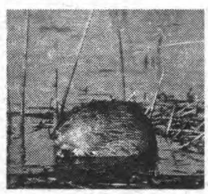
Canada Alberta Northwest Territories

Northern River Basins Study



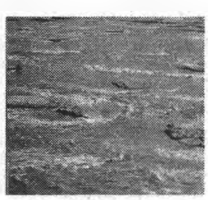






NORTHERN RIVER BASINS STUDY PROJECT REPORT NO. 94

INVESTIGATIONS OF STREAMBED OXYGEN DEMAND, ATHABASCA RIVER, OCTOBER, 1994, TO MARCH, 1995






Prepared for the
Northern River Basins Study
under Project 2222-D1

by

Leigh R. Noton,
Alberta Environmental Protection

NORTHERN RIVER BASINS STUDY PROJECT REPORT NO. 94

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ATHABASCA RIVER, OCTOBER, 1994, TO MARCH, 1995

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PREFACE:

The Northern River Basins Study was initiated through the "Canada-Alberta-Northwest Territories Agreement Respecting the Peace-Athabasca-Slave River Basin Study, Phase II - Technical Studies" which was signed September 27, 1991. The purpose of the Study is to understand and characterize the cumulative effects of development on the water and aquatic environment of the Study Area by coordinating with existing programs and undertaking appropriate new technical studies.

This publication reports the method and findings of particular work conducted as part of the Northern River Basins Study. As such, the work was governed by a specific terms of reference and is expected to contribute information about the Study Area within the context of the overall study as described by the Study Final Report. This report has been reviewed by the Study Science Advisory Committee in regards to scientific content and has been approved by the Study Board of Directors for public release.

It is explicit in the objectives of the Study to report the results of technical work regularly to the public. This objective is served by distributing project reports to an extensive network of libraries, agencies, organizations and interested individuals and by granting universal permission to reproduce the material.

NORTHERN RIVER BASINS STUDY
PROJECT REPORT RELEASE FORM

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Whereas the above publication is the result of a project conducted under the Northern River Basins Study and the terms of reference for that project are deemed to be fulfilled,
IT IS THEREFORE REQUESTED BY THE STUDY OFFICE THAT;
this publication be subjected to proper and responsible review and be considered for release to the public.

(Dr. Fred J. Wrona, Science Director) — 14 Feb 96 (Date)

Whereas it is an explicit term of reference of the Science Advisory Committee "to review, for scientific content, material for publication by the Board",
IT IS HERE ADVISED BY THE SCIENCE ADVISORY COMMITTEE THAT;
this publication has been reviewed for scientific content and that the scientific practices represented in the report are acceptable given the specific purposes of the project and subject to the field conditions encountered.
SUPPLEMENTAL COMMENTARY HAS BEEN ADDED TO THIS PUBLICATION: [ ] Yes [ ] No

(Dr. P. A. Larkin, Ph.D., Chair) — 14 Feb 96 (Date)

Whereas the Study Board is satisfied that this publication has been reviewed for scientific content and for immediate health implications,
IT IS HERE APPROVED BY THE BOARD OF DIRECTORS THAT;
this publication be released to the public, and that this publication be designated for: **[ ] STANDARD AVAILABILITY [ ] EXPANDED AVAILABILITY**

Lucille Partington
(Lucille Partington, Co-chair) — 23 Feb. /96 (Date)

Robert McLeod
(Robert McLeod, Co-chair) — 23 Feb /96 (Date)

INVESTIGATIONS OF STREAMBED OXYGEN DEMAND, ATHABASCA RIVER, OCTOBER, 1994, TO MARCH, 1995

STUDY PERSPECTIVE

Recent concern has focused on the role of natural versus man-made factors in contributing to the decrease in dissolved oxygen in the Athabasca River during winter. Computer modelling of dissolved oxygen in the Athabasca River is being used to assess the potential impacts of increased industrial development, particularly pulp and paper mill effluents, on water quality. The oxygen consumption of bacteria, fungi, aquatic plants and invertebrates found on the bed of rivers and streams is referred to scientifically as streambed oxygen demand (SOD). SOD is an important variable in the oxygen balance of rivers, in particular during winter under low flow conditions and extensive ice cover. Previous studies have measured SOD levels in the Athabasca River, but a number of questions remained unanswered. The purpose of this project is to determine (1) if SOD rates are consistently higher downstream of effluent inputs during winter, (2) how the trend varies throughout the winter, and (3) whether SOD is influenced directly by nutrient loads from effluents.

The objective of this project was addressed by obtaining a series of SOD measurements from the Athabasca River, upstream of Hinton and downstream to the Calling River using stainless steel *in situ* chambers. This sampling regime was designed to investigate SOD rates over time and distance along the river at key sites from fall through winter in both ice-free and ice-covered areas.

Related Study Questions

2) What is the current state of water quality in the Peace, Athabasca and Slave river basins, including the Peace-Athabasca Delta?

5) Are the substances added to the rivers by natural and man-made discharges likely to cause deterioration of the water quality?

7) What concentrations of dissolved oxygen are required seasonally to protect the various life stages of fish, and what factors control dissolved oxygen in the rivers?

13b) What are the cumulative effects of man-made discharges on the water and aquatic environment?

14) What long term monitoring programs and predictive models are required to provide an ongoing assessment of the state of the aquatic ecosystems? These programs must ensure that all stakeholders have the opportunity for input.

SOD measurements were obtained at 13 locations over mainly coarse substrates (pebble, cobble and boulder). Higher SOD tended to occur downstream of Hinton and downstream of Whitecourt, as compared to sites upstream of these locations. SOD was also notably higher in ice-free locations, and tended to increase later in the winter. However, this apparent increase is likely an artifact of the method, as an increased growth of benthic algae at these locations contributed to the net oxygen demand within the chambers. Overall, SOD declined slightly during the winter at sites with typical winter ice and snow cover. Nonetheless, at ice-covered sites SOD remained greater immediately downstream of Hinton and Whitecourt, likely a result of high nutrient inputs from effluents, and these SOD levels tended to increase at these sites as winter progressed. Nutrient inputs from tributaries such as the McLeod, Pembina and Lesser Slave rivers may also contribute to winter SOD.

This study was designed to address questions and deficiencies raised in the past about SOD. Measurements of SOD have been obtained in the Athabasca River during most winters in the last seven years. The methods used have been well validated, and these data will make an additional contribution to our understanding of winter oxygen levels in this river system. SOD measurements provide a useful link in biomonitoring studies, and data over several years will be valuable in the efforts to model winter dissolved oxygen in the Athabasca River.

REPORT SUMMARY

Streambed oxygen demand (SOD) was sampled in the Athabasca River from October 1994 to March 1995 with the objectives of obtaining a series of measurements from upstream of Hinton to the Calling River area, and investigating temporal change in SOD at key sites. As in previous surveys, SOD was measured with closed chambers, deployed in the river for about 24 hours. Measurements were also made of other pertinent variables including benthic chlorophyll, depth, and velocity.

Thirteen locations on the river were sampled a total of 45 times. The substrates involved were mainly coarse, with pebble, cobble, and boulder predominating. Mean SOD rates ranged from 0.024 to 0.91 $gO_2/m^2/d$. Higher SOD tended to occur downstream of Hinton and downstream of Whitecourt, as compared to sites upstream.

In ice-free locations, SOD appeared to increase after December, but this was probably an artifact of the method. Benthic algae were growing in those areas and when enclosed in the opaque chambers, contributed to oxygen consumption. The oxygen consumption measured in ice-free areas should be considered gross benthic respiration rather than net oxygen flux. At sites with typical winter ice and snow cover, SOD appeared to decline slightly during the winter.

SOD was distinctly related to epilithic chlorophyll *a* in open-water areas, for the reason noted above. SOD was more weakly related to chlorophyll at ice-covered sites, and to water velocity at all sites. The apparent temporal increase in SOD in open-water areas during winter in this survey and in January-March of 1994 was probably due to the growth of benthic algae during the increasing light of late winter. Nonetheless, at ice-covered sites SOD was greater downstream of Hinton and Whitecourt, compared to sites upstream. This is probably due to a general fertilization effect of effluents and possibly also tributary inflows.

ACKNOWLEDGEMENTS

Field work and data compilation were carried out by Chris Ware and Randy Sweeny, funded by the Northern River Basins Study, Nutrients Component. Equipment and facilities were provided by the Surface Water Monitoring Branch, AEP, and D. LeClair, J. Willis, and D. Allan of SWMB provided supervision and assistance during the field work. Epilithic chlorophyll *a* analyses were done by M. Hussey of SWMB. B. Halbig compiled data and prepared graphs.

Helpful review comments on a draft of this report were provided by R. Chabaylo, P. Larkin, D. Schindler, and two anonymous reviewers, through the NRBS.

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1.0 INTRODUCTION

The bed of rivers and streams contains bacteria, fungi, algae, higher aquatic plants, and invertebrates, all of which respire and consume oxygen. This oxygen consumption is termed sediment or streambed oxygen demand and can be a major factor in the oxygen balance of a river. Streambed oxygen demand (SOD) is thought to account for a significant fraction of the total oxygen demand in the Athabasca River in the winter (Macdonald and Radermacher 1993). Investigation of SOD in the river began in 1989 (Casey and Noton 1989) and SOD measurements have been made in most winters since then (Casey 1990b; Monenco 1992; HBT Agra 1993; HBT Agra 1994). The main method used has been to enclose stream substrate in stainless steel chambers *in situ,* and measure the decline in dissolved oxygen (DO) in the overlying chamber water during deployment. Some additional measurements have been done by incubating sediment cores in field facilities (Monenco 1992). Note that in this report the term 'streambed' oxygen demand is used in preference to the term 'sediment' oxygen demand although the latter is the common term in the scientific literature. The former is preferred here because much of the bed of the Athabasca River that has been sampled in this and previous investigations is relatively coarse gravel-cobble material, not sediment.

Although data have been collected in the previous five years, several questions remained concerning SOD and factors controlling it. These have arisen in connection with oxygen modelling and nutrient dynamics, and include the question of whether SOD accumulates downstream of effluent inputs during winter, and whether SOD is influenced by nutrient loads from effluents. In addition, there is a general need to have regular monitoring of SOD. The objectives of this project (Appendix A) were to address these questions and needs, specifically:

- to obtain a series of SOD measurements from upstream of Hinton downstream to the Calling River area,
- to investigate temporal change in SOD at key sites from fall through winter in both ice-free and ice-covered areas.

This was a joint project of the Northern River Basins Study (NRBS), which funded the field work, and Alberta Environmental Protection (AEP), which provided project management, equipment, and facilities. As well as the above, work was carried out to further develop and assess the sediment-core method of measuring SOD. That work was reported in a separate manuscript since no actual data for the Athabasca River arose from it.

2.0 METHODS

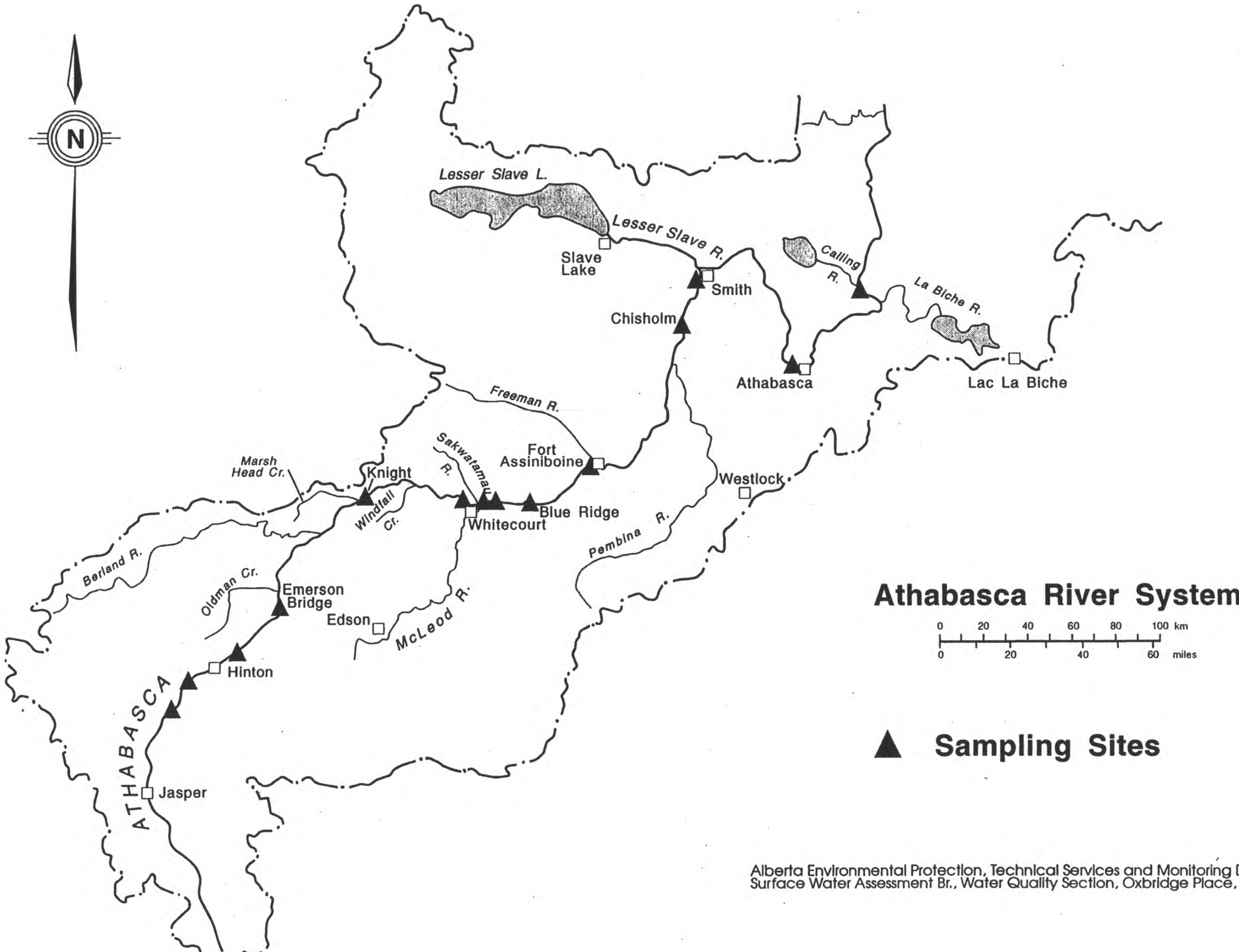
SOD measurements were made at a series of sites from upstream of Hinton to near Calling River (Figure 1). Detailed site locations are mapped in Appendix B. Measurements began in late October, 1994, and were carried out regularly until mid-March, 1995. Most sites were sampled 3-4 times.

The basic method used to measure SOD was that developed by Casey and Noton (1989; Casey 1990a), wherein river substrate is enclosed in stainless steel chambers and 'incubated' *in situ* to determine the consumption of dissolved oxygen (DO) by the substrate. Closed-bottom chambers were used in all cases in this survey (Figure 2). River substrate was loaded into the chambers in as near as possible the same position as it occurred on the river bed. As much substrate as possible was added without impinging on the water vane. The chambers were then set on the river bottom to allow silty water to clear from the chamber, the lids were sealed to the chambers, and the chambers were incubated for about 24 hours. The current-driven water vane on each chamber provided internal circulation (Figure 2). Compared to previous years, vanes were fitted with better washers to improve stirring. Four replicate chambers were normally installed this way along with one 'blank' chamber with only river water. Start and finish DO measurements were taken in duplicate with the azide-Winkler method. The starting DO sample was collected from river water beside the chambers, just prior to sealing the lids. The final DO samples were siphoned via the chamber's sampling tube into 300 ml BOD bottles.

SOD was calculated from the observed DO consumption (corrected for the blank), the measured volume of water in the chamber, and the length of incubation, and expressed as $gO_2/m^2/d$. On repeat visits to sites, a new spot was sampled so as to avoid substrates and ice cover disturbed by previous sampling. One site was sampled with 8 replicates which were extracted at regular intervals up to 48 hours, in order to check the effect that length of incubation might have on the SOD rate.

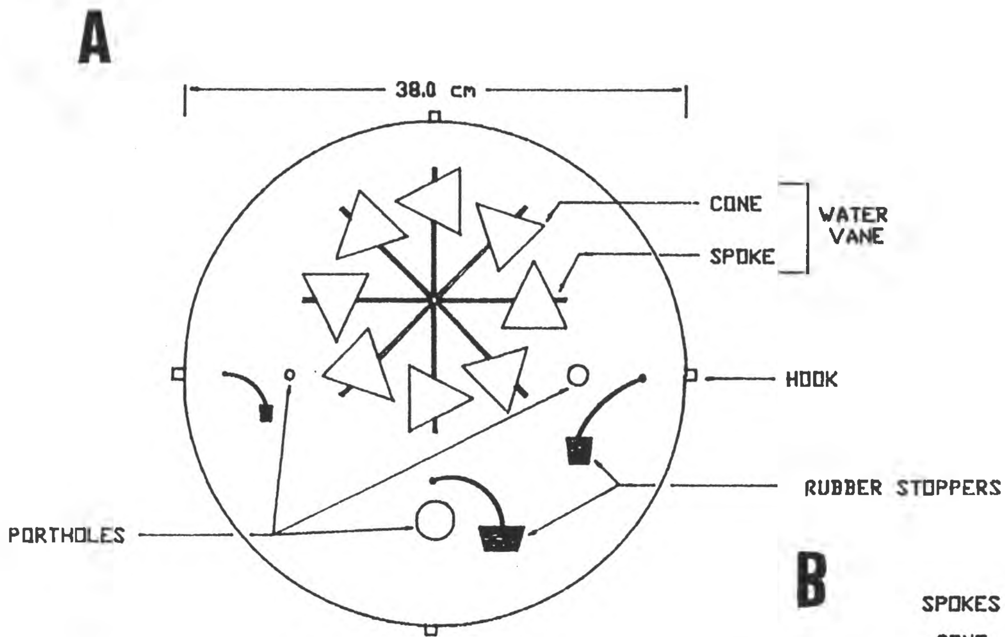
At the chambers at each sampling site, measurements were taken of velocity and water depth, and substrate particle size composition was visually estimated. Velocity was measured at the chamber tops with a Price AA meter. A sample of epilithic algae was collected from the rocks within each SOD chamber by scraping a measured area of the rock surface. These samples were preserved and analysed for chlorophyll *a* by the regular procedures of the Technical Services and Monitoring Division of AEP (NAQUADAT analytical code 06722). Data were compiled and graphed with spreadsheets, and difference testing was done with single-factor analysis of variance.

Figure 1. SOD Sampling Sites on the Athabasca River Fall-Winter, 1994-1995



Alberta Environmental Protection, Technical Services and Monitoring Division, Surface Water Assessment Br., Water Quality Section, Oxbridge Place, Edmonton.

A



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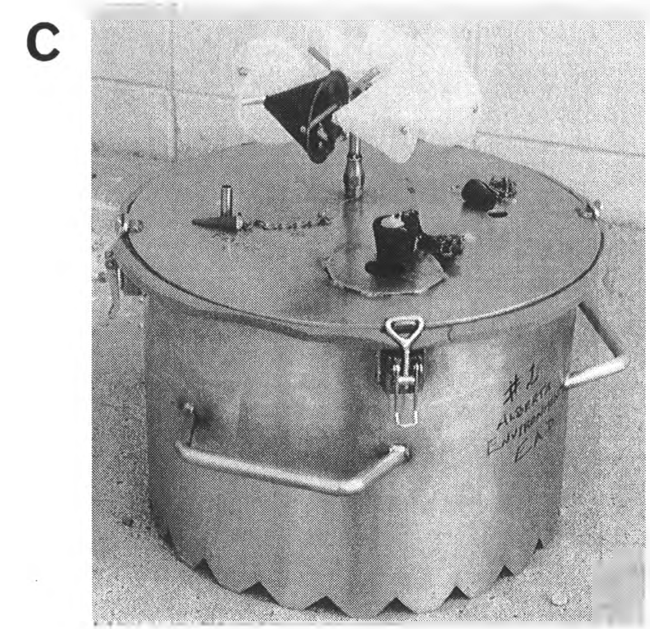

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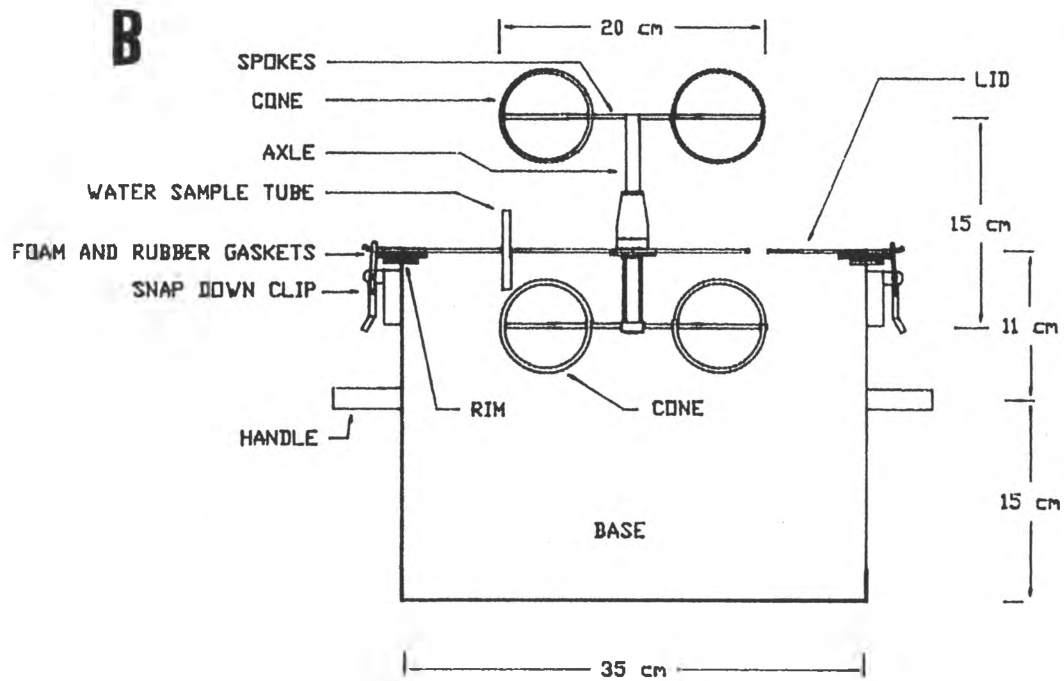


Figure 2. Streambed Oxygen Demand Chamber

A. Top view of lid
B. Vertical cross-section
C. Assembled

From Casey and Noton 1989

3.0 RESULTS AND DISCUSSION

3.1 GENERAL FINDINGS

Thirteen locations on the Athabasca River were sampled a total of 45 times, with 175 replicate SOD measurements collected (Table 1). Epilithic chlorophyll *a* measurements also were obtained for most occasions, as were mean ambient water velocity and depth (Table 2). Substrate descriptions are compiled in Appendix C and detailed site data in Appendix D. Mainly coarse, 'erosional' substrates were sampled, with pebble (8-64 mm) and cobble (64-256 mm) the most common particles. These were the predominant substrates encountered by the field crews at the sampling sites. All locations were ice-free in October and early November, but all except three were ice-covered after mid-November (Table 1). Freeze-up was accompanied by ice jamming and water level increases at some sites, which caused multiple ice layers and frozen substrate, and complicated sampling in some cases (discussed further below). As winter progressed it became more and more difficult to find spots that could be sampled with standard wading methods because ice became thicker and the channel more restricted. This made sampling impractical later in the winter at Emerson bridge and Blue Ridge (Table 1).

Mean SOD per sampling occasion ranged from a low of 0.024 $gO_2/m^2/d$ at Knight in December to a high of 0.91 $gO_2/m^2/d$ 2 km downstream of the McLeod River confluence in March (Table 1). The latter value and several other high values at that site in February-March (noted in Table 1) may be underestimates of oxygen consumption because DO in the chambers fell to low concentrations during the incubations (Appendix D) and may have limited the consumption rate. At other sites, however, this did not occur and the normal incubation length appeared to be appropriate (Appendix E). The high rates 2 km downstream of the McLeod River and the rates measured at other ice or snow-free sites may represent only total respiration of the benthic community, rather than net oxygen flux, because the opaque chambers used for the incubations prevent photosynthesis. Photosynthesis may be significant at these locations because light penetration is not prevented by ice or snow. This is discussed further below. At ice and snow covered sites in general, SOD rates appeared to be slightly higher than in some previous years although they were of similar magnitude (approximately 0.05 - 0.3 $gO_2/m^2/d$).

3.2 LONGITUDINAL AND TEMPORAL TRENDS

The mean SOD per site and occasion is plotted against river distance in Figure 3. As in previous years higher SOD tended to occur downstream of Hinton and downstream of Whitecourt, as compared to the sites immediately upstream of these locations. Prior to this survey, no measurements had been made upstream of Hinton. The SOD values obtained there in this survey were generally lower than those from downstream of Hinton, although both fluctuated in time (Figure 4), and comparisons are complicated by the growth of algae (discussed below). However, SOD farther downstream at Emerson Bridge was greater than SOD upstream of Hinton, on December 6-7 ($p = 0.003$) and on January 4-5 (compared to February 1-2: $p = 0.006$).

