DISTRICT OF SUMMERLAND

- *WMP AMENDMENT* -

April 11, 1995

Our File: 1087211.1

District of Summerland
13211 Henry Avenuue
Summerland, BC
V0H 1Z0

Attention: ***Mr. Bob Carter, Administrator***

Dear Sirs:

Re: ***WMP Amendment Application***

The attached document provides the background for the proposed Wastewater Management Plan Amendment. Hopefully, it is an accurate reflection of the process, discussions, public meetings and deliberations that have been undertaken by the District of Summerland.

The inter-ministerial workshop held to review the amendment was generally favourable. However, it did point out further work necessary to confirm the viability of the reclamation concept.

In general terms the remaining work is to confirm:

(a) the number of reclaimed water users and their water demand
(b) the feasibility and safety of a rapid infiltration back-up system, and
(c) the economic viability of a silviculture operation.

We trust the plan meets with the District's approval and look forward to assisting you in its implementation.

Yours truly,

URBAN SYSTEMS LTD.

Peter Gigliotti, P.Eng.
Senior Environmental Engineer
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1.1 PREAMBLE

The District of Summerland embarked on the preparation of a Waste Management Plan early in 1988 and completed the Plan in June 1991. The Plan was carried out in three stages in accordance with Ministry of Environment Guidelines. The final (or Stage III) report recommended a sewage collection system for the Downtown area, the Lower Town area and Trout Creek area. Out of 7 options examined, the recommended treatment/disposal schemes were:

Option 1: Regional Sewerage System

Option 5: Combined Irrigation/Lake Disposal

The final report stated: "The District of Summerland pursued the concept of Option 1 with the City of Penticton, the Regional District of Okanagan Similkimeen, and senior levels of government. The concept did not receive support and the District of Summerland decided to proceed with Option 5."

The estimated cost of Option 5 was $20,900,000 and would ultimately serve a population of 7100 persons for the design horizon year 2008. The estimate was based on 1991 costs.

The proposed phasing of Option 5 was in two phases:

Phase I: (1991-1994)
- Sewering of Town Centre only
- Sewering of the southern lakeshore of Lower Town
- Sewering of Lower Trout Creek
- Transmission and pumping to treatment plant site
- Biological Nutrient Removal (BNR) treatment plant
- Lake outfall and Irrigation System
- Approximate Cost: $13.3M
- Population Served: 1820 people

Phase II: (2004-2006)
- Extend sewered area to all of Downtown
- Extend sewered area to include remainder of Lower Town
- Extend sewered area to include Upper Trout Creek
- Approximate cost (1991 dollars): $7.6M
- Total population served by Phase II: 7100

The report also recommended further study to refine the cost estimates, establish the sewer service area, locate a suitable treatment plant site, secure irrigation agreements, and promote improvements to on-site treatment/disposal practices in the non-sewered areas.

While the plan was received by the District and ratified by the Ministry of Environment, none of the recommendations were acted upon, with the exception of promotion of improved on-site disposal practices.

Since then, growth in the District has continued, without benefit of a sewerage system, and the present Council is faced with addressing the problems associated with growth, preserving ALR, and re-visiting the Waste Management Plan.

In response to the difficulties of managing growth, the present Council commissioned the preparation of an Official Community Plan (OCP) and, concurrently, a Comprehensive Development Plan (CDP) under the auspices and assistance of the Ministry of Municipal Affairs. At the same time, the Ministry of Municipal Affairs provided funding assistance for a study to review the Waste Management Plan in the context of the growth issue and to facilitate completion of the OCP and CDP.

1.2 CONTEXT OF WMP REVIEW

While the 1991 WMP addressed nominal growth and infill within existing developed areas, it did not consider the development of new housing areas. One of the key mandates of the OCP and CDP is to preserve agricultural land (ALR) to the greatest extent possible, and attempt to reduce pressure for urban encroachment on the ALR. The District of Summerland is surrounded by good agricultural land, with over 1200 hectares of irrigated orchards. The community takes great pride in the agricultural base and the lifestyle that accompanies it. Council's mandate was to protect the rural areas while, at the same time, managing the growth that has become a common problem in the Okanagan Valley.

To this end, the OCP and CDP attempted to identify the most suitable areas for urban development and analyzed these from a variety of perspectives. The initial inventory of areas included most of the sloped and hillside areas to the north, west and south of the central plateau, since the central plateau and valley bottoms represent the best agricultural lands.

The CDP analyses include costs and examine potential development areas in terms of:

- ease and affordability of extension or provision of urban services;
- logical community expansion (not into ALR);

- traffic and transportation impact;
- commercial and institutional requirements;
- police, ambulance and fire protection services;
- recreation and community services;
- achievable densities for housing demand (short and long-term);
- slopes and slope stability; urban drainage and erosion.

The deliberations, analyses and discussions in the CDP exercise evolved a short list of desirable areas which would have the least impact on the above parameters. The preferred areas can be referred to as follows: (see Figure 1.1)

1. The Cartwright Mountain area - an area of some 230 hectares on the sloping hillside north of Prairie Valley.

2. Trotter/Jolicour/Fyffe area (South Summerland) - three hillside areas in South Summerland amounting to approximately 80 hectares.

After numerous discussions with the District's OCP Committee, the Water Committee, Waste Management Committee, and the District Council, the Cartwright Mountain area was judged to be the preferred area for short to medium-term development (10-20 years), with the South Summerland areas preferred for the more distant future (20-30 years). The Cartwright area incurred lower costs for the provision of water, drainage, electrical and other utilities and had a lesser impact on roads and traffic.

The common factor lacking in any area was the availability of sanitary sewer. Within this framework, deliberations on the provision of sewer services were initiated.

1.3 THE OCP OBJECTIVES

The OCP exercise takes a much broader perspective and attempts to address the community's common goals and objectives. The decisions taken set the stage for the future form and character of the community.

The OCP, which is not yet complete, must take into account:

- Council's goals and objectives
- The interests and policies of other levels of government
- Projected population growth and future land needs

- The views of the public
- Various other physical, resource, environmental, social and economic considerations
- Other plans adopted by Council such as the Waste Management Plan and Capital Expenditure Program
- The requirements of the ***Municipal Act***

Council established various important objectives in the revision of the Official Community Plan. These include:

- The protection of agricultural land in order to sustain the character and economy of the community.

- The further development of the local economy based on the agricultural base of the community and its tourism potential.

- Ensuring that future development is sustainable from an environmental perspective including the protection of water, air and important natural areas.

- Maintaining the character of Summerland to the greatest extent possible.

- Providing municipal services in an innovative and cost effective manner.

- Ensuring that servicing costs are allocated fairly - new growth must pay its own way.

In order to achieve the stated objectives, Council adopted the following policies:

- Promote infill of existing urban areas;

- Intensification of the downtown core area by directing multiple family and institutional development to the core;

- Development of the vacant lands in Lower Town to tourist oriented uses compatible with existing development;

- Retention of Trout Creek, Garnet Valley and other rural residential areas, in their present form;

- Development of new urban residential areas in the hillsides in the Cartwright Mountain/North Prairie Valley area;

- In the long term (beyond 20 years), possible development of other hillside areas south of the existing core area subject to the financial viability of servicing such areas;

- Protection of agricultural land;

- Protection of important natural features and land forms.

1.4 PURPOSE OF WMP REVIEW

The foregoing outlines the scope of activities, public meetings and deliberations that the District of Summerland has undertaken over the past 8 months. It is evident that there are complex issues to be dealt with, and the Waste Management Plan plays a crucial role in resolving these issues.

It also became evident that the WMP in its present form had limited scope for dealing with the growth issues and satisfying long-term objectives.

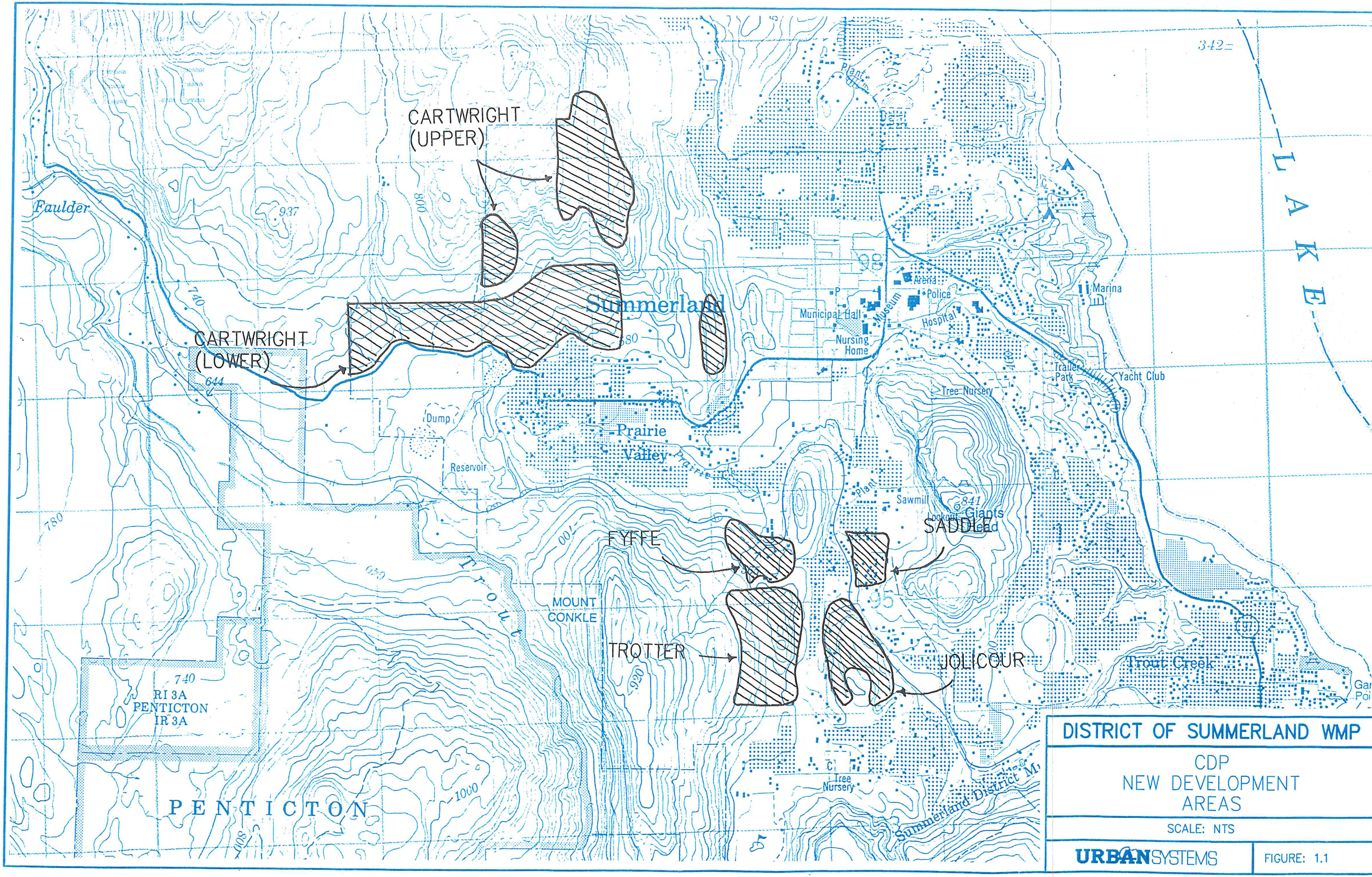
The purpose of the WMP review is to address not only the environmental problems, but also the broader issues of growth management and protection of the agricultural land.

The approach to the WMP review attempted initially to consider the sewerage options for the new areas only, and Section 3 of this report records the results of that exercise. The analysis concluded that a municipal sewage collection system would be necessary to allow development in these new areas.

Further deliberation concluded that to fulfil other OCP goals such as environmental protection and arrest of urban sprawl, a more extensive municipal collection system to serve existing developed areas should be considered. These considerations are elaborated in Section 4.

Section 5 compares these options with those originally examined in the 1991 WMP, and Section 6 discusses a potential financing plan for the sewerage works.

Section 7 contains a brief analysis of a "reduced capacity" scheme in an effort to bring down initial capital outlays and expand capacity as growth occurs.



DISTRICT OF SUMMERLAND WMP

CDP
NEW DEVELOPMENT
AREAS

SCALE: NTS

URBAN SYSTEMS

FIGURE: 1.1

2.1 GLOSSARY

D.U. - A typical dwelling unit. For the purpose of this report a typical dwelling unit is based on the 1991 Canada Census. The 1991 Census shows the population of Summerland to be 9253, with 3580 dwellings, or an average of **2.6 people/dwelling unit.**

Sewage Flow Rates:	Lcd - Litres per capita per day Lud - Litres per unit per day m^3/d - cubic metres per day ML/d - Megalitres (1,000,000 L) per day
Pollutant Concentrations:	mg/L - milligrams per litre
B.O.D.:	Biochemical Oxygen Demand
SS:	Suspended Solids
P.N.:	Phosphorus, Nitrogen
Area:	Ha - Hectares (2.47 Acres)
WMP:	Wastewater Management Plan
OCP:	Official Community Plan
CDP:	Comprehensive Development Plan
ENR:	Engineering News Record

2.2 DENSITIES - NEW AREAS

New areas **without** sewage collection systems are assumed to accommodate 3 units/hectare. Urban development densities are taken as 10-15 units/hectare. Net developable areas are taken as areas with less than 30% slopes, and 20% subtracted for road rights-of-way.

2.3 PER CAPITA SEWAGE FLOWS

The 1991 WMP used a base figure of 375 Lcd for sewage flows. However, typical per capita sewage flows in established sewer systems demonstrate a range of 400 to 500 Lcd. While a new sewer system in Summerland might be relatively watertight it is prudent to make some allowance for infiltration and for commercial and institutional establishments. A per capita figure of 460 Lcd was selected as a safe conservative figure for per capita sewage flow generation. At an occupancy of 2.6 persons per D.U., this represents a flow of 1200 L/d.u./day (Lud) or 1.2 m^3/d.u./day.

2.4 TREATMENT OBJECTIVES

Raw Sewage Levels:	B.O.D.	200 - 250 mg/L
	SS	200 - 300 mg/L
	P	6 - 7 mg/L
Conventional Secondary Treatment objectives:	BOD	40 - 50 mg/L
	SS	20 - 30 mg/L
	P	6 - 7 mg/L
Advanced Waste Treatment objectives:	BOD	less than 10
	SS	less than 10
	P	0.25 annual average

2.5 HOUSING PROJECTIONS

In the past ten years, the annual population growth rate for the District of Summerland has averaged around 3%.

For the purposes of projecting growth, an annual rate of growth between 1.5% and 3% has been identified as realistic for planning purposes.

Depending on the future rate of growth, the population of the District of Summerland can be expected to increase as follows (based on 1991 figures):

YEAR	1.5%	2%	3%
2005	11,396	12,245	13,995
2015	13,226	14,927	18,808

Again, depending on the future population growth rate, the District may have to accommodate the following number of housing units in the next 20 years:

NUMBER OF HOUSING UNITS

YEAR	1.5%	2%	3%
2005	439	766	1378
2015	704	1031	1851
TOTAL	**1143**	**1797**	**3229**

3.1 OPTION 1 - STATUS QUO

This option would essentially allow development to take place on the same basis as current practice, with individual on-site septic tanks. It would involve no cost burden to the District since on-site costs would be borne by the homeowner.

Table 3.1 provides an indication of the maximum number of dwelling units achievable in each of the new development areas should on-site systems be used. Note that with **all** areas developed, the projected housing demand to the year 2005 (10 years) cannot be satisfied even at a 2% growth rate.

It is not cost effective to allow all areas to develop simultaneously since other utility extensions (water, electrical, etc.) will be required. Since demand cannot be satisfied, this option would foster continued encroachment and sprawl on ALR lands and therefore not achieve the stated objectives.

The steeper terrain and presence of rock may preclude some areas for development or create aggravated seepage and public health problems. The initial costs to the homeowner are substantial. The District did not favour Option 1 since it met virtually none of the guiding principles for the CDP.

