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GEOCHEMICAL STUDIES - 2

TEMPORAL CHANGES IN CRUDE OIL QUALITY FROM INDIVIDUAL WELLS

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"GEOCHEMICAL STUDIES"

This series of reports, under the general title "Geochemical Studies", *makes available geochemical data on the formation fluids and rocks of Alberta which would otherwise remain unpublished. Two types of data fall in this category. First,* "Geochemical Studies" *will act effectively as a document depository in cases where a formal publication is available, but without the raw data having been published; additional interpretations may be included if pertinent. Second,* "Geochemical Studies" *will include both the raw data and a minimal descriptive report in the case where no formal publication is planned.*

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ABSTRACT

Although it is widely believed that crude oil quality, as measured by density and sulphur content, does not vary with time from an individual well, there is no published information, at least for Alberta, to support this belief. Since the advent of block price scheduling for special old oil under the NEP, possible temporal changes of crude oil quality from an individual well have become of economic importance. The files of the ERCB and the author were searched for all examples of multiple analyses from individual wells for all scheduled fields and pools.

The resulting ninety nine data sets represent a full range of crude oil quality, areal distribution, size of reserve and discovery date, for sampling periods of up to 23 years. They were examined for temporal changes in crude oil quality with respect to several factors which might cause variations in quality. These included original variations within the pool, sampling conditions, analytical techniques and a wide spectrum of engineering recovery methods, with special emphasis on water flooding and the inadvertent injection of deleterious bacteria which might induce biodegradation and the production of hydrogen sulphide.

Subjective interpretation of the data sets shows that for more than three quarters of the sets, there is no change, effectively no change, or no significant change of crude oil quality with time. The balance were either indeterminate or the changes observed could be attributed to variations in sampling conditions or analytical techniques. Subject to a data base better representative of the more than four hundred approved oil conservation projects in Alberta, it is suggested that the injection of water during the operation of an oil conservation project does not appear to affect crude oil quality, in any gross sense.

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INTRODUCTION

This report results from a request by the Office of the Auditor General, Alberta, for information on the temporal changes in crude oil quality from individual wells. The request related specifically to possible changes in crude oil quality which might cause a change in price based on the block price schedule prepared monthly by the Alberta Petroleum Marketing Commission. Pursuant to the NEP Update/82, the Commission establishes, from time to time, field prices per cubic metre for marketable quality special old oil -- which is defined as oil discovered since 1974-04-01 and designated by the Minister of Energy and Natural Resources as qualifying for special old oil price. The prices are computed according to a Block Price Schedule based on specified ranges of crude oil density (in kg/m^3) and sulphur content (in g/kg). Figure 1 is modified from the Alberta Petroleum Marketing Commission report effective 1982-10-01 (APMC, 1982) and shows the density and sulphur ranges effective at that time, and the price per cubic metre for special old oil falling within each block, e.g. for crude oils designated as special old oil and which have a density in the range 885 to 909 (kg/m^3) and sulphur in the range 2.5 to 4.9 (g/kg), the effective price was $190.85 per cubic metre. The report also contains a schedule of fields and pools falling within each block. The significance of temporal changes in crude oil quality which might cause a change in the block price are obvious.

An initial, rather cursory, study showed that there was a paucity of public data on which to base conclusions, although it appeared that, for some wells, sampling periods of up to 23 years showed no effective change in either the density or sulphur content of the produced crude oil. Other wells exhibited changes in these two crude oil properties which might relate to engineering practice or to the more academic aspect of original variations of crude oil quality within an individual reservoir. Accordingly, a more thorough study was carried out, resulting in the present report.

ACKNOWLEDGMENTS

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Block Price Schedule

Sulphur g/kg

Density kg/m³

ϱ \ S	S1 0.0-2.4	S2 2.5-4.9	S3 5.0-9.9	S4 10.0-14.9	S5 15.0-19.9	S6 20.0-24.9	S7 25.0-29.9	S8 30.0-34.9	S9 35.0 and over
D1 824 and under	202.35 Table 1	200.25 Table 2	198.15 No Data						
D2 825-844	200.00 Table 3	197.90 Table 4	195.80 Table 5	193.70 Table 6	191.60 No Data				
D3 845-864	197.65 Table 7	195.55 Table 8	193.45 Table 9	191.35 Table 10					
D4 865-884		193.20 Table 11	191.10 Table 12	189.00 Table 13	186.90 No Data	184.80 No Data			
D5 885-909		190.85 No Data	188.75 No Data	186.65 Table 14	184.55 Table 15	182.45 Table 16	180.35 Table 17	178.25 No Data	
D6 910-934				184.30 Table 18	182.20 Table 19	180.10 No Data	178.00 Table 20	175.90 No Data	
D7 935-959							175.65 No Data	173.55 Table 21	171.45 Table 22
D8 960-984							173.30 No Data	171.20 No Data	169.10 No Data
D9 985 and over						173.05 No Data		168.85 No Data	166.75 No Data

Figure 1. Block Price Schedule for Alberta special old oil (modified from APMC, 1982). The heavy line delineates blocks for which fields and pools are scheduled. Table numbers refer to data found in the Appendix.

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POSSIBLE CAUSES OF TEMPORAL VARIATIONS IN CRUDE OIL QUALITY

INTRODUCTION

There are many reasons for natural variations in crude oil quality and detailed evaluation of these causes often require expensive and sophisticated analysis. Fortunately, overall crude oil quality can be described, simply, in terms of density and sulphur content (Rogers et al., 1971).

There are two broad classes of causes which may result in temporal variations of crude oil quality from an individual well. One class relates to local variations inherent within the pool prior to production, and the other to anthropogenic factors such as sampling and analytical variables, and the wide spectrum of engineering recovery techniques that may be used to stimulate production and/or maintain reservoir pressure.

PRE-PRODUCTION VARIABLES

It is well established that there are regional (basin-wide) variations in the quality of crude oils within any specific stratigraphic unit due to such factors as thermal maturation, gas deasphalting, biodegradation and water-washing. Reports which describe these factors as they relate to Alberta and the western Canada sedimentary basin include Evans et al. (1971), Rogers et al. (1972), Bailey et al. (1973, 1974), Deroo et al. (1977), and Milner et al. (1977). Because these reports are essentially regional studies, they do not (nor would they be expected to) address the problem of variations in the quality of crude oils within any specific field or pool. Deroo et al. (1977), however, report pairs of detailed analyses from a few pools. The fact that there are well established regional variations in crude oil quality suggests, or maybe implies, that appropriate analytical information will demonstrate local, perhaps even subtle, variations in crude oil quality within individual fields and pools. The additional fact that the known regional variations are gradual and not abrupt, on a regional scale, means that if the same crude oil properties that are used to demonstrate the regional variations are applied at the local level, local variations can probably only be demonstrated for areally extensive fields or for fields with thick producing zones. Other types of analytical data may have to be used to show local variations in smaller and thinner pools.

As far as the writer is aware, there are only two papers which illustrate local variations in crude oil quality from individual fields and pools in Alberta. Hodgson and Baker (1959) demonstrated areal geochemical variations for API gravity, sulphur, asphaltenes, resins, nickel and vanadium (as well as the V/Ni ratio) for crude oils in the Upper Cretaceous Cardium sandstone at Pembina, the Lower Cretaceous Viking

sandstone at Joffre, the Lower Cretaceous Mannville Group at Lloydminster, the Upper Devonian Nisku Formation at Joffre and the Upper Devonian Leduc Formation at Redwater. In a study on the effect of regional variations of crude oil and reservoir characteristics on in situ combustion and miscible-phase recovery of oil in western Canada, Hitchon et al. (1961) produced regional maps of API gravity for many stratigraphic units, some which were in sufficient detail to demonstrate variations in API gravity across the larger fields. Thus for at least some of the areally extensive fields in Alberta local variations in crude oil quality do occur. Vertical variations within thick producing zones are more difficult to demonstrate, not so much because they are inherently of smaller magnitude but because most production wells penetrate only the top portion of such reservoirs. Vertical compositional variations do exist within some hydocarbon accumulations, as shown by Hitchon (1978) for selected properties of crude bitumen in cores from the Athabasca oil sand deposit, though these changes may be related to differing degrees of biodegradation rather than pre-biodegradation variations.

During the production history of a well, whether it is flowing or being pumped, an increasingly larger volume of oil-saturated rock is contacted with increasing time from initial production. If there are strong gradients in the original local variations in crude oil quality this would show up in an individual well through changes in produced oil quality with time. With more subtle or weaker original local variations, and depending on the well spacing, there may be no effective evidence of a change in produced crude oil quality with time from an individual well. Because of the care taken in selection of well spacing (not only to minimize drilling and surface installation costs but also to maximize reservoir productivity) as well as the generally low local gradient of crude oil compositional variations even in areally extensive fields, it is not expected that any temporal changes in crude oil quality from individual wells will result from original local compositional variations.

ANTHROPOGENIC FACTORS

There are two groups of anthropogenic factors which have to be considered. The first relates to variations in the sampling conditions and analytical procedures which may give rise to apparent, rather than real, temporal changes in crude oil quality.

Variable sampling conditions include pre-production drillstem test (DST) and other bottomhole sampling devices, and production samples from wellheads, treaters, separators, and stock tanks. The files of the Energy Resources Conservation Board (ERCB) contain a few hundred pairs of crude oil analyses from individual wells representing the pre-production DST and the initial production within a few weeks of the well coming on stream. For the vast majority of these pairs there is no record of further sampling. Hence for the present study only production samples are

considered, even though a preliminary examination shows a close relation for density and sulphur between the pairs. There is no easily discernable difference between samples from the wellhead, treater or separator for most of the data sets. Samples from stock tanks are sometimes suspect because of the propensity for loss of light ends by evaporation.

With respect to variations in analytical procedures, about the only common feature is that most analyses were performed within a few days of sampling, thus in-transit and in-laboratory degradation (weathering) is minimized. It is known that analytical procedures have changed over the past three decades and therefore some very early (pre-1950) analyses may be suspect. Not only will there be variations in the analytical methods but factors such as precision, accuracy and standard deviation vary from analyst to analyst, and over time. For a few of the samples studied, sulphur was determined by instrumented neutron activation analysis (INAA) and the relative standard deviation by counting statistics for these samples is reported by Hitchon and Filby (1983), although it is not shown in the data cited in this report. Another difference between samples could arise from differences in the procedure used to clean-up the samples prior to analysis; for the samples studied by INAA this was a rigorous standard procedure and is described by Filby and Shah (1975); for the rest of the samples the clean-up procedure is not usually indicated on the analysis sheets.

Despite all these variables it is rather surprising how little difference there is within most sets of samples from individual wells, bearing in mind that statements in the interpretive section of this report such as "no change" or "effectively no change", imply that subjective consideration of variations due to sampling conditions and analytical procedures have been taken into account by the writer based on more than a quarter of a century's experience with fluid analyses.

The second anthropogenic factor that must be considered is temporal variation induced by a wide spectrum of engineering recovery techniques that may be used to stimulate production and/or maintain reservoir pressure. They are broadly classified by the ERCB (1983) as Gas Conservation Schemes and Oil Conservation Projects.

A Gas Conservation Scheme is defined as "any scheme of operation where oil field residue gas is gathered and conserved either for purposes of marketing or for re-injection in the reservoir". Just over forty percent of the pools studied in this report operate under a gas conservation scheme, in the majority of which the major portion of the solution gas produced is conserved, mainly for purposes of marketing. In two fields (Bonnie Glen and Glen Park) the solution gas is reinjected; these two cases are considered in more detail elsewhere in this report because of the propensity reinjection may have for artificial gas deasphalting.

An Oil Conservation Project is defined as "any scheme of operations approved with the intention of increasing the recovery of hydrocarbons for a reservoir, excluding pilot tests". Basically, these are water, gas, and solvent floods, the vast majority being water floods. ERCB regulations control the composition of the injected water (usually surface water that has been treated prior to this usage) especially with respect to compatibility with the indigeneous formation water. Hence good engineering practice should produce no adverse effects in the reservoir. If, however, sulphate reducing bacteria are inadvertently introduced into the reservoir with the injected water the possibility exists of biodegradation of the oil and production of hydrogen sulphide in what otherwise might be a sweet reservoir. This phenomenon was first documented in Russian literature in the early 1960s for some fields in the Caucasus. It seems very unlikely that any analysis of the crude oil would detect the biodegradation, but, as noted by the Russians, the production of small quantities of hydrogen sulphide were relatively easy to detect. About twenty percent of the fields studied are subjected to water injection schemes and any changes in density and sulphur with time that are also apparently related to the initiation of the oil conservation project and the production of hydrogen sulphide will be noted.

