Klohn Crippen Berger

St. Mary River Irrigation District

Chin Reservoir Expansion - EIA

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Socio-Economic Assessment for the Chin Reservoir Expansion Project

January 2023

Prepared for: MPE Engineering Ltd.
Lethbridge, Alberta

Socio-Economic Study for the Chin Reservoir Expansion Project

Prepared for:
MPE Engineering Ltd., Lethbridge, Alberta

Prepared by: Acera Consult Inc., St. Jean-sur-Richelieu, Quebec and Lethbridge, Alberta.

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Photographs –

- Page 22 - Pivot irrigation system irrigating canola – Len Ring.
- Page 47 – Flooding near Coaldale – MPE Engineering Ltd.
- Page 55 – Boat launch facility at Chin Reservoir – Roger Hohm.

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Acera Consult Inc. 2023. Socio-Economic Study for the Chin Reservoir Expansion Project. Lethbridge, Alberta, Canada. 108 pp.

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EXECUTIVE SUMMARY

E.1 Background

In June 2022 MPE Engineering Ltd. commissioned Acera Consult Inc. to undertake a socio-economic assessment of the proposed Chin Reservoir Expansion project for the St. Mary River Irrigation District (SMRID). Chin Reservoir is the largest off-stream reservoir in the SMRID, approximately 30 km east of Lethbridge, Alberta, and 15 km south of Taber, Alberta (Figure E1). The reservoir was commissioned in 1954 and has a live storage capacity of 168,120 acre-feet.

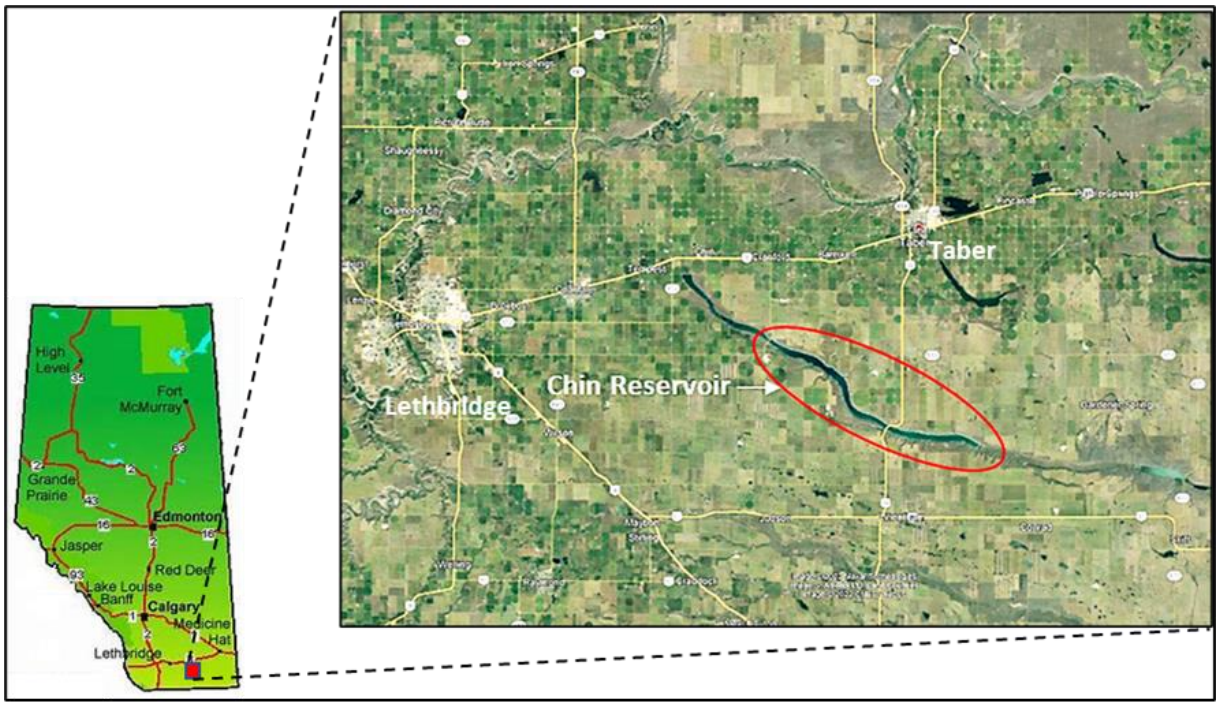

Figure E1. Location of Chin Reservoir

Proposed expansion of the existing Chin Reservoir, at an estimated cost of about $190 million, is being considered to improve irrigation water supply for existing irrigation development in the region. The proposed expansion includes construction of a new dam 6 miles east of the existing east dam and increasing the height of the existing west dam, for an increased capacity of 75,421 acre-feet.

