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ASSESSMENT OF THE 1986 EURASIAN WATER MILFOIL CONTROL PROGRAM IN CULTUS LAKE

Province of British Columbia
Ministry of Environment and Parks
WATER MANAGEMENT BRANCH

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Ministry of Environment & Parks

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ABSTRACT

The 1986 Cultus Lake Eurasian water milfoil control program utilized a rototiller and bottom barrier to treat 5.3 ha of affected area at a total cost of $20 000. All nuisance populations in the important recreational areas were treated under this cost-shared program. The total affected area in Cultus Lake increased from 19.3 ha in 1985 to 19.8 ha in 1986. Continued control using the same techniques is recommended for 1987.

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1. INTRODUCTION

A twelve week Eurasian water milfoil control program was implemented at Cultus Lake during the summer of 1986, under a cost-share agreement between the Provincial Government and the Regional District of Fraser-Cheam. The Cultus Lake Park Board administered funding provided by the Milfoil Action Committee (representing local agencies and interest groups within the Regional District) and hired a machine operator to implement weed control activities. Water Management Branch provided a rototiller, supervisory assistance, and 75 percent ($15 000) of the $20 000 cost-shared program. The Branch's contribution was in cash ($13 500) and cost-shared supervisory support (valued at $1 500). Appendix I presents an operational summary of the past six years.

In 1986, a rototiller was used as the principal method of aquatic plant management, while limited use was made of bottom barriers. Texel, a polyester geotextile first tested in 1983, was applied at a marina. Monitoring of Du Pont Canada's nylon barrier (Dartek) continued.

The Littoral Resources Unit of the Water Management Branch provided limited monitoring assistance while treatments were in progress. A complete survey of the density and distribution of Eurasian water milfoil (Myriophyllum spicatum) in Cultus Lake was conducted in the fall to determine the effectiveness of controls and define management requirements for the following year. This report summarizes program information collected by Littoral Resources Unit and Cultus Lake Park Board staff and makes recommendations for future aquatic weed control.

2. ROTOTILLING

Since 1981, rototilling has been the primary method of controlling nuisance M. spicatum in Cultus Lake (Appendix I). Bottom tillage was conducted May 28 to August 15, 1986 (details are summarized in Appendix II). An estimated 5.2 ha of predominantly moderate-dense M. spicatum were rototilled (see Cultus Lake site map, Appendix III, for treatment locations).

Table 1 below provides a breakdown of program activities within the time available for operating.

TABLE 1

SUMMARY OF 1986 ROTOTILLING SCHEDULE

	Hours	Percentage
Time available for rototilling (49 days)	369	100
Machine operating time -	244	66
Routine maintenance and daily procedures -	105.5	29
Breakdown and repairs -	19.5	5

There were no major mechanical failures of the rototiller in 1986, and repairs were of a minor nature largely due to improvements made to the hydraulic and winch systems in previous years. Breakdown/repair time accounted for 35 percent of program time in 1984, 15 percent in 1985, and only 5 percent in 1986. Time devoted to treatment increased from 60 percent in 1985 to 66 percent in 1986. The average treatment rate (Ø.11 ha/day) remained relatively unchanged compared to 1985, as more time was devoted to making additional passes within the management areas.

The program costs for maintenance, determined by the proportion of annual equipment use, was $3 400, of which approximately $400 was miscellaneous repairs during Cultus Lake operations.

An evaluation of rototilling effectiveness in 1986 consisted of periodic observations of the machine in operation and a lake-wide survey in late September (one to four months after treatments). As a result of intensive bottom tillage, the majority of high public-use beaches remained clear (sparse M. spicatum) of nuisance weed growth during the 1986 recreational period (June to September). The low level of M. spicatum regrowth observed at the end of the 1986 growth season was a good indication that sufficient time was spent in doing repetitive passes and that much of the area treated (approximately 2.0 ha) will not require rototilling in 1987. These areas can be treated in rotation every two years; however, M. spicatum populations located on shallow, sloping, silty substrates (such as found within embayments) generally regrow in one year.

The results of a S.C.U.B.A. investigation by K. Mortun (Department of Fisheries and Oceans) and R. Truelson (LRU) in December, 1985 suggested that intensive rototilling also had been effective in reversing the encroachment of M. spicatum on the sockeye shore spawning grounds along Lindell Beach. Tillage further improved spawning conditions by reducing siltation (through dispersal of fines) and destratifying the silt-sand-gravel substrates. A similar survey planned for December, 1986 had to be cancelled; water turbidity was excessive (secchi depth <1 m) due to high run-off, and Fisheries and Oceans was unable to provide diver assistance.

