pcpd - cubic metres per capita per day
gpcpd - gallons per capita per day
m^3phapd - cubic metres per hectare per day
gpapd - gallons per acre per day

The preceding design figures will be utilized for systems design. Spray irrigation and chemical removal will be evaluated.

3.1 Spray Irrigation

Spray irrigation of treated waste water is a method of land disposal designed to prevent pollution or degradation of land, surface water or groundwater. The following guidelines(4) will be used by the Waste Management Branch in assessing applications for pollution control permits. In all cases flexibility in design is encouraged.

The design of the spray irrigation system assumes that nutrients are used by plants and microorganisms, and water is lost to the atmosphere by evapotranspiration. Ideally a balance is maintained between the the effluent components, soil, climate and crops, incorporating the best current agronomic, forestry health and engineering practice.

The Waste Management Branch(4) in conjunction with the Ministry of Health produced minimal criteria for spray irrigation. The criteria presented in Appendix D will safeguard people, crops and cattle from the disease risks inherent in spray irrigating treated municipal effluent. In particular the process requirements were selected to reduce bacteria and virus content of spray aerosals below a level of risk acceptable to the Ministry of Health and to prevent perpetuating the life cycle of parasites. The agreement reached, that buffer zones are no longer required, will result in a great saving in irrigable land already in short supply. Where storage or treated effluent is not provided, as required in Table 1, buffer zones are required. Specific details are contained in the "Guidelines for Municipal Effluent Application to Land", soon to be published. Prior to the release of the report, specific criteria regarding a spray irrigation scheme can be obtained from the Waste Management Branch in Victoria.

Generally, designing for irrigation methods of disposal shall take into account all the characteristics of the crops, the soil capabilities and limitations, and the climatic conditions to achieve a water and nutrient balance that will not detrimentally affect the natural soil structure or other soil properties, surface or groundwater. The best use of current agronomic, forestry and engineering practices must be incorporated to optimize the soil plant relationships for extended periods of time (5).

3.2 Site Selection

The Resources Analysis Branch has completed an analysis of soil and climate information from the Tappen area to Silver Creek, west of Salmon Arm, and from Salmon Arm to Gardom Lake, southeast of Salmon Arm, concentrating mainly on valley bottoms and adjacent lower slopes. A copy of the completed portfolio is included with this report.

The results of this soil and climate analysis show that most of the soils close to Salmon Arm are not ideally suited for effluent irrigation. Various limitations such as wetness, adverse topographies and medium to low soil moisture deficiencies, either singly or in combination, result in dominantly medium to poor suitabilities for effluent irrigation. Small units with no significant soil limitations do occur close to Salmon Arm but they are generally divided into small holdings. However three areas were selected as possible spray irrigation sites, see Figure 1.

There is a suitable site in the Tappen area about 16 km north of Salmon Arm, Figure 2. About 800 hectares of clay to silty clay loam soils, on gently sloping undulating lacustrine, are in this area. The major soil limitation here is the moderately low soil moisture deficit. Estimates indicate that about 300 hectares would be required to dispose of 2 840 m^3pd (0.625 mgd) average design daily flow from the treatment plant onto these soils, assuming an irrigation efficiency of 72%.

Based on a site inspection by the Ministry of Environment's regional staff and an evaluation of air photographs construction of a storage lagoon in the Tappen area is possible. There are two alternatives: (1) excavating a lagoon in the lacustrine materials which underlie the area to be irrigated. These lacustrine materials are fine textured, clay to clay loams, and with compaction would be relatively impermeable: (2) damming a gully in the lacustrine material, with diversion of any upstream flows if necessary. The hydrological characteristics of the site should be investigated thoroughly.

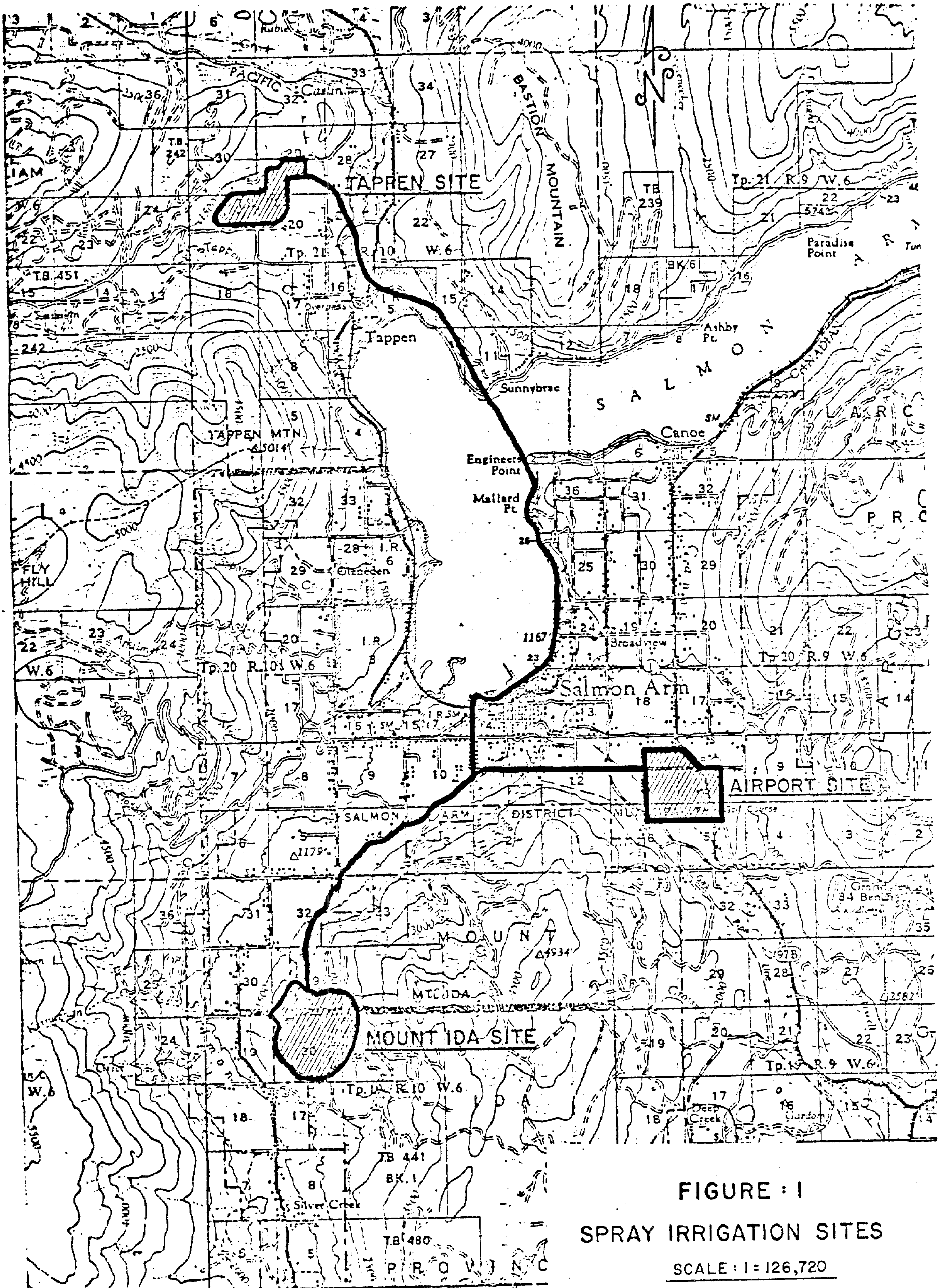


FIGURE : I

SPRAY IRRIGATION SITES

SCALE : I = 126,720

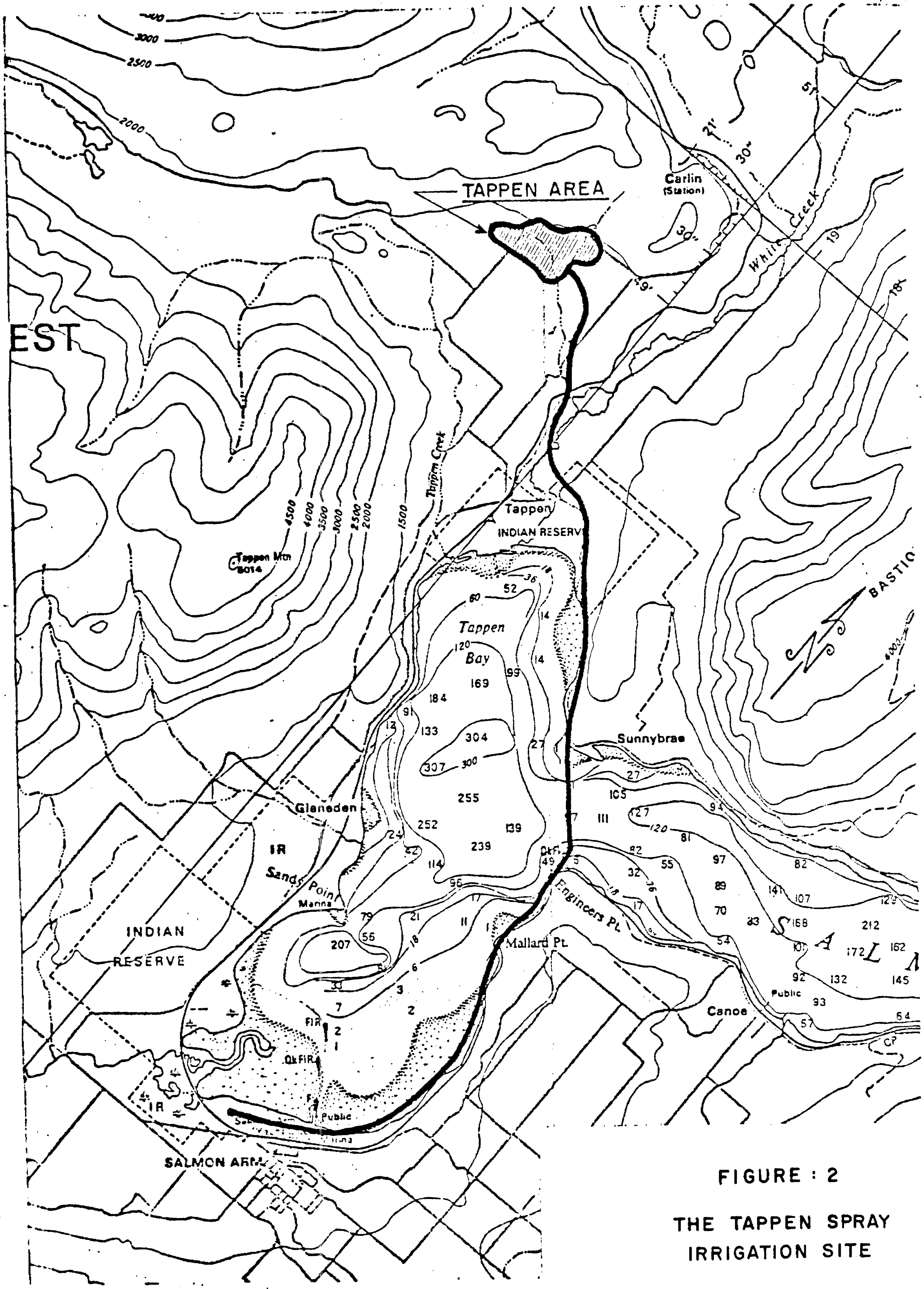


FIGURE : 2

THE TAPPEN SPRAY IRRIGATION SITE

SCALE : 1=71,000

A considerable area, Figure 3, about 600 hectares, of fine sandy loam soils on kettled and hummocky outwash deposits occur southeast of Salmon Arm near the golf course. A major limitation is the irregular topography, which varies from 5 to 30% within the map delination. This makes wheel-move sprinkler systems difficult to operate and creates problems for harvesting crops. The soil is otherwise moderately well suited for effluent irrigation, and about 250 hectares of land would be required to dispose of 2.84 m^3pd average annual daily flow of effluent.