This expansion will allow for additional irrigation development to meet the ongoing demand by existing irrigation and dryland producers adjacent to the Raymond Irrigation District (RID) and SMRID (Figure E2). Note – This study also includes the Taber Irrigation District (TID), which amalgamated with the SMRID in 2022. The amalgamated district will be known as the SMRID. An average of 489,227 acres of land were irrigated within these irrigation districts from 2011 to 2020.

E.2 Study Components

This study assessed the costs and benefits of the proposed Chin Reservoir expansion by examining two regional agricultural economies: one that included dryland production and one that included irrigation production. Dryland production is considered the current baseline economy in the proposed expansion area, and irrigation production is the economy resulting from the proposed Chin Reservoir expansion. Qualitative and quantitative methods of analysis were employed to assess the net impacts, in addition to the dryland production, of the proposed irrigation expansion.

Computer models were developed and used to assess the effects of the Chin Reservoir expansion and associated new irrigation development for:

- Primary agricultural (crop and livestock) production;
- Backward linkages;
- Forward linkages (food processing);
- Government revenues;
- Other agricultural and non-agricultural benefits;
- Overall economic value of the project; and
- Benefit-Cost analyses of the proposed project.

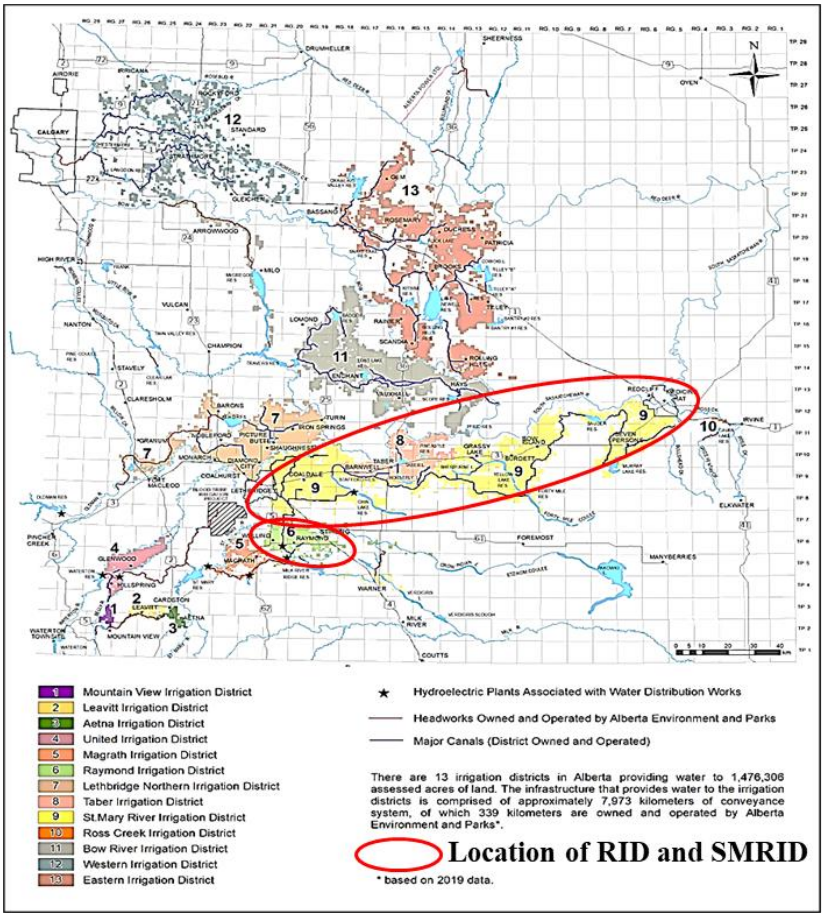

Figure E.2. Location of RID and SMRID

The Chin Reservoir Expansion Project can potentially influence three types of changes to the economy.