TABLE 1. SUMMARY OF SOD RATES, ATHABASCA RIVER (Fall/Winter 1994-95).								
LOCATION	**DATE**	**Rep 1**	**Rep 2**	**Rep 3**	**Rep 4**	**Mean**	Std Error	CV
u/s Hinton								
at Entrance	Dec 6-7	-	0.058	0.045	0.047	**0.050**	0.006	14
d/s Brule Lk (ice free)	Feb 1-2	0.102	0.123	0.056	0.096	**0.094**	0.024	30
	Feb 21-22	0.257	0.156	0.178	0.130	**0.180**	0.047	30
u/s Maskuta Ck.	Feb 22-23	0.147	0.081	0.175	0.097	**0.125**	0.038	35
d/s Hinton (all ice free)	Nov 3-4	0.249	0.167	0.203	0.127	**0.186**	0.045	28
	Dec 5-6	0.244	0.159	0.177	-	**0.194**	0.037	23
	Jan 4-5	0.466	0.255	0.394	0.307	**0.356**	0.081	26
	Feb 1-2	0.376	0.534	0.540	0.784	**0.559**	0.146	30
	Feb 22-23	0.417	0.468	0.468	0.257	**0.403**	0.086	25
Emerson Bridge	Dec 6-7	0.145	0.213	0.202	-	**0.187**	0.030	20
	Jan 4-5	0.157	0.168	0.141	0.180	**0.162**	0.014	10
Knight	Dec 12-13	0.012	0.027	0.034	0.023	**0.024**	0.008	38
	Jan 10-11	0.059	0.063	0.088	0.079	**0.072**	0.012	19
	Feb 2-3	0.034	0.037	0.069	0.057	**0.049**	0.014	34
u/s McLeod River								
LB, d/s Hwy.43 at pumphouse	Dec 12-13	0.075	0.120	0.036	0.082	**0.078**	0.030	44
LB, u/s Sakwatamau R.	Jan 19-20	0.124	0.092	0.142	0.107	**0.117**	0.019	19
LB, u/s Sakwatamau R.	Feb 6-7	0.024	0.114	0.120	0.086	**0.086**	0.038	51
RB, d/s Sakwatamau R.	Mar 7-9	0.301	0.322	0.448	0.309	**0.345**	0.060	20
2 km d/s McLeod River	Oct 25-26	0.581	0.367	0.438	0.608	**0.499**	0.100	23
(ice covered)	Dec 14-15	0.287	0.356	0.252	0.171	**0.266**	0.067	29
(ice free)	Jan 10-11	0.456	0.824	0.539	0.904	**0.681**	0.188	32
(ice free)	Feb 7-8	0.833	*0.928	*1.186	0.624	***0.893**	0.202	26
(ice free)	Mar 9-10	*0.876	0.512	*1.127	*1.109	***0.906**	0.248	32
3-4 km d/s McLeod River	Oct 20-21	0.187	0.144	0.197	0.202	**0.182**	0.023	14
	Nov 30-Dec 1	0.036	0.081	0.091	0.065	**0.068**	0.021	35
	Jan 12-13	0.286	0.226	0.240	0.236	**0.247**	0.023	11
	Feb 7-8	0.216	0.272	0.300	0.164	**0.238**	0.052	25
	Mar 7-9	0.111	0.106	0.099	0.237	**0.138**	0.057	48
Blue Ridge	Oct 26-27	0.143	0.111	0.144	0.150	**0.137**	0.015	13
	Dec 20-21	0.133	0.195	0.149	0.210	**0.172**	0.032	21
	**Jan 17-19	0.101	0.117	-	0.107	**0.108**	0.007	8
	Feb 8-9	0.110	0.111	0.162	0.140	**0.131**	0.022	19
Fort Assiniboine	Dec 19-20	0.170	0.241	0.227	0.224	**0.215**	0.027	14
	Jan 17-18	0.111	0.169	0.182	0.233	**0.174**	0.043	29
	Feb 9-10	0.090	0.084	0.079	0.046	**0.075**	0.017	26
Chisholm	Mar 14-15	0.059	0.059	0.037	0.051	**0.052**	0.009	20
Smith	Jan 23-24	0.362	0.298	0.222	0.224	**0.276**	0.058	24
	Feb 14-15	0.225	0.262	0.225	0.200	**0.228**	0.022	11
	Mar 14-15	0.133	0.082	0.194	0.133	**0.136**	0.039	34
Athabasca	Jan 24-25	0.134	0.173	0.182	0.145	**0.159**	0.020	14
	Feb15-16	0.127	0.169	0.125	0.152	**0.143**	0.018	15
	Mar 16-17	0.145	0.143	0.142	0.143	**0.143**	0.001	1
Calling River	Jan 30-31	0.088	0.097	0.121	0.091	**0.099**	0.013	15
	Feb 16-17	0.104	0.119	0.103	0.119	**0.111**	0.008	8
	Mar 15-16	0.068	0.056	0.091	0.101	**0.079**	0.018	26

Results as $gO_2/m^2/d$

* = low DO may have limited SOD rates

** = "48 hr" SOD rates

CV = coefficient of variation, = s (not shown) as % of the mean

TABLE 2. CHLOROPHYLL, DEPTH, AND VELOCITY AT SOD SITES, ATHABASCA RIVER, 1994-95.

LOCATION	RIVER km	DATE	EPILITHIC CHLOROPHYLL *a* - mg/m² Rep 1	Rep 2	Rep 3	Rep 4	Mean	Std Error	CV	Mean Depth cm	Mean Velocity cm/s
u/s Hinton											
at Entrance	1254.5	Dec 6-7	67.0	29.3	112.2	23.3	**58.0**	35.5	71	66	0
d/s Brule Lk (ice free)	1264.2	Feb 1-2	13.2	23.5	11.3	33.9	**20.5**	9.0	51	56	12
	1264.2	Feb 21-22	12.4	43.3	54.5	74.1	**46.1**	22.3	56	46	25
u/s Maskuta Ck.	1249.1	Feb 22-23	9.3	9.5	23.6	21.3	**15.9**	6.6	48	64	13
d/s Hinton (all ice free)	1240.4	Nov 3-4	n/a	n/a	n/a	n/a				53	62
		Dec 5-6	11.9	19.4	11.4		**14.2**	3.7	32	45	85
		Jan 4-5	87.8	12.7	25.9	0.4	**31.7**	33.6	122	49	94
		Feb 1-2	61.6	75.1	66.7	44.3	**61.9**	11.3	21	51	64
		Feb 22-23	18.2	9.6	10.1	15.1	**13.2**	3.6	31	44	62
Emerson Bridge	1193	Dec 6-7	58.8	42.8	118.7		**73.5**	32.6	54	84	8
		Jan 4-5	13.3	53.2	43.6	121.0	**57.8**	39.3	79	100	8
Knight	1116.05	Dec 12-13	0.2	6.4	1.0	1.2	**2.2**	2.5	129	52	42
		Jan 10-11	18.2	20.1	30.7	21.8	**22.7**	4.8	24	92	17
		Feb 2-3	2.0	25.5	42.6	15.5	**21.4**	14.8	80	84	20
u/s McLeod River											
LB, d/s Hwy.43 at pumphouse	1033.4	Dec 12-13	31.8	15.5	9.7	30.1	**21.7**	9.4	50	78	25
LB, u/s Sakwatamau R.	1033.4	Jan 19-20	121.2	138.3	29.7	70.9	**90.0**	42.8	55	72	45
LB, u/s Sakwatamau R.	1033.4	Feb 6-7	97.6	89.1	103.8	144.4	**108.7**	21.2	23	90	12
RB, d/s Sakwatamau R.	1032.8	Mar 7-9	146.5	111.1	92.5	170.1	**130.0**	30.2	27	94	23
2 km d/s McLeod River	1030.9	Oct 25-26	151	201.6	51.1	227.4	**157.8**	67.4	49	52	52
(ice covered)		Dec 14-15	124.5	65.6	136.4	107.9	**108.6**	26.8	28	60	41
(ice free)		Jan 10-11	72.4	157.5	138.5	127.0	**123.8**	31.6	30	52	47
(ice free)		Feb 7-8	298.3	538.9	494.6	332.0	**416.0**	102.7	29	60	48
(ice free)		Mar 9-10	449.5	548.8	600.8	470.3	**517.3**	60.8	14	50	69
3-4 km d/s McLeod River	1029.8	Oct 20-21	12.4	4.2	7.7	4.1	**7.1**	3.4	55	na	
	1029.8	Nov 30-Dec 1	19	19.1	12.1	18.9	**17.3**	3.0	20	84	31
	1029	Jan 12-13	70.8	92.2	128.3	75.8	**91.8**	22.5	28	91	27
	1029	Feb 7-8	36.5	41.5	79.9	95.3	**63.3**	25.0	46	88	20
	1029	Mar 7-9	70.6	84.3	38.8	70.3	**66.0**	16.7	29	79	11
Blue Ridge	1007.2	Oct 26-27	52.7	27.8	69.4	42.4	**48.1**	15.2	36	na	
		Dec 20-21	68.3	51.7	59.3	49.5	**57.2**	7.4	15	90	21
		Jan 17-19	52.7	60.0	28.3	24.5	**41.4**	15.2	43	61	56
		Feb 8-9	65.3	10.7	44.2	60.3	**45.1**	21.4	55	76	23
Fort Assiniboine	935.4	Dec 19-20	45.7	118.1	139.5	133.4	**109.2**	37.4	40	82	23
		Jan 17-18	20.0	6.3	50.0	20.4	**24.2**	16.0	76	74	11
		Feb 9-10	143.4	43.3	77.7	109.9	**93.6**	37.2	46	74	3
Chisholm	827.9	Mar 14-15	18.2	25.4	20.2	56.8	**30.2**	15.6	60	80	9
Smith	805	Jan 23-24	133.7	136.0	13.5	39.7	**80.7**	54.9	79	85	18
		Feb 14-15	6.5	38.2	15.6	29.1	**22.3**	12.2	63	82	18
		Mar 14-15	69.1	24.5	64.2	11.4	**42.3**	24.9	68	82	12
Athabasca	687	Jan 24-25	8.2	50.8	26.1	5.6	**22.7**	18.1	92	62	9
		Feb15-16	44.4	25.4	17.8	5.7	**23.3**	14.1	70	76	6
		Mar 16-17	10.3	36.6	60.6	97.1	**51.2**	31.9	72	62	17
Calling River	610.2	Jan 30-31	17.0	35.5	33.7	11.3	**24.4**	10.4	49	88	5
		Feb 16-17	8.5	23.6	8.6	45.0	**21.4**	14.9	80	88	4
		Mar 15-16	34.3	9.2	10.4	2.7	**14.2**	12.0	98	88	3

Note: Hinton Combined Effluent = 1241.5 km
CV = coefficient of variation, = s (not shown) as % of the mean

Figure 3. Mean SOD in the Athabasca River - all dates, fall-winter, 1994-95.

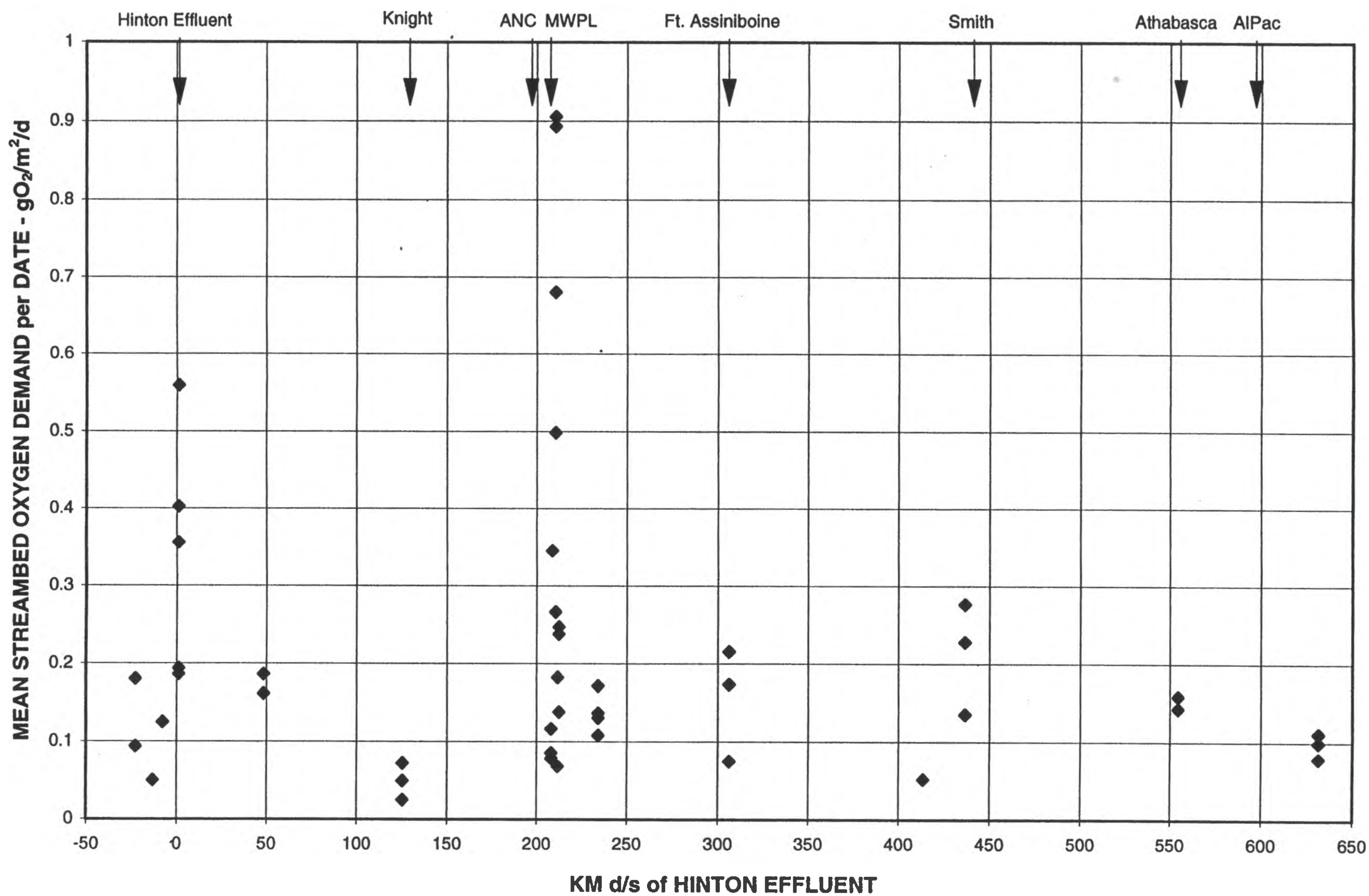
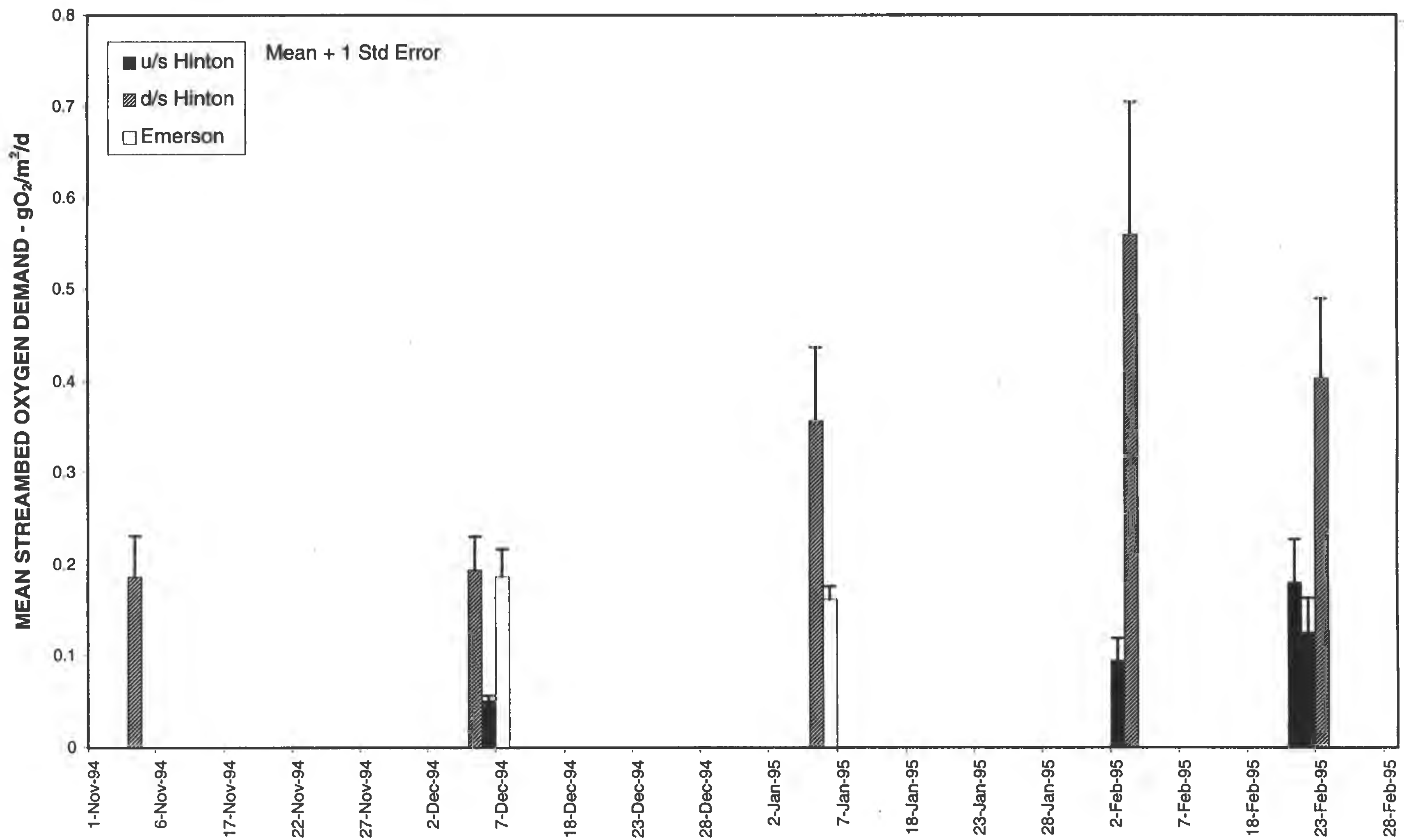


Figure 4. SOD in the Hinton area, 1994-95.



Note: date scale not exactly linear

SOD downstream of Hinton generally increased during the fall-winter period, particularly after December (Figure 4) ($p = 0.01$). This site was ice-free and a possible reason for this increase is the growth of benthic algae in this area with increasing day length and sun angle after December. Epilithic chlorophyll *a* at this site generally increased as well during this period (Table 2), suggesting that algal metabolism and biomass were increasing. This would increase the respiration rate, and although photosynthesis would also be increasing, only respiration is measured by the SOD technique used here, because the chambers are opaque. Therefore, the apparent SOD in such a situation may be an artifact of the method and is really a measure of gross benthic respiration. In these circumstances the method can not measure the net flux of oxygen. Under a typical winter ice and snow cover on the Athabasca River, light penetration and photosynthesis are negligible (Noton and Allan 1994) and the opaque SOD chambers are probably satisfactory in measuring the net flux of oxygen.

Compared to the open-water site downstream of Hinton, no change in SOD through time was apparent farther downstream at Emerson Bridge (Figure 4) ($p = 0.27$), where there was a typical winter ice and snow cover. Upstream of Hinton, SOD appeared to increase during winter, however, this also may have been for the reason discussed above because the sampling sites downstream of Brule Lake were ice-free and the site near Maskuta Creek had no snow cover on the ice. At the site downstream of Brule Lake, chlorophyll was higher on the second date, consistent with a possible increase in algal biomass.

In the Whitecourt area, SOD was low at Knight but higher just upstream of the McLeod River, which is downstream of the Alberta Newsprint Co. effluent (Table 1 and Figure 5). SOD was significantly greater at the latter site on two of the three occasions sampled ($p = 0.02$; 0.01; and 0.17) At the upstream McLeod location, SOD was fairly stable along the left bank, but higher at the spot sampled on the right bank in March (Table 1). It is not known whether the higher rates at the latter reflect temporal or spatial variability or a combination. At the ice-free site 2 km downstream of the McLeod, which is downstream of the Millar Western Pulp Ltd. effluent, apparent SOD was probably influenced by the growth of benthic algae as discussed above for ice-free sites in the Hinton area. SOD increased significantly ($p = 0.004$) after December (Figure 6), but epilithic chlorophyll *a* also increased (Table 2) and the SOD increase may be an artifact, as discussed above. Slightly downstream, at the ice and snow covered site 3-4 km downstream of the McLeod, no increase in SOD was apparent after December nor was one apparent at Blue Ridge (Figure 6). These sites had significantly greater SOD ($p < 0.01$) than Knight, during sampling in January and February at the 3-4 km site, and during sampling in December, January, and February at Blue Ridge.

Farther downstream, mean SOD ranged from 0.052 $gO_2/m^2/d$ at Chisholm in March, to 0.276 $gO_2/m^2/d$ upstream of Smith in January (Table 1 and Figure 3). No increase in SOD during winter was evident at these sites, and if anything, SOD appeared to decline (Table 1).

Figure 5. SOD in the Whitecourt reach, Athabasca River - all dates, fall-winter, 1994-95.

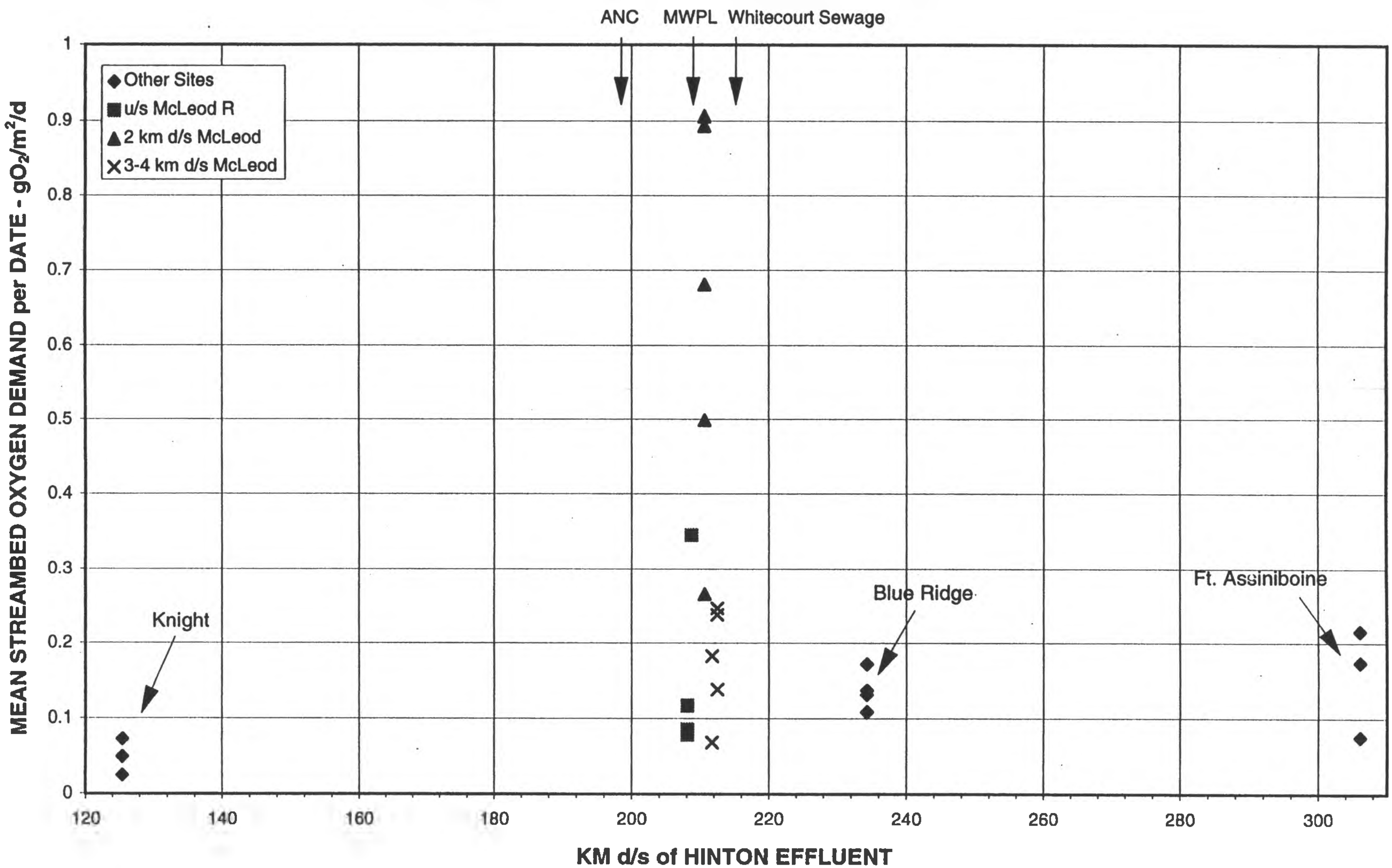
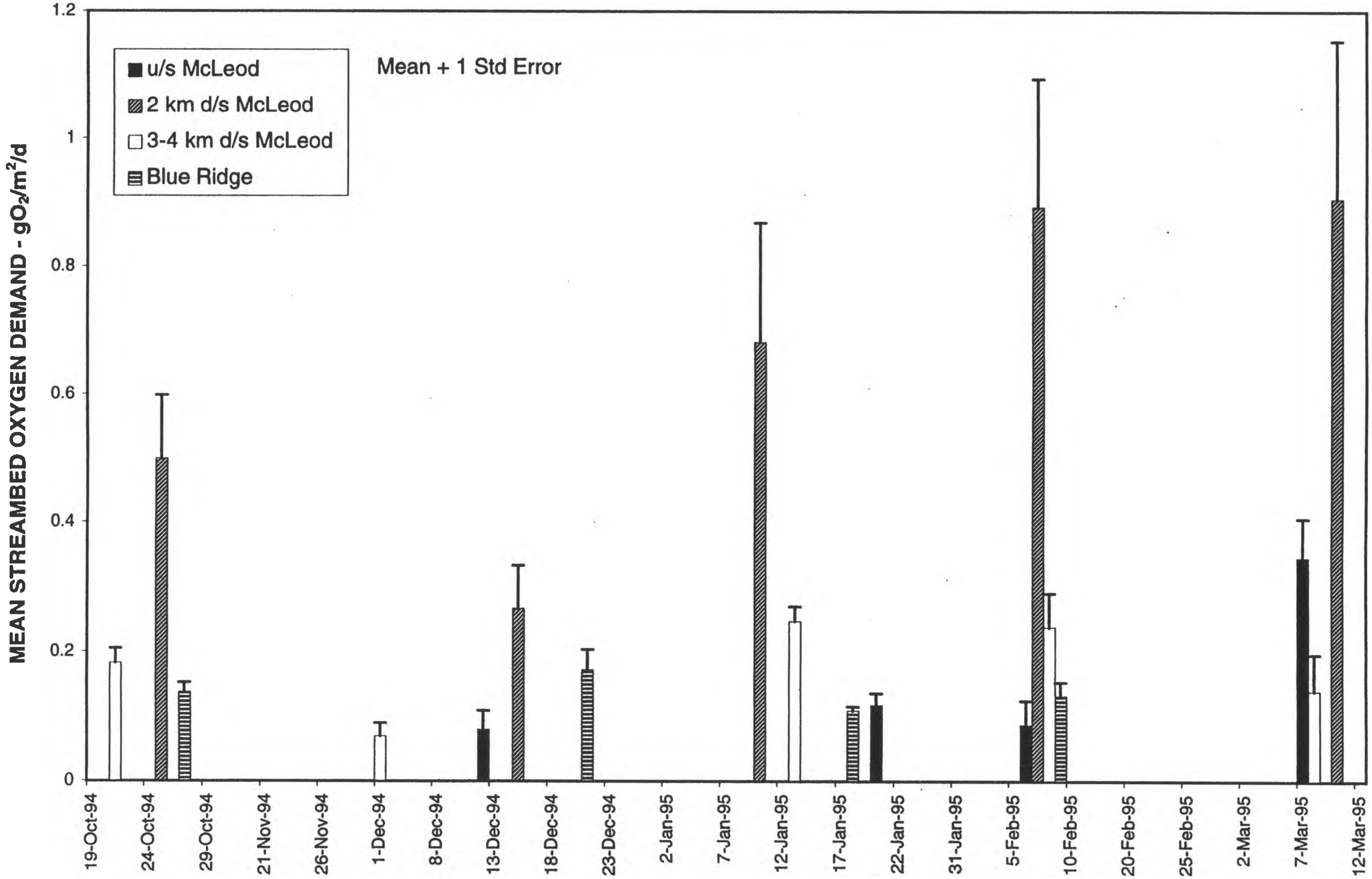


Figure 6. SOD in the Whitecourt area, 1994-95.



Note date scale not exactly linear

3.3 CONTROLLING FACTORS

The relationship of SOD to algal growth and biomass in open water locations was discussed above. At those sites SOD was positively related to epilithic chlorophyll *a* (Figure 7) as would be expected if the apparent SOD was being influenced by the growth and accumulation of algal biomass as winter progressed. As discussed, the apparent SOD was actually a measure of gross benthic respiration at those sites and the net consumption or production of oxygen is not known. In the open-water area downstream of Whitecourt in February-March of the previous year (1994), SOD also increased over time (HBT Agra 1994), possibly for the same reasons. Farther downstream under ice and snow cover at Ft. Assiniboine, SOD did not increase during the winter that year (Appendix F, Figure b).