This area is occupied by a municipal airport, and a number of holdings and farms surround the airport lands. The numerous multiple uses of this land restrict this area's potential use for spray irrigation. However, the area may be suitable if land could be obtained.

The third site considered is located on Mount Ida benchland; Figure 4 outlines this largely undeveloped land. The site encompasses 405 hectares, the majority of which is Crown land. Generally the site slopes from very flat to over 20 percent and average about 10 to 15 percent. The site elevation varies from 579 to 716 metres (1,900 to 2,350 feet). The soils vary from silty sands to gravels. The gound cover consists mainly of Douglas Fir and other common tree species. The possible acreage available for spray irrigation warranted a field inspection by the resources analysis staff to evaluate the area. Appendix F contains a detailed description of the site.

Two areas in the valley, Appendix D, would contribute an additional 30 hectares to the amount of suitable land in this area. These soils are reported to be well drained and could be suitable for effluent irrigation. Unfortunately the total amount of land in the valley is limited.

3.3 Storage Requirements

Storage requirements are controlled by climate which affects the growing season. In the Salmon Arm area 8 months of storage is sufficient.

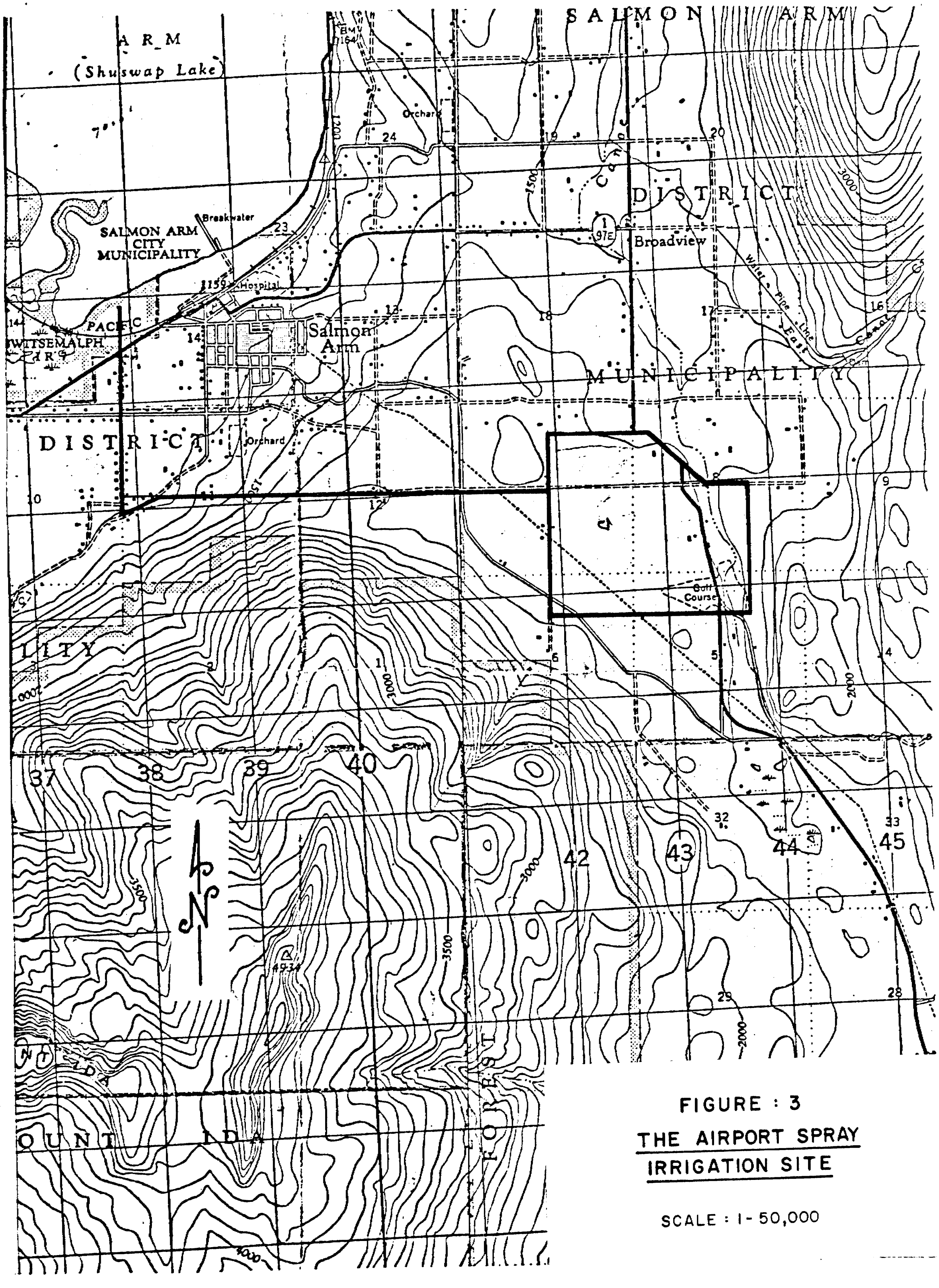


FIGURE : 3

THE AIRPORT SPRAY IRRIGATION SITE

SCALE : 1-50,000

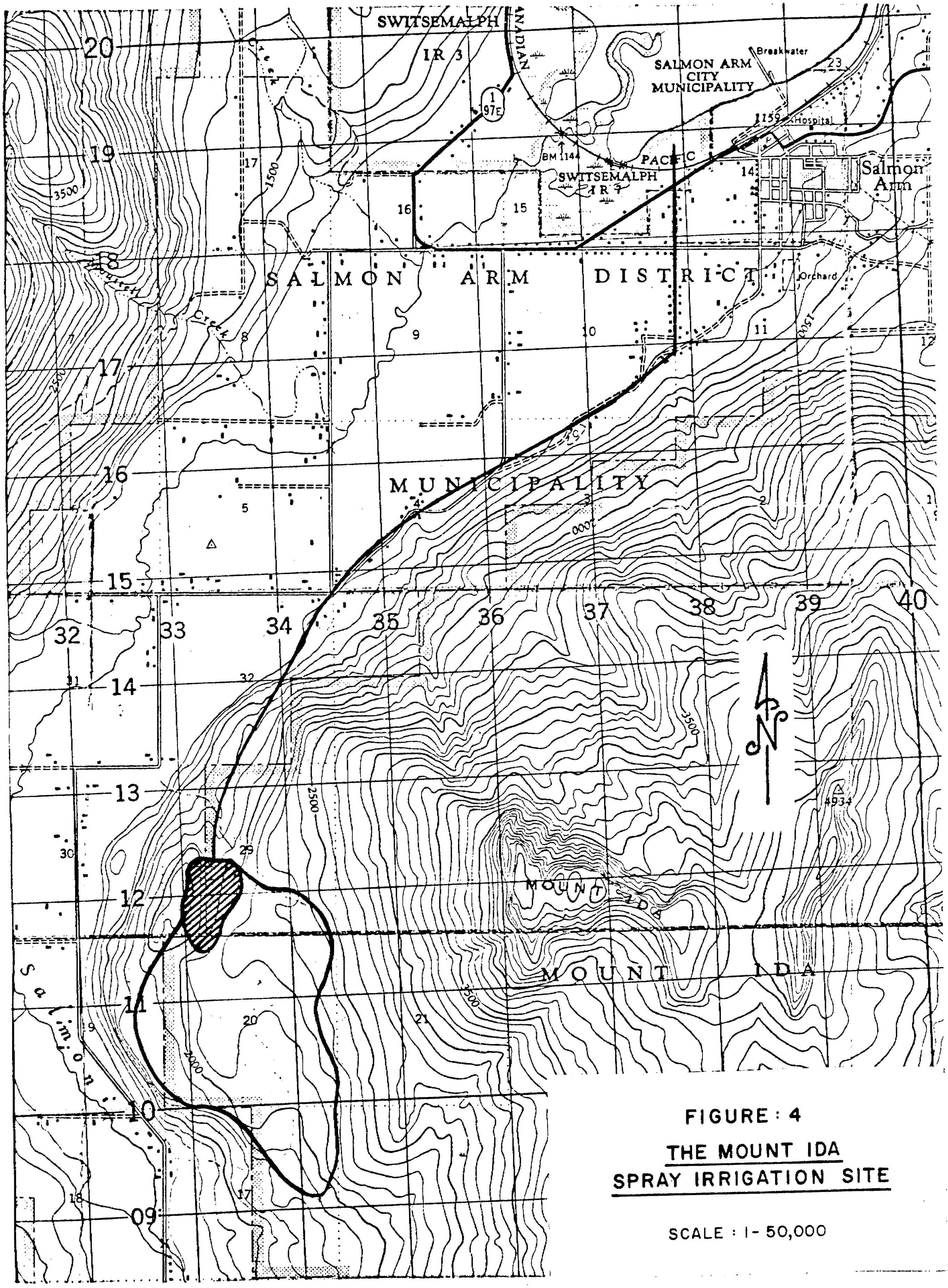


FIGURE : 4

THE MOUNT IDA SPRAY IRRIGATION SITE

SCALE : 1- 50,000

The eight months storage takes into account the following factors which require that sufficient storage be available:

(1) seeding and harvesting the crop cover;

(2) precipitation requiring the temporary reduction or cessation of application; and

(3) sixty days storage for health reasons.

3.4 Distribution System Design

The design of any spray irrigation is site specific. Detailed analysis is beyond the scope of this report. Useful references are spray irrigation handbooks by Miller (5) and Pair (6).

4.0 NUTRIENT REMOVAL COSTS

It has been assumed that installation of all spray irrigation facilities would be by contract. All costs, both material and installation, are preliminary estimates only, but do indicate the cost differences between sites and methods.

Preliminary geotechnical surveys should be undertaken to determine if there are special problems at dam sites.

Annual operation and maintenance (O & M) costs for pipelines and pumping stations have been estimated on the basis of a fixed percentage of capital cost which, for all pipelines has been assumed as 0.5% and for pumping stations as 2.5%. In addition, power costs have been estimated using total annual volumes with power estimated at 25 mils per KWH. In determining power costs, no allowance has been made for varying pumping levels at the lagoons and storage site. In assuming the maximum pumping head (minimum water level) under all flow conditions, estimated power costs are higher than would be the case if a more accurate determination had been made. Grants are also available for capital and annual costs. An example of the procedure to follow to determine annual costs after grants based on a given interest rate is given in Appendix B. Interest rates are extremely variable and will have to be recalculated. Total capital costs and O & M costs are given in Table I.