SOURCES OF DATA

The main data source was the files of the ERCB. This was supplemented by analyses published by Hitchon and Filby (1983), and for a few crude oils from Devonian strata, from unpublished data in the author's files. For each field and pool scheduled in APMC (1982) all data sources were seached for series of crude oil analyses from individual wells, regardless of whether the pools would be classified as qualifying for the special old oil prices, and excepting those pairs which represented samples from a DST and subsequent initial production. Thus all available data for nearly three hundred fields was sought, and ninety nine data sets selected for study. The basic information can be found in the Appendix. For each block (see Figure 1 for those blocks with scheduled fields and pools) which included suitable data, a table was prepared; there are twenty two tables in the Appendix which have pertinent data. Blocks without available data are indicated by "No Data" in Figure 1. During the course of the search a few extra sets of data were found which were from non-scheduled pools and these are given in Table 23, for information only.

For each of the first twenty two tables, there is a complete list of the scheduled fields by ERCB code and field (pool) name; a dash in the column "well location" indicates no suitable data were found. For the rest of the fields and pools, the individual well location is given, together with the dates sampled, the sampling conditions, and the density and sulphur content of the crude oil. Pressures and temperatures, originally given in non-metric units, were converted to metric to the

nearest kPa and tenth of a degree Celcius, respectively. Unless indicated, the density was measured on cleaned-up crude oil; the date sampled was not given in some cases, and for these samples the date analysed is shown (based on a survey of the rest of the data, this will be within a few days of the actual date sampled). Samples from the report by Hitchon and Filby (1983) are indicated by an asterisk under the date sampled, together with the sample number; if sulphur was determined on the crude oil by instrumented neutron activation analysis this is indicated by (INAA) under the sulphur value. Unpublished analyses of Devonian crude oils in the author's files are indicated by an asterisk and a D-series sample number under the date sampled.

INTERPRETATION OF DATA

Each set of data from tables 1 to 22 in the Appendix is considered sequentially in this section of the report. Any temporal changes in crude oil quality are interpreted in terms of such factors as date of initial production from the well, Gas Conservation Schemes, Oil Conservation Projects, whether Good Production Practice (GPP) as defined by the ERCB is practiced, and any observed regional or vertical variations in crude oil characteristics. When variations in sampling conditions or analytical procedures are believed to be important they are indicated. Bearing in mind the previous discussion on possible causes of temporal variations in crude oil quality, the reader is cautioned that these interpretations are subjective because the data are generally inadequate to <u>prove</u> temporal variations, or the absence thereof. Despite this, the subjective interpretation of nearly one hundred data sets allows some general conclusions to be drawn, as will be noted in the final section of this report.

BONNIE GLEN (D-3A) Table 1 in Appendix

Discovery year:	1951	Initial production:	1969-11-06
Gas Conservation Scheme started:	1954	Initial sampling:	1970-01-08
Oil Conservation Project started:	-	Final sampling:	1972-07-11
		Sampling period (Y-M):	2-05

Comments and interpretation:

Well drilled as a late extension of the pool with open hole production close to the oil/water contact. Pool has a 93 m oil column, with maximum sulphur content and one of the highest densities for crude oil from this pool being reported from this well. Solution gas reinjected. There is tentative evidence for increasing sulphur content towards the oil/water contact, which may be original or (more speculative) due to artifical gas deasphalting. The low sulphur content of the crude oil from this pool, the late production history of this well, and the relatively short sampling period suggest no significant change.

CARSON CREEK NORTH (Beaverhill Lake B) Table 1 in Appendix

Discovery year:	1958	Initial production:	1959-09-22
Gas Conservation Scheme started:	1963	Initial sampling:	1959-10-05
Oil Conservation Project started:	1964-02	Final sampling:	1971-01-13
		Sampling period (Y-M):	11-03

Comments and interpretation:

Duplicate of sample No. 86 by ERCB has density 822 and sulphur 1.7. Field shows no evidence of areal variations in crude oil composition; all gas analyses are sweet except one DST in 6-11-62-13-W5 sampled 1975-01-16, with 0.05% H_2S (duplicate from same DST is sweet). Significant increase in both density and sulphur content over sampling period, which includes commencement of water injection scheme, possibly due to bacterial action. This is despite initial sample being from a stock tank, possible subject to evaporation. More study recommended.

KAYBOB (Beaverhill Lake B) Table 1 in Appendix

Discovery year:	1961	Initial production:	1968-03-19
Gas Conservation Scheme started:	1963	Initial sampling:	1961-12-01
Oil Conservation Project started:	-	Final sampling:	1968-06-20
		Sampling period (Y-M):	5-08

Comments and interpretation:

DST No. 7 has crude oil density 795.2 and sulphur 1.2; well suspended from 1962-04-11 until 1968-03-19, effectively over the sampling period. Significant decrease in sulphur content and change in density probably result from variable sampling conditions (initial sample recovered after gas head cleared by blow-down).

NIPISI (Keg River Ss A) Table 1 in Appendix

Discovery year:	1966	Initial production:	1968-03-31
Gas Conservation Scheme started:	1975	Initial sampling:	1970-05-14
Oil Conservation Project started:	-	Final sampling:	1970-07-15
		Sampling period (Y-M):	-02

Comments and interpretation:

Very short sampling period. No change.

PECO (Cardium A) Table 1 in Appendix

Discovery year:	1956	Initial production:	1956-03-03
Gas Conservation Scheme started:	-	Initial sampling:	1959-03-05
Oil Conservation Project started:	-	Final sampling:	1971-08-20
		Sampling period (Y-M):	12-05

Comments and interpretation:

DST No. 7 has crude oil density 811.2 and sulphur 0.8. Pool subject to GPP. No systematic or significant changes (minor variations probably due to sampling conditions).

RICINUS (Cardium E) — Table 1 in Appendix

Discovery year:	1969	Initial production:	1969-08-13
Gas Conservation Scheme started:	1975	Initial sampling:	1969-08-15
Oil Conservation Project started:	-	Final sampling:	1970-03-17
		Sampling period (Y-M):	-07

Comments and interpretation:

DST No. 3 has crude oil density 825 and sulphur 1.7. Short sampling period. Variations may be due to sampling conditions.

WILLESDEN GREEN (Viking A) — Table 1 in Appendix

Discovery year:	1956	Initial production:	1957-04-27
Gas Conservation Scheme started:	1965	Initial sampling:	1961-08-10
Oil Conservation Project started:	-	Final sampling:	1970-11-18
		Sampling period (Y-M):	9-03

Comments and interpretation:

No significant change.

BLACK (Muskeg A) — Table 2 in Appendix

Discovery year:	1969	Initial production:	1969-01-08
Gas Conservation Scheme started:	-	Initial sampling:	1969-12-18
Oil Conservation Project started:	-	Final sampling:	1980-04-09
		Sampling period (Y-M):	10-05

Comments and interpretation:

DST No. 2 has crude oil density 830 and sulphur 5.2, and DST No. 3 crude oil density 829 and sulphur 5.2; wellhead swab sample taken 1968-12-19 has density 831. No change.

BRAZEAU RIVER (Cardium A) — Table 2 in Appendix

Discovery year:	1966	Initial production:	1966-11-15
Gas Conservation Scheme started:	-	Initial sampling:	1967-01-16
Oil Conservation Project started:	-	Final sampling:	1970-08-20
		Sampling period (Y-M):	3-08

Comments and interpretation:

No significant change.

EAGLESHAM (Debolt D) — Table 2 in Appendix

Discovery year:	1968	Initial production:	1968-01-13
Gas Conservation Scheme started:	-	Initial sampling:	1968-03-11
Oil Conservation Project started:	-	Final sampling:	1970-08-05
		Sampling period (Y-M):	2-05

Comments and interpretation:

Pool suspended 1981-02. No change.

EDSON (Elkton A) — Table 2 in Appendix

Discovery year:	1962	Initial production:	1963-
Gas Conservation Scheme started:	-	Initial sampling:	1963-08-21
Oil Conservation Project started:	-	Final sampling:	1964-04-05
		Sampling period (Y-M):	-08

Comments and interpretation:

Short sampling period. No significant change.

WEST DRUMHELLER (D-2A) — Table 2 in Appendix

Discovery year:	1952	Initial production:	1953-02-12
Gas Conservation Scheme started:	-	Initial sampling:	1953-02-03
Oil Conservation Project started:	-	Final sampling:	1956-05-16
		Sampling period (Y-M):	3-03

Comments and interpretation:

Pool subject to GPP. No change.

ACHESON (Blairmore A): Well 7-11-53-26-W4 — Table 3 in Appendix

Discovery year:	1952	Initial production:	1952-05-10
Gas Conservation Scheme started:	1953	Initial sampling:	1953-05-04
Oil Conservation Project started:	-	Final sampling:	1957-11-18
		Sampling period (Y-M):	4-06

Comments and interpretation:

Pool subject to GPP. No significant change.

ACHESON (Blairmore A): Well 10-11-53-26-W4 — Table 3 in Appendix

Discovery year:	1952	Initial production:	1952-04-06
Gas Conservation Scheme started:	1953	Initial sampling:	1956-06-19
Oil Conservation Project started:	-	Final sampling:	1958-05
		Sampling period (Y-M):	2-00

Comments and interpretation:

Pool subject to GPP. No change.

GARRINGTON (Cardium A) — Table 3 in Appendix

Discovery year:	1954	Initial production:	1955-01-05
Gas Conservation Scheme started:	1974	Initial sampling:	1954-12-15
Oil Conservation Project started:	1965-09	Final sampling:	1957-08-07
		Sampling period (Y-M):	2-09

Comments and interpretation:

Pool subject to GPP. Sampling period is prior to commencement of oil conservation scheme. All wells sampled up to 1980-11-25 in either the Cardium A or Cardium B pools report sweet gas. No change.

GILWOOD (Gilwood A) — Table 3 in Appendix

Discovery year:	1954	Initial production:	1954-04-09
Gas Conservation Scheme started:	-	Initial sampling:	1954-11-15
Oil Conservation Project started:	-	Final sampling:	1969-07-10
		Sampling period (Y-M):	14-09

Comments and interpretation:

Duplicate analysis of No. 91 by ERCB has density 835, sulphur 1.5. Pool subject to GPP. Density shows no temporal change, but sulphur content is small and variable in this and adjacent wells. No significant change.

GLEN PARK (Glauconitic A) — Table 3 in Appendix

Discovery year:	1953	Initial production:	1953-05-31
Gas Conservation Scheme started:	1955	Initial sampling:	1955-08-01
Oil Conservation Project started:	-	Final sampling:	1956-06-22
		Sampling period (Y-M):	-10

Comments and interpretation:

Pool abandoned 1971-05. Very short sampling period. No systematic trend.

GLEN PARK (Glauconitic B) Table 3 in Appendix

Discovery year:	1965	Initial production:	1965-02-09
Gas Conservation Scheme started:	?	Initial sampling:	1965-03-15
Oil Conservation Project started:	-	Final sampling:	1967-10-11
		Sampling period (Y-M):	2-07

Comments and interpretation:

Pool subject to GPP; solution gas reinjected. Density shows no change, but sulphur increases. No systematic trend.

GLEN PARK (D-2A) Table 3 in Appendix

Discovery year:	1952	Initial production:	1952-04-18
Gas Conservation Scheme started:	-	Initial sampling:	1953-06-15
Oil Conservation Project started:	-	Final sampling:	1956-06-20
		Sampling period (Y-M):	3-00

Comments and interpretation:

Pool suspended 1969-12. No change.

GLEN PARK (D-3A) Table 3 in Appendix

Discovery year:	1951	Initial production:	1952-03-02
Gas Conservation Scheme started:	1955	Initial sampling:	1953-06-15
Oil Conservation Project started:	-	Final sampling:	1956-06-20
		Sampling period (Y-M):	3-00

Comments and interpretation:

Sulphur content of initial analysis very low compared to last sample and one other crude oil analysis from this pool; probable analytical error. In addition, USBM distillations also differ considerably. Solution gas reinjected. On the basis of density, no significant change.