At sampling sites with typical ice and snow cover, there was also a positive relationship between SOD and chlorophyll in 1995 (Figure 8), although it was much weaker than at open water sites. The r^2 of 0.29 implies that algal biomass accounted for less than a third of the variance in SOD at these sites. Other factors that might affect SOD at all sites include current velocity, proximity to effluent and other sources of organic material, and organic content of the substrate. The latter was not measured since substrates were mainly pebble-cobble (Appendix C). SOD was positively related to velocity (Figure 9) although this factor also appeared to account for less than a third of the variance in SOD. Velocity influences the rate of oxygen consumption by affecting the mixing within the chambers and therefore the rate of replenishment of oxygen in the water-substrate interface. However, it did not seem to override the effect of location, because Knight had the lowest SOD but moderate velocity while Emerson Bridge had moderate SOD but low velocity (Tables 1 and 2). As well, substrate particle size (Appendix C) did not seem to be a major factor controlling SOD since, for example, the upstream Hinton, Knight, and upstream McLeod River locations had similar substrates but a wide range in SOD.

In January through March, 1994, SOD was measured by HBT Agra Ltd. (1994), under contract to AEP. They collected samples of epilithic 'biofilm' and of bottom sediment for subsequent analysis by AEP and by the NRBS (Appendix F). The data obtained for epilithic chlorophyll *a* do not show any relationship to SOD, although only a few sites were sampled (Figure c in Appendix F). Biofilm plus sediment were also collected from the cobbles at the sampling sites and analyzed for total organic carbon (TOC). There is some indication that the organic content of this material influenced SOD (Figure d in Appendix F), although the sample size was only 10. However, for SOD measurements made on sediment (sand, silt, clay), SOD was not related to TOC of the sediment (Figure e in Appendix F). Unlike 1995, SOD did not appear to be related to water velocity over the range of all sites (Figure f in Appendix F).

3.4 GENERAL DISCUSSION

Temporal change in SOD in the Athabasca River was first investigated by Casey (1990), who found that SOD increased during the January-March period in the open water downstream of the Millar Western pulp mill at Whitecourt, but did not change much under ice and snow cover upstream at Windfall. An increase through winter was again observed at the Whitecourt site in 1992 (Monenco

Figure 7. SOD vs chlorophyll - open water sites, 1994-95.

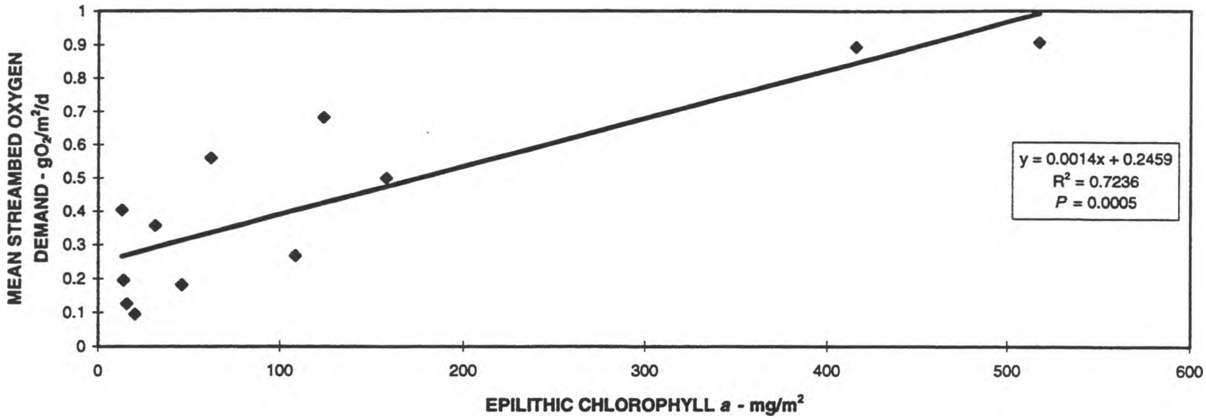


Figure 8. SOD vs chlorophyll - ice+snow cover sites, 1994-95.

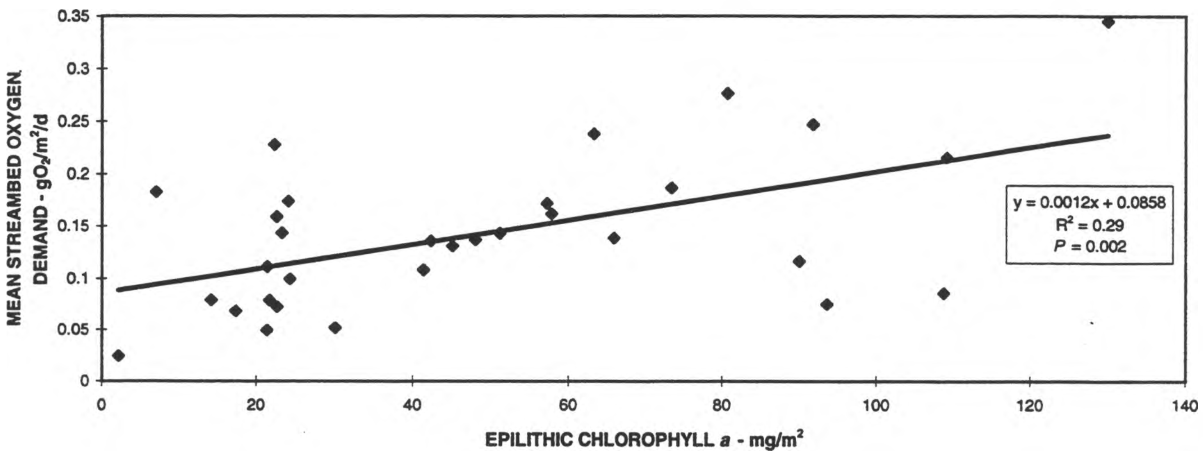
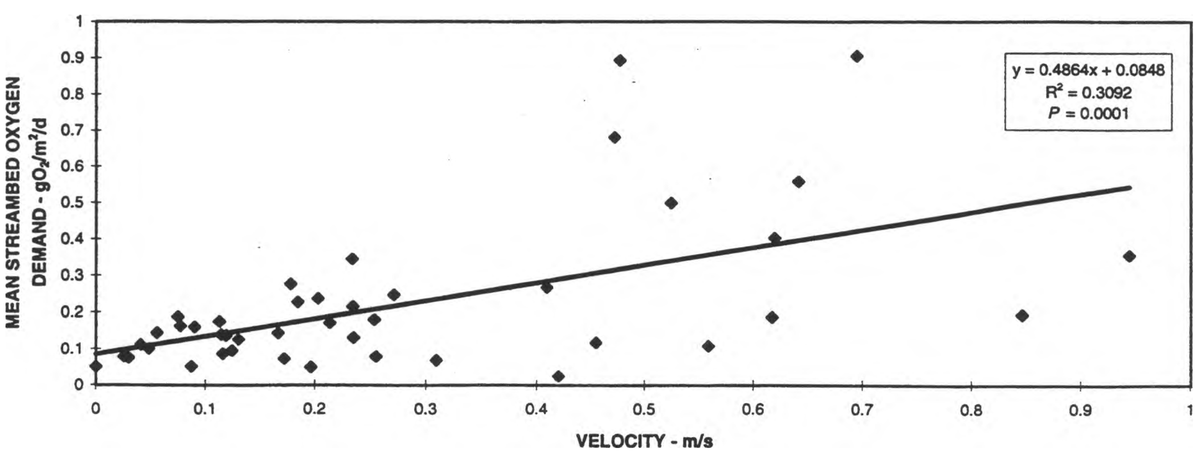


Figure 9. SOD vs velocity, all sites, 1994-95.



1992) and in 1994 (HBT Agra 1994). These increases were generally attributed to a combination of growth of algae during the lengthening days as winter progressed, and accumulation of settleable organic materials from the pulp mill effluents. In 1994, the ice-covered location at Ft. Assiniboine was sampled three times to see if this phenomenon extended that far downstream of Whitecourt. No increase through winter was observed there (HBT Agra 1994 and Appendix F). This survey's results from an ice-covered site immediately downstream (3-4 km downstream of McLeod R.) and one at Blue Ridge now strongly indicate that the winter increase in SOD only occurs at open-water sites. This was further supported by the findings from the Hinton area (Section 3.2). Therefore it appears that, at least in 1994 and 1995, the temporal increase in SOD during winter is probably not due to accumulation of settleable organic material from effluent, but to the growth of benthic algae during the increasing light of late winter.

As a corollary to this, the apparent SOD measured at open-water sites should be considered as gross benthic respiration, rather than net oxygen flux. If algae are growing and their biomass is increasing in these open-water areas, as the 1995 epilithic chlorophyll *a* data indicate, then the benthic community is probably a net producer of oxygen during the January-March period in such locations. Note that in the February-March period of 1993, snow cover was low to nil on much of the river, light penetration through the ice was high, and under-ice photosynthesis raised DO significantly during late winter (Noton and Allan 1994). This indicates that when light can penetrate, photosynthesis can exceed respiration during this time of year. However, it is not known whether production in open-water areas is significant to the overall oxygen balance of the river in a typical winter. The open-water reach downstream of Hinton fluctuates between about 5 and 15 km in length during winter while the one downstream of Whitecourt is about 2 km long. Open-water leads of 2-4 km also occur downstream of the Alberta Newsprint and Al Pac effluents. Short open leads averaging perhaps 100 m in length occur periodically in the river in winter, down to the vicinity of Vega Ferry.

The apparent SOD (gross benthic respiration) in open water areas is positively related to the benthic chlorophyll concentration (Section 3.3). However, strong relationships between SOD and other variables at ice-covered locations have not emerged, except that SOD is generally greater downstream of Hinton and Whitecourt than at sites immediately upstream of these locations. In 1994 and earlier, a quantitative relationship between SOD and epilithic chlorophyll *a* was not found. In the data presented in this report, some relationship between these two variables is apparent, perhaps as a result of a more intensive investigation and larger sample size. Similarly, no relationship between current velocity and SOD had been found in the past, but some relationship was apparent in this survey. It seems reasonable to expect that SOD would be at least partly related to the biomass of benthic algae (as measured by chlorophyll), and also the current velocity (e.g., Nakamura and Stefan 1994). Another variable that intuitively should be related to SOD is organic content of the sediment. However, no relationship has been observed in the data collected to date from the Athabasca River (sediment was not obtainable from the rocky substrates sampled in this survey). Other researchers have also noted that organic content is not necessarily well correlated to SOD (e.g., Rolley and Owens 1967; Edberg and Hofsten 1973).

In view of this lack of a strong relationship of SOD to other variables, and the relationship of apparent SOD in open-water areas to algal growth, it is appropriate to ask whether or not SOD really is influenced by effluent inputs. The answer is probably yes because measurements over several years have consistently found the lowest SOD rates at Knight and Windfall, upstream of the inputs at Whitecourt. As well, this survey found higher rates upstream of Knight at an ice-covered site closer to the Hinton effluent (Emerson Bridge). Also, rates at that location were higher than rates in an open-water site upstream of Hinton (Figure 3 and 4). The actual mechanism of action of effluents on SOD may be through general fertilization of the river, and effluent inputs will not be the only factor contributing to this. Organic and inorganic nutrient inputs from tributaries such as the McLeod, Pembina and Lesser Slave rivers may also be important in contributing to winter SOD. Further sampling under ice and snow cover upstream and downstream of Hinton where no major tributaries occur would help to clarify this question, as would sampling upstream and downstream of major tributaries.

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APPENDIX A. Terms of Reference.

NORTHERN RIVER BASINS STUDY

SCHEDULE A - TERMS OF REFERENCE

2222-D1: Mapping Riverbed SOD in Fall and Winter 1994-95, Athabasca River

I. BACKGROUND & OBJECTIVES

The pulp and paper industry is expanding rapidly in Alberta's northern river systems. In the Athabasca River basin, a new pulp mill recently began production and others are undergoing expansion. NRBS is currently modelling the oxygen balance of the Athabasca River to assess the potential impact of expanding pulp mill development on water quality, and to set appropriate effluent standards for the mills. Sediment oxygen demand (SOD), the rate of consumption of dissolved oxygen from the water column by the substratum in aquatic systems, is an important variable in the oxygen balance of river systems. Several chemical , biological and physical factors influence SOD. These include indigenous bacterial, algal and invertebrate communities, the nature of the sediment and the presence of chemical reducing agents (i.e., bacterial by-products such as sulphide) (Monenco Inc. 1993). The temperature and dissolved oxygen concentration in the water also affect SOD.

Sediment oxygen demand is considered to account for a significant fraction of the total oxygen demand in the Athabasca River during winter, when ice cover prevents or significantly reduces atmospheric aeration. Measurements of SOD have been made during most winters in the last five years, including an NRBS study on the Athabasca River in the winter of 1992 (2221-A1). Nonetheless, a number of questions concerning SOD remain unanswered, particularly in connection to oxygen modelling. Whereas some of the oxygen modelling questions have been partly addressed by previous SOD research, there remains a general need to obtain regular SOD data for the Athabasca River, particularly in relation to changing effluent loads and the impact of these nutrients on benthic production and, consequently, SOD. In July of this year, a number of these questions were identified at a joint NRBS-Alberta Forestry Products Association-Alberta Environmental Protection meeting dealing with nutrient-SOD-oxygen interactions.

This study is designed to address the questions and deficiencies raised at the July meeting, and has the following specific objectives:

1. To obtain a series of SOD measurements from upstream of Hinton, downstream to the Calling River area,
2. To investigate temporal change in SOD at key sites from fall through winter, both in ice-covered and ice-free areas, and
3. To further develop and assess the sediment core method.

II. GENERAL REQUIREMENTS

The field techniques used will be those developed for winter work in northern Alberta and used in previous surveys by Alberta Environmental Protection (AEP); i.e., stainless steel *in situ* chambers and sediment core respirometers. AEP will measure the *in situ* rate of dissolved oxygen depletion over time in specially designed chambers either containing substrate or placed directly on top of the substrate (Casey and Noton 1989, Casey 1990, Monenco 1993, HBT AGRA 1994). In the case of the sediment core method, SOD will be measured by enclosing an area of sediment in a plexiglass tube of known volume and measuring the change in dissolved oxygen over time (after McLeod and Gannon 1986). For both methods, a correction for oxygen demand by the water column will be determined by using a control chamber or core tube (i.e., with no substrate) and measuring the change in dissolved oxygen over the same time period. Differences between the test and control chambers will be expressed as estimates of SOD in grams O_2/m^2/day. For each site and time, AEP is required to take 3-5 replicate measurements.

Objective number 1 above will be addressed by sampling several sites along the river, as presented in Appendix 1. This will include a site upstream of Hinton, a location for which no previous data have been obtained. Objective number 2 (temporal change) will be addressed by sampling several sites on a 3 week or monthly interval from fall 1994 to March 1995 (Appendix 1). This method will be particularly useful in determining whether SOD 'accumulates' downstream of effluent discharges during the winter. The third objective will involve taking sediment core measurements paired with chamber measurements at two sites (perhaps downstream of Hinton and 3 km downstream of the mouth of the McLeod River), and subsequent lab experimentation to evaluate the effect that pumping velocity and other variables may have on SOD. In addition to these, sampling of a cross-channel transect will be attempted at one of the sites, likely using the sediment core method. This site will be determined in the field by local conditions. Selection of specific deployment sites at each study location will be governed by limitations of substrate, water depth, and velocity. **Substrates that appear representative of the general location are required.**

At every location where SOD is examined, the contractor will also measure the following associated variables:

- depth, current velocity, water temperature, dissolved oxygen
- a 'blank' SOD measurement (part of the method)
- substrate particle size description (texture - % boulder, cobble, gravel, sand, fines)
- epilithic chlorophyll *a* /m^2 (where cobbles or larger are sampled)
- sediment (including silt on rock surfaces) organic carbon

III. REPORTING REQUIREMENTS

The Project Manager is required to produce a technical report similar to the format presented for the 1992 winter survey (Monenco 1993) to facilitate inter-year comparisons of SOD data. The following information is to be included in the report:

The Materials and Methods section should include a detailed description of: (1) sampling equipment and field measurements for each SOD method employed, (2) methodologies for other pertinent environmental variables recorded, and (3) the calculation of SOD.

The Results and Discussion section should include a description of study site characteristics (both hydrological and substrate) and sediment oxygen demand rates. For both the closed chamber *in situ* method and sediment cores, SOD rates are to be presented as both mean values and ranges, using the coefficient of variation (CV) as a measure of the variability at the various sampling sites. Other requirements for this section include temporal changes in SOD rates, monthly longitudinal trend in SOD rate, and the influence of environmental variables on SOD.

The Conclusions section should include (1) discussion of spatial and temporal (cross-sectional and longitudinal) variability in SOD during the 1994/95 winter, and (2) comparison of year-to-year variability in SOD.

Appendices to the report should include (1) any new details of sampling equipment used for SOD measurements, (2) water velocities and water depths associated with individual SOD sample replicates, (3) laboratory data for the percentage of organic matter and epilithic chlorophyll *a* associated with sediments, and (4) SOD rates and DO concentration decreases for individual chambers and sediment cores at all sample locations.

1. The Project Manager is required to submit a brief progress report to the Component Coordinator by **March 31, 1995**, containing SOD data for the study period.

2. Ten copies of the Draft Report along with an electronic disk copy are to be submitted to the Component Coordinator by **May 30, 1995**.

3. Three weeks after the receipt of review comments on the draft report, the Project Manager is to provide the Component Coordinator with two unbound, camera ready copies and ten cerlox bound copies of the final report along with an electronic version.

4. The Project Manager is to provide draft and final reports in the style and format outlined in the NRBS document, "A Guide for the Preparation of Reports," which will be supplied upon execution of the contract.

The final report is to include the following: an acknowledgement section that indicates any local involvement in the project, Report Summary, Table of Contents, List of Tables, List of Figures and an Appendix with the Terms of Reference for this project. .

Text for the report should be set up in the following format:

a) Times Roman 12 point (Pro) or Times New Roman (WPWIN60) font.
b) Margins; are 1" at top and bottom, 7/8" on left and right.
c) Headings; in the report body are labelled with hierarchical decimal Arabic numbers.
d) Text; is presented with full justification; that is, the text aligns on both left and right margins.
e) Page numbers; are Arabic numerals for the body of the report, centred at the bottom of each page and bold.

- If photographs are to be included in the report text they should be high contrast black and white.
- All tables and figures in the report should be clearly reproducible by a black and white photocopier.
- Along with copies of the final report, the Contractor is to supply an electronic version of the report in Word Perfect 5.1 or Word Perfect for Windows Version 6.0 format.
- Electronic copies of tables, figures and data appendices in the report are also to be submitted to the Project Liaison Officer along with the final report. These should be submitted in a spreadsheet (Quattro Pro preferred, but also Excel or Lotus) or database (dBase IV) format. Where appropriate, data in tables, figures and appendices should be geo-referenced.

5. All figures and maps are to be delivered in both hard copy (paper) and digital formats. Acceptable formats include: DXF, uncompressed E⌀⌀, VEC/VEH, Atlas and ISIF. All digital maps must be properly geo-referenced.

6. All sampling locations presented in report and electronic format should be geo-referenced. This is to include decimal latitudes and longitudes (to six decimal places) and UTM coordinates. The first field for decimal latitudes / longitudes should be latitudes (10 spaces wide). The second field should be longitude (11 spaces wide).

7. A presentation package of 35 mm slides is to comprise of one original and four duplicates of each slide.

IV. DELIVERABLES

1. A technical project report presenting and discussing the fall-winter SOD rates in the Athabasca River.

2. Ten to twenty-five 35 mm slides that can be used at public meetings to summarize the project, methods and key findings.

V. CONTRACT ADMINISTRATION

This project has been proposed by the Nutrients Component of the NRBS (Component Leader - Dr. Patricia Chambers, National Hydrology Research Institute, Saskatoon).

The Project Manager is:

Mr. Leigh Noton Biologist Surface Water Assessment Branch Alberta Environmental Protection 6^{th} Floor, Oxbridge Place		
9820 - 106 Street	Phone:	427-6277
Edmonton, Alberta T5K 2J6	Fax:	422-6712

Questions of a technical nature should be directed to him. Technical questions could also be directed to the Scientific Authority for this project, Dr. Patricia Chambers, at the following address:

Environmental Research National Hydrology Research Institute		
11 Innovation Boulevard	Phone:	(306) 975-5592
Saskatoon, Saskatchewan S7N 3H5	Fax:	(306) 975-5143

The Component Coordinator for this project is:

Richard Chabaylo Northern River Basins Study 690 Standard Life Centre		
10405 Jasper Avenue	Phone:	427-1742
Edmonton, Alberta T5J 3N4	Fax:	422-3055

Questions of an administrative nature should be directed to him.

VI. LITERATURE CITED

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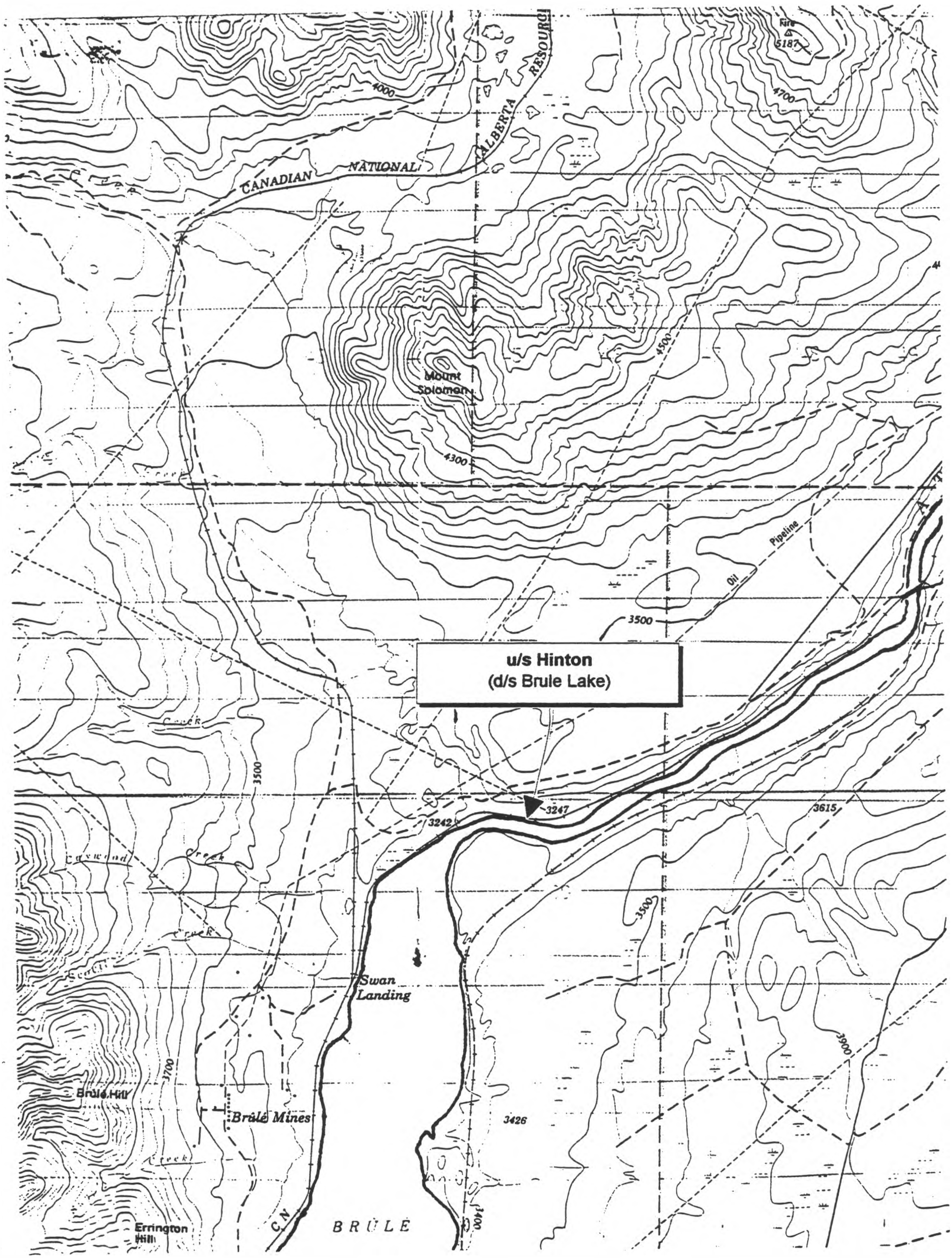
Appendix 1. Sampling sites, methodology and timing of SOD measurements in the fall and winter 1994-95, Athabasca River.

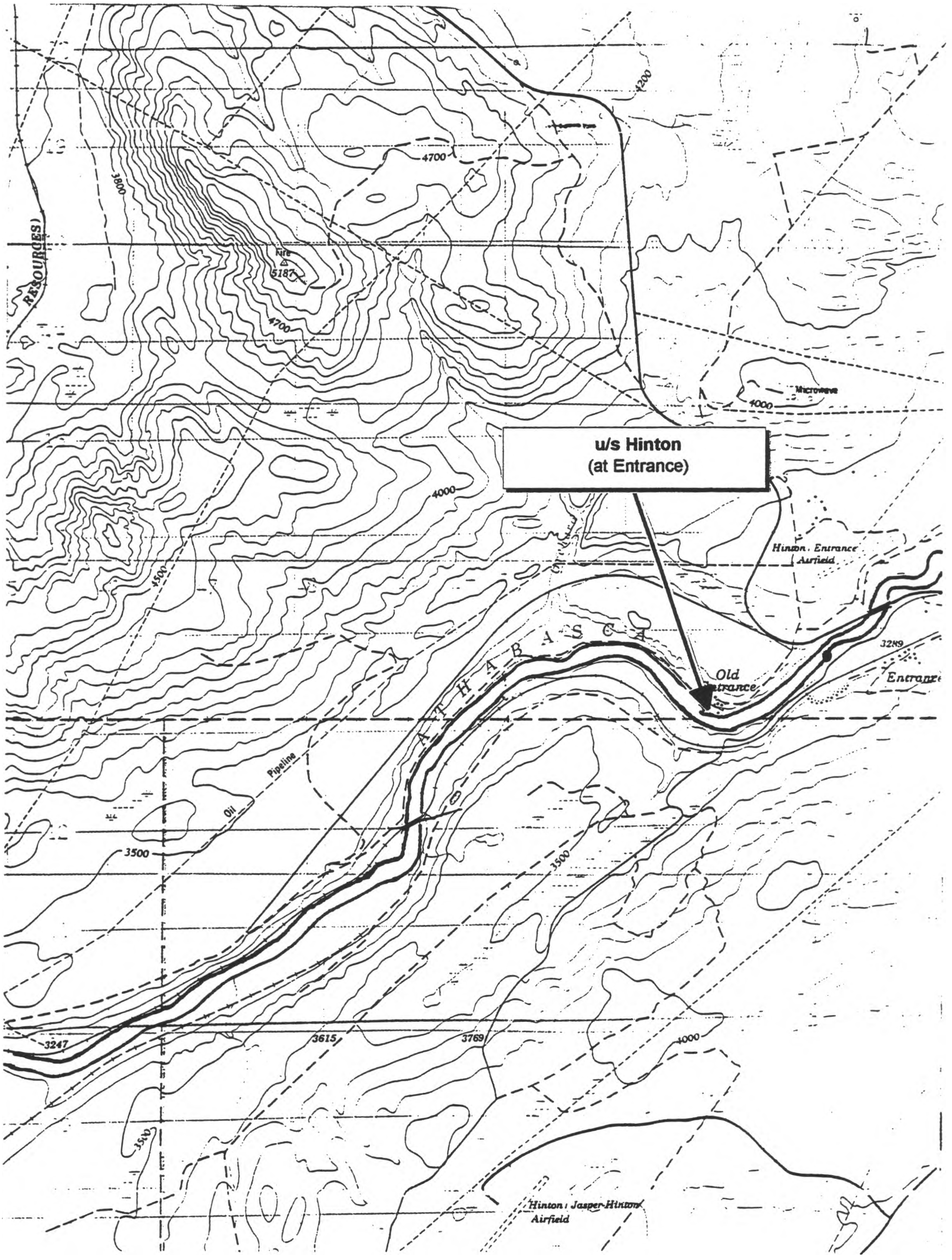
Location	Method	Starting Date	Interval or Time
u/s of Hinton	CC	October	O,D,J,F
d/s of Hinton (ice-free)	CC	October	3 week
Obed area	CC		O,D,J,F
Windfall	CC		O,D,J,F
u/s of McLeod River confluence	CC		O,D,J,F,M
d/s of McLeod River at Millar Western Pulp (ice-free)	CC	October	3 week
3 km d/s of McLeod River confluence	SC		O,D,J,F
	CC	October	3 week
Blue Ridge area	CC		O,D,J,F
Ft. Assiniboine area	CC		O,D,J,F
Chisholm			once only; J-M
u/s Smith	CC		J.F.M
Athabasca			J,F,M
LaBiche-Calling R. area	TBD		J,F,M

Note: **CC** - closed chamber; **SC** - sediment core; **TBD** - to be determined in the field.
Cross-channel transect at one of the sites will also be determined in the field.