- **Direct Impacts:** Money spent by companies and irrigation producers on goods and services.
- **Indirect Impacts:** Economic activities triggered by the purchase of goods and services from other businesses (fertilizer, herbicides, banking services, construction materials, and other professional services).
- **Induced Impacts:** Expenditures of income, earned under direct and indirect impacts, which result in higher demand for goods and services.

Six types of economic impacts were assessed in this study.

- **Direct Impacts of On-farm Irrigation Activities:** The direct contribution of on-farm crop and livestock production using following criteria:
  - Value of sales (measured as gross farm income); and
  - Employment.
- **Indirect Impacts of On-farm Activities (Created Through Backward Linkages):** Generated through sale of inputs (goods and services) required for irrigation production. This includes seed, feed, fertilizer, pesticides, fuel, machinery, irrigation equipment, and agronomic services.
- **Indirect Impacts of Value-added Activities (Generated Through Forward Linkages):** Relates to additional economic activity created by provincial industries through further processing of irrigation products.
- **Induced Impacts (Created by Backward Linkages):** Businesses that sell goods and services to irrigation producers see additional demand for their products, and therefore invest money to hire more people to meet this demand. This leads to more money being spent on goods and services within the region and the province of Alberta, leading to an increase in economic and social activities.
- **Induced Impacts (Created by Forward Linkages):** Relates to the additional economic activity created by the industries that pay wages and salaries to workers, and dividends to shareholders. When these additional incomes are spent, additional demand for local goods and services is created, thereby leading to an increase in provincial economic and social activities.
- **Other Quantitative Impacts of Irrigation:** Include benefits to urban and rural municipalities, industries, power generation, recreation, and the public-at-large. These impacts were assessed quantitatively using a mixture of market and non-market methods.

E.3 Key Conclusions

It was determined that the proposed expansion of Chin Reservoir could support sustained irrigation on about 46,500 acres of existing dryland farms in the areas served by the RID and SMRID. The irrigation expansion is recommended to take place in four areas, within or adjacent to the RID and SMRID, to diversify and optimize the potential regional benefits of the new irrigation development.

- **Area 1:** Includes 11,500 acres upstream of the proposed expanded Chin Reservoir (includes 6,500 acres in the RID, and 5,000 acres in the SMRID West).
- **Area 2:** Includes 16,000 acres served directly from the expanded Chin Reservoir.
- **Area 3:** Includes 9,000 acres downstream of Chin Reservoir in the Taber to Grassy Lake area. Most of the irrigation water would likely be delivered directly from the SMRID main canal, as infill potential in this area is limited.
- **Area 4:** Includes 10,000 acres downstream of Chin Reservoir, in the Bow Island to Medicine Hat area. Most of the irrigation water would also be delivered directly from the SMRID main canal.

E.3.1 Irrigation Crop Mix

The proposed crop mix for the expansion areas (Table E.1) was based on an assessment of current crops grown in the RID and SMRID, and crops that could be grown within each of the four expansion areas in the future.

Table E.1. Projected irrigation crop mix for the Chin Reservoir expansion areas.

Crop Mix								
Expansion Area (acres)	**Cereals**		**Forages**		**Oilseeds**		**Special Crops**	
	%	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**	**Acres**
Area 1 - 11,500	32	3,630	35	4,070	20	2,260	13	1,540
Area 2 - 16,000	37	5,920	22	3,520	16	2,560	25	4,000
Area 3 - 9,000	32	2,880	26	2,340	10	900	32	2,880
Area 4 - 10,000	37	3,700	27	2,700	10	1,000	26	2,600
Total - 46,500	35	16,130	27	12,630	14	6,720	24	11,020

E.3.2 Irrigation Development Capital Investments

Producers interested in converting from dryland to irrigation as part of the Chin Reservoir Expansion Project will need to make two capital investments before producing their first irrigation crop. These include a capital asset charge, and a capital investment expense.

- **Capital Asset Charge:** Irrigation districts charge producers wishing to add new irrigation acres a capital assets charge for every acre added to the irrigation district roll.
- **Capital Infrastructure Cost:** Producers selected to participate in the Chin Reservoir expansion areas will need to purchase and install all equipment required to convert their dryland farms into fully functioning irrigation farms.

The combined irrigation capital asset charges and capital infrastructure costs associated with the 46,500-acre expansion area are expected to cost about $278,610,000 (Table E.2).

Table E.2. Capital asset charges and capital infrastructure costs for the expansion areas related to the Chin Reservoir Expansion Project.