GOLDEN SPIKE (D-3B) Table 3 in Appendix

Discovery year:	1950	Initial production:	1959-05-26
Gas Conservation Scheme started:	1974	Initial sampling:	1959-05-22
Oil Conservation Project started:	-	Final sampling:	1962-07-27
		Sampling period (Y-M):	3-02

Comments and interpretation:

DST No. 3 has crude oil density 858 and sulphur 7.3. Initial sample is from well swab and similar to DST crude oil characteristics, hence temporal trends indeterminate.

GOOSE RIVER (D-2A) Table 3 in Appendix

Discovery year:	1965	Initial production:	1966-07-31
Gas Conservation Scheme started:	-	Initial sampling:	1966-07-31
Oil Conservation Project started:	-	Final sampling:	1967-09-23
		Sampling period (Y-M):	1-02

Comments and interpretation:

DST No. 1 has crude oil density 859 and sulphur 3.3. Pool abandoned 1969-08. No systematic trend.

GOOSE RIVER (Beaverhill Lake B) Table 3 in Appendix

Discovery year:	1965	Initial production:	?
Gas Conservation Scheme started:	-	Initial sampling:	1965-03-29
Oil Conservation Project started:	-	Final sampling:	1968-11-07
		Sampling period (Y-M):	3-07

Comments and interpretation:

Pool suspended 1976-03. No change.

LEDUC-WOODBEND (Blairmore K) Table 3 in Appendix

Discovery year:	1951	Initial production:	1951-05-22
Gas Conservation Scheme started:	?	Initial sampling:	1953-03-18
Oil Conservation Project started:	-	Final sampling:	1956-08-02
		Sampling period (Y-M):	3-04

Comments and interpretation:

Pool subject to GPP. Effectively no change.

LEDUC-WOODBEND (D-3A) Table 3 in Appendix

Discovery year:	1947	Initial production:	1948-09-06
Gas Conservation Scheme started:	1950	Initial sampling:	1959-03-25
Oil Conservation Project started:	1960-10	Final sampling:	1966-09-09
		Sampling period (Y-M):	7-05

Comments and interpretation:

Initial sample obtained before oil conservation scheme started. No change.

PEMBINA (Belly River H) Table 3 in Appendix

Discovery year:	1956	Initial production:	1956-01-21
Gas Conservation Scheme started:	1958	Initial sampling:	1956-03-22
Oil Conservation Project started:	-	Final sampling:	1958-03-12
		Sampling period (Y-M):	2-00

Comments and interpretation:

Pool subject to GPP. No change.

PEMBINA (Keystone Belly River X) Table 3 in Appendix

Discovery year:	1965	Initial production:	1965-07-06
Gas Conservation Scheme started:	?	Initial sampling:	1968-08-08
Oil Conservation Project started:	1978-04	Final sampling:	1969-05-13
		Sampling period (Y-M):	-09

Comments and interpretation:

Sampling period prior to start of oil conservation scheme; very short sampling period. No change.

PEMBINA (Keystone Ellerslie A) Table 3 in Appendix

Discovery year:	1957	Initial production:	1957-07-21
Gas Conservation Scheme started:	1958	Initial sampling:	1958-11-21
Oil Conservation Project started:	-	Final sampling:	1970-02-04
		Sampling period (Y-M):	11-03

Comments and interpretation:

No change.

PEMBINA (Pekisko A) Table 3 in Appendix

Discovery year:	1960	Initial production:	1960-02-24
Gas Conservation Scheme started:	-	Initial sampling:	1960-02-20
Oil Conservation Project started:	-	Final sampling:	1962-04-11
		Sampling period (Y-M):	2-01

Comments and interpretation:

No change in density, but considerable reduction in sulphur content - for which there is no obvious explanation. Both density and sulphur vary considerably in nearby crude oils from DSTs in Pekisko Formation. Temporal trends indeterminate.

SENEX (Keg River A) Table 3 in Appendix

Discovery year:	1969	Initial production:	1970-01-24
Gas Conservation Scheme started:	-	Initial sampling:	1969-07-17
Oil Conservation Project started:	-	Final sampling:	1970-03-19
		Sampling period (Y-M):	-08

Comments and interpretation:

DST No. 1 has crude oil density 824.1 and sulphur 3.1, similar to final sample taken two months after well came on stream. Initial sample is from swabbing operation and probably unreliable. Temporal trends indeterminate.

WASKAHIGAN (Dunvegan A) Table 3 in Appendix

Discovery year:	1967	Initial production:	?
Gas Conservation Scheme started:	-	Initial sampling:	1969-03-04
Oil Conservation Project started:	-	Final sampling:	1970-07-24
		Sampling period (Y-M):	1-04

Comments and interpretation:

Pool subject to GPP with maximum rate limitation. Sulphur content very low, but suggests effectively no change.

CROSSFIELD (Jumping Pound A) Table 4 in Appendix

Discovery year:	1961	Initial production:	1961-02-16
Gas Conservation Scheme started:	-	Initial sampling:	1961-02-15
Oil Conservation Project started:	-	Final sampling:	1970-06-23
		Sampling period (Y-M):	9-04

Comments and interpretation:

Pool subject to GPP. Effectively no change.

CROSSFIELD (Viking A) Table 4 in Appendix

Discovery year:	1964	Initial production:	1964-02-20
Gas Conservation Scheme started:	-	Initial sampling:	1966-10-28
Oil Conservation Project started:	-	Final sampling:	1969-04-08
		Sampling period (Y-M):	2-05

Comments and interpretation:

DST No. 1 has crude oil density 842 and sulphur "trace". Pool subject to GPP. No change.

CROSSFIELD (Rundle D) Table 4 in Appendix

Discovery year:	?	Initial production:	?
Gas Conservation Scheme started:	-	Initial sampling:	1951-08-14
Oil Conservation Project started:	-	Final sampling:	1963-08-22
		Sampling period (Y-M):	12-00

Comments and interpretation:

A condensate. Initial analysis suspect. Temporal changes indeterminate.

MALMO (Blairmore A) Table 4 in Appendix

Discovery year:	1952	Initial production:	1952-09-01
Gas Conservation Scheme started:	-	Initial sampling:	1952-11
Oil Conservation Project started:	-	Final sampling:	1970-11-03
		Sampling period (Y-M):	18-00

Comments and interpretation:

Note that initial sampling conditions are unknown; bearing in mind the early date of the initial sample -- effectively no change.

STURGEON LAKE (D-3) Table 4 in Appendix

Discovery year:	1952	Initial production:	1952-10-18
Gas Conservation Scheme started:	1980	Initial sampling:	1953-12-10
Oil Conservation Project started:	-	Final sampling:	1957-08-28
		Sampling period (Y-M):	3-10

Comments and interpretation:

No evidence of vertical variations in crude oil composition. Both 1953 crude oil analyses have low sulphur values, possibly due to analytical techniques. Based on density, effectively no change.

WESTWARD HO (Rundle A) Table 4 in Appendix

Discovery year:	1955	Initial production:	1955-02-28
Gas Conservation Scheme started:	1969	Initial sampling:	1955-02-26
Oil Conservation Project started:	1964-10	Final sampling:	1958-04-28
		Sampling period (Y-M):	3-02

Comments and interpretation:

Sampling period prior to commencement of oil conservation project. No change.

BASHAW (D-3A) Table 5 in Appendix

Discovery year:	1951	Initial production:	1951-08-06
Gas Conservation Scheme started:	-	Initial sampling:	1951-09-20
Oil Conservation Project started:	-	Final sampling:	1955-03-28
		Sampling period (Y-M):	3-06

Comments and interpretation:

Pool subject to GPP. Effectively no change.

DEL BONITA (Rundle): Well 15-18-1-21-W4 — Table 5 in Appendix

Discovery year:	1936	Initial production:	?
Gas Conservation Scheme started:	-	Initial sampling:	1939-01-17
Oil Conservation Project started:	-	Final sampling:	1946-07-25
		Sampling period (Y-M):	7-06

Comments and interpretation:

Pool subject to GPP. Despite the very early date of both samples, density shows effectively no change.

DEL BONITA (Rundle): Well 5-19-1-21-W4 — Table 5 in Appendix

Discovery year:	1936	Initial production:	-
Gas Conservation Scheme started:	-	Initial sampling:	1956-08-08
Oil Conservation Project started:	-	Final sampling:	1962-03-15
		Sampling period (Y-M):	5-07

Comments and interpretation:

Pool subject to GPP. Initial sample has higher density, probably related to its source from a stock tank; sulphur content is constant. No change.

DUHAMEL (D-2A) — Table 5 in Appendix

Discovery year:	1951	Initial production:	1952-03-07
Gas Conservation Scheme started:	1972	Initial sampling:	1953-06-17
Oil Conservation Project started:	-	Final sampling:	1959-08-14
		Sampling period (Y-M):	6-02

Comments and interpretation:

Minor increase in both density and sulphur, without obvious cause. Effectively no change.

DUHAMEL (D-3B) — Table 5 in Appendix

Discovery year:	1950	Initial production:	1951-09-20
Gas Conservation Scheme started:	1972	Initial sampling:	1952-09-02
Oil Conservation Project started:	-	Final sampling:	1960-08-14
		Sampling period (Y-M):	7-00

Comments and interpretation:

No systematic changes. Effectively no change.

HUSSAR (Viking B) — Table 5 in Appendix

Discovery year:	1955	Initial production: (?)	1964-10-11
Gas Conservation Scheme started:	1959	Initial sampling:	1965-01-26
Oil Conservation Project started:	-	Final sampling:	1967-07-05
		Sampling period (Y-M):	2-05

Comments and interpretation:

Effectively no change.

HUSSAR (Basal Mannville Z) — Table 5 in Appendix

Discovery year:	1955	Initial production:	1955-10-13
Gas Conservation Scheme started:	1959	Initial sampling:	1962-04-26
Oil Conservation Project started:	-	Final sampling:	1967-09-20
		Sampling period (Y-M):	5-05

Comments and interpretation:

Both density and sulphur higher in final sample from stock tank drain, probably due to evaporation of light ends. Temporal changes indeterminate.

NITON (Basal Quartz B) — Table 5 in Appendix

Discovery year:	1965	Initial production:	1966-01-10
Gas Conservation Scheme started:	-	Initial sampling:	1966-01-12
Oil Conservation Project started:	1978-10	Final sampling:	1967-05-24
		Sampling period (Y-M):	1-04

Comments and interpretation:

Sampling period prior to start of oil conservation project. Both density and sulphur higher in initial sample from lease tank, probably due to evaporation of light ends. Temporal changes indeterminate.

NORMANDVILLE (Mississippian B) Table 5 in Appendix

Discovery year:	1957	Initial production:	1957-09-18
Gas Conservation Scheme started:	-	Initial sampling:	1957-09-10
Oil Conservation Project started:	-	Final sampling:	1959-07-17
		Sampling period (Y-M):	1-10

Comments and interpretation:

Pool abandoned 1961-11. Because the initial sample was from swabbing and the final sample from a tank (with the possibility of loss of light ends by evaporation), temporal changes are indeterminate.

NORMANDVILLE (D-1A) Table 5 in Appendix

Discovery year:	1957	Initial production:	1957-03-02
Gas Conservation Scheme started:	-	Initial sampling:	1958-05-08
Oil Conservation Project started:	-	Final sampling:	1970-07-22
		Sampling period (Y-M):	12-02

Comments and interpretation:

Pool subject to GPP. Probably no effective change.

NORMANDVILLE (D-3A) Table 5 in Appendix

Discovery year:	1949	Initial production:	1949-10-12
Gas Conservation Scheme started:	-	Initial sampling:	1949-10
Oil Conservation Project started:	-	Final sampling:	1972-09-21
		Sampling period (Y-M):	23-00

Comments and interpretation:

Pool subject to GPP. This is the longest sampling period found. Bearing in mind the early date of the first few samples and the very variable source of the samples (when known), there is surprisingly little variation over the 23 year sampling period. No significant change.

NORMANDVILLE (D-3B) — Table 5 in Appendix

Discovery year:	1958	Initial production:	1958-04-18
Gas Conservation Scheme started:	-	Initial sampling:	1959-07-16
Oil Conservation Project started:	-	Final sampling:	1964-09-16
		Sampling period (Y-M):	5-02

Comments and interpretation:

Pool subject to GPP. No change in density.

BIGORAY (Ostracod) — Table 6 in Appendix

Discovery year:	1959	Initial production:	1961-05-08
Gas Conservation Scheme started:	1980	Initial sampling:	1961-05-24
Oil Conservation Project started:	1964-12	Final sampling:	1962-06-21
		Sampling period (Y-M):	1-01

Comments and interpretation:

Sampling period short, and prior to start of oil conservation project. Small decrease in density and sulphur probably not significant, and without apparent reason. Effectively no change.