Several years would be required to implement a spray irrigation scheme on the scale required for Salmon Arm. Biological removal of phosphorus, and nitrogen (not covered in this report) would require major plant modifications and would require several years planning and construction.

In-plant precipitation of phosphorus by a compound such as alum should be investigated while establishing a long term plan to reduce the nutrient load from the Salmon River and the treatment plant. Precipitation of phosphorus by alum can be used on an interm or permanent basis depending upon the funds available to implement an alterate method. In-plant phosphorus removal would cost \$22,000 for capital equipment and \$21,000 annual operating and maintenance cost. A more detailed discussion of in-plant phosphorus removal is included in Appendix A.

TABLE I

CAPITAL AND OPERATING AND MAINTENANCE

(O & M) COSTS FOR THE SPRAY IRRIGATION SITES

Capital Costs	Tappen	Airport Site	Mount Ida Site
Up to and including storage, excluding land	$3,425,000	$2,037,000	$ 2,875,000
After storage	$437,000	$419,000	$467,000
Land Costs	$2,000,000	$1,200,000	---*
Total capital costs	$5,862,000	$3,656,000	$3,342,000
Annual O&M Costs			
Pipelines	$10,000	$4,600	$7,500
Pumping Station	$3,000	$3,900	$5,600
Power Costs	$14,000	$21,700	$37,200
Total annual O&M costs for transmission facilities	$27,000	$30,200	$50,300

*additional land may be required in valley which would increase costs.

5.0 SUMMARY

Three sites were evaluated for spray irrigation. The Tappen site and the Airport site appear to be the most favourable . Unfortunately the soil evaluation in the Salmon Arm area indicates that the moisture deficiency is low, and large acreages are necessary. The Mount Ida Site does not have adequate area of suitable soil types to adequately treat the design flow.

Limnological data indicates that the Salmon River nutrient load is of the same order of magnitude as the discharge from the sewage treatment plant and phosphorus is the limiting nutrient. Removal of phosphorus from the treatment plant effluent by any method would significantly improve the Tappen Arm water clarity.

The existing treatment plant is relatively new and has considerable excess capacity. Phosphorus can and should be removed from the treated sewage, if not by spray irrigation, by the addition of alum, or by another suitable phosphorus removal method.

The addition of alum, inplant for the removal of phosphorus is relatively inexpensive and can be installed and operational within six months. Unfortunately no other system can be operational without years of lead time even if additional grants were immediately available.

REFERENCES

1. PE-1251, Salmon Arm Wastewater Survey, Report to the District of Salmon Arm on Collection, Treatment and Disposal of Sanitary Sewage Dayton and Knight Ltd., December, 1972.

2. PE-4165, Report on the Assessment of Proposed Spray Irrigation Sites Included in the Application for a Pollution Control Permit, Dayton and Knight Ltd., 1975.

3. Anonymous, The Problem of Restoration of Salmon in the Salmon River, Department of Fisheries, Canada and I.P.S.F.C., 1954

4. Spencer, J.G., Pollution Control Guidelines for Municipal Effluent Application to Land, British Columbia Ministry of Environment, Waste Management Branch, Unpublished, 1980.

5. Miller, R.J.; E. Schulz, Irrigation Design Manual for Farm Systems in British Columbia, British Columbia Ministry of Agriculture, Victoria, British Columbia, 1975 Revision.

6. Pair, C.H., Sprinkler Irrigation, 3rd Edition, Sprinkler Irrigation Association, Washington, D.C., 1969.

APPENDIX A

INPLANT PHOSPHORUS REMOVAL

Chemical removal of phosphorus with alum has been demonstrated at a number of activated sludge treatment plants, the closest to Salmon Arm being Penticton and Merritt. The Penticton plant is a standard activated sludge plant, and the treatment plant at Merritt is an extended aeration system. Extended aeration plants differ from the conventional plants in two important respects.

First, the extended aeration process is designed to operate in the endogenous phase of the bacterial growth curve where the net sludge growth is minimal. When alum is added for phosphorus removal, the precipitates formed will accumulate in the system, causing sludge production to increase. The magnitude of this increase and its effect on sludge handling are critical factors which must be considered when upgrading an existing aeration plant for phosphorus removal.

Secondly, nitrification which affects alkalinity will occur in an extended aeration plant because of the long sludge age of micro-organisms. Furthermore, when alum is added to any treatment plant, alkalinity is consumed, and a depression in pH will result if sufficient alkalinity is not available. If the system is well buffered and the alkalinity is high, the pH depression will be slight. The normal pH is approximately 7.2, whereas the optimum pH range for phosphorus precipitation is between 5.5 and 6.5.

Industrial discharges can affect the biological system and modify the settling characteristics of activated sludge. Serious consideration must be given to the effect of the industrial wastes on the extended aeration plant before inplant removal of phosphorus is initiated.

The Salmon Arm treatment plant is considered a suitable system for attempting inplant phosphorus removal and the addition of alum inplant would reduce the phosphorus concentration to less than 0.5 mg/L from a typical influent concentration of 7 mg/L. Phosphorus input to Tappen Arm from the sewage treatment plant would be insignificant compared to the phosphorus load from the Salmon River after inplant removal.

Since the extended aeration system at the Salmon Arm treatment plant is basically two parallel units, alum could be metered to the wet well. Adequate mixing would then occur in the aeration tank. However, improved clarification of suspended solids usually occurs if alum is added just ahead of the clarifiers in the aeration tanks, but considering the small plant size, addition to the wet well would be the most convenient.

An initial dosage of 100 mg/L, as alum is recommended, and the dosage can be varied up or down to achieve the most economical operation with maximum phosphorus removal, depending upon the initial phosphorus concentration and flow rate. The following is a hypothetical example of the calculations involved:

Example:

Assume $\frac{P}{Al} = 1.4$ MW, Al = 54

$P = 7$ mg/L MW, Alum = 594

Design Flow = 0.625 mg

$$\therefore \text{ Dosage required} = \frac{(7)(594)(1.4)}{(54)} = 108 \text{ mg/L}$$

$$\text{Dry Weight} = \left(108 \frac{mg}{L}\right)\left(2.84 \times \frac{10^6 L}{day}\right) = 306 \text{ kg/day}$$

$$= 67.4 \text{ lb/day}$$

$$\text{Volume of Liquid Alum} = \frac{30.6}{(1.34)(0.485)} = 471 \text{ L/day}$$

$$= 109 \text{ gal/day}$$

Chemical Costs:

On a dry basis 2,000 lbs costs $156.00

including transport 7.8¢/lb

or 17.2¢/kg

$$\text{Cost/year} = \left(\$0.172\ \frac{1}{\text{kg}}\right)\left(30.6\ \frac{\text{kg}}{\text{day}}\right)\left(365\ \frac{\text{day}}{\text{yr}}\right) = \$19{,}200/\text{year}$$

The capital cost for an insulated tank with heat tapes would be approximately $2.50/gallon, and a 7,500 gallon tank is the recommended storage tank capacity.

Capital Cost of Tanks	$18,800
Metering Pump	$ 3,000
Total Capital Cost	$21,800

Amortized at 12% over 20 years ($21,800 x 0.1339)	$ 2,900
Maintenance & Operation 10%	$ 1,900
Chemical Costs	$19,200
Total Annual Cost	$24,000

APPENDIX B

COSTS & GRANTS

AVAILABLE FOR SEWAGE

TREATMENT

Annual Cost Grants

The provincial government provides assistance under the Sewerage Facilities Assistance Act (SFA) towards the repayment of capital debt charges for sewerage projects. The SFA annual grant amounts to 75 percent of the net annual debt charges on all eligible sewerage system debts, in excess of a levy of 2 - 1/2 mills on the full assessed value of land and 75 percent of the assessed value of improvements.

Capital Cost Grants

The previously existing grant structure for sewage treatment projects, administered by Central Mortgage and Housing Corporation (CMHC) under Part VIII of the National Housing Act, has been discontinued. A similar program is presently being implemented under provinicial jurisdiction, funded from federal capital allotments to the provinces.

The new grant program is entitled Community Services Contribution Programme (CSCP), and is administered through the Ministry of Municipal Affairs. This program, like the old CMHC program, covers sewage treatment plants and major trunk sewers and pumping stations. All works proposed would be eligible for this grant.

Although funding regulations and guidelines have been published since April, 1979, no grant approvals have been received under this programme. Apparently grant applications have exceeded the available funds at the time of writing for the first two program years. The availability of funds for this project under CSCP is impossible to predict at this time. For purposes of this predesign report, a detailed annual cost calculation is presented based on full availability of grants under this program; however, the eventuality that no such grants would be available.

Grants under the CSCP are in the following classifications:

(i) a grant of 20 percent of the total capital cost;

(ii) a "high cost" grant which amounts to the lesser of

- 50 percent of the total capital cost of the project or,
- 50 percent of the aggregate of previous and present eligible capital costs exceeding $250 per capita.

There is no senior government funding available for annual operation and maintenance costs.

SUMMARY OF COSTS FOR THREE POSSIBLE SPRAY IRRIGATION SITES*

	Mount Ida Site		Tappen Site		Airport Site	
	CSCP + SFA	SFA	CSCP + SFA	SFA	CSCP + SFA	SFA
1. Capital costs up to and including storage	$2,875,000	$2,875,000	$ 3425,000	$ 3,425,000	$2,037,000	$2,037,000
Net annual cost of capital works to Salmon Arm	$ 77,000	$ 96,000	$ 92,000	$ 115,000	$ 54,000	$ 68,000
2. Capital cost after storage	$ 470,000	$ 470,000	$ 437,000	$ 437,000	$ 419,000	$ 419,000
Annual capital repayment and O & M cost after storage	$ 78,000	$ 81,000	$ 54,000	$ 57,000	$ 56,000	$ 59,000
Net annual cost of capital works and O & M costs to Salmon Arm excluding land	$ 155,000	$ 177,000	$ 145,000	$ 171,000	$ 111,000	$ 127,000
3. Land costs	--	--	$2,000,000	$2,000,000	$1,200,000	$1,200,000
Net annual cost of land	--	--	$ 53,000	$ 67,000	$ 32,000	$ 40,000
Net annual cost of capital works, land and O & M costs to Salmon Arm	--	--	$ 199,000	$ 238,000	$ 143,000	$ 168,000
Remarks	Additional land may be required at this site				hydrogeologist report required	

* Thousands of dollars

Tappen Site

Capital Costs

1. Mainline - Salmon Arm STP to Engineers Pt.
   Pipe - 10 inch diameter x 0.312 inch wall thickness, steel
   Length - 21,000 feet
   Design Flow - 1 MGD
   Estimated Costs - $630,000

2. Mainline - Engineers Pt. to Sunnybrae
   Pipe - 10 inch diameter x 0.312 inch wall thickness, steel
   Length - 6,000 feet
   Design Flow - 1 MGD
   Estimated Costs - $360,000

