PRAIRIE DROUGHT IMPACT STUDY

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Prepared for:

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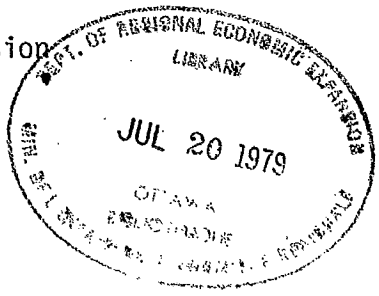

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Preface

This report has been prepared for the Department of Regional Economic Expansion by InterGroup Consulting Economists Ltd.; it assesses the effect a serious drought could have on the Canadian Prairies, the possible size and impact of such a drought, and suggested priorities and programs in the event of a drought.

This study was conducted during March, 1977; the data and analysis presented are based on the material available at that time.

The terms of reference focused on the range of below normal water supply conditions which could reasonably occur during the spring and summer of 1977, with additional brief commentary on the longer term impacts that could be associated with prolonged dry conditions beyond the fall of 1977. No attempt was made, however, to predict the probability that any specific set of dry weather conditions would occur within this time period.

Three major tasks were conducted:

Task 1: Range of Potential Drought Conditions

> Based on the best available assessments provided by meteorological and water management staff in the region, the analysis describes the range of drought conditions which could reasonably occur this summer on the Canadian Prairies.

Task 2: Socio-Economic Impact Analysis

> Based on readily available socio-economic studies and data, interviews with government and industry officials, and the results of Task 1, the analysis describes the socio-economic impact of drought conditions on the industries and communities of the region.

Task 3: Policy and Research Priorities

> Based on the results of Tasks 1 and 2, the analysis recommends policy and action priorities relevant to governments at this time.

The consultants wish to acknowledge the important assistance provided by Federal, Manitoba, Saskatchewan and Alberta government staff in many different departments.

Although the above assistance is gratefully acknowledged, InterGroup Consulting Economists Ltd. accepts full responsibility for the analysis presented in this report.

Introduction

This report assesses the effect that a serious drought could have on the Canadian Prairies, the possible size and impact of such a drought, and priorities and programs in the event of a drought.

Throughout this report, the term "drought" is used in a non-scientific manner to describe unusually dry conditions rather than the technical definition of the term used by Environment Canada.

The analysis examines the impact of two possible water supply scenarios without attempting to predict actual water supply conditions in the future:

(1) "Normal" spring and summer precipitation augmenting conditions recorded in March, 1977.

(2) Severe drought conditions throughout the region created by continued below normal precipitation through the spring and summer.

Commentary focuses on impact during the spring and summer of 1977; however, longer term problems associated with continued severe drought conditions are identified briefly where relevant.

It might be noted that many government officials throughout the region suggest that a clear destinction should be made between a "dry year" (unusually low precipitation lasting through one year) and a "drought" (the persistence of such conditions during two or more years). In essence, this distinction serves as a reminder that the drought conditions of the 1930's in the Canadian Prairies reflected recurring dry weather lasting through many years.

This report consists of a brief Summary Report and an Appendix containing two detailed Working Papers.

The Summary Report parallels the terms of reference and includes three sections:

Section 1: Range of Potential Drought Conditions
Section 2: Socio-Economic Impacts of Drought
Section 3: Policy and Action Priorities

The Working Papers present the supporting detailed analysis of water supply conditions and socio-economic impacts:

Working Paper No. 1

A review of present and potential water supply conditions on the Prairies.

Working Paper No. 2

Potential drought impacts on different enterprises on the Prairies.

SUMMARY REPORT

1. Range of Potential Drought Conditions

At the time when this study was being written, water supply conditions in southern agricultural areas of the Canadian Prairies were, in general, at the lowest levels ever recorded for March.

The major unknown for the 1977 season is the water supply available for crops and forage in non-irrigated regions, as well as shallow well and dugout water supplies in certain areas. The widespread existence of record low soil moisture conditions indicates the critical importance of spring and early summer precipitation for crop and forage enterprises where regional irrigation systems do not provide assistance.

Spring and summer precipitation, however, is most unlikely to create measurable run-off; thus, streamflow levels (independent of storage regulation) will certainly be much below normal in most southern areas during the spring and summer.

The use of water now held in man-made storage reservoirs throughout the region will tend to minimize the impact of water shortages during the 1977 season; however, continued below normal precipitation through the next winter would create serious storage and streamflow shortages in many areas during 1978.

The only general exception to current dry weather conditions exists in northern non-agricultural parts of the prairie provinces, eg. the Churchill River basin.

The dry conditions currently existing on the prairies began last July in the eastern areas and moved north and west during the growing season. Several areas were dry in the spring of 1976, but substantial early summer rains replenished soil moisture, aquifer and reservoir storage. For instance, May 1976 precipitation at Winnipeg was only 18 per cent of normal, whereas June 1976 precipitation was 227 per cent of normal.

By the end of November 1976, seasonal precipitation (September onwards) was less than fifty per cent of normal in most of the southern prairies east of a line through Lethbridge and Drumheller, Alberta. Since then, dry conditions have continued to move west. As of the end of February, seasonal precipitation was generally less than forty per cent of normal in southern areas.

A brief summary of current conditions is provided below for each of the four water supply classes examined, i.e. soil moisture, ground water, streamflow and reservoir storage. (See Working Paper No. 1 for a more detailed description.)

Soil Moisture:

(1) Soil moisture levels are extremely low throughout broad areas of the prairies, eg. the area of Alberta south of Calgary; the agricultural areas of Saskatchewan with the exception of some small regions in the northeast and northwest; southern Manitoba (Brandon, Portage la Prairie, Winnipeg, Morden) and parts of the Interlake and Parklands areas.

(2) These conditions have not been overcome by melting snow, and may be aggravated by warm temperatures and high winds -- blowing soil conditions have been reported already in certain areas.

(3) Significant precipitation before July is required in these agricultural areas.

(4) As of February 28, there was a probability of less than five per cent that even eighty per cent of the seasonal precipitation deficits recorded at Winnipeg, Brandon, Regina, Saskatoon and Swift Current would be recovered prior to April 30.

Ground Water

(1) Ground water supply problems are being, or are likely to be, encountered in areas where shallow aquifers depend on annual recharge.

(2) Little problem is anticipated in Alberta.

(3) In Saskatchewan, communities facing ground water volume problems include Lumsden, White City, Broadview, Whitewood, Kamsack and Canora.

(4) In Manitoba, problems are focused primarily in the Almasippi sands area.

(5) Shortages of shallow aquifer water can necessitate the trucking of water for stock watering purposes (such activity has already been reported in some parts of Manitoba and Saskatchewan).

(6) Yields from deep wells (eg. over 100 feet) are not likely to be affected during the summer of 1977. The impact of prolonged dry conditions through next winter, however, is not known at this time.

Streamflow

(1) The Saskatchewan River flow is likely to be in the range of sixty per cent of normal.

(2) The Winnipeg, Nelson, Red, Assiniboine and Souris rivers flows are expected to be well below normal.

(3) Low flows are expected on the Oldman, Red Deer and Bow rivers.

(4) The Churchill system and other northern rivers are expected to achieve approximately normal flows.

(5) Flows on most of the small local rivers throughout the southern areas are expected to be well below normal.

Storage

(1) Current high reservoir levels will act to protect stream flow and municipal water supply in many areas during 1977.

(2) The main overall concern at present is that inadequate stream-flows this year could create serious reservoir shortages next year if dry weather conditions persist -- detailed evaluation of this concern, however, is not available at present.

(3) Dugout storage and farm ponds are low or dry throughout the southern farm regions, and are not expected to refill from spring run-off in many areas. Stock watering and waterfowl breeding problems are thus anticipated in these areas.

(4) In Alberta, below normal reservoir storage is anticipated at the Waterton Reservoir and St. Mary's Reservoir (currently drawn down for repairs).

(5) In Saskatchewan, the Diefenbaker Lake reservoir is below normal and would be inadequate to meet all consumptive demands in the summer of 1978 if dry conditions continue. Hydroelectric generation from this source is already sharply curtailed.

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(6) In Manitoba, the Jackson Lake, Morden and Stephenfield reservoirs would be inadequate by 1978 if dry conditions persist; some restriction of water use may be prudent or necessary this year in these cases.

It is difficult to place the current prairie water supply conditions into historical perspective.

The Canadian Prairies have experienced a number of "dry" years in the past, the most recent being the summer of 1961. These dry periods were characteristically of short duration. In most areas, for example, the 1961 drought was sandwiched between two periods of unusually heavy precipitation.

In contrast, the infamous drought conditions of the 1930's reflected recurring dry weather lasting through many years.

Table 1 focuses on the September to June period, comparing 1930-31 and 1960-61 precipitation with the 1921-76 average at both Winnipeg and Regina. It is apparent that both drought periods were affected by the very low March to June precipitation; in Regina, well below normal September to February precipitation was also recorded.

This year, however, Winnipeg's recorded seasonal precipitation at the end of February was only 65 millimetres -- less than 37 per cent of the normal shown in Table 1, and only 72 per cent of the previous low year (1939-40) recorded since 1921. Unless average precipitation at Winnipeg during the March to June period exceeds 78 per cent of normal conditions, this year's average September to June precipitation will fall below the previous low (1960-61) recorded since 1921.

Regina's recorded seasonal precipitation this year at the end of February was only 30 millimetres -- less than 25 per cent of the normal shown in Table 1, and only 62 per cent of the 1960-61 record low level. This year's overall September to June precipitation at Regina will fall below the record low year of the 1930's (1936-37) unless average precipitation during the March to June period exceeds 76 per cent of normal conditions.

Assuming that Winnipeg and Regina conditions are broadly indicative

TABLE 1

SEASONAL PRECIPITATION: WINNIPEG AND REGINA

	Average 1921-76	1930-31	1960-61	1976-77
		(millimetres)		
Winnipeg				
September 1 - February 28	179	175	147	65
March	26	23	14	*
April	35	9	43	*
May	57	62	10	*
June	76	29	3	*
Total: September 1 - June 30	373	298	217	*
Regina				
September 1 - February 28	122	83	49	30
March	19	17	7	*
April	22	1	14	*
May	42	9	57	*
June	94	63	14	*
Total: September 1 - June 30	299	173	141	*

Source: Environment Canada

* Current and future periods yet to be recorded.

of the overall problem throughout southern prairie farm areas, the risk that 1977 will be a record dry year throughout the region becomes apparent.

This study cannot, however, evaluate the likelihood that a dry summer in 1977 will be followed by at least one (and possibly more) dry years in the Canadian Prairies. Theories have been advanced that a drought similar to that of the 1930's could be expected at this time; nevertheless, the authors of this report are unable to provide a basis for either accepting or rejecting such hypotheses.

A prudent perspective at present would appear to suggest the wisdom of planning to meet the contingencies of a serious longer term drought -- the actual situation will only become clearer as spring, summer and fall precipitation is revealed.[1/]

1/ It can be noted that concern also exists in the United States that severe drought conditions may be returning to the western states. A recent annual meeting of the American Association for the Advancement of Science heard views from some climatologists that the current extended dryness is threateningly similar to the conditions that preceded the drought days of the mid-1930's. (See Time, March 7, 1977; pp. 42-47.)

2. Socio-Economic Impacts of Drought

Drought conditions reduce water supply available to meet the requirements of industries and communities. The net result creates hardships in the form of reduced outputs, incomes, and employment within the affected industries; consumers can also suffer through increased prices, inconveniences, water restrictions and a temporary deterioration in the general quality of life.

Direct drought impacts will in turn lead to a variety of indirect socio-economic effects throughout the region's industries and communities. In the instance of a severe prolonged drought, it can be anticipated that impacts will continue to exist long after the drought itself has ended.

Drought impact analysis must begin by identifying the industries or enterprises which will be affected by water shortages. In total, thirteen separate enterprises are examined in this paper (see Table 2).[1/]

The results of this enterprise analysis can then be used to assess overall impacts on regional incomes and employment.

1/ Working Paper No. 2 provides detailed analysis of impacts on each enterprise.

TABLE 2

OUTLINE OF ENTERPRISES EXAMINED

1. Crop Enterprises

   a) Major field crops, eg. wheat, oats, barley, rye, rapeseed and flaxseed

   b) Vegetable crops

   c) Potatoes

   d) Sugar Beets

2. Livestock and Forage Enterprises

   a) Beef

   b) Dairy

   c) Other livestock

3. Non Agricultural Enterprises

   a) Electric power (hydro and thermal)

   b) Mining

   c) Forestry

   d) Wildlife and fishing

   e) Recreation and tourism

   f) Municipal water supplies and relevant impacts on related enterprises not discussed above

Direct Enterprise Impacts

Severe drought conditions would seriously curtail production of major field crops, beef, and hydroelectric power. At a lower level of importance, severe drought conditions could also affect dairy production, vegetables, potatoes, sugar beets, wildlife and fishing, tourism, recreation and forestry and could disrupt municipal water supply used by industries and consumers. Of the enterprises examined only poultry production, hog production and mining would not be seriously affected by a major drought.

Tables 2.14, 2.15 and 2.16 at the end of Working Paper No. 2 provide a summary of drought impacts by enterprise for Alberta, Saskatchewan and Manitoba respectively.

The significant enterprise impacts are highlighted below:

Major Field Crops

(1) Drought conditions cause serious yield reductions, particularly for cereal grains; very little change in seeding patterns is anticipated.

(2) Historically, drought conditions have affected the yield of field crops more severely in Saskatchewan than in Manitoba or Alberta. Saskatchewan wheat yields during the worst recorded drought conditions have fallen by as much as eighty-five per cent.

(3) Severe drought in the prairies would exert an upward pressure on prices for major field crops; actual prices, however, will be determined by the combined effect of many market factors -- therefore, no prediction of drought price impact is provided at this time.

(4) The timing and distribution of the resultant income losses would be significantly affected by existing government programs, eg. Canadian Wheat Board payment patterns, crop insurance, the Western Grain Stabilization Program.

(5) Prolonged drought would create a more serious situation than a one year drought, eg. winter wind erosion in 1977-78, and cumulative reduction of farm income. The capacity of farmers to service loans would be at hazard.

Beef Enterprises

(1) Drought conditions can create shortages of summer forage, winter forage, and water for stock watering.

(2) Moderate drought would lead to an earlier than normal sale of many animals destined for slaughter; a severe drought would cause some selling off of breeding stock.

(3) Increased demand for hay, trucking water to cattle, and some possible movement of cattle to less affected areas can also be anticipated.

(4) Prolonged drought would create longer term impacts associated with reduced breeding stock as well as excess slaughtering and meat packing capacity.

Dairy Enterprises

(1) It is unlikely that drought conditions would severely reduce dairy production.

(2) Industrial milk plants (eg. cheese factories) might suffer from abnormally low supplies of milk.

(3) Dairy producers would face increased costs for trucking water and purchasing forage; this could cause a cost-price squeeze in the industry.

(4) Reductions in dairy herd size are unlikely.

Vegetables, Potatoes and Sugar Beets

(1) The only serious drought impact for vegetables is the possible loss of Manitoba's commercial canning crop.

(2) The Manitoba potato crop (some fifty per cent of the prairie total) would be sharply reduced. Most potatoes are grown under irrigation in Saskatchewan and Alberta and yield there would be unaffected. ely.

(3) Drought would cause significantly reduced yields for Manitoba sugar beet producers; sugar beet production in Alberta should be unaffected.

Hydroelectric Power

(1) Reduced hydroelectric power generation would occur in each province, with the most severe system impacts occurring in Manitoba.

(2) Additional use of thermal capacity would increase system electricity generation costs.

(3) Power exports from Manitoba would be curtailed or eliminated, and revenue losses would result.

(4) Effects of prolonged drought have not been determined in this study.

Forestry

(1) Increased fire hazards would occur, with resulting effects on fire suppression costs, tourism, wildlife and conversion operations.

(2) Significant long term impacts on forestry resources could arise with continuation of drought conditions, affecting a variety of enterprise activities, eg. wildlife and tourism, in addition to conversion operations. Long term impacts here could be second in importance only to agriculture.

Wildlife and Fishing

(1) Waterfowl population would be severely reduced by drought.

(2) Drought could also reduce antelope, muskrat, beaver, and mule deer populations.

(3) Sports fishing would be reduced in affected areas and low lake levels could affect the commercial fishing.

(4) Prolonged drought would force reduced bag limits for waterfowl and possibly for deer and antelope.

Tourism and Recreation

(1) A mixture of improvements and detrimental impacts could be expected depending on specific site conditions. In affected areas, small businesses depending on tourist and recreation traffic would suffer reductions in business revenue. In addition, cottagers could be adversely impacted in specific areas by lack of swimming, boating and other facilities.

Municipal Water Supply

(1) Working Paper No. 2 identifies communities which could face problems.

(2) Winnipeg, Regina and Moose Jaw might experience voluntary rationing during 1977.

(3) The impacts of prolonged drought could not be evaluated in this study; it is important to determine at what future point in time water storage systems could become depleted to a level where critical shortages would be encountered for large segments of the prairie community.

In general, the enterprise analysis indicates that Saskatchewan is the province most severely affected by drought conditions. Manitoba follows in second place, with Alberta a distant third.

This report has been able to estimate income losses associated with drought for only a limited number of enterprises, i.e. most agricultural enterprises and forestry. Table 3 summarizes these partial estimates of direct income losses created by a drought. Ignoring transfer payment mechanisms, approximately seventy per cent of all direct losses would occur in Saskatchewan, with the balance being split almost evenly between Manitoba and Alberta. In total, annual direct income losses to these prairie enterprises (ignoring the effect of government programs) would approximate $560 million for a moderate drought, and over $2.3 billion for a severe drought.

The overall economic costs estimated for a drought in Table 3 are conservative, reflecting the fact that this study could not obtain sufficient information to quantify direct income impacts associated with electricity generation systems (where a severe drought would cause significant cost increases and export revenue losses), dairy production, hunting and wildlife, tourism and recreation, and municipal water supply systems.

TABLE 3

DROUGHT IMPACT ANALYSIS: PARTIAL DIRECT

ANNUAL INCOME LOSSES BY ENTERPRISE[1/]

	Alberta	Saskatchewan	Manitoba	Total
		($000,000)		
Moderate Drought				
Major Field Crops	75.56	362.16	87.63	525.35
Vegetables, Potatoes and Sugar Beets	-	-	3.90	3.90
Beef	13.00	10.00	3.60	26.60
Sub-total Agriculture	88.56	372.16	95.13	555.85
Forestry	2.25	1.50	2.50	6.25
Total	90.81	373.66	97.63	562.10
Severe Drought				
Major Field Crops	166.54	1,540.00	271.88	1,978.42
Vegetables, Potatoes and Sugar Beets	-	-	12.00	12.00
Beef	128.00	172.00	36.00	336.00
Sub-total Agriculture	294.54	1,712.00	319.88	2,326.42
Forestry	3.25	4.50	3.75	11.50
Total	297.79	1,716.50	323.63	2,337.92

Source: InterGroup Consulting Economists Ltd.

1/ The income losses presented here exclude any consideration of government assistance, crop insurance, the Western Grain Stabilization Program and other transfer payment mechanisms.

Indirect Impacts

The direct enterprise impacts of a drought would create a series of shock waves throughout the prairie and Canadian economies.

In general, a severe drought would create significant output and income losses within one of the region's major export industries (agriculture); it can therefore be expected that the net impact would create significant reductions in regional spending, incomes and employment. The impact of these reductions would be most serious within the region itself; however, significant effects would be felt by outside industries supplying goods and services to the prairie region. In addition, all Canadians would be affected through the resultant impacts on net federal transfers within the country, i.e. a severe drought would decrease federal income receipts from the prairies while simultaneously increasing federal spending in the region.

The indirect effects of a severe drought would occur through a variety of mechanisms:

Output Reductions

(1) Reductions in farm outputs would create income losses for a host of related manufacturing and service industries, eg. processing industries such as slaughtering and meat packing, sugar refining, vegetable processing, grain handling and transportation, etc., and supply industries such as farm machinery, fertilizer production, financial and retail services, etc.

(2) Any significant reduction in tourism and recreation, wildlife hunting, and commercial or sports fishing would also create income losses throughout a variety of service sector industries.

(3) A prolonged and severe drought could possibly bring electricity and/or water rationing to a variety of manufacturing and service industries, resulting in additional indirect income losses associated with reduced industrial output.

Price Effects

(1) In the short term, certain consumers might face price increases related to water supply purchases and specific recreation or tourist services; it is also possible that drought-induced dumping of cattle onto the market could create short term price declines for beef.

(2) In the longer term, severe drought could lead to increased consumer prices for dairy and beef products, vegetables and potatoes as well as electricity.

Increased Enterprise Costs

(1) Increased costs would occur for certain enterprises without necessarily curtailing output levels, eg. electricity generation, dairy production, forestry, cases where trucking of water is required, etc.

(2) The net regional impact of these increased costs would depend on the spending patterns associated with each situation.

(3) In livestock production, increased trucking costs for water (for example) would provide added income to a local service industry; the net regional impact would depend on where the farmer would otherwise have spent this money.

(4) Similar analyses would be required to evaluate the net regional impact of increased forest fire suppression costs for the forest industry, and increased thermal generation costs for the electric power industry (in the electric power industry, the impact might lead to higher electricity rates charged to all consumers).

Quality Reduction Impacts

(1) Severe drought conditions would reduce water quality (odour, hardness, etc.) in certain areas.

(2) Urban residents would face reduced water supply for lawns, gardens and recreational pursuits.

(3) Site specific recreation and tourist facilities could suffer severe declines in quality.

(4) Blowing soil, dust, and forest or grass fire smoke could create a general decline in air quality; this could bring significant discomfort to residents who suffer from breathing disabilities.