WORSLEY (D-3B) — Table 6 in Appendix

Discovery year:	1960	Initial production:	?
Gas Conservation Scheme started:	-	Initial sampling:	1961-03-03
Oil Conservation Project started:	-	Final sampling:	1968-11-20
		Sampling period (Y-M):	7-07

Comments and interpretation:

Condensate. Initial sample from low pressure open flow potential test. Because these are condensate samples with very low sulphur contents the decrease in density and sulphur probably relates to sampling or analytical variables. Temporal changes indeterminate.

BONNIE GLEN (Cardium A) — Table 7 in Appendix

Discovery year:	1955	Initial production:	1955-07-31
Gas Conservation Scheme started:	?	Initial sampling:	1955-11-16
Oil Conservation Project started:	1972-12	Final sampling:	1963-11-22
		Sampling period (Y-M):	8-00

Comments and interpretation:

Sampling period prior to start of oil conservation project. Pool subject to GPP. No change.

GILBY (Cardium A) — Table 8 in Appendix

Discovery year:	1962	Initial production:	1962-06-10
Gas Conservation Scheme started:	-	Initial sampling:	1966-09-20
Oil Conservation Project started:	-	Final sampling:	1970-07-20
		Sampling period (Y-M):	3-10

Comments and interpretation:

Pool subject to GPP. Effectively no change.

PROVOST (Viking A,C,K): Well 7-14-37-7-W4 — Table 8 in Appendix

Discovery year:	1946	Initial production:	1958-09-12
Gas Conservation Scheme started:	1971	Initial sampling:	1959-10-02
Oil Conservation Project started:	1969-06	Final sampling:	1970-06-29
		Sampling period (Y-M):	10-09

Comments and interpretation:

Pool subject to GPP. Sample period includes starting date of oil conservation project. There is a small increase in density and a significant increase in sulphur content which are not obviously related to sampling conditions. With one exception (which may be an analytical error), all gas analyses from the Viking Formation in the Provost field are sweet; this includes samples that were taken in the townships in and around the waterflood project, both before and after the commencement of the oil conservation project. It therefore seems unlikely that the change in crude oil characteristics is related to the waterflood project. Therefore the reason for the composition change remains unknown and indeterminate.

PROVOST (Viking A, C, K): Well 7-30-38-7-W4 — Table 8 in Appendix

Discovery year:	1946	Initial production:	1954-02-05
Gas Conservation Scheme started:	1971	Initial sampling:	1955-08-15
Oil Conservation Project started:	-	Final sampling:	1960-10-02
		Sampling period (Y-M):	5-01

Comments and interpretation:

Pool subject to GPP. Note that this sample is not from an area within an oil conservation project. Effectively, a small decrease in density is accompanied by a significant decrease in sulphur content, which appears unrelated to sampling conditions (other than a possible decrease in sampling pressure). Reason for changes indeterminate.

REDWATER (D-3) — Table 8 in Appendix

Discovery year:	1948	Initial production:	1951-01-14
Gas Conservation Scheme started:	1956	Initial sampling:	1969-05-07
Oil Conservation Project started:	-	Final sampling:	1969-07-09
		Sampling period (Y-M):	-02

Comments and interpretation:

Very short time period. No change.

ST. ALBERT - BIG LAKE (Big Lake D-2A) — Table 8 in Appendix

Discovery year:	1956	Initial production:	1958-06-05
Gas Conservation Scheme started:	-	Initial sampling:	1961-07-10
Oil Conservation Project started:	-	Final sampling:	1972-07-19
		Sampling period (Y-M):	11-00

Comments and interpretation:

Density constant; small increase in sulphur, probably not significant. Effectively no change.

SKARO (Cooking Lake) Table 8 in Appendix

Discovery year:	1952	Initial production:	1952-06-06
Gas Conservation Scheme started:	-	Initial sampling:	1959-08-20
Oil Conservation Project started:	-	Final sampling:	1972-07-25
		Sampling period (Y-M):	12-11

Comments and interpretation:

Pool subject to GPP. Increase in density and sulphur probably not significant. Effectively no change.

BOUNDARY LAKE SOUTH (Triassic E) Table 9 in Appendix

Discovery year:	1964	Initial production:	1964-06-23
Gas Conservation Scheme started:	-	Initial sampling:	1967-06-02
Oil Conservation Project started:	1972-05	Final sampling:	1970-07-23
		Sampling period (Y-M):	3-02

Comments and interpretation:

Sample period is prior to commencement of oil conservation project. Small increase in density and significant increase in sulphur which appear unrelated to sampling conditions. Other sulphur values in pool are in range 6.5 to 9.3 (avg. 7.6), suggesting an analytical error in the initial sample. Probably effectively no change.

MEDICINE RIVER (Ostracod A) Table 9 in Appendix

Discovery year:	1963	Initial production:	1963-10-14
Gas Conservation Scheme started:	1972	Initial sampling:	1963-12-04
Oil Conservation Project started:	1970-09	Final sampling:	1970-06-18
		Sampling period (Y-M):	6-08

Comments and interpretation:

Well just outside oil conservation project and sampling period just prior to commencement. Effectively no change.

SPRING COULEE (Rundle): Well 11-36-3-23-W4 — Table 9 in Appendix

Discovery year:	1950	Initial production:	1951-01-21
Gas Conservation Scheme started:	-	Initial sampling:	1950-10-31
Oil Conservation Project started:	-	Final sampling:	1954-04-13
		Sampling period (Y-M):	3-04

Comments and interpretation:

Source of initial sample unknown and source of final sample was a stock tank. Both early analyses. Temporal changes indeterminate.

SPRING COULEE (Rundle): Well 14-36-3-23-W4 — Table 9 in Appendix

Discovery year:	1950	Initial production:	1950-
Gas Conservation Scheme started:	-	Initial sampling:	1950-04-02
Oil Conservation Project started:	-	Final sampling:	1962-03-15
		Sampling period (Y-M):	12-00

Comments and interpretation:

All samples from stock tanks. Temporal changes indeterminate.

DRUMHELLER (Mannville A) — Table 10 in Appendix

Discovery year:	1950	Initial production:	1951-05-19
Gas Conservation Scheme started:	-	Initial sampling:	1956-05-16
Oil Conservation Project started:	-	Final sampling:	1957-08-30
		Sampling period (Y-M):	1-03

Comments and interpretation:

Pool subject to GPP. No change.

DRUMHELLER (D-2B) — Table 10 in Appendix

Discovery year:	1962	Initial production:	1962-08-19
Gas Conservation Scheme started:	-	Initial sampling:	1962-12-14
Oil Conservation Project started:	-	Final sampling:	1966-06-09
		Sampling period (Y-M):	3-07

Comments and interpretation:

DST No. 2 has crude oil density 872 and sulphur 9.9. Probably no significant change.

GHOST PINE (Lower Mannville B) Table 10 in Appendix

Discovery year:	1959	Initial production:	1959-11-03
Gas Conservation Scheme started:	-	Initial sampling:	1959-11-17
Oil Conservation Project started:	-	Final sampling:	1970-09-08
		Sampling period (Y-M):	9-11

Comments and interpretation:

Pool subject to GPP. No systematic trend; initial and final samples effectively the same. Intermediate sample may be in error. Effectively no change.

GHOST PINE (Pekisko F) Table 10 in Appendix

Discovery year:	1965	Initial production:	1965 -
Gas Conservation Scheme started:	-	Initial sampling:	1965-12-08
Oil Conservation Project started:	-	Final sampling:	1967-09-12
		Sampling period (Y-M):	1-10

Comments and interpretation:

DST No. 2 has crude oil density 875 and 873 (duplicate samples). Pool subject to GPP. No change.

BARONS (Colorado) Table 11 in Appendix

Discovery year:	1950	Initial production:	1952-11-27
Gas Conservation Scheme started:	-	Initial sampling:	1953-02
Oil Conservation Project started:	-	Final sampling:	1955-03-29
		Sampling period (Y-M):	2-01

Comments and interpretation:

Pool subject to GPP. Higher density and sulphur of initial sample probably relate to a source from stock tank. Temporal variations indeterminate.

PEAVEY (Viking) Table 12 in Appendix

Discovery year:	1953	Initial production:	1953-09-11
Gas Conservation Scheme started:	-	Initial sampling:	1957-01-16
Oil Conservation Project started:	-	Final sampling:	1960-04-27
		Sampling period (Y-M):	3-03

Comments and interpretation:

Pool subject to GPP. Effectively no change.

SUNDRE (Rundle A) Table 12 in Appendix

Discovery year:	1955	Initial production:	1955-01-25
Gas Conservation Scheme started:	1969	Initial sampling:	1955-01-25
Oil Conservation Project started:	1959-12	Final sampling:	1955-07-14
		Sampling period (Y-M):	-05

Comments and interpretation:

Short time period prior to commencement of oil conservation project. Effectively no change.

SYLVAN LAKE - LANAWAY WEST (Pekisko B) Table 12 in Appendix

Discovery year:	1962	Initial production:	1963-09-18
Gas Conservation Scheme started:	-	Initial sampling:	1969-06-24
Oil Conservation Project started:	-	Final sampling:	1969-07-04
		Sampling period (Y-M):	-01

Comments and interpretation:

Very short time period; differences almost certainly due to different analytical laboratories and techniques.

SYLVAN LAKE - LANAWAY WEST (Pekisko E) Table 12 in Appendix

Discovery year:	1963	Initial production:	1963-03-07
Gas Conservation Scheme started:	-	Initial sampling:	1964-02-18
Oil Conservation Project started:	-	Final sampling:	1967-11-10
		Sampling period (Y-M):	3-08

Comments and interpretation:

Pool suspended 1972-11. Probably effectively no change.

WOOD RIVER (D-2B) Table 12 in Appendix

Discovery year:	1963	Initial production:	1963-12-11
Gas Conservation Scheme started:	-	Initial sampling:	1966-10-27
Oil Conservation Project started:	-	Final sampling:	1972-02-18
		Sampling period (Y-M):	5-04

Comments and interpretation:

DST No. 2 has crude oil density 890 and sulphur 12.5. Pool subject to GPP. Higher sulphur of final sample may be due to source from storage tank. No systematic change in density from DST to final sample. Temporal changes indeterminate.

FENN BIG VALLEY (Big Valley D-3A) Table 13 in Appendix

Discovery year:	1950	Initial production:	1950-11-25
Gas Conservation Scheme started:	1956	Initial sampling:	1951-10-02
Oil Conservation Project started:	-	Final sampling:	1959-06-24
		Sampling period (Y-M):	7-09

Comments and interpretation:

Although the sulphur gradually increases, density is variable. Because of this and both the lack of data on sampling conditions for the initial sample and the early time of the first two samples, the trends are probably not significant.

FENN BIG VALLEY (Fenn D-3E) Table 13 in Appendix

Discovery year:	1953	Initial production:	1953-03-09
Gas Conservation Scheme started:	1956	Initial sampling:	1956-06-14
Oil Conservation Project started:	-	Final sampling:	1972-10-17
		Sampling period (Y-M):	16-04

Comments and interpretation:

Pool subject to GPP. Probably insignificant changes in density; sulphur remarkably constant. No change.

RED COULEE (Cutbank B) — Table 13 in Appendix

Discovery year:	1960	Initial production:	1960-08-30
Gas Conservation Scheme started:	-	Initial sampling:	1962-03-15
Oil Conservation Project started:	-	Final sampling:	1970-08-11
		Sampling period (Y-M):	8-05

Comments and interpretation:

Both DST No. 1 and DST No. 2 have crude oil density 884 and sulphur 17.4. Pool subject to GPP. Effectively no change.

STETTLER (D-2A) — Table 13 in Appendix

Discovery year:	1949	Initial production:	1949-11-28
Gas Conservation Scheme started:	1956	Initial sampling:	1949-11-30
Oil Conservation Project started:	1957-05	Final sampling:	1961-11-10
		Sampling period (Y-M):	12-00

Comments and interpretation:

Sampling period includes commencement of oil conservation project. Pool subject to GPP. Density effectively the same, but the early date of the initial analysis means the apparent trend may be due to analytical error. Probably effectively no change.