Expansion Area	Expansion Acres	Irrigation System***	Capital Asset Charge/ Acre	Total Capital Asset Costs	Capital Infrastructure Cost/Acre	Total Capital Infrastructure Costs
Area 1*	11,500	Pivot	$2,870	$33,005,000	$1,970	$22,655,000
Area 2**	16,000	Pivot	$4,000	$64,000,000	$2,550	$40,800,000
Area 3*	9,000	Pivot	$4,000	$36,000,000	$2,350	$21,150,000
Area 4*	10,000	Pivot	$4,000	$40,000,000	$2,100	$21,000,000
Total (All Areas)	**46,500**			**$173,005,000**		**$105,605,000**

*Assume one, 132-acre pivot per delivery point
**Assume 16, 132-acre pivots (2112 acres) per delivery point
*** Assume each pivot irrigates 132 acres.

The economic impacts of the Chin Reservoir expansion are also affected by the time frame when these activities occur. Three impact time-frame categories were identified for this study (Table E.3).

- **Short-term Impacts:** Create economic impacts for a limited period.
- **Periodic Impacts**: Create economic impacts periodically, and often without any predictability.
- **Annual Impacts:** Generate continuous annual economic impacts with time.

Table E.3. Category of economic activities related to Chin Reservoir Expansion Project.

Short-Term Impacts	Periodic Impacts	Annual Impacts
Construction expenditures.	Farm machinery investment by agricultural producers. Drought mitigation. Flood mitigation.	Crop production. Livestock production. Backward linkages - crop production. Backward linkages - livestock production. Forward linkages – food processing.

The following summarizes the short, periodic, and annual economic impacts and the combined economic impacts of all activities.

E.3.3 Short-term Economic Impacts

Short-term economic impacts are created primarily through construction expenditures for the Chin Reservoir expansion, which is estimated at $190 million for a 3-year period. These construction expenditures are expected to increase the provincial gross domestic product (GDP) by about $163.7 million, generate about $61.4 million in labour income, and create 865 direct full-time equivalent positions (FTEs). The total number of FTEs in the province would increase by 1,528, but only during the 3-year construction period.

E.3.4 Periodic Impacts

Periodic economic activities are those whose timing is not fixed, including:

- Drought mitigation;
- Flood mitigation; and
- On-farm machinery and equipment investments.

The timing of these impacts cannot be determined precisely, and the impact is therefore estimated based on the past occurrences and occurrence probability.

E.3.4.1 Drought Mitigation

The value of irrigation in a drought year was estimated at $3.3 million. This estimate was based on an 8% drought probability in any given year. These events are estimated to increase the provincial GDP by $3.3 million and labour income by $3.3 million. No FTEs are supported. These impacts would only be realized during a drought period.

E.3.4.2 Flood Mitigation

Construction of the Chin Reservoir expansion, combined with other infrastructure development along the SMRID main canal, are expected to significantly reduce the damaging impacts of overland flooding in the region served by the SMRID main canal. Construction of the Chin Reservoir expansion is expected to increase the provincial GDP by about $99 million, generate $77 million in labour income, and create an additional 546 FTEs in the province.

E.3.4.3 On-Farm Investment in Machinery and Irrigation Equipment

Irrigation development on the 46,500-acre irrigation expansion area is expected to require on-farm investments totaling about $110.3 million during project development. This will include about $105.2 million for on-farm irrigation systems, and $5.1 million for specialized farm machinery. This investment is estimated to take place once every 15 years for the on-farm pivot systems, and every 10 years for the specialized farm machinery. These investments are estimated

to generate about $41.4 million to the Alberta GDP, $26.7 million in labour income, and about 410 FTEs.

E.3.5 Annual Impacts

Annual economic impacts result from activities that are undertaken each year after the completion of the Chin Reservoir expansion.

E.3.5.1 Primary Crop Production – Direct and Backward Linked Impacts

For the total irrigated area of 46,500 acres in the expansion area, the gross sales of irrigated crop production are estimated to be $38 million annually. By comparison, the same area of dryland, generates about $10.8 million in crop production gross sales. The irrigated croplands are estimated to produce total net revenues of $12,857,570 ($276.51/acre) for the 46,500 acres, compared with $1,148,799 ($24.70/acre) under dryland conditions – about 11 times higher.