(5) Severe drought can create foundation and structure problems in certain areas, affecting homes, buildings, streets, sewer and water systems, etc.

(6) The impact of drought on grasshoppers, mosquitoes and other insects has not been determined in this study.

Land Values and Security of Tenure

(1) In the absence of transfer payment mechanisms or mitigation measures, a severe and prolonged drought would cause a dramatic decline in land values in agricultural areas as well as in some recreational or tourist areas.

(2) Enterprises facing significant debt repayment obligations (eg. farmers who recently purchased additional farmland or new machinery) would face severe cash shortages which would threaten their security of tenure and drastically increase the risk of bankruptcy.

Government Fiscal Regimes

(1) In the absence of transfer payment mechanisms, municipal and provincial governments would face major reductions in their tax revenues.

(2) The situation could be severe for rural municipalities relying on farmland property taxes as a source of revenue.

(3) Provincial governments would face increased costs for relief and assistance as well as significant reductions in their income and sales tax revenues.

In short, a prolonged severe drought would have pervasive effects throughout the prairie community, affecting urban as well as rural citizens. The most dramatic hardships would be bankruptcy, relocation and adjustment dilemmas facing individuals and families most acutely affected by drought. The entire region, however, would suffer from the loss of farm export income -- a loss which could only be replaced by federal transfer payments and/or the end of the drought itself.

An indication of the overall net economic impact of a prairie drought can be provided through use of the DREE interprovincial input-output model.[1/] It is emphasized, however, that the results of this analysis are not a precise estimate of impact; in addition to the many limitations inherent in the use of such models,[2/] the initial estimates of direct losses (see Table 3) are acknowledged to omit certain losses that could not be quantified at this time.

1/ Department of Regional Economic Expansion; An Interprovincial Input-Output Model: Version III (Ottawa: 1976)

2/ The input-output model assumes that all induced impacts are "instantaneous", even though the direct effects may be spread over many months; the model also ignores situations (eg. beef enterprises) where temporary surges in income may occur prior to the eventual realization of losses.

Table 4 indicates the overall annual net loss in personal income by province associated with a severe drought, ignoring the impact of any transfer payment mechanisms which might alleviate the regional impact.

These impacts are summarized below:

	Severe Drought Impact	
	Annual Personal Income Loss	Per Cent Distribution
	($ million)	(%)
Alberta	268.9	11.3
Saskatchewan	1,498.6	63.0
Manitoba	288.1	12.1
Rest of Canada	322.8	13.6
Total Canada	2,378.3	100.0

It is apparent that the major drought impact (63 per cent of the total loss) would occur in Saskatchewan; however, a significant amount (14 per cent) of the overall $2.4 billion loss in annual personal incomes would occur outside the prairie region.

Reduction in employment levels associated with the above declines in personal income are difficult to estimate, particularly since losses of income in agriculture result more in under-employment of human resources than in unemployment. For Canada, a severe drought can be anticipated to increase national unemployment levels by 1.5 to 1.75 percentage points, while the increase in the prairie provinces would be much higher. Actual impacts would depend not only upon the withdrawal of labour from agriculture and other sectors, but also upon the mitigating effects of transfer payment mechanisms (see below).

TABLE 4

ANNUAL PERSONAL INCOME LOSSES FROM DROUGHT

(EXCLUDING TRANSFER PAYMENT MECHANISMS)[1/]

	Alberta	Saskatchewan	Manitoba	Rest of Canada	Total Canada
			($ million)		
Moderate Drought					
Direct Loss[1/]	86.31	370.66	92.63	-	549.60
Total Personal Income Loss[2/]	76.20	326.21	82.03	76.63	561.07
Per Cent of 1975 Personal Income (%)	0.7	6.0	1.4	negligible	0.4
Severe Drought					
Direct Loss[1/]	297.79	1,716.5	323.63	-	2,337.92
Total Personal Income Loss	268.86	1,498.56	288.10	322.78	2,378.30
Per Cent of 1975 Personal Income (%)	2.5	27.3	5.6	0.3	1.8

Source: InterGroup Consulting Economists Ltd.

1/ These estimates are derived from Table 3; it is assumed that agricultural income losses equal the full decline in production values, and that these losses represent net regional income losses; forestry income losses are assumed to represent net regional income gains (i.e. this money would represent increased local income for forest fire suppression). As noted in the text, actual regional farm income losses would be significantly offset by existing transfer payment mechanisms.

2/ Estimates based on the DREE Interprovincial Input-Output Model (Version III).

Comparison With the 1930's Drought

The preceding analysis outlines the economic impacts which would be associated with a recurrence of the severe drought conditions last experienced in the 1930's. A modern drought, however, would take place within an economic and fiscal environment radically different from that of the 1930's.

In the 1930's, the prairie economy was afflicted with severe and recurring drought at the same time as the depression cut major crop prices almost by half. The combined effect of these two forces was, of course, far greater than the drought impacts estimated in this study. It is essential, therefore, to remember that a drought today would not occur in the midst of a worldwide depression.

The prairie regional economy of the 1930's was also far less diversified than is the case today -- an additional factor helping to lessen the relative regional economic impact of a modern drought.

In short, the modern economic environment in the prairies is radically different from that of the 1930's. Regional income declines caused by a modern drought would thus be far less severe than the income declines associated with the 1930's.

An additional feature of the 1930's situation was the absence of in-place transfer payment mechanisms to mitigate against the severe regional economic impacts described by the earlier input-output analysis. Incomes in the region did in fact fall, and unemployment increased, in direct reaction to drought conditions. Land values and tax revenues plumetted, and the fiscal integrity of local governments (municipal and provincial) was severely threatened.

In contrast, a severe prairie drought during the last half of the 1970's would take place within a radically different regime of federal-

provincial, provincial-municipal, government-farmer, and government-citizen transfer mechanisms.

The current complex federal-provincial fiscal arrangements, including provision for equalization payments to the provinces, represent in part an outgrowth of the 1930's disaster. The net result provides far greater fiscal security to prairie provincial governments than that which prevailed prior to World War II. Provincial revenues in Manitoba and Saskatchewan (and to a lesser extent, Alberta) nevertheless still rely heavily on a combination of income taxes and consumption taxes. These, in turn, are very sensitive to changes in personal income. The governments of Manitoba and Saskatchewan would therefore still face financial problems in the event of drought.

Municipal government and school board revenues today are far more tied to provincial income sources (and equalization procedures) than during the 1930's. This factor could increase the overall fiscal impact of a drought on the provincial government.

Modern federal transfer payments to citizens would also have a significant mitigating impact on actual prairie personal income losses during a severe drought, eg. old age pensions, family allowances, unemployment insurance, etc.

Most importantly, the current federal Western Grain Stabilization program would ensure that farm cash receipts from grain for the prairie region would tend to stabilize close to the previous five year average. This program would certainly provide major regional income support during the initial few years of a severe drought, shifting a large short term cost onto the federal treasury; the long term cost would presumably be shared between the federal government and future farmers participating in the program.

It should be noted, however, that the Western Grain Stabilization Program does not necessarily stabilize grain farm cash receipts for either individual producers or provinces. Payments would go only to participating producers (approximately 77 per cent of the Wheat Board's permit holders), and would be based solely on each producer's levy paid to date. Thus, a severe drought in Saskatchewan and Manitoba would provide benefits to producers in Alberta and the distribution of the transfer payments would not reflect the distribution of drought induced farm income losses.

Drought induced farm income losses would also be affected by existing crop insurance programs which provide additional income support to participating farmers. A severe drought would probably necessitate added federal and provincial support in the form of direct loans to these programs.

For livestock, income losses will be mitigated for slaughter cattle and for calves by the Agricultural Stabilization Act, under which producers will receive assistance equivalent to ninety per cent of the five year average for prices (taking into consideration production costs). Calves have been designated for short term support during 1977 by Order-in-Council, while slaughter cattle are automatically covered under this Act.

In summary, the impacts of a severe modern drought would be significantly affected by the present day economic and fiscal environment. Regional socio-economic impacts today would be far less disastrous than those associated with the drought of the 1930's. Our existing major transfer payment mechanisms would in fact substantively mitigate against even many of the regional income losses estimated earlier in this report (see Tables 3 and 4).

This report has not attempted to evaluate the full effect that existing transfer payment mechanisms would have on the socio-economic impact of a prairie drought. The following comments, however, are made on this point:

(1) Transfer payment mechanisms would significantly shift the critical grain crop income losses into future time periods and onto federal government fiscal sources (and thus onto the overall national economy).

(2) A moderate drought, or one dry year, would therefore tend to create minimal overall income losses and unemployment within the prairie region (with the possible exception of the Saskatchewan economy).

(3) A severe drought would have to recur over a number of years in order to create anything approaching the regional or provincial income losses and regional or provincial unemployment levels estimated earlier (see Tables 3 and 4) in this report.

(4) Impacts on the non-prairie regions of Canada would probably be greater than indicated earlier in this report (see Table 4).

Conclusions: Socio-Economic Impacts of a Severe Drought

Severe and recurring drought in the Canadian Prairies would cause drastic declines in field crop production, significant losses for beef producers, increased electric power generation costs, serious municipal water supply problems in many communities, and a variety of recreational impacts which would act to reduce the quality of life for the region's urban and rural residents.

It is possible that such conditions could cause significant reductions in tourism and recreation, wildlife hunting, and commercial and sports fishing. Water and/or electricity rationing are also a possibility in some areas.

In the absence of present day transfer payment mechanisms, a severe drought would create an annual loss in Canadian personal income in excess of $2.4 billion; 63 per cent of this loss would be concentrated in Saskatchewan. Overall Canadian unemployment would increase by about at least 1.5 percentage points; prairie unemployment would increase by a much higher margin, with Saskatchewan in particular being affected.

The regional impacts of such a drought would be far less disastrous than than those associated with the drought of the 1930's, due to the present day Canadian economic and fiscal environment, i.e. the absence of a worldwide depression, the existence of a more diversified regional economy and the presence of present-day transfer payment mechanisms.

In particular, existing transfer payment mechanisms would act to provide some protection of provincial and municipal government fiscal integrity; transfer payment mechanisms would also significantly shift the critical crop income losses into future time periods and onto federal government fiscal sources (and thus onto the overall national economy).

A moderate drought, or a short drought (i.e. one dry year) would tend to create minimal overall income losses and unemployment within the prairies (with the possible exception of Saskatchewan).

Severe and recurring drought, however, would certainly create serious economic problems within the region, with impacts continuing to be felt for many years after the drought itself had ended. Provincial governments would face significant fiscal problems caused by revenue losses combined with increased expenditures. The federal government fiscal regime and the overall Canadian economy would also both receive significant shocks from such a drought.

3. Policy and Action Priorities

This Summary Report has indicated the magnitude of impacts associated with a serious and prolonged drought on the Canadian Prairies.

It has been noted that at the time when this report was being written, water supply conditions in southern agricultural areas were in general at the lowest levels ever recorded for March. The risk is very real that 1977 will be an extremely dry year throughout the region; it cannot presently be evaluated, however, whether a dry summer in 1977 will be followed by at least one (and possibly more) dry years.

The major policy conclusion of this report is to recommend that the federal government be in a position by early summer 1977 to commence a co-ordinated Drought Information Program within the region. This program would be a contingency measure for implementation in the event that spring and early summer precipitation is indeed insufficient to prevent a 1977 drought. It is anticipated that a very small group within one department could initially be responsible for this program; their function would be to co-ordinate information for governments and the public concerning prairie drought prospects, impacts, and contingency measures.

Policy Perspectives

The relevance of a federal Drought Information Program is suggested on the basis of the following policy perspectives:

(1) Public Awareness and Concern

There is widespread public awareness and concern about current dry weather conditions; insufficient spring and early summer precipitation can be anticipated to create by midsummer an intense public interest and questioning of government drought impact assessment analysis and contingency plans. It is therefore important that the federal government be in a position to respond fully to such concerns in the event that a serious 1977 drought is confirmed by mid July.

(2) The 1930's Perspective Versus Modern Realities

Information programs appear relevant to explain major differences between the 1930's and today as regards the overall economic and fiscal environment (see Section 2 of the Summary Report); it is important to point out the lessons learned and the actions taken since the 1930's:

(i) Water management improvements, eg. PFRA, federal-provincial planning boards, storage reservoirs, etc.

(ii) Fiscal transfer payment mechanisms to protect farmer, municipal and provincial incomes.

(iii) Agricultural and other enterprise practices to alleviate drought impacts.

The spectre of a modern drought provides an excellent opportunity to highlight the potential relevance of the federal structure to the modern prairie economy (in contrast to the 1930's situation).

(3) Impacts on the Federal Government

A severe drought in the Canadian Prairies would impose significant fiscal burdens on the federal government; it would also create demands for federal initiatives to assist the region's farm and rural communities, and (perhaps) to co-ordinate overall regional water planning. The ultimate impacts of such a drought would certainly be felt outside as well as inside the prairie region. It is therefore concluded that co-ordinated ongoing federal assessment of drought impacts is indeed very relevant at this time.

At the present time drought impact assessments are being separately conducted by a wide number of federal and provincial departments, boards and agencies. It is therefore useful for federal authorities to provide one group to assist in co-ordinating all regional drought information; there is not yet, however, any clear need for the federal government to suggest establishment of a co-ordinating agency to plan and administer drought mitigation measures.

Action Priorities

Numerous provincial and federal groups are presently undertaking actions to assess drought impacts and to prepare various contingency measures. These actions suggest that the situation is, in general, well in hand for the current year.

The main action priority at present is to provide co-ordinated federal government assessments of drought impacts and anticipated mitigation measures; in addition, it is prudent to suggest that contingency assessments should now start to be made of the situation beyond a 1977 drought, i.e. the situation which could exist if serious dry conditions persist for two or more years in the region. Proper evaluation of longer term drought possibilities might suggest the wisdom of initiating certain contingency measures this summer and fall in order to protect future water supplies as well as other resource factors.

In addition, this report has indicated that existing federal government transfer payment mechanisms would play an overriding role in determining the ultimate socio-economic impact of a severe prairie drought. It is therefore important that the impact of these transfer payment mechanisms be more fully documented and evaluated within the next few months.

Within the above framework, detailed action areas relevant to be completed during the period prior to July, 1977 are outlined in four tables at the end of this section. These detailed action areas are presented under the following four enterprise groupings:

Table 5: Crop Enterprises
Table 6: Livestock Enterprises
Table 7: Recreation, Tourism, Wildlife, Fishing and Forestry Enterprises
Table 8: Other River and Water Storage Related Enterprises

TABLE 5

DETAILED ACTION AREAS:

CROP ENTERPRISES

A Immediate advice to farmers concerning this year's crop selection, seeding stubble land, and dry land farming techniques to preserve soil moisture in seeding and cultivation (already under way in each province).

B Evaluate impact of existing federal-provincial transfer payment mechanisms and assistance programs related to western crops, i.e. their impact under severe drought re: farmers in each province, each provincial government, and the federal government.

C Examine SMEP and other possible programs to evaluate soil moisture and crop yield relationships on a sub-provincial basis (eg. crop districts) in order to improve overall drought impact assessment prior to harvest time.

D Identify and evaluate crop enterprise contingency programs for the period after June 30, 1977, assuming that severe drought conditions materialize; indicate implementation timing for these programs as related to weather and/or crop condition reports for each sub-provincial area.

TABLE 6

DETAILED ACTION AREAS:

LIVESTOCK ENTERPRISES

A Immediate description and assessment on a sub-provincial basis of this year's livestock problems under severe drought conditions affecting stock watering, summer forage and winter forage; integrate the results of May waterfowl breeding area surveys wherever relevant to assist in the evaluation of local pothole and dugout water supplies.

B Evaluate impact of existing federal-provincial transfer payment mechanisms and assistance programs related to western livestock, i.e. their impact under severe drought conditions re: farmers in each province, each provincial government, and the federal government.

C Identify and evaluate livestock enterprise contingency programs for the period after June 30, 1977, assuming that severe drought conditions materialize; indicate implementation timing for these programs by sub-provincial areas where relevant; in particular, examine the following:

- measures to ensure orderly disposal and marketing of cattle and calves when and if abnormal herd reductions are warranted;
- measures to maintain breeding stock;
- measures related to construction of wells, dugouts, stock-watering dams and irrigation projects;
- forage carryover policies and appropriate use of existing and anticipated prairie grain supplies.

TABLE 7

DETAILED ACTION AREAS:

RECREATION, TOURISM, WILDLIFE, FISHING AND FORESTRY ENTERPRISES

A Co-ordinate a description and assessment on a sub-provincial basis of problems expected through the next two years under severe drought conditions; estimate by province the direct impact on forest harvesting and conversion operations, as well as on tourist and recreational activities and spending.

B Identify and evaluate contingency programs by enterprise for the period after June 30, 1977, assuming that severe drought conditions materialize; indicate implementation timing for these programs by sub-provincial areas where relevant; in particular, examine measures to sustain wildlife and fish populations and habitat, and to preserve prime logging areas.

TABLE 8

DETAILED ACTION AREAS:

OTHER RIVER AND WATER STORAGE RELATED ENTERPRISES

A Co-ordinate an evaluation of the following water supplies and requirements on a sub-provincial basis through the next two to three years under sustained severe drought conditions:

- regional river flows;
- reservoir storage related to regional rivers;
- irrigation related to regional rivers;
- local river, local storage, and ground water supplies in the remaining areas.

B Identify and evaluate contingency programs for flows, storage and irrigation related to regional rivers during the period after June 30, 1977, assuming that severe drought conditions materialize; indicate federal, provincial and local costs and implementation timing for these programs as related to weather reports for each sub-provincial area; in particular, examine emergency measures and priority uses for any possible water rationing.

C Identify and evaluate contingency programs for local river, local storage and ground water supplies during the period after June 30, 1977, assuming that severe drought conditions materialize; indicate federal, provincial and local costs and implementation timing for these programs as related to weather reports for each sub-provincial area; in particular, examine the following (including evaluation of present capability):

TABLE 8 (continued)

DETAILED ACTION AREAS:

OTHER RIVER AND WATER STORAGE RELATED ENTERPRISES

C
- emergency trucking or pumping of water;
- drilling of new wells or extension of existing wells;
- emergency modifications to existing works;
- construction of dams and dugouts.

D In light of the above, co-ordinate an evaluation of the impacts (if any) that severe drought conditions would have on the following (by sub-provincial areas where relevant):

- electric power generation (thermal cooling plus hydroelectric generation) and costs;
- manufacturing and service industries;
- residential water consumers.

Identify and evaluate contingency programs where relevant.

APPENDIX

March 21st, 1977

WORKING PAPER NO. 1

A REVIEW OF PRESENT AND POTENTIAL WATER SUPPLY CONDITIONS ON THE PRAIRIES

Introduction

The purpose of this working paper is to review present and potential water supply conditions on the Canadian Prairies during the spring and summer of 1977. The review presented below is the result of a series of telephone and personal interviews with water supply experts in agencies of both provincial and federal governments. The interviews were conducted during the first two weeks of March.

For the purposes of this review, four sub-categories of overall water supply have been considered:

Soil Moisture: the stored moisture content of the part of the soil useful for plant growth. Soil moisture storage provides the mechanism for temporal matching of plant moisture requirements and moisture availability. The residual moisture in the soil following harvest is stored through the winter in the frozen ground. This moisture is augmented by melting snow. If soil moisture is low the timing of spring rains becomes critical for production of a successful crop. If soil moisture available for plant use is less than 75 mm, seeding is often not recommended.

Ground Water: ground water is a significant source of water supply in many parts of the Prairies. Deep wells penetrating "permanent" aquifers are normally immune to the effects of short term meteorological variations. Shallow wells penetrating surficial aquifers are frequently less productive during drought conditions since the run-off recharge or stream flow recharge upon which they depend is not available.

Streamflow

(a) Regional Rivers: the major river systems of the Prairies (the North and South Saskatchewan, the Churchill, the Nelson, the Red, the Assiniboine and the Winnipeg) are treated separately because of the extensive nature of their impact.

(b) Local Rivers: other rivers of specific local importance for water supply are reviewed.

Reservoir Storage: the divergence in timing of precipitation, runoff and streamflow from the timing of water demands on the prairies has resulted in an extensive system of dams and reservoirs for conservation storage of water used for hydroelectric generation, municipal supply, domestic rural supply, stock watering and irrigation. In addition to the reservoir system, many farmers have constructed dugouts and farm ponds for individual farm water supply.

The common factor among the above four types of water supply is, of course, precipitation. Winter snowpack accumulation is the most important type of precipitation for major streamflows -- contributing 80-90 per cent of the annual regional river water supply on the prairies. Given that such a large proportion of annual water comes from snow accumulation, good estimates of maximum water supply from streamflow may be developed substantially before the beginning of runoff.[1/]

In the case of reservoir storage, the forecast of total water supply on a particular river is crucial because it determines the amount of water which can be consumed and yet leave the reservoir storage full at the end of the runoff period. It would be normal to find reservoirs relatively empty at this time of year in anticipation of the receipt of significant runoff streamflow. Streamflow will in general be much below normal this year. Thus, many reservoirs will not fill this year.

While snowmelt runoff provides the major proportion of prairie streamflow water supplies, spring and summer rainfall precipitation can be significant in certain basins. For instance, the upper reaches of the North

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1/ The Prairie Provinces Water Board issues forecasts each month (starting in in March) of regional river streamflow volumes throughout the prairies for the rest of the year; these forecasts (using a model that took four years to develop) place major emphasis on mountain snowpack conditions which are, for practical purposes, fully recorded by mid March. Early spring mountain rains can create local flash floods; however, this precipitation is most unlikely to offset serious below normal snowpack levels.

Saskatchewan River Basin in Alberta have a higher tendency to get substantial spring rains than most other prairie basins. This tendency for rain precipitation increases the difficulty of forecasting seasonal runoff.