3. BOTTOM BARRIERS

- new applications and observations of existing barriers

The technique of applying bottom barriers over rooted aquatic vegetation has been demonstrated to be appropriate in areas of high recreational value in Cultus Lake, particularly where limited access or impenetrable substrate makes rototilling ineffective. In 1986, Texel was applied at Lakeside Marina to control nuisance M. spicatum. Monitoring of previous applications of Texel and Dartek continued. Other bottom barriers, which were still in position from previous programs and provided some level of control of M. spicatum through 1986, included Aquascreen, window screen, and burlap - these materials are no longer considered appropriate for use in Cultus Lake.

3.1 TEXEL

Texel is a felt-like, polyester geotextile used primarily in construction projects for drainage, filtration, and soils separation. The fabric has a specific gravity greater than water, which allows it to sink readily, and it is needle-punched (not woven) to allow liquids and gases to permeate through. In the first trial application at Cultus Lake in 1983, the conspicuous white colouration was considered a disadvantage since it was more apt to be disturbed by water users. The manufacturer responded to this concern and now markets a grey geotextile (TAC 210) specifically for use in aquatic weed control. Observations of the material's effectiveness for aquatic plant control have determined that M. spicatum cannot penetrate from below or remain viable for more than one growth season (while covered). However, M. spicatum fragments which collect on the surface can eventually pierce the 2.6 mm thickness of the product and enter the sediment, firmly anchoring the stems.

In 1984, the first application of Texel in Cultus Lake on a working scale (500 m^2 single panel) was at Sunnyside Beach swim area (Site 18 on map). Annual observations made at this plot (Appendix IV-a) showed very positive characteristics with respect to stability, gas exchange, suppression of covered plants, and resistance to surface colonization by fragments.

An application of Texel at Main Beach in 1985 was made directly above decomposed burlap which had been in place since 1983 and no longer provided effective control of M. spicatum. Observations made pre- and post-treatment during the past two growth seasons are contained in Appendix V-b. The first experience with lifting, as a result of trapped gas from decaying plants, occurred during the third and fourth months following installation. It was necessary on two occasions to make small slits to vent the 1.0-1.5 m high bulges in the material. Regrowth of M. spicatum by rooting fragments was still minor (<1 percent plant density) by late September, 1985, four months after treatment, and the slits did not encourage plant growth through the material. After the first year, decomposition of covered plants was complete; there was no recurrence of the Texel lifting in 1986. Unfortunately, unscheduled rototilling activities in June, 1986, directly adjacent to the bottom covering, resulted in a heavy deposition of silt over the plot. This new substrate was much easier for rooting plant fragments to colonize, and by the end of the growth season up to 15 percent of the barrier was covered by M. spicatum and Chara sp. Control activities in 1987 should include a provision for cleaning the Texel at Main Beach, and tillage in the immediate vicinity of any bottom barrier should be avoided.

An application of Texel at Lakeside Marina, begun in 1985, was completed in 1986 (total area covered: 0.07 ha). The steep bottom slope and low sediment/fragment load here should minimize annual maintenance requirements.

3.2 DU PONT DARTEK

Testing of Du Pont Canada's nylon bottom barrier (Dartek) began in 1982 at Cultus Lake. The initial version of the product was found to be largely ineffective because large, cross-shaped slits used to vent underlying gases also allowed excessive penetration of plants from below. In 1985, three years after treatment, M. spicatum also had become established between the closely spaced perforations on the initial test panel. Plant roots had spread along the surface of the impervious nylon and intermingled with accumulated organic matter to form a loose mat. Upright plants above this 'false' bottom achieved the same 2.0 m height as plants within the slits and alongside the barrier, although plant density was moderate (40 percent cover) above the barrier and maximum (100 percent) in adjacent, untreated areas.

In 1983, Du Pont supplied a modified version of Dartek with single slits (2 cm long). Two 2.4 m x 30 m panels were positioned at Main Beach in July, 1983 and have been monitored through the past three growth seasons (Appendix IV-c). By September 19, 1986, 38 months after application, the barrier continued to provide excellent control of nuisance M. spicatum with only 10 percent of the slits penetrated by covered plants. No fragments had successfully established on the surface of the material (i.e. achieved a height of more than a few centimeters).

To take advantage of the barrier's resistance to rooting fragments, a panel of Dartek was placed along a portion of the deep, outer edge of the Texel plot at Main Beach in 1985, in an attempt to slow the rate of reinfestation from dense M. spicatum growth beside this site. Plants commonly overhang the barrier here, and the layer of fragments being deposited can be several centimeters thick. Dartek successfully inhibited covered plants and rooting fragments to the end of the 1986 growth season; however, apparent deterioration from ultraviolet radiation left it with little structural strength. The manufacturer considers this to have been an isolated production problem whereby an uneven distribution of carbon-black pigment in the sample supplied could have exposed the nylon to sunlight damage once in the water.