CAMPBELL NAMAO (Namao Blairmore C) — Table 14 in Appendix

Discovery year:	1953	Initial production:	1953-03-31
Gas Conservation Scheme started:	1972	Initial sampling:	1954-01-08
Oil Conservation Project started:	-	Final sampling:	1962-04-17
		Sampling period (Y-M):	8-03

Comments and interpretation:

Pool subject to GPP. No change.

FAIRYDELL - BON ACCORD (D-2B): Well 12-16-57-24-W4 Table 14 in Appendix

Discovery year:	1954	Initial production:	1954-11-11
Gas Conservation Scheme started:	-	Initial sampling:	1954-11-15
Oil Conservation Project started:	-	Final sampling:	1958-04-28
		Sampling period (Y-M):	3-06

Comments and interpretation:

Density constant; sulphur change probably not significant. Effectively no change.

FAIRYDELL - BON ACCORD (D-2B): Well 16-17-57-24-W4 Table 14 in Appendix

Discovery year:	1954	Initial production:	1955-06-16
Gas Conservation Scheme started:	-	Initial sampling:	1956-06-19
Oil Conservation Project started:	-	Final sampling:	1965-07-15
		Sampling period (Y-M):	9-01

Comments and interpretation:

No systematic trend. Probably no significant change.

MEDICINE RIVER (Jurassic A): Well 6-28-39-3-W5 Table 14 in Appendix

Discovery year:	1956	Initial production:	1959-09-29
Gas Conservation Scheme started:	1972	Initial sampling:	1959-12-27
Oil Conservation Project started:	1966-02	Final sampling:	1962-03-08
		Sampling period (Y-M):	2-03

Comments and interpretation:

Sampling period prior to commencement of oil conservation project. Effectively no change.

MEDICINE RIVER (Jurassic A): Well 7-32-39-3-W5 Table 14 in Appendix

Discovery year:	1956	Initial production:	1956-10-10
Gas Conservation Scheme started:	1972	Initial sampling:	1956-08-11
Oil Conservation Project started:	1966-02	Final sampling:	1970-06-18
		Sampling period (Y-M):	13-10

Comments and interpretation:

Sampling period includes start of oil conservation project. Initial sample was a swab test; no density for final sample; sulphur effectively the same. Probably effectively no change.

MEDICINE RIVER (Basal Quartz G)

Table 14 in Appendix

Discovery year:	1963	Initial production:	1963-01-11
Gas Conservation Scheme started:	1972	Initial sampling:	1968-05-07
Oil Conservation Project started:	1967-12	Final sampling:	1970-06-16
		Sampling period (Y-M):	2-01

Comments and interpretation:

Sampling period was after commencement of oil conservation project. Pool suspended 1982-03. Significant increase of both density and sulphur, which is not obviously attributable to variations in sampling conditions. Only gas analysis from this pool was sampled 1970-06-09 from the same well and was sweet. Sample description of final sample, as received, records one inch of "glup" on the bottom of the container. Therefore, not only was this material indeterminate, but so are any temporal variations in crude oil quality!

MEDICINE RIVER (Pekisko B)

Table 14 in Appendix

Discovery year:	1959	Initial production:	1960-10-04
Gas Conservation Scheme started:	1972	Initial sampling:	1960-11-04
Oil Conservation Project started:	1970-09	Final sampling:	1961-08-15
		Sampling period (Y-M):	-10

Comments and interpretation:

DST No. 3 has crude oil density 899.9 and sulphur 16.3. Short time period, prior to commencement of oil conservation project. Density effectively constant, with small, probably not significant, decrease in sulphur. Effectively no change.

MEDICINE RIVER (Pekisko I)

Table 14 in Appendix

Discovery year:	1954	Initial production:	1955-08-27
Gas Conservation Scheme started:	1972	Initial sampling:	1957-02-20
Oil Conservation Project started:	-	Final sampling:	1961-08-15
		Sampling period (Y-M):	4-06

Comments and interpretation:

No change.

NEVIS (Devonian) Table 14 in Appendix

Discovery year:	1952	Initial production:	1959-12-06
Gas Conservation Scheme started:	-	Initial sampling:	1952-04-17
Oil Conservation Project started:	-	Final sampling:	1959-11-18
		Sampling period (Y-M):	7-07

Comments and interpretation:

Well capped from 1952-08 until 1959-12-06. Pool suspended 1962-05. Major differences in density and sulphur probably relate to sampling variables (not specified for the initial sample) for this light crude oil. Temporal changes indeterminate.

ERSKINE (D-2) Table 15 in Appendix

Discovery year:	1959	Initial production:	1959-04-10
Gas Conservation Scheme started:	1970	Initial sampling:	1959-06-30
Oil Conservation Project started:	-	Final sampling:	1970-03-25
		Sampling period (Y-M):	10-09

Comments and interpretation:

Pool subject to GPP. Small change in sulphur; probably not significant. Probably effectively no change.

ERSKINE (D-3) Table 15 in Appendix

Discovery year:	1953	Initial production:	1955-07-09
Gas Conservation Scheme started:	1970	Initial sampling:	1956-06-13
Oil Conservation Project started:	-	Final sampling:	1970-02-18
		Sampling period (Y-M):	13-08

Comments and interpretation:

Effectively no change.

BANTRY (Mannville A) — Table 16 in Appendix

Discovery year:	1948	Initial production:	1948-01-03
Gas Conservation Scheme started:	1969	Initial sampling:	1952-10-02
Oil Conservation Project started:	-	Final sampling:	1954-04-26
		Sampling period (Y-M):	1-07

Comments and interpretation:

No change.

BANTRY (Mannville M) — Table 16 in Appendix

Discovery year:	1950	Initial production:	1958-09-02
Gas Conservation Scheme started:	1969	Initial sampling:	1958-10-10
Oil Conservation Project started:	-	Final sampling:	1962-06-08
		Sampling period (Y-M):	3-09

Comments and interpretation:

Pool suspended 1975-01. No change.

CONRAD (Ellis) — Table 17 in Appendix

Discovery year:	1944	Initial production:	1945-08-04
Gas Conservation Scheme started:	-	Initial sampling:	1952-10-15
Oil Conservation Project started:	-	Final sampling:	1962-06-06
		Sampling period (Y-M):	9-08

Comments and interpretation:

Pool subject to GPP. No change.

BLACK BUTTE (Mannville B) — Table 18 in Appendix

Discovery year:	1969	Initial production:	1969-06-11
Gas Conservation Scheme started:	-	Initial sampling:	1969-06-12
Oil Conservation Project started:	-	Final sampling:	1970-04-24
		Sampling period (Y-M):	-11

Comments and interpretation:

Pool subject to GPP. Effectively no change.

CESSFORD (Basal Colorado A)

Table 19 in Appendix

Discovery year:	1952	Initial production:	1952-11-20
Gas Conservation Scheme started:	1962	Initial sampling:	1956-05-31
Oil Conservation Project started:	-	Final sampling:	1962-02-02
		Sampling period (Y-M):	5-08

Comments and interpretation:

Pool subject to GPP. No change.

GLENEVIS (Banff)

Table 19 in Appendix

Discovery year:	1951(?)	Initial production:	1951-09-07
Gas Conservation Scheme started:	-	Initial sampling:	1956-05-29
Oil Conservation Project started:	-	Final sampling:	1965-05-13
		Sampling period (Y-M):	9-00

Comments and interpretation:

Pool subject to GPP. Effectively no change.

CHAUVIN SOUTH (Sparky A/B)

Table 20 in Appendix

Discovery year:	1952	Initial production:	1968-12-20
Gas Conservation Scheme started:	-	Initial sampling:	1969-05-09
Oil Conservation Project started:	-	Final sampling:	1970-02-24
		Sampling period (Y-M):	-11

Comments and interpretation:

No change.

JENNER (Upper Mannville F)

Table 21 in Appendix

Discovery year:	1965	Initial production:	1965-08-10
Gas Conservation Scheme started:	-	Initial sampling:	1965-11-25
Oil Conservation Project started:	-	Final sampling:	1966-06-27
		Sampling period (Y-M):	-08

Comments and interpretation:

DST No. 3 has crude oil density 962 and sulphur 26.1. Pool subject to GPP. Based on density, no change over short time period.

JENNER (Lower Mannville A) Table 21 in Appendix

Discovery year:	1965	Initial production:	1965-08-09
Gas Conservation Scheme started:	-	Initial sampling:	1964-12
Oil Conservation Project started:	-	Final sampling:	1965-11-25
		Sampling period (Y-M):	1-00

Comments and interpretation:

DST No. 2 has crude oil density 977 and sulphur 29.6. Pool suspended 1969-11. Based on ERCB G-Order 3743, effective 1983-02-01, well now outside Lower Mannville A pool. Based on density, no change over short time period.

TABER (Mannville A) Table 21 in Appendix

Discovery year:	1944	Initial production:	1944-?
Gas Conservation Scheme started:	-	Initial sampling:	1952-12
Oil Conservation Project started:	-	Final sampling:	1954-08-16
		Sampling period (Y-M):	1-09

Comments and interpretation:

Pool subject to GPP. Effectively no change.

TABER (Mannville D) Table 21 in Appendix

Discovery year:	1942	Initial production:	1949-12-22
Gas Conservation Scheme started:	-	Initial sampling:	1945-01-03
Oil Conservation Project started:	1971-01	Final sampling:	1962-06-07
		Sampling period (Y-M):	17-06

Comments and interpretation:

Well completed 1943-12-22, but not as a Taber oilwell until 1949-12-22. Samples taken prior to commencement of oil conservation project. GPP in waterflood project area. Effectively no change.

TABER SOUTH (Mannville B)

Table 22 in Appendix

Discovery year:	1963	Initial production:	1963-06-19
Gas Conservation Scheme started:	-	Initial sampling:	1963-07-30
Oil Conservation Project started:	1967-02	Final sampling:	1965-07-19
		Sampling period (Y-M):	2-00

Comments and interpretation:

Sampling period prior to commencement of oil conservation project. GPP in waterflood area. Based on density, probably no significant change.

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SUMMARY OF INTERPRETATIONS

Ninety nine sets of data have been interpreted, representing crude oils ranging effectively from condensates to heavy crude oils, with corresponding variations in density and sulphur content. They came from pools scattered all over Alberta, representing both major and minor reserves, and discovery dates from 1936 to 1969. The sampling periods range from one month to 23 years, with an average of five years and seven months.

For data sets from wells in oil conservation project areas, most were sampled prior to commencement of the project, and one after the project commenced. In four cases the project commencement date fell within the sampling period. In no instance was it demonstrated that the injection of water had affected crude oil quality, although some were indeterminate (for a variety of reasons) and more study was recommended in another case.

The subjective conclusions may be summarized as follows:

No change	33%
Effectively no change	30%
No significant change	13%
Indeterminate	16%
Other	8%

CONCLUSIONS

1. From a subjective interpretation of ninety nine sets of data from individual wells, representing a full range of crude oil quality (based on density and sulphur content), areal distribution, size of reserve and discovery date, for sampling periods of up to 23 years, it was found that more than three quarters of the data sets showed no change, effectively no change, or no significant change of crude oil quality with time.

2. Sixteen percent of the interpretations were classed as indeterminate, and eight percent represented changes in crude oil quality definitely attributable to sampling and analytical variations; in a few data sets with multiple samples there were no systematic trends from which an interpretation could be made.

3. Based on the evidence available at this time, the injection of water during the operation of an oil conservation project does not appear to affect crude oil quality. This statement must be qualified, however, with the observation that only nineteen of the data sets were from wells in oil conservation project areas, out of a total of more than four hundred approved projects, and the majority of the sampling periods were prior to commencement of the project.