Figure 3.1 depicts a typical individual septic tank/tile field concept.

TABLE 3.1

OPTION 1 - STATUS QUO

Individual On-Site Septic Tanks

		Net Developable Area (Hectares)	Maximum No. of Units
1.	Cartwright:	185	555 Units
2.	Trotter:	34	102 Units
3.	Jolicour:	9	27 Units
4.	Fyffe/LGH:	13	39 Units
		Total	**723 Units**

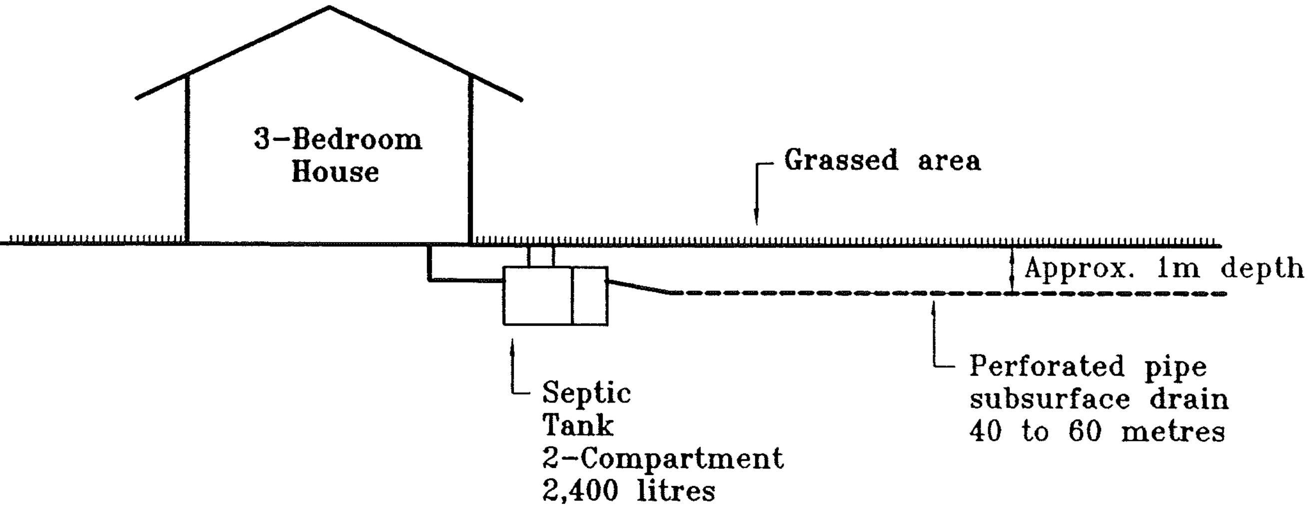
Constraints

- Maximum Density: 3 units/hectare
- Cartwright area subject to seepage-effluent may surface on downslope properties or roadside ditches.
- Many areas may not be approved due to rock.
- Perpetuates phosphorous loading and seepage problems.

Advantages

- Phasing is simplified

		Capital	O & M
Cost:	Approximately	$3,000/unit	$40/unit



Removal Efficiency

BOD	90-95%
SS	95-98%
Nitrogen	10-30%
Phosphorus*	70-90%

*Dependant on specific soils

Cost

Capital:	$3,000 per unit
O&M:	$25 per year

Desirable
- Low maintenance.
- Independent.
- Average removals.

Undesirable
- Larger lots required.
- Limited life.
- Seepage to downslope properties.
- Groundwater contamination
- Removals dependent on specific soils.

DISTRICT OF SUMMERLAND WMP

TYPICAL ON-SITE SEPTIC TANK SYSTEM

SCALE: NTS

URBAN SYSTEMS

FIGURE: 3.1

3.2 CLUSTER SYSTEMS

Cluster systems were examined in an effort to reduce costs, provide a collection system which could be available for future centralization and utilize common areas for ground disposal. This method is currently being used to some extent in townhouse developments in Summerland. Sewage is collected in the same fashion as a conventional gravity system and is directed to a communal septic tank (or package treatment plant) with effluent disposal in a tile field located in a public area.

The number of units per cluster is restricted to less than 100, otherwise, distribution in the tile field becomes unwieldy. Table 3.2 presents the results of this analysis. Figure 3.2 depicts a typicall cluster system concept. Remarkably, this option results in higher costs per unit, even **without** considering the costs of the street-by-street collection system.

Part of the reason for the high cost is the reduction in housing area created by the large public area tile field requirements. In addition, the scheme has some inherent problems in terms of jurisdiction and operation of the treatment and disposal system. In a strata-title development the strata corporation remains responsible for the maintenance. In this case Permit requirements are usually difficult to enforce. In a public system, the municipality would have to take over the operation of numerous small plants; not a desirable position.

Notwithstanding the advantages of these systems, the costs, which would not likely be eligible for senior government assistance, precluded this option from further consideration.

TABLE 3.2

OPTION 2 - Collection sewers for clusters of approximately 100 units each; septic tanks and tile fields in public park areas, option 2A uses package treatment plants and tile fields

			Public Areas Required	
			2	**2A**
1.	Cartwright	(Lower)	8 @ 5 ha = 40 ha	3 @ 5 ha = 15 ha
		(Upper)	6 @ 5 ha = 30 ha	3 @ 4 ha = 12 ha
2.	Trotter		4 @ 3 ha = 12 ha	2 @ 2.5 ha = 5 ha
3.	Jolicour		2 @ 2 ha = 4 ha	2 @ 1 ha = 2 ha
4.	Fyffe/LGH		2 @ 2.5 ha = 5 ha	2 @ 1 ha = 2 ha

Constraints

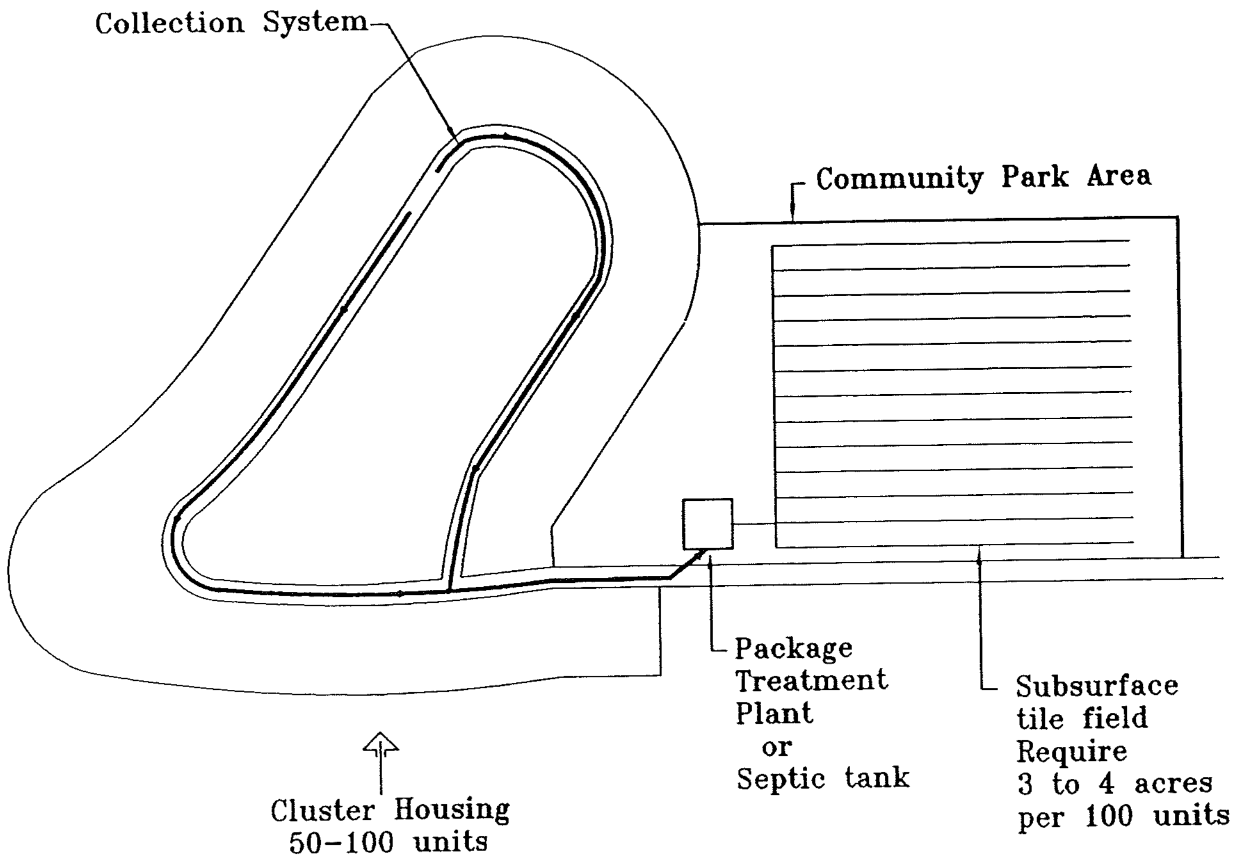
- Maximum density 10 units/ha.
- Reduces net developable units to maximum total: 1900 units (2400 for 2A).
- Site constraints may further reduce development potential.
- Perpetuates phosphorous loading and seepage problems.

Advantages

- Phasing simplified.
- Collection system available for future centralization.

*Cost:		Capital	O & M
	Approximately	$4600/unit (2)	$30/unit
	Approximately	$3800/unit (2A)	$120/unit

*Note:
- Collection sewers not included
- Land cost not included



Removal Efficiency

BOD	95-98%
SS	98-99%
Nitrogen	20-40%
Phosphorus*	80-90%

*Dependant on specific soils

Cost

Capital: $7,000 per unit (treatment & collection)

O&M: $140 per year

Desirable
- Tile field selection more flexible.
- Collection system available.
- Maintenance of numerous small plants.

Undesirable
- Large land areas required for tile fields.
- Numerous package plants to maintain

DISTRICT OF SUMMERLAND WMP

TYPICAL COMMUNAL SYSTEM

SCALE: NTS

URBAN SYSTEMS

FIGURE: 3.2

3.3 CENTRALIZED COLLECTION SYSTEMS

A third conceptual scheme was developed whereby a treatment plant would be provided for each of the two main development areas (Cartwright and South Summerland). These would have capacities as follows:

Cartwright	**Phase I**	-	**1650 units**
	Phase II	-	**1350 units**
South Summerland	**Phase I**	-	**1030 units**

The treatment examined included conventional secondary treatment plants with added chemical precipation for phosphorus removal and disposal to the ground by means of rapid infiltration. Table 3.3 presents the cost estimates for this concept. Figure 3.3 depicts the locations of the treatment plants and RI disposal areas.

The costs per unit are lower than either of Options 1 and 2. It is highly unlikely that this option would be eligible for significant senior government funding, since its purpose is to service new growth only.

While the disposal areas being considered appear to have deep gravel deposits and a reasonable depth to the water table, the viability of rapid infiltration for year-round use remains doubtful. Significant on-site testing and drilling would be required before this concept could be confirmed.

TABLE 3.3

OPTION 3 - Collection Sewers
Two municipal treatment plants (north/south)
Chemical phosphorous removal
Disposal by infiltration

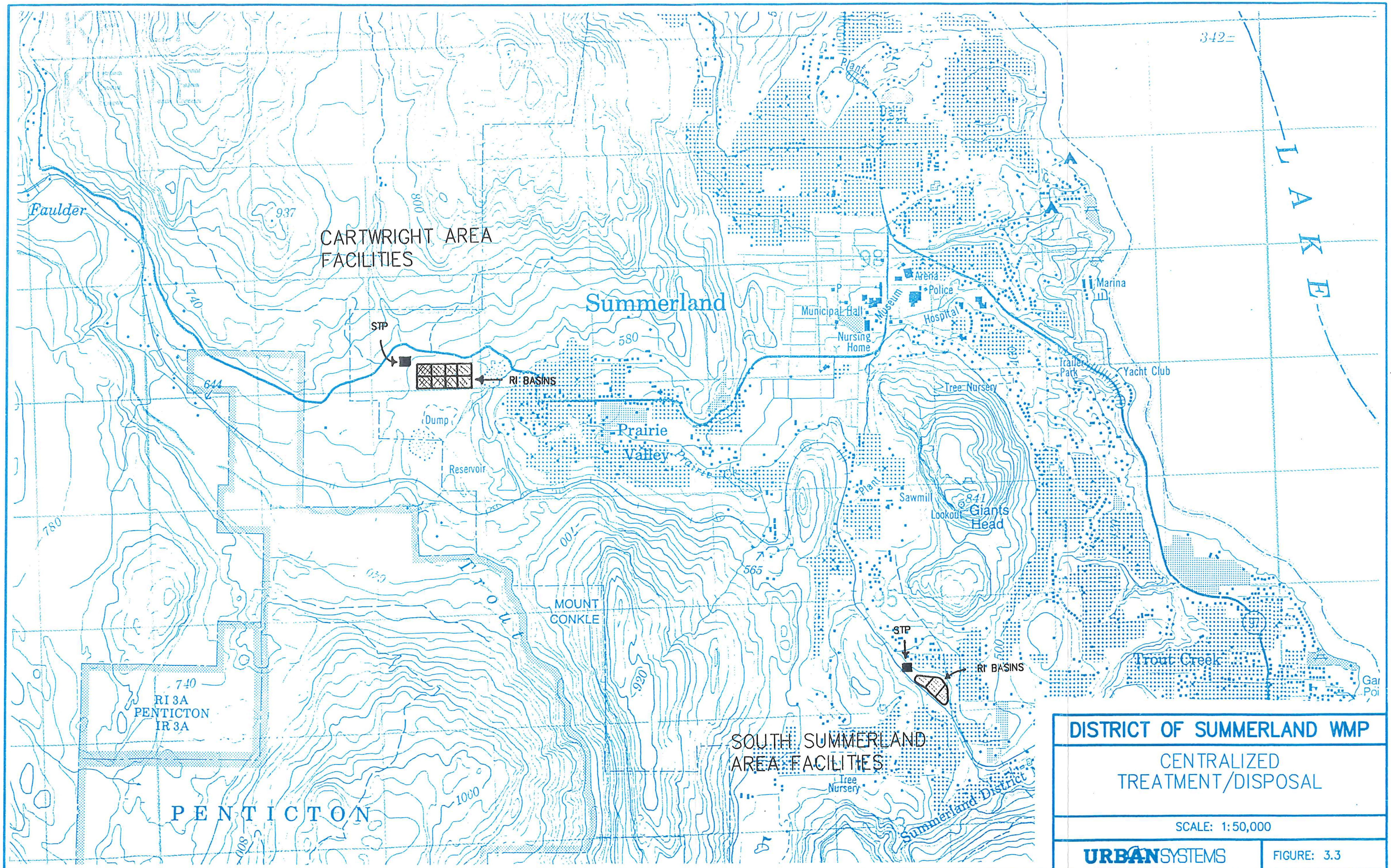
1. North Plant

		Capacity	Units
Cartwright (Lower) Phase I		1980m^3/d	1650
Cartwright (Upper) Phase II		1620m^3/d	1350
		Phase I	**Phase II**
*Capital Costs:	Pumping & Transmission	1,000,000	850,000
	Plant	2,600,000	2,000,000
	Disposal	950,000	650,000
	Total	**4,550,000**	**3,500,000**
Cost per unit		Capital	O & M
		Phase I $2760	$116
		Phase II $2600	$95

2. South Plant

		Capacity	Units
Trotter, Jolicour, etc.		1236m^3/d	1030
*Capital Costs	Pumping & Transmission	850,000	
	Plant	1,800,000	
	Disposal	600,000	
	Total	**3,250,000**	
Cost per unit		Capital	O & M
		$3155	$120

*Note:
- Collection system not included
- Land cost not included



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CENTRALIZED TREATMENT/DISPOSAL

SCALE: 1:50,000

URBANSYSTEMS

FIGURE: 3.3

3.4 EVALUATION OF NEW AREA OPTIONS

Option 3 appeared to offer the greatest economic advantage and also allowed reasonable urban densities to be achieved in the designated development areas. However, it had drawbacks from several perspectives:

(a) Undetermined soil and hydrogeological factors which might constrain or preclude rapid infiltration as a form of disposal.