Dartek was not applied in Cultus Lake in 1986, although its use as a border to slow regrowth from fragments at some Texel plots is recommended. The nylon film lacks the ruggedness of Texel and could not withstand frequent contact by water users within the shallow bathing areas.

3.3 QUALITATIVE COMPARISON OF BOTTOM BARRIERS USED IN CULTUS LAKE

Prior to 1983, bottom coverings which had been tested for use in aquatic weed control at Cultus Lake included Aquascreen, window screen and burlap. Experiences with these barriers are documented in earlier assessment reports. Recent evaluations of Texel and Dartek have shown improved results; however, it is apparent that no single product is the best choice in all aquatic plant management situations. A comparison guide of barriers within several principal categories may facilitate the selection process.

Table 2 ranks the performance of the four varieties of bottom barriers which have been examined (note: Aquascreen and window screen are similar in construction and are considered to perform equally for these purposes). All materials are negatively buoyant (require minimal ballast) and installation requirements are comparable.

Texel: The polyester geotextile had the best overall performance rating, but it should be noted that the highest ratings were not concentrated in the most important categories. For example, this fabric would not be the best choice for use in areas where continual problems with gas build-up are anticipated (from the substrate or decomposition of covered plants) or where the fragment load is excessive.

Dartek: No problems with lifting (due to trapped gas) or successful fragment reinfestation have been experienced with Du Pont's latest version of this perforated nylon film. Plants can penetrate the slits, but generally not in sufficient numbers that constitute a nuisance. The major drawback with this material is that it is easily damaged and dislodged by water users. The thin film is also more difficult to install, particularly if a large amount of plant material is being covered.

Aquascreen: Contrary to the manufacturer's claims, the aperture size of this vinyl-coated, fibreglass mesh has not proved small enough to kill covered plants by blockage of light. In addition, overlain stems are reasonably successful at penetrating the screen from the underside (often in several places per stem). Fragments also have little difficulty in attaching to the top surface. As of September, 1986, Aquascreen was the most expensive covering available - $\$2.90/m^2$ (Texel: $\$1.15/m^2$, Dartek: $\$0.84/m^2$, and burlap: $\$0.69/m^2$).

Burlap: Jute has similar performance characteristics to Aquascreen. The woven construction has low resistance to rooting fragments, although the the tight weave is more difficult for covered plants to penetrate than Aquascreen. The greatest limitation of burlap is severe decomposition after one or two growth seasons. This feature could be desirable if the objective is short-term control at relatively low cost.

TABLE 2

RANKED COMPARISON OF FOUR BOTTOM BARRIER MATERIALS
USED AT CULTUS LAKE, 1981-1986

Category*	Performance Scale from 1 (highest) to 4 (lowest)			
	Aquascreen	Burlap	Dartek	Texel
Permeability to gas (lower permeabilities prone to lifting)	2	3	1	4
Resistance to plant penetration from the underside	4	2	3	1
Cost effectiveness (in terms of price and longevity of material)	4	3	1	2
Resistance to ultraviolet or microbial breakdown	1	3	2	1
Resistance to fragment accumulation/colonization	3	4	1	2
Strength-resistance to physical disruption (boat motors, wading activity, wave action, etc.)	2	3**	4	1
Ease of handling during installation and cleaning	2	3	4	1
Effectiveness in killing covered plants	4	2	3	1
	22	23	19	13

* Listed in relative order of importance (highest to lowest)
** Loses structural strength after first year

4. YEAR-END SURVEY OF MYRIOPHYLLUM SPICATUM IN CULTUS LAKE

Water Management Branch staff conducted a survey in September, 1986, of the density and distribution of aquatic vegetation in Cultus Lake (see Appendix III, site map). In recent years, the invasion of M. spicatum into non-infested areas and expansion of existing populations has been minimal but nevertheless constant (Table 3).

TABLE 3

OBSERVED CHANGES IN THE AREA AFFECTED BY M. SPICATUM IN CULTUS LAKE, 1985-1986

		Hectares
Littoral Area:		36.5
1985 Infestation:		19.3
Area Increases - Site expansion	(+)	0.5
1986 Infestation:		19.8

Appendix VI compares the area and density of M. spicatum in Cultus Lake over the past ten years. In 1986, M. spicatum density continued to increase in unmanaged areas.

In general, the potential nuisance level of M. spicatum in 1986 was similar to that of the previous year due to the cool, cloudy weather during much of June and July (period of most active growth). This weather pattern has been fairly consistent since monitoring activities first began and appears to be the norm for the Lower Mainland region. The plants did not have sufficient time to attain their maximum height potential as their growth rate slowed considerably by the end of July (normal), coincident with reproduction by fragmentation. Thus, the extensive M. spicatum populations along the north end of the lake seldom reached the 0 - 0.5 m depth range (measured distance from the surface) where swimming and boating activities are seriously impaired by aquatic plants.