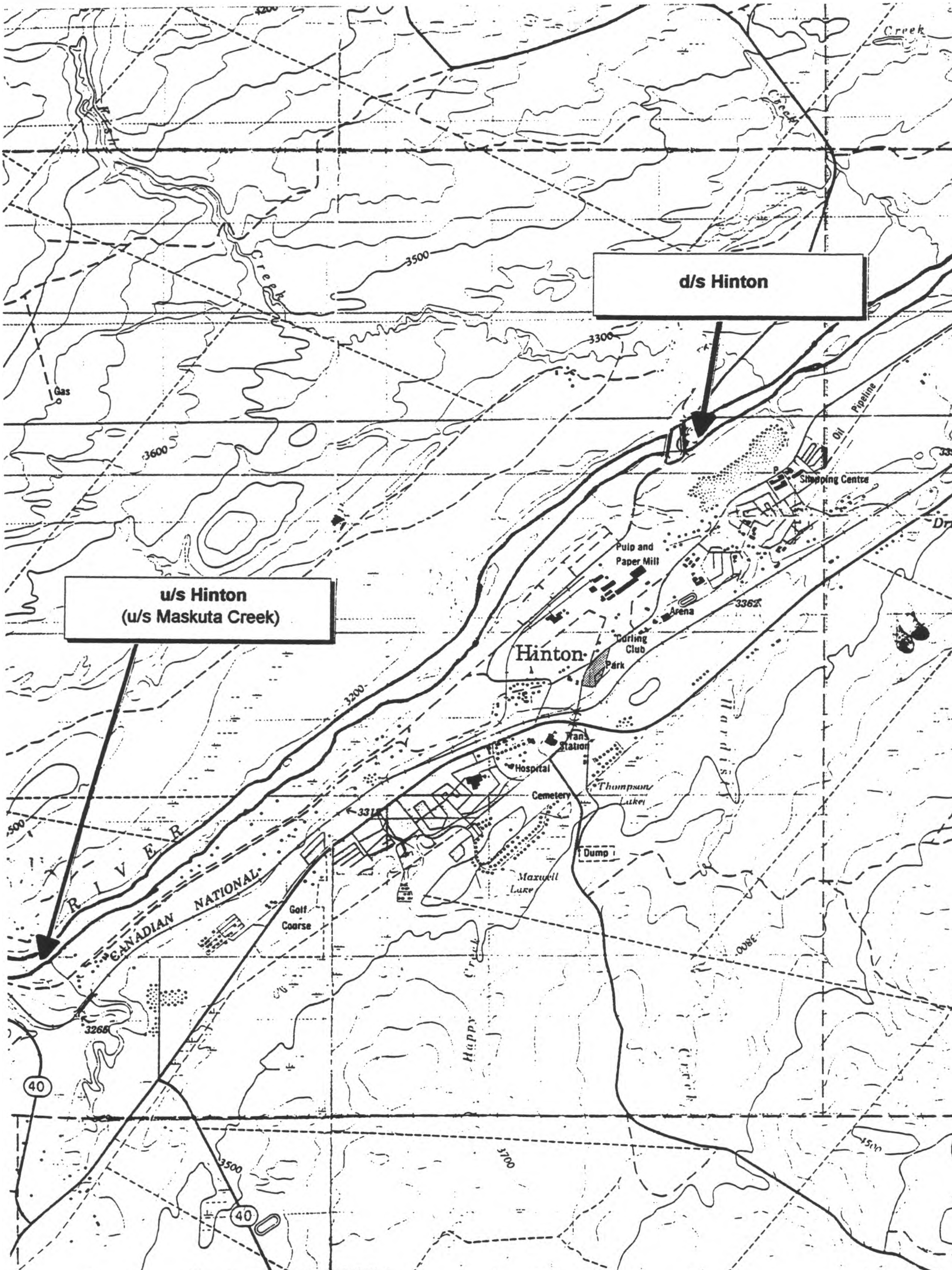
APPENDIX B. Detailed site maps.
Scale approximately 1:50,000



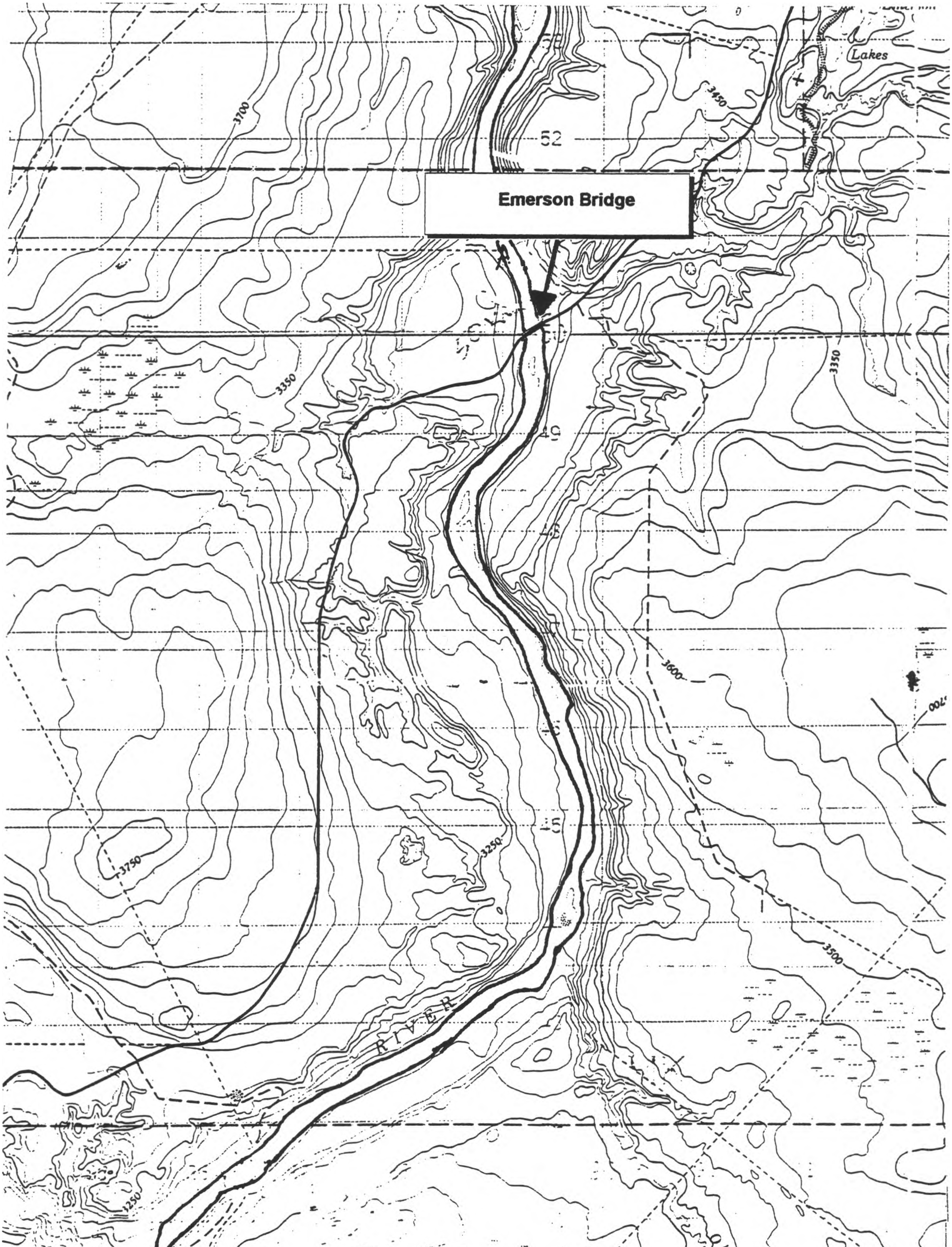
u/s Hinton
(d/s Brule Lake)
CANADIAN NATIONAL
ALBERTA RESOURC
Mount Solomon
Oil Pipeline
Swan Landing
Brûlé Hill
Brûlé Mines
Errington Hill
BRÛLE
CN
Creek
4000
4700
5187
4500
4300
3500
3247
3242
3615
3700
3900
3426

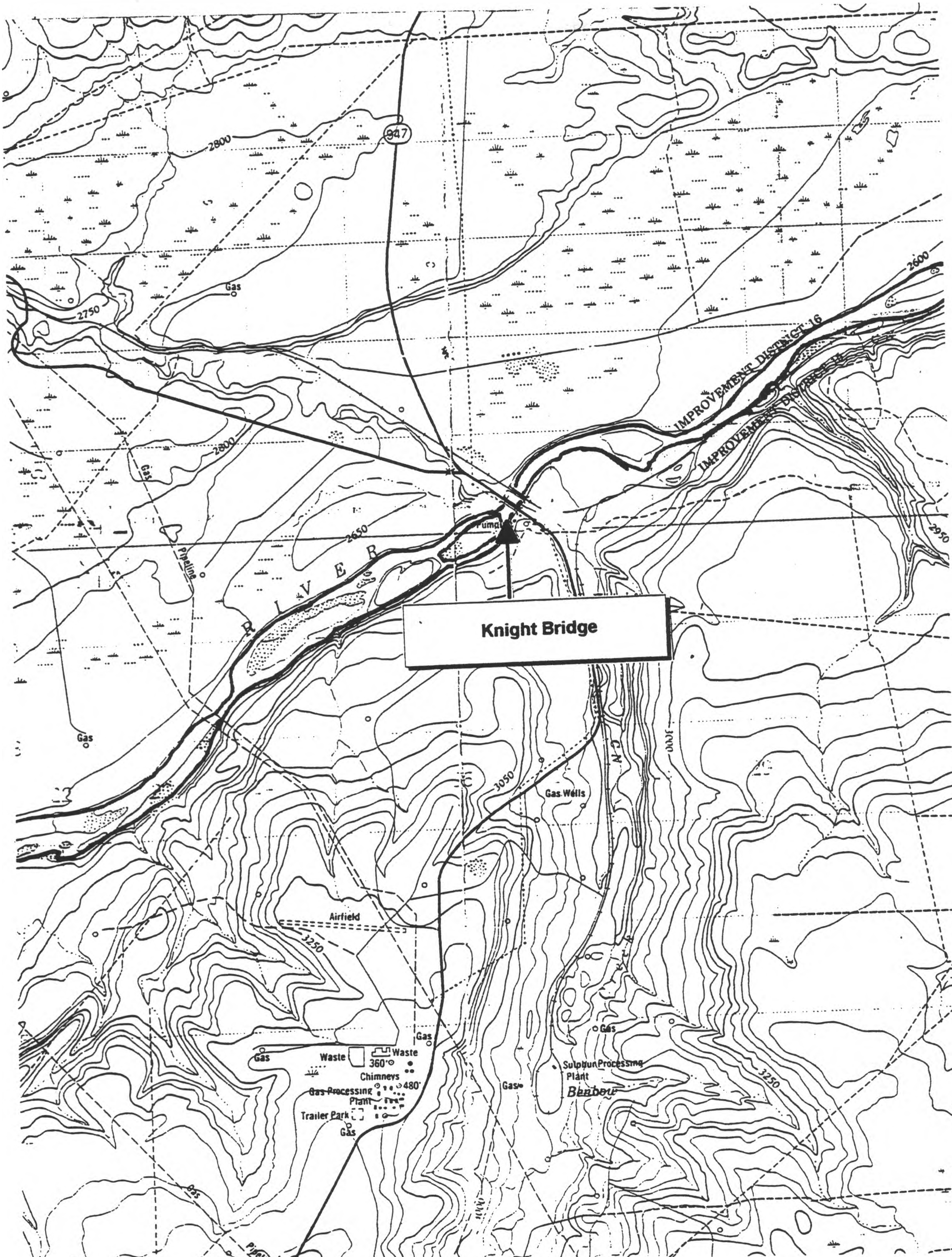


u/s Hinton
(at Entrance)
Old
Entrance
Hinton, Entrance
Airfield
Microwave
ATHABASCA
Oil
Pipeline
RESOURCES)
Fire
5187
4700
4200
4000
3800
4500
3500
3247
3615
3769
3289
Entrance
Hinton : Jasper-Hinton
Airfield

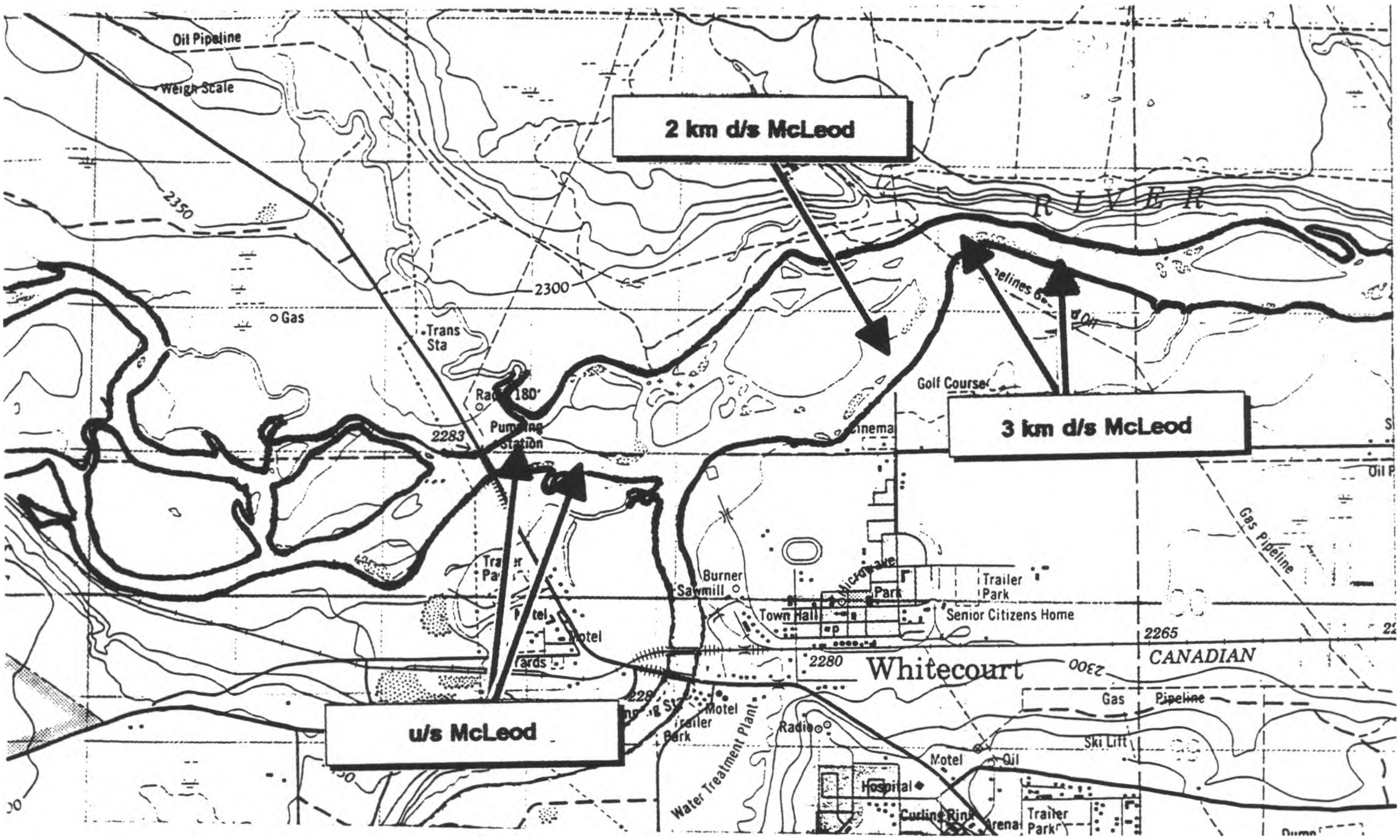


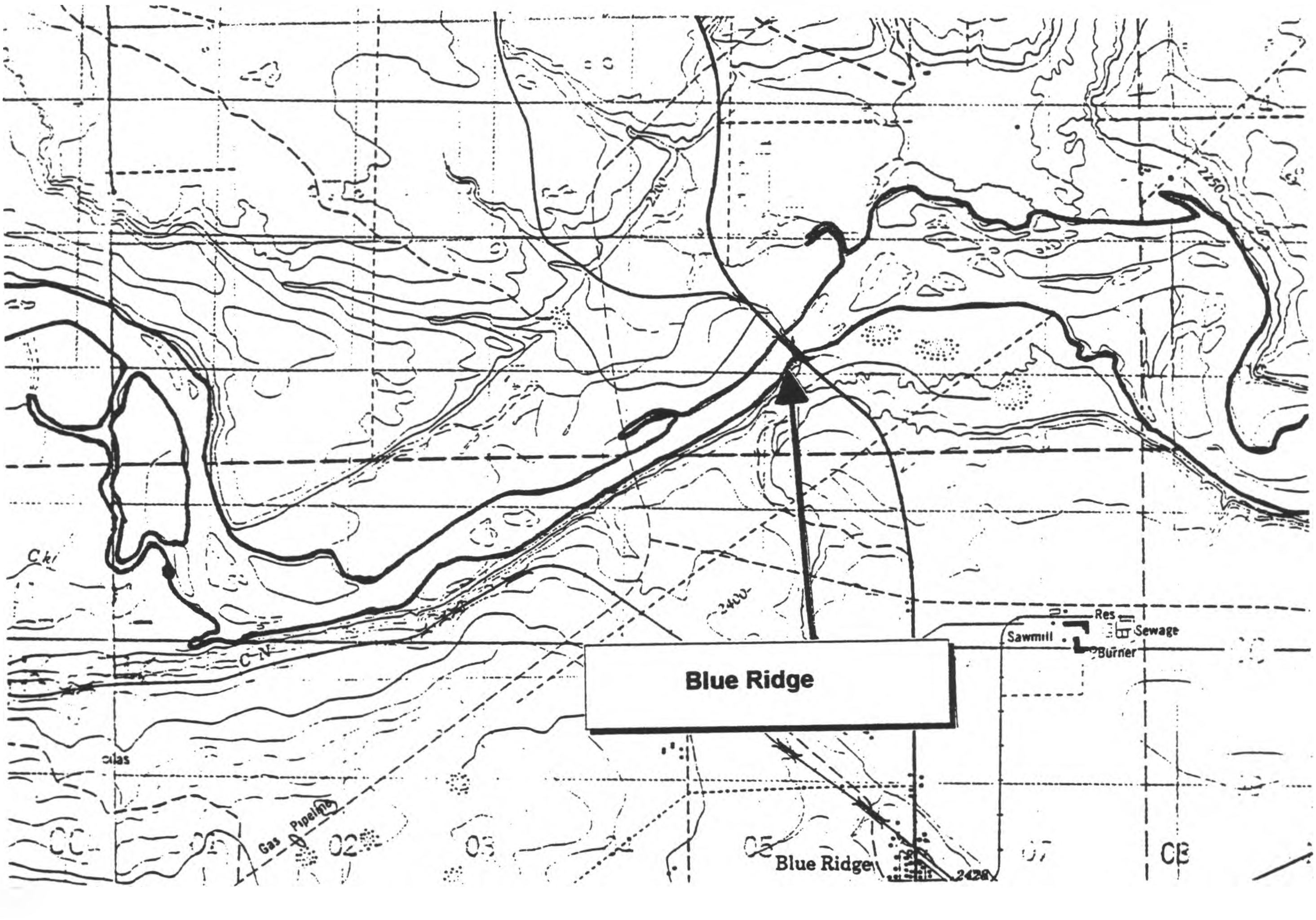
d/s Hinton
u/s Hinton
(u/s Maskuta Creek)
Hinton
Pulp and Paper Mill
Shopping Centre
Oil Pipeline
Arena
Curling Club
Park
Trans Station
Hospital
Cemetery
Thompson Lake
Dump
Maxwell Lake
Golf Course
CANADIAN NATIONAL
RIVER
Happy Creek
Hardisty Creek
Creek
Gas
3500
3300
3600
3200
3700
3800
3362
3318
3268
40

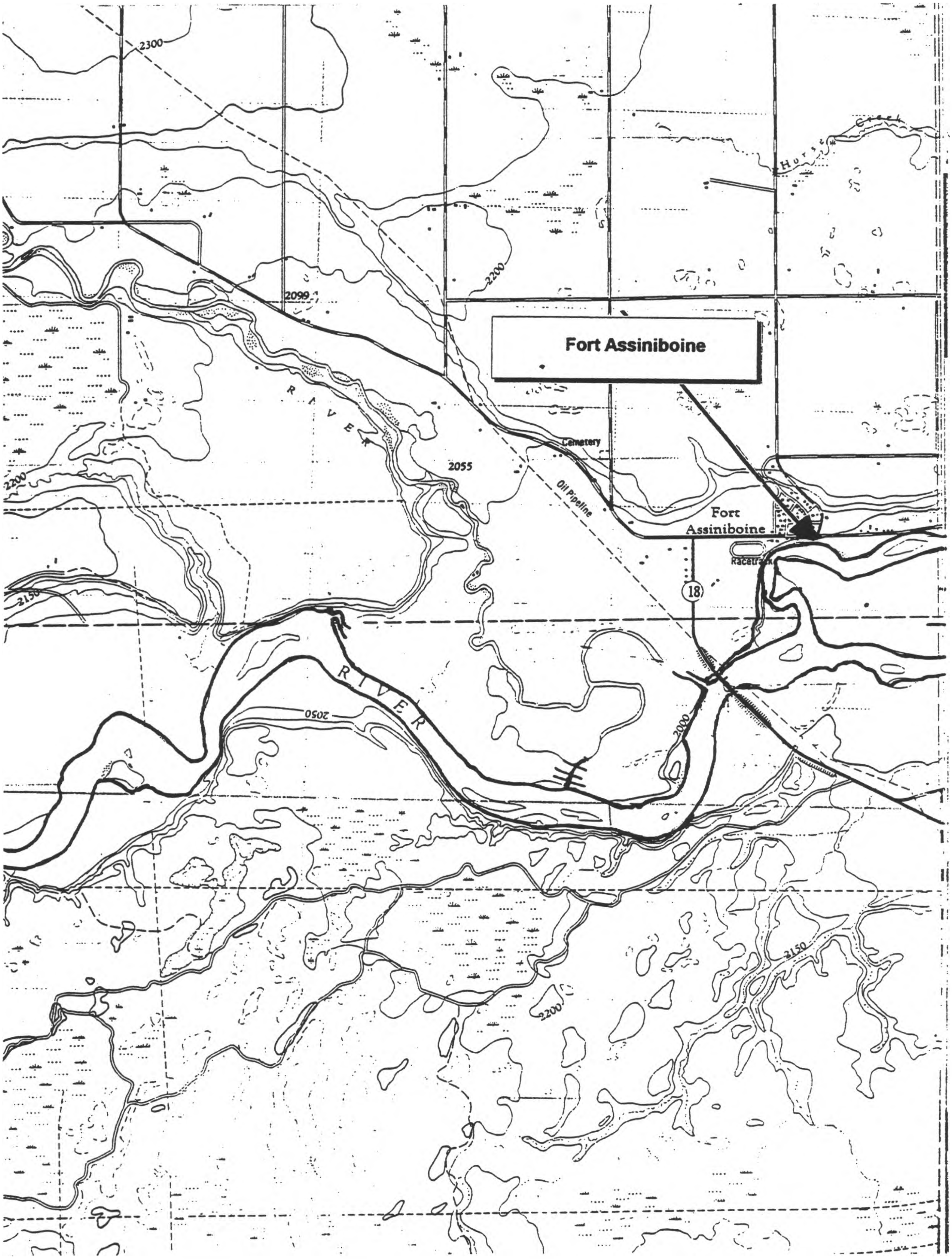

Emerson Bridge
Lakes
3700
3450
52
3350
3350
49
3600
45
3750
3250
3500
RIVER
3250

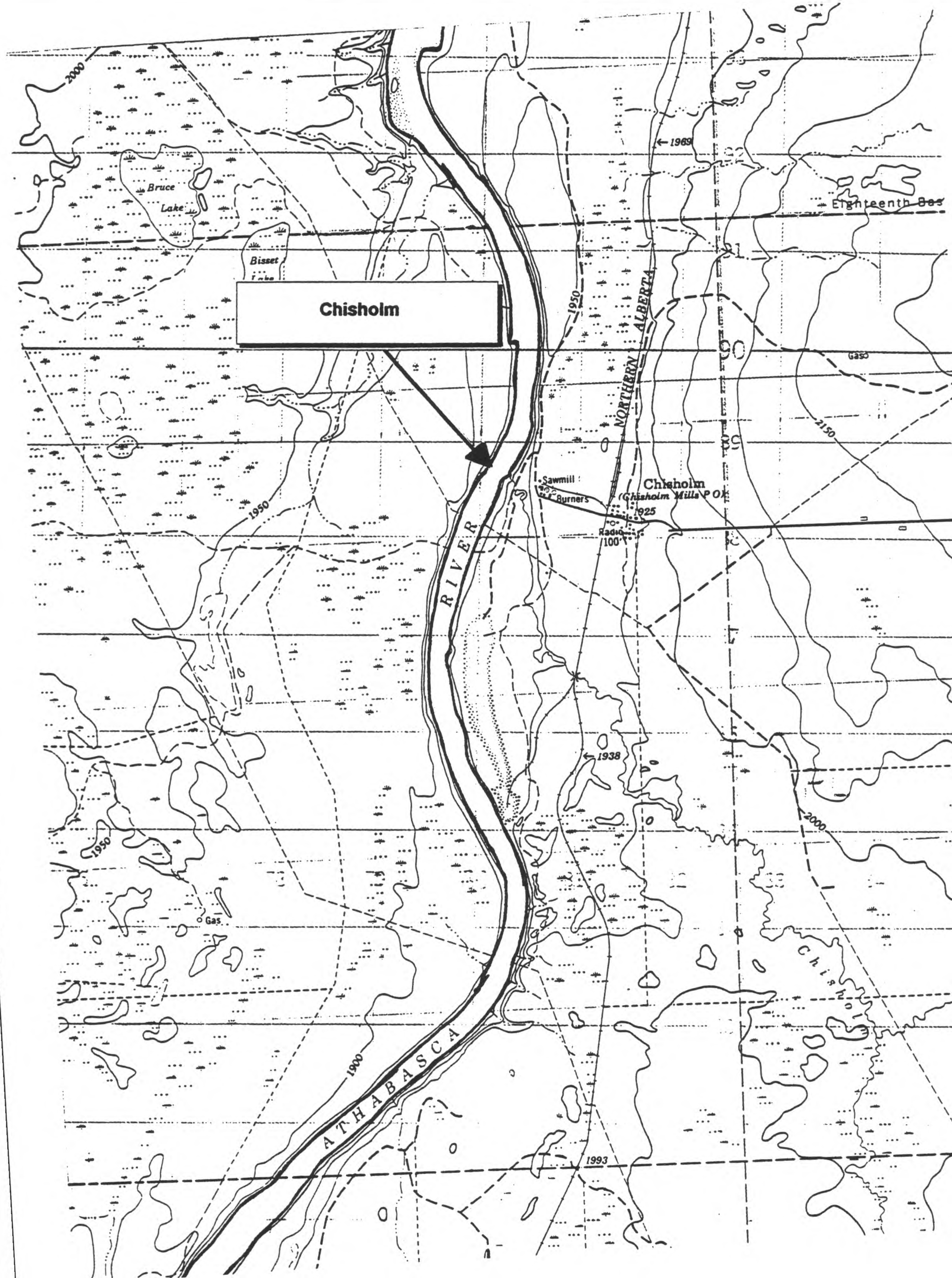


Knight Bridge
847
2800
2750
Gas
IMPROVEMENT DISTRICT 16
IMPROVEMENT DISTRICT 14
2600
2650
2950
Pump
RIVER
Pipeline
Gas Wells
CN
3050
3000
Airfield
3250
Waste
360
Chimneys
480
Gas Processing Plant
Trailer Park
Sulphur Processing Plant
Benbow