(b) Since the works would be strictly for new growth, the eligibility of the costs for senior government funding would be questionable. Municipal assist would also be considered questionable and would deviate from the principle that growth pays its own way.

(c) The capital investments required appeared high for any single developer. Land holdings in these areas are not large and single small developers would be hard pressed to raise the initial investment.

Again, if there is no economic viability to developing on the hillsides, the pressure for sprawl into the ALR lands would continue.

(d) The scheme presents no net environmental gain over the current situation.

(e) The scheme does not directly promote reduction, re-use, re-cycling, or reclamation as mandated by Ministry of Environment.

(f) The scheme does not promote infill in existing developed areas.

In view of these drawbacks, the District decided to examine sewerage in a broader context in order to include existing areas as well as new areas. As previously stated, the 1991 WMP identified three priority areas as major contributors of phosphorus loading to Okanagan Lake: Downtown, Lower Town and Trout Creek. Other areas such as Crescent Beach and Front Bench were relatively small contributors of phosphorus.

The geographic locations of these areas led to discussion of "best fit" between existing and new areas. The best fit combinations were deemed to be as follows:

	New		Existing
1.	Cartwright Area	*with*	Downtown, Possibly Lower Town
2.	South Summerland	*with*	Upper and Lower Trout Creek

The above two "corridors" are separated by large tracts of ALR lands. The next phase in the process was to examine sewerage services for these corridors as combinations of existing and new development. The main premise in the analysis was that while existing residents would pay for the benefit of having sewer service and environmental improvement, new development could pay for the capacity allotted in the major facilities.

4.1 SELECTED AREAS

The concept of making sewer service available on a 50/50 basis between new and existing areas was applied to the areas under consideration and yielded the following combinations:

Combination 1:	Cartwright (new area)	2000 D.U.'s
	Downtown and Lower Town (existing & infill)	2000 D.U.'s
	Total Served	**4000 D.U.'s**
Combination 2:	South Summerland (new areas)	1000 D.U.'s
	Upper & Lower Trout Creek & Front Bench (existing & infill)	1000 D.U.'s
	Total Served	**2000 D.U.'s**

4.2 PRIORITY AREAS

The District recognized that it could not move into sewerage on all fronts and would need to address priority areas, relegating other areas to future phases. Given that Cartwright was the most desirable in terms of new development and that the Downtown/Lower Town areas had high priority assigned in the WMP, Combination 1 was selected as first priority.

The Downtown area, in addition to phosphorus contribution, also has numerous other factors which should be addressed:

- commercial core uses rock pits instead of tile fields due to lack of yard space;

- instances of effluent seepage are becoming more common;

- all larger institutional uses are located in this area (hospital, schools, arenas);

- recent higher density townhouse developments have located in this area.

Lower Town, in addition to the phosphorus transmission problem is designated to bolster the District's tourist/commercial activities and this could be possible only with the availability of a sewer system.

The combination 1 sewered area corridor was selected to satisfy the District's growth management strategy over the next 20 years.

Combination 2 (South Summerland/Trout Creek/Front Bench) was selected for the second phase of sewering and development. The South Summerland area, because of its distance to other utilities will be designated for longer term future development.

The Trout Creek area, while it suffers from a troublesome phosphorus transmission problem, has developed predominantly as large lots and contains approximately 300 units. Satisfying housing demand in other areas will relieve the pressure for densification in Trout Creek. In the meantime, the District has already initiated a program to promote the use of phosphate-free detergents and the installation of low water consuming fixtures. It has also initiated a program of inspection and remedial measures for improperly operating septic tanks.

4.3 SEWERAGE OPTIONS FOR PRIORITY AREAS

Sewerage of the priority corridor was approached from the perspective of the final destination of the treated wastewater. In this case, two basic options exist:

A. Final destination to Okanagan Lake
B. Final destination to the ground

The initial treatment requirements in each case are different. Final treatment in the lake occurs mainly by dilution and assimilation. Although aquatic plants will use up some of the nutrients, weed growth is not desirable. Legislation requires that wastewater be treated to the "advanced" level as described in Section 2. This means that at least 95-97% of the phosphorus must be removed prior to discharge, and this can be achieved with an advanced waste treatment plant incorporating biological nutrient removal. Treated effluent must also be filtered, chlorinated and de-chlorinated.

Application of effluent to the ground can be achieved as either a "slow rate" application or a "rapid rate" application. Slow rate application methods include surface irrigation (by drip or spray) and sub-surface tile fields. Essentially, the soils and vegetation perform the function of filtration, nutrient uptake and retention.

Rapid rate application also traps nutrients and filters the effluent, but since the water is applied at much higher rates and in a smaller area, the removals are somewhat less than slow rate applications. Where soil chemistry is favourable, rapid rate application can achieve significant reductions of pollutants.

Two other ground application methods are commonly used: overland flow (wetlands), and subsurface irrigation (tile fields). The wetlands option was examined in some detail at the request of the Waste Management Committee. However, since the region has minimal natural wetland areas, the cost of a constructed wetland was found to be excessive ($6M-$9M). Subsurface irrigation systems require very large tracts of land, and the length of tile field required for the flows being considered becomes unmanageable. This option was also discarded.

For comparison purposes, nutrient removal that can be anticipated from the above methods as follows:

Slow rate irrigation:	95 - 98% or better
Rapid infiltration:	60 - 75%
Wetlands:	30 - 80%
Subsurface irrigation:	75 - 90%
Advanced Waste Treatment Plant:	95 - 97%

4.4 CONCEPT A - ADVANCED WASTE TREATMENT AND LAKE DISPOSAL

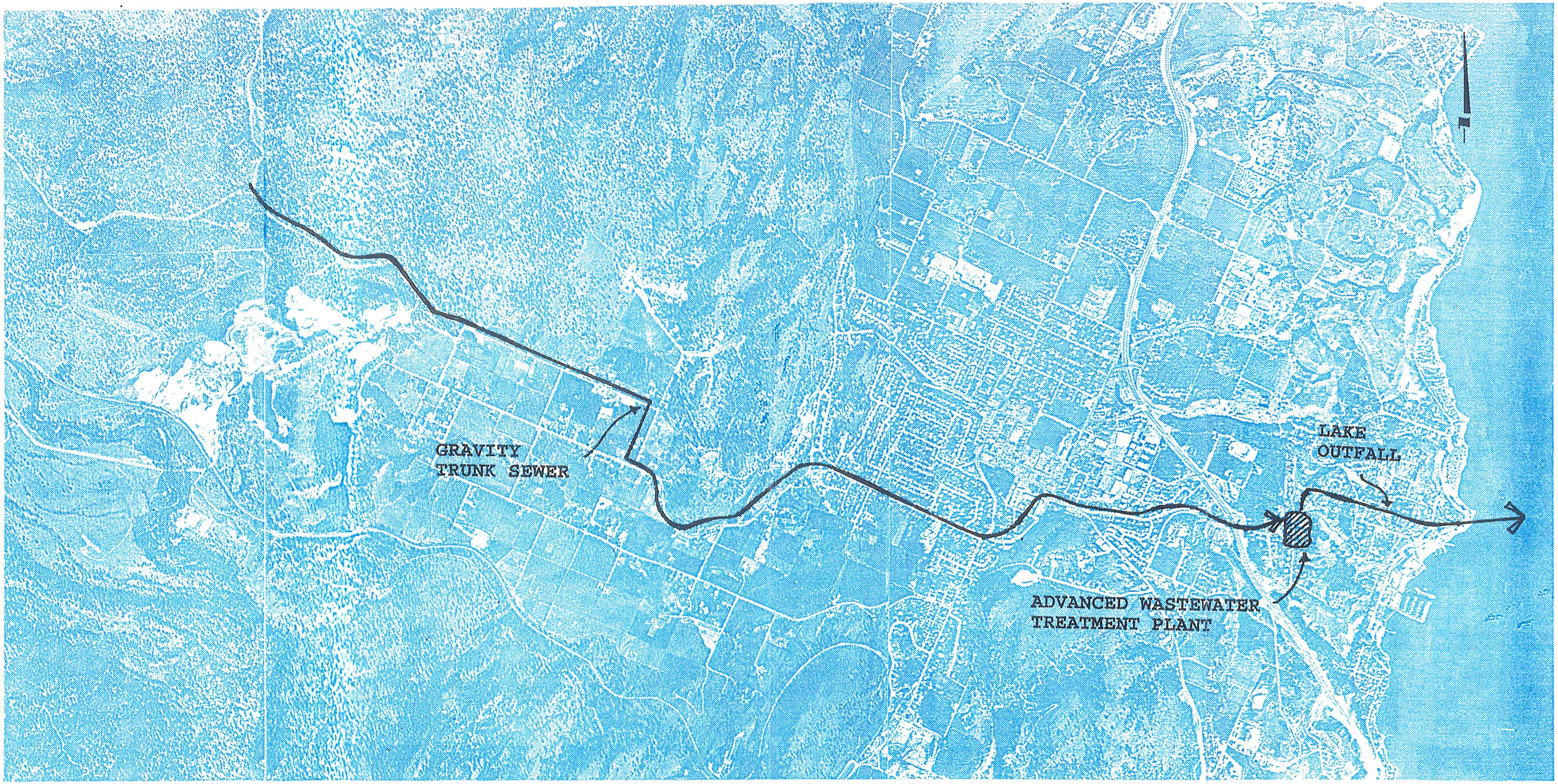
This concept would incorporate a gravity trunk sewer through Prairie Valley, Downtown, across Highway 97 and through Lower Town to an advanced waste treatment plant located in Lower Town. The plant would have an outfall pipe to Okanagan Lake. Figure 4.1 depicts the scheme and Table 4.1 summarizes the estimated costs.

The site for the plant is indeterminate. Discussions with staff and Council indicated a potential parcel on a bench below Highway 97. This parcel is privately owned and an active vineyard. Pumping from the lakeshore properties would be required to direct sewage to this parcel. Low lift pumping would also be required at the plant since a gravity sewer would enter the site at a 3 m depth, and top of tankage is generally 1 m above ground. The land costs are not included in the analysis, but first-cut approximations on the purchase of an adequate site in Lower Town are in excess of $700,000.

TABLE 4.1

CONCEPT A:	Collect all areas to be sewered to a central plant located in Lower Town	
	Use biological nutrient removal plant and deep lake outfall	
Plant Capacity:	$4800 m^3/d$	
Units Serviced:	4000 (2000 FROM Cartwright, 2000 existing)	
Capital Costs:	Pumping and Transmission	2,200,000
	BNR Plant	10,000,000
	Lake Outfall	1,400,000
	Sub-Total	$13,600,000
	Collection System 2000 existing units @ $5,800/unit (Collection system for new units by developer)	
	TOTAL	11,600,000
		$25,200,000
O & M Costs:	Plant (including Sludge Dewatering)	350,000/yr.
	Pumping and Transmission	40,000/yr.
	Collection System	70,000/yr.
	TOTAL ANNUAL O & M	**$460,000/yr.**

Note: Land costs are not included in this analysis.



DISTRICT OF SUMMERLAND WMP

CONCEPT A
LAKE DISPOSAL

SCALE: 1:20,000

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FIGURE: 4.1

The non-financial aspects of this scheme that were discussed with the Committees and with Council revealed some significant negative aspects, including:

- the Lower Town area has high sensitivity to aesthetics and odours;
- road access for the transport of waste sludge goes through prime residential areas;
- no re-use or reclamation is promoted in this concept;
- no reduction of irrigation water consumption is promoted in this concept;
- transfer of phosphorus-rich waste sludge to the landfill site perpetuates the phosphorus problem unless an upsized composting operation is implemented and a market found for the composted product;
- perception that downstream Okanagan Lake water users (e.g. City of Penticton, Penticton Indian Band) might object to effluent discharged to the Lake;
- the plant requires greater than average skills for operation;
- accidental upset of plant processing has no standby mechanism for disposal of unacceptable effluent;
- land costs are not included in the analysis. Rough estimate of land purchase is approximately $700,000.00.

4.5 CONCEPT B - SLOW RATE GROUND APPLICATION

Slow rate ground application by means of irrigation was discussed in the 1991 WMP and given a high rating. The District is in agreement with this assessment, especially in view of the 1200 hectares of land currently being irrigated and consuming vast quantities of the District's water supply.

The problem encountered in the 1991 WMP was the lack of adequate sites for winter storage. It is surmised that this led to the development of the recommended Option 5 - Lake disposal and irrigation through the summer months.

After considerable searching (including both District staff and Committee members), several potential storage sites were identified. These were:

Site 1)	Gravel pit northwest of landfill site
Site 2)	Stink Lake
Site 3)	The Cartwright Mountain "draw"
Site 4)	Garnet Valley

These storage sites are shown on Figure 4.2. A cost analysis revealed Site (1) to be the most cost effective. The summary of costs is shown on Table 4.2. The Garnet Valley site was extremely remote and not costed in detail.

While the pond at Site (1) would be lined, the Water Committee expressed some concern over potential leakage to the Trout Creek Reservoir. The District is concurrently in the process of examining sites for the provision of additional domestic water storage. A cursory analysis of these sites was carried out for relocating the water reservoir to a location more distant from both the landfill and the proposed effluent pond. A preliminary cost comparison of these sites is presented in Table 4.3.

TABLE 4.2

OPTION 1 - STORAGE AT GRAVEL PIT

A. Storage:

1.	Site Preparation 60,000m² at $1.00	$60,000
2.	Excavation and Embankment 40,000m³ at $5.00	200,000
3.	Liner Bedding Sand 12,000m³ at $10.00	120,000
4.	Liner 900,000m² at $12.00	1,080,000
5.	Inlet/Outlet Piping, Controls	30,000
Subtotal		$1,490,000

B. Irrigation Main (to Jones Flats and to DL 3403):

1.	3,000m of 300mm pipe at $100	$300,000
2.	6,000m of 300mm pipe at $180	1,080,000
3.	Reinstatement 6,000m at $25.00	150,000
4.	Valves, Fittings, Parts	150,000
5.	Pumphouse	140,000
Subtotal		1,820,000
Total Construction Cost		3,310,000
Contingency and Engineering (30%)		993,000
GST (Net 3%)		129,000
TOTAL CAPITAL		$4,432,000

PROS	CONS
• Low cost storage	• Perceived risk of leakage to water supply
• Gravity feed to orchards	• Long distance to tree farm on DL 3403
• Low lift to tree farm	
• Gravity supply from STP	
ASSUMPTIONS	
• STP @ gravel pit site	
• No surface lines or sprinklers included	
• DL 3403 available from crown	
• Tree farm area approximately 330 acres	
• Agricultural area accessible: 600 acres	

OPTION 2 - STORAGE AT STINK LAKE

A. Storage:

1.	Site Preparation 120,000m² at $1.00	$120,000
2.	Dam Construction 260,000m³ at $5.00	130,000
3.	Spillway, Cut-off Trenches	80,000
4.	Pump Station (1)	400,000
5.	Booster Station (1)	300,000
6.	Supply Main 5,400m of 300mm pipe @ $180	972,000
7.	Gravel Road Access	200,000
8.	Valves, Fittings	150,000
9.	Inlet/Outlet Controls	30,000
10.	Power Station	15,000
Subtotal		$3,702,000

B. Irrigation Main

1.	Irrigation Pumphouse	$600,000
2.	1,000m of 300mm pipe at $180	180,000
3.	Valves/Fittings	50,000
Subtotal		830,000
Total Construction Cost		4,532,000
Contingency and Engineering (30%)		1,360,000
GST (Net 3%)		178,000
TOTAL CAPITAL		$6,070,000