5. SUMMARY AND RECOMMENDATIONS FOR AQUATIC PLANT MANAGEMENT IN CULTUS LAKE

In 1986, the aquatic weed control program at Cultus Lake incorporated the use of a rototiller and bottom barriers. Management activities were directed at 12 locations around the lake, which encompassed all nuisance M. spicatum in the important recreational areas. The total area treated was 5.28 ha, slightly more than the original objective of 4.5 ha.

5.1 1986 PROGRAM ACTIVITIES

Rototilling: An estimated 5.21 ha of predominantly moderate-dense M. spicatum were rototilled at Cultus Lake in 1986.

The amount of breakdown time was reduced compared to past programs as a result of major mechanical improvements incorporated in 1984. The proportion of operating time was increased and sufficient time was available to conduct intensive bottom tillage. Experience has shown that if an insufficient number of repetitive passes are made in some sites, there can be a return to nuisance conditions the same season.

Bottom Barriers: Monitoring and installation of bottom coverings continued in 1986. Texel was applied at Lakeside Marina (area covered: 0.03 ha), and material which had been applied here in 1985 was cleaned and adjusted (0.04 ha). Excellent control of nuisance M. spicatum was achieved. Monitoring of Dartek continued, although no new applications were made in 1986. The barrier continued to provide good control of covered plants and has shown excellent resistance to reinfestation from rooting fragments.

A qualitative comparison was done of the four varieties of bottom barriers which have been tested in Cultus lake. The overall performance of Texel was ranked first and Dartek second; Aquascreen and burlap were considered the least appropriate for use in this lake.

Year-End Survey: The final documentation of aquatic plants in Cultus Lake at the end of the 1986 growth season indicated that the total area affected by M. spicatum had increased only slightly from 19.3 ha in 1985 to 19.8 ha in 1986.

5.2 RECOMMENDATIONS FOR FUTURE MANAGEMENT

Based on continued assessments of M. spicatum growth in Cultus Lake and experience gained through monitoring control programs since 1978, some recommendations for future management follow:

(i) Rototilling remains the most effective control method for the majority of the present management areas. The only area which limits the effectiveness of this machine is the north shore of Cultus Lake where the rocky substrate prevents good penetration of the rototiller tines. The extensive M. spicatum beds in this region have not yet developed into a serious nuisance, therefore treatment is not crucial.

(ii) Several bottom barriers tested in Cultus Lake have been found useful in the following situations:

- -areas of highest recreational value where intensive control is required regardless of extra cost,
- -where the rototiller cannot manoeuvre or gain access (docks, swim enclosures),
- -where the rototiller is limited by a compacted, rocky substrate, and
- -at some boat launches where the rototiller could undercut the sloping bottom supporting the cement ramp.

Texel, and to a lesser degree, Dartek, are best suited to applications where routine maintenance can be performed and long-term control is desirable. It is recommended that control activities in Cultus Lake in 1987 include a provision for investigating techniques for cleaning accumulations of plants and sediment from bottom barriers.

APPENDIX I

Cultus Lake Operational Summary: Eurasian water milfoil Control, 1981 - 1986

APPENDIX I

CULTUS LAKE OPERATIONAL SUMMARY
EURASIAN WATER MILFOIL CONTROL 1981-1986

	1981	1982	1983	1984	1985	1986
TOTAL AREA INFESTED	17.4 ha	18.0 ha	18.3 ha	18.7 ha	19.2 ha	19.7 ha
AREA TREATED	4.52 ha	3.09 ha	4.55 ha	3.84 ha	4.65 ha	5.28 ha
METHOD						
ROTOTILLER	3.55 ha	2.99 ha	2.88 ha	3.77 ha	4.47 ha	5.21 ha
HARVESTER			1.40 ha			
DIVER DREDGE	0.72 ha		0.08 ha			
BOTTOM BARRIERS	0.25 ha	0.10 ha	0.19 ha	0.07 ha	0.18 ha	0.07 ha
TOTAL PROGRAM COST	$49 000	$21 000	$17 000	$17 000	$18 000	$20 000

APPENDIX II

Treatment Activities in Cultus Lake, May 28 - August 15, 1986 and Observations on Regrowth, September 18, 1986