In most river basins, however, significant runoff on the plains from rain precipitation carries a low probability. In Saskatchewan, for example, spring rains this year have about a 10 per cent chance of creating measurable runoff.

Notwithstanding the small probability that they will create measurable runoff, spring and summer rains on the plains can have a significant impact on:

i) recharging soil moisture and reducing demands on deep soil moisture reserves
ii) recharging surficial sub-surface aquifers and dugouts
iii) reducing the level of demand for stored irrigation water.

The drought conditions[1/] currently in existence on the prairies began last July in the eastern prairies and moved north and west as the summer and fall progressed. Several areas were dry in the spring of 1976 but substantial early summer rains replenished soil moisture, aquifer and reservoir storage. For instance, May 1976 precipitation at Winnipeg was only 18 per cent of normal, but June 1976 precipitation was 227 per cent of normal.

By the end of November 1976, seasonal precipitation (September through November) was less than 50 per cent of normal in most of the southern prairies east of a line through Lethbridge and Drumheller, Alberta. Since then, the drought has continued to move west. As of the end of February, seasonal precipitation was less than 37 per cent of normal in southern prairie areas east of Swift Current. In some areas, particularly around Winnipeg and Regina, precipitation was about 30 per cent of normal levels.

1/ Throughout this paper, the term "drought" is used in a non-scientific manner to describe unusually dry conditions; strict technical application as per environmental studies is not intended.

The working paper proceeds below to analyze the water supply conditions in each of the three prairie provinces under the water supply headings listed above. Appendix A provides a list of agencies and personnel contacted.

ALBERTA

General

Precipitation in Southern Alberta has been below normal since the major rain fall during the first week of August, 1976. By the end of November only the Bow River watershed upstream of Calgary had received normal or above normal precipitation for the period September 1 to November 30, 1976. East of a line through Lethbridge and Drumheller, precipitation was less than 50 per cent of normal. During December 1976 and January 1977, the southern portions of the province continued to receive below normal snow (Medicine Hat received 33 percent of normal in December and 76 per cent of normal in January) and the snowpack did not accumulate in the mountains.

Little snow cover remains on the plains following warm temperatures through February and early March. There is only a low probability that sufficient snowpack will accumulate during the remaining snow season to bring snow accumulation back to normal.

Soil Moisture

Surface soil moisture is very low and blowing soil has been reported in southern sections of the province where snow cover is gone. Lower soil levels are relatively moist as a result of the heavy August precipitation last summer.

The Canada Department of Agriculture has developed a computer analysis program to estimate soil moisture levels based on antecedent conditions[1/].

1/ Soil Moisture Evaluation Project (SMEP) Project Leader: S. N. Edey, Agrometeorology Research and Service Section, Agriculture Canada, Ottawa.

Estimates produced by this program for stations in Southern Alberta (Lethbridge, Brooks and Medicine Hat) indicate that soil moisture levels as of January 31, 1977 were in the range of 10-20 per cent of capacity on stubble and 15-25 per cent of capacity for fallow on coarse and medium textured soils. The levels were slightly higher for fine textured soils.

Long term averages of soil moisture are not available for this time of year but in 1976, at the end of February, moisture levels in stubble fields were about 25 per cent of capacity on all soil types, while in fallow fields contents ran about 50 per cent of capacity on all soil types. Thus 1977 moisture contents are significantly below those of 1976.

The CDA study indicates that as of January 31, 1977 water content of snow on both stubble and fallow fields in the area south of Calgary was less than 15 mm. This moisture, if completely added to the soil moisture content at January 31, 1977, would give soil moisture levels in coarse and medium soils at Lethbridge, Brooks and Medicine Hat below or only marginally above the minimum 75 mm. normally thought to be required for seeding.

Ground Water

According to ground water specialists in Alberta, wells penetrating deep aquifers have not been influenced by the drought and would not be influenced unless it carries on for many months into the future. They also report that only an extremely small minority of Alberta wells will have penetrated shallow aquifers subject to surficial water recharge.

Streamflow

a) Regional Rivers[1/]

Streamflow in the regional river systems depends heavily on snow pack runoff and regulation on the upper reaches. The regional rivers defined for Alberta are the North Saskatchewan, and the South Saskatchewan plus its two major components (the Oldman and the Bow River) and its major tributary, the Red Deer River.

Runoff in the North Saskatchewan basin is presently forecast to be between 50 and 80 per cent of normal. The most probable runoff level is 60 per cent of normal. (The lower end of the range is based on a forecast of future precipitation at the lower quartile of the historical range. The upper end of the range uses a precipitation forecast at the upper quartile of the historical range.)

Normal April-October seasonal streamflow at Edmonton is about 5.0 million acre-feet. Thus, the most probable runoff this year is about 3.0 million acre-feet.

The shape of the streamflow hydrograph at Edmonton will depend on rate of snowmelt and, to a lesser extent, the pattern of regulation at the Brazeau and Big Horn reservoirs. We have been unable to obtain a forecast of summer flows of the North Saskatchewan through Edmonton.

It seems likely that the North Saskatchewan river could peak in May this year given the warm weather presently being experienced. Based on forecasts of flows on the North Saskatchewan in Saskatchewan and the relatively minor tributary flows to the river between Edmonton and the boundary, flows of

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[1/] Streamflow and runoff forecasts presented here are based on late February and early March reports prepared by the Flow Forecasting Branch, Alberta Department of the Environment.

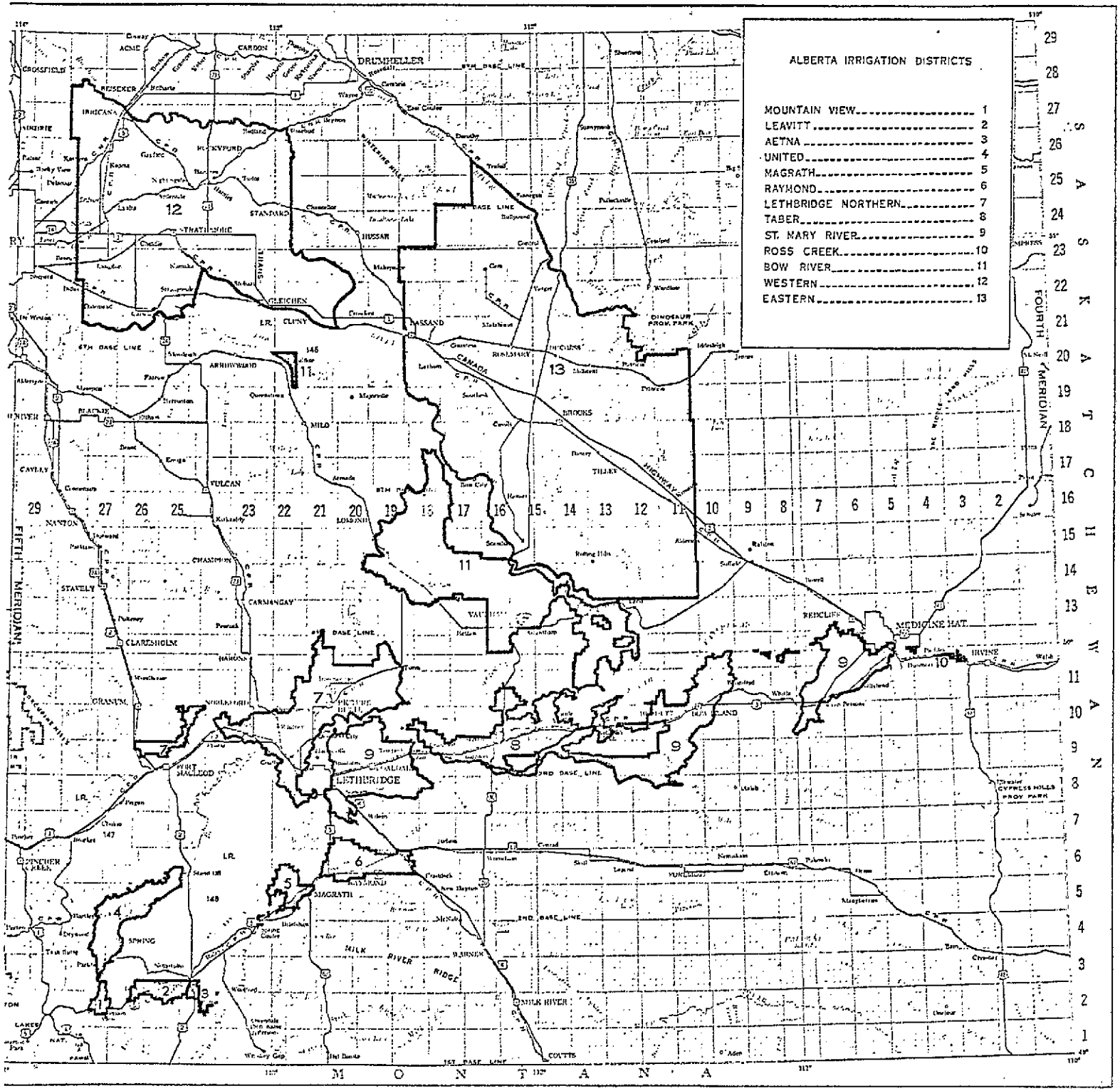
9,000-10,000 cfs through Edmonton seem reasonable. These levels of flows should be adequate for all uses.

Runoff on the two principal components of the South Saskatchewan River, the Oldman and the Bow, is forecast to be considerably below normal. Runoff on the Oldman proper is forecast to range between 40 and 60 per cent of normal with the most probable level being 45 per cent. Normal runoff on the main stem is 1.35 million acre-feet. On the St. Mary's river, the principal tributary of the Oldman, the most probable runoff is 70 per cent of normal or 0.35 million acre-feet.

The main stem of the Oldman has no onstream storage but does have facilities for direct stream diversion. There is little storage connected to these diversion facilities.

The St. Mary's River contains both onstream and offstream storage. This spring, however, alterations at the St. Mary's reservoir prevent the use of maximum storage until late March or early April. Thus all runoff will be unregulated flow until work is completed, and the reservoir may not be entirely filled this year.

We were unable to obtain specific forecasts of streamflows this summer on the Oldman. We did obtain an expression of concern, however, about the adequacy of irrigation water supplies for the Lethbridge North District. (See attached map.) This District does not have substantial reservoir storage; water is diverted directly from the Oldman River into the canals, and thus the maximum rate of diversion is set by the streamflow in the river.


ALBERTA IRRIGATION DISTRICTS
MOUNTAIN VIEW 1
LEAVITT 2
AETNA 3
UNITED 4
MAGRATH 5
RAYMOND 6
LETHBRIDGE NORTHERN 7
TABER 8
ST. MARY RIVER 9
ROSS CREEK 10
BOW RIVER 11
WESTERN 12
EASTERN 13
SASKATCHEWAN
MONTANA
FIFTH MERIDIAN
FOURTH MERIDIAN
LETHBRIDGE
MEDICINE HAT
DRUMHELLER
BROOKS
VULCAN
TABER
MILK RIVER
COUTTS

During a low water year such as this year, especially if the peak flow occurs early, before major irrigation demands commence, it is probable that maximum irrigation demands would coincide with relatively low flows on the recession portion of the hydrograph. The Lethbridge Northern District, and other districts, have terminable contracts, which are the first to be terminated if demand for irrigation water exceeds available supply.

Runoff on the Bow River is forecast to range between 55 and 65 per cent of normal with 60 per cent being the most probable level. Normal runoff on the Bow River is 1.3 million acre-feet. The streamflow on the Bow River at Calgary is substantially regulated by storage in reservoirs operated by Calgary Power. Of the seven reservoirs on the upper reaches, all but one reservoir contain considerably more storage than normal at this time.

Flows through Calgary are forecast to be between 1,500 and 2,000 cfs in May, 5,000 cfs in June and July, and 5,000-6,000 cfs in August. These flow levels should be adequate for all demands on the river including irrigation diversions in the Bow River Irrigation District, (BRID), the Western Irrigation District (WID) and the Eastern Irrigation District (EID). Total diversion capacity of these three projects is 5,865 cfs. Based on the experience of previous low-flow years, shortages will be experienced in August and September on the EID, the furthest downstream location which will bear the brunt of the shortage. Releases from Calgary Power reservoirs may be sufficient to meet the demands on the other two districts.

The BRID is unlikely to divert anywhere near the maximum, however. Their large internal storage capacity is capable of supporting their requirements for about two irrigation years.

Runoff on the Red Deer River (which joins the South Saskatchewan River just east of the Saskatchewan boundary) is forecast to occur in the range 30 to 70 per cent of normal with the most probable flow forecast at 45 per cent or about 0.28 million acre-feet.

We were unable to obtain a forecast of streamflow on the Red Deer during the summer months. Flow records, however, indicate that monthly mean flows have not fallen below 1,200 cfs at Drumheller (1930's not reported) or 1,000 cfs at Red Deer (only 1930 and 1932 reported during the 1930's drought).

b) Local Rivers

The snow cover on the southern and eastern plains has already melted and the runoff has occurred. Only minimal additional runoff is likely. Thus streamflow will approach zero in most local creeks and rivers this summer unless significantly above-normal rainfall occurs. Farm ponds and dugouts used for stock watering will not fill this summer unless significant rain occurs.

Reservoir Storage

The main reservoir storage in Alberta consists of the system of irrigation reservoirs in the southern part of the province and Calgary Power's hydroelectric reservoirs on the Bow and North Saskatchewan rivers.

The St. Mary's, Waterton and Ridge Reservoirs are operated by the St. Mary's River Irrigation District as their main irrigation water storage. The system of reservoirs is connected by canals so that water stored in Waterton can be restored in St. Mary's or Ridge Reservoirs to optimize the storage pattern.

Waterton Reservoir (on the Waterton River) is currently below normal storage levels and is not expected to fill. St. Mary's Reservoir is drawn down for repairs and can neither store water nor divert flows on the St. Mary's River to Ridge Reservoir. Water supplies for the St. Mary's Irrigation District are thus expected to be only 80-90 per cent of requirements.

The Bow River Irrigation District operates an extensive reservoir system including Travers Dam and Lake McGregor. Levels of storage in the BRID system are adequate for this year.

Calgary Power operates Brazeau and Big Horn reservoirs on the North Saskatchewan River and Spray, Cascade, Pocaterra, Interlakes, Barrier, Ghost and Bearspaw Reservoirs on the Bow River. All except Interlakes reservoir are filled beyond normal levels for this time of year in anticipation of low runoff levels. Interlakes Reservoir is empty.

Calgary Power will operate the reservoirs in order to conserve as much water as possible for the next winter peak load season. Loss of energy generated will be 120 gwh or about 7 per cent of the average generation of 1,800 gwh per average water-year.

Dugout storage and farm ponds are an important feature of range stock operations in southern and eastern Alberta. As mentioned above, it is unlikely that dugouts will fill this year without substantially above normal streamflow. Thus stock watering problems will likely be encountered throughout southern and eastern Alberta this year.

SASKATCHEWAN

General

In Saskatchewan, spring 1976 soil moisture reserves were augmented by early summer rains in excess of normal (June/July precipitation was 338 per cent of normal at Regina, 269 per cent of normal at Saskatoon and 158 per cent at Swift Current) resulting in high levels of soil moisture and full reservoirs early in the 1976 growing season.

From early August on (September around Swift Current) precipitation levels have been far below normal in central and southern Saskatchewan. The result has been that soil moisture levels have been reduced and little or no runoff can be expected to top up reservoirs.

Soil Moisture

Soil moisture levels in Saskatchewan differ both geographically and by cropping pattern. The major difference occurs between lands that were summer fallowed in 1976 and those which yielded grains or forage in 1976.

Summer fallow areas have retained significant soil moisture from early spring 1976. On these lands, normal or slightly below normal precipitation levels this summer may yield approximately normal crops.

Lands that were cultivated last year tend to be very dry with some regional variation.

Southeastern Saskatchewan is fairly dry in the top 24 inches; below that level residual soil moisture from last year's wet spring is relatively high. Normal rain conditions would in general be adequate to bring the surface layers of soil to minimum necessary soil moisture levels.

Northeastern Saskatchewan continues to maintain snow cover. Soil moisture levels are not presently being depleted in this area and normal precipitation would be adequate.

Northwestern Saskatchewan has received higher levels of precipitation since July (65 per cent of normal) and soil moisture contents are higher than elsewhere. Normal precipitation would be adequate.

South central and southwestern Saskatchewan soil moisture levels are extremely low on land cultivated last year. Precipitation levels of three to four times the normal are required to make up this soil moisture deficit. The probability of such an occurrence is extremely low. As of January 31, 1977, Environment Canada reports a probability of less than 6 per cent of recovering even 80 per cent of the precipitation deficits recorded at Regina, Saskatoon and Swift Current prior to April 30th.

The CDA soil moisture analysis program illustrates the dryness of Saskatchewan soils. On coarse textured soils in stubble, January 31, 1977 soil moisture levels were less than 15 per cent of capacity at Prince Albert, North Battleford, Saskatoon, Yorkton, Swift Current and Estevan. Fallowed fields at those stations are at 40 per cent of capacity or less on coarse soils. In 1976 those same centres reported moisture contents in the range of 20-30 per cent of capacity on both stubble and fallow.

On medium textured soils, those main stations report moisture levels in the range of 10-20 per cent of capacity on stubble and 25-35 per cent on fallow. In 1976, comparable readings were 20-30 per cent in stubble and 45-55 per cent on fallow.

On fine textured soils, soil moisture levels of the above Saskatchewan stations are in the range of 45-55 per cent on both stubble and fallow. These moisture contents are equal to or higher than comparable figures for 1976 -- particularly on stubble soils.

The water available from snow cover in Saskatchewan at January 31, 1977 ranged between 15 and 30 mm on the east side except for the southeast corner in fallow lands. Elsewhere in the province's southern half, moisture content is 15-30 mm except in the band stretching from Moose Jaw-Regina west to the Alberta boundary, including Kindersley and Swift Current where moisture contents are less than 15 mm. These is also a band around Yorkton where moisture content is 30-45 mm.

Given current moisture level conditions, coarse soils in stubble may be too dry for seeding, particularly at Prince Albert, North Battleford, Saskatoon, Yorkton, Swift Current and Estevan. Soil moisture contents on fallow coarse soils and stubble medium soils are only marginal relative to the 75 mm minimum requirement.

Ground water

Ground water is relatively important in Saskatchewan with roughly 75 per cent of farms and 75 per cent of municipalities with water systems depending on ground water supplies. Well depth ranges from surficial to 500-600 feet.

There is no general concern about ground water supplies in Saskatchewan, especially for wells with a depth in excess of 100 feet. These latter wells have tapped deep aquifers with significant storage. Such

wells, in general, will not respond to short term meteorological fluctuations. The wells in the northwestern, west central and western parts of the province tend to be deep wells.

There is some expectation of problems this summer in areas where shallow wells driven into gravel or sand aquifers are predominately recharged by surface runoff or streamflow seepage. Water levels in these wells are currently quite low (as is normal at this time of year), and are not likely to be totally recharged in several areas. Availability of water for stock watering could be significantly impacted in these areas.[1/]

Another area where problems could occur this year (unless above normal precipitation occurs this spring) is the Qu'Appelle River valley where aquifers tend to be shallow and streamflow for recharge will be very low. In addition to problems faced by individual farmers, municipal water systems which may be inadequate this year include White City, Lumsden, Broadview and Whitewood. Both White City and Lumsden have experienced significant growth over the past several years and their aquifer has yet to be tested at the resulting higher drawdown rates in a dry summer.

Other areas facing problems include Canora (where upstream reservoir capacity is available) and, potentially, Weyburn and Melville. The problems at Weyburn and Melville would not be quantity of ground water as much as quality. Both communities have ground water systems to augment surface water supplies during dry years. As the proportion of ground water in the combined supply increases, overall water quality decreases. For instance, the total dissolved solids in Weyburn's ground water supply are about five times higher than in the surface water supply.

1/ In the area north from Saskatoon, some farmers are already reported to be trucking water.

Streamflow

a) Regional Rivers

The major regional rivers in Saskatchewan are the North and South Saskatchewan Rivers and the Churchill River. Precipitation in the Churchill River Basin is reported to be about normal -- thus the Churchill River will not be considered further.

Minimum flows on the North and South Saskatchewan Rivers are subject to an interprovincial agreement. Releases from reservoirs in Alberta may be made this summer to meet the terms of the agreement.

On the South Saskatchewan, the ponding effect of Lake Diefenbaker is evident as far upstream as Saskatchewan Landing Provincial Park. Flows into the reservoir will be much below normal but more than adequate for the consumptive demands along the river, although irrigation intake levels may have to be lowered. Flows may not be adequate to fill Lake Diefenbaker.

Below Gardiner Dam, it is anticipated that flows on the South Saskatchewan will be gradually reduced from current levels of about 3,000-4,000 cfs to the riparian level of 1,500 cfs. This latter flow would be maintained throughout the summer to maximize water conservation in Lake Diefenbaker.

The average flow of 1,500 cfs would not be maintained continuously. Hydroelectric requirements would probably lead to significant daily fluctuations in streamflow immediately below the Gardiner Dam. These fluctuations could contribute to municipal water supply problems at Outlook.

The community of St. Louis, further downstream from Outlook, will also have water supply difficulties at these flow levels. Historically, flows

of 2,000 cfs have created problems in this community. It is likely that water intake adjustments will be necessary at 1,500 cfs.

Flows on the North Saskatchewan are expected to average about 10,000 cfs over the summer period. These flows should be adequate for consumptive withdrawals upstream of the confluence of the North and South Saskatchewan.

Flows into Tobin Lake will be about 12,000 cfs. Summer outflows from Tobin Lake will be severely reduced to conserve water for next winter. Saskatchewan Power will face power reductions.