3. Mainline - Sunnybrae to Tappen
   Pipe - 10 inch diameter x 0.312 inch wall thickness, steel
   Length - 25,000 feet
   Design Flow - 1 MGD
   Estimated Costs - $750,000

4. Distribution Pipelines - Irrigation Site
   Pipe - 10 inch diameter to 14 inch diameter Class 150, asbestos cement
   Lengths - 3,000 feet of 10 inch diameter
   - 2,400 feet of 12 inch diameter
   - 2,750 feet of 14 inch diameter
   - 3,000 feet of 16 inch diameter
   Design Flow - 4.5 MGD (740 ac. @ 4.2 gper/acre)
   Estimated Cost - $300,000

5. Pumping Station #1 - High-Lift at Treatment Plant

Design Flow - 1 MGD

Static Head - 235 feet

Dynamic Head - 260 feet

Total Head - 495 feet

Assumed V.T. Pump Efficiency - 75%

Calculated Horsepower Required - 87 HP

Pumps 3 x 50 HP (including one standby unit)

Estimated Cost - $100,000

6. Pumping Station #2

Design Flow - 3 MGD

Total Head - 115 feet

Calculated Horsepower Required - 20

Pumps 2 x 20 HP (including one standby unit)

Estimated cost - $ 25,000

7. Allowance for Powerlines to Irrigation Site

Estimated Cost - $ 25,000

8. Reservoir - $900,000

Annual O & M Costs

1. Pipelines

O & M costs @ .05% of 2,040,000 — $10,200

2. Pumping Station

O & M @ 2.5% of 125,000 — $ 3,100

3. Power Cost

Pumping Station #1

Average annual flow $= 0.625$ MGD

$= 434$ GPM

Average annual HP $= \dfrac{495 \times 434}{3{,}300 \times 0.75}$

$= 87$ HP

$= \dfrac{87 \times 0.746}{0.9}$

$= 72$ kw

Annual Power Cost $= 72 \times 24 \times 365 \times 0.015$

= — $ 9,500

Pumping Station #2

Flow as above

Average annual HP $= \dfrac{434 \times 115}{3{,}300 \times 0.75}$

$= 20$ HP

$= \dfrac{20 \times 0.746}{0.9}$

$= 17$ kw

Annual Power Cost $= 17 \times 24 \times 365 \times 0.015$ — $ 4,200

Total annual O & M costs for transmission facilities - $27,000

Capital Cost Summary

1. Cost Estimate Up To and Including Storage

Force Main	$ 630,000
	$ 360,000
	$ 750,000
Pumping Station	$ 100,000
Storage Basin	$ 900,000
	$2,740,000
Plus 25% Contingencies and Engineering	$ 685,000
Total	$3,425,000

2. Cost Estimates After Storage

Distribution Pipelines	$ 300,000
Pump Station	$ 25,000
Powerlines to Pumping Station	$ 25,000
	$ 350,000
Plus 25% Contingencies and Engineering	$ 87,500
	$ 437,500

Cost Estimate of Land - 800 Acres @ $2,500/acre	$2,000,000

Annual Costs

	CSCP + SFA	SFA
1. Up to and including storage excluding land		
Total cost of work	$3,862,500	$3,862,500
Ministry of Municipal Affairs grant 20% x $3,862,500	$ 772,500	--
	$3,090,000	--

The calculation of annual debt repayment is based on a rate of interest of 12% with a 20 year amortization period.

Annual Expenditures:

	CSCP + SFA	SFA
Amortization of Capital cost 20 years @ 12% (capital x 0.1339)	$ 413,800	$ 517,200
Assuming 2 1/2 mill levy already imposed, therefore Provincial Government Sewage assistance is 75% (0.75 x 413,800)	$ 310,400	$ 387,900
Net annual cost of capital works to Salmon Arm	$ 103,400	$ 129,300

	CSCP + SFA	SFA
2. After Storage		
Capital Cost	$ 437,500	$ 437,500
Ministry of Municipal Affairs grant 20% x $437,500	$ 87,500	--
	$ 350,000	--
Amortization of capital cost 20 years @ 12% (capital cost x 0.1339)	$ 46,900	$ 58,600
Provincial Government assistance (0.75 x $46,900)	$ 35,200	$ 44,000
	$ 11,700	$ 14,600

	CSCP + SFA	SFA
Irrigation operating allowance	$ 15,000	$ 15,000
Annual O & M cost for pipelines pumping station and power costs	$ 27,000	$ 27,000
Annual capital repayment and O & M costs after storage	$ 53,700	$ 56,600
Net annual cost of capital works and O & M costs to Salmon Arm excluding land	$ 157,100	$ 185,900

3. Land Costs

Capital cost of 800 Acres @ $2,500/acre	$2,000,000	$2,000,000
Ministry of Municipal Affairs grand 20% x $2,000,000	$ 400,000	--
	$1,600,000	
Amortization of capital cost 20 years @ 12% (capital cost x 0.1339)	$ 214,200	$ 267,800
Provincial Government assistance is 75% (0.75 x $214,200)	$ 160,700	$ 200,900
Net annual cost of land	$ 53,500	$ 66,900
Net annual cost of capital works, land and O & M costs to Salmon Arm	$ 210,600	$ 252,800

Annual Costs

1. Up to and including storage excluding land

	CSCP + SFA	SFA
Total cost of work	$3,425,000	$3,425,000
Ministry of Municipal Affairs grant 20% x $3,425,000.	$ 685,000	--
	$2,740,000	--

The calculation of annual debt repayment is based on a rate of interest of 12% with a 20 year amortization period.

Annual Expenditures:

	CSCP + SFA	SFA
Amortization of Capital cost 20 years @ 12% (capital x 0.1339)	$ 366,900	$ 485,600
Assuming 2 1/2 mill levy already imposed, therefore Provincial Government Sewage assistance is 75% (0.75 x 413,800)	$ 275,200	$ 344,000
Net annual cost of capital works to Salmon Arm	$ 91,700	$ 114,600

2. After Storage

	CSCP + SFA	SFA
Capital Cost	$ 437,500	$ 437,500
Ministry of Municipal Affairs grant 20% x $437,500	$ 87,500	--
	$ 350,000	--
Amortization of capital cost 20 years @ 12% (capital cost x 0.1339)	$ 46,900	$ 58,600
Provincial Government assistance (0.75 x $46,900)	$ 35,200	$ 44,000
	$ 11,700	$ 14,600

	CSCP + SFA	SFA
Irrigation operating allowance	$ 15,000	$ 15,000
Annual O & M cost for pipelines pumping station and power costs	$ 27,000	$ 27,000
Annual capital repayment and O & M costs after storage	$ 53,700	$ 56,600
Net annual cost of capital works and O & M costs to Salmon Arm excluding land	$ 145,000	$ 171,000

3. Land Costs

Capital cost of 800 Acres @ $2,500/acre	$2,000,000	$2,000,000
Ministry of Municipal Affairs grand 20% x $2,000,000	$ 400,000	--
	$1,600,000	
Amortization of capital cost 20 years @ 12% (capital cost x 0.1339)	$ 214,200	$ 267,800
Provincial Government assistance is 75% (0.75 x $214,200)	$ 160,700	$ 200,900
Net annual cost of land	$ 53,500	$ 66,900
Net annual cost of capital works, land and O & M costs to Salmon Arm	$ 198,000	$ 238,000

Airport Site

Capital Costs

1. Mainline - Salmon Arm STP to Airport Site
   - Pipe - 10 inch diameter x 0.312 inch wall thickness, steel
   - Length - 21,000 feet
   - Design Flow - 1.0 MGD
   - Estimated Costs - $630,000

2. Distribution Pipelines - Irrigation Site
   - Pipe - 10 inch diameter to 14 inch diameter Class 150 asbestos cement
   - Lengths - 3,000 feet of 10 inch diameter
     - 2,400 feet of 12 inch diameter
     - 2,750 feet of 14 inch diameter
     - 3,000 feet of 16 inch diameter
   - Design Flow - 4.5 MGD (617 acres @ 5.1 gpm/acre)
   - Estimated Cost - $300,000

3. Pumping Station #1 - High Lift at Treatment Plant
   - Design Flow - 1.5 MGD
   - Static Head - 530 feet
   - Dynamic Head - 90 feet
   - Assumed V.T. Pump Efficiency - 75%
   - Calculated Horsepower Required - 109 HP
   - Pumps 3 x 60 HP (including one standby unit)
   - Estimated Cost - $100,000

4. Pumping Station #2 - Irrigation Pressure
   - Design Flow - 3 MGD
   - Total Head - 115 feet
   - Calculated Horsepower Required - 20
   - Pumps 2 x 20 HP (including one standby unit)
   - Estimated Cost - $ 25,000

5. Allowance for Powerlines to Irrigation Site
   - Estimated Cost - $10,000

Annual O & M Costs

1. Pipelines

   O & M costs @ 0.5% of $930,000 — $ 4,600

2. Pumping Station

   O & M costs @ 2.5% of $175,000 — $ 3,900

3. Power Cost

   Pumping Station #1

   Average annual flow = 0.625 MGD

   = 434 GPM

   Average annual HP $= \frac{620 \times 434}{3{,}300 \times 0.75}$

   = 109 HP

   $= \frac{109 \times 0.746}{0.9}$

   = 82 kw

   Annual Power Costs = 82 x 24 x 365 x $0.025

   = $18,000

   Pumping Station #2

   Flow as above

   Average annual HP $= \frac{434 \times 115}{3{,}300 \times 0.75}$

   = 20 HP

   $= \frac{20 \times 0.746}{0.9}$

   = 17 kw

   Annual Power Cost = 17 x 24 x 365 x 0.025

   = $ 3,700

   Total Annual O & M Costs for Transmission Facilities $30,200

Capital Cost Summary

1. Cost Estimate Up To and Including Storage

Force Main	$ 630,000
Pumping Station	$ 100,000
Storage Basin	$ 900,000
	$1,630,000
Plus 25% Contingencies and Engineering	407,500
Total	$2,037,500

2. Cost Estimates After Storage

Distribution Pipeline	$ 300,000
Pump Station	$ 25,000
Powerlines to Pumping Station	$ 10,000
	$ 335,000
Plus 25% Contingencies and Engineering	$ 83,800
	$ 418,800

3. Cost Estimate of Land

An additional 300 a of land could possibly be obtained in addition to the 126 ha owned by the Regional District. 300 a @ $4000 Acres.	$1,200,000

Annual Costs

		CSCP + SFA	SFA
1.	Up to and including storage excluding land		
	Total cost of work	$2,037,500	$2,037,500
	Ministry of Municipal Affairs grant 20% x $2,037,500	$ 407,500	--
		$1,630,000	--
	The calculation of annual debt repayment is based on a rate of interest of 12% with a 20 year amortization period.		
	Annual Expenditures:		
	Amortization of Capital cost 20 years @ 12% (capital x 0.1339)	$ 218,000	$ 272,800
	Assuming 2 1/2 mill levy already imposed therefore Provincial Government Sewage assistance is 75% (0.75 x 413,800)	$ 163,500	$ 204,600
	Net annual cost of capital works to Salmon Arm	$ 54,500	$ 68,200
2.	After Storage		
	Capital Cost	$ 418,800	$ 418,800
	Ministry of Municipal Affairs grant 20% x $418,800	$ 83,800	--
		$ 335,000	--
	Amortization of capital cost 20 years @ 12% (capital cost x 0.1339)	$ 44,900	$ 56,100
	Provincial Government assistance (0.75 x $48,900)	$ 33,700	$ 42,100
		$ 11,200	$ 14,000