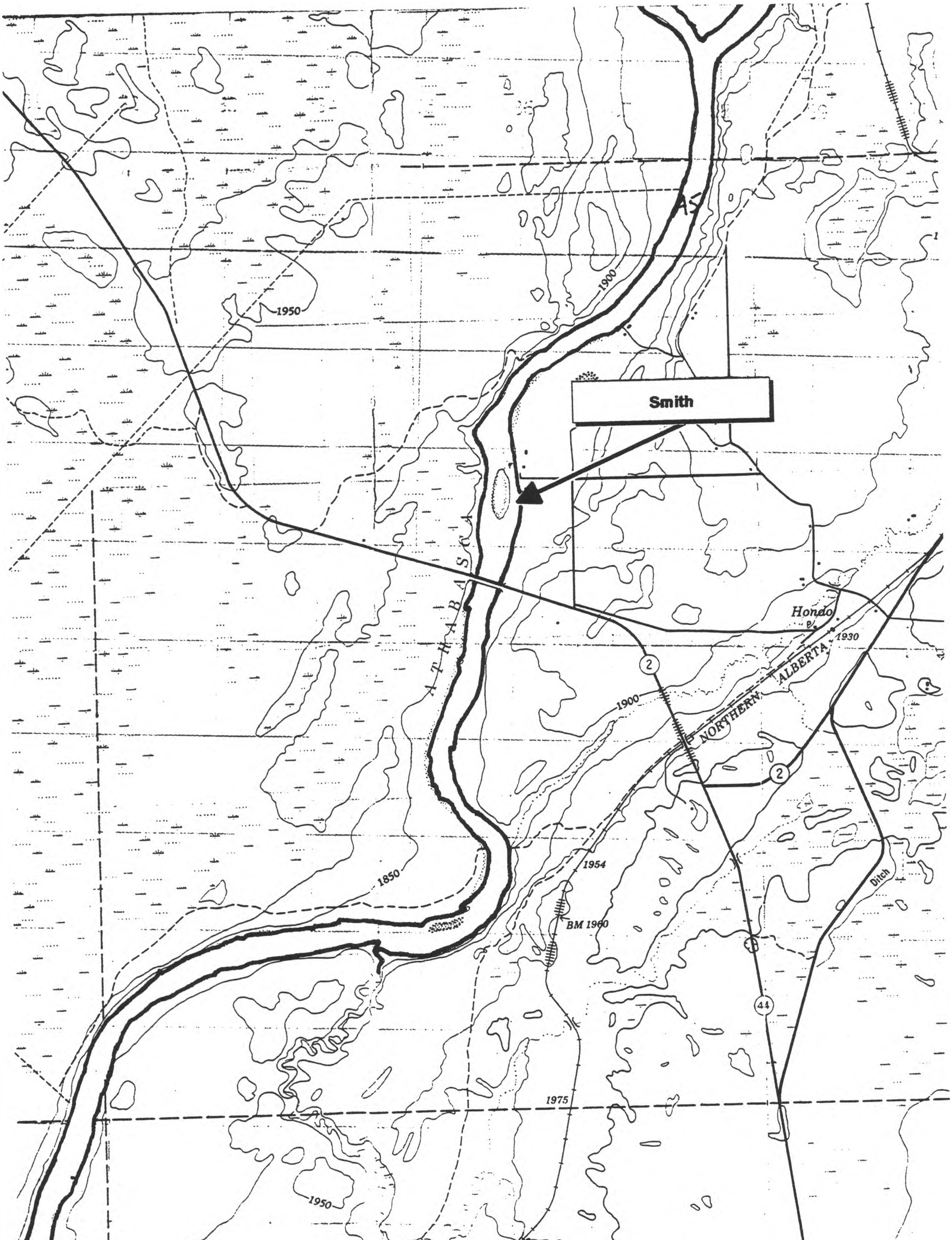

2 km d/s McLeod
3 km d/s McLeod
u/s McLeod
Oil Pipeline
Weigh Scale
RIVER
Gas
Trans Sta
Radio
Pumping Station
Golf Course
Cinema
Trailer Park
Motel
Burner
Sawmill
Town Hall
Senior Citizens Home
Whitecourt
CANADIAN
Gas Pipeline
Water Treatment Plant
Hospital
Curling Rink
Arena
Ski Lift
Dump

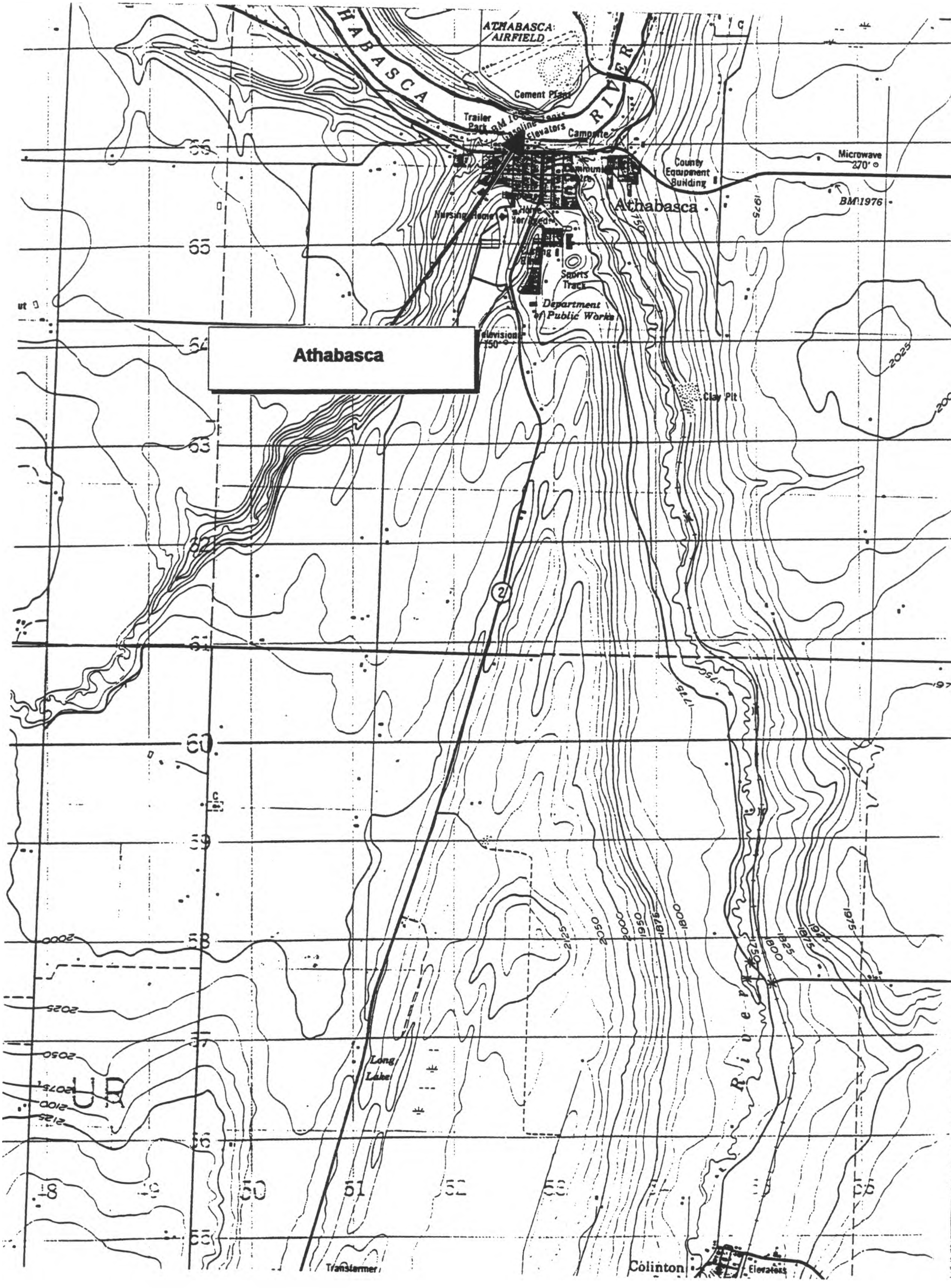

Blue Ridge
Res
Sawmill
Sewage
Burner
CN
Gas Pipeline
Blue Ridge

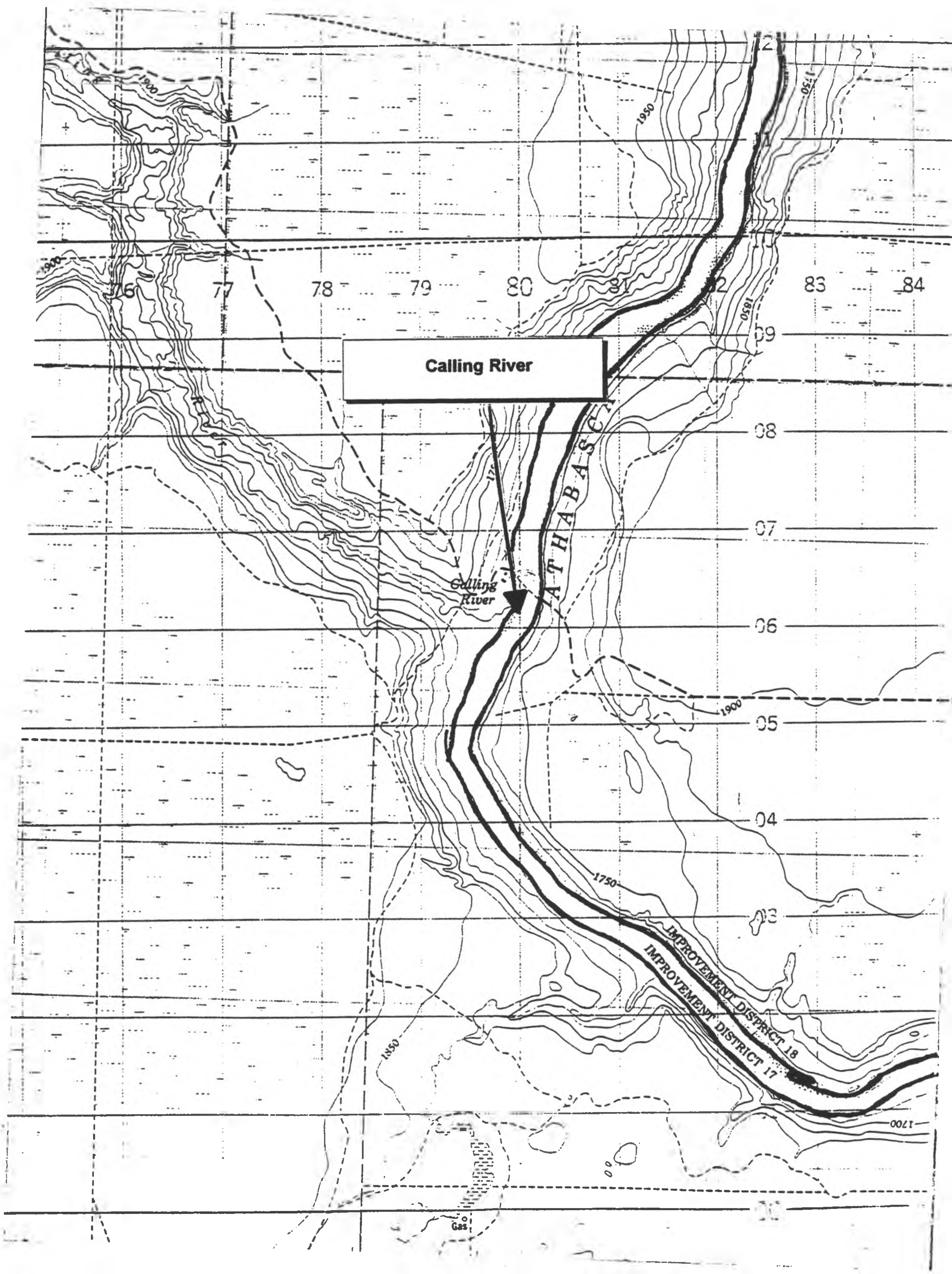

Fort Assiniboine
2300
Horse Creek
2200
2099
RIVER
2055
Cemetery
Oil Pipeline
Fort
Assiniboine
Racetrack
18
2150
RIVER
2050
2000
2150
2200



Chisholm
Bruce
Lake
Bisset
Eighteenth Bas
NORTHERN ALBERTA
Sawmill
Burners
Chisholm
(Chisholm Mills P O)
1925
Radio
100'
RIVER
ATHABASCA
Gas
Gaso
2000
1969
1950
2150
1938
1900
1993
Chisholm


AS
1900
1950
Smith
ATHABASCA
Hondo
1930
NORTHERN ALBERTA
2
1900
2
1954
1850
BM 1960
Ditch
44
1975
1950


ATHABASCA AIRFIELD
ATHABASCA RIVER
Cement Plant
Trailer Park
Elevators
Campsite
County Equipment Building
Microwave
270'
BM1976
Athabasca
Nursing Home
Home for Aged
Sports Track
Department of Public Works
Television
750'
Athabasca
Clay Pit
2
Long Lake
River
Colinton
Elevators
Transformer


Calling River
Calling River
ATHABASCA
IMPROVEMENT DISTRICT 18
IMPROVEMENT DISTRICT 17
76
77
78
79
80
81
82
83
84
09
08
07
06
05
04
1900
1950
1850
1750
1700
Gas

APPENDIX C. SUBSTRATE DESCRIPTIONS FOR SOD SAMPLING SITES, 1994-95.

		VISUALLY ESTIMATED % SUBSTRATE COMPOSITION				
LOCATION	DATE	SILT	SAND	PEBBLE	COBBLE	BOULDER
		< 2 mm	2-8 mm	8-64 mm	64-256 mm	> 256 mm
u/s Hinton						
at Entrance	Dec 6-7	20	5	10	45	20
d/s Brule Lk (ice free)	Feb 1-2			20	20	60
d/s Brule Lk.(ice free)	Feb 21-22	20			30	50
u/s Maskuta Ck.	Feb 22-23	10	30	10	20	30
d/s Hinton	Nov 3-4	10	10	40	40	
(all ice free)	Dec 5-6	5	15	75	5	
	Jan 4-5	10	20	70		
	Feb 1-2		25	65	10	
	Feb 22-23			mainly pebble/small cobble		
Emerson Bridge	Dec 6-7			10	90	
	Jan 4-5	10	5	10	75	
Knight	Dec 12-13	10	5	20	50	15
	Jan 10-11	5		25	20	50
	Feb 2-3		10	10	40	40
u/s McLeod River						
LB, d/s Hwy.43 at pumphouse	Dec 12-13	5	10	15	60	10
LB, u/s Sakwatamau R.	Jan 19-20			15	25	60
LB, u/s Sakwatamau R.	Feb 6-7		5	10	55	30
RB, d/s Sakwatamau R.	Mar 7-9		5	35	60	
2 km d/s McLeod River	Oct 25-26	<2	<5	50	40	
(ice covered)	Dec 14-15		10	20	70	
(ice free)	Jan 10-11	10		30	60	
(ice free)	Feb 7-8		10	40	50	
(ice free)	Mar 9-10	5	5	30	60	
3-4 km d/s McLeod River	Oct 20-21			mainly cobble and pebble		
	Nov 30-Dec 1	<5	30	50	15	
	Jan 12-13	5	25	30	40	
	Feb 7-8	5	15	25	50	5
	Mar 7-9	10	20	40	30	
Blue Ridge	Oct 26-27			predominantly cobble/pebble		
	Dec 20-21	5	5	10	70	10
	**Jan 17-19	5	5	25	50	15
	Feb 8-9		5	20	65	10
Fort Assiniboine	Dec 19-20	5	5	20	65	5
	Jan 17-18	10	5	15	50	20
	Feb 9-10	20		10	30	40
Chisholm	Mar 14-15		20	10	70	
Smith	Jan 23-24		10	20	70	
	Feb 14-15		10	30	60	
	Mar 14-15		5	30	50	15
Athabasca	Jan 24-25		30	30	40	
	Feb15-16	10	40	15	30	5
	Mar 16-17		20	20	40	20
Calling River	Jan 30-31	25	10	40	25	
	Feb 16-17	10	40	30	20	
	Mar 15-16	10	20	40	30	

APPENDIX D. Detailed site data.

SITE: ATHABASCA U/S HINTON (at Entrance)
GPS: N 53 22' 00" W 117 43' 11"
DATES: Dec 6-7, 1994

Ambient DO (mg/L): 11.96

	Control				
Chamber #:	1	13	5	11	4
Install Date/Time:	12/6/94 9:55	12/6/94 9:50	12/6/94 9:45	12/6/94 9:55	12/6/94 10:05
Removal Date/Time:	12/7/94 9:20	12/7/94 9:10	12/7/94 9:10	12/7/94 9:05	12/7/94 9:15
Final DO (mg/L):	11.49	11.58	11.2	11.25	11.24
Depths (cm) 12 req'd:		15.8	15.7	13.5	11.5
		20	16.7	13.7	16
		22.5	17.2	14.5	16.9
		23.8	18.7	16.3	17
		22	19.6	16.5	17.7
		20	20.3	17	17.9
		22.8	20.7	16.9	16.9
		22.9	22.5	17.9	18.6
		18.2	16.5	19.7	18.8
		22.2	25	20.7	19.8
		21.2	20.2	20.9	20.7
		21.2	20.7	24.5	22
Run time (hrs):	23.42	23.33	23.42	23.17	23.17
DO change (mg/L):	0.47	0.38	0.76	0.71	0.72
DO change (mg/L/hr):	0.0201	0.0163	0.0325	0.0306	0.0311
Mean depth (m):		0.2105	0.1948	0.1768	0.1782
Volume (L):		19.68	18.22	16.53	16.66
SOD rate (g/m2/day):		-	0.058	0.045	0.047
Epi Chloro (mg/m2):		67.028	29.315	112.158	23.32

SITE: ATHABASCA U/S HINTON (d/s Brule Lake)
GPS: N 53 20' 28" W 117 49' 56"
DATES: Feb 1-2, 1995

Ambient DO (mg/L): 11.59

	Control				
Chamber #:	7	11	13	1	3
Install Date/Time:	2/1/95 11:10	2/1/95 11:00	2/1/95 11:00	2/1/95 11:05	2/1/95 11:05
Removal Date/Time:	2/2/95 8:50	2/2/95 8:30	2/2/95 8:30	2/2/95 8:45	2/2/95 8:40
Final DO (mg/L):	11.59	10.94	10.87	11.27	11.04
Depths (cm) 12 req'd:		13.5	10	15.5	15.5
		12.5	16.5	17	24.5
		12.5	13	17.5	14.5
		14	10	15	11.5
		17.5	17	16.5	17
		18.5	16.5	14.5	14.5
		10.5	18	17	14
		13.5	16.5	14.5	15.5
		13	18	14	14.5
		14.5	18.5	13.5	13.5
		18	15	18.5	17.5
		10.5	14.5	15	16.5
Run time (hrs):	21.67	21.50	21.50	21.67	21.58
DO change (mg/L):	0.00	0.65	0.72	0.32	0.55
DO change (mg/L/hr):	0.0000	0.0302	0.0335	0.0148	0.0255
Mean depth (m):		0.1404	0.1529	0.1571	0.1575
Volume (L):		13.13	14.30	14.69	14.73
SOD rate (g/m2/day):		0.102	0.123	0.056	0.096
Epi Chloro (mg/m2):		13.155	23.467	11.325	33.928

SITE: ATHABASCA U/S HINTON (d/s Brule Lake)
GPS: N 53 20' 28" W 117 49' 56"
DATES: Feb 21-22, 1995

Ambient DO (mg/L): 11.04

	Control				
Chamber #:	4	7	8	9	5
Install Date/Time:	2/21/95 14:10	2/21/95 14:00	2/21/95 14:05	2/21/95 14:00	2/21/95 14:05
Removal Date/Time:	2/22/95 12:45	2/22/95 12:35	2/22/95 12:40	2/22/95 12:30	2/22/95 12:35
Final DO (mg/L):	11.04	9.38	10.04	9.95	10.15
Depths (cm) 12 req'd		18	11	14.5	14
		12.5	17.5	14	12
		10.5	13.5	13.5	12.5
		12.5	15	17	19.5
		13.5	11.5	20	14.5
		13.5	12.5	13	11
		12	14.5	14.5	11.5
		17.5	11	14.5	13
		15.5	17.5	16.5	16.5
		15.5	22.5	16	12.5
		15.5	13.5	17	14.5
		18	16	13.5	13
Run time (hrs):	22.58	22.58	22.58	22.50	22.50
DO change (mg/L):	0.00	1.66	1.00	1.09	0.89
DO change (mg/L/hr):	0.0000	0.0735	0.0443	0.0484	0.0396
Mean depth (m):		0.1454	0.1467	0.1533	0.1371
Volume (L):		13.60	13.71	14.34	12.82
SOD rate (g/m2/day):		0.257	0.156	0.178	0.130
Epi Chloro (mg/m2):		12.438	43.32	54.497	74.138

SITE: ATHABASCA U/S HINTON (u/s Maskuta Ck.)
GPS: N 53 22' 50" W 117 39' 08"
DATES: Feb 22-23, 1995

Ambient DO (mg/L): 11.16

	Control				
Chamber #:	5	4	7	8	9
Install Date/Time:	2/22/95 15:20	2/22/95 15:10	2/22/95 15:10	2/22/95 15:15	2/22/95 15:15
Removal Date/Time:	2/23/95 12:30	2/23/95 12:25	2/23/95 12:20	2/23/95 12:10	2/23/95 12:15
Final DO (mg/L):	11.16	10.2	10.7	10.13	10.6
Depths (cm) 12 req'd		13.5	14	14.5	14.5
		14.5	17.5	15.5	16.5
		16.5	14	13.5	15
		11.5	17.5	13	17
		12.5	14	17.5	16
		13.5	17.5	12.5	13.5
		15	15.5	13	16
		15.5	13	15	16
		13.5	12	15	15
		13	14.5	17.5	15
		11.5	19.5	16	12
		12.5	17	15	14.5
Run time (hrs):	21.17	21.25	21.17	20.92	21.00
DO change (mg/L):	0.00	0.96	0.46	1.03	0.56
DO change (mg/L/hr):	0.0000	0.0452	0.0217	0.0492	0.0267
Mean depth (m):		0.1358	0.1550	0.1483	0.1508
Volume (L):		12.70	14.49	13.87	14.10
SOD rate (g/m2/day)		0.147	0.081	0.175	0.097
Epi Chloro (mg/m2):		9.284	9.537	23.645	21.314

SITE: ATHABASCA D/S HINTON
GPS: N 53 25' 77" W 117 33' 34"
DATES: Nov 3-4, 1994

Ambient DO (mg/L):	**12.37**				
	Control				
Chamber #:	12	9	1	7	9
Install Date/Time:	11/3/94 11:20	11/3/94 10:30	11/3/94 10:45	11/3/94 11:00	11/3/94 11:10
Removal Date/Time:	11/4/94 9:30	11/4/94 9:15	11/4/94 9:35	11/4/94 9:35	11/4/94 9:45
Final DO (mg/L):	**12.31**	**11.24**	**11.62**	**11.46**	**11.78**
Depths (cm) 12 req'd:		23.3	23.1	22	23
		22.5	24.8	22.9	23
		21.5	23.5	23.4	23.5
		22.2	23.1	23.6	23.4
		22.6	21.5	21.9	21.5
		22.4	23.1	21.3	21.4
		20.9	22.3	23.2	23.2
		22.3	21.4	20.7	22.8
		22.3	23.8	21.9	22
		21.6	23.5	21.4	23
		21.7	23.4	24.1	22.2
		21.3	22.8	23.7	23
Run time (hrs):	22.17	22.75	22.83	22.58	22.58
DO change (mg/L):	0.06	1.13	0.75	0.91	0.59
DO change (mg/L/hr):	0.0027	0.0497	0.0328	0.0403	0.0261
Mean depth (m):		0.2205	0.2303	0.2251	0.2267
Volume (L):		20.62	21.53	21.05	21.19
SOD rate (g/m2/day):		**0.249**	**0.167**	**0.203**	**0.127**
Epi Chloro (mg/m2):		n/a	n/a	n/a	n/a

SITE: ATHABASCA D/S HINTON
GPS: N 53 25' 77" W 117 33' 34"
DATES: Dec 5-6, 1994

Ambient DO (mg/L):	**12.44**			
	Control			
Chamber #:	7	12	3	9
Install Date/Time:	12/5/94 11:55	12/5/94 11:30	12/5/94 11:35	12/5/94 11:50
Removal Date/Time:	12/6/94 13:00	12/6/94 12:55	12/6/94 12:50	12/6/94 12:45
Final DO (mg/L):	**12.21**	**11.08**	**11.44**	**11.38**
Depths (cm) 12 req'd:		23	21.5	22.2
		23	22.2	23.2
		22.5	22.8	21.5
		23.6	20.3	23
		22.8	22.3	22.8
		23.8	21.7	23.2
		22	21.8	22.2
		23.2	23.8	21
		22.5	22.9	21.6
		22.5	21	20.2
		23.5	20.8	22.2
		23.2	20.7	22.7
Run time (hrs):	25.08	25.42	25.25	24.92
DO change (mg/L):	0.23	1.36	1.00	1.06
DO change (mg/L/hr):	0.0092	0.0535	0.0396	0.0425
Mean depth (m):		0.2297	0.2182	0.2215
Volume (L):		21.47	20.40	20.71
SOD rate (g/m2/day):		**0.244**	**0.159**	**0.177**
Epi Chloro (mg/m2):		11.875	19.444	11.408