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APPENDIX

Table 1. BLOCK D1, S1 (D1 824 and under, S1 0.0-2.4)

Temporal Changes in Density and Sulphur from Individual Wells

ERCB Code	Field (Pool)	Well Location	Date Sampled (Y-M-D)	Sampling Conditions	Density (kg/m^3)	Sulphur (g/kg)
055	Ante Creek	-				
056	Ante Creek North	-				
107	Beaton	-				
151	Bonnie Glen (D-3A)	5-21-47-27-W4	1970-01-08	Separator, flowing (55kPa, 4.4°C)	815.6	3.3
			1972-07-11	Inlet line to treater, pumping	829	2.9
			(* 11-D)	(207kPa, 27.8°C)		
198	Carson Creek	-				
200	Carson Creek North (Beaverhill Lake B)	6-9-62-12-W5	1959-10-05	Stock Tank, flowing (99kPa, -1°C)	803	0.8
			1971-01-13 (* No. 86)	Wellhead, flowing	824	1.4
354	Ethel	-				
377	Ferrier	-				
505	Joffre-Viking, D2 Pools	-				
507	Joffre South	-				
509	Judy Creek	-				
510	Judy Creek South	-				
513	Kaybob (Beaverhill Lake B)	2-4-64-18-W5	1961-12-01	Tubing, flowing (Atmos. press. & temp.)	808	1.1
			1968-06-20	Separator, flowing	781	0.6
519	Kakwa	-				
521	Jayar	-				
604	Medicine River-Viking Pool	-				
615	Mitsue	-				
644	Nipisi (Keg River Ss A)	12-5-81-8-W5	1970-05-14	Separator, flowing	842	2.5
			1970-07-15 (* No. 89)	Wellhead, pumping (345kPa, 14.4°C)	842	2.86 (INAA)
667	Open Creek	-				
682	Peco (Cardium A)	5-26-47-15-W5	1959-03-05	Separator, flowing (276kPa, 3.9°C)	796	2.5
			1960-08-20	Separator	795	1.4
			1961-08-07	Wellhead, flowing	811	1.4
			1963-07-20	Wellhead, pumping (Atmos. press., 15.6°C)	808	1.8
			1971-08-20	Stock Tank, flowing (Atmos. press., 21.1°C)	803	1.1
710	Pine North West	-				
785	Ricinus (Cardium E)	6-24-34-8-W5	1969-08-15	LP Separator, flowing	770	<0.5
			1970-03-17	Separator, flowing	811.8	1.9
837	Shane	-				
839	Slave	-				
887	Swan Hills	-				
889	Swan Hills South	-				
967	Willesden Green (Viking A)	16-16-40-5-W5	1961-08-10	Wellhead flowline, flowing (6205kPa)	832	0.6
			1970-11-18 (* No. 20)	Tubing, flowing (2413kPa, 3.9°C)	829	1.0
969	Willingdon	-				

Table 2. BLOCK D1, S2 (D1 824 and under, S2 2.5-4.9)

Temporal Changes in Density and Sulphur from Individual Wells

ERCB Code	Field (Pool)	Well Location	Date Sampled (Y-M-D)	Sampling Conditions	Density (kg/m^3)	Sulphur (g/kg)
144	Black (Muskeg A)	11-19-110-8-W6	1969-12-18	Tank	827	5.3
			1980-02-18	Wellhead, pumping	824	5.8
			1980-03-12	Wellhead, pumping	827	5.5
			1980-04-09	Wellhead, pumping	828	6.5
168	Brazeau River (Cardium A)	10-21-46-14-W5	1967-01-16	Separator, flowing	801	0.8
			1970-02-19 (* No. 6)	Storage Tank, flowing (Atmos. press., 0°C)	800	0.61 (INAA)
			1970-08-20	Stock Tank, flowing (Atmos. press., 21.1°C)	804	1.0
168	Brazeau River-Mannville A	-				
168	Brazeau River-Viking B	-				
194	Caroline-Cardium	-				
224	Clive	-				
315	Eaglesham (Debolt D)	6-14-77-25-W5	1968-03-11	Treater, pumping	826	5.8
			1968-07-10	Treater, pumping	824	6.0
			1970-08-05 (* No. 52)	Flowline, pumping (689kPa, 18.3°C)	826	6.93 (INAA)
320	Edson (Elkton A)	6-9-51-17-W5	1963-08-21	Stock Tank, flowing	784	2.5
			1964-04-05	Stock Tank, flowing	792	2.33
405	Garrington-Mannville B	-				
432	Hackett	-				
450	Harmattan Elkton	-				
492	Innisfail	-				
632	Muskeg	-				
729	Pouce Coupe South	-				
844	Simonette	-				
882	Sundre-Basal Quartz	-				
891	Sylvan Lake-Viking A	-				
938	West Drumheller (D-2A)	11-1-30-21-W4	1953-02-03	-	824	4.4
			1956-05-16	Wellhead	826	4.4
941	Westerose	-				

Table 3. BLOCK D2, S1 (D2 825-844, S1 0.0-2.4)

Temporal Changes in Density and Sulphur from Individual Wells

ERCB Code	Field (Pool)	Well Location	Date Sampled (Y-M-D)	Sampling Conditions	Density (kg/m^3)	Sulphur (g/kg)
009	Acheson (Blairmore A)	7-11-53-26-W4	1953-05-04	Line, flowing (Tubing 3792kPa)	840	6.6
			1957-11-18	Wellhead, pumping	838	4.2
		10-11-53-26-W4	1956-06-19	Wellhead	844	3.8
			1957-11-18	Wellhead, casing blow down	834	3.4
			1958-05	Treater, flowing	837	3.4
011	Acheson East	-				
194	Caroline-Viking	-				
271	Cynthia-Pembina	-				
353	Evi	-				
405	Garrington (Cardium A)	11-33-34-4-W5	1954-12-15	Separator	829.5	1.1
			1954-12-22	Swabbing	833.1	1.2
			1957-08-07	Separator, pumping (110kPa, 16.7°C)	827	1.2
412	Gilby-Viking	-				
413	Gilwood (Gilwood A)	1-9-73-18-W5	1954-11-15	Line, flowing	834	0.05
			1955-01-17	Line, flowing	836	0.7
			1969-07-10 (* No. 91)	Upstream of treater inlet (207kPa)	835	1.01 (INAA)
414	Giroux Lake	-				
418	Glen Park (Glauconitic A)	4-1-49-27-W4	1955-08-01	Tubing, pumping	885	14.3
			1956-06-22	Wellhead	897	12.8
	(Glauconitic B)	13-35-48-27-W4	1965-03-15	Stock Tank, pumping	898	12.6
			1967-10-11	Production Tank, pumping	893	16.1
	(D-2A)	3-2-49-27-W4	1953-06-15	Wellhead, flowing (152kPa)	842	1.3
			1956-06-20	Wellhead	843	1.5
	(D-3A)	4-2-49-27-W4	1953-06-15	Separator, flowing (241kPa)	836	0.8
			1956-06-20	Wellhead	850	1.4
421	Golden Spike (D-3B)	5-24-51-27-W4	1959-05-22	Flow Line, swabbing	852	6.8
			1962-07-27	Wellhead, pumping (552kPa)	851	1.7
423	Golden	-				
425	Goose River (D-2A)	12-18-67-18-W5	1966-07-31	Wellhead, flowing	857	4.2
			1966-08-23	Wellhead, flowing	834	2.1
			1967-09-23	Stock Tank, flowing	852	3.0
	(Beaverhill Lake B)	12-23-67-18-W5	1965-03-29	Tubing, flowing	837	1.4
			1968-11-07	Tubing, pumping (1310kPa)	837	1.5
503	Joarcam	-				
551	Leduc-Woodbend (Blairmore K)	14-30-50-26-W4	1953-03-18	Line, flowing (2965kPa)	852	5.0
			1956-08-02	Wellhead Tubing, flowing	856	6.7
	(D-3A)	7-3-50-26-W4	1959-03-25 (Date analyzed)	Separator, flowing	830	3.3
			1966-09-09	Wellhead, flowing	826	3.4
563	Little Smoky	-				
573	Lochend	-				
605	Meekwap	-				
685	Pembina (Belly River H)	16-10-47-9-W5	1956-03-22	Tank, flowing	820	1.1
			1958-03-12	Line, pumping (103kPa)	822	0.7
	(Keystone Belly R. X)	10-14-47-4-W5	1968-08-08	Separator, flowing (400kPa, 15.6°C)	851	2.5
			1969-05-13	Separator, flowing (414kPa, 10°C)	846	2.7
	(Keystone Ellerslie A)	6-32-48-4-W5	1958-11-21	Separator, flowing (138kPa)	868	9.5
			1970-02-04 (* No. 32)	Separator, flowing (414kPa, cold)	869	9.28 (INAA)

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Table 3. (continued)

ERCB Code	Field (Pool)	Well Location	Date Sampled (Y-M-D)	Sampling Conditions	Density (kg/m^3)	Sulphur (g/kg)
	(Pekisko A)	10-8-50-7-W5	1960-02-20 (Date analyzed)	Tubing, flowing (5516kPa, 26.7°C)	910	28.2
			1962-04-11	Flowline, flowing (207kPa, 4.4°C)	905	8.0
764	Red Earth	-				
834	Senex (Keg River A)	6-36-92-4-W5	1969-07-17	Tubing, swabbing	845.8	1.7
			1970-03-19	Wellhead, flowing	826.5	2.8
856	Snipe Lake	-				
891	Sylvan Lake-Cardium	-				
909	Turner Valley	-				
917	Utikuma Lake	-				
924	Virginia Hills	-				
930	Waskahigan (Dunvegan A)	6-26-64-23-W5	1969-03-04	Stock Tank, flowing	805	0.5
			1970-07-24 (* No. 11)	Gas Plant, flowing (69kPa, 8.9°C)	ND	0.9
942	Westpem	-				
943	Westerose South	-				
948	Wembley	-				
967	Willesden Green-Belly R.	-				
985	Wizard Lake	-				

Table 4. BLOCK D2, S2 (D2 825-844, S2 2.5-4.9)

Temporal Changes in Density and Sulphur from Individual Wells

ERCB Code	Field (Pool)	Well Location	Date Sampled (Y-M-D)	Sampling Conditions	Density (kg/m^3)	Sulphur (g/kg)
098	Battle	-				
100	Battle North	-				
101	Battle South	-				
196	Carrot Creek	-				
202	Carstairs	-				
207	Chain	-				
267	Crossfield (Jumping Pound A)	10-31-26-1-W5	1961-02-15	Line, flowing (Atmos. press., -6.7°C)	834	1.5
			1962-10-03	Separator, flowing (69kPa, 22.2°C)	823	1.0
			1970-06-23 (* No. 10)	Tank, pumping (Atmos., 26.7°C)	830	1.7
	(Viking A)	10-13-29-2-W5	1966-10-28	Tubing, pumping (345kPa, 14.4°C)	834	1.4
			1969-04-08	Stock Tank, pumping (Atmos. press., 10°C)	837	1.3
	(Rundle D)	9-26-30-3-W5	1951-08-14	-	764	2.0
			1963-08-22	Stock Tank, flowing (303kPa, 42.2°C)	779	trace
269	Crossfield East	-				
428	Gordondale	-				
448	Harmattan East	-				
455	Haynes	-				
544	Lanaway-Cardium	-				
552	Leedale	-				
579	Loon	-				
581	Lousana	-				
587	Lubicon	-				
593	Malmo (Blairmore A)	6-14-44-22-W4	1952-11	-	835	5.1
			1970-11-03 (* No. 38)	Tubing, pumping (241kPa, -6.7°C)	829	7.36 (INAA)
604	Medicine River - Condor Ostracod	-				
610	Markerville	-				
612	Minnehik-Buck Lake	-				
664	Ogston	-				
668	Olds-Cardium and Viking	-				
827	Seal	-				
874	Sturgeon Lake (D-3)	7-32-71-23-W5	1953-12-10	Wellhead, flowing	833	2.1
			1957-08-28	Line, flowing (2068kPa, 0°C)	836	3.8
876	Sturgeon Lake South -D3	-				
949	Westward Ho (Rundle A)	7-8-33-4-W5	1955-02-26	Wellhead	848.3	5.2
			1958-04-28 (Date analyzed)	Production Tank	843	5.5

Table 5. BLOCK D2, S3 (D2 825-844, S3 5.0-9.9)