The low releases from Tobin Lake will not create problems along the reach of the river from Tobin Lake to Cumberland Lake. Cumberland Lake will be low this summer, causing problems for fishermen and water transportation.

b) Local Rivers

The major "local rivers" of concern include Swift Current Creek, the Souris River and the Qu'Appelle River.

Flows in Swift Current Creek will be low but reservoir storage releases will be adequate to meet both municipal demands at Swift Current and normal irrigation demands.

The Qu'Appelle River will have variable flows. Releases from Lake Diefenbaker will ensure adequate flows for municipal purposes at Moose Jaw and Regina. As mentioned above, flows in some tributaries of the Qu'Appelle around Regina (particularly Boggy Creek at Lumsden) could be inadequate to recharge shallow ground water aquifers.

Further downstream on the Qu'Appelle,it will likely not be possible to maintain flows in all reaches. Releases will be made from Katepwa Lake, Crooked Lake and Round Lake, but channel capacity constrictions and channel losses and evaporation will likely reduce flows to zero in several reaches. Raising flows from the above reservoirs to overcome such losses would be too inefficient in terms of water released and water received.

During the period of record at Tantallon (continuous 1942-1973), average monthly flows for the summer months approached zero only in the dry years of 1961-1962. In the past ten years, average monthly flows in the summer have fallen below 10 cfs only once, during August of 1961.

The Souris River in southeastern Saskatchewan faces a pattern similar to that of the Qu'Appelle River. Little or no runoff will occur in the Souris River proper upstream of Estevan. Releases from Boundary Dam of about 1 cfs will maintain municipal supplies at Estevan but the river will likely be dry over substantial reaches from Estevan to Oxbow. Releases from Moose Mountain Lake could temporarily maintain flows in the upper reaches of Moose Mountain Creek but sections of this tributary upstream of Oxbow could also be dry. Virtually zero flow in the Souris River between Estevan and Oxbow is a condition to which long term residents should be accustomed. August mean flows near Estevan were less than 0.6 cfs on five occasions during the decade 1960 to 1970. During the 1961 drought, monthly mean flows near Estevan were less than 0.5 cfs for the period March through October and were zero during July through October (period of record).

The record at Oxbow shows flows similar to those at Estevan. Slightly higher flows were maintained at Oxbow in 1961.

International treaty obligations require that a minimum flow of 4 cfs be maintained at the U.S.-Canada border if natural flows exceed that level.

Reservoir Storage Water

Saskatchewan has a number of reservoirs (about 80) in the southern and central part of the province, designed for water conservation. They range in size from Lake Diefenbaker with about 8 million acre-feet of total storage to Sheho Project reservoir with storage of about 18 acre-feet.

Water supply levels in storage of course vary from reservoir to reservoir. Some key reservoirs are highlighted below:

Diefenbaker Lake: Most of the live storage is empty but it is forecast that Diefenbaker will meet all consumptive demands this summer. Hydroelectric releases this summer will be severely restricted in order to conserve water to meet peak power demands next winter. If the drought were to continue a second year, remaining storage would be inadequate to meet all consumptive demands next summer (1978). (No estimates of generating capacity losses were, however, forthcoming from Saskatchewan Power Corporation).

Duncairn Reservoir: This reservoir serves the Swift Current Project and is supplemented by the Highfield Reservoir. Storage totals about 68,000 acre-feet which is adequate for two to three years.

Cypress Lake: Storage in this reservoir is well down and it will not fill this spring. Stored water will be conserved for municipal and irrigation purposes and should be adequate for the summer. This reservoir will be depleted at the end of the year however, and will require recharge before 1978.

Some small private operators irrigate along Frenchman River. These farmers are licensed for spring flood flows only and will be dry this summer.

Tobin Lake: This reservoir is primarily used for hydro-electric purposes. Water will be conserved on the lake for peak electrical demands in the winter of 1977-1978. Flows on the Saskatchewan River at the Squaw Rapids site are predicted to be 12,000-15,000 cfs by early summer, but Saskatchewan Power Corporation has not indicated the impact of reduced river flows on generating capacity.

Weyburn Reservoir: This reservoir was recharged at the end of 1976. Minimal inflows are expected, but the full condition of the reservoir will permit normal consumptive uses for 1977. If the drought continues into 1978, consumptive demands could not be met.

Estevan Reservoir: This reservoir is filled to capacity and it is anticipated that normal demands will be met over the next two or perhaps three years, including water for cooling of S.P.C. thermal plants.

Thompson Lake Reservoir: Municipal water supply for Lafleche and Gravelbourg storage is adequate for 1977.

Gouverneur Dam, Admiral and Cadillac: Gouverneur is now storing about 2,750 acre-feet which could be inadequate for the irrigation this year of the 1,000 Acres of the Ponteix Water Users' Association. Admiral and Cadillac together hold about another 2,000 acre-feet. This water would not normally be used but could be used for supplemental supply at Gouvenor if required.

Russell Creek Reservoir: This reservoir serves 3 or 4 farmers irrigating about 600 acres. It presently holds about 300 acre-feet of water which is insufficient for even one irrigation.

Downie Lake and Harris Reservoirs: These reservoirs serve about 4,000 acres on two blocks of land about 20 miles apart. (3,000 and 1,000). Storage totals about 5,500 acre-feet which would permit about two irrigations on the main project but would be inadequate for the smaller project.

MANITOBA

General

The drought situation in southern Manitoba (including the Lake of the Woods district of northwestern Ontario) began in July of 1976. June was a wet month at Kenora, Winnipeg, Portage and Brandon with rainfalls in the range of 133 per cent to 227 per cent of normal (Winnipeg). July was dry (particularly at Kenora and Portage) while August precipitation at the four stations was in the range of 59 per cent to 80 per cent of normal.

Since September, seasonal precipitation is less than 40 per cent of normal at all stations. Winnipeg is the driest of the four stations.

In northern Manitoba, the area north of The Pas received normal precipitation through the end of October. Between November 1 and January 31 the area south east of Thompson (Cross Lake, Oxford House area and east) received above normal precipitation while the remainder of the north has varied between 50 per cent of normal and normal precipitation (Lynn Lake 86 per cent, Thompson 90 per cent, Flin Flon 51 per cent). By and large, water supply conditions in the north are not in a drought condition.

Soil Moisture

Surface soil moisture is very low. Snow cover is disappearing and it is expected that blowing soil conditions will exist following snow cover disappearance unless additional precipitation is received. February snow surveys in the Brandon, Wawanesa, Rivers, Portage and Red River areas indicated water content levels of from 0.51 inches (Wawanesa)to 2.04 inches

(Rivers). These levels ranged from 39 per cent (Wawanesa) to 86 per cent (Rivers) of normal for February.

The CDA estimates of soil moisture at Brandon, Portage, Winnipeg and Morden indicate soil moistures of less than 10 per cent of capacity on stubble and around 30 per cent for fallow on coarse soils; between 15 and 20 per cent on stubble and between 30 and 45 per cent on fallow for medium soils and between 30 and 55 per cent for both stubble and fallow on the fine textured soils. As of January 31, maximum water available from snow on fallow land was between 15 and 30 mm. On stubble the moisture availability was the same except for the south-west corner of the province where available moisture was 30-45 mm.

Based on January 31 soil moisture contents and the above estimates of snow cover moisture content, soil moisture contents could be too low for planting at Brandon, Portage, Winnipeg and Morden on coarse and medium soils in stubble and possibly even on fallow lands at Brandon, Winnipeg and Morden.

Ground Water

Ground water tables in many parts of the province are at record high levels although they have begun to recede from the peak. The exception to this statement is the area east of the Red River where water tables have generally been declining over the past two years.[1/]

The areas of greatest problems lie along a line running from near McCreary south to about McGregor and along an intersecting line running from about Glenwood northeast to a point just north of Portage la Prairie. This area stretches southeast of this line to include the area around St. Claude.

1/ High water tables in the Interlake, Parklands and other areas reflect above-average precipitation levels in the previous 3-4 years, including the very high levels in the autumn of 1975.

The ground water in this area is quite saline and is currently at record high levels. Perched above the true ground water table is a surficial aquifer which is frequently associated with Almasippi sands. This surficial aquifer is subject to ground water recharge which will be inadequate in most areas this year. About a dozen community tank loading facilities have been established on aquifers or surface flows to permit farmers to haul water for domestic and stock watering purposes. At least two or three of these tank loading facilities are on shallow wells which may run dry this summer.

Except for these problems and a limited number of other areas with shallow wells, ground water supply problems are not anticipated this year.

Streamflow

a) Regional Rivers

The major regional rivers in Manitoba include the Saskatchewan, the Churchill, the Nelson, the Assiniboine, the Red and the Winnipeg.

Flows on the Saskatchewan River through The Pas are dependent on releases from Tobin Lake in Saskatchewan plus the moderating effect of storage in Cumberland Lake in Saskatchewan. Flows at The Pas are forecast to average 12,000-15,000 cfs during the early summer months.

Releases from the Grand Rapids dam over the summer months will be minimal to conserve water for the peak power demand period of winter 1977 - 1978. Flows of the Saskatchewan River into Lake Winnipeg are thus forecast to average 3,000 - 4,000 cfs this summer.

Precipitation in the Churchill watershed is normal or slightly above normal -- thus adequate streamflows on the Churchill are forecast. Manitoba Hydro is presently diverting 10,000 cfs, and depending on the rate of completion of protective facilities on the diversion route, is forecasting flows of 20,000 cfs later this spring and 30,000 cfs in October.

The Nelson River at Kelsey Generating Station will have flows derived from the controlled and uncontrolled releases from Lake Winnipeg plus drawdown of Cross Lake, Sipiwesk Lake and other local inflows. Flows at Kelsey are forecast to average 35,000 cfs over the early summer compared to normal summer flows of about 110,000 cfs. Releases from Lake Winnipeg will be about 30,000 cfs -- slightly above the minimum permitted under the license. The flow at Kelsey will not be sufficient to maintain the base load of the plant.

Nelson River flows at Kettle Generating Station would then be about 65,000 cfs during the early summer. These flows are the sum of the Kelsey flows and local flows of 4,000 cfs, plus Churchill River diversions, assumed at 25,000 cfs average.

Flows on the Assiniboine River over the summer months will be maintained at a minimum of 400 cfs at Brandon by releases from Shellmouth Reservoir. Releases of this magnitude are required for non-consumptive cooling purposes at Brandon and will ensure sufficient flows downstream of Brandon for municipal water supply and irrigated agriculture around Portage la Prairie. Low spring runoffs next year could, however, lead to supply problems.

Flows on the Red River this summer will primarily be determined by releases from U.S. storage in North Dakota and Minnesota. Minimum flows are forecast to be 200-300 cfs upstream of Winnipeg which will be adequate for municipal water supply purposes. The main communities depending on the river upstream

of Winnipeg are Morris (where a lower intake has been installed), St. Jean de Baptiste and Emerson.

On the Red River downstream of Winnipeg, streamflows could vary between 600-1,000 cfs. At this level, neither the Manitoba Hydro thermoelectric plant (which requires 400 cfs for cooling) nor the Selkirk municipal water system will encounter any problems with respect to supply.

On the Winnipeg River flows will be restricted by conservation efforts at Lake of the Woods. If dry weather continues, average summer flows will be less than 15,000 cfs, and possibly as low as 10,000 cfs. Normal summer flows would be in the range of 25,000-30,000 cfs. The lower level of flows would be adequate for municipal water supplies. Hydroelectric capacity will be substantially reduced. Actual stream flows are likely to fluctuate as releases for power purposes are varied to maximize power revenues.

Local Rivers

Except in the Riding Mountain-Duck Mountain areas snow accumulation is far below normal. Thus, runoff and natural streamflow are expected to be quite low. Flows in many local rivers will be dependent on releases from storage reservoirs.

On the Minnedosa River, flows of 20-30 cfs are anticipated. Since both Minnedosa and Rapid City have their own reservoirs, municipal water supply should not be adversely affected by low streamflows. While average monthly flows at Rapid City reached 0.01 cfs in August 1961, summer flows

during the period of record (to 1970) have at no other time approached this record low.

On the Whitemud River, flows above Neepawa through Hallboro and Oberon are also expected to approach zero. Flows downstream of Neepawa will be maintained at levels between 3 and 7 cfs by releases from the Neepawa reservoir. During the period of record of flows on the Whitemud River above Neepawa reservoir (since 1961) average monthly summer flows have in general not fallen below 5 cfs.

The Rat River below the dam at St. Malo will have flows approaching zero, except for periodic releases to fill the potholes. Average monthly summer flows on the Rat (at Otterburne) have not approached zero during the period of record except for the dry thirties and 1961(1.1 cfs in August).

West Squirrel Creek will be dry north of the Trans Canada Highway unless rains occur. The channel losses for releases from Jackson Lake are too great to maintain flows past that point. Austin-McGregor municipal water supplies will be assured by releases from Jackson Lake (see further discussion below).

The Boyne River flows upstream of the Stephenfield Reservoir at Carman will probably experience average monthly flows approaching zero during the summer months. Downstream of the reservoir flows averaging 2 cfs will be maintained by releases from the reservoir.

Reservoir Storage

The province operates about 50 reservoirs in the southern part of Manitoba for water conservation, water supply and recreational purposes. Of

this number of reservoirs about a dozen are not expected to fill by the end of runoff 1977. Most of these reservoirs will contain sufficient storage for the 1977 water supply year as well as carry-over storage into 1978.

Of particular concern, however, are:

Jackson Lake: sufficient storage to supply Austin-McGregor for 1977 assuming no releases are made to ensure streamflow downstream of the Trans Canada Highway.

Morden Reservoir: this reservoir is about two-thirds full and contains sufficient storage to provide municipal water supply to the town in 1977 provided that no agricultural releases are made.

Stephenfield Reservoir: this reservoir is about one-half full and contains sufficient storage for municipal demands in 1977.

Dugout storage of water by individual farmers is primarily confined to areas south of Winnipeg on the west side of the Red River Valley and to the area west of a line between Virden and Pipestone in the southwest corner of the province. Dugouts in both areas are reported empty and are not expected to fill.

Farmers are reported to be trucking water already at Altona, Winkler and at Brunkild south of Winnipeg and in the areas west and south of Portage la Prairie in the Almasippi sands area. Although farmers have traditionally had to haul water in the area south of Winkler during the winter, the number of farmers doing so is greater this year. If the dry season continues, the vast majority of farmers will be hauling water this year.

APPENDIX A

INDIVIDUALS CONTACTED FOR WORKING PAPER NO. 1

ALBERTA

Department of the Environment

Ron Deeprose	- Director of Technical Services
Majeed Mustapra	- Streamflow Forecasting Head, River Engineering Branch
Allan Kerr	- Head, Ground Water

Department of Agriculture

Jay Parnell	- Director, Irrigation Division at Lethbridge
Konrad Gietz	- Agrometeorologist
Howard Fulcher	- Associate Director, Farm Development Division

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Department of the Environment

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MANITOBA

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Nes. Mudry	- Director of Planning, Water Resources Division
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George Brown	- Chief, Water Development and Service
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Sherman Veitenheimer	- District Officer, Water Development Division, Swift Current
Murray Stillwell	- District Engineer, Swift Current

Department of Agriculture

Stewart Edey	- Soil Moisture Estimates
Wayne Lindwall	- Lethbridge Research Station

Environment Canada

Hugh Fraser	- Supervisor, Scientific Services, Winnipeg
Fred Burbridge	- Edmonton

Prairie Provinces Water Board

Jim Berry	- Regina

Water Survey of Canada

Al Mattick	- Acting District Engineer, Winnipeg

WORKING PAPER NO. 2

POTENTIAL DROUGHT IMPACTS ON DIFFERENT ENTERPRISES

1. Introduction

Working Paper No. 2 describes potential drought impacts on different enterprises on the Canadian prairies.

Table 2.1 outlines the enterprises examined. This paper focuses solely on micro impacts related to the enterprise level of analysis. The following are evaluated (to the extent feasible and relevant) for each enterprise:

(1) Drought impact on enterprise water needs

(2) Resultant effects on enterprise output, prices, sales, etc., as well as major linkage impacts on other enterprises

(3) Range and impact of possible mitigating measures.

The potential drought conditions studied are based on Working Paper No. 1. Four classes of water supply are examined, eg. soil moisture, ground water, streamflow and reservoir storage. Where feasible, the analysis notes how drought conditions could vary by areas and time periods.

The analysis examines the impact of two possible water supply scenarios, without attempting to predict actual water supply conditions in the future.

(1) "Normal" spring and summer precipitation augmenting water supply conditions recorded in March, 1977.

(2) Severe drought conditions throughout the region created by continued below normal precipitation through the spring and summer.

Commentary focuses on the spring and summer period impacts; however, longer term problems are identified briefly where relevant.

At the time when this paper is written (mid March), natural prairie water supply conditions are in general at all-time low levels. Spring and summer precipitation is most unlikely to create measurable run-off; thus, streamflow levels (independent of storage regulation) will certainly be much below normal in most areas throughout the spring and summer.

Man-made storage reservoirs throughout the region will tend to minimize the impact of water supply shortages during the 1977 spring and summer season; however, continued below normal precipitation through the next winter would create serious storage and streamflow shortages in many areas during 1978.

The major unknown for the 1977 season is the water supply available for crops and forage in non-irrigated regions, as well as shallow well and dugout supplies in certain areas. The widespread existence of record low soil moisture conditions indicates the critical importance of spring and early summer precipitation for crop and forage enterprises where regional irrigation systems do not provide assistance.

TABLE 2.1

OUTLINE OF ENTERPRISES EXAMINED

1. Crop Enterprises

a) Major field crops, eg. wheat, oats, barley, rye, rapeseed and flaxseed

b) Vegetable crops

c) Potatoes

d) Sugar Beets

2. Livestock and Forage Enterprises

a) Beef

b) Dairy

c) Other livestock

3. Non Agricultural Enterprises

a) Electric power (hydro and thermal)

b) Mining

c) Forestry

d) Wildlife and fishing

e) Recreation and tourism

f) Municipal water supplies and relevant impacts on related enterprises not discussed above

2. Major Field Crop Enterprises

Within the prairie provinces, the major field crops are wheat, oats, barley, rye, rapeseed and flax. Excluded from this category are such forage crops as tame hay and silage corn, as well as potatoes, sugar beets, vegetables and other miscellaneous crops. Production of the major field crops in 1976 in the prairies amounted to 1,620 million bushels, of which 833 million bushels (51.4 per cent) was wheat.

For major field crops, soil moisture conditions are the primary water supply variable influencing production levels. In order to analyze the impact of soil moisture conditions on production, three key factors must be considered, namely conditions at spring planting, conditions on different soils, and the impact of spring and summer precipitation:

(1) Spring Planting

Soil moisture conditions during the spring planting period may influence the farmer in his decision whether to seed at all, and what crop to seed.

A general rule of thumb among agrologists is that if plant available water at time of seeding is less than three inches (75 mm.), then seeding is not recommended. This rule of thumb, however, is unlikely to have much practical validity in 1977, for the following reasons:

- areas of Manitoba and Alberta are generally wetter than Saskatchewan, where such a rule may apply. Reference to water deficiency maps, for example, clearly establishes that areas outside the Palliser Triangle enjoy water deficits two to six inches less than the levels prevailing within the Palliser Triangle. In these areas, spring soil moisture conditions of two inches (50 mm.) may be entirely adequate to warrant seeding. 1/

- there is no evidence that farmers in the past have reduced their seeded acreages in response to drought conditions. A review of acreages seeded to wheat in the prairie provinces, for example, indicates no downward trend during either the 1930's or in 1961.

1/ L. J. Chapman and D. M. Brown, The Climates of Canada for Agriculture Canada Land Inventory Report No. 3 (Ottawa: 1966)

More likely, reduced soil moisture conditions will influence the choice of crop seeded, eg. farmers may reduce acreages planted to shallow seeded crops such as rapeseed and flax, and turn instead to wheat, oats or barley. On the other hand, rapeseed tends to be grown in the more northerly parts of the prairies where soil moisture conditions are by no means as severe.

(2) Different Soils

As Working Paper No. 1 has already indicated, soil moisture conditions in the prairies also vary widely by type of cropping practiced and texture of soil. Stubble fields are, for example, substantially drier this year than fallow fields, while medium and fine textured soils tend to hold far more plant available water than coarse textured soils.

In assessing the impact of drought on yields of major field crops, recognition must therefore be given to the following points:

- medium textured soils are the single most important soil texture type throughout the prairie provinces; coarse textured soils (where plant available water is far lower) are far less important for the raising of field crops.

- a very high proportion of field crops are grown on fallow rather than stubble fields. As Table 2.2 indicates, this is particularly the case for wheat, rapeseed and flax, and to a lesser extent for oats and barley.

- low plant available water on stubble fields, then, is of less concern for the 1977/1978 crop, although continuing dry conditions into 1978 could certainly aggravate yields for the next crop year when rotation occurs. 1/

(3) Spring and Summer Precipitation

Beyond soil moisture conditions at planting time, precipitation during the early growing season, i.e. May and June, can have a dramatic impact on ultimate yields. In 1976, for example, low soil moisture conditions were also prevalent in May, (although not at the levels being experienced this year); heavy rains during June, however, resulted in excellent yields on most field crops, as Table 2.3 indicates. Rains after mid-July are less important in determining overall yields, and may in fact lead to some reduction in output.

1/ See also G. E. Britnell and V. C. Fowke Canadian Agriculture in War and Peace 1935-1950 for commentary (page 63) on the effect of summerfallow on yields during an extended dry period. Summerfallow during such periods leads to increases in the level of soil erosion.