SITE: ATHABASCA D/S HINTON
GPS: N 53 25' 77" W 117 33' 34"
DATES: Jan 4-5, 1995

Ambient DO (mg/L):	**11.79**				
	Control				
Chamber #:	1	7	8	11	3
Install Date/Time:	1/4/95 12:45	1/4/95 12:20	1/4/95 12:30	1/4/95 12:15	1/4/95 12:35
Removal Date/Time:	1/5/95 13:00	1/5/95 12:50	1/5/95 12:45	1/5/95 12:30	1/5/95 12:35
Final DO (mg/L):	**11.55**	**8.58**	**10.06**	**9.28**	**9.49**
Depths (cm) 12 req'd:		13.8	17.1	20.5	16
		18.6	18.2	18.2	13.4
		16.1	18.8	17	16
		17.5	14	18.6	13.5
		18	19.7	15	14.6
		18.1	16.7	14.6	15.1
		17	16.3	16.4	15
		14.2	17.6	21	14.7
		13.8	19.5	13.3	15.2
		17	14.8	20.2	14.5
		16	17.6	17.3	16.9
		12.4	17.6	18.3	14
Run time (hrs):	24.25	24.50	24.25	24.25	24.00
DO change (mg/L):	0.24	3.21	1.73	2.51	2.30
DO change (mg/L/hr):	0.0099	0.1310	0.0713	0.1035	0.0958
Mean depth (m):		0.1604	0.1733	0.1753	0.1491
Volume (L):		15.00	16.20	16.39	13.94
SOD rate (g/m2/day):		**0.466**	**0.255**	**0.394**	**0.307**
Epi Chloro (mg/m2):		87.803	12.725	25.888	0.388

SITE: ATHABASCA D/S HINTON
GPS: N 53 25' 77" W 117 33' 34"
DATES: Feb 1-2, 1995

Ambient DO (mg/L):	**11.3**				
	Control				
Chamber #:	12	8	9	4	5
Install Date/Time:	2/1/95 13:05	2/1/95 12:45	2/1/95 12:45	2/1/95 12:45	2/1/95 12:45
Removal Date/Time:	2/2/95 10:40	2/2/95 10:35	2/2/95 10:35	2/2/95 10:25	2/2/95 10:30
Final DO (mg/L):	**11.24**	**8.24**	**7.5**	**7.49**	**5.96**
Depths (cm) 12 req'd:		11.5	11.5	11.5	13.5
		11.5	13.5	14.5	13
		11	11.5	10	12.5
		13.5	12.5	13.5	14
		12.5	11.5	12	12.5
		10.5	13	13.5	17
		10	14	16.5	14.5
		10	10.5	14.5	13
		14	15.5	14	11.5
		10	13.5	13	12
		12.5	13	12.5	15
		10	16	10.5	13
Run time (hrs):	21.58	21.83	21.83	21.67	21.75
DO change (mg/L):	0.06	3.06	3.80	3.81	5.34
DO change (mg/L/hr):	0.0028	0.1402	0.1740	0.1758	0.2455
Mean depth (m):		0.1142	0.1300	0.1300	0.1346
Volume (L):		10.67	12.16	12.16	12.58
SOD rate (g/m2/day):		**0.376**	**0.534**	**0.540**	**0.784**
Epi Chloro (mg/m2):		61.641	75.088	66.707	44.279

SITE: ATHABASCA D/S HINTON
GPS: N 53 25' 77" W 117 33' 34"
DATES: Feb 22-23, 1995

	Control				
Ambient DO (mg/L):	11.24				
Chamber #:	13	1	3	11	12
Install Date/Time:	2/22/95 9:25	2/22/95 9:15	2/22/95 9:15	2/22/95 9:20	2/22/95 9:20
Removal Date/Time:	2/23/95 9:35	2/23/95 9:10	2/23/95 9:30	2/23/95 9:20	2/23/95 9:15
Final DO (mg/L):	11.24	8	7.58	7.66	9.28
Depths (cm) 12 req'd:		11.5	11	14.5	12.5
		12	13.5	12.5	12
		12	11.5	13	14.5
		13.5	14	14.5	14.5
		11.5	14.5	14	13.5
		14	12.5	10.5	14.5
		14	13.5	13.5	13
		12.5	9.5	14	15.5
		13	14.5	10.5	13.5
		15	13.5	14	12.5
		13.5	15.5	13.5	11
		11.5	11.5	12.5	10
Run time (hrs):	24.17	23.92	24.25	24.00	23.92
DO change (mg/L):	0.00	3.24	3.66	3.58	1.96
DO change (mg/L/hr):	0.0000	0.1355	0.1509	0.1492	0.0820
Mean depth (m):		0.1283	0.1292	0.1308	0.1308
Volume (L):		12.00	12.08	12.23	12.23
SOD rate (g/m2/day):		0.417	0.468	0.468	0.257
Epi Chloro (mg/m2):		18.195	9.579	10.083	15.089

SITE: ATHABASCA AT EMERSON BRIDGE
GPS: N 53 42' 03" W 117 09' 44"
DATES: Jan 4-5, 1995

	Control				
Ambient DO (mg/L):	11.49				
Chamber #:	13	5	4	9	12
Install Date/Time:	1/4/95 16:20	1/4/95 16:00	1/4/95 16:05	1/4/95 16:10	1/4/95 16:15
Removal Date/Time:	1/5/95 15:15	1/5/95 15:10	1/5/95 15:00	1/5/95 14:55	1/5/95 14:45
Final DO (mg/L):	11.27	10.27	10.08	10.49	10.19
Depths (cm) 12 req'd:		15.6	9.8	16.7	12.5
		16.7	13.1	17.5	15.1
		16	16.5	18.2	15.2
		13	16.6	15.3	20.9
		16.7	12.3	19.8	20.5
		11.5	10.1	17.8	20.5
		17	14.4	18.9	10.5
		18.2	13.2	16.5	14.1
		13	14.4	17	13
		14.8	11.5	16.7	11.6
		13	17.2	13.7	19.3
		16.6	12.6	17.2	13.8
Run time (hrs):	22.92	23.17	22.92	22.75	22.50
DO change (mg/L):	0.22	1.22	1.41	1.00	1.30
DO change (mg/L/hr):	0.0096	0.0527	0.0615	0.0440	0.0578
Mean depth (m):		0.1518	0.1348	0.1711	0.1558
Volume (L):		14.19	12.60	16.00	14.57
SOD rate (g/m2/day):		0.157	0.168	0.141	0.180
Epi Chloro (mg/m2):		13.335	53.188	43.648	121.036

SITE: ATHABASCA AT EMERSON BRIDGE
GPS: N 53 42' 03" W 117 09' 44"
DATES: Dec 6-7, 1994

	Control			
Ambient DO (mg/L):	11.96			
Chamber #:	7	3	9	12
Install Date/Time:	12/6/94 16:15	12/6/94 15:55	12/6/94 16:05	12/6/94 16:10
Removal Date/Time:	12/7/94 14:40	12/7/94 14:15	12/7/94 14:25	12/7/94 14:35
Final DO (mg/L):	11.73	11.07	10.72	10.76
Depths (cm) 12 req'd:		20.2	18.7	16.8
		18.7	22.5	22
		17	21.2	21.8
		26.5	20	19.2
		22.8	15.5	20.4
		21.8	21.5	22.1
		18.5	23.2	20.2
		24.2	15.4	16.5
		20.5	17.5	15.6
		20.1	19.5	18.6
		19.1	19.7	21.2
		14.8	20.7	19
Run time (hrs):	22.42	22.33	22.33	22.42
DO change (mg/L):	0.23	0.89	1.24	1.20
DO change (mg/L/hr):	0.0103	0.0399	0.0555	0.0535
Mean depth (m):		0.2035	0.1962	0.1945
Volume (L):		19.03	18.34	18.19
SOD rate (g/m2/day):		0.145	0.213	0.202
Epi Chloro (mg/m2):		58.841	42.831	118.68

SITE: ATHABASCA AT KNIGHT BRIDGE
GPS: N 54 09' 04" W 116 35' 58"
DATES: Dec 12-13, 1994

	Control				
Ambient DO (mg/L):	11.92				
Chamber #:	13	11	12	4	7
Install Date/Time:	12/12/94 13:40	12/12/94 13:05	12/12/94 13:15	12/12/94 13:25	12/12/94 13:35
Removal Date/Time:	12/13/94 12:40	12/13/94 12:20	12/13/94 12:30	12/13/94 12:45	12/13/94 12:55
Final DO (mg/L):	11.78	11.72	11.62	11.6	11.66
Depths (cm) 12 req'd:		16.2	17.5	15	18.7
		15.7	13	17.8	20.5
		21	18.3	19	19.5
		22.2	17.9	24.5	16.7
		20	16.1	18.8	16.6
		20.4	18.9	26	26
		20.5	18.3	16.1	18.1
		19.1	18.8	16.5	20.4
		25.5	16.4	21.6	23.3
		19.4	13.3	13.3	15.6
		22.8	17.1	16.8	17.5
		18.5	14.2	18.8	15.5
Run time (hrs):	23.00	23.25	23.25	23.33	23.33
DO change (mg/L):	0.14	0.20	0.30	0.32	0.26
DO change (mg/L/hr):	0.0061	0.0086	0.0129	0.0137	0.0111
Mean depth (m):		0.2011	0.1665	0.1868	0.1903
Volume (L):		18.80	15.57	17.47	17.80
SOD rate (g/m2/day):		0.012	0.027	0.034	0.023
Epi Chloro (mg/m2):		0.224	6.425	1.029	1.155

SITE: ATHABASCA AT KNIGHT BRIDGE
GPS: N 54 09' 04" W 116 35' 58"
DATES: Jan 10-11, 1995

Ambient DO (mg/L):	**10.13**				
	Control				
Chamber #:	4	1	5	3	8
Install Date/Time:	1/10/95 12:55	1/10/95 12:35	1/10/95 12:40	1/10/95 12:45	1/10/95 12:50
Removal Date/Time:	1/11/95 13:35	1/11/95 13:30	1/11/95 13:15	1/11/95 13:25	1/11/95 13:05
Final DO (mg/L):	**10.13**	**9.7**	**9.55**	**9.42**	**9.44**
Depths (cm) 12 req'd:		12	13.5	13	11
		11.5	7	12.5	13.5
		13.5	10.5	11	9.5
		13	12	12.5	13.5
		14	10.5	13	16
		19	10.5	17.5	10.5
		12.5	9	12	10.5
		15.5	13.5	11.5	13
		16.5	10	10	10
		14.5	10	13.5	10
		17.5	11.5	16.5	10
		10.5	15.5	10.5	10.5
Run time (hrs):	24.67	24.92	24.58	24.67	24.25
DO change (mg/L):	0.00	0.43	0.58	0.71	0.69
DO change (mg/L/hr)	0.0000	0.0173	0.0236	0.0288	0.0285
Mean depth (m):		0.1417	0.1113	0.1279	0.1150
Volume (L):		13.25	10.40	11.96	10.75
SOD rate (g/m2/day):		**0.059**	**0.063**	**0.088**	**0.079**
Epi Chloro (mg/m2):		18.205	20.138	30.717	21.78

SITE: ATHABASCA U/S MCLEOD (d/s Hwy 43, at Pumphouse)
GPS: N 54 09' 06" W 115 42' 57"
DATES: Dec 12-13, 1994

Ambient DO (mg/L):	**11.88**				
	Control				
Chamber #:	3	9	5	8	1
Install Date/Time:	12/12/94 16:50	12/12/94 16:30	12/12/94 16:35	12/12/94 16:40	12/12/94 16:45
Removal Date/Time:	12/13/94 14:55	12/13/94 15:00	12/13/94 14:40	12/13/94 14:50	12/13/94 15:05
Final DO (mg/L):	**11.88**	**11.48**	**11.26**	**11.7**	**11.52**
Depths (cm) 12 req'd:		17.6	16.7	19.4	21.5
		17	19.2	25.2	19.6
		17.8	15.4	17.7	20.6
		15.8	15.1	20.7	18.2
		17.8	17.1	20.3	18.5
		20	14.5	15.6	16.8
		16.1	18.2	17.5	26.5
		13.4	19.2	18.2	26.5
		15.8	20.5	18.5	20.5
		20.6	15.2	17.1	19.3
		19.8	25	18	26.3
		18.3	18.3	16.1	21.6
Run time (hrs):	22.08	22.50	22.08	22.17	22.33
DO change (mg/L):	0.00	0.40	0.62	0.18	0.36
DO change (mg/L/hr):	0.0000	0.0178	0.0281	0.0081	0.0161
Mean depth (m):		0.1750	0.1787	0.1869	0.2133
Volume (L):		16.36	16.71	17.48	19.94
SOD rate (g/m2/day):		**0.075**	**0.120**	**0.036**	**0.082**
Epi Chloro (mg/m2):		31.793	15.45	9.69	30.065

SITE: ATHABASCA AT KNIGHT BRIDGE
GPS: N 54 09' 04" W 116 35' 58"
DATES: Feb 2-3, 1995

Ambient DO (mg/L):	**10.22**				
	Control				
Chamber #:	4	12	5	8	9
Install Date/Time:	2/2/95 15:05	2/2/95 14:45	2/2/95 14:50	2/2/95 14:55	2/2/95 15:00
Removal Date/Time:	2/3/95 12:15	2/3/95 12:05	2/3/95 12:00	2/3/95 12:15	2/3/95 12:10
Final DO (mg/L):	**10.22**	**9.98**	**10**	**9.74**	**9.86**
Depths (cm) 12 req'd:		11.5	14.5	9.5	12
		10.5	15.5	17	15.5
		10.5	15.5	17.5	14.5
		17.5	14.5	13	16
		15.5	14.5	14.5	14.5
		13	13	17	16
		12.5	17	11	11.5
		10.5	14.5	14.5	13
		11.5	14	9.5	11
		13	15.5	9	12.5
		11	13.5	9.5	18.5
		13.5	15	10.5	12.5
Run time (hrs):	21.17	21.33	21.17	21.33	21.17
DO change (mg/L):	0.00	0.24	0.22	0.48	0.36
DO change (mg/L/hr)	0.0000	0.0113	0.0104	0.0225	0.0170
Mean depth (m):		0.1254	0.1475	0.1271	0.1396
Volume (L):		11.73	13.79	11.88	13.05
SOD rate (g/m2/day):		**0.034**	**0.037**	**0.069**	**0.057**
Epi Chloro (mg/m2):		2.013	25.483	42.582	15.466

SITE: ATHABASCA U/S MCLEOD (u/s Sakwatamau R.)
GPS: N 54 09' 10" W 115 42' 45"
DATES: Jan 19-20, 1995

Ambient DO (mg/L):	**10.04**				
	Control				
Chamber #:	11	1	12	3	9
Install Date/Time:	1/19/95 14:30	1/19/95 14:10	1/19/95 14:15	1/19/95 14:20	1/19/95 14:25
Removal Date/Time:	1/20/95 11:30	1/20/95 11:25	1/20/95 11:20	1/20/95 11:15	1/20/95 11:10
Final DO (mg/L):	**10.04**	**9.26**	**9.4**	**9.09**	**9.36**
Depths (cm) 12 req'd:		11.5	16.5	14.5	13.5
		12.5	10	12	10.5
		16.5	10.5	11.5	15.5
		18.5	11	20.5	16
		13.5	10	14	16
		15.5	11	12	15
		14	16.5	13.5	14
		9	10	14	14.5
		17.5	11	11.5	13.5
		12	14.5	10	16.5
		12.5	16.5	13.5	10
		16.5	14.5	9.5	8.5
Run time (hrs):	21.00	21.25	21.08	20.92	20.75
DO change (mg/L):	0.00	0.78	0.64	0.95	0.68
DO change (mg/L/hr):	0.0000	0.0367	0.0304	0.0454	0.0328
Mean depth (m):		0.1413	0.1267	0.1304	0.1363
Volume (L):		13.21	11.84	12.19	12.74
SOD rate (g/m2/day):		**0.124**	**0.092**	**0.142**	**0.107**
Epi Chloro (mg/m2):		121.2	138.294	29.67	70.85

SITE: ATHABASCA U/S MCLEOD (u/s Sakwatamau R.)
GPS: N 54 09' 10" W 115 42' 45"
DATES: Feb 6-7, 1995

Ambient DO (mg/L):	10.9				
	Control				
Chamber #:	9	11	12	1	3
Install Date/Time:	2/6/95 15:20	2/6/95 15:00	2/6/95 15:05	2/6/95 15:10	2/6/95 15:15
Removal Date/Time:	2/7/95 13:40	2/7/95 13:35	2/7/95 13:25	2/7/95 13:30	2/7/95 13:30
Final DO (mg/L):	**10.5**	**10.33**	**9.78**	**9.71**	**9.88**
Depths (cm) 12 req'd:		14.5	13	13.5	15
		14.5	19	18	11.5
		16	13.5	16	11.5
		14.5	15.5	11	10
		11.5	14.5	16.5	12.5
		10.5	12	14.5	14.5
		10	15	12.5	14.5
		14	16.5	13.5	11.5
		14.5	14	14	13.5
		12.5	17.5	12.5	12
		12.5	15	16	11.5
		16	11	11	15.5
Run time (hrs):	22.33	22.58	22.33	22.33	22.25
DO change (mg/L):	0.40	0.57	1.12	1.19	1.02
DO change (mg/L/hr):	0.0179	0.0252	0.0501	0.0533	0.0458
Mean depth (m):		0.1342	0.1471	0.1408	0.1279
Volume (L):		12.54	13.75	13.17	11.96
SOD rate (g/m2/day):		**0.024**	**0.114**	**0.120**	**0.086**
Epi Chloro (mg/m2):		97.613	89.139	103.776	144.425

SITE: ATHABASCA 2 KM D/S McLEOD (Ice Free)
GPS: N 54 09' 42" W 115 40' 33"
DATES: Oct 25-26, 1994

Ambient DO (mg/L):	12.80				
	Control				
Chamber #:	13	3	1	4	10
Install Date/Time:	10/25/94 12:40	10/25/94 11:50	10/25/94 12:00	10/25/94 12:30	10/25/94 11:40
Removal Date/Time:	10/26/94 10:50	10/26/94 10:45	10/26/94 11:15	10/26/94 11:00	10/26/94 10:20
Final DO (mg/L):	**12.80**	**10.00**	**10.91**	**10.46**	**9.42**
Depths (cm) 12 req'd:		22.4	20.4	18	14.4
		16.5	19.3	17.1	15.1
		20	20	16	16
		20.4	21	16.4	20
		18	17.2	19.6	17.1
		19	19.8	17.6	16.6
		21.6	17.8	21.6	19.3
		20.7	20.4	12.8	19
		23.2	17.2	18	17.4
		13.7	17.1	17.1	15.7
		21.4	18	15.2	16.6
		21	17.7	21.1	16.7
Run time (hrs):	22.17	22.92	23.25	22.50	22.67
DO change (mg/L):	0.00	2.80	1.89	2.34	3.38
DO change (mg/L/hr):	0.0000	0.1222	0.0813	0.1040	0.1491
Mean depth (m):		0.1983	0.1883	0.1754	0.1699
Volume (L):		18.54	17.60	16.40	15.89
SOD rate (g/m2/day):		**0.581**	**0.367**	**0.438**	**0.608**
Epi Chloro (mg/m2):		151	201.6	51.1	227.4

SITE: ATHABASCA U/S MCLEOD (d/s Sakwatamau R.)
GPS: N 54 09' 06" W 115 42' 41"
DATES: Mar 8-9, 1995

Ambient DO (mg/L):	11.54				
	Control				
Chamber #:	11	4	7	1	13
Install Date/Time:	3/8/95 17:00	3/8/95 16:45	3/8/95 16:50	3/8/95 16:55	3/8/95 17:00
Removal Date/Time:	3/9/95 13:05	3/9/95 13:10	3/9/95 13:15	3/9/95 13:10	3/9/95 13:00
Final DO (mg/L):	**11.36**	**9.35**	**9.24**	**8.68**	**9.31**
Depths (cm) 12 req'd:		11.5	12.5	16.5	12.5
		11.5	17.5	16.5	11.5
		11	12.5	13.5	11.5
		16	16.5	15.5	12
		10.5	10.5	15.5	13.5
		15.5	13	14	10
		14.5	12	14.5	11
		14	13.5	12	13
		12	15	12.5	15.5
		12.5	10.5	14.5	13
		11.5	10	14.5	14
		12.5	12	10	13
Run time (hrs):	20.08	20.42	20.42	20.25	20.00
DO change (mg/L):	0.18	2.19	2.30	2.86	2.23
DO change (mg/L/hr):	0.0090	0.1073	0.1127	0.1412	0.1115
Mean depth (m):		0.1275	0.1296	0.1413	0.1254
Volume (L):		11.92	12.12	13.21	11.73
SOD rate (g/m2/day):		**0.301**	**0.322**	**0.448**	**0.309**
Epi Chloro (mg/m2):		146.45	111.1	92.528	170.115

SITE: ATHABASCA 2 KM D/S McLEOD (Ice Free)
GPS: N 54 09' 42" W 115 40' 33"
DATES: Dec 14-15, 1994

Ambient DO (mg/L):	8.53				
	Control				
Chamber #:	12	1	3	7	8
Install Date/Time:	12/14/94 13:40	12/14/94 11:45	12/14/94 11:55	12/14/94 12:00	12/14/94 12:05
Removal Date/Time:	12/15/94 12:50	12/15/94 12:40	12/15/94 12:45	12/15/94 12:35	12/15/94 12:30
Final DO (mg/L):	**8.53**	**6.59**	**6.35**	**6.97**	**7.35**
Depths (cm) 12 req'd:		15.7	19	20	12
		17.2	19.5	21.8	15.1
		11.6	15.9	12.7	16.6
		13.4	12.1	16.8	14.1
		17.4	16.9	20.2	14
		15.8	17.2	18.5	14.2
		12.7	19	19.6	15.2
		15.6	16.3	11.7	11.9
		10.8	19.2	13.4	13.8
		19.6	15.7	11.3	14.1
		17	19.1	13.5	18.8
		17.2	13	18.8	17
Run time (hrs):	23.17	24.92	24.83	24.58	24.42
DO change (mg/L):	0.00	1.94	2.18	1.56	1.18
DO change (mg/L/hr):	0.0000	0.0779	0.0878	0.0635	0.0483
Mean depth (m):		0.1533	0.1691	0.1653	0.1473
Volume (L):		14.34	15.81	15.45	13.78
SOD rate (g/m2/day):		**0.287**	**0.356**	**0.252**	**0.171**
Epi Chloro (mg/m2):		124.46	65.61	136.35	107.93

SITE: ATHABASCA 2 KM D/S McLEOD (Ice Free)
GPS: N 54 09' 42" W 115 40' 33"
DATES: Jan 10-11, 1995

Ambient DO (mg/L): **9.25**

	Control				
Chamber #:	7	9	11	12	13
Install Date/Time:	1/10/95 15:35	1/10/95 15:15	1/10/95 15:30	1/10/95 15:25	1/10/95 15:20
Removal Date/Time:	1/11/95 16:25	1/11/95 15:50	1/11/95 16:00	1/11/95 16:20	1/11/95 16:10
Final DO (mg/L):	**9.25**	**5.14**	**3.63**	**5.59**	**3.55**
Depths (cm) 12 req'd:		10	12.5	14.5	13
		10.5	15	16.5	13.5
		9.5	16	14	19
		17	15.5	14.5	19
		11.5	17.5	14	14.5
		8.5	14	14	19
		10.5	16	14	20
		12	14.5	14.5	16
		15	14	12	15
		12.5	16	19.5	15.5
		8.5	14.5	16	18
		11	14	20	14.5
Run time (hrs):	24.83	24.58	24.50	24.92	24.83
DO change (mg/L):	0.00	4.11	5.62	3.66	5.70
DO change (mg/L/hr):	0.0000	0.1672	0.2294	0.1469	0.2295
Mean depth (m):		0.1138	0.1496	0.1529	0.1642
Volume (L):		10.64	13.99	14.30	15.35
SOD rate (g/m2/day):		**0.456**	**0.824**	**0.539**	**0.904**
Epi Chloro (mg/m2):		72.36	157.451	138.51	127.033

Suspected leakage in chamber #12, possibly #9. (Will check at lab)

SITE: ATHABASCA 2 KM D/S McLEOD (Ice Free)
GPS: N 54 09' 42" W 115 40' 33"
DATES: Mar 9-10, 1995

Ambient DO (mg/L): **9.55**

	Control				
Chamber #:	8	5	9	3	12
Install Date/Time:	3/9/95 10:40	3/9/95 10:30	3/9/95 10:35	3/9/95 10:30	3/9/95 10:35
Removal Date/Time:	3/10/95 13:05	3/10/95 13:00	3/10/95 12:55	3/10/95 12:45	3/10/95 12:50
Final DO (mg/L):	**9.52**	**0.2**	**4.25**	**0.1**	**0.14**
Depths (cm) 12 req'd:		9.5	9	12.5	11
		9.5	11	10.5	13
		9	14.5	13.5	15.5
		13	9.5	13.5	16.5
		14	11	10.5	11
		10.5	8.5	12	14.5
		11	10	13.5	13
		9	13	11.5	10.5
		10	11	13.5	13.5
		8	11	18	11.5
		10	9.5	17	13.5
		11	10	11	11.5
Run time (hrs):	26.42	26.50	26.33	26.25	26.25
DO change (mg/L):	0.03	9.35	5.30	9.45	9.41
DO change (mg/L/hr):	0.0011	0.3528	0.2013	0.3600	0.3585
Mean depth (m):		0.1038	0.1067	0.1308	0.1292
Volume (L):		9.70	9.97	12.23	12.08
SOD rate (g/m2/day):		***0.876**	**0.512**	***1.127**	***1.109**
Epi Chloro (mg/m2):		449.475	548.8	600.794	470.321

SITE: ATHABASCA 2 KM D/S McLEOD (Ice Free)
GPS: N 54 09' 42" W 115 40' 33"
DATES: Feb 7-8, 1995

Ambient DO (mg/L): **8.99**

	Control				
Chamber #:	4	13	7	8	5
Install Date/Time:	2/7/95 9:30	2/7/95 9:20	2/7/95 9:20	2/7/95 9:25	2/7/95 9:25
Removal Date/Time:	2/8/95 8:35	2/8/95 8:20	2/8/95 8:25	2/8/95 8:30	2/8/95 8:30
Final DO (mg/L):	**8.99**	**3.44**	**2.67**	**0.84**	**4.73**
Depths (cm) 12 req'd:		14	15.5	13	12
		13	13	13	12.5
		17	14.5	14.5	13.5
		13	15	13.5	14
		11	12.5	13	16
		15	12	11	13.5
		11	13.5	14.5	13.5
		16.5	13	13.5	15.5
		16	17.5	14	17.5
		14	14	19.5	18
		17	15.5	13.5	11
		15	13.5	15	12
Run time (hrs):	23.08	23.00	23.08	23.08	23.08
DO change (mg/L):	0.00	5.55	6.32	8.15	4.26
DO change (mg/L/hr):	0.0000	0.2413	0.2738	0.3531	0.1845
Mean depth (m):		0.1438	0.1413	0.1400	0.1408
Volume (L):		13.44	13.21	13.09	13.17
SOD rate (g/m2/day):		**0.833**	***0.928**	***1.186**	**0.624**
Epi Chloro (mg/m2):		298.308	538.902	494.614	332.032