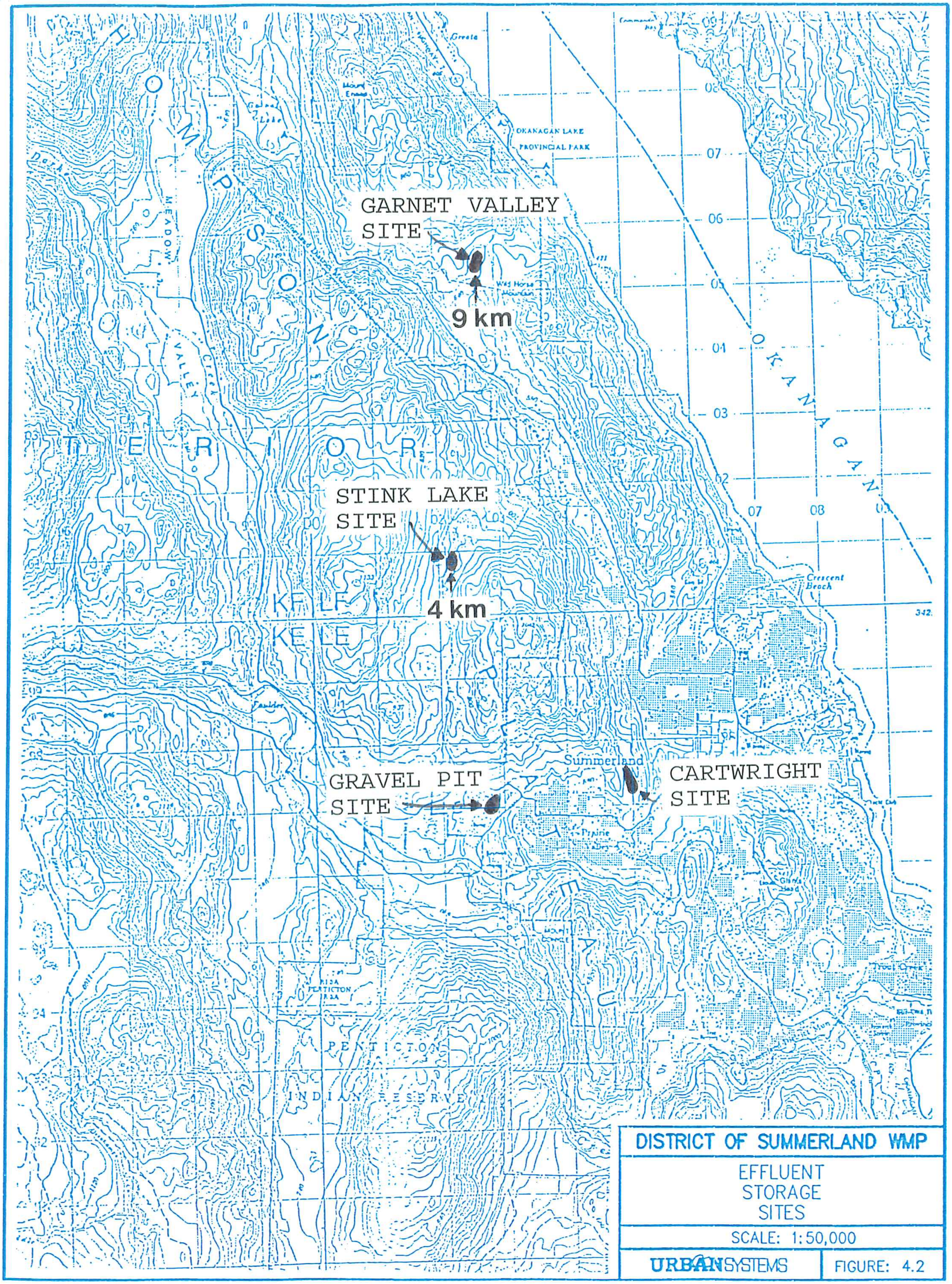
PROS	CONS
• Remote area - little public impact	• Additional 130m of pumping
• No perceived risk to water supply	• Need re-pumping to spray irrigate
ASSUMPTIONS	• Irrigation limited to tree farm (too remote to supply agriculture)
• STP @ gravel pit site	
• No surface lines or sprinklers included	• Access difficult
• Tree farm on DL 3313 (200 acres) + 200 acres on unsurveyed crown land	• Unknown soil conditions - assumed no liner necessary
• No return line for agriculture	

OPTION 3 - RELOCATE WATER STORAGE TO CARTWRIGHT SITE (300 ACRE-FEET)

Water Storage Relocation:

1.	48 inch supply main diversion around Trout Reservoir 600m @ $700	$420,000
2.	24" diversion to Cartwright 900m @ $300	$270,000
3.	48" return main 700m @ $700 300m @$400, (in common trench)	 490,000 120,000
4.	Secondary feed on Haddrell 300m of 24" @ $300	90,000
5.	Valves, fittings	100,000
6.	Clearing, Grubbing, Stripping	60,000
7.	Dam 150,000m³ @ $5.00	750,000
8.	Liner and Bedding 53,000m² @ $11.00	583,000
9.	Fence 1,000m @ $50.00	50,000
10.	Relocate Chlorination and Building	300,000
11.	Spillway and Cut-off Trench	70,000
Total Construction Cost		3,303,000
Contingency and Engineering (30%)		991,000
GST (3% net)		129,000
TOTAL CAPITAL		$4,423,000

UNIT STORAGE COST		
@ 300 acre-feet:	$14,700/acre-ft.	
@ 500 acre-feet:	$9,200/acre-ft.	
@ 1000 acre-feet:	$6,000/acre-ft.	



DISTRICT OF SUMMERLAND WMP

EFFLUENT STORAGE SITES

SCALE: 1:50,000

URBANSYSTEMS

FIGURE: 4.2

TABLE 4.3

WATER STORAGE OPTIONS SUMMARY

OPTION 1 - $3.2M - (small gravel pit)	provides lowest storage capacity (135 acre-ft.)
-	highest unit cost (≈ $24,000/acre-ft.)
-	distance from landfill/effluent pond is approximately 500m
-	must wait for gravel pit to be mined out
OPTION 2 - $3.0M - (natural site near Kettle Valley rail)	provides a maximum of 275 acre-ft.
-	top water level at 2060 ft. is 100 ft. higher than Trout Reservoir and 20 ft. lower than the landfill
-	distance from landfill/effluent pond is approximately 700m
-	cost per acre-foot is $11,000
OPTION 3 - $4.4M - (Cartwright Mountain draw)	provides a 300 acre-ft. of storage
-	top water level is same as Trout Reservoir (1,950 ft.)
-	remote from landfill/effluent pond
-	cost per acre-foot is $14,700 - can be easily expanded to 500 acre-ft. which brings cost down to $9,200 acre-ft.
-	loss of developable land

Notwithstanding the relocation of the water reservoir to gain additional storage and preclude any intrusion of landfill leachate, it was concluded that the risk of contamination from the proposed effluent pond was minimal and this should not be the prime motivator for relocation of water storage.

Location of the treatment plant for this concept was then examined. The same problems that were identified in concept A for locating a plant in Lower Town apply in this case. Furthermore, most irrigation takes place above elevation 500m and it would make little sense to direct all sewage down to lake level (330m), only to pump 100% back up to the irrigation areas.

It became apparent that it would be more cost effective to pump sectors up from Lower Town in small segments up to the vicinity of the storage site (elevation 640m). The District already owns significant land in and around the landfill site, and there is adequate flat area near the landfill for construction of a conventional treatment plant. Indeed, there is adequate area for construction of an aerated lagoon system.

The concept that evolved from these considerations included the following major elements:

- A series of pump stations starting with small ones at Lower Town to larger ones in the Cartwright area, each lifting 40-50m. (total lift:; elevation 330m to elevation 650m, or a total of 320m)
- Forcemain interconnection between pump stations. No individual connections allowed to forcemain;
- Aerated lagoons located above effluent storage pond;
- Filtration basins in native gravels;
- Storage pond in gravel pit (sized for 300-day storage at design flow, 1440 ML).
- Chlorination facility;
- Reclaimed water supply line placed in the same trench as the forcemain to the treatment plant;
- Supply line is to be directed south past Prairie Valley and terminate at the golf course.

The preliminary cost estimates for the scheme are presented in Table 4.4 and a conceptual plan presented on Figure 4.4.

TABLE 4.4

CONCEPT B:	Collect all areas to be sewered to a central treatment plant, use winter storage and irrigation for disposal (Cartwright, Downtown and Lower Town)

PHASE I

Plant Capacity: 4800m^3/d
Units Serviced: 4000 (2000 from Cartwright, 2000 existing)

Capital Costs:	Pumping and Transmission	3,800,000
	Plant	6,600,000
	Storage	2,000,000
	Irrigation Main	$1,900,000
	Subtotal	$14,400,000
	Collection System	
	2000 existing units @ $5800/unit (Collection system for new units by developer)	11,600,000
	TOTAL CAPITAL	**$26,000,000**

O & M Costs:	Plant	$180,000/yr.
	Pumping Stations	$100,000/yr.
	Collection System	$70,000/yr.
	TOTAL ANNUAL O & M	**$350,000/YR.**

This concept appeared to fulfil the District's objectives in that:

- Treatment and storage could be achieved in an economical fashion;
- Operation of aerated lagoons is relatively passive and requires minimal operator skills and time;
- Waste sludge processing is minimized since sludge is digested and densified at the bottom of the lagoons. De-sludging every 10-15 years can be carried out on a contract basis with mobile dewatering equipment; dried sludge can be composted in the adjacent composting facility;
- The location of all facilities near the landfill minimizes impact on aesthetics and residential areas;
- The scheme makes full use of reclamation opportunities and potentially reduces the irrigation water demands;
- Use of a forcemain for transmission minimizes pressures for additional connections and ALR exclusions where the main is adjacent to ALR;
- Location of the storage pond at elevation 640m provides adequate water pressure for irrigation at elevation 500m (190 psi static) without further pumping;
- The use of pump stations provides a more definitive boundary on the limits of the sewered (urban) area.

4.6 IRRIGATION CONSTRAINTS & CONTINGENCY PROVISIONS

The irrigation concept meets the majority of the District's objectives and conforms to its guiding principles for growth. However, there are several indeterminte factors which can influence wide acceptance of the reclaimed water. The intent of the District is to use all reclaimed water for agricultural irrigation, replacing some of the currently used Trout Creek water.

While acceptance of the reclaimed water is anticipated to grow with time, the District also anticipates initial start-up problems. An information brochure has been sent to agriculturalists in the area soliciting their input on their potential needs for the reclaimed water and providing a financial incentive to do so. Appendix III provides a copy of the questionnaire.

The reclaimed water is suitable for drip irrigation on fruit trees and vines, spray irrigation on golf courses, pastures and silage crops, nurseries and silviculture operations. It is also suitable for cooling water, gravel washing and other industrial uses.

There are currently over 1200 hectares of irrigated agricultural land and roughly 50 hectares of irrigated parks and golf courses in the District of Summerland. The majority of the irrigated lands are orchards, and these consume roughly 12 M m^3 per year out of the 18 M m^3 total consumption (maximum year).

The **average** monthly demand for irrigation is 1.8 M m^3/month from mid-May to mid-September, or a total of 7.2 M m^3 per season.

The amount of treated effluent produced by 4000 units is approximately 1.8 M m^3 per year. Over a 4 month period, this equates to 0.45 M m^3/month, or, at current irrigation rates, reclaimed water would irrigate an area of some 300 hectares. With conversion to drip irrigation, and lower application rates, the area required would be approximately 400 hectares. Preliminary indications are that numerous orchardists have converted or are converting portions of their operations to drip irrigation, and use of reclaimed water would be acceptable. Initially, only half of the design volume would be available, with an area requirement of 150 hectares.

A calculation of the available volumes and nutrients is provided on Table 4.5. Figure 4.5 plots area required versus units served.

Notwithstanding these efforts, the District recognizes that "back-up" systems for the application of reclaimed water will be necessary to cover events such as unusually wet years, slow acceptance by agriculturalists, and other unanticipated problems. The proposed "back-up" systems are as follows:

Back-up No. 1: A reclaimed water supply line to DL 3403, obtained as a Crown lease. This lot has approximately 100 hectares (240 acres) of reasonably sloped land and could be used for the farming of trees for marketable lumber.

The tree farm may be contracted out to a private operator through a proposal call, or the District may opt to invest in the operation. Onsite distribution and sprinkler system costs would be the responsibility of the investor.

The District currently owns roughly 36 hectares (90 acres) of treed area in the vicinity of the treatment facility - a surface spray irrigation system could be installed in this area at nominal cost. These areas are depicted on Figure 4.6.

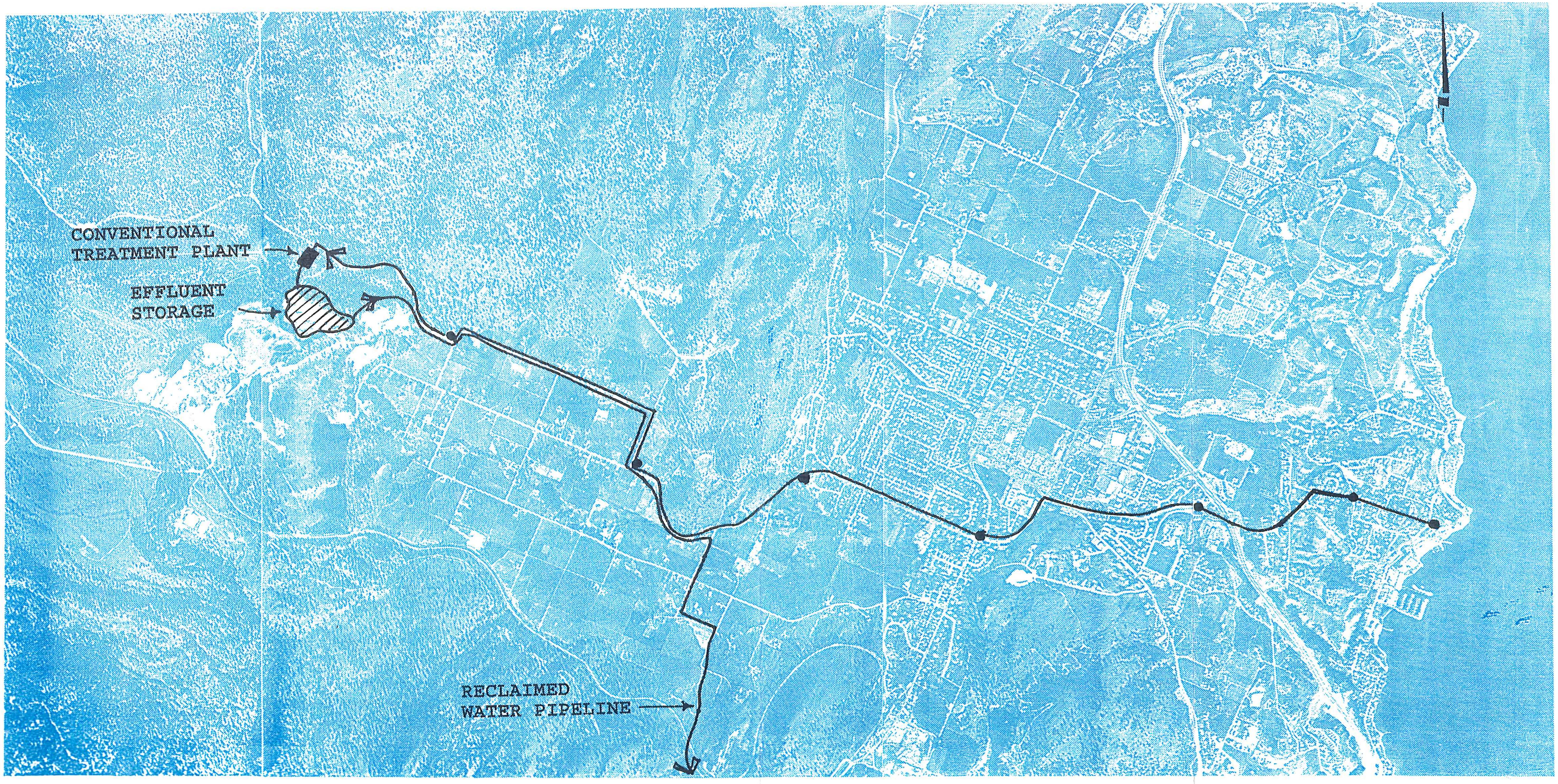
Back-up No. 2: For particularly wet years or to dispose of excess water at the end of the irrigation season, rapid infiltration basins are proposed on the same site as the treatment plant.