TABLE 2.2

ACREAGES SEEDED ON STUBBLE AND SUMMERFALLOW,

BY CROP AND PROVINCE, 1976

	Alberta		Saskatchewan		Manitoba		Total	
	000 Acres	Per Cent	000 Acres	Per Cent	000 Acres	Per Cent	000 Acres	Per Cent
Wheat								
Summerfallow	4,067	73	14,838	85	1,829	48	20,734	77
Stubble	1,533	27	2,562	15	1,971	52	6,066	23
Total	5,600	100	17,400	100	3,800	100	26,800	100
Oats								
Summerfallow	560	31	735	40	180	14	1,475	30
Stubble	1,240	69	1,115	60	1,070	86	3,425	70
Total	1,800	100	1,850	100	1,250	100	4,900	100
Barley								
Summerfallow	1,535	28	1,454	48	269	17	3,258	32
Stubble	3,965	72	1,546	52	1,281	83	6,792	68
Total	5,500	100	3,000	100	1,550	100	10,050	100
Flaxseed								
Summerfallow	82	82	168	75	102	18	352	40
Stubble	18	18	57	25	448	82	523	60
Total	100	100	225	100	550	100	875	100
Rapeseed								
Summerfallow	606	71	805	93	120	48	1,531	79
Stubble	244	29	45	7	130	52	419	21
Total	850	100	850	100	250	100	1,950	100

Source: Statistics Canada.

TABLE 2.3

AVERAGE YIELDS PER ACRE FOR MAJOR FIELD CROPS, BY PROVINCE AND YEAR

		1976	5 year average 1972-1976	1961	Lowest Yield 1931-1976	
					Year	Yield
		(bushels/acre)				
Wheat	Alberta	32.5	28.2	15.8	1936	8.8
	Saskatchewan	31.5	25.1	8.5	1937	2.6
	Manitoba	27.1	25.1	11.7	1935	9.0
Oats	Alberta	58.9	54.7	36.9	1936	19.7
	Saskatchewan	55.7	47.6	12.7	1937	5.1
	Manitoba	48.8	45.4	18.5	1936	14.0
Barley	Alberta	44.5	41.4	26.9	1949	17.0
	Saskatchewan	45.0	38.3	10.9	1937	4.7
	Manitoba	41.9	37.1	13.7	1936	13.3
Rye	Alberta	28.0	25.0	13.2	1933	4.4
	Saskatchewan	26.6	21.3	6.9	1937	1.2
	Manitoba	28.5	25.1	11.1	1936	10.8
Rapeseed	Alberta (1)	19.4	17.7	17.1	1955	11.2
	Saskatchewan (2)	22.8	18.0	15.0	1950	5.0
	Manitoba (2)	18.0	17.8	17.1	1946	8.0
Flax	Alberta	16.0	15.0	11.0	1933	4.0
	Saskatchewan	16.9	13.2	6.0	1933	2.0
	Manitoba	11.5	11.3	5.7	1931	3.5

Source: Canada Grain Council; Statistics Canada.

(1) 1955-1976

(2) 1943-1976

Several key conclusions derive from the above commentary. The first conclusion is that while reduced seeding may occur in some isolated areas (principally in the Palliser Triangle) in response to very low moisture conditions at seeding time, most farmers will continue to plant crops in the expectation of good May and June rains. The second conclusion is that sharp declines in yields will be moderated by farmers planting on fallow fields. The third conclusion is that, should drought conditions continue, the impact on yields will be felt most strongly in Saskatchewan, followed by Manitoba and (to a significantly lesser extent) Alberta. Indeed, Table 2.3 suggests that for many crops, the impact on Alberta will almost be negligible, eg. in 1961 when drought conditions were generally described as pervasive, yields on oats and barley in Alberta were at least two and one-half times higher than in Saskatchewan, while yields on wheat, rye and flax were approximately two times that of Saskatchewan. Only rapeseed yields in Alberta in 1961 were similar to those in Saskatchewan.

In light of the extremely low precipitation levels over the winter, it is unlikely that even normal precipitation during April would cause dramatic improvement in soil moisture conditions before seeding time.[1/] Depending on the sensitivity of various crops to water deficits, therefore, only significantly above-average precipitation during May and June will provide the prospect of average yields.

The probability of above-average rains occurring, however, is small. Chart I illustrates this point, using monthly precipitation data for Winnipeg, Brandon and Dauphin over the period 1948-1976. The chance of receiving in

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1/ At the request of InterGroup, the Agrometeorology Branch of Canada Department of Agriculture updated its Soil Moisture Evaluation Project with "normal" synthetic weather data from March 16 to April 30, 1977. The results indicated only a modest increase in plant available water. For example, on medium texture fallow soils, soil moisture predicted for May 1 in Brandon was 58.6 per cent of the long term average, for Regina 88.4 per cent, Saskatoon 51.6 per cent and Medicine Hat 57.8 per cent.

excess of six inches of rain[1/] during May and June is, for example, approximately 50 per cent in Winnipeg, 26 per cent in Brandon and 42 per cent in Dauphin.[2/] The probabilities would, of course, be correspondingly lower in Saskatchewan and in some crop districts in southern Alberta.

Carrying the example somewhat further, the SMEP update for Brandon would suggest that with normal precipitation during the last half of March and during April, moisture levels for medium textured fallow soils will be approximately 1.1 inches below the long term average. Based on Chart I, the probability of receiving this moisture (in addition to normal precipitation) during May and June is approximately 35 per cent.

In order to estimate the impact of drought on crop yields and production, two different scenarios have been considered at this stage. The first scenario assumes that normal precipitation will occur between mid-March and the end of June, with above-average water deficits due solely to low precipitation since late fall 1976. Impacts on yields under such conditions have been discussed with provincial Department of Agriculture officials. The second case assumes a drought at least as severe as 1961 for Manitoba and Alberta, and as severe as 1937 for Saskatchewan. In recognition of improved agricultural practices, however, the actual 1937 and 1961 yields were not utilized; rather, the percentage decline in yields in comparison to the previous five year average was used as the basis for calculation.[3/]

1/ One source contacted suggested that three inches of rain each month on dry soil during both May and June could ensure adequate yield on major field crops.

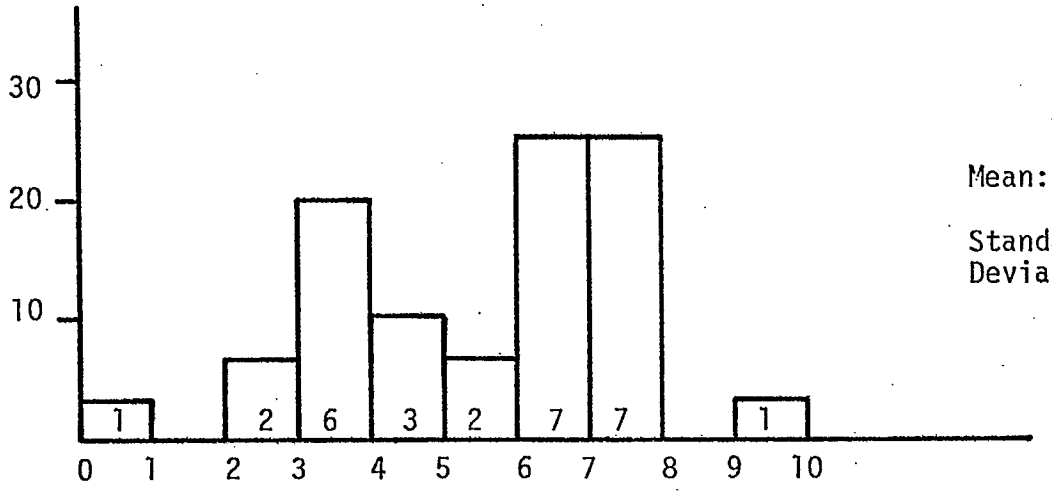
2/ Probability is calculated on the basis of actual observations, rather than on the assumption of a normal distribution about the mean.

3/ To illustrate, the 1961 wheat yield in Manitoba was 11.7 bushels per acre, 49 per cent of the average yield for 1956-1960. Since the five year average yield for wheat in 1972-1976 was 27.1 bushels per acre, the yield calculated under the second scenario was 27.1 x 0.49 = 13.3 bushels per acre. For Saskatchewan, the 1926-1930 base period was used, except for rapeseed where no change in yield was assumed.

CHART I

MAY/JUNE PRECIPITATION LEVELS 1948-1976

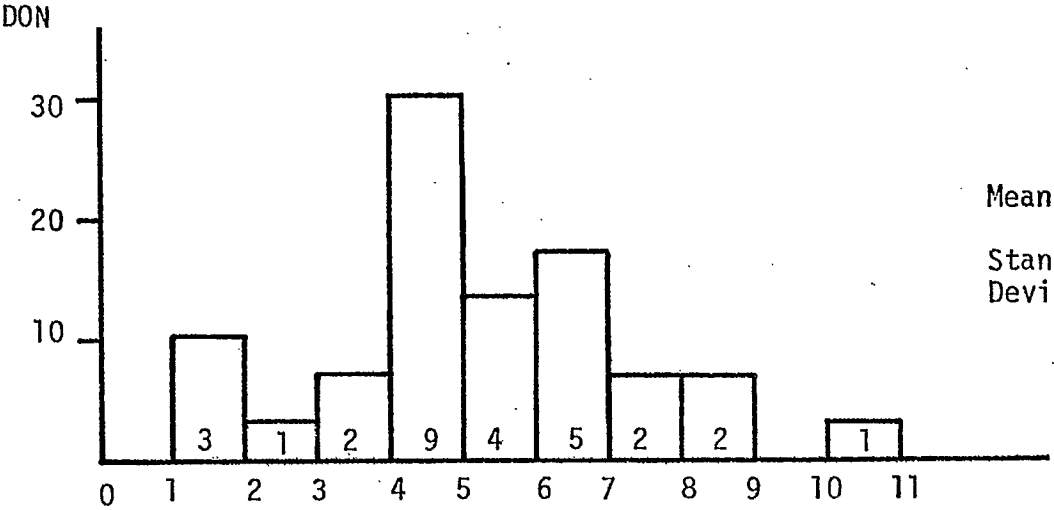
WINNIPEG



Mean: 5.424"

Standard Deviation: 2.055"

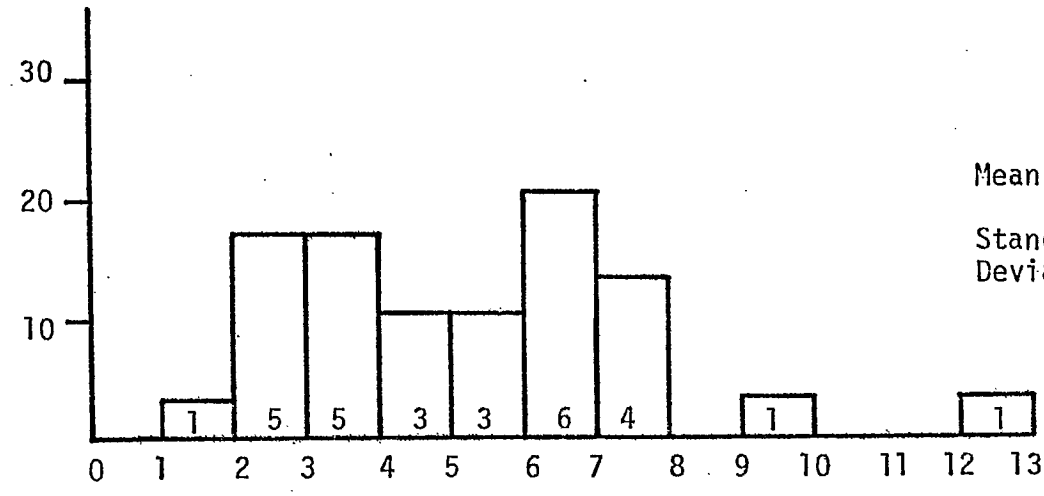
BRANDON



Mean: 5.207"

Standard Deviation: 2.177"

DAUPHIN



Mean: 5.253"

Standard Deviation: 2.487"

Table 2.4 summarizes the factors employed in adjusting production levels downward under the "moderate" and "severe" drought cases (based on seeded acreages equivalent to the five year average of seeding 1972-1976). As Table 2.4 indicates, wheat, oats and barley tend to be more affected by drought than rye, flax and rapeseed. The impact of drought is also less pronounced in Alberta, and is virtually limited to wheat under the "moderate" case.

Table 2.5 summarizes drought impact production levels by province, based on these two cases. Saskatchewan demonstrates the highest variability in yield, with overall production declining by 19.1 per cent (126.2 million bushels) under the "moderate" case and 80.4 per cent (530.6 million bushels) under the "severe" case. In contrast, Manitoba declines by 17.0 per cent and 49.6 per cent respectively under the two cases, while production in Alberta slips only marginally, i.e. 6.1 per cent under the "moderate" case and 12.3 per cent under the "severe" case.

The results portrayed here are preliminary estimates and are the probable extreme conditions resulting from drought in the prairie provinces. The analysis could be significantly improved by evaluating water deficit conditions at the crop district or similar level, and relating these conditions to declines in yield by crop.

Work undertaken at the University of Manitoba, for example, indicates that within a range of several inches, wheat yields will not be adversely affected by declining water supplies, whereas crops such as barley will be affected sooner. In general, declining water supplies in the traditionally drier areas of the prairie provinces should lead to the first and most severe impacts on yields, eg. southern Saskatchewan yields in dry years are on average much lower than the yields in Manitoba.

It is also possible to incorporate probability into this analysis, and to define a range of crop production outcomes based on a set of given probability

levels, especially as they relate to May and June rains. Such analysis, however, is beyond the terms of reference for this study.

While preliminary, the above results do indicate the extent to which actual crop yields are subject to weather and other conditions beyond the immediate control of farmers or government. From the viewpoint of short term mitigating measures relating to production, efforts must necessarily be concentrated on providing appropriate advice to producers on choice of crops, seeding of stubble land and other measures relating to dry land farming, eg. conserving soil moisture in seeding and cultivation. Such efforts are already underway in all three provinces, so far as the resources of the provincial Departments of Agriculture will allow.

From the perspective of farm income, programmes already in place provide some cushion in the case of declining production, viz.:

(1) Final payments for crops marketed through the Canadian Wheat Board are deferred until the end of the crop year. Consequently, the impact of declining production levels on income will not be felt until 1978. On the other hand, farmers may be expected to alter their patterns of purchase and consumption well in advance of receiving final payments.

(2) During the past ten to fifteen years, crop insurance has provided the individual producer with a hedge against the risk of crop failure. Current arrangements call for farmers to pay half the premium, with the remainder paid for by the Federal government. The number of farmers purchasing crop insurance has increased substantially over last year in both Manitoba and Saskatchewan, although complete figures are not yet available. In the event of wide-spread crop failure, however, it is clear that the premium fund will be unable to finance the entire cost of insurance claims, necessitating recourse to the re-insurance fund and probably to direct loans from both Federal and provincial governments.

(3) The Western Grain Stabilization Programme also provides income support for approximately 77 per cent of the 160,000 permit holders within Canadian Wheat Board designated areas in western Canada. Crops covered include wheat, oats, barley, rye, flax and rapeseed (mustard may shortly be added). Producers contribute two per cent of their cash receipts to a maximum of $500, while the Federal government contributes four per cent of receipts. The fund, which currently stands at $71.5 million in contributions, has been in operation since 1975.

TABLE 2.4

DROUGHT IMPACT YIELDS: PER CENT OF NORMAL PRODUCTION BY CROP

	Wheat	Oats	Barley	Rye	Rapeseed	Flax
	(per cent of 1972-1976 average yield)					
"Moderate" Drought Conditions						
Alberta	90	95	95	95	100	100
Saskatchewan	80	80	80	85	100	85
Manitoba	85	80	80	90	100	90
"Severe" Drought Conditions						
Alberta	74	94	92	80	100	100
Saskatchewan	15	20	18	13	100	13
Manitoba	49	50	45	62	87	72

Source: InterGroup Consulting Economists Ltd.

TABLE 2.5

DROUGHT IMPACT YIELD: MAJOR FIELD CROPS

	Production (000 bushels)			Farm Value ($000)		
	Normalized (1)	Moderate Drought Conditions	Severe Drought Conditions	Normalized (2)	Moderate Drought Conditions (2)	Severe Drought Conditions (2)
Alberta	480,240	450,840	421,130	1,215,630	1,140,070	1,049,086
Saskatchewan	659,760	533,560	129,160	2,000,420	1,638,260	460,420
Manitoba	215,700	179,020	108,660	591,770	504,140	319,888
Total	1,355,700	1,163,420	658,950	3,807,820	3,282,470	1,829,394

Source: InterGroup Consulting Economists Ltd.

(1) Assumes 1972-1976 average seeded acreage and 1972-1976 average yield by crop.

(2) For illustrative purposes, assumes $3.50 per bushel for wheat, $1.35 per bushel for oats, $2.00 per bushel for barley, $2.50 per bushel for rye, $6.80 per bushel for rapeseed, and $7.50 per bushel for flax. The prices for rapeseed and flax, while high in relation to historical levels, have only minor impacts on farm value, since production of these crops is smaller (and more stable) than cereal grains.

> The intent of the programme is to ensure that net farm cash receipts in total in any given year will not fall below the previous five year average, whether as the result of falling prices, declining production, reduced marketability or rising costs. In the event of widespread drought and declining production, it is clear that the existing fund could not support the payments required, and funds would have to be borrowed from general revenues of the Federal government (and ultimately repaid).
>
> While total payment under this programme is determined on the basis of overall changes in net farm income (adjusted for participation levels), payments to individual producers are based solely on their levy paid. In other words, this programme is not a substitute for individual crop insurance, eg. in the event of drought in Saskatchewan and Manitoba, producers in Alberta would continue to benefit directly from the programme.

In short, the effects of the above stabilization and insurance measures are that the producer will not face immediate problems of declining cash income in the event of poor yields on major field crops this year, nor will he necessarily shoulder the entire burden of lost income on a deferred basis either. The most serious consequence of drought arising in 1977 is that, should it persist into 1978, producers will be forced to undergo major adjustments in income, recovery from which will require two to three years of good crops and prices.

3. Vegetable Crop Enterprise

Primary vegetable crops grown in the prairie provinces for the fresh market or for processing include corn, peas, and beans, as well as carrots, rutabagas and other miscellaneous vegetables. Vegetable production is concentrated in the southern portions of Alberta (under irrigation) and in Manitoba (under both dry land farming and irrigation).

Since the growing season is shorter for most vegetable crops than for cereal grains, lack of moisture at planting time and during the early summer is, on balance, more critical for vegetables than for cereal crops. The previous section and Working Paper No. 1 have already highlighted the low soil moisture conditions in both southern Alberta and in the Morden area of Manitoba, particularly with respect to the coarse and medium textured soils.

With the exception of the 1,900 to 2,000 acres of vegetables grown under dry land conditions in Manitoba to supply the canning operation of Morden Fine Foods, the bulk of vegetables grown in the prairie provinces are grown under conditions of irrigation. In Alberta, most vegetables are grown in the Bow River, Eastern and St. Mary Irrigation Districts; while the latter two districts may experience some water supply problems in the late summer (see Working Paper No. 1), the impact on acreages seeded and yields is not expected to be large, viz.

- water supply problems, if any, will not likely develop until after most vegetable crops have been harvested (mid-July)
- farmers will probably divert acreage from tame hay, eg. alfalfa and cereal grains, in order to conserve necessary water for specialty crops such as vegetables, which yield higher net returns per acre

The largest group of vegetable producers in Alberta likely to be affected by drought are those with "interruptible" water supply contracts with Irrigation Districts. No data are readily available on the acreages under such contract, but the area is not believed to be large.

In Manitoba, most irrigated vegetable crops draw water from either the Assiniboine or Red Rivers. Streamflows in both rivers should be adequate to maintain irrigation, therefore no significant decline in production of these crops is anticipated at this time. The Campbell Soup operation at Portage la Prairie, for example, should not be adversely affected by either declining production or lack of water for its own operation.

Only crops grown under contract with Morden Fine Foods, therefore, are likely to be affected by drought. Yields from this planted acreage, however, already tend to fluctuate widely from year to year, eg. in both 1973 and 1974, significant losses were reported in beans and corn. Assuming "normal" value of production of $400,000 (1976 value), losses could quite easily reduce the value of production to $240,000 (1973/1974 values) and in extreme conditions could lead to effective total loss of the crop. Corresponding losses in income and employment at the Morden Cannery during the short harvesting season could also be expected. For a summary of estimated drought impacts on vegetable crop enterprises, see Table 2.6.

TABLE 2.6

DROUGHT IMPACT ON VEGETABLE CROP ENTERPRISES: 1977

		Production Value
Alberta:	No estimate provided -- losses unlikely in irrigated areas	
Saskatchewan:	No estimate provided -- production limited	
Manitoba:	1976 value (commercial canning crops)	$ 400,000
	Case A: Moderate drought	$ 240,000
	Case B: Severe drought	Ø

4. Potato Crop Enterprises

Potatoes are grown in all three prairie provinces, but production is concentrated in Alberta and Manitoba. Potatoes are grown both for processing and for the table market, as well as for seed.

In Alberta, approximately 18,000 acres of potatoes are currently being planted each year, of which the majority (14,000 acres) are grown under irrigation -- primarily in the Bow River, Eastern, St. Mary and Taber Irrigation Districts. The remainder are grown in the Edmonton area, and to a lesser extent, in the vicinity of Calgary and Lacombe[1/]. Processing uses in Alberta encompass such enterprises as the York Farm and Empress Food plants in Lethbridge, as well as some other smaller producers in southern Alberta, Calgary and Edmonton. Potatoes for the table market are packaged both in southern Alberta and in Edmonton.

Acreages in potatoes in Saskatchewan are relatively small (2,500 acres), and are grown under irrigation principally in the area of the South Saskatchewan River Irrigation District. In general, these potatoes are destined for the table market.