Temporal Changes in Density and Sulphur from Individual Wells

ERCB Code	Field (Pool)	Well Location	Date Sampled (Y-M-D)	Sampling Conditions	Density (kg/m^3)	Sulphur (g/kg)
014	Aden	-				
070	Armisie	-				
096	Bashaw (D3-A)	16-31-41-22-W4	1951-09-20 (Date analyzed)	Separator	820	6.4
			1955-03-28	Separator, flowing	820	5.0
260	Coutts	-				
275	Del Bonita (Rundle)	15-18-1-21-W4	1939-01-17	-	846.8	ND
			1946-07-25	-	852	ND
		5-19-1-21-W4	1956-08-08	Tank	842	6.2
			1962-03-15	Tubing, pumping (172kPa, 3.3°C)	833	6.2
296	Duhamel (D-2A)	7-32-45-21-W4	1953-06-17	Line, flowing	842	7.3
			1959-08-14	Flowline, flowing (1172kPa)	847	8.7
	(D-3B)	14-29-45-21-W4	1952-09-02 (Date analyzed)	Line after separator	846 (As received)	3.8
			1953-06-17	Line, flowing	844	3.4
			1960-08-14	Flowline at manifold, flowing (1448kPa)	855	4.8
364	Excelsior	-				
410	George	-				
486	Hussar (Viking B)	10-13-27-21-W4	1965-01-26	Separator	813	9.8
			1967-07-05	Stock Tank, segregation test	819	9.3
	(Basal Mannville Z)	11-8-25-20-W4	1962-04-26	Treater, flowing (103kPa, 54.4°C)	849	7.0
			1967-09-20	Stock Tank drain, flowing (Atmos. press., 26.7°C)	868	7.9
514	Kaybob South	-				
548	Lator	-				
576	Lone Pine Creek	-				
595	Manyberries	-				
641	New Norway	-				
650	Niton (Basal Quartz B)	4-30-54-12-W5	1966-01-12	Lease Tank, flowing (-23°C)	839	6.7
			1967-05-24	Separator, flowing (414kPa)	826	5.5
654	Normandville (Mississippian B)	13-20-79-22-W5	1957-09-10	Swabbing (perforations)	838	9.3
			1959-07-17	Tank, pumping (Atmos. press., 25.6°C)	850	8.4
	(D-1A)	8-16-79-22-W5	1958-05-08	Tubing, flowing (276kPa)	838	4.0
			1970-07-22 (* No. 60)	Tubing, pumping (138kPa, 12.8°C)	ND	6.64 (INAA)
	(D-3A)	1-16-79-22-W5	1949-10	Tank	840	2.35
			1951-07	-	827 (as received)	1.8
			1952-11	?, pumping	832	2.2
			1953-09-03	Tank, flowing	828	2.2
			1956-09-19	Perforations	828	1.8
			1958-05-08	Tubing, flowing	831	ND
			1972-09-21 (* 38-D)	Wellhead, pumping (345kPa, 8.9°C)	830	2.5
	(D-3B)	1-17-79-22-W5	1959-07-16	Line, pumping (276kPa, 23.9°C)	829	1.4
			1964-09-16	Tubing, pumping (69kPa, 10°C)	830	ND
668	Olds-Wabamun	-				
756	Red Coulee-Moulton A, B, C	-				
858	Sousa	-				
900	Tehze	-				

Table 6. BLOCK D2, S4 (D2 825-844, S4 10.0-14.9)

Temporal Changes in Density and Sulphur from Individual Wells

ERCB Code	Field (Pool)	Well Location	Date Sampled (Y-M-D)	Sampling Conditions	Density (kg/m^3)	Sulphur (g/kg)
126	Bigoray (Ostracod)	11-26-51-8-W5	1961-05-24	Separator, flowing (365kPa)	838	11.4
			1962-06-21	Separator, flowing (276kPa, 11.1°C)	835	9.6
876	Sturgeon Lake South -Triassic	-				
976	Wimborne-D3	-				
979	Windfall	-				
991	Worsley (D-3B)	10-19-87-6-W6	1961-03-03	LP Separator, AOF test (234kPa, 21.1°C)	748	0.9
			1968-11-20	Separator, flowing	738	0.2

Table 7. BLOCK D3, S1 (D3 845-864, S1 0.0-2.4)

Temporal Changes in Density and Sulphur from Individual Wells

ERCB Code	Field (Pool)	Well Location	Date Sampled (Y-M-D)	Sampling Conditions	Density (kg/m^3)	Sulphur (g/kg)
151	Bonnie Glen (Cardium A)	11-26-46-28-W4	1955-11-16	Wellhead tubing, flowing	856	1.8
			1956-08-21	Wellhead tubing, flowing	858	1.7
			1963-11-22	Wellhead, pumping (97kPa, -8.9°C)	851 (as received)	ND
365	Eyremore	-				
402	Gladys	-				
760	Reagan	-				

Table 8. BLOCK D3, S2 (D3 845-864, S2 2.5-4.9)
Temporal Changes in Density and Sulphur from Individual Wells

ERCB Code	Field (Pool)	Well Location	Date Sampled (Y-M-D)	Sampling Conditions	Density (kg/m^3)	Sulphur (g/kg)
153	Bonanza	-				
412	Gilby (Cardium A)	10-21-41-4-W5	1966-09-20	Separator, pumping (345kPa, 21.1°C)	859	2.0
			1970-07-02 (* No. 7)	Separator, pumping (276kPa, 18.3°C)	859	3.1
446	Hanna	-				
497	Jarrow	-				
617	Monitor	-				
656	Norris	-				
672	Paddle River	-				
750	Provost (Viking A,C,K)	7-14-37-7-W4	1959-10-02	Separator, pumping (110kPa)	850	1.4
			1970-06-29 (* No. 23)	Tubing, pumping (586kPa, 10°C)	857	3.9
		7-30-38-7-W4	1955-08-15	Wellhead, flowing (3758kPa)	854	3.5
			1957-06-25	Separator, flowing (90kPa)	852	2.6
			1960-10-02	Flowline, flowing	848	1.5
770	Redwater (D-3)	14-19-56-20-W4	1969-05-07	Separator, pumping (2758kPa, 10.6°C)	853	5.1
			1969-07-09 (* No. 74)	Separator (2586kPa, 15.6°C)	855	4.74 (INAA)
783	Richdale	-				
804	St. Albert-Big Lake (Big Lake D-2A)	11-25-53-26-W4	1961-07-10	Separator, flowing (276kPa)	846	2.5
			1972-07-19 (* 14-D)	Test Separator, flowing (365kPa, 13.9°C)	845	3.8
848	Skaro (Cooking Lake)	9-29-57-19-W4	1959-08-20	Tubing, pumping (Atmos. press., 7.2°C)	836	3.2
			1972-07-25 (* 15-D)	Wellhead, pumping (145kPa, 18.9°C)	856	4.0
857	Sounding	-				
929	Warwick	-				
996	Youngstown	-				

Table 9. BLOCK D3, S3 (D3 845-864, S3 5.0-9.9)

Temporal Changes in Density and Sulphur from Individual Wells

ERCB Code	Field (Pool)	Well Location	Date Sampled (Y-M-D)	Sampling Conditions	Density (kg/m^3)	Sulphur (g/kg)
157	Boundary Lake South (Triassic E)	6-11-85-13-W6	1967-06-02	Wellhead, pumping (414kPa, 20°C)	851	6.0
			1970-07-23 (* No. 47)	Tubing, pumping (689kPa, 10°C)	860	10.30 (INAA)
185	Campbell Namao - Campbell	-				
267	Crossfield-Elkton	-				
373	Fenn West	-				
604	Medicine River (Ostracod A)	14-10-39-3-W5	1963-12-04	Treater, flowing (74.4°C)	877 (as received)	ND
			1967-09-14	Wellhead, flowing	875	12.5
			1970-06-18 (* No. 29)	Wellhead, pumping (1069kPa, 10°C)	866	11.15 (INAA)
735	Presley	-				
840	Seiu Lake	-				
860	Spring Coulee (Rundle)	11-36-3-23-W4	1950-10-31 (Date analyzed)	-	839	5.5
			1954-04-13	Tank, pumping	858	8.5
		14-36-3-23-W4	1950-04-02	Tank	843	6.6
			1952-10-15	Tank, pumping	856	6.8
			1962-03-15	Tank (Atmos. press., 1.7°C)	842	9.3
936	Watelet-Belly River	-				

Table 10. BLOCK D3, S4 (D3 845-864, S4 10.0-14.9)

Temporal Changes in Density and Sulphur from Individual Wells

ERCB Code	Field (Pool)	Well Location	Date Sampled (Y-M-D)	Sampling Conditions	Density (kg/m^3)	Sulphur (g/kg)
020	Aerial	-				
223	Claresholm	-				
292	Drumheller (Mannville A)	12-36-29-20-W4	1956-05-16	Wellhead (before separator)	878	13.6
			1957-08-30	Wellhead, pumping (2586kPa, 11.7°C)	877	13.6
	(D-2B)	6-13-29-20-W4	1962-12-14	Tubing, flowing (1379kPa, ~7.2°C)	857	9.4
			1966-06-09 (Date analyzed)	-	872	ND
408	Ghost Pine (Lower Mannville B)	11-34-30-22-W4	1959-11-17 (Date analyzed)	Tubing, flowing (1724kPa, 4.4°C)	872	12.3
			1969-10-07	Treater Inlet, flowing (186kPa, 4.4°C)	868	9.6
	(Pekisko F)	7-4-31-21-W4	1970-09-08	Line, flowing	873	11.9
			1965-12-08	Separator, flowing	870	12.9
			1967-09-12	Stock Tank, pumping (34kPa, 15.6°C)	873	11.2
913	Twining-Three Hills	-				

Table 11. BLOCK D4, S2 (D4 865-884, S2 2.5-4.9)

Temporal Changes in Density and Sulphur from Individual Wells

ERCB Code	Field (Pool)	Well Location	Date Sampled (Y-M-D)	Sampling Conditions	Density (kg/m^3)	Sulphur (g/kg)
094	Barons (Colorado)	15-15-12-23-W4	1953-02	Tank, pumping	860	1.5
			1955-03-29	Tubing at Wellhead, pumping	856	0.1
520	Keho	-				
553	Legal	-				
603	McLeod	-				
620	Morinville	-				

Table 12. BLOCK D4, S3 (D4 865-884, S3 5.0-9.9)

Temporal Changes in Density and Sulphur from Individual Wells

ERCB Code	Field (Pool)	Well Location	Date Sampled (Y-M-D)	Sampling Conditions	Density (kg/m^3)	Sulphur (g/kg)
636	Nevis-D3C	-				
683	Peavey (Viking)	6-32-56-24-W4	1957-01-16	Flowline	865	3.3
			1960-04-27	Wellhead, pumping (12.8°C)	860	2.1
882	Sundre (Rundle A)	1-4-34-5-W5	1955-01-25	Perforations	872	6.6
			1955-07-14	Separator, flowing	865	6.4
891	Sylvan Lake - Lanaway West (Pekisko B)	-				
		4-16-38-3-W5	1969-06-24 (* No. 57)	Wellhead, flowing (2620kPa, 10°C)	906	14.95 (INAA)
			1969-07-04	Wellhead, flowing	890	8.9
	(Pekisko E)	10-15-38-2-W5	1964-02-18	Treater Oil Leg, flowing (138kPa, 48.9°C)	965 (as received)	19.8
			1967-11-10	Wellhead, flowing	955	ND
967	Willesden Green - Glauconitic	-				
988	Wood River (D-2B)	11-34-42-23-W4	1966-10-27	Treater Outlet, pumping (138kPa, 2.2°C)	870	12.5
			1972-02-18	Storage Tank, flowing	878	16.3

Table 13. BLOCK D4, S4 (D4 865-884, S4 10.0-14.9)

Temporal Changes in Density and Sulphur from Individual Wells

ERCB Code	Field (Pool)	Well Location	Date Sampled (Y-M-D)	Sampling Conditions	Density (kg/m^3)	Sulphur (g/kg)
371	Fenn Big Valley (Big Valley D-3A)	3-10-35-20-W4	1951-10-02 (Date analyzed)	-	852	5.41
			1952-06-18 (Date analyzed)	Line to Tank	849 (as received)	6.2
			1959-06-24	Tubing, flowing (2137kPa, 11.7°C)	873	6.3
	(Fenn D-3E)	3-26-36-20-W4	1956-06-14	Wellhead	948	29.4
			1957-05-01	Line, pumping (124kPa)	922	30.0
			1970-02-05 (* No. 82)	Wellhead, pumping (621kPa, -1.1°C)	ND	29.91 (INAA)
			1972-10-17 (* 48-D)	Separator, pumping (267kPa, 3.3°C)	923	31.1
547	Lathom	-				
550	Leckie	-				
662	Oberlin	-				
694	Penhold	-				
736	Prevo	-				
756	Red Coulee (Cutbank B)	12-3-1-17-W4	1962-03-15	Tubing, pumping (483kPa, 2.2°C)	881	17.7
			1970-08-11	Tubing, pumping (689kPa, 10-13°C est.)	884	15.4
798	Rowley	-				
866	Stettler (D-2A)	4-27-38-20-W4	1949-11-30	-	881	20.0
			1961-11-10	Line, pumping (207kPa, 22.2°C)	878	13.6
867	Stettler North	-				
913	Twining-Rundle	-				
915	Twining North	-				
947	Tony Creek North	-				