APPENDIX II

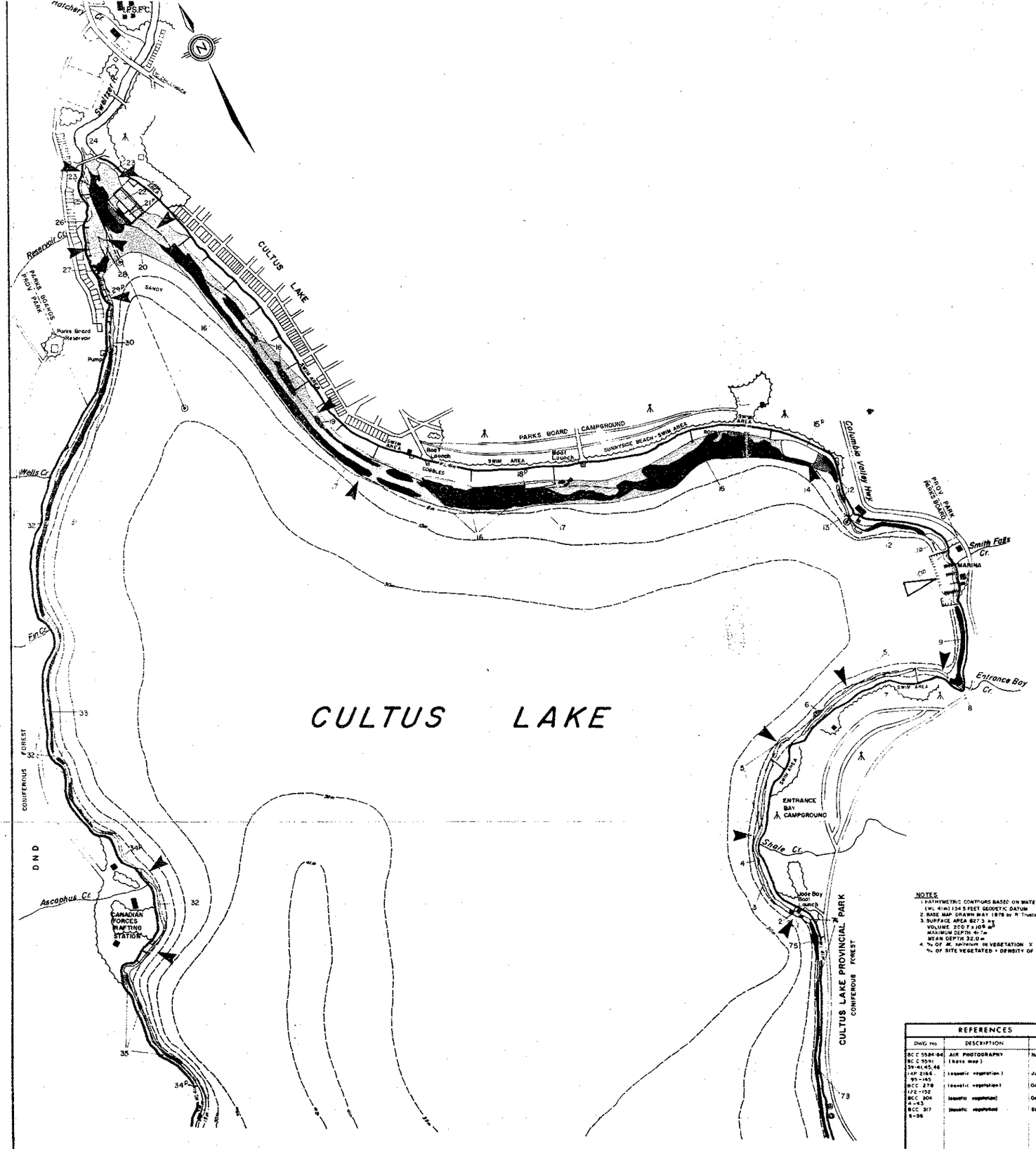
TREATMENT ACTIVITIES IN CULTUS LAKE, MAY 28 - AUGUST 15, 1986, AND OBSERVATIONS ON REGROWTH, SEPTEMBER 18, 1986

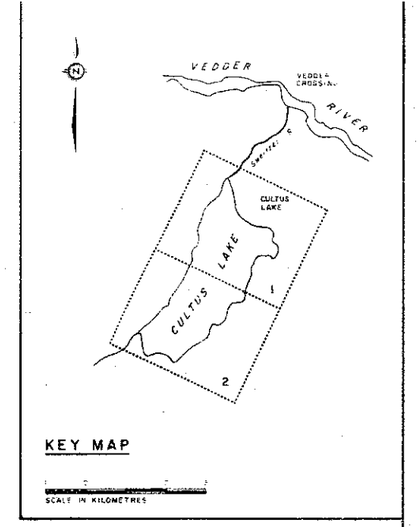
AGENCY JURISDICTION FOR AREA TREATED	SITE NO. (1986)	METHOD OF CONTROL	AREA TREATED (ha)	PRETREATMENT DENSITY[1]	DENSITY RECORDED SEPT. 18, 1986
Cultus Lake Park Bd.:					
- West Side Park	23	Rototiller	0.19	Sparse	Sparse
	25-30	Rototiller	0.64	Dense	Present-Dense
- Main Beach	23	Rototiller	0.20	Sparse	Sparse
- East Side Park	16,17	Rototiller	1.04	Dense	Sparse
- Sunnyside Beach	15	Rototiller	0.30	Moderate	Present
Cultus Lake Marina:	10	Texel	0.07	Moderate	Present
	11	Rototiller	0.07	Moderate	Present
C.F.B. Chilliwack Rafting Station:	32	Rototiller	0.15	Moderate	Sparse
Cultus Lake Prov. Park:					
- Entrance Bay	3-7	Rototiller	0.47	Sparse, Dense	Sparse
- Spring Bay	69,70	Rototiller	1.06	Dense	Sparse, Dense
- Delta Grove	65-68	Rototiller	0.21	Moderate, Dense	Present-Moderate
- Honeymoon Bay	60-63	Rototiller	0.10	Moderate	Present-Moderate
- Maple Bay	51-56	Rototiller	0.26	Dense	Present-Moderate
Lindell Beach:	44-47	Rototiller	0.52	Moderate	Present, Sparse
		Total:	5.28 ha		