Initial observations of the surficial geology indicate favourable conditions for RI basins as the area appears to have at least 30m of coarse gravel overburden with no sign of water table. However, rigorous site drilling and test pitting should be carried out prior to design.

Back-up No. 3: The District intends to develop a demonstration orchard of reasonable acreage. This orchard would serve as a test facility for application of reclaimed water in a drip emitter system, and an undertree spray system. Testing and monitoring would be carried out by Summerland Research Station staff.

Funding for the study is anticipated under the Science Council of BC grant program, with potential contributions from BC Tree Fruit Authority.

Given the several "back-up" systems for contingency events, the District feels comfortable that the irrigation scheme is viable and is committed to long-term promotion of reclaimed water use for the benefit of the community.



● LIFT STATIONS

DISTRICT OF SUMMERLAND WMP

CONCEPT B
RECLAMATION

SCALE: 1:20,000

URBAN SYSTEMS

FIGURE: 4.4

TABLE 4.5

WATER VOLUMES AVAILABLE

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1. **INITIAL YEARS - 2000 UNITS**

a) YEARLY VOLUME: 2.4 ML/d x 365 days = 876 ML
APPLICATION PERIOD: 120 days
CURRENT AVERAGE APPLICATION RATE: 6 mm/day (1/4")
AMOUNT OVER SEASON: 6 x 120 = 720 mm = 0.72 m (28")
ACREAGE THAT CAN BE IRRIGATED:

$$\frac{876{,}000 \text{ m}^3}{0.72 \text{ m}} = 1{,}217{,}000 \text{ m}^2 = 122 \text{ ha} = \mathbf{300 \text{ acres}}$$

b) WITH DRIP IRRIGATION: **450 acres**

2. **LATER YEARS - 4000 UNITS**

a) AT CURRENT RATES
DOUBLE THE ACREAGE: **600 acres**

b) WITH CONVERSION TO DRIP IRRIGATION
APPLICATION RATE: 4 mm/day (0.16")
AMOUNT OVER SEASON: 4 x 120 = 480 mm = 0.48 m (18.9")
ACREAGE THAT CAN BE IRRIGATED:

$$\frac{1{,}752{,}000 \text{ m}^3}{0.48 \text{ m}} = 3{,}650{,}000 \text{ m}^2 = 365 \text{ ha} = \mathbf{900 \text{ acres}}$$

APPROXIMATE NUTRIENT CALCULATIONS

1. **TYPICAL CONCENTRATIONS IN TREATED DOMESTIC WASTEWATER**

TOTAL P: 7 mg/L
TOTAL N: 18 mg/L (10 mg/L soluble)

2. **TYPICAL CONCENTRATIONS IN TREATED AND FILTERED WASTEWATER**

TOTAL P: 4 mg/L
TOTAL N: 10 mg/L (7 mg/L soluble)

3. **ASSUMED WATER APPLICATION RATE (DRIP SYSTEM)**

AVERAGE 10 L/day per tree over 120 day season

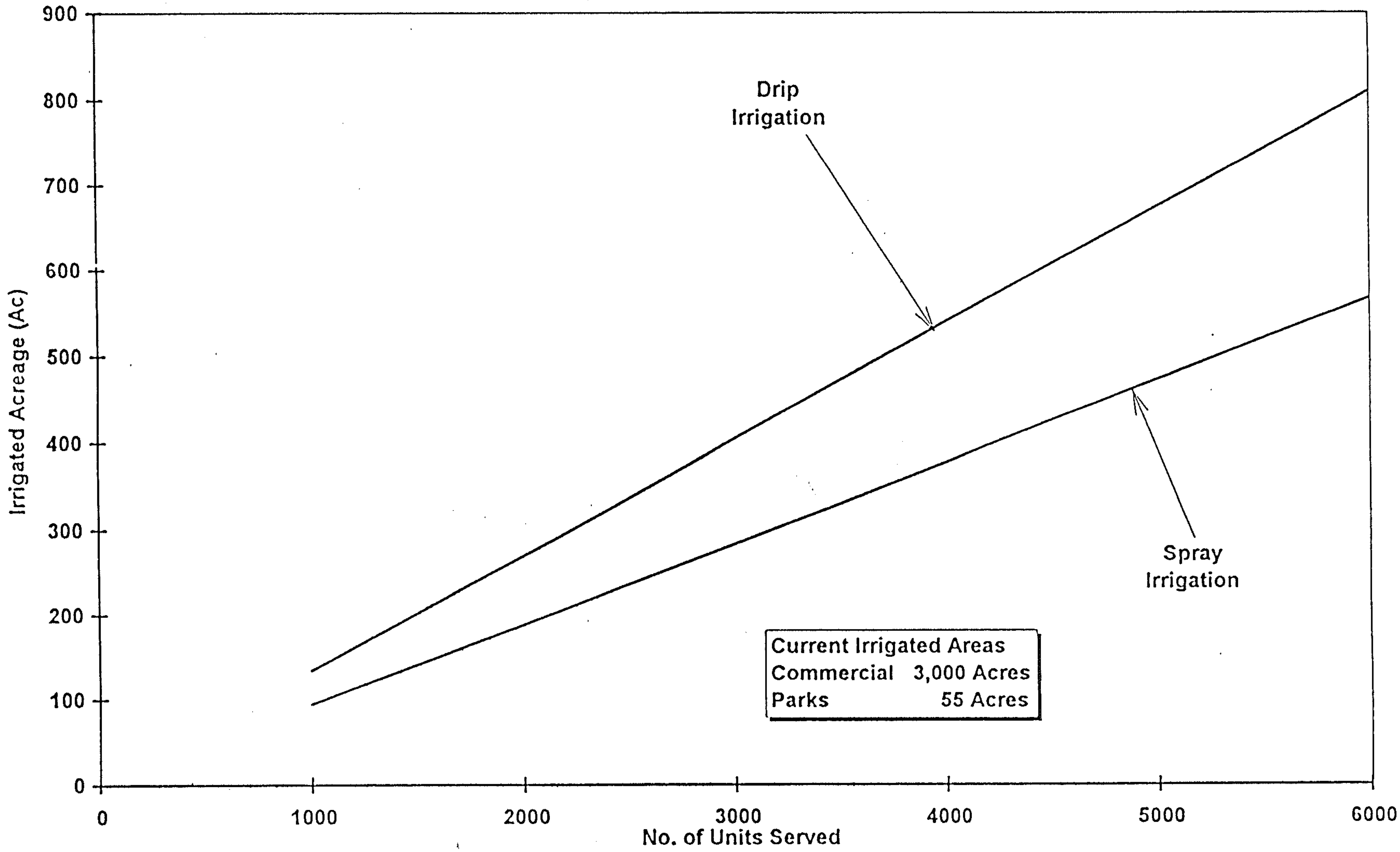
4. **AMOUNT OF P,N APPLIED OVER SEASON (UNFILTERED WATER) - PER TREE**

P: 10 L/d x 7 mg/L x 120 days = 8400 mg = **8.4 g/season**
N: 10 L/d x 10 mg/L x 120 days = 21,600 mg = **12.0 g/season**

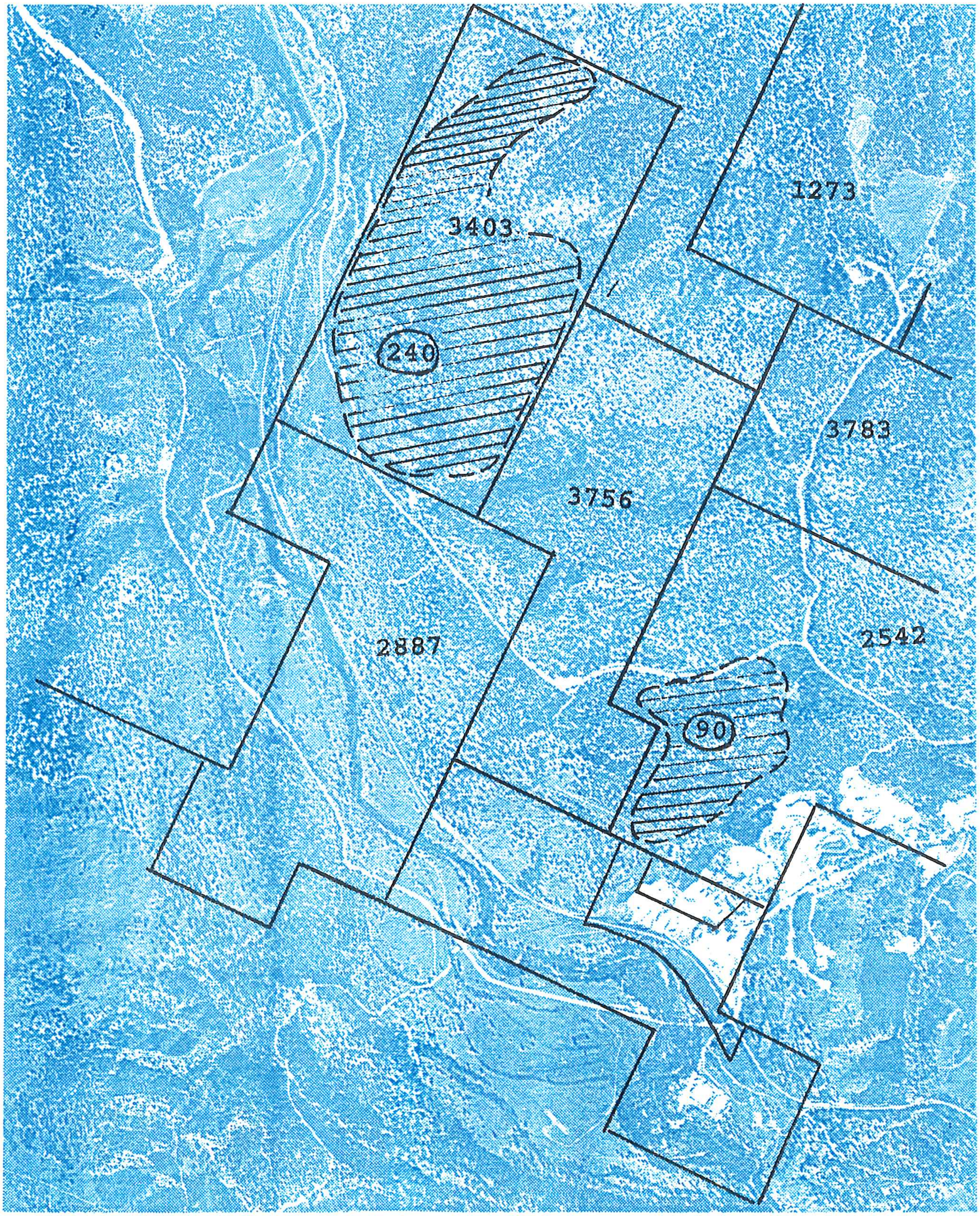
5. **AMOUNT OF P,N APPLIED OVER SEASON (FILTERED WATER) - PER TREE**

P: 10 L/d x 4 mg/L x 120 days = 4800 mg = **4.8 g/season**
N: 10 L/d x 7 mg/L x 120 days = 8,400 mg = **8.4 g/season**

Effluent Irrigation Areas



DISTRICT OF SUMMERLAND WMP	
IRRIGATION AREA GRAPH	
SCALE: NTS	
URBAN SYSTEMS	FIGURE: 4.5



DISTRICT OF SUMMERLAND WMP	
CROWN LAND FOR TREE FARMING	
SCALE: 1:20,000	
URBAN SYSTEMS	FIGURE: 4.6

4.7 SOUTH SUMMERLAND/TROUT CREEK AREA

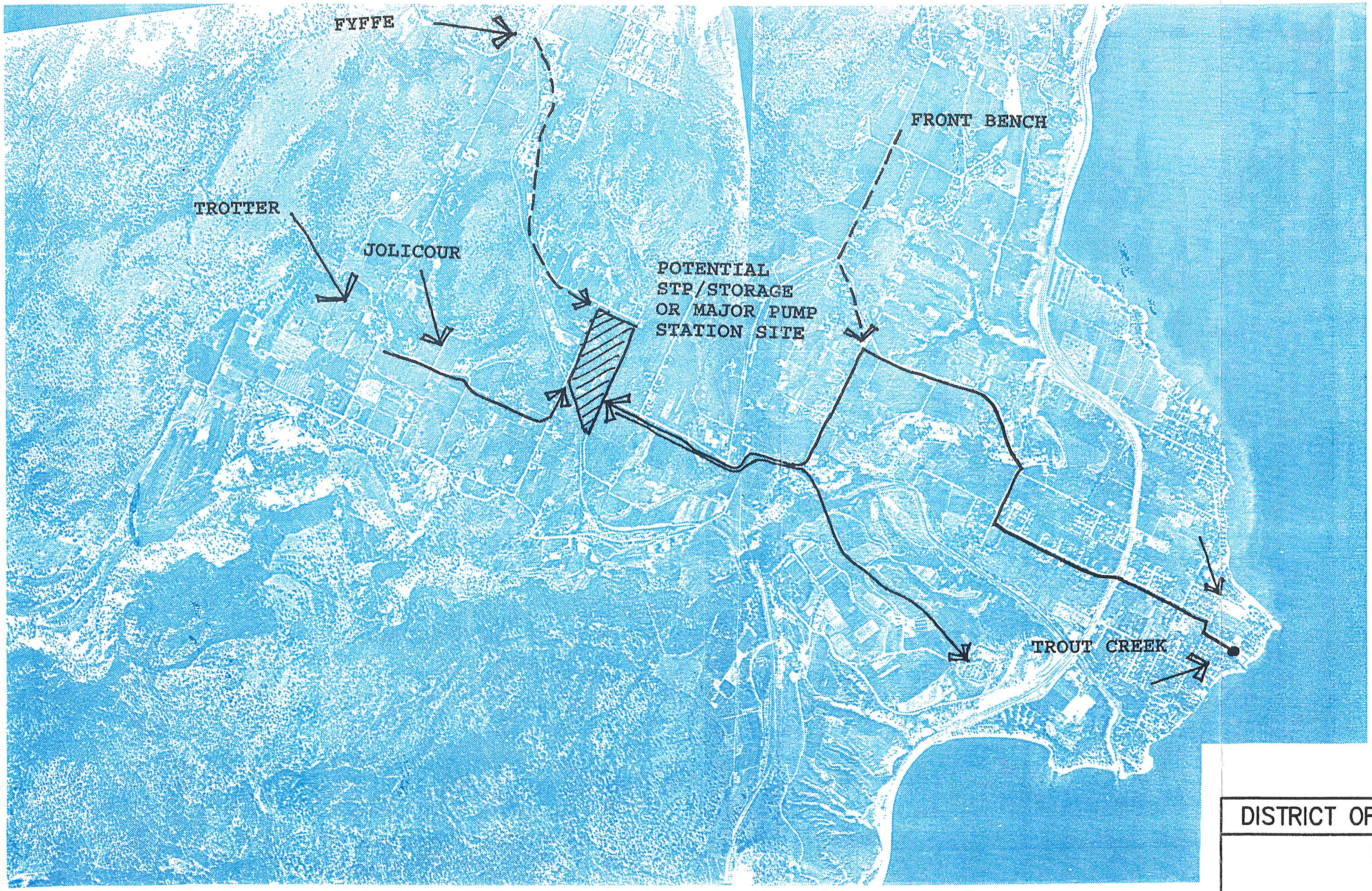
Future development and densification of these areas (beyond 20 years) is expected to follow parallel guiding principles to the proposed first phase. That is, the specified area would include the new areas as well as the existing area.

If irrigation is successful in the first phase, the same method can be implemented in the second phase. A potential treatment plant/storage site exists next to the Kettle Valley Railway as indicated on Figure 4.7. This site should be safeguarded for future public use.