** Low DO may have limited SOD rates*

SITE: ATHABASCA 3 KM D/S McLEOD
GPS: N 54 09' 95" W 115 40' 02"
DATES: Oct 20-21, 1994

Ambient DO (mg/L): **12.47**

	Control				
Chamber #:	1	10	4	13	3
Install Date/Time:	10/20/94 12:35	10/20/94 11:10	10/20/94 11:37	10/20/94 12:00	10/20/94 12:15
Removal Date/Time:	10/21/94 13:05	10/21/94 12:20	10/21/94 12:40	10/21/94 12:50	10/21/94 13:00
Final DO (mg/L):	**12.19**	**11.18**	**11.4**	**11.06**	**11.06**
Depths (cm) 12 req'd:		18	15	17.5	20.5
		20	21	17.8	17.9
		22.5	22.6	18.1	17.3
		20	23	17.3	16.5
		18	18	16.6	20.2
		17	19.8	19.3	19.3
		17.5	20	17.3	18.1
		19	17.6	21.8	17.9
		13.5	20	14.9	20
		20	14.8	19	16.4
		23.5	20.1	19.5	20.6
		25.5	18.4	18	17.2
Run time (hrs):	24.50	25.17	25.05	24.83	24.75
DO change (mg/L):	0.28	1.29	1.07	1.41	1.41
DO change (mg/L/hr):	0.01	0.05	0.04	0.06	0.06
Mean depth (m):		0.1954	0.1919	0.1609	0.1849
Volume (L):		18.27	17.94	16.92	17.29
SOD rate (g/m2/day):		**0.187**	**0.144**	**0.197**	**0.202**
Epi Chloro (mg/m2):		12.4	4.2	7.7	4.1

SITE: ATHABASCA 3 KM D/S McLEOD
GPS: N 54 09' 95" W115 40' 02"
DATES: Nov 30 - Dec 1, 1994

	Control				
Ambient DO (mg/L):	12.26				
Chamber #:	3	13	12	6	9
Install Date/Time:	11/30/94 12:55	11/30/94 12:15	11/30/94 12:25	11/30/94 12:35	11/30/94 12:50
Removal Date/Time:	12/1/94 12:35	12/1/94 11:30	12/1/94 11:30	12/1/94 11:35	12/1/94 11:30
Final DO (mg/L):	**12.26**	**12.07**	**11.91**	**11.89**	**11.97**
Depths (cm) 12 req'd:		13.6	24.3	24.8	21.4
		15.7	17.9	25.5	24.5
		19.6	25	22.2	19
		21.8	18.8	27	23.4
		19	25.3	23.1	22
		19.6	23.1	21.8	20.8
		20.7	24.3	22.8	24
		16.5	20.6	20	18.7
		13.2	24	22.5	19.4
		16.5	23.3	23.7	18.5
		20.8	17.3	26.6	21.2
		20.7	24	21.3	21.5
Run time (hrs):	23.67	23.25	23.08	23.00	22.67
DO change (mg/L):	0.00	0.19	0.35	0.37	0.29
DO change (mg/L/hr):	0.0000	0.0082	0.0152	0.0161	0.0128
Mean depth (m):		0.1814	0.2233	0.2344	0.2120
Volume (L):		16.96	20.87	21.92	19.82
SOD rate (g/m2/day):		**0.036**	**0.081**	**0.091**	**0.065**
Epi Chloro (mg/m2):		19	19.12	12.09	18.934

SITE: ATHABASCA 3 KM D/S McLEOD
GPS: N 54 09' 47" W 115 39' 26"
DATES: Feb 7-8, 1995

	Control				
Ambient DO (mg/L):	10.41				
Chamber #:	3	11	12	1	9
Install Date/Time:	2/7/95 15:20	2/7/95 15:00	2/7/95 15:05	2/7/95 15:10	2/7/95 15:15
Removal Date/Time:	2/8/95 13:15	2/8/95 13:10	2/8/95 13:00	2/8/95 13:00	2/8/95 13:05
Final DO (mg/L):	**10.41**	**9.02**	**8.7**	**8.68**	**9.37**
Depths (cm) 12 req'd:		14	13	14	14
		14	19.5	18	12.5
		19	12	16	13
		14	12	21.5	13.5
		15.5	15.5	14	19.5
		13	20.5	14.5	15.5
		13	13.5	15	13
		15.5	15.5	15.5	16.5
		16	14	18.5	13.5
		13	13.5	15	13.5
		10.5	13	12.5	15
		14.5	12	15	12.5
Run time (hrs):	21.92	22.17	21.92	21.83	21.83
DO change (mg/L):	0.00	1.39	1.71	1.73	1.04
DO change (mg/L/hr):	0.0000	0.0627	0.0780	0.0792	0.0476
Mean depth (m):		0.1433	0.1450	0.1579	0.1433
Volume (L):		13.40	13.56	14.77	13.40
SOD rate (g/m2/day):		**0.216**	**0.272**	**0.300**	**0.164**
Epi Chloro (mg/m2):		36.524	41.54	79.868	95.329

SITE: ATHABASCA 3 KM D/S McLEOD
GPS: N 54 09' 47" W 115 39' 26"
DATES: Jan 12-13, 1995

	Control				
Ambient DO (mg/L):	9.73				
Chamber #:	4	7	1	9	3
Install Date/Time:	1/12/95 12:40	1/12/95 12:20	1/12/95 12:25	1/12/95 12:30	1/12/95 12:35
Removal Date/Time:	1/13/95 12:05	1/13/95 11:30	1/13/95 11:40	1/13/95 11:50	1/13/95 12:00
Final DO (mg/L):	**9.73**	**7.64**	**7.91**	**8.03**	**8.23**
Depths (cm) 12 req'd:		15	6.5	16	18
		15	10.5	10.5	13.5
		14	12.5	14	14
		13	15	13	13.5
		12.5	11.5	19	17.5
		11.5	12	12	15.5
		9.5	9.5	11	16.5
		17	15	11.5	12.5
		11.5	17.5	18	16.5
		12	15	12	20
		16.5	7	10	11.5
		11	12.5	17.5	15
Run time (hrs):	23.42	23.17	23.25	23.33	23.42
DO change (mg/L):	0.00	2.09	1.82	1.70	1.50
DO change (mg/L/hr):	0.0000	0.0902	0.0783	0.0729	0.0641
Mean depth (m):		0.1321	0.1204	0.1371	0.1533
Volume (L):		12.35	11.26	12.82	14.34
SOD rate (g/m2/day):		**0.286**	**0.226**	**0.240**	**0.236**
Epi Chloro (mg/m2):		70.77	92.225	128.283	75.835

SITE: ATHABASCA 3 KM D/S McLEOD
GPS: N 54 09' 47" W 115 39' 26"
DATES: Mar 7-9, 1995

	Control				
Ambient DO (mg/L):	10.33				
Chamber #:	3	13	7	11	4
Install Date/Time:	3/7/95 12:50	3/7/95 12:35	3/7/95 12:40	3/7/95 12:30	3/7/95 12:45
Removal Date/Time:	3/8/95 15:30	3/8/95 8:30	3/8/95 8:40	3/8/95 15:00	3/8/95 15:15
Final DO (mg/L):	**10.33**	**9.62**	**9.74**	**9.46**	**8.34**
Depths (cm) 12 req'd:		14.5	16.5	11	11.5
		15.5	12	11.5	14.5
		12	13	12.5	16.5
		10	13	13	15
		11.5	15	12	12.5
		14	16	14	12
		13	15.5	11.5	13.5
		14	14.5	14	16.5
		15	17.5	13.5	12.5
		12	14	12.5	11.5
		9.5	17	12.5	11
		14	15.5	13	11
Run time (hrs):	**26.67**	**19.92**	**20.00**	**26.50**	**26.50**
DO change (mg/L):	0.00	0.71	0.59	0.87	1.99
DO change (mg/L/hr):	0.0000	0.0356	0.0295	0.0328	0.0751
Mean depth (m):		0.1292	0.1496	0.1258	0.1317
Volume (L):		12.08	13.99	11.77	12.31
SOD rate (g/m2/day):		**0.111**	**0.106**	**0.099**	**0.237**
Epi Chloro (mg/m2):		70.63	84.263	38.783	70.268

SITE: ATHABASCA 3 KM D/S McLEOD
GPS: N 54 09' 47" W 115 39' 26"
DATES: Mar 7-9,1995

Ambient DO (mg/L): **10.34**

	Control				
Chamber #:	12	1	9	8	5
Install Date/Time:	3/7/95 12:50	3/7/95 12:30	3/7/95 12:45	3/7/95 12:35	3/7/95 12:40
Removal Date/Time:	3/9/95 9:20	3/7/95 21:45	3/7/95 21:45	3/8/95 21:30	3/9/95 9:15
Final DO (mg/L):	**10.34**	**9.9**	**9.97**	**8.74**	**8.29**
Depths (cm) 12 req'd:		10.5	10.5	15.5	12.5
		13	11	18.5	13
		10	11.5	10.5	15
		16	11.5	17	19.5
		14.5	13	17.5	13
		11.5	11	13	12.5
		11	12.5	12.5	16
		13.5	12.5	16	16.5
		14.5	14.5	15.5	19.5
		12.5	14.5	13.5	15.5
		11.5	12.5	10	14
		13.5	12.5	14.5	16.5
Run time (hrs):	44.50	9.25	9.00	32.92	44.58
DO change (mg/L):	0.00	0.44	0.37	1.60	2.05
DO change (mg/L/hr):	0.0000	0.0476	0.0411	0.0486	0.0460
Mean depth (m):		0.1267	0.1229	0.1450	0.1529
Volume (L):		11.84	11.49	13.56	14.30
SOD rate (g/m2/day):		**0.145**	**0.121**	**0.169**	**0.169**
Epi Chloro (mg/m2):		47.385	28.38	35.84	119.813

SITE: ATHABASCA AT BLUE RIDGE BRIDGE
GPS: N 54 09' 29" W 115 23' 24"
DATES: Dec 20-21, 1994

Ambient DO (mg/L): **10.43**

	Control				
Chamber #:	8	1	3	4	11
Install Date/Time:	12/20/94 12:00	12/20/94 11:50	12/20/94 11:40	12/20/94 11:45	12/20/94 11:55
Removal Date/Time:	12/21/94 11:55	12/21/94 10:35	12/21/94 10:40	12/21/94 10:30	12/21/94 10:45
Final DO (mg/L):	**10.42**	**9.58**	**9.09**	**9.54**	**9.19**
Depths (cm) 12 req'd:		14.5	10.2	16.7	17.8
		17.3	13	13.3	14.8
		15.6	15.8	15.2	17.1
		14.8	12.8	12.7	22.8
		12.1	15	16.5	14.7
		14.5	18.2	15.8	14.5
		15.9	15	17.3	15.6
		13.5	15.3	14.2	14.8
		15	13.3	17.8	13.2
		14.8	14.8	16.3	16.5
		14	13.3	15	16.3
		17.9	11.8	21.3	16.5
Run time (hrs):	23.92	22.75	23.00	22.75	22.83
DO change (mg/L):	0.01	0.85	1.34	0.89	1.24
DO change (mg/L/hr):	0.0004	0.0374	0.0583	0.0391	0.0543
Mean depth (m):		0.1499	0.1404	0.1601	0.1622
Volume (L):		14.02	13.13	14.97	15.16
SOD rate (g/m2/day):		**0.133**	**0.195**	**0.149**	**0.210**
Epi Chloro (mg/m2):		68.31	51.711	59.338	49.495

SITE: ATHABASCA AT BLUE RIDGE BRIDGE
GPS: N 54 09' 95" W 115 40' 02"
DATES: Oct 26-27, 1994

Ambient DO (mg/L): **12.14**

	Control				
Chamber #:	4	13	10	1	3
Install Date/Time:	10/26/94 13:40	10/26/94 13:15	10/26/94 13:20	10/26/94 13:30	10/26/94 13:35
Removal Date/Time:	10/27/94 14:45	10/27/94 14:10	10/27/94 13:35	10/27/94 13:50	10/27/94 14:25
Final DO (mg/L):	**12.12**	**11.39**	**11.6**	**11.4**	**11.36**
Depths (cm) 12 req'd:		20.4	23	22	20
		17.8	21	22.4	20.3
		18	23.5	18.4	22
		23	22.2	19.5	22.6
		19.5	22.6	23.5	18.8
		22.8	20.2	21	16
		21.8	20	15.5	22.7
		20.8	23.5	21	19.8
		19.7	18	22	16.7
		16.4	21	17	22.3
		20	20.3	22.7	22.8
		23.5	23.5	17.4	21.2
Run time (hrs):	25.08	24.92	24.25	24.33	24.83
DO change (mg/L):	0.02	0.75	0.54	0.74	0.78
DO change (mg/L/hr):	0.00	0.03	0.02	0.03	0.03
Mean depth (m):		0.2031	0.2157	0.2020	0.2043
Volume (L):		18.99	20.16	18.89	19.11
SOD rate (g/m2/day):		**0.143**	**0.111**	**0.144**	**0.150**
Epi Chloro (mg/m2):		52.7	27.8	69.4	42.4

SITE: ATHABASCA AT BLUE RIDGE BRIDGE
GPS: N 54 09' 29" W 115 23' 24"
DATES: Jan 17-19, 1995

Ambient DO (mg/L): **9.45**

	Control			Chamber Leak	
Chamber #:	11	9	5	8	1
Install Date/Time:	1/17/95 15:00	1/17/95 14:40	1/17/95 14:45	1/17/95 14:50	1/17/95 14:55
Removal Date/Time:	1/19/95 11:05	1/19/95 10:45	1/19/95 10:50	1/19/95 11:05	1/19/95 11:00
Final DO (mg/L):	**9.45**	**8.2**	**8.02**	**9.48**	**7.98**
Depths (cm) 12 req'd:		15.5	10	14	15
		19.5	14	20	11.5
		13.5	15.5	10.5	13.5
		12.5	21	12.5	11.5
		15	16.5	10	14.5
		13	16.5	20.5	14
		14.5	12.5	17.5	13.5
		15	12.5	15.5	16
		15	12	14	14.5
		14.5	17	16.5	12
		13.5	16.5	13	11.5
		16	16	13.5	12.5
Run time (hrs):	44.08	44.08	44.08	44.25	44.08
DO change (mg/L):	0.00	1.25	1.43	-0.03	1.47
DO change (mg/L/hr):	0.0000	0.0284	0.0324	-0.0007	0.0333
Mean depth (m):		0.1479	0.1500	0.1479	0.1333
Volume (L):		13.83	14.03	13.83	12.47
SOD rate (g/m2/day):		**0.101**	**0.117**	-	**0.107**
Epi Chloro (mg/m2):		52.675	60.008	28.338	24.488

SITE: ATHABASCA AT BLUE RIDGE BRIDGE
GPS: N 54 09' 29" W 115 23' 24"
DATES: Feb 8-9, 1995

Ambient DO (mg/L): 10.06

	Control				
Chamber #:	5	13	7	8	4
Install Date/Time:	2/8/95 12:05	2/8/95 11:45	2/8/95 11:50	2/8/95 11:55	2/8/95 12:00
Removal Date/Time:	2/9/95 12:40	2/9/95 12:20	2/9/95 12:30	2/9/95 12:30	2/9/95 12:35
Final DO (mg/L):	**10.06**	**9.17**	**9.21**	**8.91**	**9.12**
Depths (cm) 12 req'd:		10.5	14.5	13.5	14.5
		11	13	13	16.5
		11.5	13	12	14
		11	11	15.5	11.5
		10.5	12.5	14	16
		14.5	17	13.5	20.5
		11.5	11.5	15	16.5
		13	15.5	16.5	18
		13.5	16	15	17
		16	13.5	15.5	11
		14.5	10.5	18.5	13.5
		15	13	11.5	13.5
Run time (hrs):	24.58	24.58	24.67	24.58	24.58
DO change (mg/L):	0.00	0.89	0.85	1.15	0.94
DO change (mg/L/hr):	0.0000	0.0362	0.0345	0.0468	0.0382
Mean depth (m):		0.1271	0.1342	0.1446	0.1521
Volume (L):		11.88	12.54	13.52	14.22
SOD rate (g/m2/day):		**0.110**	**0.111**	**0.162**	**0.140**
Epi Chloro (mg/m2):		65.331	10.663	44.205	60.278

SITE: ATHABASCA NEAR FORT ASSINIBOINE
GPS: N 54 09' 29" W 115 23' 24"
DATES: Jan 17-18, 1995

Ambient DO (mg/L): 9.2

	Control				
Chamber #:	7	13	3	12	4
Install Date/Time:	1/17/95 11:15	1/17/95 11:00	1/17/95 11:10	1/17/95 11:05	1/17/95 11:10
Removal Date/Time:	1/18/95 10:05	1/18/95 9:50	1/18/95 9:45	1/18/95 10:00	1/18/95 9:55
Final DO (mg/L):	**9.1**	**8.23**	**7.86**	**7.86**	**7.54**
Depths (cm) 12 req'd:		12.5	13	13.5	9.5
		13.5	15	14	11
		12	19.5	14	9.5
		13	10.5	13.5	13.5
		11	13	16	13.5
		13	18.5	12.5	19.5
		12	13.5	17	20.5
		10.5	9	11.5	15
		11	10.5	14	23 5
		13.5	8.5	17.5	12
		12	12	12.5	11.5
		11.5	10.5	12.5	10.5
Run time (hrs):	22.83	22.83	22.58	22.92	22.75
DO change (mg/L):	0.10	0.97	1.34	1.34	1.66
DO change (mg/L/hr)	0.0044	0.0425	0.0593	0.0585	0.0730
Mean depth (m):		0.1213	0.1279	0.1404	0.1413
Volume (L):		11.34	11.96	13.13	13.21
SOD rate (g/m2/day):		**0.111**	**0.169**	**0.182**	**0.233**
Epi Chloro (mg/m2):		19.968	6.281	49.988	20.425

SITE: ATHABASCA NEAR FORT ASSINIBOINE
GPS: N 54 19' 57" W 115 46' 14"
DATES: Dec 19-20, 1994

Ambient DO (mg/L): 10.31

	Control				
Chamber #:	12	7	9	5	13
Install Date/Time:	12/19/94 15:55	12/19/94 15:45	12/19/94 15:40	12/19/94 15:30	12/19/94 15:50
Removal Date/Time:	12/20/94 13:50	12/20/94 13:15	12/20/94 13:30	12/20/94 13:35	12/20/94 13:40
Final DO (mg/L):	**10.31**	**9.28**	**8.96**	**9.05**	**8.97**
Depths (cm) 12 req'd:		15.9	16.4	18	16.2
		16.2	16.1	19.5	14
		14.9	14.7	16.7	15.3
		12	13	20.7	16.8
		15.7	16.8	16.3	12
		17.3	13.7	18.5	13.8
		14.7	19.6	14.6	16
		12.8	14.5	16.9	15.1
		16.1	17.4	17	13.2
		12.5	15.5	13	13.8
		15	19.7	14.5	16
		14.4	17.1	13.2	20
Run time (hrs):	21.92	21.50	21.83	22.08	21.83
DO change (mg/L):	0.00	1.03	1.35	1.26	1.34
DO change (mg/L/hr):	0.0000	0.0479	0.0618	0.0571	0.0614
Mean depth (m):		0.1479	0.1621	0.1658	0.1518
Volume (L):		13.83	15.15	15.50	14.20
SOD rate (g/m2/day):		**0.170**	**0.241**	**0.227**	**0.224**
Epi Chloro (mg/m2):		45.741	118.088	139.455	133.375

SITE: ATHABASCA NEAR FORT ASSINIBOINE
GPS: N 54 19' 57" W 115 46' 14"
DATES: Feb 9-10, 1995

Ambient DO (mg/L): 9.66

	Control				
Chamber #:	12	11	3	1	9
Install Date/Time:	2/9/95 11:30	2/9/95 11:20	2/9/95 11:20	2/9/95 11:25	2/9/95 11:25
Removal Date/Time:	2/10/95 11:00	2/10/95 10:30	2/10/95 10:50	2/10/95 10:35	2/10/95 10:40
Final DO (mg/L):	**9.48**	**8.82**	**8.9**	**8.94**	**9.13**
Depths (cm) 12 req'd:		11.5	14.5	9.5	12 5
		14	15.5	14.5	11 5
		13.5	16	12	13
		12.5	14	12	12 5
		13.5	14.5	16.5	16
		13.5	16.5	13	12 5
		11.5	12.5	16.5	13 5
		13.5	18	14.5	10.5
		13.5	13	12.5	10.5
		12.5	10	17.5	12 5
		15.5	14	12.5	12 5
		11.5	11.5	18.5	15
Run time (hrs):	23.50	23.17	23.50	23.17	23.25
DO change (mg/L):	0.18	0.84	0.76	0.72	0.53
DO change (mg/L/hr):	0.0077	0.0363	0.0323	0.0311	0.0228
Mean depth (m):		0.1304	0.1417	0.1413	0.1271
Volume (L):		12.19	13.25	13.21	11.88
SOD rate (g/m2/day)		**0.090**	**0.084**	**0.079**	**0.046**
Epi Chloro (mg/m2):		143.385	43.304	77.678	109.926

SITE: ATHABASCA AT CHISHOLM
GPS: N 54 54' 50" W 114 11' 26"
DATES: Mar 14-15,1995

Ambient DO (mg/L): 9.08

	Control				
Chamber #:	5	13	7	11	9
Install Date/Time:	3/14/95 10:50	3/14/95 10:30	3/14/95 10:35	3/14/95 10:40	3/14/95 10:45
Removal Date/Time:	3/15/95 10:05	3/15/95 10:05	3/15/95 10:00	3/15/95 9:55	3/15/95 9:50
Final DO (mg/L):	**9.08**	**8.66**	**8.59**	**8.78**	**8.68**
Depths (cm) 12 req'd:		14	8.5	12.5	11.5
		17	16	10.5	11.5
		12.5	9	12	17.5
		12	12.5	10.5	11.5
		10.5	11.5	10.5	15
		16	13	11.5	10
		10.5	8.5	16.5	11.5
		13	12.5	11	12
		15.5	16.5	12	10
		13.5	10	13	14
		19.5	13.5	12	13.5
		11.5	10.5	13	8
Run time (hrs):	23.25	23.58	23.42	23.25	23.08
DO change (mg/L):	0.00	0.42	0.49	0.30	0.40
DO change (mg/L/hr):	0.0000	0.0178	0.0209	0.0129	0.0173
Mean depth (m):		0.1379	0.1183	0.1208	0.1217
Volume (L):		12.90	11.06	11.30	11.38
SOD rate (g/m2/day):		**0.059**	**0.059**	**0.037**	**0.051**
Epi Chloro (mg/m2):		18.244	25.41	20.2	56.76

SITE: ATHABASCA U/S SMITH
GPS: N 54 43' 21" W 113 16' 57"
DATES: Feb 14-15, 1995

Ambient DO (mg/L): 7.9

	Control				
Chamber #:	4	8	7	1	9
Install Date/Time:	2/14/95 12:05	2/14/95 12:00	2/14/95 12:00	2/14/95 12:05	2/14/95 12:05
Removal Date/Time:	2/15/95 13:40	2/15/95 13:15	2/15/95 13:25	2/15/95 13:25	2/15/95 13:30
Final DO (mg/L):	**7.9**	**6.15**	**5.92**	**6.32**	**6.33**
Depths (cm) 12 req'd:		14.5	13.5	14.5	13.5
		10.5	16	17	14
		9.5	13.5	15.5	14.5
		10	15.5	15.5	12
		12	14	12.5	12.5
		11	13.5	14	12.5
		17.5	13	16	12.5
		15.5	11.5	18	11.5
		18.5	15.5	11.5	16.5
		17	14	19	14
		13.5	17.5	14.5	14.5
		12.5	10.5	12.5	13.5
Run time (hrs):	25.58	25.25	25.42	25.33	25.42
DO change (mg/L):	0.00	1.75	1.98	1.58	1.57
DO change (mg/L/hr):	0.0000	0.0693	0.0779	0.0624	0.0618
Mean depth (m):		0.1350	0.1400	0.1504	0.1346
Volume (L):		12.62	13.09	14.06	12.58
SOD rate (g/m2/day):		**0.225**	**0.262**	**0.225**	**0.200**
Epi Chloro (mg/m2):		6.482	38.162	15.638	29.105

SITE: ATHABASCA U/S SMITH
GPS: N 54 43' 21" W 113 16' 57"
DATES: Jan 23-24, 1995

Ambient DO (mg/L): 7.59

	Control				
Chamber #:	1	3	7	4	9
Install Date/Time:	1/23/95 16:00	1/23/95 15:40	1/23/95 15:45	1/23/95 15:50	1/23/95 15:55
Removal Date/Time:	1/24/95 15:30	1/24/95 15:00	1/24/95 15:10	1/24/95 15:15	1/24/95 15:25
Final DO (mg/L):	**7.57**	**4.6**	**5.63**	**6.04**	**6.02**
Depths (cm) 12 req'd:		12.5	14.5	17.5	12
		14	14	13	13.5
		10.5	13.5	15	15.5
		9.5	18	12.5	12.5
		11.5	15.5	16	22.5
		14.5	13	14	15.5
		10.5	12.5	17.5	11.5
		13.5	16.5	12	13
		11	16.5	13	13
		12.5	17.5	15	14
		12	14.5	13.5	12
		10	14	10.5	15
Run time (hrs):	23.50	23.33	23.42	23.42	23.50
DO change (mg/L):	0.02	2.99	1.96	1.55	1.57
DO change (mg/L/hr):	0.0009	0.1281	0.0837	0.0662	0.0668
Mean depth (m):		0.1183	0.1500	0.1413	0.1417
Volume (L):		11.06	14.03	13.21	13.25
SOD rate (g/m2/day):		**0.362**	**0.298**	**0.222**	**0.224**
Epi Chloro (mg/m2):		133.684	136	13.513	39.739

SITE: ATHABASCA U/S SMITH
GPS: N 54 43' 21" W 113 16' 57"
DATES: Mar 14-15, 1995

Ambient DO (mg/L): 8.3

	Control				
Chamber #:	1	4	12	8	3
Install Date/Time:	3/14/95 12:25	3/14/95 12:25	3/14/95 12:00	3/14/95 12:20	3/14/95 12:15
Removal Date/Time:	3/15/95 11:25	3/15/95 11:25	3/15/95 11:00	3/15/95 11:20	3/15/95 11:15
Final DO (mg/L):	**8.3**	**7.39**	**7.69**	**7**	**7.23**
Depths (cm) 12 req'd:		15.5	10.5	20.5	12.5
		13	15	13	12
		14.5	15	14.5	9
		13	14.5	13.5	12
		13.5	15	12	13
		14.5	11.5	12.5	13.5
		13	11.5	13	12.5
		15.5	16	13	11
		14.5	12.5	13	9 5
		14	13.5	16	13.5
		12	10	14.5	13
		15	10.5	16	11.5
Run time (hrs):	23.00	23.00	23.00	23.00	23.00
DO change (mg/L):	0.00	0.91	0.61	1.30	1.07
DO change (mg/L/hr):	0.0000	0.0396	0.0265	0.0565	0.0465
Mean depth (m):		0.1400	0.1296	0.1429	0.1192
Volume (L):		13.09	12.12	13.36	11.14
SOD rate (g/m2/day):		**0.133**	**0.082**	**0.194**	**0.133**
Epi Chloro (mg/m2):		69.122	24.536	64.228	11.408