	CSCP + SFA	SFA
Irrigation operating allowance	$ 15,000	$ 15,000
Annual O & M cost for pipelines pumping station and power costs	$ 30,200	$ 30,200
Annual capital repayment and O & M costs after storage	$ 56,400	$ 59,200
Net annual cost of capital works and O & M costs to Salmon Arm excluding land	$ 110,900	$ 127,400

3. Land Costs

Capital cost of 300 acres @ 40 00/acre	$1,200,000	$1,200,000
Ministry of Municipal Affairs grant 20% x $1,200,000	$ 240,000	--
	$ 960,000	--
Amortization of capital cost 20 years @ 12% (capital cost x 0.1339)	$ 128,500	$ 160,700
Provincial Government assistance is 75% (0.75 x $128,500)	$ 96,400	$ 120,500
Net annual cost of land	$ 32,100	$ 40,200
Net annual cost of capital works, land and O & M costs to Salmon Arm	$ 143,000	$ 167,600

Mount Ida Site

Capital Costs

1. Mainline - Salmon Arm STP to Mount Ida Storage
   - Pipe - 10 inch diameter x 0.312 inch wall thickness, steel
   - Length - 40,000 feet
   - Design Flow - 1 MGD
   - Estimated Costs — $1,200,000

2. Distribution Pipelines - Irrigation Site
   - Pipe - 10 inch diameter to 14 inch diameter, Class 150 asbestos cement
   - Lengths - 3,000 feet of 10 inch diameter
     - 2,400 feet of 12 inch diameter
     - 2,750 feet of 14 inch diameter
     - 3,000 feet of 16 inch diameter
   - Design Flow - 3.80 MGD (420 acc. @ 6.3 pmpa
   - Estimated Cost - — $ 300,000

3. Pumping Station #1 - High-Life at Treatment Plant
   - Design Flow - 1 MGD
   - Static Head - 850 feet
   - Dynamic Head - 200 feet
   - Total Head - 1,050 feet
   - Assumed V.T. Pump Efficiency - 75%
   - Calculated Horsepower Required - 184 HP
   - Pumps 3 x 100 HP (Including one standby unit)
   - Estimated Cost - — $ 200,000

4. Pumping Station #2 - Irrigating Pressure
   - Design Flow - 3 MGD
   - Total Head - 115 feet
   - Calculated Horsepower Required - 20 HP
   - Pumps 2 x 20 HP (Including one standby unit)
   - Estimated Cost - — $ 22,000

5. Allowance for Power Lines to Pumping Stations

Estimated Cost - $ 50,000

6. Reservoir Dam

Storage Capacity - 500 ac. ft.

Crest Elevation - 2,010 feet

Crest length - 750 feet

Maximum Height of Dam - 63 feet (includes stripping, excavation, fill rip rap, crest cover)

Estimated Cost - $ 900,000

Annual O & M Costs

1. Pipelines

   O & M costs @ 0.5% of \$1,500,000 — \$ 7,500

2. Pumping Station

   O & M @ 2.5 % of \$223,000 — \$ 5,600

3. Power Cost

   Pumping Station #1

   Permit annual volume = 839 ac. ft.

   Average annual flow = 0.625 MGD

   = 434 GPM

   Average annual HP $= \frac{434 \times 1050}{3300 \times 0.75}$

   = 184 HP

   $= \frac{184 \times 0.746}{0.9}$

   = 153 kw

   Annual Power Cost = 153 x 24 x 356 x \$0.025 = — \$33,500

   Pumping Station #2

   Flow as above

   Average annual HP $= \frac{434 \times 115}{3300 \times 0.75}$

   = 20 HP

   $= \frac{20 \times 0.746}{0.9}$

   = 17 kw

   Annual Power Cost = 17 x 24 x 365 x \$0.025 = — \$ 3,700

Total Annual O & M Costs for Transmission Facilities — \$50,300

Capital Cost Summary

1. Cost Estimate Up To and Including Storage

Force Main	$1,200,000
Pumping Station	$ 200,000
Storage Basin	$ 900,000
	$2,300,000
Plus 25% Contingencies and Engineering	$ 575,000
Total	$2,875,000

2. Cost Estimates After Storage

Distribution Pipelines	$ 300,000
Pump Station	$ 22,000
Powerlines to Pumping Station	$ 50,000
	$ 372,000
Plus 25% Contingencies and Engineering	$ 95,000
Total	$ 467,000

3. Cost Estimate of Land

Crown Land	--

Annual Costs

	CSCP + SFA	SFA
1. Up to and including storage excluding land		
Capital Cost	$2,875,000	$2,875,000
Ministry of Municipal Affairs grant 20% x $2,875,000	$ 571,000	--
Cost after grant	$2,304,000	--
The calculation of annual debt repayment is based on a rate of interest of 12% with a 20 year amortization period.		
Annual Expenditure		
Amortization of Capital Cost 20 years @ 12% (Capital Cost x 0.1339)	$ 308,500	$ 385,000
Assuming 2 1/2 mill levy already imposed, therefore Provincial Government Sewage Assistance is 75% (0.75 x Annual P & I Payment)	$ 231,000	$ 288,000
Net annual cost of capital works to Salmon Arm	$ 77,500	$ 96,200
2. After Storage		
Capital cost	$ 470,000	$ 470,000
Ministry of Municipal Affairs grant 20% x $470,000	$ 94,000	--
Cost after grant	$ 376,000	
Amortization of capital cost 20 years @ 12% (capital cost x 0.1339)	$ 50,300	$ 62,900
Provincial Government assistance (0.75 x P & I Payment)	$ 37,700	$ 47,200
	$ 12,600	$ 15,700

	CSCP + SFA	SFA
Irrigation operating allowance	$ 15,000	$ 15,000
Annual O & M cost for pipeline pumping station and power costs	$ 50,300	$ 50,300
Annual capital repayment and O & M costs after storage	$ 77,900	$ 81,000
Net annual cost of capital works and O & M costs to Salmon Arm excluding land	$ 155,400	$ 177,200

APPENDIX C

SEWAGE TREATMENT AND STORAGE REQUIREMENTS FOR DISPOSAL BY SPRAY IRRIGATION FOR ZERO BUFFER ZONES (3)

SEWAGE TREATMENT AND STORAGE REQUIREMENTS FOR DISPOSAL BY SPRAY IRRIGATION FOR ZERO BUFFER ZONES (3)

End Use		Forage Production	Livestock Grazing		Forests SILVICULTURE (a) and RANGE (b)		Recreation	HORTICULTURE (2)
			Meat Production	Milk Production				
Effluent Quality Prior to Retention In Storage (1)	BOD_5 mg/L	45	45	45	130 (a)	45 (b)	20	45
	SS mg/L	60	60	60	130	60	30	60
Minimum Retention Storage Time in Days		60	60	60	90	60	60	60
Disinfect After Storage 1 mg/L total Cl residual after 60 minutes		Yes	Yes	Yes	Yes	Yes	Yes	Yes
Minimum Lag Time Between End of Spray Application and Use in Days		3	3	6	0	0	0(3)	3

NOTES

1. ALGAE and ZOOPLANKTON entering the storage basin from a suitable long term (minimum 60 days) lagoon treatment system may be excluded from the qualitative determination of BOD_5 and SS characteristics.

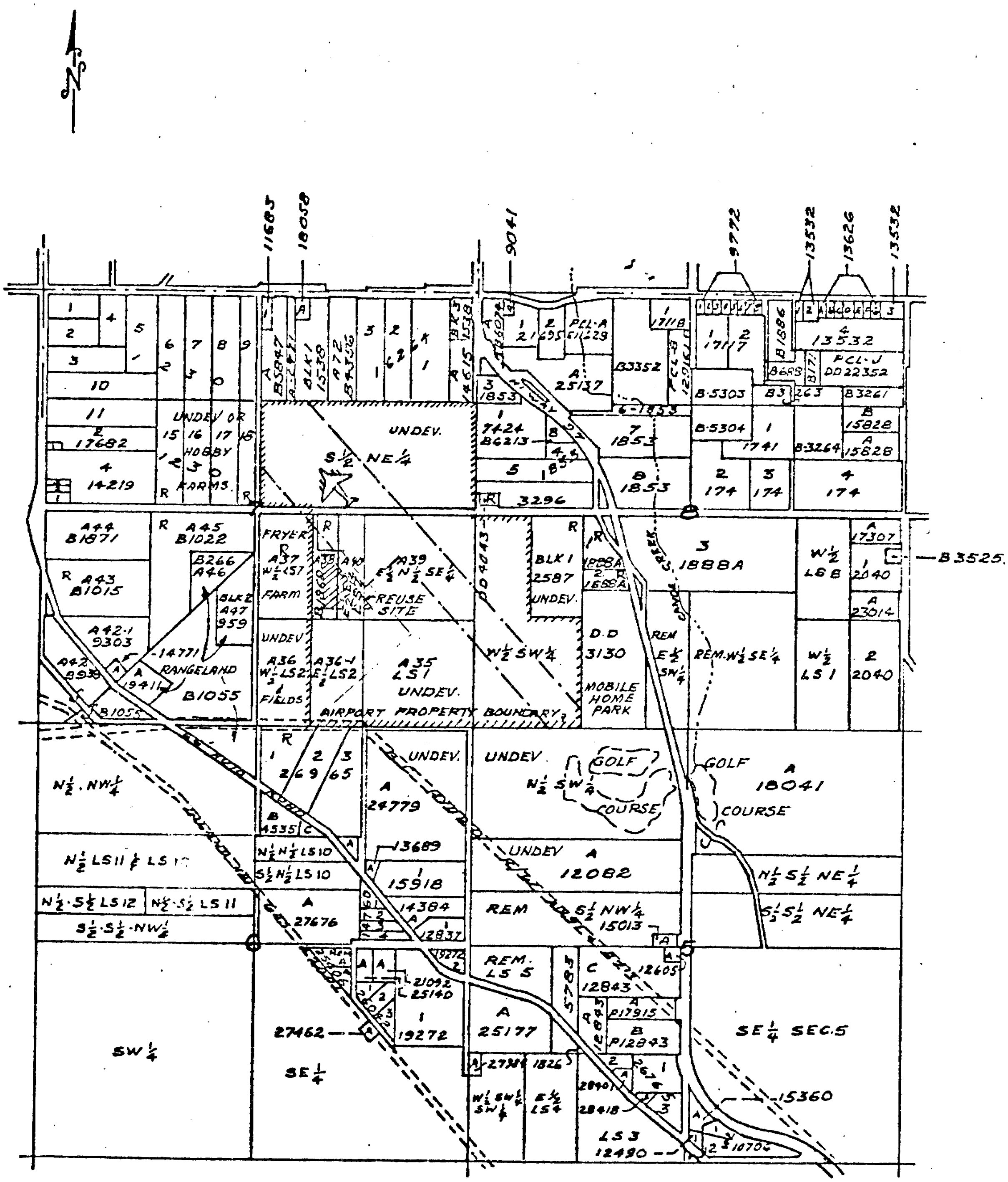
2. Tree and Shrub nursery only.