[1]Density of Myriophyllum spicatum: Present (<1%), Sparse (1-29%), Moderate (30-69%), Dense (70-100%) (bottom cover)

APPENDIX III

Cultus Lake Site Map





TREATMENT METHOD

- Rototiller
- Bottom Barrier

MAP LEGEND

- WOODED AREA
- BRUSH AREA
- TREE
- PROMINENT TREE OR SMALL GROUP OF TREES
- PROMINENT BUILDING
- WATER INTAKE

DENSITY OF *Myriophyllum spicatum*

- DENSE 70-100% cover
- MODERATE 30-69 % cover
- SPARSE 1-29 % cover
- P PRESENT % cover too low to be estimated
- X *M. spicatum* plant or clump
- Aquatic vegetation (submersed), no *M. spicatum* detected

NOTES
1. BATHYMETRIC CONTOURS BASED ON WATER LEVEL (WL 41m) 134.5 FEET GEODETIC DATUM
2. BASE MAP DRAWN MAY 1978 by R Truelson
3. SURFACE AREA 827.3 ha
VOLUME 200.7 x 10^6 m^3
MAXIMUM DEPTH 49.7m
MEAN DEPTH 32.0m
4. % OF *M. spicatum* IN VEGETATION X
% OF SITE VEGETATED + DENSITY OF *M. spicatum*

0 100 200 300 METRES
SCALE

REFERENCES		
DWG No	DESCRIPTION	DATE
BC C 5584-84	AIR PHOTOGRAPHY	Nov 31, 1974
BC C 5591 39-41,45,46	(base map)	
HP 2164 95-145	(aquatic vegetation)	July 16, 1978
BCC 278 128-152	(aquatic vegetation)	Oct. 9, 1980
BCC 304 4-43	(aquatic vegetation)	Oct 14, 1981
BCC 317 6-56	(aquatic vegetation)	Sept 23, 1982

REVISIONS		
No	DESCRIPTION	DATE

SURVEYED R Truelson
DATE Sept. 1986
COMPILED R Truelson
CHECKED
DATE
DRAWN B. McL
CHECKED
DATE

Province of British Columbia — Ministry of Environment and Parks, Water Management Branch

CULTUS LAKE - NORTH
SURVEY OF *Myriophyllum spicatum* AND OTHER AQUATIC PLANTS
1986