Table 14. BLOCK D5, S4 (D5 885-909, S4 10.0-14.9)

Temporal Changes in Density and Sulphur from Individual Wells

ERCB Code	Field (Pool)	Well Location	Date Sampled (Y-M-D)	Sampling Conditions	Density (kg/m^3)	Sulphur (g/kg)
176	Buffalo Lake-D3B	-				
185	Campbell Namao (Namao Blairmore C)	7-34-54-25-W4	1954-01-08	Separator, flowing (345kPa)	848	7.0
			1954-01-08	Treater, flowing	852	8.0
			1960-09-09	Separator, pumping (Atmos. press., 15.6°C)	852	7.1
			1962-04-17	Wellhead, pumping	849	8.0
367	Fairydell-Bon Accord (D-2B)	12-16-57-24-W4	1954-11-15	Line, pumping	884	10.1
			1958-04-28	Tubing, pumping (Atmos. press., 4.4°C)	885	13.1
		16-17-57-24-W4	1956-06-19	Wellhead	884	14.0
			1965-07-15	Tubing, pumping	898	11.6
412	Gilby-Gabriel Lake Jurassic	-				
505	Joffre-Basal Quartz	-				
513	Kaybob-Cadomin C	-				
545	Larne	-				
604	Medicine River (Jurassic A)	6-28-39-3-W5	1959-12-27	Line, pumping (1034kPa, 1.7°C)	900	14.8
			1962-03-08	Wellhead, pumping (3.3°C)	897	13.2
		7-32-39-3-W5	1956-08-11 (Date analyzed)	Swab Test	901	15.55
			1970-06-18 (* No. 45)	Wellhead, pumping (214kPa, 10°C)	ND	14.38 (INAA)
	(Basal Quartz G)	7-9-40-3-W5	1968-05-07	Treater Inlet, flowing (69kPa, -1.1°C)	858	8.9
			1970-06-16	Wellhead, pumping (965kPa, 10°C)	902	12.8
	(Pekisko B)	8-5-40-3-W5	1960-11-04	Separator, flowing	897.3	14.5
			1961-08-15	Line, pumping (276kPa, 10°C)	901	13.7
	(Pekisko I)	16-32-38-3W5	1957-02-20	Group Treater	898	13.7
			1958-01-22	Wellhead, pumping (1034kPa, 4.4°C)	895	11.7
			1961-08-15	Line, pumping (1034kPa, 12.8°C)	895	11.8
636	Nevis (Devonian)	4-32-38-22-W4	1952-04-17	Separator, flowing	842	8.3
			1959-11-18 (Date analyzed)	HP Separator, flowing (3861kPa, 3.9°C)	772.1	5.5
868	Stettler South	-				
891	Sylvan Lake	-				
988	Wood River-D2A	-				

Table 15. BLOCK D5, S5 (D5 885-909, S5 15.0-19.9)
Temporal Changes in Density and Sulphur from Individual Wells

ERCB Code	Field (Pool)	Well Location	Date Sampled (Y-M-D)	Sampling Conditions	Density (kg/m^3)	Sulphur (g/kg)
096	Bashaw-Ireton and D2A	-				
115	Bellshill Lake	-				
176	Buffalo Lake-D3	-				
259	Countess	-				
343	Erskine (D-2)	8-13-39-21-W4	1959-06-30	Tubing, pumping (2682kPa, 5.6°C)	911	18.5
			1970-03-25 (* No. 64)	Separator, pumping (621kPa, 7.8°C)	ND	23.0
	(D-3)	6-7-39-20-W4	1956-06-13	Wellhead	895	24.9
			1970-02-18 (* No. 81)	Flow Line, flowing (147kPa, -1.1°C)	884	21.44 (INAA)
524	Killam	-				
525	Killam North	-				
604	Medicine River-Condor Glauconitic	-				
636	Nevis-Blairmore C	-				
902	Thompson Lake	-				
936	Watelet-Ellerslie	-				

Table 16. BLOCK D5, S6 (D5 885-909, S6 20.0-24.9)

Temporal Changes in Density and Sulphur from Indivivual Wells

ERCB Code	Field (Pool)	Well Location	Date Sampled (Y-M-D)	Sampling Conditions	Density (kg/m^3)	Sulphur (g/kg)
043	Alderson	-				
092	Bantry (Mannville A)	1-2-18-13-W4	1952-10-02 (Date analyzed	Loading Line to Tank	917 (as received)	24.4
			1954-04-26	Line to Treater, pumping	912	24.0
	(Mannville M)	7-9-19-14-W4	1958-10-10 (Date analyzed)	Storage Tank, flowing (4.4°C)	900	19.0
			1962-06-08	Treater, flowing (103kPa, 48.9°C)	918	18.9
430	Grand Forks	-				
744	Princess	-				
792	Ronalane	-				

Table 17. BLOCK D5, S7 (D5 885-909, S7 25.0-29.9)

Temporal Changes in Density and Sulphur from Individual Wells

ERCB Code	Field (Pool)	Well Location	Date Sampled (Y-M-D)	Sampling Conditions	Density (kg/m^3)	Sulphur (g/kg)
255	Conrad (Ellis)	8-5-6-15-W4	1952-10-15	Wellhead, pumping	905	22.5
			1962-06-06	Treater, pumping (103kPa, 37.8°C)	898	21.3
414	Giroux Lake	-				
894	Taber North	-				

Table 18. BLOCK D6, S4 (D6 910-934, S4 10.0-14.9)

Temporal Changes in Density and Sulphur from Individual Wells

ERCB Code	Field (Pool)	Well Location	Date Sampled (Y-M-D)	Sampling Conditions	Density (kg/m^3)	Sulphur (g/kg)
145	Black Butte (Mannville B)	6-29-1-8-W4	1969-06-12	Flow Line, pumping	915	15.3
			1970-04-24	Wellhead, pumping	913	13.4

Table 19. BLOCK D6, S5 (D6 910-934, S5 15.0-19.9)

Temporal Changes in Density and Sulphur from Individual Wells

ERCB Code	Field (Pool)	Well Location	Date Sampled (Y-M-D)	Sampling Conditions	Density (kg/m^3)	Sulphur (g/kg)
185	Campbell-Namao-Blairmore	-				
206	Cessford (Basal Colorado A)	10-6-24-12-W4	1956-05-31	Wellhead	902	16.2
			1962-02-02	Tubing, pumping (689kPa, 7.2°C)	904	14.8
416	Glenevis (Banff)	7-35-55-4-W5	1956-05-29	Wellhead, flowing	939	31.2
			1963-11-27	Treater, flowing (97kPa, 71.1°C)	846 (as received)	ND
			1965-05-13	Tubing, flowing (621kPa)	943	27.3
431	Greencourt	-				

Table 20. BLOCK D6, S7 (D6 910-934, S7 25.0-29.9)
Temporal Changes in Density and Sulphur from Individual Wells

ERCB Code	Field (Pool)	Well Location	Date Sampled (Y-M-D)	Sampling Conditions	Density (kg/m^3)	Sulphur (g/kg)
069	Artland	-				
102	Barrhead	-				
210	Chauvin	-				
212	Chauvin South (Sparky A/B)	12-23-42-2-W4	1969-05-09 1970-02-24	Wellhead, pumping Separator, flowing	922 923.6	26.3 27.9
217	Chin Coulee	-				
457	Hayter	-				
481	Hatton	-				
560	Little Bow	-				
896	Taber South East	-				

Table 21. BLOCK D7, S8 (D7 935-959, S8 30.0-34.9)

Temporal Changes in Density and Sulphur from Individual Wells

ERCB Code	Field (Pool)	Well Location	Date Sampled (Y-M-D)	Sampling Conditions	Density (kg/m^3)	Sulphur (g/kg)
336	Enchant	-				
366	Gunn	-				
500	Jenner (Upper Mannville F)	14-32-20-8-W4	1965-11-25	Wellhead, flowing	965	ND
			1966-06-27	Tubing, flowing	961	ND
	(Lower Mannville A)	10-32-20-8-W4	1964-12	Wellhead, pumping	967	ND
			1965-11-25	Wellhead, pumping	962	ND
893	Taber (Mannville A)	14-15-9-17-W4	1952-12	Tubing, pumping	923	23
			1954-08-16	Tubing, pumping	922	27
	(Mannville D)	16-18-9-16-W4	1945-01-03	Flow Line, pumping	952	35
			1954-08-16	Tubing, pumping	944	34
			1962-06-07	Tubing, pumping (34kPa, 21.1°C)	947	31.8
963	Wildmere	-				

Table 22. BLOCK D7, S9 (D7 935-959, S9 35.0 and over)
Temporal Changes in Density and Sulphur from Individual Wells

ERCB Code	Field (Pool)	Well Location	Date Sampled (Y-M-D)	Sampling Conditions	Density (kg/m^3)	Sulphur (g/kg)
053	Amisk	-				
895	Taber South (Mannville B)	16-20-7-16-W4	1963-07-30	Tubing, pumping (138kPa, 15.6°C)	941	33.2
			1965-07-19	Stock Tank, pumping	973 (as received)	ND

Table 23. Temporal Changes in Density and Sulphur from Individual Wells
Fields and Pools not listed in APMC (1982)

ERCB Code	Field (Pool)	Well Location	Date Sampled (Y-M-D)	Sampling Conditions	Density (kg/m^3)	Sulphur (g/kg)
148	Blueridge (Lower Mannville A)	10-22-58-11-W5	1968-02-20	Flareline, well blow down	757	1.1
			1970-06-11	Separator, flowing	761	1.5
194	Caroline (Basal Mannville B)	4-2-35-6-W5	1968-12-06	3-Phase Separator, flowing (7791kPa, 25.6°C)	758	0.4
			1970-11-12 (* No. 37)	Separator, flowing (7329kPa, -8.9°C)	ND	0.4
214	Chigwell (D-2A)	11-8-41-24-W4	1955-11-10	- , flowing	827	4.8
			1961-06-28	Treater, pumping (48kPa, 26.7°C)	832	2.7
412	Gilby (Basal Mannville B)	7-29-40-3-W5	1958-09-29	Tank, pumping (207kPa, 4.4°C)	887	12.5
			1969-07-04 (* No. 34)	Separator, pumping (359kPa, 13.3°C)	893	15.34 (INAA)
			1970-07-02 (* No. 35)	Wellhead, pumping (621kPa, 15.6°C)	912	13.91 (INAA)
456	Hays:Jurassic (non-pool)	12-27-13-14-W4	1964-12-31	Production sample	876	18.1
			1966-05-30	Wellhead, flowing (1379kPa, 7.2°C)	872	15.3
513	Kaybob (Cadomin B)	10-21-63-19-W5	1960-02-15 (Date analyzed)	Tubing, flowing (2068kPa)	894	18.0
			1967-06-21	Wellhead, pumping	889	17.4
682	Peco:Belly River (non-pool)	5-26-47-15-W5	1957-03-02	Separator, swabbing (207kPa)	853	1.9
			1957-03-09	Separator, swabbing (138kPa)	860	1.0
			1959-02-20	Separator, pumping	846	1.9
			1960-08-20	Wellhead	823	0.6
			1961-08-07	Wellhead	852	3.4
			1963-07-20	Wellhead, pumping (Atmos. press., 15.6°C)	848	2.5
886	Swalwell (D-2A)	10-14-29-24-W4	1970-08-25	Battery Heading, flowing (276kPa, 15.6°C)	843	5.0
			1977-03-18	Header	854.5	ND
909	Turner Valley:Blairmore (non-pool)	11-4-19-2-W5	1967-09-21	Stock Tank Drain, pumping (Atmos. press., 21.1°C)	810	0.8
			1970-06-25 (* No. 42)	Tank, pumping (26.7°C)	818	0.85 (INAA)
997	Zama (Keg River G),	8-7-117-4-W6	1967-02-27	Separator	875	9.3
			1968-03-01	Header, pumping (276kPa)	863	7.9
	(Keg River MM)	4-3-118-4-W6	1967-04-30	- , flowing	862.7	9.8
			1969-02-29	Wellhead, flowing (3172kPa)	878	6.9
	(Keg River QQ)	2-33-116-6-W6	1967-06-14	Tubing, flowing	838	5.9
			1969-05-31	Separator, flowing (689kPa)	829	5.3