In Manitoba, approximately 35,000 acres are seeded to potatoes, primarily in the Pembina Triangle and Carberry areas. Netted gems are grown under contract for the Carnation plant at Carberry, while specialized varieties are grown for use in the Old Dutch potato chip plant in Winnipeg. Some potatoes are also sold to the Campbell Soup plant at Portage la Prairie and to a farm co-operative plant in Grand Forks, North Dakota. Most of the remainder are red potatoes grown for the local table market.[2/]

1/ Alberta Agricultural Products Marketing Council, An Inquiry into the Production and Marketing of Vegetables in Alberta (Edmonton: 1973)

2/ The McCain plant at Portage la Prairie is only in initial stages of construction.

Low soil moisture levels can significantly affect the yield of potatoes in the prairie provinces. Potatoes may not sprout and develop proper roots, for example, when moisture is insufficient. Although potatoes are generally grown on stubble land, current lack of soil moisture may lead to some farmers switching to fallow land for production purposes. Some modest declines in acreage seeded may be anticipated this year, but on balance the acreages in potatoes should be similar to last year -- with producers looking forward to adequate rainfall during the growing season to sustain reasonable production levels.

In Alberta, production of potatoes will be highly dependent on conditions in the irrigated areas. As stated previously, declines in seedings of specialty crops are not anticipated at this time, in light of possible water supply deficiencies in this area. In the Edmonton area, soil moisture conditions are sufficiently similar to last year that no decline in yield in response to drought can be predicted.

In Saskatchewan, production will be a function of water available from Lake Diefenbaker. As noted in Working Paper No. 1, water for agricultural uses from Lake Diefenbaker will be reduced this year, but no precise estimate of impact on potatoes is as yet available.

On the other hand, Manitoba production of potatoes can be expected to decline in response to poor moisture conditions. Yields per acre within the province over the past 35 years have fluctuated from a high of 244 bushels per acre in 1973 under extremely favorable conditions to 63 bushels per acre in the drought year of 1961. In 1976, yield was 203 bushels per acre; the most recent five year average yield (1972-1976) is 220 bushels per acre.

Evaluating the impact of drought conditions is a difficult process, but on balance, a yield of 170 bushels per acre (approximately 100 cwt. per acre) might be expected if normal precipitation occurs until the end of the growing season. Under conditions approximating those of 1961 or worse, a yield of 60 bushels per acre or less is possible.

Translating the above production losses into monetary losses is also difficult, since farm value per bushel for potatoes has a tendency to fluctuate. Farm value recently declined from $2.33 per bushel in 1975 to $1.88 per bushel in 1976; an even greater decline might have occurred if a large part of the surplus supply in the United States had not been diverted to drought-stricken Europe last year. In 1977, however, reduced acreages in the United States (coupled with drought conditions in certain locales) could serve to raise prices again. Price increases could be in evidence in the table market by early summer, with Manitoba reds for sale by mid-July. The effect will be less in evidence in the contract processing potato market, although there may be isolated incidents of producers attempting to shift their potatoes into the table market in response to higher prices.

On balance, a farm value of $1.90 per bushel has been set for this analysis, assuming seeding of approximately 31,200 acres (five year average). Table 2.7 details the impact on production and on farm output value.

There is no evidence to suggest that potatoes for processing would be more adversely affected than table potatoes by declining yields (netted gems for the processing market are generally harvested in September). Impacts on employment, therefore, would be relatively evenly distributed between fresh pack and processing plants -- although the latter plants may import potatoes to maintain their operations and retain key labour force. The Carberry plants, for example, imported potatoes from Alberta last year for this purpose.

TABLE 2.7

DROUGHT IMPACT ON POTATO ENTERPRISES: 1977

	Yield per Acre	Acres Seeded	Output	Value at $1.90/ bushel 1/
	(bushels/acre)	(000)	(000 bushels)	($000)
Alberta:	No estimate provided -- losses unlikely.			
Saskatchewan:	No estimate provided -- losses unlikely.			
Manitoba:				
1972-1976 average	220	31.2	6,864	13,042
Range of Drought Impact:				
Case A	170	31.2	5,304	10,078
Case B	60	31.2	1,872	3,557

1/ Arbitrary value for comparison purposes.

5. Sugar Beet Crop Enterprises

Sugar beets are grown in both Alberta and Manitoba, supplying refineries at Raymond, Taber and Winnipeg. In Alberta, approximately 39,000 acres of irrigated land in southern Alberta is dedicated to the raising of sugar beets. Slightly less than half this land is in the St. Mary Irrigation District, with the remainder in the Taber, Lethbridge North and Bow River Districts. In Manitoba, sugar beets are grown under dry land conditions, in the Altona/Carman area. The acreage seeded in 1976 under contract was 31,130 acres.

The yield on sugar beets can be severely affected by low moisture conditions. Low moisture conditions, however, will probably not preclude many farmers from planting this year, for the following reasons:

- the effort involved in seeding sugar beets is small in comparison to later tilling, thinning and harvesting operations; if moisture levels fail to improve, farmers can adjust their levels of effort in cultivating this crop.
- the high futures price for sugar makes planting a worthwhile risk; even with reduced yields, the prospect of at least breaking even on operations is high.

In Alberta, little change in either acreage or yield is anticipated. Although the Lethbridge North Irrigation District in particular may suffer from irrigation water deficiencies (see Working Paper No. 1), farmers will probably divert water from other crops to provide the five to six irrigations required for growing sugar beets in southern Alberta. As stated previously, farmers may also reduce irrigation of tame hay -- which is a high water user -- in favour of cereal crops. It is unlikely that much land will be summer-fallowed, owing to the danger of soil erosion.

In Manitoba, yields will be far more sensitive to soil moisture conditions and precipitation. The very low spring moisture conditions in the

Pembina Triangle suggest that even with adequate precipitation throughout the growing season, yields in excess of 10.5 tons per acre cannot be anticipated; under severe conditions yields equivalent to or lower than 1961 levels (8.9 tons per acre) are possible. Table 2.8 summarizes the impact on production and farm output value[1/].

Declines in tonnage (adjusted for sugar content) will also have corresponding impacts on the operation of the Manitoba Sugar Company in Fort Garry, i.e. stocks of sugar beets will be depleted earlier and the plant will lay off staff earlier in the winter than usual.

1/ Farm value is based on an arbitrary unit value of $30.00 per ton.

TABLE 2.8

DROUGHT IMPACT ON SUGAR BEET ENTERPRISES: 1977

	Yield (tons/acre)	Acreage	Production (000 tons)	Farm Value at $30.00 per ton 1/ ($000)
Alberta:	No estimate provided -- sugar beets grown on irrigated acreage.			
Saskatchewan:	No production			
Manitoba:				
1972-1976 average	11.4	28,700	327.2	9,816
Range of Drought Impact:				
Case A	10.5	28,700	301.4	9,040
Case B	8.9	28,700	255.4	7,663

1/ Arbitrary value assumed for computation purposes.

6. Beef Enterprises

Drought has three potential effects on the beef producer: shortage of summer forage, shortage of winter forage and shortage of water for stock watering. The producer can respond to a shortage of summer forage by reducing herd size to the carrying capacity of the range at his disposal by selling animals destined for slaughter at an earlier age than normal and, if drought is severe, by selling off breeding stock. A shortage of winter forage can be handled in a similar manner, or by purchasing hay to augment forage available. A water shortage can be offset by trucking water to the cattle, moving cattle to the water supply (if there is forage where the water is available), or by reducing herd size to match available water supply.

Soil moisture conditions affect the carrying capacity of grazing land, with early spring rains being critical in influencing tame hay and other pasture production. Soil moisture conditions are reviewed in some depth in both Working Paper No. 1 and the preceding section; to summarize briefly, at six to eight weeks before the normal spring recovery of pasture and grazing areas, it would seem that adequate spring and summer grazing is unlikely.

Where the sources of water for stock are deep wells or major reservoirs, water supply should be adequate. In all three provinces, however, shallow wells may fail, and ponds and dugouts in some areas could dry up. Water is already being hauled in Manitoba, at costs estimated to average about fifteen cents per animal per day. The intensity of the effect of water supply failures will not be known for about sixty days, i.e. until the season for spring rains is over.

In the event of a moderate drought, beef producers tend to react by making technical adjustments, i.e. by selling off early animals destined for slaughter. As an example, the drought in 1961 resulted in a decline in forage

yields by approximately fifty per cent in both Manitoba and Saskatchewan. The demand for summer and winter forage was reduced by decreasing the number of animals held on feed for eventual slaughter, rather than by reducing breeding stock.

In Manitoba, total cattle numbers declined by 1.4 per cent (13,000 animals) between 1961 and 1962. The number of cows did not decline and in 1962, the number of calves dropped was almost exactly equal to the number dropped in 1961. Steers, however, declined by about 11,000 and heifers by about 2,000.

This pattern was somewhat more pronounced in Saskatchewan. Total cattle declined by about 1.7 per cent (27,000 animals). The number of calves dropped increased from 1961 to 1962 by about 5,000 (less than one per cent). Heifer numbers were reduced by 15,000 and steers by 32,000, while the number of beef cows on farms increased. Clearly, the reduced availability of summer and winter forage was accommodated in a short term fashion by means of a technical adjustment, i.e. marketing slaughter animals at an earlier age. No long term adjustments to herd size were intended.

A more prolonged drought, such as that of the 1930's, elicited a different pattern of response from beef producers. In the worst drought years (1937-38), herd sizes declined and did not regain their 1937 levels for several years.

In Alberta, for example, herd size declined by about nine per cent between 1937 and 1938 (139,000 animals), including a substantial decrease in the number of cows and bulls. The number of calves dropped in 1938 was about 17,000 less than in 1937. Herds did not recover their 1937 size until 1943 (about 1,500,000 head).

Similarly in Saskatchewan, cattle numbers were reduced by about

twenty-four per cent (1,491,800 to 1,138,000 head) between 1937 and 1938. The reduction applied to cows, bulls, heifers and stock on feed. In 1938, about twenty-one per cent (80,000) fewer calves were dropped than in 1937. Herd size did not recover its previous level until 1944.

The drought in Manitoba in 1937-38 was less severe than in Alberta and Saskatchewan, and cattle herds underwent a technical adjustment, similar to that of 1961-62, but less extensive. The more severe drought in the two more western provinces resulted in substantial herd reductions.

The moderate drought in 1931-32 in Manitoba and Saskatchewan was similar in intensity to the one in 1961 for those provinces; however, in the earlier of the two droughts, beef producers reacted by increasing herd size by about ten per cent. This contrasts to the herd reductions in 1961-62.

The pattern of responses to the drought of the thirties may not be applicable to any drought in the near future. First, the economic circumstances of farmers at that time were affected by the depression and extremely low prices. Secondly, the agricultural industry of the time was less highly developed than it is at present and there was greater surplus natural resource capacity available, eg. grazing land at nominal or no charge. Finally, the capacity of the farmer to combat natural adversity has been extended by advanced technology, more machinery, improved control of markets and greater access to information.

While the pattern of responses to the thirties' drought is worth emphasizing, conclusions should be drawn with great caution. These responses were made by a different generation working within different external circumstances.

In summary, prairie beef and cattle producers respond to a relatively minor drought (lasting no more than one year and lowering forage yields by no more than fifty per cent) by making a technical adjustment in herd size, i.e. selling off stock destined for future slaughter at an earlier age. This adds

some unfinished beef to the market, probably depressing the price of stockers, feeders and calves.

A more serious drought, one which reduces field crop and forage yields below fifty per cent of normal, would affect cattle herds more seriously. Herds now on prairie farms are roughly twice as large as they were forty years ago. At that time, a serious drought which reduced field crop yields by more than seventy-five per cent was sufficient to force herd reductions as large as twenty-five per cent in Saskatchewan.

Table 2.9 portrays two different impacts of drought, one under moderate and the other under severe conditions. Case A assumes a situation similar to 1961. Case B estimates the most extreme drought impact, assuming the severe drought conditions of 1937 with adjustments to take into account the fact that herd size has doubled in all three provinces. It should be noted that such conditions are unlikely to occur simultaneously in all provinces.

In Table 2.9, the loss per animal sold has been set somewhat arbitrarily at $200. This loss is calculated to be the difference between selling a 500 pound animal at forty cents per pound in June and selling a 900 pound animal later at forty-four cents per pound. For cows, it is assumed that these animals sell for approximately $200 on the slaughter market, to be replaced one year later by heifers worth $400 on the market.

The income losses depicted in Table 2.9 will not be suffered entirely by western Canadian producers, but will be absorbed in part by the Federal treasury and by those provinces operating their own income assurance plans. Under the Agricultural Stabilization Act, for example, both slaughter cattle and calves have been designated as eligible for Federal assistance, under which a support level equivalent to ninety per cent of the previous five year average price (adjusted for costs of production) is guaranteed. Calves, however, have only been designated by Order-in-Council for 1977, in comparison to slaughter

TABLE 2.9

DROUGHT IMPACT: BEEF ENTERPRISES

	Reduction In Herd (%)	Herd Reduction (000 head)	Producer Loss ($ Millions)
Alberta			
Case A: Moderate Drought	1.5	65	13.0
Case B: Severe Drought	15.0	640	128.0
Saskatchewan			
Case A: Moderate Drought	1.7	50	10.0
Case B: Severe Drought	30.0	860	172.0
Manitoba			
Case A: Moderate Drought	1.5	18	3.6
Case B: Severe Drought	15.0	180	36.0

cattle which are designated under the Act itself and which are therefore eligible for assistance in 1978 and beyond.

Case B assumes extremely high sale of herds, on a scale equal to or beyond that experienced in the 1930's. Such reductions in herds would likely begin in the early summer and continue throughout the fall and winter, as forage and water supplies are depleted. Reductions under Case A will in all probability be mitigated by factors such as emergency grazing or harvesting of wild hay in traditionally sub-marginal pasture areas, eg. Pasqua in northern Manitoba. In addition, more fortunate northern beef producers may purchase feeders (possibly at distress prices) from southern producers who face particularly difficult water and forage conditions.

Under either Case A or Case B, the immediate impact of herd reduction on the slaughtering and meat packing industry would be beneficial, with higher throughputs creating additional employment opportunities. Current levels of excess capacity in the industry should be sufficient to handle this additional throughput, unless reductions under Case B are concentrated over a very short time span. In the longer run, the industry could experience additional excess capacity, if herd reductions eventually lead to lower throughput levels.

7. Dairy Enterprises

The biophysical impacts of a drought on the dairy industry are similar to those which would affect the beef industry (see preceding section), but because the dairy industry is smaller and concentrated in different geographic areas than the beef industry, the magnitude and intensity of the impact would likely be less.

Dairy producers could handle shortages relating to summer and winter forage, and water supply just as beef producers do, but with some additional problems, i.e. a supply of clean water is needed for washing and processing. If this supply is derived from shallow wells, it could prove expensive for some operators to obtain a replacement or emergency supply.

In addition, where emergency supplies of water or feed are of poor quality or of inadequate quantity, production could be reduced. The supply of manufacturing milk would be curtailed first, with cheese factories and butter makers the most seriously affected. In Manitoba, where milk production is pooled, the Milk Producers' Marketing Board can be expected to allocate milk to its highest end use first, namely to the fluid market.

Shortages of winter forage may result in cost increases for dairy operators who are currently complaining of a cost-price squeeze. The effect of a moderate regional shortage of winter forage would probably affect the cost side primarily; unless costs rose very sharply, however, it is unlikely that herd size would be reduced or production curtailed. In most circumstances, dairy producers would probably outbid beef producers for scarce forage.

The main dairy producing areas in the prairie provinces are the Winnipeg milk shed, St. Claude, the Regina and Saskatoon milk sheds, Calgary, Red Deer and Edmonton. Red Deer and Edmonton, which are the largest, would be virtually unaffected by the continuation of present weather patterns; i.e.

these areas are not presently suffering from drought. The Calgary milk shed, however, would be adversely affected, as would Saskatchewan (especially the new producing area around Swift Current).

In Manitoba, the area around Winnipeg will probably have its usual water problems, but spring forage should not be desperately short. St. Claude, on the other hand, faces the possibility of well failure and increasing reliance on truck water supplies, as well as a shortage of spring and summer forage. Smaller producing areas, eg. Winkler, are already suffering from water shortage, due to extremely brackish water.

Even in the case of a severe drought, dairy producers are unlikely to cut back immediately on herd size, unless the drought is widespread, intense and of probable long term duration. Since demand for dairy products is relatively stable, producers will in most circumstances be reacting to long term cost-price pressures, recognizing that replacement of their herds is an extremely expensive proposition. These cost-price pressures, if they exist, will result primarily from higher costs of scarce water and feed.

Previous experience provides little guidance here. Through the drought years of the thirties (and the early sixties as well), milk production fluctuated greatly and no particular pattern of reduction or expansion in size of herds emerged, if the statistics available are to be believed.

On balance, given high fluid milk prices and the existence of a federal support programme for industrial milk used in butter and skim milk powder production, it seems unlikely that the prairies will experience a drought severe enough to limit dairy production. Industrial milk plants, eg. cheese factories, may, however, suffer from abnormally low supplies of milk, particularly in the late summer and beyond.

[Error in numbering pages 90 through 132. Page 90 should be page 80, page 91 should be page 81, etc.]

8. Hog Enterprises and Poultry Enterprises

While some individual hog and poultry enterprises are likely to experience cost increases as a result of a drought, and while a drought might engender some increase in feed grain prices, the total output of hogs, eggs and poultry meat is not likely to be adversely affected by a drought.

Hog operations and poultry operations require water for stock watering, with supply usually obtained from deep or shallow wells. Those using deep wells will not likely be affected in 1977, while some of those producers using shallow wells may experience a water shortage and be forced to haul water. This would not likely curtail production nor affect gross farm income. It would, however, reduce marginally net farm income for those affected.

There should be no general feed shortage for either hog or poultry enterprises on the prairies. Those farmers relying on feed grains produced on their own farms might be forced, in some cases, to purchase feed grains. Those who grow a portion of their feed grain needs, and who are located in drought stricken areas, would be similarly affected.

The price of feed grains might be forced upward by pervasive drought conditions. In this event, pork and poultry prices might also be forced upward. A cost-price squeeze might or might not occur. A general shortage of feed grains on the prairies in 1977, however, is most unlikely. Consequently, at worst, there might be some decline in net farm income from poultry and hog operations but it is not yet clear that this result should be expected. No decline in gross farm income derived from hog and poultry production is to be anticipated and no adverse effects on consumer interests are foreseeable at this time. Indeed, some short to medium term increase in production might be anticipated in response to declining prospects elsewhere in agriculture.

9. Electric Power Enterprises

Utilities responsible for the generation of electric power in the prairie provinces include Calgary Power and Alberta Power in the province of Alberta, Saskatchewan Power Corporation (SPC) in Saskatchewan, and Manitoba Hydro/Winnipeg Hydro in Manitoba. Some industrial plants also have their own electricity generating capability.

Interruptions in electric power supply affect industries, commercial enterprises and residential customers. While fossil fuels continue to dominate energy supply and demand in the prairie provinces, electricity provides crucial lighting and power applications, as well as some space heating and processing applications.

Drought conditions can affect electricity generation capabilities in three ways:

(1) reduced streamflow can reduce generating capability of run-of-the-river hydro plants, eg. Winnipeg River plants of Manitoba Hydro and Winnipeg Hydro

(2) reduced reservoir discharges can reduce generating capability of associated hydroelectric stations, eg. Coteau Creek station of SPC at Lake Diefenbaker

(3) reduced streamflow or reservoir discharges can limit availability of water for cooling purposes at thermal plants.

The impacts here can also be short term or long term, depending upon the severity and length of drought conditions. Unlike agricultural enterprises, however, snow pack run-off rather than summer precipitation is the principal factor influencing electric power generation capability. Hence, prospects for the summer of 1977 and following winter are already reasonably well-defined.

In Alberta, Calgary Power operates seven reservoirs on the Bow River and two reservoirs on the North Saskatchewan River (see Working Paper No. 1).

All except Interlakes reservoir -- which is empty -- are filled beyond normal levels for this time of year in anticipation of low run-off levels. Calgary Power will operate the reservoirs in order to conserve as much water as possible for the next winter peak load season, taking into account the multi-purpose nature of these reservoirs. Loss of energy generated will be about 120 gwh[1/], or seven per cent of average generation.

Elsewhere in Alberta, low water levels are unlikely to have much impact on electric generation which is primarily from thermal sources, i.e. cooling water shortages are not anticipated. Since thermal currently accounts for approximately 77.6 per cent of all generation in Alberta[2/], declines in hydro generating capability are unlikely to have profound supply or cost impacts on utility operations in that province.

The SPC currently operates two hydro stations in Saskatchewan, one at Squaw Rapids on the Saskatchewan River and the other at Coteau Creek (Lake Diefenbaker). Rated generating capacity of these two stations in 1975 was 280,000 kW and 187,000 kw respectively, compared to 1,057,000 kw for steam plants and 167,000 kw for internal combustion plants. Generating capability (as opposed to capacity) of these two stations has been sharply reduced this summer, especially at Coteau Creek where electricity generation has third priority after municipal water supply and irrigation. Flows on the Saskatchewan River from Tobin Lake (12,000 to 15,000 cfs and possibly lower) will also limit generation at Squaw Rapids.

Saskatchewan Power Corporation has not provided any estimates of impact on loss of energy generated as the result of drought, other than to

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1/ gigawatt hours, i.e. 1 gwh = 1,000,000 kilowatt hours.

2/ 1976 cumulative preliminary data from Statistics Canada 57-001.

indicate that thermal power will meet an increasing proportion of Saskatchewan electricity requirements during the summer[1/]. In the winter months, electricity generation will increase at both Coteau Creek and Squaw Rapids in response to summer ponding on Lake Diefenbaker and Tobin Lake.