H.Q.T. No.
Branch 0316933-01
Section

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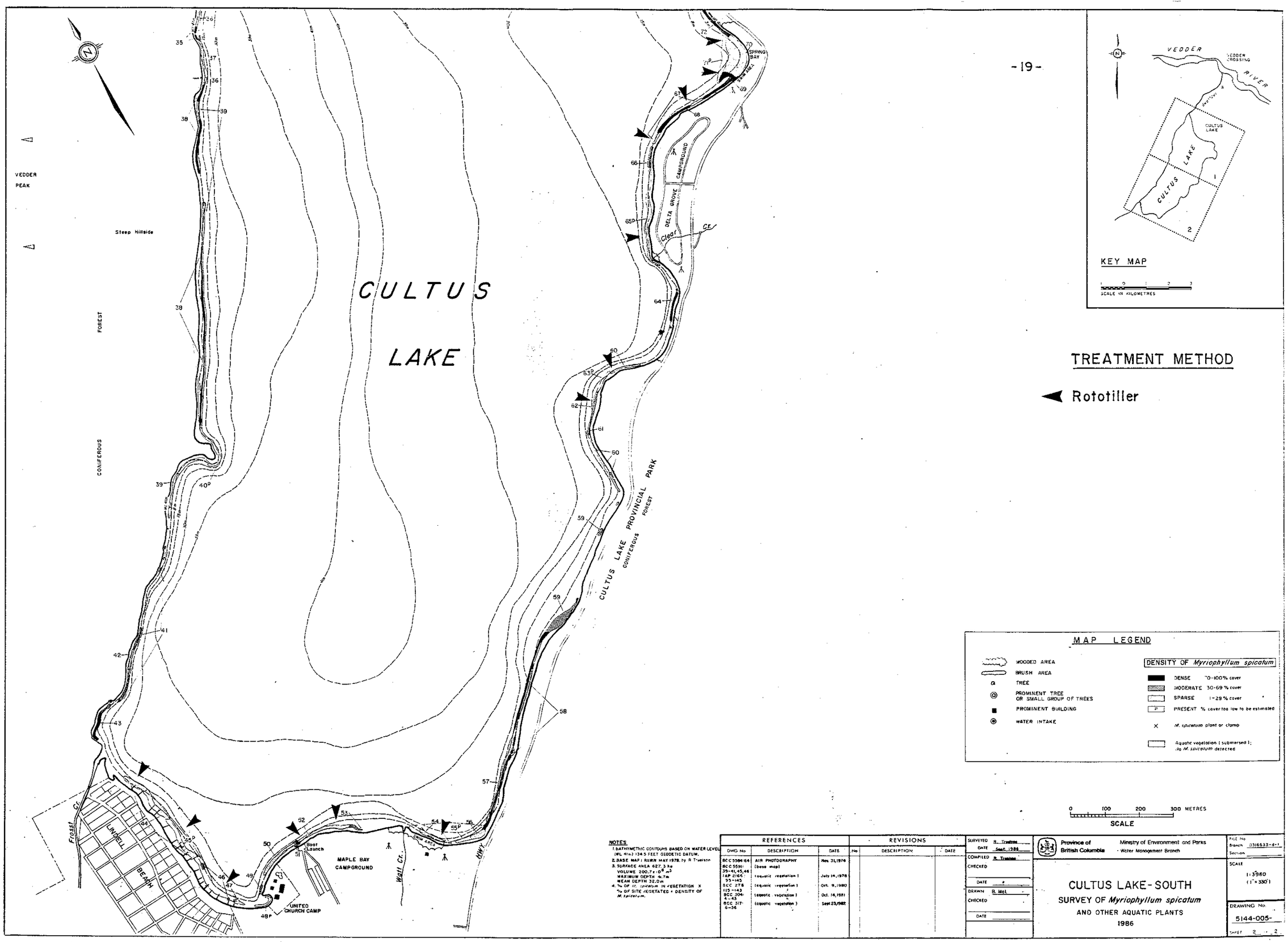

TREATMENT METHOD

◀ Rototiller

MAP LEGEND

- WOODED AREA
- BRUSH AREA
- TREE
- PROMINENT TREE OR SMALL GROUP OF TREES
- PROMINENT BUILDING
- WATER INTAKE

DENSITY OF *Myriophyllum spicatum*

- DENSE 70-100% cover
- MODERATE 30-69% cover
- SPARSE 1-29% cover
- P PRESENT % cover too low to be estimated
- × *M. spicatum* plant or clump
- Aquatic vegetation (submersed); No *M. spicatum* detected

0 100 200 300 METRES
SCALE

NOTES:
1. BATHYMETRIC CONTOURS BASED ON WATER LEVEL (WL Rim) 134.5 FEET GEODETIC DATUM.
2. BASE MAP: RAWN MAY 1978. by R Trustron
3. SURFACE AREA 627.3 ha
VOLUME 200.7 x 10^6 m^3
MAXIMUM DEPTH 46.7m
MEAN DEPTH 32.0m
4. % OF *M. spicatum* IN VEGETATION X
% OF SITE VEGETATED = DENSITY OF *M. spicatum*.

REFERENCES			REVISIONS		
DWG No	DESCRIPTION	DATE	No	DESCRIPTION	DATE
BCC 5584-64	AIR PHOTOGRAPHY	Nov. 31, 1976			
BCC 5591-39-41, 45, 46	(base map)				
1AP 2165-93-145	(aquatic vegetation)	July 14, 1978			
BCC 278-115-143	(aquatic vegetation)	Oct. 9, 1980			
BCC 304-4-43	(aquatic vegetation)	Oct. 14, 1981			
BCC 317-6-36	(aquatic vegetation)	Sept 23, 1982			

SURVEYED R. Trustron
DATE Sept. 1986
COMPILED R. Trustron
CHECKED
DATE
DRAWN B. Mol
CHECKED
DATE

Province of British Columbia
Ministry of Environment and Parks
Water Management Branch

CULTUS LAKE - SOUTH
SURVEY OF *Myriophyllum spicatum* AND OTHER AQUATIC PLANTS 1986