Detailed costing in the second phase may reveal that it may be more economical to pump to the landfill site plant and expand the plant to accommodate additional flows. Expansion of storage at this site is also possible, especially if the water supply reservoir is relocated.

Alternatively, the second phase may opt to use an advanced waste treatment plant and discharge to the Lake. This is not anticipated however, given the current philosophy of the community and Ministry of Environment continued promotion and fostering of viable reclamation and re-use strategies.

The areas outside of the two sewered corridors are expected to be enshrined in the OCP for rural and agricultural development into the long-term future.



DISTRICT OF SUMMERLAND WMP

PHASE II
OPTIONS

SCALE: 1:20,000

URBANSYSTEMS | FIGURE: 4.7

5.1 THE OPTION 5 RECOMMENDATION (1991 WMP)

The recommended Option 5 in the 1991 WMP was to provide sewer service initially for 5700 people and in 20 years for 7100 people. Its built-in excess capacity was for 1400 people, or roughly 540 units. The District's current housing demand is in excess of 100 units/year. Clearly the system would have required expansion prior to the 20-year horizon. The estimated capital cost of the scheme was $21.5M in 1991 dollars (approximately $26.0M in 1994 costs). Its directive was to service as many existing units as possible. To reduce initial capital costs, a first phase was recommended which would serve approximately 700 units, at an estimated cost of $13.3M (1991 dollars).

5.2 FOCUS OF THE AMENDMENT

The proposed amendment to the WMP evolved from a consideration of a broad range of municipal infrastructure objectives, of which sewerage became a vital part. Some of the key policies that led to the amendment were:

(a) That the Trout Creek area and South Summerland area would remain as large lot rural areas within the 20-year timeframe.

(b) That the demands for additional housing should be satisfied in non-agricultural hillside areas and at more efficient urban densities.

Within this framework, the extent of the sewered area was tailored to alleviate environmental problems in two of the larger existing areas, as well as provide access to sewer infrastructure for the largely undeveloped area.

A design horizon of 4000 units, in the 20-year timeframe, was selected to accommodate:

- 2000 existing units
- 500 infill units (in developed area)
- 1500 new units (in new area)

The evolution of the treatment and reclamation scheme derived from the considerations discussed in Section 4. Reclamation was considered desirable in the previous WMP analysis but the high cost of a remote storage site made the scheme uneconomic.

5.3 COMPARISON TO PREVIOUS OPTIONS

Several tables in the 1991 WMP have been reproduced, and the current options A and B added in order to provide an overall comparison. These are:

Table 5.1	Total Annual Cost and Present Worth Comparison
Table 5.2	Cost versus Phosphorus Reduction Comparison
Table 5.3	Cost Benefit Matrix

The 1991 costs have been indexed up to 1994 by a factor of 13% (in accordance with ENR Cost Indices). In British Columbia these costs may need to be factored by an additional 15-20% to respect the Fair Wage Policy. Debt retirement costs are based on a 25-year repayment at an interest rate of 10%. Cost estimates for options A aand B are based on 1994 costs, including Fair Wage Policy.

The total annual cost and present worth comparisons reveal that the Reclamation option (B) is indeed cost effective, and in the final analysis has the lowest present worth/population served ratio of all the schemes.

The phosphorus reduction comparisons are not appropriate on a direct basis, since the previous comparisons did not project any development or phosphorus loading from Cartwright Mountain. The proposed plan, however, will provide the removal of approximately 800 kg of P/year out of the estimated total of 1750 kg/year to the Lake. These are 1985 estimates and will have increased over the last 10 years. The ratio of approximately 45% removal should still apply.

The point assignation in the Cost Benefit Matrix is somewhat subjective. All told however, Option B more clearly adheres to the Ministry of Environment 1992 WMP Guidelines which stress:

- The use of the 3 Rs (reduce, re-use, recycle).
- Best Available Control Technology for resource recovery and residuals management.
- Polluter Pay Principle with emphasis on pollution prevention.

TABLE 5.1

OPTION	SERVICED POPULATION (YEAR 2008)	CAPITAL COSTS $M								ANNUAL COSTS						
		COLLECTION & TRANSMISSION	INITIAL TREATMENT	FINAL TREATMENT	E & C (30%)	GST (3%)	TOTAL CAPITAL	LAND COST	AM'T TO FINANCE (33.3%)	INITIAL O & M	@ 2008 O & M	CAPITAL REPAYMENT	TOTAL ANNUAL	PRESENT WORTH (PW)	COST PER PERSON PW/POPULATION INITIAL	COST PER PERSON PW/POPULATION FINAL
1 REGIONAL SYSTEM	7100	17.18	–	–	5.15	0.67	23.00	–	7.67	0.43	0.49	0.85	1.31	11.89	2086	1675
2A LAKE DISPOSAL	7100	13.67	4.52	0.40	5.58	0.73	24.90	–	8.30	0.28	0.29	0.91	1.22	10.89	1910	1534
2B LAKE DISPOSAL (REDUCED SIZE)	1250	4.01	1.36	0.28	1.70	0.22	7.57	–	2.52	0.14	0.14	0.28	0.42	3.81	3048	3048
3A EFFLUENT IRRIGATION	7100	13.67	1.36	8.36	7.02	0.91	31.32	–	10.44	0.27	0.29	1.15	1.43	12.98	2277	1828
3B EFFLUENT IRRIGATION (REDUCED SIZE)	4750	7.12	1.02	6.22	4.31	0.56	19.23	–	6.41	0.20	0.21	0.71	0.92	8.35	1758	1758
4 HIGH RATE LAND DIPSOSAL	4750	9.70	1.02	1.81	3.76	0.49	16.78	–	5.59	0.19	0.21	0.62	0.82	7.44	1566	1566
5 COMBINED IRRIGATION/LAKE DISPOSAL	7100	13.67	4.75	1.02	5.83	0.76	26.03	–	8.68	0.28	0.29	0.96	1.25	11.35	1991	1599
6 CLUSTER SYSTEMS	900	1.67	0.93	1.19	1.14	0.15	5.08	–	1.69	0.12	0.13	0.19	0.32	2.90	3222	3222
7 ENHANCED ON-SITE	N.A.	–	1.58	–	0.47	0.06	2.11	–	2.11	0.14	0.14	0.23	0.37	3.36	N/A	N/A
A BNR PLANT/LAKE DISPOSAL (NEW)	10400	10.86	7.00	0.94	5.64	0.73	25.17	0.70	9.09	0.41	0.51	1.00	1.46	13.25	2325	1274
B RECLAMATION (NEW)	10400	11.60	4.90	2.91	5.82	0.76	25.99	–	8.66	0.30	0.40	0.95	1.35	12.25	2149	1179

NOTES:

1. Options 1 through 7 are from 1991 WMP
   Updated costs as follows
   1991 ENR Index: 4800
   1994 ENR Index: 5400
   % increase: 13%

   E & C – 30% USED
   GST – Net 3%

2. Land purchase cost added for Lower Town STP site (Option A)
   No land costs included in previous options

4. Capital Repayment CRF = 0.11017 (10% @ 25 years)

5. Present Worth PWF = 9.077 (10% @ 25 years)

6. Cost per person is PW Divided by Population

	Initial	Final
Options 1,2A,3A,5:	5700 people	7100 people
Option 2B:	1250 people	1250 people
Option 3B:	4750 people	4750 people
Option 6	900 people	900 people
Options A,B:	5700 people	10,400 people

TABLE 5.2

COST VERSUS PHOSPHORUS REDUCTION

OPTION	CAPITAL COST	ANNUAL COST	INCREMENTAL P REDUCTION Kg/yr (to 2008)	CAP COST PER KG OF P REDUCTION $/Kg/Yr	ANNUAL COST PER Kg of P REDUCTION $/Kg/Yr
1	23.00	2.99	1285	17,900	2325
2A	24.90	3.03	1285	19,377	2358
2B	7.57	0.97	689	11,000	1408
3A	31.32	3.73	1509	20,755	2472
3B	19.23	2.32	600	32,050	3867
4	16.78	2.05	738	22,737	2778
5	26.03	3.16	1376	18,917	2297
6	5.08	0.69	620	8,194	1113
7	2.11	0.37	386	5,466	958
(NEW) A	25.87	3.31	1152	22,460	2873
(NEW) B	25.99	3.21	1152	22,560	2786

TABLE 5.3
COST BENEFIT MATRIX

PARAMETER	OPTION 1: REGIONAL SEWERAGE SYSTEM	OPTION 2A: LAKE DISPOSAL	OPTION 2B: LAKE DISPOSAL	OPTION 3A: EFFLUENT IRRIGATION	OPTION 3B: EFFLUENT IRRIGATION	OPTION 4: HIGH RATE LAND DISPOSAL	OPTION 5: COMBINED IRRIGATION/ LAKE DISPOSAL	OPTION 6: CLUSTER SYSTEMS	OPTION 7: ENHANCED ONSITE DISPOSAL/LAND USE CONTROL	OPTION A: BNR PLANT TO LAKE	OPTION B: RECLAMATION
ECONOMICS	15	15	45	10	20	20	15	60	100	15	30
USER COST	75	85	50	75	75	100	85	40	45	85	90
PHOSPORUS REDUCTION	180	170	95	200	80	100	180	80	50	160	190
ENVIRONMENTAL IMPACT	180	160	160	200	120	160	180	160	160	160	200
IMPLEMENTATION/OPERATIONAL RISK	100	120	120	60	90	100	90	60	120	120	60
FLEXIBILITY	150	120	80	100	80	80	150	80	80	120	100
LAND USE IMPACT*	100	80	80	60	60	70	70	70	100	120	160
TOTAL	**800**	**750**	**630**	**705**	**495**	**620**	**780**	**580**	**595**	**780**	**830**
	FROM 91 WMP									NEW	

* The "New" options are assigned higher values for Land Use Impact since they are directed at protection of ALR and directing growth to the hillside areas.

6.1 CONCEPT B MODIFICATIONS

Further discussions with District Council, the various Committees, and Ministry of Environment led to the following modifications to Concept B:

a) Since the District owns large tracts of land near the landfill site, secondary treatment could be achieved with the use of lagoons instead of a mechanical plant. This would reduce the capital cost of the plant as well as the operating costs.

b) Ministry of Environment indicated that filtration prior to storage was not essential. Rather, a rapid infiltration facility could be used as the No. 1 backup.

c) The priority for "back-up" facilities was re-oriented as follows:

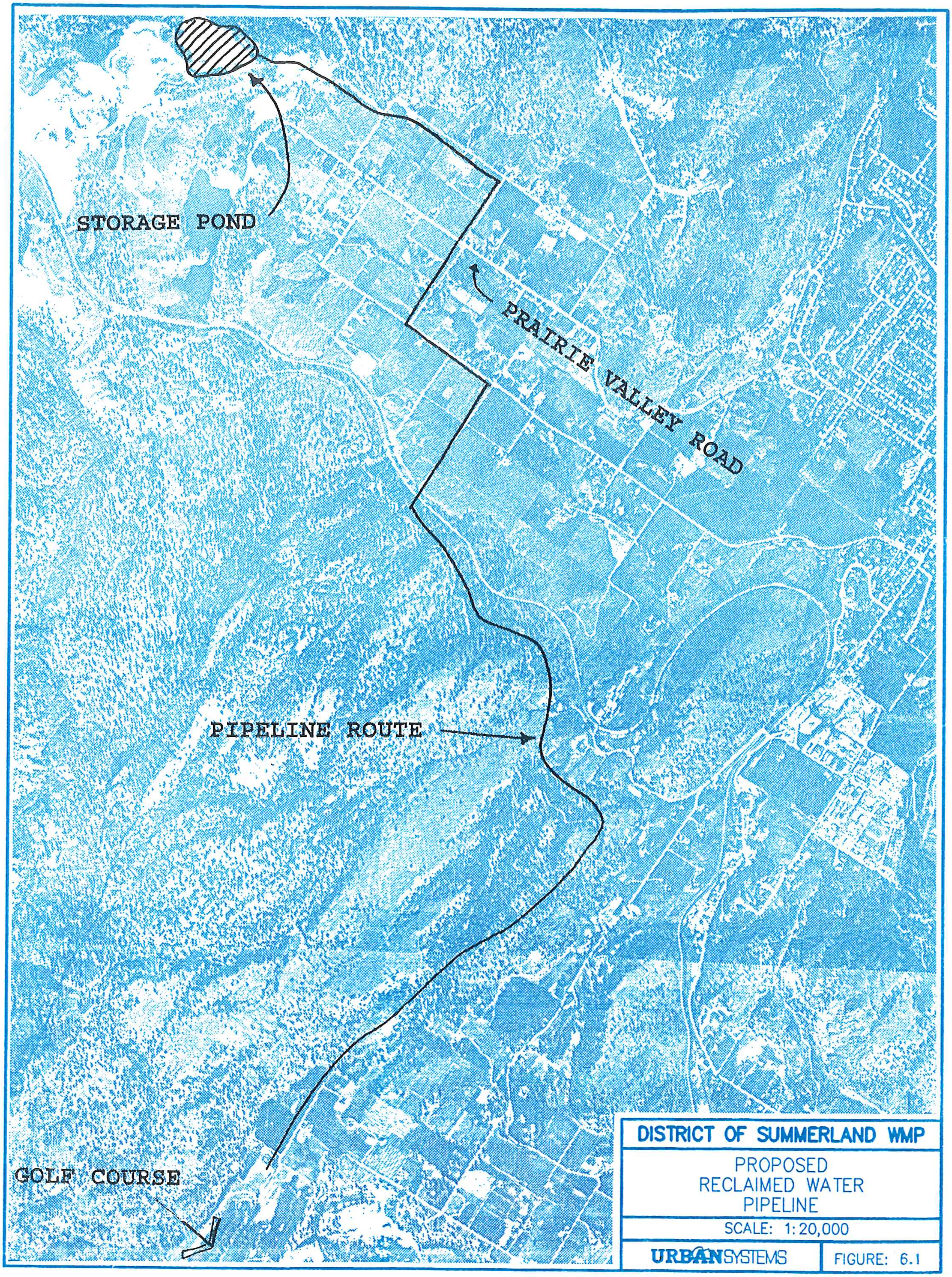
No. 1 Rapid Infiltration
No. 2 Demonstration Orchard
No. 3 Silviculture

6.2 COST ESTIMATES

Capital Costs	Pumping and Transmission	2,850,000
	Collection System	8,900,000
	Aerated Lagoons	2,650,000
	Storage Facility	1,500,000
	RI Facility	900,000
	Reclaimed Water Supply Line	1,450,000
	Pump and Supply To Silviculture	250,000
		$18,500,000
	Contingency & Engineering (30%)	5,550,000
	GST (Net 3%)	720,000
	Total Capital	**$24,770,000**

Annual Operating and Maintenance Costs	Plant	120,000/yr.
	Reclamation	60,000/yr.
	Pumping Stations	100,000/yr.
	Collection System	70,000/yr.
	Total Annual Operating & Maintenance	**$350,000/yr.**

Figures 6.1 and 6.2 show the proposed and specified areas, plan and reclaimed water pipeline location.