Increased requirements for thermal generation of power are not expected to result in any shortage of cooling water this summer at either Estevan or Saskatoon. In addition, assuming that additional capacity at Estevan can be brought on stream later this year, there should be sufficient capacity within the SPC system to handle winter peaking needs. In the event of construction or other delays at either Estevan or the new Poplar River thermal plant, continuing drought conditions could limit the future ability of SPC to meet requirements without resorting to extensive imports from neighbouring utilities.

In Manitoba, the integrated Manitoba Hydro/Winnipeg Hydro system relies primarily on hydroelectric power, with some peaking capacity traditionally being provided by coal-burning thermal stations at Amy Street in Winnipeg, at East Selkirk and at Brandon. Working Paper No. 1 has already highlighted streamflow and lake conditions applicable to both the hydro and thermal system plants in Manitoba. While flows along both the Assiniboine and Red Rivers should be sufficient to provide water for cooling purposes at the three thermal plants, low run-off this year has reduced hydro generation capability at all Winnipeg River plants, at Grand Rapids and at Kelsey. Generation capability at Kettle on the Nelson River may also decline, depending on whether increased streamflows are permitted along the Churchill River diversion. Drought should not have any impact on the generating capability

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1/ In 1976, preliminary data indicates that 32.8 per cent of all electricity generated in Saskatchewan was from hydro sources. In 1975, some 38 per cent of all power generated came from hydroelectric generators. (Statistics Canada 57-001)

of units being installed during 1977 at either Jenpeg or Long Spruce; additional units installed after 1977, however, may encounter problems if low streamflow levels persist.

Reductions in hydroelectric generating capability are not expected to result in any supply interruptions in Manitoba during this summer or through the winter of 1977/1978 (by which time the first two units at Long Spruce will be on stream). Losses to the Manitoba Hydro system, then, will be of the following dimensions:

(1) increased average cost of electricity generated, as the result of increased reliance on thermal power -- testimony before the Public Utilities Committee of the Manitoba legislature indicates that, whereas Manitoba Hydro traditionally supplies four per cent of electricity generated from its thermal plants, the current share is close to twenty per cent.

(2) loss in export revenue (or conversely, increased purchases of imported power from Northern States Power and other utilities).

In summary, electricity supply system <u>security</u> throughout the prairie provinces should not be affected by drought conditions throughout the next year.

In the short term, drought impacts will be limited to higher system costs created by above-normal thermal generation, and/or declines in export sales revenue. Beyond 1977/78, however, continued drought conditions would severely reduce the storage available to prairie hydroelectric plants; the impact of such a situation on electricity supply security and cost in each province merits thorough examination while sufficient lead time exists to consider a range of mitigating measures.

10. Mining Enterprises

Mining in the prairie provinces includes the extraction of such materials as crude petroleum and natural gas, metallic minerals such as nickel and copper, non-metallic minerals such as potash and uranium, and industrial materials such as sand, gravel and limestone. Metallic mining operations are of course concentrated in the Canadian shield region of the prairie provinces, along with uranium. Petroleum, potash and industrial materials, on the other hand, tend to be located in the southern areas outside the Canadian shield.

In general, drought conditions in the prairie provinces would affect mining enterprises directly through reduced streamflow on major rivers, i.e. water used for processing purposes. Currently, there is no evidence to suggest that, for example, potash mines in Saskatchewan or metallic mining operations in northern Manitoba will encounter any special difficulties with respect to water supply. For this reason, no direct reduction in output in response to drought conditions is anticipated to develop at this time.

Indirect impacts, on the other hand, may occur in some sectors of the mining industry from a widespread drought in North America. The obvious example is the potash industry, which produces fertilizer for agriculture. This industry is geared to supplying the United States market, rather than to satisfying domestic requirements for potash (western Canadian soils do not normally require additional potash). Recent reports suggest the possibility of increased inventories of potash in the United States during the first half of 1977, in response to cutbacks in planting in drought areas and other factors. While the short term prospects to June, 1977 are promising, the

longer term impact of declining sales in response to drought cannot as yet be determined.[1/]

Other indirect impacts on mining may arise through reduced demand for mineral products, in cases where secondary manufacturing firms using these products within the region encounter problems with respect to water supply. The impact, however, is not expected to be large; not only is the number of firms involved relatively small in relation to total sales of the industry, but these firms also tend to be concentrated in the major metropolitan areas where water supply interruptions of critical dimensions are not anticipated.

On balance, drought conditions on the prairies should not affect mining output. The linkages of the industry to general economic conditions within the region are sufficiently indirect that even demand induced impacts should be relatively minor.

1/ "Fertilizer's gloomy outlook", Business Week, March 21, 1977. Discussions with potash officials suggest that potash sales will be particularly sensitive to patterns of fall planting in states such as Iowa, Wisconsin, Missouri and Minnesota. No problems are currently anticipated in either the south-eastern or mid-south regions of the United States.

11. Forestry Enterprises

The forest resources of the prairie provinces are used primarily for forest conversion operations, such as sawmills, pulp and paper plants and veneer plants. Conversion operations tend to be concentrated on the southern edge of the commercial forest zone. Key firms involved in primary processing operations include Abitibi Pulp and Paper and ManFor in Manitoba; Simpson Timber, Saskatchewan Forest Products Corporation and Prince Albert Pulp Company in Saskatchewan; and NorthWest Pulp and Power and Simpson Timber in Alberta. There are also a number of other smaller enterprises engaged in conversion operations throughout the prairie provinces.

Other uses of the forest include tourism and recreation, wildlife and watershed management. These topics are discussed in separate sections.

Impacts of drought on primary conversion operations focus not on their direct water requirements, but rather on the possibility that forest fires may interrupt summer harvesting operations, leading to loss of employment in logging and possibly to premature closure of plant. Discussions with forestry officials of all three provinces, however, suggest that the likelihood of this occurrence is small, unless severe fire conditions shut down all forest-related activities, including harvesting and recreation. Logging crews would be pressed into service only in cases where these crews were close to actual fires burning in the province.

Notwithstanding the above comments, forest protection and fire control officials do anticipate a very high risk of fire loss this year, possibly well above the levels experienced last year. While precipitation levels in the forest zones during the winter did not decline as dramatically as in southern regions, the snow cover was not heavy and the sub-soil is already dry. Conditions in Manitoba have been severe enough to prompt the

provincial government to bring its ban on open fires without permit into effect four to six weeks earlier than normal. A special force has also been established to control peat bog fires, which have been burning throughout the winter in the Whiteshell area and southeastern Manitoba. The budget for this special force is $400,000.

In Alberta, special attention is being paid to the eastern slopes of the Rocky Mountains, where streamflow was low during the autumn and snow pack accumulation has not been extensive. This area is considered to be prime forest area, not only from the point of view of forest conversion operations, but also from the perspective of tourism, recreation, wildlife and watershed management. Access, however, is difficult and costs of suppression tend to be higher than in the boreal forest zones.

In Saskatchewan, all areas of the commercial forest zone are dry, but the central region (the PAPCO lease area) appears to be somewhat drier than either the western or eastern zones. Fire dangers here arise primarily from "settlement" fires, i.e. fires started by agricultural activity, tourism/recreation and related causes. Further north in the non-commercial zone, precipitation levels more closely approach normal, but the prospects of lightning fires are much higher.

While conditions in Manitoba in general mirror those of Saskatchewan, there are some areas where snow cover is relatively good, eg. Island Lake, Thompson and Lynn Lake. Dry conditions are, however, causing concern and the expectation is that the number of fires this year will exceed the record high (1,100 fires) of last year.

Additional direct fire suppression costs arising from drought are difficult to estimate, since costs depend on such factors as the size and location of the fire, i.e. costs of fire suppression per acre are proportionately

much greater for larger than for smaller fires. Based upon discussion with forestry officials, Table 2.10 presents estimates of additional direct suppression costs by province, assuming moderately severe and severe conditions. Forestry officials stressed, however, that such estimates of additional cost are extremely subjective and may be in error by as much as fifty per cent.[1/]

As stated above, severe fire conditions could lead to the shutdown of some logging operations. Currently, no estimates are available regarding possible losses in income and employment arising from shutdowns, since the impact will be site specific. There is no evidence, however, that any of the major forestry companies have been deliberately building up inventories in anticipation of interruptions in summer logging operation (in Alberta, some operators had difficulty in maintaining their logging operations throughout the winter). For the above reasons, no impact beyond fire suppression costs have been estimated for forestry, and it is assumed that both primary and secondary conversion operations, eg. sash and door mills, will be relatively unaffected by drought[2/]. Demand induced impacts on construction activity, which might in turn lead to declines in demand for forest products, are evaluated within the context of broader macroeconomic analysis.

1/ In 1976, for example, 162,000 acres of forest land were destroyed in Manitoba. By way of comparison, 3,000,000 acres were destroyed in 1961, the last year of severe drought. The above "severe" estimate, however, assumes early suppression and a limited number of large fires.

2/ Continuing drought conditions may also lead to "browning out" of stands on traditionally dry sites; the impact of this loss could not be quantified by forestry officials.

TABLE 2.10

DROUGHT IMPACT ON DIRECT FOREST FIRE SUPPRESSION COSTS: 1977 [1/]

		Additional Fire Suppression Levels
Alberta:		
Case A	Moderate Drought	$ 2,250,000
Case B	Severe Drought	3,250,000
Saskatchewan:		
Case A	Moderate Drought	1,500,000
Case B	Severe Drought	4,500,000
Manitoba:		
Case A	Moderate Drought	2,500,000
Case B	Severe Drought	3,750,000

1/ No allowance for impact on primary forest conversion operations.

12. Wildlife and Fishing

From a strict economic or financial viewpoint, fish and game are harvested for both their commercial and sports value throughout the prairie provinces. In the Western Northlands, fish and game are also used for "country food", i.e. domestic consumption, especially in northern native communities. Since the short term impacts of drought on wildlife and fishing will, on balance, tend to be concentrated in the prairie grassland and transitional zones, only commercial and sports harvesting aspects will be reviewed in this working paper. It is assumed that drought will have only limited impacts on harvesting activities within the Western Northlands.

Valuing wildlife resources used in sports fishing, duck hunting and similar pursuits is difficult, since these activities frequently occur outside the market economy. Records on commercial harvesting are, however, maintained -- Table 2.11 illustrates the relative importance of commercial fishing and trapping in the three prairie provinces, and emphasizes the significance of commercial fishing in Manitoba and the relatively equal importance attached to harvesting of fur-bearing animals in each of the provinces.

The impacts of drought on fish and wildlife can be summarized as follows:

- for commercial and sport fish species, low water levels in shallow lakes or reservoirs can result in significant winter kill of fish species. Such lakes are frequently used by anglers for sports fishing. In larger lakes where commercial fishing occurs, impacts of drought are likely to be pronounced for stream spawning fish such as walleye, which may not reach the lake because of low discharge, change in water temperature or other factors. The impact of low spawning success may not, however, be felt in reductions in catch for three to four years.

- for fur-bearing animals in the wild, low water levels are likely to result in freezing-out of muskrat and to a lesser extent, beavers. The direct impact of drought on other fur-bearing animals cannot be determined precisely, but it is thought to be small.

- for ducks and Canada geese, drought conditions create very unfavorable impacts. While ducks, for example, do breed in parkland areas, highest productivity areas are in the prairies. Drying up of dugouts and shallow ponds in the prairies (see Working Paper No. 1) will therefore force the ducks to fly over their traditional breeding areas and to nest further north. Since migration will occur by mid-April, precipitation levels must increase sharply if reductions in duck and Canada geese populations are not to occur this year. Precipitation in May and beyond will be far less significant in determining impact on waterfowl populations.

  In addition to the above, dry conditions lead to an acceleration in destruction of habitat (by farmers in particular) as burning increases and potholes/ponds are drained or otherwise incorporated into farm drainage systems. Permanent loss of habitat, of course, leads to further long term declines in waterfowl populations. 1/

- for big game and upland game birds, drought conditions may lead to some improvement in populations. Since severe winters have the greatest impact on mortality rates, a mild winter of the type experienced this year should lead to an overall increase in population, as a larger number of animals and game birds survive the winter.

Based upon the above factors, and following discussions with staff of the Canadian Wildlife Service, Ducks Unlimited and staff of the provincial government, impacts of drought on fish and wildlife in Alberta can be briefly summarized as follows:

(i) for commercial and sports fishing, minimal impact from drought is forecast this year. Fish populations in shallow lakes in southern Alberta may be affected, but the overall impact is not expected to be significant. Little evidence exists in Alberta that lower lake levels necessarily reduce spawning success for commercial species such as whitefish; the impact on catches, moreover, would not be felt for five to six years.

(ii) for wild fur-bearing animals, no difficulties are anticipated. Muskrats, for example, are concentrated in the Peace River and Athabaska regions of Alberta, where sufficient water was available last winter. Continuation of the drought cycle could, however, contribute to trapping problems next year.

1/ Ducks Unlimited has indicated that during 1961, forty per cent of the breeding mallard population in the prairie provinces was lost as the result of drought.

TABLE 2.11

VALUE OF COMMERCIAL HARVEST OF FISH AND WILDLIFE, PRAIRIE PROVINCES, 1975-1976

	Alberta*	Saskatchewan	Manitoba	Total
Commercial Fishing				
Quantity landed (000 lbs.)	5,239	10,400	20,610	36,249
Value of catch ($000)	1,754	2,200	5,894	9,848
Trapping (excluding ranch raised)				
Value of pelts ($000)	3,493	4,416	4,250	12,159

Source: Manitoba Department of Renewable Resources;
Saskatchewan Department of Tourism and Renewable Resources;
Alberta Department of Lands and Forests.

* Note that Alberta estimates are based on the 1974/75 fiscal year as 1975/76 figures were not available.

(iii) for ducks, lack of sufficient precipitation before May 1st to fill ponds and other breeding areas in Alberta could result in significant losses in population -- varying anywhere from twenty to fifty per cent of the total duck population. There is no suggestion, however, that the hunting season this year would be restricted as the result of such a loss.

(iv) for big game, no serious impact is anticipated, other than possibly for antelope (where poor grass conditions and/or grassland fires could contribute to declines in population).

(v) for upland game birds such as grouse and pheasant, impacts will also be marginal, i.e. lack of cover may contribute to problems in brooding and escape from predators. Basically, however, these birds prefer dry conditions.

In Saskatchewan, drought impacts are similar, and can be summarized as follows:

(i) for commercial and sport fishing, the impact of drought will likely be concentrated on stream spawning varieties such as pike and walleye, especially in the Qu'Appelle Valley and in the many reservoirs in southern Saskatchewan stocked for local fishing purposes. Trout in the Cypress Hills area and white-fish in Lake Diefenbaker will also experience declines in population. Since seventy to seventy-five per cent of commercial fish harvest occurs in the Northern Administrative District, impacts of drought on this resource are unlikely to be severe unless drought conditions continue.

(ii) for wild fur-bearing animals, some impacts are anticipated for the muskrat and beaver. Populations of these animals are, however, concentrated in the parkland zones of Saskatchewan, where drought conditions are by no means as severe as on the prairies. Continuation of drought conditions into a second year could result in significant impact on the muskrat population.

(iii) for ducks and Canada geese, drought conditions will lead to a sharp decline in the number of waterfowl breeding in prairie areas; the decline in populations, however, will be moderated by continued breeding in the parkland zones. Currently, Saskatchewan has a good carry-over of ducks reflecting, among other factors, lower hunting pressure than in Manitoba. For this reason, it is unlikely that the hunting season will be closed (or severely limited), even in the face of sharply lowered productivity this year.

Continuation of the drought into a second year, however, could drastically affect the overall waterfowl population and warrant measures to restrict hunting activity.

(iv) as mentioned previously, the impact of drought on big game and upland game birds may be beneficial in the short run. In southwest Saskatchewan, very dry conditions, however, could lead to declines in the population of mule deer and (especially) antelope. In these circumstances, the possibility exists that hunting seasons for these two species may not open in 1977.

Forest fire conditions could also lead to closures of hunting seasons in some areas of Saskatchewan, if conditions are serious enough. Total closure of the season, however, is unlikely.

In Manitoba, the following impacts of drought are anticipated:

(i) for commercial and sport fishing, winter kill of fish may already have occurred in shallow lakes such as Red Deer Lake, Pelican Lake and Rock Lake. Spawning of pike along the Souris River and its tributaries may also be affected. Elsewhere in Manitoba, it is difficult to link changes in fish population and harvest to changes in water regimes, although sharp declines in catches in Lake Winnipegosis after 1962 may have been due in part to 1961 drought conditions. As stated above, any direct impacts on commercial catches are unlikely to be felt for a period of four years.

(ii) for trapping, the single largest impact has been on the muskrat, with freeze outs in both northern and southern Manitoba. Losses will not be precisely quantified until the end of summer, but a preliminary estimate by the Department of Renewable Resources is that spring harvest losses may be on the order of $500,000. The beaver is also being monitored.

(iii) for ducks, continuation of drought conditions could lead to significant declines in population in southern Manitoba and (in the extreme) to closure of the duck hunting season in the fall of 1977. The Canadian Wildlife Service, in co-operation with the Manitoba Department of Renewable Resources, is currently evaluating the impact of different drought scenarios on duck populations, aided by results from semi-annual surveys of ponds and dugouts in the province. The impact could be as severe as a fifty per cent loss of the mallard population, which traditionally accounts for forty to sixty per cent of the Manitoba waterfowl hunter's bag.

(iv) for big game animals, drought conditions could lead to either an improvement or reduction in populations. Mild winter conditions, for example, increase survival rates for such species as white tailed deer (fifty per cent of which are in the southwest quartile of Manitoba). Summer drought conditions, on the other hand, could reduce the capability of herds to survive the winter, as the result of impacts through the food chain. It is not anticipated, however, that drought conditions

will influence the decision of the Department of Renewable Resources regarding re-opening white tailed deer hunting season, which closed in 1973.

(v) for upland game birds, effects are similar to those in Alberta and Saskatchewan. While lack of snow cover may have contributed to increased mortality during the winter (especially during periods of severe weather), the Department of Renewable Resources does not anticipate any serious impacts on population levels.

As the above comments indicate, the short term impacts of drought in the prairie provinces are likely to be concentrated on the muskrat and duck populations, with only limited adverse impacts on fish, other fur-bearing animals, upland game birds and big game (see Table 2.12). Only limited opportunities exist for mitigating measures over this time period, other than perhaps closing or (more probably) restricting the duck hunting season[1/] and encouraging farmers not to accelerate the destruction of breeding habitat.

In the longer term, continuation of drought conditions could serve to have a broader impact on wildlife and fish populations. For fish, losses will be particularly heavy in shallow lakes used primarily for angling; in the larger commercial lakes, the impact will be less certain, but will likely be concentrated on stream spawning species. The impact of drought on muskrat and ducks will be compounded in the second year, with parkland areas in Saskatchewan, for example, being affected. In these circumstances, the animal population in general will also face greater danger from forest fires. Mitigating efforts feasible in the longer run include habitat preservation and improvement (especially for waterfowl), as well as restocking of lakes, reservoirs and streams with fish.

1/ Economic losses arising from declines in duck populations have not been estimated. Closure of the duck hunting season, for example, could lead to immediate losses in the form of license revenues, travel expenditures, purchase of ammunition and supplies. Federal and provincial government license revenue alone is estimated at slightly under $1.5 million in the prairies, with approximately 43,000 licenses issued in 1975 in Manitoba, 58,000 in Saskatchewan, and 69,000 in Alberta. Beyond immediate hunting revenues, there are also broader resource impacts associated with naturalist and other activities.

TABLE 2.12

DROUGHT IMPACTS: FISH AND WILDLIFE

	Description of Impacts
Alberta	
Fish	Only minimal impacts.
Fur Bearing Animals	No impact expected; severe drought impact minimal.
Ducks	Twenty to fifty per cent reduction possible.
Upland Game, Big Game	No impact expected, except for antelope.
Saskatchewan	
Fish	Pike and walleye in Qu'Appelle Valley and southern reservoirs; trout in Cypress Hills and whitefish in Lake Diefenbaker.
Fur Bearing Animals	Some moderate impact on muskrat and beaver; prolonged drought could have significant impact.
Ducks and Geese	Sharp decline in prairie area breeding; little effect on this year's hunting; prolonged drought could significantly restrict hunting.
Upland Game, Big Game	Impact only for mule deer and antelope; could restrict or close hunting season.
Manitoba	
Fish	Shallow lake impacts (Red Deer Lake, Pelican Lake, Rock Lake); Souris River spawning.
Fur Bearing Animals	Muskrat; estimated harvest loss $500,000 in spring 1977; additional muskrat harvest loss possible in fall; beaver being monitored.
Ducks	Decline of fifty per cent or more; possible effects on hunting.
Upland Game, Big Game	No significant impact expected.

13. Tourism and Recreation

Impacts of drought on tourism and recreation will be felt largely in water-based activities during the summer, and should dry conditions continue, in snow-based activities during the winter. Water-based activities affected include such traditional activities as swimming, boating, camping and sight-seeing, while snow-based activities include snowmobiling, cross-country and downhill skiing. Sports fishing, duck hunting and big game hunting are discussed under a separate section.

While drought conditions may lead in some limited cases to interruptions in tourism or in recreational activity, eg. closure of camps, parks and wilderness areas in response to forest fire conditions, the impact of drought will be felt largely in terms of quality decline.

Outside urban areas, low lake levels and reduced streamflow will hamper boating and swimming, for example, although in some instances, eg. Lake Winnipeg, these activities could actually improve in quality. In the Rocky Mountains, reduced snowpack accumulation could lead to declines in both summer and winter tourist activity. In the urban areas, reduced streamflows on rivers and streams could hamper recreational enjoyment of park areas and summer boating, although it is not anticipated that tourism within urban areas, eg. conventions, will be adversely affected by drought conditions.