3. Spraying only allowed when facilities closed to the public, i.e. at night or on non-operating days.

APPENDIX D

TYPICAL ASSESSED VALUES OF PROPERTY FOR:

1. TAPPEN SITE
2. AIRPORT SITE
3. BELOW THE MOUNT IDA SITE



SECTIONS 5,6,7,8
TP.20,RG9
W6M
SCALE: 1" = 1970'
R = RESIDENCE.

POSSIBLE AIRPORT SITE FOR SRAY IRRIGATION

PROPERTY AT THE AIRPORT SITE

ASSESSMENT MAP SECTOR NO. 4

PLAN NUMBER	ROLL NUMBER	ACREAGE		ACTUAL VALUE		
				LAND	BUILDINGS	TOTAL
1538	01069.000	11.81	Hoffman, R. R. R. #3 Salmon Arm, BC Lot #1	45,950	14,900	60,850
1871	01044.000	20.0	Nakagawa, M. R. R. #3 Salmon Arm, BC	1,210 (farm)		1,210
1055	01041.000	38.10	Lidstone, D. K. R. R. #3 Salmon Arm, BC	1,330		1,330

PROPERTY AT AIRPORT SITE

ASSESSMENT MAP SECTOR NO. 5

PLAN NUMBER	ROLL NUMBER	ACREAGE		ACTUAL VALUE		
				LAND	BUILDINGS	TOTAL
1853	01088.000	3.77	Kelly, H. R. R. #3 Salmon Arm, BC Lot #3	24,850	21,350	46,200
1853	01089.000	1.77	Whyte, H. A. R. R. #3 Salmon Arm, BC Lot #4	23,650	22,650	46,300
1853	01090.000	9.85	Dimion, P. R. R. #3 Salmon Arm, BC	1,140	25,050	26,190

PROPERTY AT THE AIRPORT SITE

ASSESSMENT MAP SECTOR NO. 3

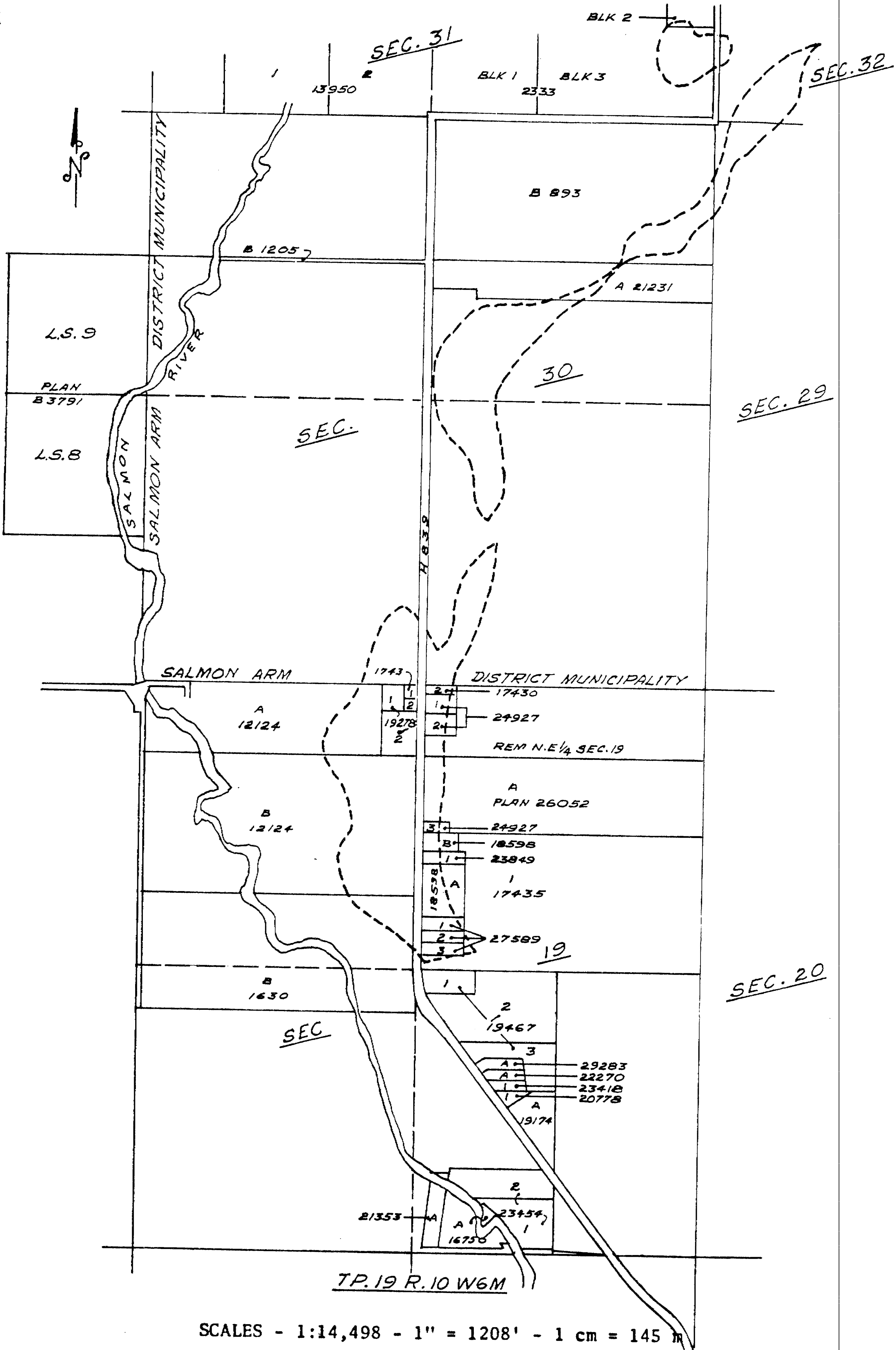
PLAN NUMBER	ROLL NUMBER	ACREAGE		ACTUAL VALUE		
				LAND	BUILDINGS	TOTAL
26965	01031.100	10.0	Hilltop Estates Ltd. c/o H. Yawney 454 Bernard Avenue Kelowna, BC Lot #1	42,500	30,650	73,150
26965	01031.200	10.0	Lot #2	42,500		42,500
26965	01031.300	12.42	Lot #3	47,100		47,100
24779	01034.000	46.63	Montida Investment Ltd. Box 118 Salmon Arm, BC Lot A	73,450	800	74,250

<u>PROPERTY AT THE AIRPORT SITE</u>

ASSESSMENT MAP SECTOR NO. 2
Tp. 20 R. 9 W6 (Jur. 322)

PLAN NUMBER	ROLL NUMBER	ACREAGE		ACTUAL VALUE		
				LAND	BUILDINGS	TOTAL
12082	01017.000	39.77	Pressman Irving 111 East 6th Street Carson City, Nevada U.S.A.	52,800	3,950	56,750
25177	01015.000	16.07	Newnes Holdings Ltd. 120 - 316 Hudson Avenue Salmon Arm, BC	109,450		109,450
18041	01018.002		Shuswap Golf & Recreation Ltd. Box 998 Salmon Arm, BC Lot A, N.E. Sec. Part 2 of 2 Parts		9,800	9,800
18041	01018.001	88.11	Shuswap Golf & Recreation Ltd. Box 998 Salmon Arm, BC Part 1 of 2 Parts	123,000	58,200	181,200
18041	01018.003		Shuswap Golf & Recreation Ltd. N.W. Sec. 5, N 1/2 Part 2 of 2 Parts		19,300	19,300

* Based on 1978 Assessment



SCALES - 1:14,498 - 1" = 1208' - 1 cm = 145 m

PROPERTY BELOW THE MOUNT IDA SITE

ASSESSMENT MAP SECTOR NO. 109

PLAN NUMBER	ROLL NUMBER	ACREAGE		ACTUAL VALUE		
				LAND	BUILDINGS	TOTAL
21353	08734.005	2.62	Grier, T. R. R. #1 Salmon Arm, BC Lot A	22,800	34,300	57,100
23454	08734.015	5.50	Dibblee, C. R. R. #1 Salmon Arm, BC Lot #1	29,700	21,500	51,200
23454	08734.020	5.68	Romyn, P. General Delivery Revelstoke, BC Lot #2	31,450	20,400	51,850
19467	08735.000	2.40	Irmen, M. R. R. #1 Salmon Arm, BC	17,250	22,700	39,950
19467	08735.020	15.0	Larson, G. R. R. #1 Salmon Arm, BC Lot #2	36,700	18,350	55,050
19467	08735.041	5.31	Price Wallace R. R. #1 Salmon Arm, BC Lot #3	24,800	9,400	34,200
17435	08737.200		Triebwasser, A R. R. #1 Salmon Arm,BBC			

PROPERTY BELOW THE MOUNT IDA SITE

ASSESSMENT MAP SECTOR NO. 109

PLAN NUMBER	ROLL NUMBER	ACREAGE		ACTUAL VALUE		
				LAND	BUILDINGS	TOTAL
24927	08737.205	.93	Parkinson, D. Box 187 Salmon Arm, BC Lot #1	15,300	30,450	45,750
24927	08737.210	1.10	Kennedy, H. 7 Brae Glen Court Calgary, Alberta Lot # 2	16,450	27,050	43,500
24927	08737.215	.46	Budrow, H. R. R. #1 Salmon Arm, BC Lot #3	10,300	26,900	37,200
27589	08737.110	1.0	Hobbs, Lynn R. R. #1 Salmon Arm, BC Lot #1	13,350	35,100	48,450
27589	08737.115	1.0	Carlson, R. Box 2553 Salmon Arm, BC Lot #2	13,350	21,000	34,350