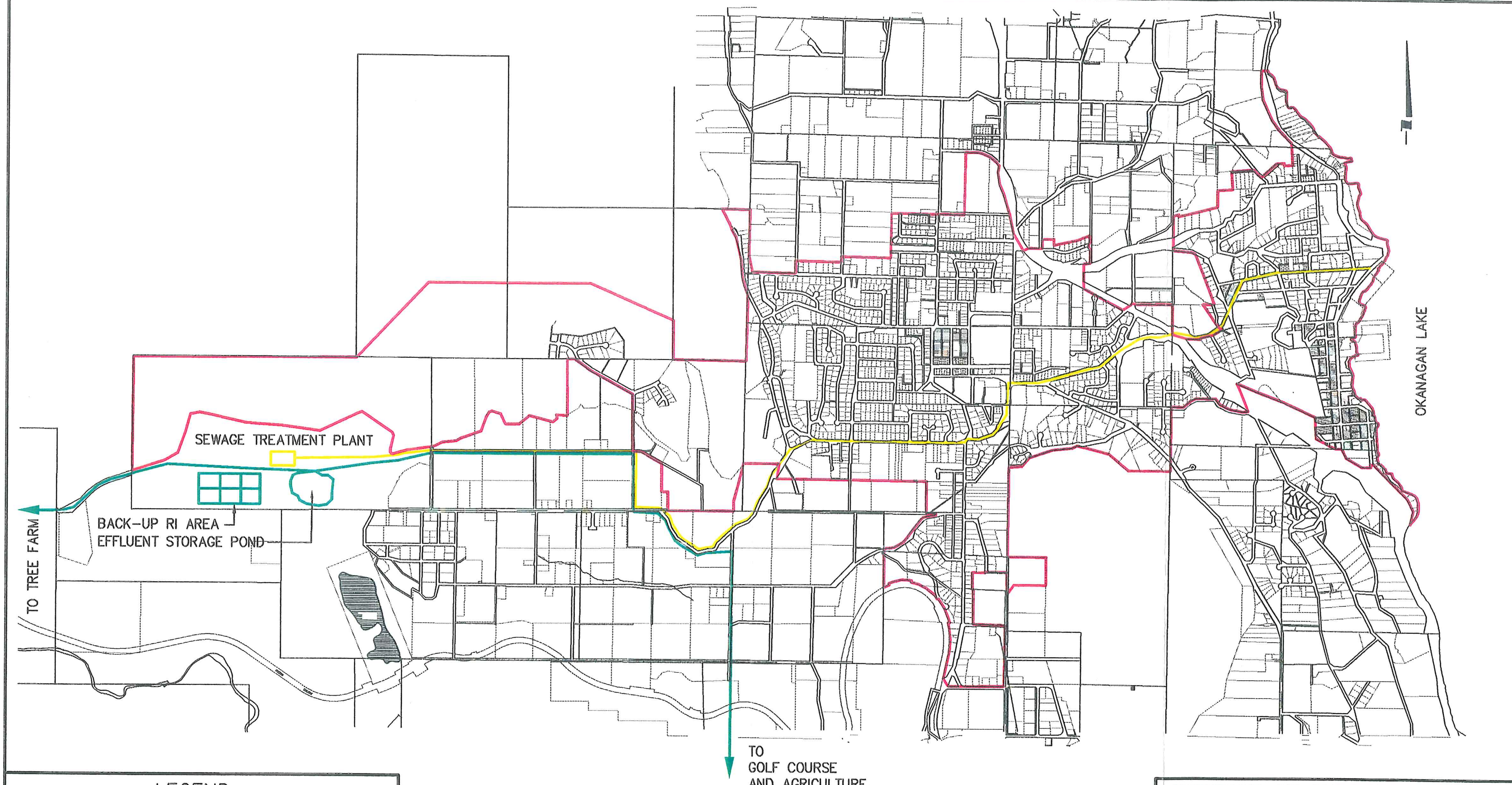


DISTRICT OF SUMMERLAND WMP

PROPOSED RECLAIMED WATER PIPELINE

SCALE: 1:20,000

FIGURE: 6.1



LEGEND

SPECIFIED AREA BOUNDARY	(red line)
TRUNK SEWER FORCEMAIN	(yellow line)
IRRIGATION SUPPLY MAIN	(green line)

DISTRICT OF SUMMERLAND WMP

PROPOSED
SEWERAGE & RECLAMATION
PLAN

SCALE 1:20,000

URBAN SYSTEMS

FIGURE: 6.2

7.1 SENIOR GOVERNMENT GRANTS

The cost recovery analysis assumes the availability of the following senior government grant programs:

(a) Federal-Provincial Infrastructure Grant:
2/3 of initial capital cost

(b) Okanagan Basin Water Board:
- debt repayment assistance calculated on current formula
(2.5 mill rate, 25% of excess and 24% Grant)

7.2 REVENUES

After review of a variety of mechanisms for cost recovery, the District's approach will be to use the Dwelling Unit (D.U.) as the basis for assessment. The D.U. will be defined as a typical detached single family home with an average 2.6 people per unit.

A Specified Area Tax is also being contemplated on an acreage basis for all parcels within the Specified Area, whether developed or not. Over a total of approximately 1800 acres, the area tax would be in the order of $100 to $150 per acre.

Table 7.1 highlights the repayment and revenue calculation based on the above assumptions. The typical costs to an existing homeowner are as follows:

Specified Area Tax:	$120/acre
Cost for 1/3-acre lot:	$40/year
Sewer D.U. Flat Rate:	$150/year
Sewer User Fee:	$175/year
Total Annual	$365/year

Initial connection Cost to Homeowner: $300 Connection Fee to District.
Average $1200 onsite cost.
(Figure 7.1 depicts the homeowner connection options)

Connection to the sewer system for existing homeowners would likely be mandatory within one year of the service becoming available.

The cost/revenue figures would require refinement based on the actual amount of senior government funding available, and more detailed assessment of the total acreage and number of parcels within the Specified Area.

TABLE 7.1

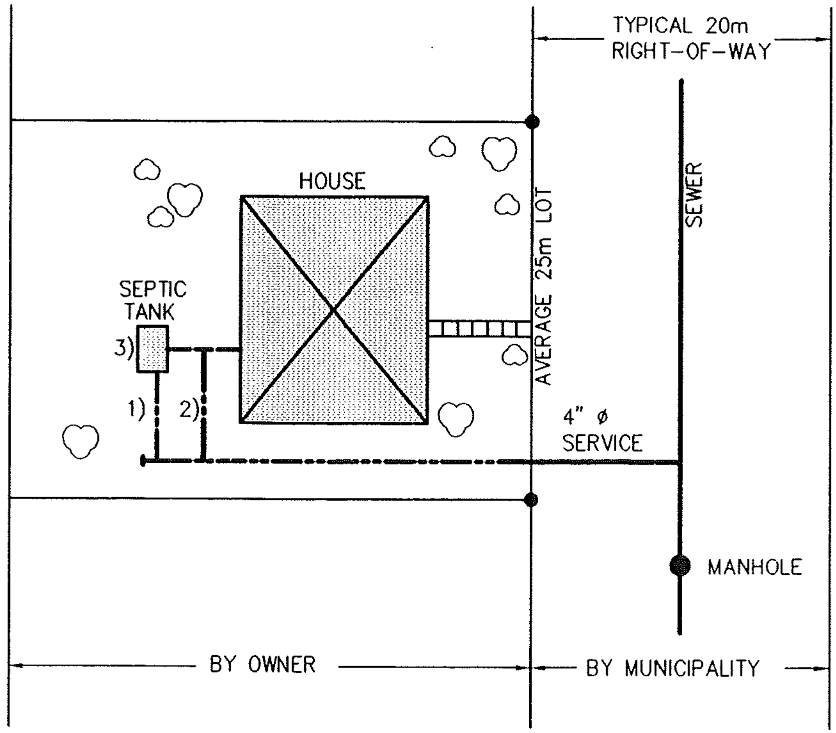
CALCULATION OF TYPICAL HOMEOWNER COST

Capital Construction cost	$24,770,000
Interim financing	+ 830,000
Total capital	$25,600,000
Fed/Prov program grant (2/3)	- 17,070,000
Net capital	$8,530,000
Annual repayment on $8.530 million debenture	$939,750/yr
OBWB grant (annual)	- 440,000/yr
Net annual debt cost	$499,750/yr
Specified area tax	- 200,000/yr
Net assessed to existing homeowners	$299,750/yr
Average sewer service charge per unit (for 2,000 units)	$150.00/unit/yr
Annual operation & maintenance cost	$350,000/yr
Annual user fee (on 2,000 units)	$175.00/unit/yr

APPROXIMATE INITIAL CAPITAL COSTS FOR AVERAGE HOUSE

1. Connection charge (service line in road R.O.W.)	$300
2. Approximate cost to homeowner (connection from septic tank to property line)	
a) With septic tank in rear	$1,100
b) With septic tank in front	$600
c) With pump in septic tank	$1,400
Average	$1,200
Net average initial cost to homeowner	$1,500

Typical Single House Connection



Municipality	4"ø service:	10m @ $53 per metre	530.00
		Saddle or wye	160.00
		Re-pave	180.00
		Total	870.00
		67% assist.	− 570.00
			$300.00

Owner	4"ø service:	20m @ $53 per metre	1,060.00
		Clean-out	80.00
		Sand to fill septic tank	60.00
			$1,200.00

Options for Homeowner

1) Leave septic tank & make gravity connection to sewer (save $60).
2) Abandon septic tank and fill with sand.
3) If lot too low for sewer, use pump in the septic tank – (add $300).

DISTRICT OF SUMMERLAND WMP	
TYPICAL HOMEOWNER COSTS	
SCALE: NTS	
URBAN SYSTEMS	FIGURE: 7.1

APPENDICES

APPENDIX I
COST ESTIMATES

APPENDIX I

1. Treatment Plant Cost Estimate (Conventional Activated Sludge)

a) Conventional Plant for 4800m^3/d:

ITEM	
Capital Costs	
1. Stripping	$30,000
2. Excavation and Embankment	80,000
3. Foundation Prep.	60,000
4. Pipework	250,000
5. Access Roads and Parking	90,000
6. Building	240,000
7. Maceration or Screening	80,000
8. Electrical Services	150,000
9. Heating and Ventilating	40,000
10. Controls	120,000
11. Aeration Equipment	540,000
12. Clarifier Equipment	280,000
13. Digester Equipment	220,000
14. Sludge Dewatering and Composting	400,000
15. Air Piping	50,000
16. Concrete Tanks	870,000
17. Landscaping and Fencing	90,000
SUB-TOTAL	**$3,590,000**

b) Filtration Basins:

Assumed minimum eight basins at 3600m² each:

1. Stripping	$60,000
2. Excavation and Compaction	380,000
3. Distribution Piping and Sub-Drain Piping	470,000
4. Import Sand	190,000
5. Fencing	120,000
6. Roads and Surface Works	90,000
SUB-TOTAL	**$1,310,000**
Total Construction Cost	$4,900,000
Contingency and Engineering (30%)	$1,470,000
GST (Net 3%)	$191,000
TOTAL CAPITAL	**$6,561,000**

2. Storage

1.	Site Preparation 60,000m^2 at \$1.00	\$60,000
2.	Excavation and Embankment 40,000m^3 at \$5.00	200,000
3.	Liner Bedding Sand 12,000m^3 at \$10.00	120,000
4.	Liner 90,000m^2 at \$12.00	1,080,000
5.	Inlet/Outlet Piping, Controls	30,000
Sub-Total		**1,490,000**
Contingency and Engineering (30%)		447,000
GST (Net 3%)		58,000
TOTAL CAPITAL		**\$1,995,000**

3. Pumping and Transmission

1.	7 Pumping Stations	
	2 at $380,000 2 at $260,000 3 at $200,000	$760,000 520,000 600,000
2.	Forcemain 6600m at $110	726,000
3.	Reinstatement 6600m at $25	165,000
4.	Highway Crossing	75,000
Sub-Total		**2,846,000**
Contingency and Engineering (30%)		854,000
GST (Net 3%)		111,000
TOTAL CAPITAL		**$3,811,000**

4. Irrigation Main

1. 6000m of 300mm pipe at $180	$1,080,000
2. Reinstatement 6000m at $25	150,000
3. Valves, Fittings, Parts	150,000
4. Services (Allowance)	40,000
Sub-Total	**1,420,000**
Contingency and Engineering (30%)	426,000
GST (Net 3%)	55,000
TOTAL CAPITAL	**$1,901,000**

5. Collection System

Collection system costs are calculated on the basis of an average 20m wide lot, using 200mm sewer pipe, manhole spacing at 150m, 10m average length of 100mm service pipe to property line.

1. 20m pipe at $120	$2,400
2. Manhole (by proportion on 20m)	600
3. Service Pipe	800
4. Reinstatement 20m at $25	500
Sub-Total	**4,300**
Contingency and Engineering (30%)	1,290
GST (Net 3%)	170
TOTAL CAPITAL/UNIT	**$5,760/UNIT**
TOTAL CAPITAL (2000 UNITS)	**$11,600,000**

6. Operating and Maintenance Costs

Conventional Plant		
1.	Labour	$85,000
2.	Power	48,000
3.	Testing	6,000
4.	Permit Fees	2,000
5.	Sludge Disposal	20,000
6.	Vehicle, Parts, etc.	10,000
7.	Administration and Miscellaneous	9,000
Annual		**$180,000**
Pumping Stations		
1.	2 at 320,000 kwh/yr at #0.05/kw-hr	$32,000
2.	2 at 220,000 kwh/yr at #0.05/kw-hr	22,000
3.	3 at 140,000 kwh/yr at #0.05/kw-hr	21,900
4.	Labour 7 hrs/wk at 52 wks at $25	9,100
5.	Equipment, Parts	8,000
6.	Emergency Call-Outs (Allowance)	7,000
Annual		**$100,000**
Collection System		
1.	Labour 20 hrs/wk at 52 wks at $25	$26,000
2.	Equipment, Parts	20,000
3.	Flushing Program	10,000
4.	Emergency Call-Outs (Allowance)	14,000
Annual		**$70,000**
TOTAL ANNUAL O & M		**$350,000**

APPENDIX II
OPEN HOUSE EXIT SURVEY RESULTS

DISTRICT OF SUMMERLAND
OPEN HOUSE

- EXIT SURVEY - RESULTS

157 RESPONDENTS

1. Do you generally agree or disagree with Council's preferred option for the future development of the Community?

Agree	115 ☐	**73.2%**	Disagree	40 ☐	- **25.5%**
Not Answered	2 ☐	- **13%**			

If you disagree, what are the aspects you disagree with?

____

2. Which option for sewage disposal do you support:

18.5%	29 ☐	Continued onsite sewage disposal (septic tank/field) for all areas of the District.
2.5%	4 ☐	Cluster systems.
70.1%	110 ☐	Community sewer system for proposed *new* development areas and selected existing areas such as the downtown core, residential areas surrounding the core and Lower Town; rural and rural residential areas would continue to use onsite disposal systems.
8.9%	14 ☐	Not Answered/Not Sure/Other

3. If you support a community sewer system, which treatment and disposal option do you support:

76.4%	120 ☐	Treatment and use of the wastewater for irrigation (either agricultural crops or for silviculture).
3.8%	6 ☐	Treatment and disposal of wastewater to Okanagan Lake.
19.8%	31 ☐	Not Answered/Not Sure/Other

4. Do you think the cost of a community sewer system to the homeowner is:

24.8%	39 ☐	Excessive
62.4%	98 ☐	Reasonable
12.8%	20 ☐	Not Answered/Don't Know

5. What area of the community do you reside in?

____

APPENDIX III
RECLAIMED WATER USER SURVEY

THE CORPORATION OF THE DISTRICT OF SUMMERLAND
P.O. BOX 159
SUMMERLAND, BRITISH COLUMBIA V0H 1Z0
TELEPHONE 494-6451

August 15, 1994

Dear

Re:

The District of Summerland is contemplating the installation of a Sewage Collection, Treatment and Reclamation System for a portion of Summerland. Reclamation involves making the best use of water in agricultural and silvicultural applications. Ever increasing demands on the water system are leading to increased costs.

At this point, since there are limited funds for the project, the District is attempting to determine the optimum location for a reclaimed water supply line so that it will serve the greatest number of interested users. Since the Golf Course is interested and it could be a large user, it was suggested to follow approximately the old flume line to this area and determine the number of possible users along this route.

First, let us provide a brief description of the product. The reclaimed water will, in essence, be no different than your current water source, with the exception of dissolved nutrients, namely phosphorus and nitrogen and minor amounts of trace metals. The process of reclaimed water consists of four treatment steps as follows, which will result in a safe water resource:

1. **Secondary Treatment Plant**

   - reduction of all components in the wastewater - normally suitable for discharge to a river system

2. **Gravel Filtration**

   - further removal of bacteria and suspended solids as well as reduction of phosphorus, nitrogen and trace metals

3. **300-day Storage and Settling Pond**

   - storage with settling ensures die-off of remaining bacteria and further settlings of suspended particles

4. **Chlorination**

- water entering the supply main will be disinfected with chlorine to comply with Ministry of Health requirements.