Completion of the Chin Reservoir expansion would result in an increase in the total value of irrigation production by $27.2 million. This is expected to increase the provincial GDP by $34.8 million, generate $25.6 million as labour income, and create 261 FTEs.

E.3.5.2 Primary Livestock Production – Direct and Backward Linked Impacts

Total annual sales of livestock products related to the Chin Reservoir expansion are estimated to be about $98.3 million, compared with dryland livestock sales of about $8.7 million. The $89.6 million difference between irrigated and dryland livestock production is expected to increase the provincial GDP by $62.6 million, generate $40.9 million in labour income, and create 727 FTEs.

E.3.5.3 Food Processing (Forward Linkages)

The net value (direct) of processed crop and livestock products is estimated to be about $66 million. This is expected to increase the provincial GDP by $82.6 million, generate about $30 million in labour income, and create 630 FTEs. These impacts are over and above the value of the primary irrigated crop and livestock production.

E3.5.4 Summary of Key Impacts

Table E.4 provides a breakdown of all economic impacts related to the Chin Reservoir Expansion Project.

The 3-year construction period impacts are expected to increase the provincial GDP by about $163.7 million, labour income by about $61.4 million, and create 1,528 FTEs over the 3-year construction period.

Irrigated crop and livestock production, and their associated backward and forward linkages, are expected to increase the provincial GDP by about $180 million annually, create about $96.7 million in labour income, and create 1,618 FTEs.

Increased investment in farm machinery and equipment by irrigation producers, increased irrigation income during the drought periods, and increased protection of farm and non-farm properties during overland flood events are estimated to increase the provincial GDP by about $143 million, generate about $107 million in labour income, and about 956 FTEs.

Table E.4. Summary of economic impacts related to Chin Reservoir Expansion Project.

Description	Output (Goods and Services) ($'000)				GDP ($'000)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Short-term Impacts								
Construction Expenditures	190,000	100,337	53,582	343,919	74,741	55,933	32,999	163,673
Subtotal	**190,000**	**100,337**	**53,582**	**343,919**	**74,741**	**55,933**	**32,999**	**163,673**
Periodic Impacts								
Investment in Pivot Systems	105,555	47,418	17,958	170,931	1,014	27,594	10,912	39,520
Farm Machinery and Equipment	5,052	2,269	859	8,180	48	1,321	522	1,891
Drought Mitigation	3,300	0	0	3,300	3,300	0	0	3,300
Flood Mitigation	66,853	20,227	68,846	155,927	46,024	10,732	41,837	98,593
Subtotal	**180,760**	**69,914**	**87,663**	**338,337**	**50,386**	**39,647**	**53,271**	**143,304**
Annual Impacts								
Crop Production-Direct and Backward Linkages	27,210	9,498	22,667	59,375	16,200	4,900	13,700	34,800
Livestock Production-Direct and Backward Linkages	89,445	67,650	63,271	220,366	8,700	32,100	21,800	62,600
Forward Linkages-Direct and Backward Linkages*	66,205	57,652	28,880	152,737	34,110	30,857	17,665	82,632
Sub-Total	**182,860**	**134,800**	**114,818**	**432,478**	**59,010**	**67,857**	**53,165**	**180,032**
Description	**Labour Income ($'000)**				**Employment (FTEs)**			
	Direct	**Indirect**	**Induced**	**Total**	**Direct**	**Indirect**	**Induced**	**Total**
Short-term Impacts								
Construction Expenditures	3,902	34,717	22,792	61,410	865	370	293	1,528
Subtotal	**3,902**	**34,717**	**22,792**	**61,410**	**865**	**370**	**293**	**1,528**
Periodic Impacts								
Investment in Pivot Systems	0	17,966	7,491	25,457	0	292	99	391
Specialized Farm Machinery and Equipment	0	860	359	1,219	0	14	5	19
Drought Mitigation	3,300	0	0	3,300	0	0	0	0
Flood Mitigation	42,520	5,886	28,720	77,126	102	68	376	546
Subtotal	**45,820**	**24,712**	**36,570**	**107,102**	**102**	**374**	**480**	**956**
Annual Impacts								
Crop Production-Direct and Backward Linkages*	13,600	2,600	9,400	25,600	107	30	124	261
Livestock Production-Direct and Backward Linkages*	7,935	17,546	15,419	40,900	201	328	198	727
Forward Linkages-Direct and Backward Linkages*	14,586	3,453	12,149	30,188	224	247	159	630
Subtotal	**36,121**	**23,599**	**36,968**	**96,688**	**532**	**605**	**481**	**1,618**

*Net over dryland

E.3.5.5 Total Economic Impacts

The Chin Reservoir Expansion Project, during the 50-year project life, is estimated to increase the provincial GDP by about $487 million, generate about $265 million in labour income, and create 4,102 FTEs (Table E.5).