PROPERTY BELOW THE MOUNT IDA SITE

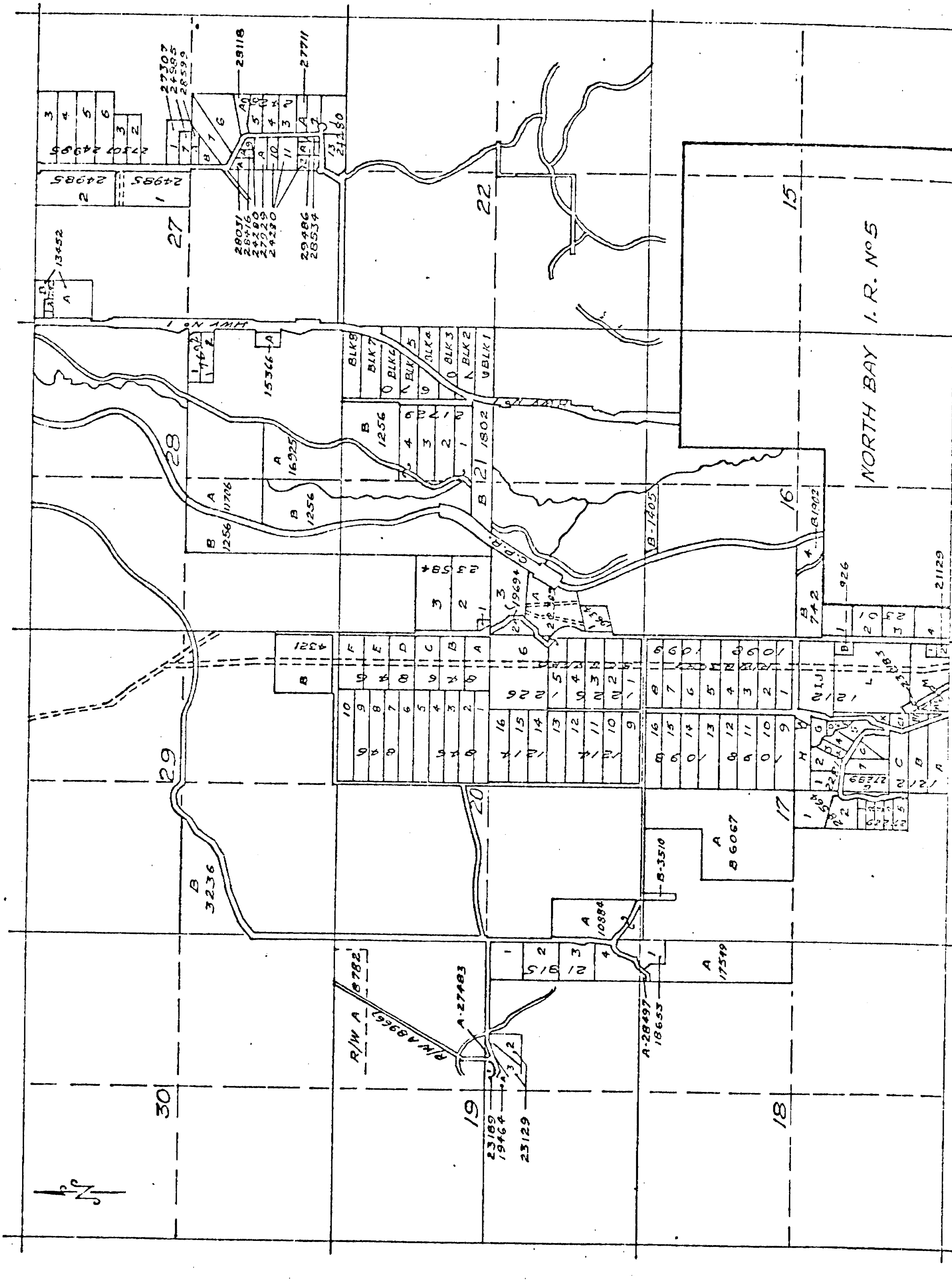
ASSESSMENT MAP SECTOR NO. 113

PLAN NUMBER	ROLL NUMBER	ACREAGE		ACTUAL VALUE		
				LAND	BUILDINGS	TOTAL
12124	08738.050	32.28	Crockrill, D. 208 - 5401, 207th Street Langley, BC Lot A	2,168	41,250	43,418
12124	08738.100	79.7	Battersby, J. R. R. #1 Salmon Arm, BC Lot B	5,219 (farm)	36,700	41,919
19278	08738.080	3.52	Bohn, E R. R. #1 Salmon Arm, BC Lot #2	26,150	42,400	68,550
19278	08738.075	1.18	Fowler, K. Box 2423 Salmon Arm, BC Lot #1	16,250	7,400	23,650

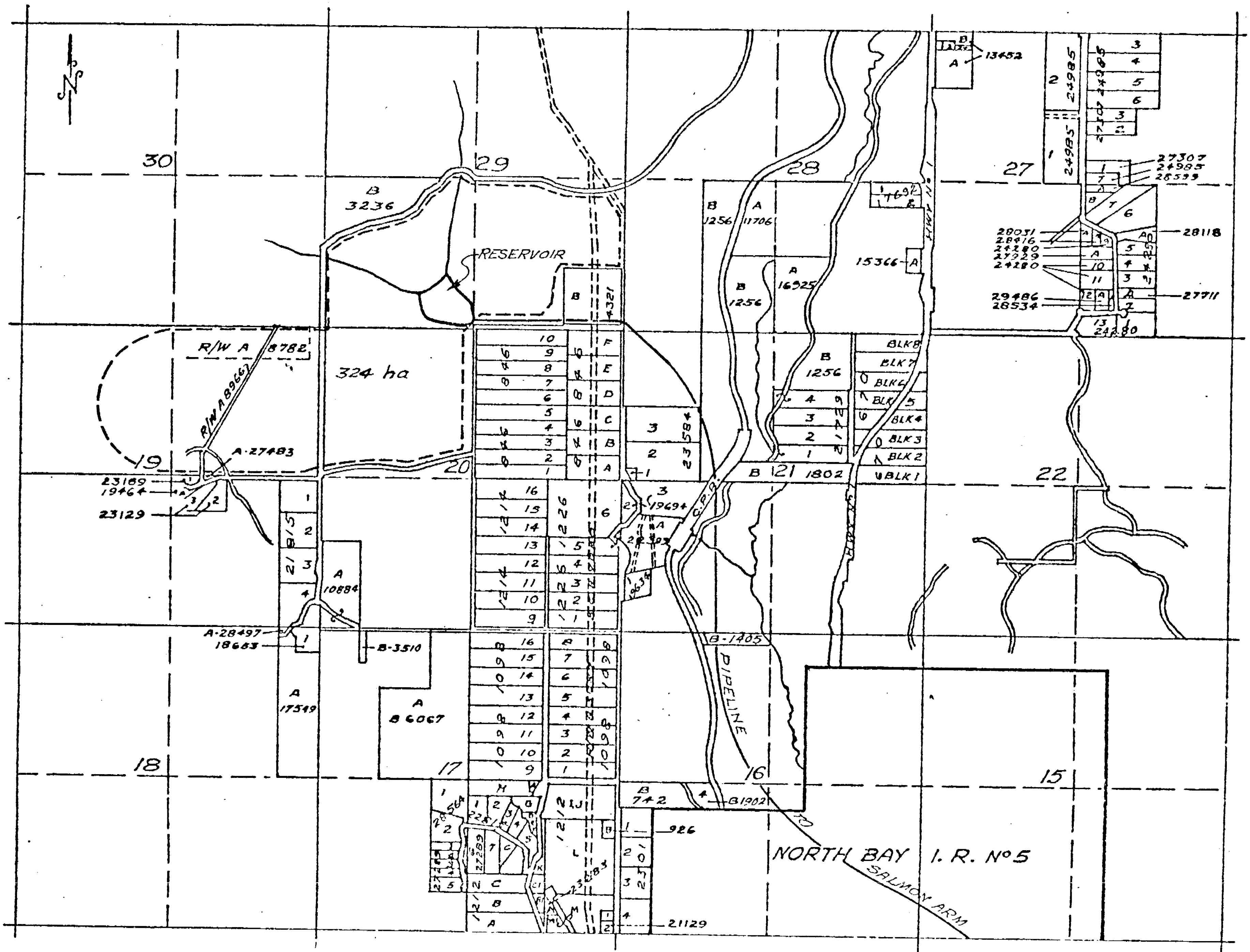
PROPERTY BELOW THE MOUNT IDA SITE

ASSESSMENT MAP SECTOR NO. 114

PLAN NUMBER	ROLL NUMBER	ACREAGE		ACTUAL VALUE		
				LAND	BUILDINGS	TOTAL
2333	02018.000	60.15	Vander, Hoek R. R. #1 Salmon Arm, BC Lot #1	4,960 (farm)	17,550	22,510
2333	02019.000	54.00	Syne, T. R. R. #1 Salmon Arm, BC Lot #2	4,870		4,870
2333	02020.000	46.00	Lot #3	4,110 (farm)	30,650	34,760
B893	02016.000	78.46	Jackson, T. R. R. #1 Salmon Arm, BC	6,340 (farm)	17,450	23,790



T.P. 21, R.10, W6M. SCALES - 1:28,159 - 1"=2346' - 1Cm = 282 m.



T.P. 21, R.10, W6M. SCALE: 1"= 2296'

POSSIBLE SPRAY IRRIGATION AREA IN THE TAPPEN AREA

PROPERTY AT THE TAPPEN AREA

ASSESSMENT MAP SECTOR NO. 176

PLAN NUMBER	ROLL NUMBER	ACREAGE		ACTUAL VALUE		
				LAND	BUILDINGS	TOTAL
846	08851.000	10.0	Forsang, W. R. R. #1 Tappen, BC Lot A	25,550	38,400	63,950
846	08852.000	10.0	Tumlinson, S. Box 51 Salmon Arm, BC Lot B	25,550	10,900	36,450
846	08852.010	20.0	Codd, K. R. R. #1 Tappen, BC Lot C & D	424 (farm)		424
846	08853.000	10.0	Lot E	231 (farm)		231
	08854.000	10.0	Lot F	328 (farm)		328
846	08855.000	99.5	Gooch, W. J. R. R. #1 Tappen, BC Lots 1 - 8	2,783		2,783

APPENDIX E

LIMNOLOGICAL CALCULATIONS

1. Lake Volume

Surface area 23,513,100 m^2

Volume	0 - 30.5 m stratum	487,655,600 m^3
	30.5 - 61.0 m stratum	195,933,100 m^3
	61 - 91.5 stratum	75,543,200 m^3
	91.5 - bottom	8,926,100 m^3
	TOTAL	768,058,000 m^3

2. Loading changes

A. if present overturn TP concentration 17 μg/L
from Dillon + Rigler (1975) J. Fish Res. Bd. Can. 32:1519

$$(P) = \frac{L}{(\sigma + \rho)\ \bar{Z}}$$

L is theoretical loading
(P) is overturn phosphorus
σ sedimentation coefficient
ρ water exchange rate
$\bar{Z}$ is mean depth

$$.017 = \frac{L}{\left(\frac{10}{33} + .25\right) 33}$$

L = .3103 gm/m^2/year

Surface area of Tappen Arm 23,513000 m^2
= annual load of 7.29 metric tonnes/yr.