Based upon discussions with officials of the National Parks Administration and Provincial Tourism Departments, areas of particular concern have been identified. In Alberta, special attention is being paid to Banff, Jasper and Waterton Lakes National Parks, although Parks Canada does not expect serious impacts arising from drought (during the winter of 1976/1977, visitors to these three National Parks declined by only 3.7 per cent, in comparison to the

previous year). Elsewhere in Alberta, only Cypress Hills Provincial Park has been identified as sensitive to drought conditions. Impacts on this Park could range from a lack of water for camping and day use purposes to restricted travel in response to grassland fire hazards. Also affected would be the carrying capacity for animals grazing in the Park. (See Section 2).

In Saskatchewan, the Qu'Appelle River basin is likely to be most affected by drought, due mainly to deterioration in quality of water in such locations as Last Mountain Lake and along the river itself. As a result, a wide spectrum of the population living in southern Saskatchewan -- especially in Regina -- could potentially be affected by drought conditions. Residents of Saskatoon may also experience some discomfort this summer, in response to reduced streamflows from the Gardiner Dam. Provincial Parks bordering on Lake Diefenbaker, on the other hand, may improve in attractiveness (especially beach areas), unless access is restricted by grassland fire hazards.

Other major recreational areas in Saskatchewan, eg. Prince Albert National Park, La Ronge and Meadow Lake Provincial Parks, should not be unduly affected by drought during the summer period, as moisture conditions are closer to normal in the northern areas of the province. Wilderness travel may be slightly impeded by reduced streamflow and lower lake levels.

In Manitoba, the Whiteshell Provincial Park/Winnipeg River/Lake of the Woods area is likely to be adversely affected by low lake and streamflow levels, restricting boating, swimming and similar activities in some circumstances. In contrast, lower levels on Lake Winnipeg could contribute to improved beaches at sites such as Grand, Winnipeg and Victoria Beaches, which are heavily used by residents of Winnipeg. Neither National Parks nor provincial government officials, however, anticipate any particularly serious problems

this year with respect to park operations, unless forest fire hazards restrict access to and travel within parks.

In summary, while significant impacts on tourism and recreation may occur this summer (and possibly into the winter, if dry conditions continue) in response to drought conditions, these impacts will largely be site-specific. Losses will primarily be of the quality variety, unless forest fires force closure of major recreational areas such as the Whiteshell or portions of the National Parks in Alberta. Parks officials can be expected to identify potential problem areas for the 1978 season by late summer, if drought conditions persist.

14. Municipal Water Supply

Depending upon location, municipal water supply in the prairie provinces may be dependent upon either streamflow conditions along rivers and streams, groundwater supply or reservoir storage. Whatever the source of supply, it is anticipated that the impact of prolonged water shortage on communities will be far more severe than, for example, forty years ago. At least three factors can be cited to explain the severity of impact.

(1) urban communities in particular have grown rapidly in size, and per capita use of water has increased sharply, even before industrial use is taken into account.

(2) industrial use has become a very significant factor in the demand for water, particularly in smaller urban communities such as Portage la Prairie, Morden, Medicine Hat and Lethbridge, where food processing industries have located.

(3) traditional water supply sources (eg. wells) during periods of water shortage can fail to handle the requirements of households now connected to line sewage disposal facilities, where water pressure is necessary to operate flush toilets, washing machines and similar modern appliances.

It is unlikely that any conceivable drought conditions will result in an immediate and unanticipated interruption in water supply. Rather, communities will pass through clearly defined stages of water shortage, with system shutdown representing only the final outcome under the most extreme conditions.

Four stages of municipal water shortages are identified below:

(1) Initially, water quality will deteriorate, in response to such factors as increased salinity, inadequate dilution of upstream pollution, increased use of deep wells, aquifer draw down and/or stagnation and algae build-up in lakes or reservoirs. Water supply will be adequate in quantity, however, to meet requirements.

(2) Once some water shortages are experienced, municipal authorities can be expected to take action to promote voluntary conservation of water, particularly during times of peak demand. Measures here would involve prohibition of lawn and garden watering, economizing on household use, and possibly some industrial slowdowns.

(3) Critical shortage conditions are encountered (where curbing peak demand requirements is not sufficient to ensure adequate water supply): it may then be necessary for municipal authorities to cut off supplies for several hours per day, and thus restrict toilet flushing, laundry and bathing. At this stage, most industrial and process use of water would be prohibited and serious local unemployment problems would arise.

(4) In the final stage of shortage, it would become necessary to shut down the entire water and sewer system. Any community so unfortunate as to experience this level of impact would require emergency water supplies for essential uses and the creation of emergency sanitary arrangements. Employment problems would be very serious.

Working Paper No. 1 has already highlighted many of the municipal water supply impacts that could potentially arise from drought conditions in the prairie provinces. In general, while system shutdown is not anticipated to any degree during the summer of 1977, local problems could arise as early as June or July in some communities, and would be more widespread by September.

In Alberta, none of the major urban communities such as Edmonton, Calgary, Lethbridge, Red Deer and Medicine Hat are forecast to experience water supply problems of any magnitude during 1977, i.e. releases on the North Saskatchewan, Bow, Oldman and Red Deer Rivers should be sufficient to meet requirements. Any restrictions on peak demand which will occur in 1977 in communities such as Lethbridge, will be in response to system capacity problems.

Elsewhere in Alberta, the following rural communities may be affected by water shortage: Lamont, Holden, Viking, Tolfield, Legal, Crossfield, Champion, Nanton and Hanna. With the exception of the last two communities, these communities rely on spring run-off to divert water into off-stream storage. No data is currently available on water supply conditions for communities served by wells.

Should drought conditions persist, water supply in Vegreville -- which also relies on off-stream storage -- could also be affected in 1978.

In Saskatchewan, provincial officials have already compiled a list of thirty-nine communities which may experience water supply problems this summer. This list excludes Regina and Moose Jaw, which may experience a need for voluntary rationing to limit peak demand, although the source of supply is secure (the constraint is the design capacity of the pipe line). Some of the larger communities where water supply problems may be encountered include the following:

White City	-	supplied mainly by individual wells. Recent growth of community may require extension of wells to handle requirements and ultimately installation of conventional water supply system.
Lumsden	-	supplied by well from the Qu'Appelle River. While the well is unlikely to go completely dry, additional pumping and/or rationing may be required.
St. Louis	-	reduced water flow levels on South Saskatchewan may require modification to works to ensure supply.
Outlook	-	also affected by low or variable flows from the Gardiner Dam. Outlook may require modification to works and possibly some rationing.
Davidson	-	small reservoir which may not be adequate this year.
Weyburn	-	immediate problem one of quality of supplemental water from groundwater sources. Continuation of drought cycle could lead to water shortages during 1978.
Radville	-	surface water reservoirs, supplies from which may not be adequate this year.

Other communities which may also be affected include Canora, Foam Lake, Gull Lake, Birch Hills, Cabrie and Montmartre. Continuation of the drought cycle into 1978 can be expected to have an impact on the following centres: Weyburn, Melville and Kipling.

In Manitoba, a number of large and small communities could be affected by drought. For example the City of Winnipeg (which relies on Shoal Lake for its water) could face the prospect of voluntary rationing of water if

levels at Shoal Lake continue to decline and one of the two diesel pumping units installed at the intake breaks down. Conditions would then be similar to those prevailing in 1961, when rationing of water was last imposed in Winnipeg.[1/]

Elsewhere in Manitoba, other communities potentially affected by drought include St. Jean Baptiste, Emerson and Morris on the Red River, possibly Austin and McGregor on West Squirrel Creek, and (especially) Altona. Under relatively severe drought conditions, water supply and/or quality problems could also be encountered in Baldur, Benito, Dauphin and Souris, but other rural food processing centers such as Portage la Prairie, Carberry, New Bothwell, St. Claude and Morden should not experience any serious water supply problems this year. A prolonged drought, however, could affect Morden's water supply in 1978. For additional detail, see Working Paper No. 1.

In summary, although local problems of municipal water supply may emerge in 1977 (see Table 2.13), there should be no widespread problem of absolute water shortages across the prairies in response to drought conditions. Of all major urban centers, the Cities of Winnipeg, Regina and Moose Jaw are those most likely to introduce voluntary water rationing during 1977. Short term mitigating measures for municipal water supply shortages would logically include provision of emergency (truck) water supplies for communities suffering acute shortages, as well as assistance in extending existing wells, drilling new wells or making emergency modifications to existing works.

Persistence of low precipitation levels into 1978, however, could substantially increase the number of communities affected by municipal water supply problems, as well as intensifying the level of impact in the communities noted in this working paper.

1/ Low soil moisture conditions have also resulted in cracking of numerous house foundations in certain areas of Winnipeg, and may have contributed to an excessive level of watermain breaks during the winter.

TABLE 2.13

DROUGHT IMPACT: SELECTIVE LIST OF COMMUNITIES WITH POTENTIAL MUNICIPAL WATER SUPPLY PROBLEMS

	1977		1978
Alberta	Lamont		Vegreville
	Holden		
	Viking		
	Tolfield		
	Legal		
	Crossfield		
	Champion		
	Nanton		
	Hanna		
Saskatchewan	Regina	(Voluntary Rationing)	Weyburn
	Moose Jaw	(Voluntary Rationing)	Melville
	Weyburn	(Water Quality)	Kipling
	Lumsden		
	St. Louis		
	Outlook		
	Davidson		
	Radville		
	Canora		
	Foam Lake		
	Gull Lake		
	Birch Hills		
	Cabrie		
	Montmartre		
Manitoba	Winnipeg	(Voluntary Rationing)	Morden
	Souris	(Water Quality)	Carman
	St. Jean Baptiste		
	Morris		
	Emerson		
	Austin		
	McGregor		
	Altona		
	Baldur		
	Benito		
	Dauphin		

15. Summary of Enterprise Impacts by Province

Tables 2.14, 2.15 and 2.16 provide a summary of the preceding drought impact analysis for Alberta, Saskatchewan and Manitoba respectively.

TABLE 2.14

SUMMARY OF DROUGHT IMPACT

ANALYSIS: PROVINCE OF ALBERTA

	Summer/Fall 1977	Winter 1977 and Beyond
Moderate Drought Impact		
Major Field Crops	Possible decline in output of of 6.1 per cent; possible loss of farm income of 75.6 million dollars. Problems concentrated in southern Alberta.	Exacerbation of problems in southern Alberta. No widespread impact anticipated
Vegetables, Potatoes, Sugar Beets	No impact anticipated in principal irrigated areas.	No impact anticipated.
Beef	Possible decline in herd size of 1.5 per cent, with associated income loss of 13.0 million dollars. Herd reductions in summer due to water and grazing shortage.	Continuation and possible acceleration of herd reduction, if winter forage supplies inadequate.
Dairy	Possible decline in production in Calgary milk shed. Possible cost-price squeeze on producers. Reductions in herd sizes unlikely.	Some decline in availability of industrial milk.
Other Livestock	No impact on production levels anticipated.	No impact anticipated.
Electric Power	No major impact anticipated.	Expect higher cost of electricity generation, but impact unlikely to be large.
Mining	No impact anticipated.	No impact anticipated.
Forestry	Fire hazards on eastern slopes of Rocky Mountains, and in boreal forest areas. No major impact anticipated on conversion operations. Additional fire suppression costs of $2.25 million.	Possible exacerbation of fire hazard conditions in 1978, with attendant impacts on conversion operations, tourism, wildlife and watershed management.

TABLE 2.14 (continued)

SUMMARY OF DROUGHT IMPACT

ANALYSIS: PROVINCE OF ALBERTA

	Summer/Fall 1977	Winter 1977 and Beyond
Moderate Drought Impact		
Wildlife and Fishing	Major impacts on duck populations (20-50 per cent loss), but no likely change in hunting season. Antelope in southern Alberta could also be affected.	Possible impact on muskrat population.
Tourism and Recreation	Impact concentrated in Cypress Hills Provincial Park, mainly danger of grassland fires.	Some possible impact on National Parks and exacerbation of conditions in Cypress Hills Provincial Park.
Municipal Water Supply	Problems concentrated in six to eight small communities, with off-stream storage from runoff.	Possible addition of Vegreville to shortage category. No data on communities relying on groundwater supply.
Severe Drought Impact		
Major Field Crops	Possible decline in output of 12.3 per cent; possible loss of farm income of 166.5 million dollars.	Exacerbation of problems in southern Alberta. Some problems on fields summerfallowed in 1977.
Vegetables, Potatoes, Sugar Beets	See above.	May encounter water shortages in southern Alberta Irrigation Districts.
Beef	Possible decline of 15 per cent of herd, with associated income loss of $128.0 million. Considerable "low end" beef on market.	See above.

TABLE 2.14 (continued)

SUMMARY OF DROUGHT IMPACT

ANALYSIS: PROVINCE OF ALBERTA

Severe Drought Impact	Summer/Fall 1977	Winter 1977 and Beyond
Dairy	See above.	Continued decline in availability of industrial milk. Possible decline in herd size in response to long term cost-price pressures.
Other Livestock	No major impact on production levels anticipated, with possible exception of sheep.	No major impact anticipated, other than higher input costs for feed grain.
Electric Power	See above.	See above.
Mining	See above.	See above.
Forestry	Increased fire hazards, some possible impact on conversion operations in limited cases. Additional fire suppression costs of $3.25 million.	Probable intensification of forest and grassland fire conditions throughout Alberta.
Wildlife and Fishing	High loss in duck populations, possibly some loss in sports fishing and antelope in southern Alberta.	Loss of muskrat population in Peace River region. Possible impact on duck hunting season.
Tourism and Recreation	See above.	See above.
Municipal Water Supply	See above.	See above.

Source: InterGroup Consulting Economists Ltd.

TABLE 2.15

SUMMARY OF DROUGHT IMPACT

ANALYSIS: PROVINCE OF SASKATCHEWAN

Moderate Drought Impact	Summer/Fall 1977	Winter 1977 and Beyond
Major Field Crops	Possible decline in output of 19.1 per cent; possible loss in farm income of $362.2 million. Declines in production concentrated in wheat, oats and barley.	Problems in soils summer-fallowed in 1977, particularly light and medium textured soils.
Vegetables, Potatoes, Sugar Beets	No significant production.	No significant production.
Beef	Possible decline of 1.7 per cent of herd, with associated loss of income of $10.0 million. Herd reduction in summer due to shortages of water and/or sufficient grazing land.	Continuation and possible acceleration in herd reduction, if winter forage supplies inadequate.
Dairy	Possible decline in production levels in Regina, Saskatoon and particularly Swift Current milksheds. Possible cost-price squeeze on producers. Reductions in herd size unlikely.	Some decline in availability of industrial milk.
Other Livestock	No impact on production levels anticipated.	Production may increase in response to drought conditions elsewhere.
Electric Power	Significant decline in proportion of power available from hydro sources. No supply interruptions anticipated.	Continued problems in hydro generation. Addition of thermal unit at Estevan should overcome overall supply problem.
Mining	No impact anticipated.	No impact anticipated.

TABLE 2.15 (continued)

SUMMARY OF DROUGHT IMPACT

ANALYSIS: PROVINCE OF SASKATCHEWAN

	Summer/Fall 1977	Winter 1977 and Beyond
Moderate Drought Impact		
Forestry	No major impact on conversion operations currently anticipated. Additional fire suppression costs of $1.5 million.	Possible exacerbation of fire hazard conditions in 1978, with attendant impacts on conversion operations, tourism, wildlife and watershed management.
Wildlife and Fishing	Major impact on duck populations, but no probable impact on hunting season. Hunting season could be closed for antelope and mule deer. Loss of sports fish in local reservoirs and elsewhere.	Possible impact on muskrat in parkland zones. Further impact on ducks. Longer term impact on commercial fishing.
Tourism and Recreation	Possible short term beneficial impacts.	No adverse impacts identified.
Municipal Water Supply	Provincial authorities have identified 39 communities (mostly small) where water supply problems could be encountered. Regina and Moose Jaw may experience voluntary rationing.	Weyburn, Melville and Kipling could encounter shortages in 1978.
Severe Drought Impact		
Major Field Crops	Severe decline in level of production by 80.4 per cent; loss in gross farm income of $1,540 million. Particular losses in cereal grains.	Serious problems with soil erosion on summerfallow lands. Possibility of lower yields in 1978.
Vegetables, Potatoes, Sugar Beets	See above.	See above.

TABLE 2.16 (continued)

SUMMARY OF DROUGHT IMPACT

ANALYSIS: PROVINCE OF SASKATCHEWAN

Severe Drought Impact	Summer/Fall 1977	Winter 1977 and Beyond
Beef	Possible decline in herd size of 30 per cent, with associated income loss approximating $172.0 million. Considerable quantities of low end beef on market.	See above. In long run, could result in additional excess capacity in slaughtering and meat packing industry.
Dairy	See above.	Possible decline in herd size in response to long term cost-price pressures. Impact largely on processing plants, eg. Yorkton cheese factory.
Other Livestock	See above.	See above.
Electric Power	See above.	May experience sharp decline in proportion of electricity generated from hydro sources. System increasingly dependent on thermal facilities, whether existing or under construction.
Mining	No impact anticipated.	No impact anticipated.
Forestry	Possible limited impact on conversion operations. Additional fire suppression costs of $4.5 million.	Probable intensification of forest fire conditions in 1978, with escalating impacts on conversion operations, tourism and wildlife.
Wildlife and Fishing	See above.	See above.
Tourism and Recreation	See above.	Possible impacts through forest fires, reduced water flows and other hazards.
Municipal Water Supply	See above.	See above.

Source: InterGroup Consulting Economists Ltd.

TABLE 2.16

SUMMARY OF DROUGHT IMPACT

ANALYSIS: PROVINCE OF MANITOBA

Moderate Drought Impact	Summer/Fall 1977	Winter 1977 and Beyond
Major Field Crops	Possible decline in output of 17.0 per cent; possible loss in farm income of $87.6 million. Declines in production probably concentrated outside Red River Valley area.	Problems in soils summer-fallowed in 1977, particularly light and medium textured soils. Soil erosion.
Vegetables, Potatoes, Sugar Beets	Losses in production in non-irrigated areas of 40 per cent for vegetables, 23 per cent for potatoes and 8 per cent for sugar beets. Total income loss of $3.9 million.	No long term impact identified, beyond concomitant decline in normal crop yield.
Beef	Possible decline of 1.5 per cent of herd, with associated income loss of $3.6 million.	Continuation and possible acceleration in herd reduction, if supplies of winter forage inadequate.
Dairy	No major declines in milk production anticipated, except possibly in vicinity of centres such as St. Claude, Winkler and possibly Dauphin. Primarily cost-price pressure on operators.	Some possible decline in supply of milk for industrial plants, expecially cheese plants in rural areas.
Other Livestock	No impact on production levels anticipated.	Production may increase in response to drought conditions elsewhere.
Electric Power	Heavy reliance on higher cost thermal power for generation (15-20 per cent of power generated). Loss of export revenue. No domestic supply interruptions anticipated.	Sufficient streamflow to operate initial units at Long Spruce and Jenpeg during winter 1977/1978. Ability of Manitoba Hydro to meet requirements beyond this time period is unclear.
Mining	No impact anticipated.	No impact anticipated.

TABLE 2.16 (continued)

SUMMARY OF DROUGHT IMPACT

ANALYSIS: PROVINCE OF MANITOBA

	Summer/Fall 1977	Winter 1977 and Beyond
Moderate Drought Impact		
Forestry	No major impact on conversion operations. Additional fire suppression costs of $2.5 million.	Possible intensification of conditions, with attendant impacts on conversion operations, tourism, wildlife and watershed management.
Wildlife and Fishing	Major impact on muskrat and duck populations, with some limited impacts on sports fishing. Hunting seasons are unlikely to be closed in response to a perceived short term drought condition.	Exacerbation of impact on ducks and muskrats, plus other species. Declining trapping revenues. Longer term impacts on commercial fishing.
Tourism and Recreation	Possible problems in Whiteshell recreational area. Some improvement elsewhere, eg. Lake Winnipeg.	No adverse impacts identified. Forest fire hazards could limit activity.
Municipal Water Supply	Some chance of voluntary rationing during summer in Winnipeg. Other communities potentially affected include Austin, MacGregor and Altona.	Problem may emerge in communities such as Souris and Dauphin. Longer term impact on water supply has yet to be fully defined.
Severe Drought Impact		
Major Field Crops	Major decline in output of 49.6 per cent; possible loss in farm income of $271.9 million. Losses concentrated primarily in cereal grains, with some declines in rapeseed and flax.	Serious problems with soil erosion on summerfallow land. Possibility of lower yields in 1978.

TABLE 2.16 (continued)

SUMMARY OF DROUGHT IMPACT

ANALYSIS: PROVINCE OF MANITOBA

Severe Drought Impact	Summer/Fall 1977	Winter 1977 and Beyond
Vegetables, Potatoes, Sugar Beets	Possible loss of commercial canning crop; potato output declines by 73 per cent, sugar beets by 22 per cent. Total income loss of $12.0 million.	See above.
Beef	Possible reduction in herd size of 15 per cent, with accompanying income loss of $36.0 million.	See above.
Dairy	See above.	See above.
Other Livestock	See above.	See above.
Electric Power	See above.	See above.
Mining	No impact anticipated.	No impact anticipated.
Forestry	Possible limited impact on summer logging operations of major companies. Additional fire suppression costs of $3.75 million.	See above.
Wildlife and Fishing	See above.	See above.
Tourism and Recreation	See above.	See above.
Municipal Water Supply	See above.	See above.

Source: InterGroup Consulting Economists Ltd.