Table E.5. Total economic impacts related to the Chin Reservoir Expansion Project.

Economic Activity	GDP	Labour Income	FTEs
Net Irrigation Crops – Direct	$16,200,000	$13,600,000	107
Net Irrigation Crops – Indirect and Induced	$18,600,000	$12,000,000	154
Net Irrigation Livestock – Direct	$8,700,000	$7,935,000	201
Net Irrigation Livestock – Indirect and Induced	$53,900,000	$32,965,000	526
Irrigation Crops and Livestock - Forward Linkages	$82,632,000	$30,188,000	630
Total Farm Level Investment	$41,411,000	$26,676,000	410
Construction of Infrastructure	$163,673,000	$61,410,000	1,528
Drought Management	$3,300,000	$3,300,000	0
Flood Mitigation	$98,593,000	$77,126,000	546
Total Economic Impacts	**$487,009,000**	**$265,200,000**	**4,102**

E.4 Fiscal Revenues

The Chin Reservoir Expansion Project is expected to annually generate about $121.9 million to the Government of Alberta (GOA) and Government of Canada (GOC), and this includes about $12.6 million in transfer payments from the GOC to the GOA. About 45% ($54.9 million) of the total fiscal revenue will be generated each year after the project comes to full operation, and the remaining 55% ($67.0 million) will be generated only during specified years during the 50-year life of the project.

E.5 Benefit Cost Analysis

Two different types of analyses were developed for the Chin Reservoir Expansion Project:

- Farm Financial Benefit-Cost Analysis (private accounting standpoint); and
- Social Benefit-Cost Analysis.

E.5.1 Farm Financial Benefit – Cost Analysis

Table E.6 summarizes the farm financial benefits related to the Chin Reservoir Expansion Project. Financial analysis of the Chin Reservoir Expansion Project was undertaken on the assumption that producers pay all on-farm development costs and the capital assets charges related to the 46,500-acre irrigation expansion area. The analysis indicates that during the 50-year project life, the total benefits to irrigation producers were estimated at about $1.83 billion, compared with total costs of about $1.83 billion. The net present value (NPV) for irrigation development on the 46,500-acre expansion area during the 50-year project life is estimated to be $1.35 million.

The analysis indicates that the financial benefit-cost ratio for the Chin Reservoir irrigation expansion is 1.00, which shows the project to be financially neutral. The internal rate of return (IRR) is 3.63%, which is slightly lower than the 4% discount rate used in the analysis. Producers would be expected to see the benefits of this investment within 27 years.

Table E.6. Financial analysis results for the Chin Reservoir Expansion Project.

Indicators	
Net Present Value	$1,353,526
Financial Benefit-Cost Ratio	**1.00**
Internal Rate of Return (%)	3.63
Return Period (Years)	27

E.5.2 Factors Affecting New Irrigation Uptake by Producers

The financial Benefit-Cost Ratio is influenced by the SMRID's $4,000/acre capital asset charge for all new irrigation development in the Chin Reservoir expansion area. Combined with the $2,000/acre capital asset charge by the RID, new irrigation producers in the 46,500-acre Chin Reservoir expansion area will need to pay about $173 million before any irrigation development takes place. Without this capital asset charge, the Cost-Benefit Ratio is 1.07, which is somewhat more financially positive.

This study assumed that full irrigation development on the 46,500-acre expansion area would take place within ten years after construction of the Chin Reservoir expansion was complete. Discussions with representative irrigation producers in southern Alberta were held to identify issues that might influence new irrigation development in the Chin Reservoir expansion area. Following are key conclusions from those discussions.