The District will monitor all of the parameters shown on the attached table to ensure safety. Many crops, like fruit trees, are sensitive to salt in the soil, and sodium in the reclaimed water will be monitored on a regular basis in order to properly manage it. Calcium and magnesium can be used as stabilizing agents to offset any excess sodium problems if they occur.

Reclaimed water is currently being used in over 20 countries, including the U.S. and Canada. Indeed, the practice is rapidly increasing worldwide as water resources become scarce. Towns and cities such as Oliver, Osoyoos and Penticton are using reclaimed water on their golf courses and parks as well as alfalfa fields and drip irrigation for orchards. Orange County, California have gone a step further and are reclaiming water for domestic purposes.

Current regulations in B.C. allow the use of reclaimed water for application in either spray or drip emitters on all non-edible crops including pasture, forage, silage, nursery plants, sod farms, golf courses and others. Application on edible fruit trees is allowed only with drip emitters, at this time.

Product Delivery

The District's objective is to deliver the water via an appropriate size service line to your property and at a reasonable pressure. It will be your responsibility to distribute the water from your property line. Your service would include a water meter which would be read once per year at the end of the irrigation season. Your regular water bill would then be adjusted with a credit for the quantity of reclaimed water that you used over the course of the year. Your supply line would be shut down and drained for the winter season by the Municipality.

While reclaimed water has been found to be generally nuisance-free in terms of sprinkler nozzles and micro-emitters, you should consider the provision of an in-line cartridge filter on your service (100 to 200 micron mesh) to minimize clogging potential.

Local Experience

The Summerland Research Station has conducted extensive testing of fruit and vegetable products irrigated with reclaimed water and compared to a similar plot irrigated with well water over an eight-year period. These plants included sweet cherries, Okanagan Riesling grapes, apple trees (MacIntosh and Red Delicious) and a variety of trickle-irrigated vegetables (tomato, sweet pepper, onion, cucumber, bush bean and melon).

The results of the testing program are published and generally indicate no major limitations in plant structure or product quality with using reclaimed water. The abstracts of these papers are attached. The complete articles can be made available to you upon request.

The District also intends to operate, as part of this project, a demonstration plot in conjunction with the Research Station and continue to rigorously test the product quality.

Availability

The availability of reclaimed water is based on an average seasonal application of 1/4 inch per day, or 28 inches over a 120 day period. Initially, enough water would be available to irrigate approximately 300 acres (or 450 acres with drip irrigation), increasing to 600 acres (or 900 acres with drip irrigation) when the system reaches it's pre-designed capacity, estimated to take 15 to 20 years, as per the Official Community Plan.

The amount of phosphorus and nitrogen available from the reclaimed water is roughly 5 grams of P per season and 12 grams of N per season (assuming a drip irrigation rate of 10 litres per day per tree). See the attached rough calculations. Note that nitrogen is expressed as Total, but the actual take-up would be only the organic portion or about 8 grams per tree. The amount of water use and the length of time will be up to each property owner and this will be pre-determined with the user.

WHERE WILL IT BE?

You can appreciate that the District can initially construct a supply line to only one sector of the municipality. **A Two Million Dollar** budget has been allocated for this purpose. The strategy will be to construct the line to the area that has indicated the greatest interest in this product.

You are, **by no means**, forced to take this reclaimed water and are free to opt out of the scheme. However, if you are interested in taking advantage of this opportunity, please complete the question sheet and drop it in to the Municipal Hall at your earliest convenience (before the end of August). This will allow us to determine where the initial supply line should be constructed.

Your initial costs for coming into the program will involve your own service on your own property to get from the service at the property line to your irrigation system. Your yearly savings will depend upon the amount of reclaimed water that you use which would be credited against your present irrigation rate. You will, of course, have some additional savings in reduction of commercial fertilizer.

The District greatly appreciates your response and is confident that the program will benefit the community and the agricultural sector in a variety of ways. Thank you for your co-operation and participation in this questionnaire.

R. A. Carter, CMC
Administrator

QUESTION SHEET

1. Name: ______________________________

2. Address: ______________________________

3. Area Currently Irrigated:

Overhead Spray	______	acres
Undertree Spray	______	acres
Drip	______	acres
TOTAL	______	acres

4. Type of Activity:

Tree Fruit	☐
Vineyard	☐
Nursery	☐
Golf Course	☐
Greenhouse	☐
Landscape	☐
Forage Crops	☐
Other	☐

5. Are you interested in using reclaimed water? Yes ☐ No ☐

6. Would you like more information on:
   - the water ☐
   - the cost savings ☐
   - the reclaimed water system ☐

7. Other comments:

____

____

____

____

8. Signature: ______________________________

Completed questionnaires can be returned to the District Office located at 13211 Henry Avenue, Summerland, B. C. or mail to:

District of Summerland
P.O. Box 159
Summerland, B. C. V0H 1Z0

J. AMER. SOC. HORT. SCI. 114(3):377–383. 1989.

Nutrition and Yield of Young Apple Trees Irrigated with Municipal Waste Water

G.H. Neilsen[1], D.S. Stevenson[1], J.J. Fitzpatrick[2], and C.H. Brownlee[3]
Agriculture Canada Research Station, Summerland, B.C. V0H 120, Canada

Additional index words. nitrogen, phosphorus, potassium, trickle irrigation

Abstract. 'Macspur McIntosh' and 'Red Chief Delicious' apple (*Malus domestica* Borkh.) on M.7a rootstock were subjected to treatments involving all combinations of two types of irrigation water (well-water or municipal effluent) from 1983, the year of planting, through 1987 and three rates of N fertilization (0, 200, 400 g NH_4NO_3/tree per year), from 1984 through 1987. The zero N treatment was increased to 100 g NH_4NO_3/tree per year in 1986 due to low vigor of these trees. Effluent irrigation increased leaf N, P, and K concentration in 4 of 5 years for 'McIntosh', while leaf N, P, and K increased in 1, 4, and 2 years, respectively, for 'Delicious'. Effluent irrigation increased trunk diameter increment in all years and fruit number and yield in 1985–86 for both cultivars. No major horticultural limitations to the use of effluent irrigation were observed. Nitrogen fertilization increased leaf N in 3 years for 'McIntosh' and 2 years for 'Delicious', while leaf P and K were decreased at the highest N rate in 2 years for each cultivar. Nitrogen fertilization did not increase trunk diameter and increased fruit number and yield only in 1986 after 3 years of a zero N treatment. The results implied a role for P in the establishment and early growth and yield of young apple trees.

HORTSCIENCE 24(2):249–252. 1989.

Yield and Plant Nutrient Content of Vegetables Trickle-irrigated with Municipal Wastewater

G.H. Neilsen[1], D.S. Stevenson[1], J.J. Fitzpatrick[2], and C.H. Brownlee[3]
Agriculture Canada Research Station, Summerland, BC V0H 1Z0, Canada

Additional index words. sewage effluent, tissue P, exchangeable Na

Abstract. Tomato (*Lycopersicon esculentum* L.), sweet pepper (*Capsicum annuum* L.), onion (*Allium cepa* L.), cucumber (*Cucumis sativus* L.), bush bean (*Phaseolus vulgaris* L.), and melon (*Cucumis melo* L.) were grown from 1983 through 1986 with trickle irrigation using either well water or secondary effluent. Yields with effluent irrigation were greater than or similar to yields obtained with well water. Effluent irrigation resulted in decreased Zn, increased P, and variable results for other nutrients in plant tissues. After 4 years of effluent irrigation, the exchangeable Na content of the 0.0 to 0.3-m depth increased, but soil chemical changes were of little practical significance. No major limitations were found for the production of high yields of vegetables irrigated with municipal wastewater on the loamy sand soil at the experimental site after 4 years.

THE EFFECT OF MUNICIPAL WASTEWATER IRRIGATION AND RATE OF N FERTILIZATION ON PETIOLE COMPOSITION, YIELD AND QUALITY OF OKANAGAN RIESLING GRAPES

G. H. NEILSEN[1], D. S. STEVENSON[1], and J. J. FITZPATRICK[2]

[1]*Research Station, Agriculture Canada, Summerland, British Columbia, Canada V0H 1Z0. Contribution no. 722, received 11 Oct. 1988, accepted 12 June 1989.*

NEILSEN, G. H., STEVENSON, D. S. AND FITZPATRICK, J. J. 1989. The effect of municipal wastewater irrigation and rate of N fertilization on petiole composition, yield and quality of 'Okanagan Riesling' grapes. Can. J. Plant Sci. 69: 1285-1294.

Okanagan Riesling (*Vitis* sp.) vines, planted on a sandy soil in 1983, were trickle irrigated with municipal wastewater or well water and with each source of water there were 3 rates of N fertilization (0, 17 and 34 g N as NH_4NO_3 vine^{-1} y^{-1}), 1984-1987. The zero-N treatment was increased to 8.5 g N vine^{-1} in 1986-1987. Wastewater-irrigated vines had increased petiole P, K and Ca but decreased Mg and in 2 of 3 yr decreased N in August. Increased rate of N fertilization increased petiole N at bloomtime but not in August, had minor effects on petiole P, K, Ca and Mg, and increased petiole Mn at highest N rates, especially (2 of 4 yr) in association with wastewater irrigation. Yield increased both for vines irrigated with wastewater and linearly with rate of applied N in 2 of the 3 fruiting years. Increased yield was not associated with increased petiole N concentration in August. Minor increases in soluble solids and juice pH of grapes at harvest were measured for wastewater-irrigated grapes in 2 yr. No horticultural limitations to the use of this wastewater to irrigate Okanagan Riesling grapes were observed over the 4-yr period.

Fruit quality of McIntosh apples irrigated with well or municipal waste water

Meheriuk, M. and Neilsen, G. H. 1991. **Fruit quality of McIntosh apples irrigated with well or municipal waste water.** Can. J. Plant Sci. 71: 1267–1269. McIntosh apples (*Malus domestica* Borkh.) irrigated with municipal waste water were softer at harvest and had lower fruit Cu than comparable fruit irrigated with well water. Fruit size, percent red skin color, soluble solids content and fruit N, Ca, K/Ca, K+Mg/Ca, K+Mg+Na/Ca, B, Fe, Mn and Zn were not affected by source of water. Fruit P, Mg, K and Na were higher in apples irrigated with waste water in the second but not the first year of the 2-yr study. Titratable acidity was higher with well water the first year and with waste water the second year. Incidence of core flush was higher in the fruit irrigated with waste water.

Key words: Apple, skin color, flesh firmness, titratable acidity, soluble solids content, fruit Ca, Mg, K, Cu, Na, N and P, core flush

Soil and sweet cherry responses to irrigation with wastewater

G. H. Neilsen[1], D. S. Stevenson[1,2], J. J. Fitzpatrick[3], and C. H. Brownlee[4]

[1]*Research Station, Agriculture Canada, Summerland, British Columbia, Canada V0H 1Z0.*
Contribution no. 755, received 5 Apr. 1990, accepted 19 Sept. 1990.

Neilsen, G. H., Stevenson, D. S., Fitzpatrick, J. J. and Brownlee, C. H. 1991. **Soil and sweet cherry responses to irrigation with wastewater.** Can. J. Soil Sci. **71**: 31–41. Lambert sweet cherry (*Prunus avium* L.) established on Osoyoos loamy sand in 1983 was subjected to treatments involving all combinations of two types of irrigation (wellwater or municipal wastewater) and three rates of N fertilization (0, 68 and 136 g of N as NH_4NO_3 tree^{-1} yr^{-1}), 1984–1987. The zero-N treatment was increased to 34 g N tree^{-1} in 1986–1987. Wastewater irrigation increased leaf N, P, K, B and Mn concentration, decreased leaf Mg and Ca and had few consistent effects on leaf Fe and Cu. Tree growth was increased after 2 yr but not after 5 yr by wastewater irrigation. Inadequate N and Zn nutrition appeared to limit long-term tree growth. After 5 yr, wastewater-irrigated soils had higher extractable P, K, and B and lower Ca and Mg than well-water-irrigated soils which had higher Ca and Mg to 0.9-m depth. Wastewater irrigation also increased extractable Na throughout the soil but insufficiently to adversely affect tree growth. Soil pH and electrical conductivity also increased during the experiment for both well- and wastewater-irrigated soils, but these increases did not cause alkalinity or salinity problems.

Key words: *Prunus avium* L., wastewater irrigation, leaf nutrition, soil quality

Table 19. Recommended Limits for Constituents in Reclaimed Water for Irrigation

TRACE HEAVY METALS

Constituent	Long-Term Use (mg/L)	Short-Term Use (mg/L)	Remarks
Aluminum	5.0	20	Can cause nonproductivity in acid soils, but soils at pH 5.5 to 8.0 will precipitate the ion and eliminate toxicity.
Arsenic	0.10	2.0	Toxicity to plants varies widely, ranging from 12 mg/L for Sudan grass to less than 0.05 mg/L for rice.
Beryllium	0.10	0.5	Toxicity to plants varies widely, ranging from 5 mg/L for kale to 0.5 mg/L for bush beans.
Boron	0.75	2.0	Essential to plant growth, with optimum yields for many obtained at a few-tenths mg/L in nutrient solutions. Toxic to many sensitive plants (e.g., citrus) at 1 mg/L. Usually sufficient quantities in reclaimed water to correct soil deficiencies. Most grasses relatively tolerant at 2.0 to 10 mg/L.
Cadmium	0.01	0.05	Toxic to beans, beets, and turnips at concentrations as low as 0.1 mg/L in nutrient solution. Conservative limits recommended.
Chromium	0.1	1.0	Not generally recognized as essential growth element. Conservative limits recommended due to lack of knowledge on toxicity to plants.
Cobalt	0.05	5.0	Toxic to tomato plants at 0.1 mg/L in nutrient solution. Tends to be inactivated by neutral and alkaline soils.
Copper	0.2	5.0	Toxic to a number of plants at 0.1 to 1.0 mg/L in nutrient solution.
Fluoride	1.0	15.0	Inactivated by neutral and alkaline soils.
Iron	5.0	20.0	Not toxic to plants in aerated soils, but can contribute to soil acidification and loss of essential phosphorus and molybdendum.
Lead	5.0	10.0	Can inhibit plant cell growth at very high concentrations.
Lithium	2.5	2.5	Tolerated by most crops at up to 5 mg/L; mobile in soil. Toxic to citrus at low doses - recommended limit is 0.075 mg/L.
Manganese	0.2	10.0	Toxic to a number of crops at a few-tenths to a few mg/L in acid soils.
Molybdenum	0.01	0.05	Nontoxic to plants at normal concentrations in soil and water. Can be toxic to livestock if forage is grown in soils with high levels of available molybdenum.
Nickel	0.2	2.0	Toxic to a number of plants at 0.5 to 1.0 mg/L; reduced toxicity at neutral or alkaline pH.
Selenium	0.02	0.02	Toxic to plants at low concentrations and to livestock if forage is grown in soils with low levels of added selenium.
Tin, Tungsten, & Titanium	—	—	Effectively excluded by plants; specific tolerance levels unknown
Vanadium	0.1	1.0	Toxic to many plants at relatively low concentrations.
Zinc	2.0	10.0	Toxic to many plants at widely varying concentrations; reduced toxicity at increased pH (6 or above) and in fine-textured or organic soils.

OTHER PARAMETERS

Constituent	Recommended Limit	Remarks
pH	6.0	Most effects of pH on plant growth are indirect (e.g., pH effects on heavy metals' toxicity described above).
TDS	500-2,000 mg/L	Below 500 mg/L, no detrimental effects are usually noticed. Between 500 and 1,000 mg/L, TDS in irrigation water can affect sensitive plants. At 1,000 to 2,000 mg/L, TDS levels can affect many crops and careful management practices should be followed. Above 2,000 mg/L, water can be used regularly only for tolerant plants on permeable soils.
Free Chlorine Residual	< 1 mg/L	

Source: Adapted from EPA, 1973.