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APPENDIX IV

Summary of Post-Treatment Observations in Bottom Barrier Control Plots

APPENDIX IV-a

PRE-TREATMENT/POST-TREATMENT OBSERVATIONS OF TEXEL AT SUNNYSIDE BEACH SWIM AREA (SITE 18)

OBSERVATION	Applied May 17, 1984 PRE-TREATMENT	September 13, 1984 FOUR MONTHS POST-TREATMENT	September 25, 1985 SIXTEEN MONTHS POST-TREATMENT	September 19, 1986 TWENTY-EIGHT MONTHS POST-TREATMENT
Stability/bottom contact:		Excellent	Excellent	Excellent
Gas accumulation below:		Nil	Nil	Nil
Sedimentation:		Nil	Nil	Nil
Plant growth on or through barrier:				
area covered -	90%	<1%	<1%	<1%
dominant species -	M. spicatum (90%)	M. spicatum (100%)	M. spicatum (100%)	M. spicatum (100%)
maximum height -	1.0 m	0.3 m	0.2 m	1.0 m (at edge)
average height -	0.8 m	0.15 m	0.1 m	0.2 m
Condition of M. spicatum under barrier:		80% of covered plants still living	None viable	None viable
Rooting Fragments:		Accounted for all attached M. spicatum (no covered plants penetrating barrier)	Accounted for all attached M. spicatum; only in large numbers near the edge of plot	Accounted for all attached M. spicatum
Epiphyton coverage/depth:		95%; 2 mm depth	100%; 4 mm depth	100%; 3 mm depth
General:		Height of M. spicatum in adjacent, untreated area averaged 1.9m at a depth of 2.5m		Height of M. spicatum in adjacent, untreated area averaged 2.5 m at a depth of 2.6-3 m No deterioration in material strength noticed

APPENDIX IV-b

PRE-TREATMENT/POST-TREATMENT OBSERVATIONS OF TEXEL AT MAIN BEACH SWIM AREA (SITE 21)

OBSERVATION	Applied May 22-24, 1985 PRE-TREATMENT	September 25, 1985 FOUR MONTHS POST-TREATMENT	September 19, 1986 SIXTEEN MONTHS POST-TREATMENT
Stability/bottom contact:		Fair-good; four 1 m high bulges from trapped gas	Excellent
Gas accumulation below:		Quantity of trapped gas had declined since August	Nil; has not recurred since the initial plant decomposition period
Sedimentation:		Nil	5-15 mm; caused from rototilling activities nearby
Plant growth on or through barrier:			
area covered -	80%	<1%	1-15% (5% av.)
dominant species -	M. spicatum (90%)	M. spicatum (100%)	M. spicatum(60%), Chara(40%)
maximum height -	1.5 m	0.3 m	1.0 m
average height -	1.0 m	0.2 m	0.2 m
Condition of M. spicatum under barrier:		None viable (≈50% were green in August)	None viable
Rooting Fragments:		<1/m²; higher near edges	Accounted for all established plants
Epiphyton coverage/depth:		100%; 3 mm	100%; 1 mm
General:	Applied over deteriorated burlap (in place since spring, 1983)	Gas pockets were vented by making slits and/or striking the material to force gas through	The heavy sedimentation caused by rototilling negated the material's ability to slow the establishment of rooting fragments

APPENDIX V-c

CONTINUED POST-TREATMENT OBSERVATIONS OF DARTEK AT MAIN BEACH SWIM AREA (SITE 21)

OBSERVATION	Applied July, 1983 PRE-TREATMENT	September 13, 1984 FOURTEEN MONTHS POST-TREATMENT	September 25, 1985 TWENTY-SIX MONTHS POST-TREATMENT	September 19, 1986 THIRTY-EIGHT MONTHS POST-TREATMENT
Stability/bottom contact:		Good	Good	Good
Gas accumulation below:		Nil	Nil	Nil
Sedimentation:		Nil	Nil	Nil
Plant growth on or through barrier:				
area covered -	90%	<5%	<5%	<5%
dominant species -	M. spicatum (80%)	M. spicatum (80%)	M. spicatum (100%)	M. spicatum (100%)
maximum height -	2.0 m	1.3 m	1.4 m	1.3 m
average height -	1.5 m	0.7 m	0.7 m	0.5 m
Condition of M. spicatum under barrier:		None viable	None viable	None viable (except for plants penetrating slits)
Rooting Fragments:		None	None	None
Epiphyton coverage/depth:		30%; <1 mm depth	100%, 4 mm	95%; 2 mm
General:		Many fragments on barrier but not attached	All plant growth was through the slits in the material	Nylon has shown no deterioration in strength

APPENDIX V

Area and Density of *Myriophyllum spicatum*
in Cultus Lake, 1977-1986

M. spicatum IN CULTUS LAKE