SITE: ATHABASCA AT TOWN OF ATHABASCA
GPS: N 54 43' 02" W 113 17' 21"
DATES: Jan 24-25, 1995

Ambient DO (mg/L): **8.6**

	Control				
Chamber #:	12	13	8	11	5
Install Date/Time:	1/24/95 13:25	1/24/95 13:05	1/24/95 13:10	1/24/95 13:15	1/24/95 13:20
Removal Date/Time:	1/25/95 15:05	1/25/95 14:40	1/25/95 14:50	1/25/95 14:55	1/25/95 15:00
Final DO (mg/L):	**8.6**	**7.71**	**7.45**	**7.11**	**7.56**
Depths (cm) 12 req'd:		17	17	13.5	17.5
		12	20	12.5	16.5
		16.5	13	14	15.5
		16	15.5	12.5	17.5
		16	15.5	13.5	12.5
		17	16	13.5	13.5
		17	14.5	13	15.5
		17.5	11.5	10.5	14
		17.5	16.5	14.5	14.5
		15	18.5	14	15
		16.5	17.5	12.5	14.5
		14.5	18	13	12.5
Run time (hrs):	25.67	25.58	25.67	25.67	25.67
DO change (mg/L):	0.00	0.89	1.15	1.49	1.04
DO change (mg/L/hr):	0.0000	0.0348	0.0448	0.0581	0.0405
Mean depth (m):		0.1604	0.1613	0.1308	0.1492
Volume (L):		15.00	15.08	12.23	13.95
SOD rate (g/m2/day):		**0.134**	**0.173**	**0.182**	**0.145**
Epi Chloro (mg/m2):		8.202	50.811	26.087	5.587

SITE: ATHABASCA AT TOWN OF ATHABASCA
N 54 43' 02" W 113 17' 21"
DATES: Mar 16-17, 1995

Ambient DO (mg/L): **9.18**

	Control				
Chamber #:	13	3	4	7	9
Install Date/Time:	3/16/95 12:00	3/16/95 11:45	3/16/95 11:50	3/16/95 11:45	3/16/95 11:50
Removal Date/Time:	3/17/95 11:20	3/17/95 11:00	3/17/95 11:10	3/17/95 11:05	3/17/95 11:15
Final DO (mg/L):	**9.18**	**8.06**	**8.05**	**8.21**	**8.1**
Depths (cm) 12 req'd:		13	13.5	10.5	15
		11.5	11.5	13	17
		11.5	12	13.5	12.5
		10	9.5	12.5	12.5
		18	12.5	14.5	12
		15	12	14.5	13.5
		11.5	13.5	17.5	13
		11.5	11	15	14.5
		10.5	13	19.5	12.5
		10.5	14.5	10.5	9.5
		11	10	19	11
		16	14.5	11	11.5
Run time (hrs):	23.33	23.25	23.33	23.33	23.42
DO change (mg/L):	0.00	1.12	1.13	0.97	1.08
DO change (mg/L/hr):	0.0000	0.0482	0.0484	0.0416	0.0461
Mean depth (m):		0.1250	0.1229	0.1425	0.1288
Volume (L):		11.69	11.49	13.32	12.04
SOD rate (g/m2/day):		**0.145**	**0.143**	**0.142**	**0.143**
Epi Chloro (mg/m2):		10.313	36.585	60.631	97.082

SITE: ATHABASCA AT TOWN OF ATHABASCA
GPS: N 54 43' 02" W 113 17' 21"
DATES: Feb 15-16, 1995

Ambient DO (mg/L): **8.3**

	Control				
Chamber #:	3	5	11	12	13
Install Date/Time:	2/15/95 11:20	2/15/95 11:10	2/15/95 11:15	2/15/95 11:15	2/15/95 11:10
Removal Date/Time:	2/16/95 15:40	2/16/95 15:15	2/16/95 15:25	2/16/95 15:30	2/16/95 15:35
Final DO (mg/L):	**8.3**	**7.25**	**6.92**	**7.32**	**7.12**
Depths (cm) 12 req'd:		11.5	15.5	13.5	13.5
		10.5	15.5	16	18
		14	13.5	15	13.5
		16	11.5	13	13
		14	14	16	12
		14.5	15	13	17
		15	15	15	14
		15.5	15.5	16	13
		14	15.5	14.5	15
		14	12	16	24
		19	14.5	15.5	15.5
		12.5	14.5	16	15
Run time (hrs):	28.33	28.08	28.17	28.25	28.42
DO change (mg/L):	0.00	1.05	1.38	0.98	1.18
DO change (mg/L/hr):	0.0000	0.0374	0.0490	0.0347	0.0415
Mean depth (m):		0.1421	0.1433	0.1496	0.1529
Volume (L):		13.28	13.40	13.99	14.30
SOD rate (g/m2/day):		**0.127**	**0.169**	**0.125**	**0.152**
Epi Chloro (mg/m2):		44.422	25.41	17.769	5.674

SITE: ATHABASCA U/S CALLING RIVER
GPS: N 55 05' 40" W 112 52' 85"
DATES: Jan 30-31, 1995

Ambient DO (mg/L): **8.34**

	Control				
Chamber #:	13	4	9	7	8
Install Date/Time:	1/30/95 15:20	1/30/95 15:00	1/30/95 15:05	1/30/95 15:10	1/30/95 15:15
Removal Date/Time:	1/31/95 13:55	1/31/95 13:30	1/31/95 13:45	1/31/95 13:40	1/31/95 13:20
Final DO (mg/L):	**8.32**	**7.68**	**7.68**	**7.59**	**7.71**
Depths (cm) 12 req'd:		14	15.5	13.5	17
		10.5	14	12	12.5
		12.5	13.5	16	13.5
		14	16.5	17.5	12.5
		12.5	12	16	16.5
		15	13.5	20.5	13
		10.5	14.5	15.5	11.5
		16	18	14	15
		14	11.5	14	12.5
		12.5	18	15	14
		12	11.5	14.5	16
		11	14	17.5	11.5
Run time (hrs):	22.58	22.50	22.67	22.50	22.08
DO change (mg/L):	0.02	0.66	0.66	0.75	0.63
DO change (mg/L/hr):	0.0009	0.0293	0.0291	0.0333	0.0285
Mean depth (m):		0.1288	0.1438	0.1550	0.1379
Volume (L):		12.04	13.44	14.49	12.90
SOD rate (g/m2/day):		**0.088**	**0.097**	**0.121**	**0.091**
Epi Chloro (mg/m2):		16.981	35.468	33.7	11.299

SITE: ATHABASCA U/S CALLING RIVER
GPS: N 55 05' 40" W 112 52' 85"
DATES: Feb 16-17, 1995

Ambient DO (mg/L):	8.21				
	Control				
Chamber #:	4	1	7	8	9
Install Date/Time:	2/16/95 13:10	2/16/95 12:45	2/16/95 13:00	2/16/95 12:50	2/16/95 12:55
Removal Date/Time:	2/17/95 12:25	2/17/95 12:10	2/17/95 12:05	2/17/95 12:15	2/17/95 12:20
Final DO (mg/L):	**8.21**	**7.46**	**7.3**	**7.45**	**7.32**
Depths (cm) 12 req'd:		16.5	9.5	14	9.5
		15	10.5	13.5	17.5
		15	16.5	14.5	11.5
		17.5	10.5	13	11.5
		10.5	14	11	14.5
		13.5	15.5	15.5	13.5
		11.5	11	11.5	10.5
		12.5	16.5	15.5	13.5
		13	9.5	11.5	12
		12	10	12.5	17
		11.5	12.5	15	12.5
		14	14.5	11.5	13
Run time (hrs):	23.25	23.42	23.08	23.42	23.42
DO change (mg/L):	0.00	0.75	0.91	0.76	0.89
DO change (mg/L/hr):	0.0000	0.0320	0.0394	0.0325	0.0380
Mean depth (m):		0.1354	0.1254	0.1325	0.1304
Volume (L):		12.66	11.73	12.39	12.19
SOD rate (g/m2/day):		**0.104**	**0.119**	**0.103**	**0.119**
Epi Chloro (mg/m2):		8.457	23.637	8.644	44.991

SITE: ATHABASCA U/S CALLING RIVER
GPS: N 55 05' 40" W 112 52' 85"
DATES: Mar 15-16, 1995

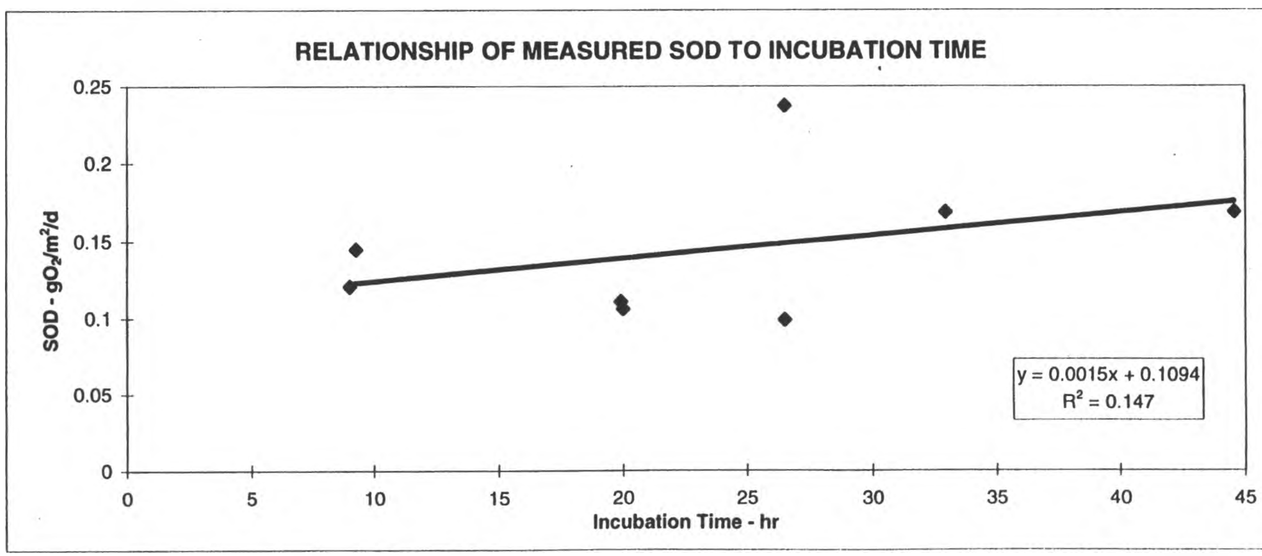
Ambient DO (mg/L):	9.6				
	Control				
Chamber #:	5	11	8	12	1
Install Date/Time:	3/15/95 16:00	3/15/95 15:40	3/15/95 15:45	3/15/95 15:50	3/15/95 15:55
Removal Date/Time:	3/16/95 14:00	3/16/95 13:50	3/16/95 13:45	3/16/95 13:50	3/16/95 14:00
Final DO (mg/L):	**9.56**	**9.13**	**9.1**	**8.88**	**8.88**
Depths (cm) 12 req'd:		11.5	11.5	10	13
		13	11.5	16	11.5
		16.5	12	13	8.5
		14	12.5	11	13
		13.5	11.5	12.5	14.5
		12.5	10	14.5	16.5
		14.5	12	12	14
		13.5	11	10.5	13
		18	13	10	20
		12	9	11.5	12.5
		20	11	14	11.5
		15.5	8	12	16
Run time (hrs):	22.00	22.17	22.00	22.00	22.08
DO change (mg/L):	0.04	0.47	0.50	0.72	0.72
DO change (mg/L/hr):	0.0018	0.0212	0.0227	0.0327	0.0326
Mean depth (m):		0.1454	0.1108	0.1225	0.1367
Volume (L):		13.60	10.36	11.45	12.78
SOD rate (g/m2/day):		**0.068**	**0.056**	**0.091**	**0.101**
Epi Chloro (mg/m2):		34.344	9.208	10.395	2.672

APPENDIX E. EFFECT OF INCUBATION TIME ON EXPRESSED SOD.

On 7 March 1995, 8 chambers with substrate and 2 blank chambers were installed at the site 3-4 km d/s of the Mcleod River. The chambers were deployed as normal but sequentially removed at about 9, 20, 27, 32, and 44 hours after installation. The purpose was to check the effect of 'incubation' length on the O_2 consumption rate (i.e., SOD). The concern is that as incubation continues, DO may be consumed near the substrate to the point of limiting respiration, and/or that initial set-up agitates things thus inducing a high consumption rate which drops back after a while. If these things are a problem, the expressed rate of SOD should decrease with increasing incubation time.

The results are tabled and graphed below. SOD did not appear to decrease with increasing incubation time. The slope of the linear regression line is not significant ($p = 0.34$). Thus the normal incubation length of about 24 hours appears to be acceptable, at least for the rates and conditions tested here. Note however, that some rates at the site 2 km d/s of McLeod were so high that DO fell to low levels in the chambers and very well may have limited the SOD rate. These are indicated in the report text.

Run Time - hrs	SOD - $gO_2/m^2/d$
9	0.121
9.25	0.145
19.92	0.111
20	0.106
26.5	0.099
26.5	0.237
32.92	0.169
44.58	0.169



APPENDIX F. SOD AND ASSOCIATED DATA, ATHABASCA RIVER, JANUARY-MARCH, 1994.							From: HBT Agra 1994	
LOCATION	**SITE**	**DATE**	**CHAMBER**	**SOD - $gO_2/m^2/d$**		**EPIL.CHLa**	**TOC - % dry weight**	
			OR CORE #	Mean	Reps	mg/m^2	Biofilm+Sed.	Sediment
Hinton (d/s Weldwood)	1	15/16-Feb-94	CC 8	0.17	0.3		0.92	
			11		0.08			
			12		0.08			
	2	14/15-Feb-94	SC 2	0.39	0.31			1.01
			3		0.37			
			6		0.48			
Windfall Bridge	1	17/18-Feb-94	CC 9	0.04	0.02		1.14	
			8		0.03			
			12		0.04			
			7		0.05			
			11		0.05			
Whitecourt (d/s Millar Western)	1	31-Jan/01-Feb-94	CC	0.24	0.1			
					0.21			
					0.25			
					0.25			
					0.39			
		16/17-Feb-94	CC 9	0.29	0.08	412.075	5.36	
			11		0.25	258.672		
			7		0.36	396.866		
			8		0.46	396.549		
		14/15-Mar-94	CC 7	0.46	0.59	157.181	5.32	
			8		0.55	117.994		
			9		0.33	109.838		
			11		0.42	75.268		
			13		0.4	89.375		
Blue Ridge	1	19/20-Feb-94	CC 7	0.11	0.09	267.335	0.85	
			8		0.11	448.054		
			9		0.12	780.246		
Fort Assiniboine	1	02/03-Feb-94	CC	0.13	0.06			
					0.07			
					0.11			
					0.2			
					0.2			
		21/22-Feb-94	CC 7	0.1	0.07	226.44	1.98	
			12		0.08	259.771		
			8		0.1	234.71		
			1?		0.13	217.998		
		15/16-Mar-94	CC 7	0.16	0.16	277.3	1.31	
			8		0.44	235.463		
			9		0.18	190.53		
			11		0.01	148.087		
			13		0.03	189.442		
Chisholm	1	23/24-Feb-94	CC 9	0.12	0.1	139.368	0.67	
			12		0.12	108.548		
			8		0.14	94.43		
Smith (u/s Lesser Slave River)	1	04/05-Feb-94	CC	0.12	0.05			
					0.12			
					0.13			
					0.14			
					0.14			
	1	25/26-Feb-94	CC 8	0.09	0.08	187.38	1.83	
	2		12		0.08	345.834		
	3		9		0.11	289.788		
	1	17/19-Mar-94	CC 7	0.1	0.09	10.552	2.76	
			8		0.12	75.167		
			9		0.15	90.642		
			11		0.04			
			13		0.12			
Smith (d/s Lesser Slave River)	1	27/28-Feb-94	CC 8	0.59	0.65			1.51
	2		CC 11		0.57			1.1
	3		CC 12		0.56			1.68
	4	18/19-Mar-94	SC 1	0.61	0.34			3.08
			2		0.67			3.02
			3		0.7			3.18
			4		0.72			1.73
Athabasca	1	01/02-Mar-94	SC 1	0.11	0.18			1.15
			2		0.06			1.48
			3		0.13			1
			4		0.07			0.97
			5		0.13			1.47
AlPac (u/s effluent discharge)	1	04/05-Mar-94	SC 1	0.15	0.13			0.65
	2		2		0.18			0.71
	3		3		0.19			0.23
	4		4		0.09			0.44
AlPac (d/s effluent discharge)	1	03/04-Mar-94	SC 1	0.25	0.28			3.85
			2		0.17			2.49
			3		0.47			2.14
			4		0.23			2.14
			5		0.09			3.23
Calling River	1	06/07-Mar-94	SC 1	0.12	0.06			2.98
			2		0.15			1.51
			3		0.16			3.56

CC = closed chamber; SC = sediment core. Biofilm+sediment samples are composites for the site. Non-significant digits are retained.

Figure a. SOD by location in Feb-Mar 1994, Athabasca River.

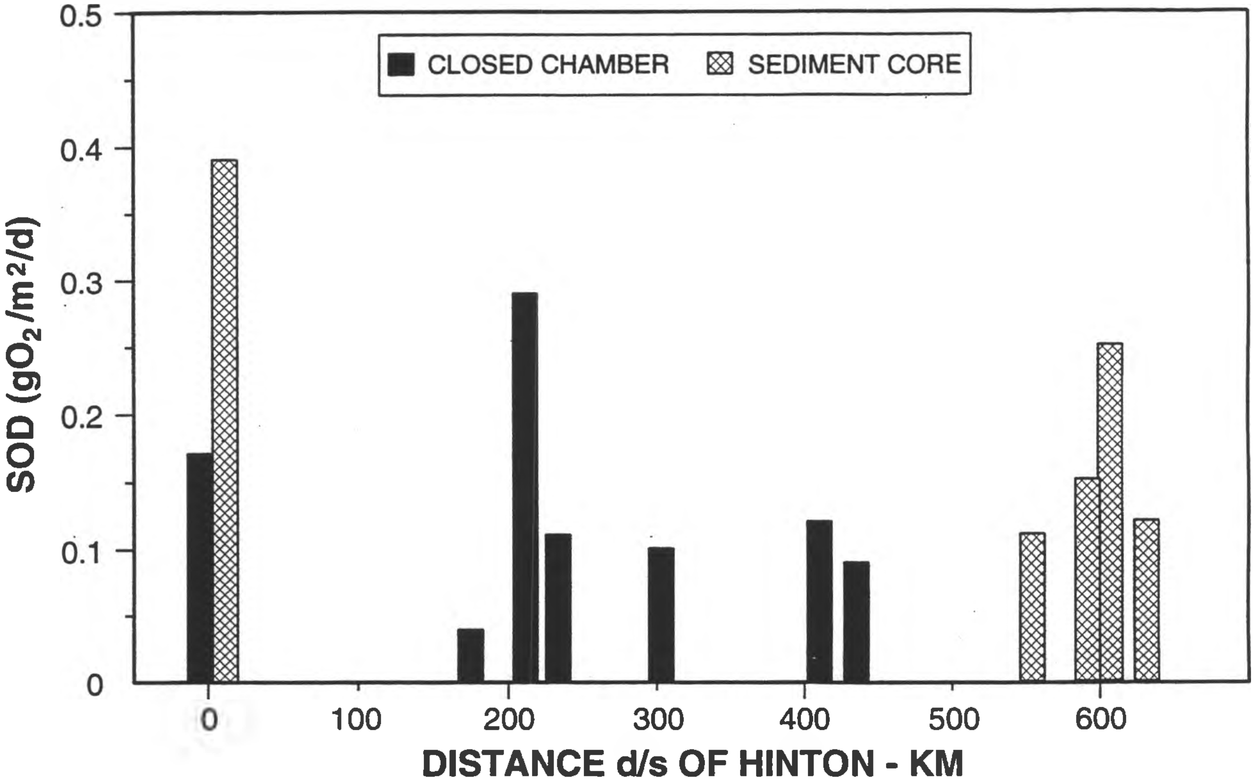


Figure b. SOD versus time, Athabasca River, 1994.

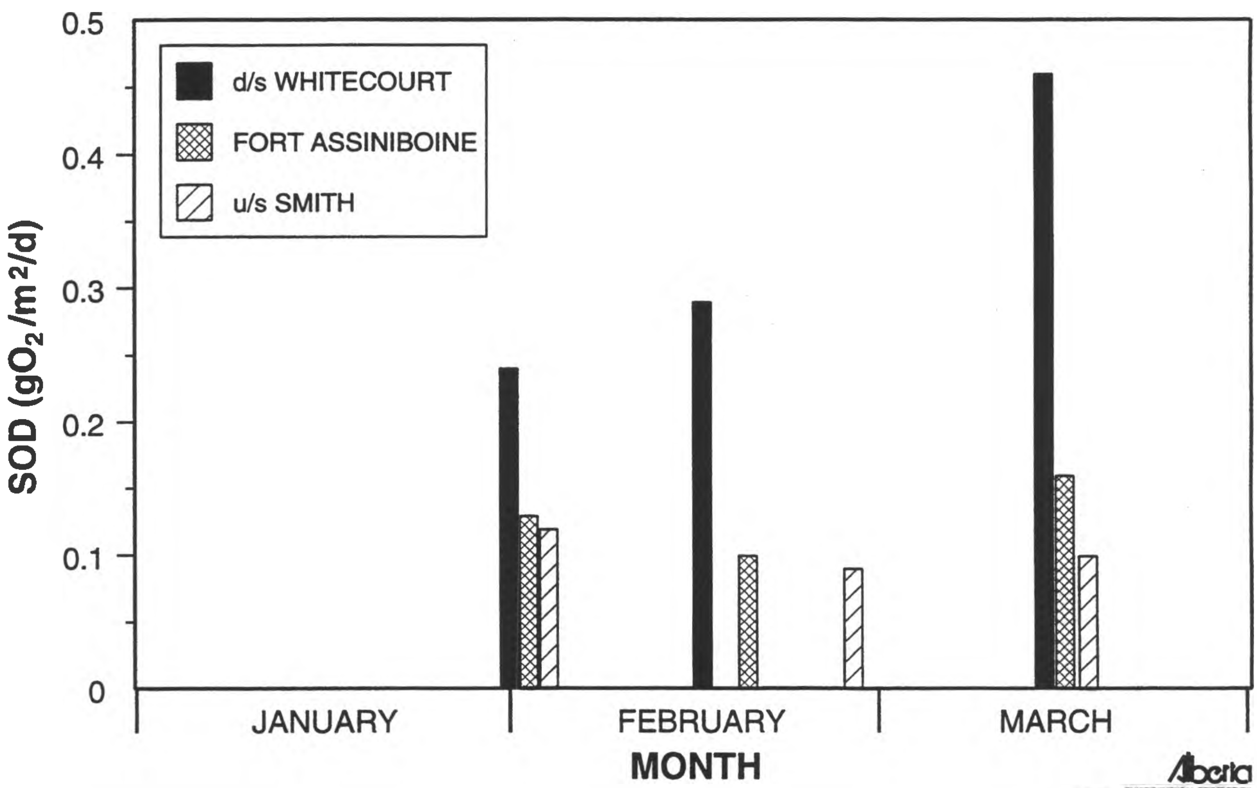


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Figure c. SOD vs chlorophyll, ice cover sites, 1994.

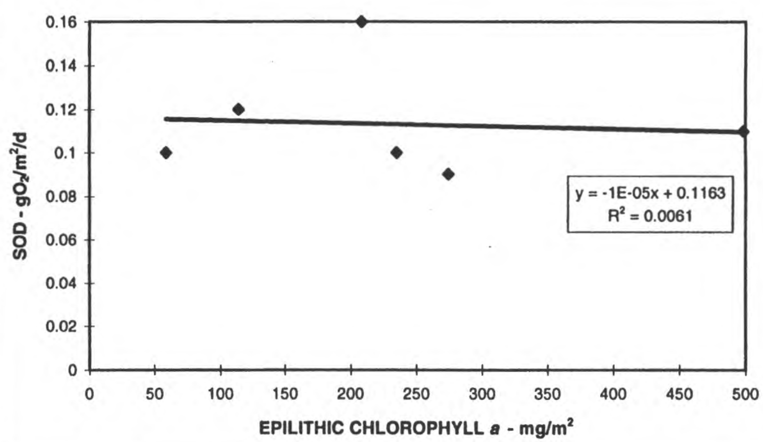

Figure e. SOD vs TOC in sediment, 1994.

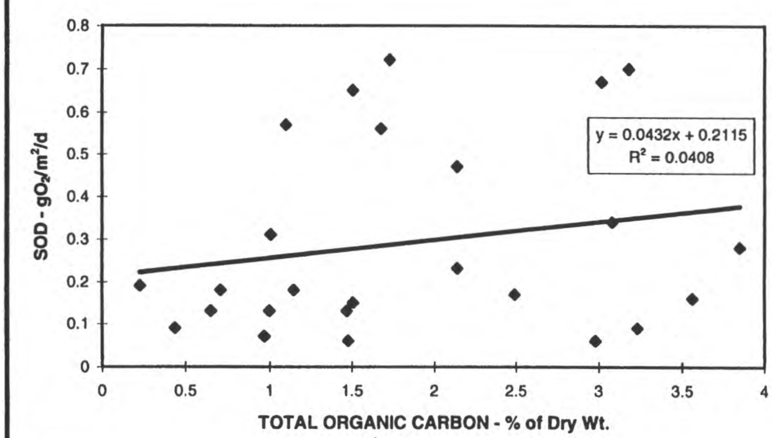

Figure d. SOD vs biofilm+sediment TOC, 1994.

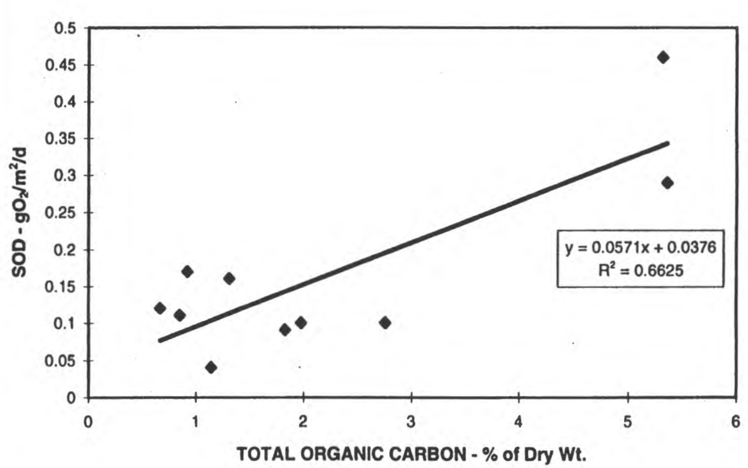

Figure f. SOD vs velocity, 1994.