B. 90% removal (3 tonnes) then annual load is about 5 tonnes or .212 gm/m^2/year.

$$\text{thus } (P) = \frac{.212}{(.25 + \frac{10}{33})\ 33}$$

$$= 11.7\ \mu g/L$$

c. 25% loading increase i.e., .3879 gm/m^2/year
then (P) = 21.2 μg/L

3. Chlorophyll concentrations which correspond to loading rates from Dillon and Rigler (1975)

$\log_{10}$ (chl a) = 1.45 $\log_{10}$ (P) - 1.14

A. If overturn phosphorus 17 μg/L

$\log_{10}$(chl a) = 1.45 $\log_{10}$ (17) - 1.14

= .644

$10^{.644}$ = 4.41 mg/m^3

B. for phosphorus of 11.7 μg/L P
(chl a) = 2.56 mg/m^3

C. for 21.2 P/L, (chl a) = 6.06 mg/m^3

4. Correlation between water clarity and chlorophyll
secchi = 11.28 x $(\text{chlorophyll})^{-1.17}$

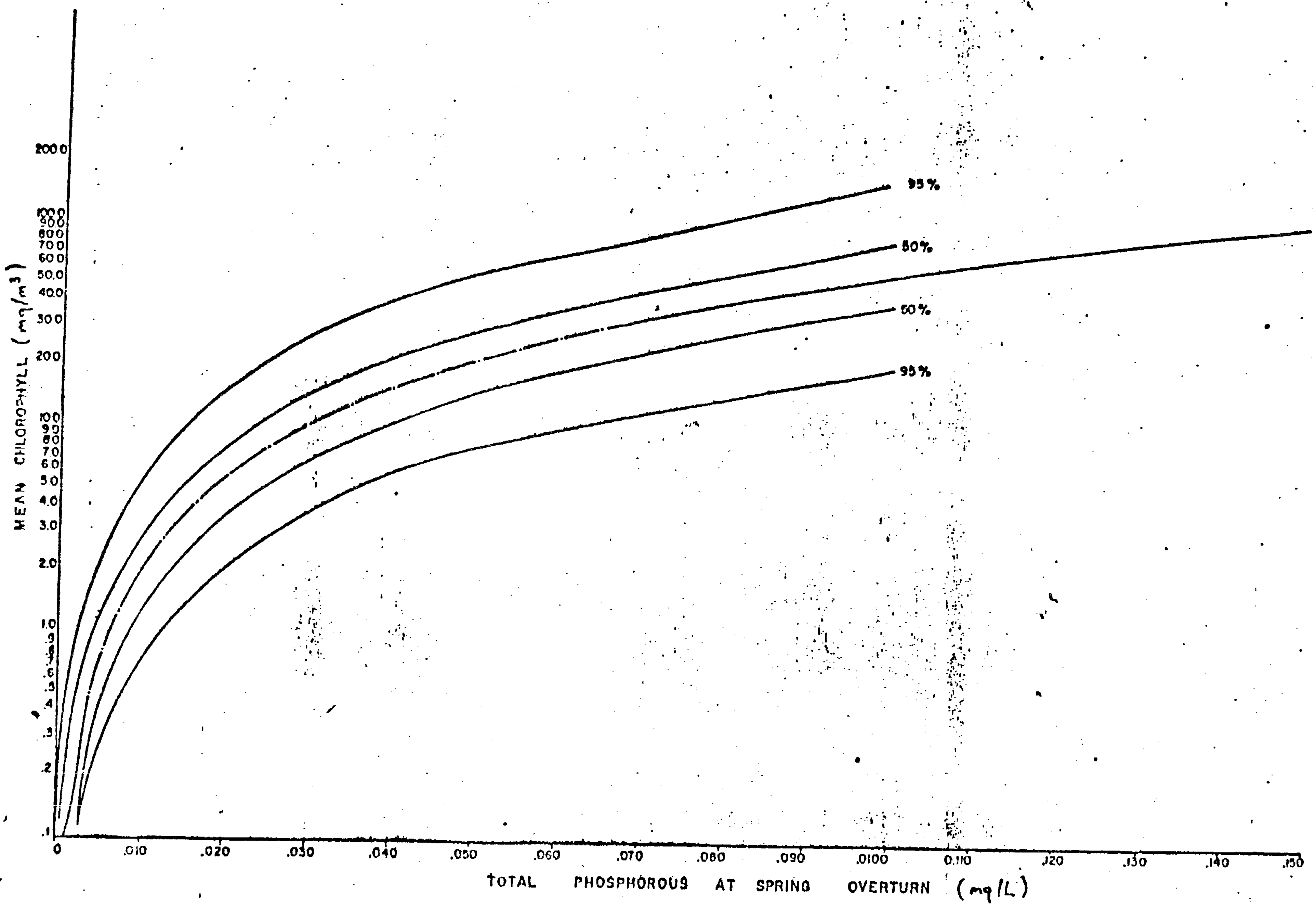
chlorophyll of 2.56 mg/m^3	=	secchi	about 3.75 metres
4.41	=		about 2.0 metres
6.06	=		about 1.4 metres

5. Lake response time

$$t_{\frac{1}{2}} = \frac{.69}{\rho + \frac{10}{\bar{z}}}$$ (Dillon and Rigler 1975)

$$= \frac{.69}{.25 + \frac{10}{33}}$$

= 1.24 years 3 - 5 years x to reach equilibrium
3.74 to 6.24 years



MEAN CHLOROPHYLL (mg/m³)
2000
1000
900
800
700
600
50.0
40.0
30.0
20.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
95%
80%
50%
95%
0
.010
.020
.030
.040
.050
.060
.070
.080
.090
.0100
0.110
.120
.130
.140
.150
TOTAL PHOSPHOROUS AT SPRING OVERTURN (mg/L)

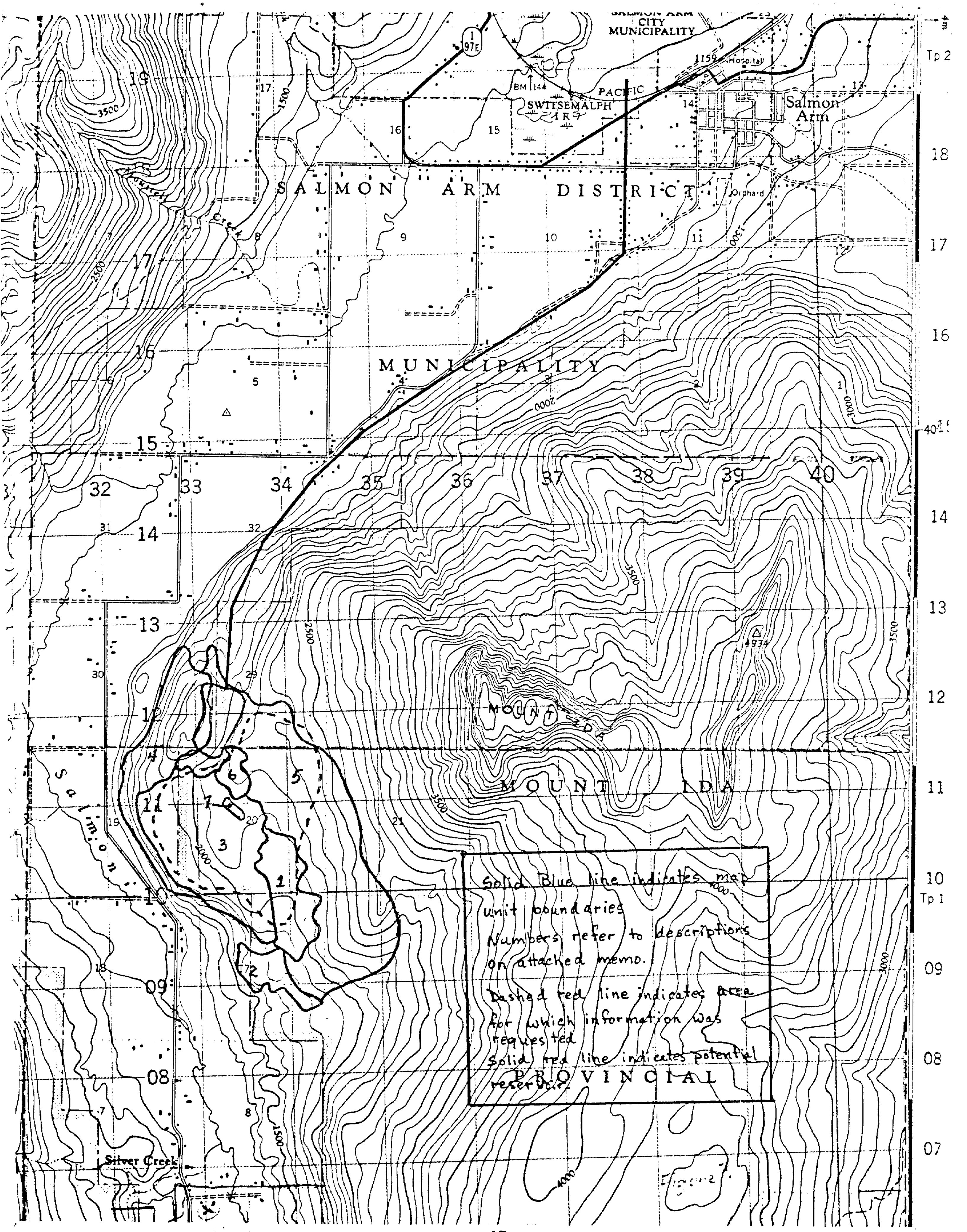
APPENDIX F

DESCRIPTION OF THE MOUNT IDA SITE

BY THE

RESOURCES ANALYSIS BRANCH

Map Unit	Description
1	Approximately 55 hectares. Generally suitable for effluent irrigation with the exception of a buffer area adjacent to creek. Soils are greater than 1 m deep, well to moderately well drained, loam textured with moderate moisture deficiencies, and are developed on morainal parent materials. Imperfectly drained inclusions may occur adjacent to the creek within the buffer zone. Slopes are less than 10% and fairly regular. Soil development ranges from Orthic Eutric Brunisols to Brunisolic Gray Luvisols. Irrigation requirements are approximately 250 to 275 mm in an average summer.
2	Approximately 26 hectares. Generally suitable for effluent irrigation. Soils are greater than 1 m deep, well drained, silt loam textured with moderate moisture deficiencies on lacustrine over morainal parent materials. Slopes are less than 10% and fairly regular. Soil development ranges from Orthic Eutric Brunisols to Brunisolic Gray Luvisols. Irrigation requirements are approximately 250 to 275 mm in an average summer.
3	Unsuitable for effluent irrigation. Soils are mainly less than 1 m deep with frequent (30%) rock outcropping. Materials are morainal veneers with loam textures. Slopes are irregular and range from 50 to 30%.
4	Unsuitable for effluent irrigation. Dominantly bedrock with minor shallow soils. Slopes are irregular and generally over 30%.
5	Unsuitable for effluent irrigation. Soils are mainly less than 1 m deep with frequent (20%) rock outcroppings. Materials are loam textured morainal veneers with minor (20%) morainal blankets (>1 m deep). Slopes are somewhat irregular and range to 30%.
6	Unsuitable for effluent irrigation. Rock outcropping.
7	Unsuitable for effluent irrigation. Wet meadow. Inferred from aereal photos - not ground checked.


CITY
MUNICIPALITY
Hospital
Salmon Arm
PACIFIC
SWITSEMALPH I R 7
SALMON ARM DISTRICT
Orchard
MUNICIPALITY
MOUNT IDA
Salmon
Silver Creek
PROVINCIAL
Tp 2
Tp 1
Solid Blue line indicates map unit boundaries
Numbers refer to descriptions on attached memo.
Dashed red line indicates area for which information was requested
Solid red line indicates potential reservoir.