- **Acceptance of Capital Asset Charge:** Producers generally understand the need for the $4,000/acre capital asset charge and recognize there will be long-term benefits accruing from irrigation development in the Chin Reservoir expansion area.
- **Land Values:** Producers recognize that investing in new irrigation development immediately increases the value of dryland acres from about $6,500/acre to $16,000 - $20,000 per acre. This provides a significant incentive to participate in the Chin Reservoir expansion area.
- **Crop Prices:** Relatively high crop prices currently support investment in the irrigation expansion. However, most producers expect these prices to decline to more historic levels within the next 2 to 3 years.
- **Interest Rates:** Increasing interest rate charges will significantly impact annual loan payments, and some producers may delay committing to new irrigation development until they better understand interest rate trends and crop/livestock pricing.
- **RID Participation:** Large and small producers will likely participate early to take advantage of the irrigation expansion opportunity within the RID because of the $2,000/acre capital asset charge.
- **SMRID Participation:** Even with the $4,000/acre capital asset charge, producers with large irrigation land bases are more likely to participate early in the Chin Reservoir expansion area, because they have sufficient irrigation acres to support interest payments related to the new irrigation development. New and/or smaller irrigation producers may

have difficulty front-ending the funds required for the $4,000/acre capital asset charge, plus the $2,270/acre irrigation infrastructure costs.

- **Participation Rate:** Irrigation uptake in the 46,500-acre Chin Reservoir expansion area may take longer than projected in this report because of increasing interest rates, and current limits to irrigation development, which are currently set at 160 acres per producer. This policy was enacted to ensure that as many producers as possible can participate in the expansion. However, this may result in a slowdown in the rate of new irrigation development if smaller producers are unwilling to participate because of the high front-end costs and increasing interest rates.

E.5.3 Social Benefit-Cost Analysis

The social benefit-cost analysis was undertaken using benefits related to all economic entities in the province of Alberta. Benefits accruing to all regions outside the boundaries of the province were excluded. Results indicate that the Chin Reservoir Expansion Project would generate an NPV of 389 million (direct benefits), and $1.2 billion if direct, indirect, and induced benefits are considered (Table E.7).

Table E.7. Estimated present value of societal benefits and costs related to the Chin Reservoir Expansion Project.

Particulars	Direct Benefits and Costs	Direct, Indirect & Induced Benefits/ Costs
Benefits		
Net Benefits from Crop Production	$221,118,456	$418,213,164
Net Benefits from Livestock Production	$114,026,895	$605,296,546
Benefits from Drought Mitigation	$6,125,558	$6,125,558
Food Processing (Forward Linkages) Benefits	$227,836,983	$271,503,986
Benefits to Irrigation Equipment Dealers	$0	$772,741
Benefits to Specialized Machinery/Equipment Dealers	$0	$50,055
Benefits of Mitigated Flood Damage	$155,919,525	$282,818,656
Total Benefits	**$725,027,417**	**$1,584,780,706**
Construction Costs	$177,489,901	$177,490,000
Investment in Pivot Systems & Specialized Farm Machinery	$158,638,696	$158,638,696
Total Costs	**$336,128,597**	**$336,128,696**
Net Present Value	$388,898,820	$1,248,652,008

The Benefit-Cost Ratio related to direct benefits is estimated to be 2.16 (Table E.8), and increases to 4.78 if direct, indirect, and induced benefits are considered.

The Benefit-Cost Ratio indicates that undertaking the Chin Reservoir Expansion Project is economically positive. The IRR increases from 10.5% (direct benefits) to 19.6% (direct, indirect, and induced benefits). The payback period shows that Alberta society will realize the benefits of this investment within 14 years (if direct benefits are included) or 9 years (if all benefits are included).

Conclusion – The Chin Reservoir Expansion project is economically positive for the Alberta economy.

Table E.8. Economic indicators for the Chin Reservoir Expansion Project.

Indicators	Direct Benefits and Costs	Direct, Indirect and Induced Benefits
Net Present Value	$388,898,820	$1,248,652,008
Benefit-Cost Ratio	**2.19**	**4.78**
Internal Rate of Return (%)	10.7	19.9
Return Period (Years)	14	9

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CHAPTER 1.0 INTRODUCTION

Chin Reservoir is an off-stream reservoir in the St. Mary River Irrigation District (SMRID), approximately 30 km east of Lethbridge, Alberta, and 15 km south of Taber, Alberta (Figure 1). The reservoir was commissioned in 1954 and is the largest water storage reservoir in the SMRID, with a live storage capacity of 168,120 acre-feet (AAF, 2021).

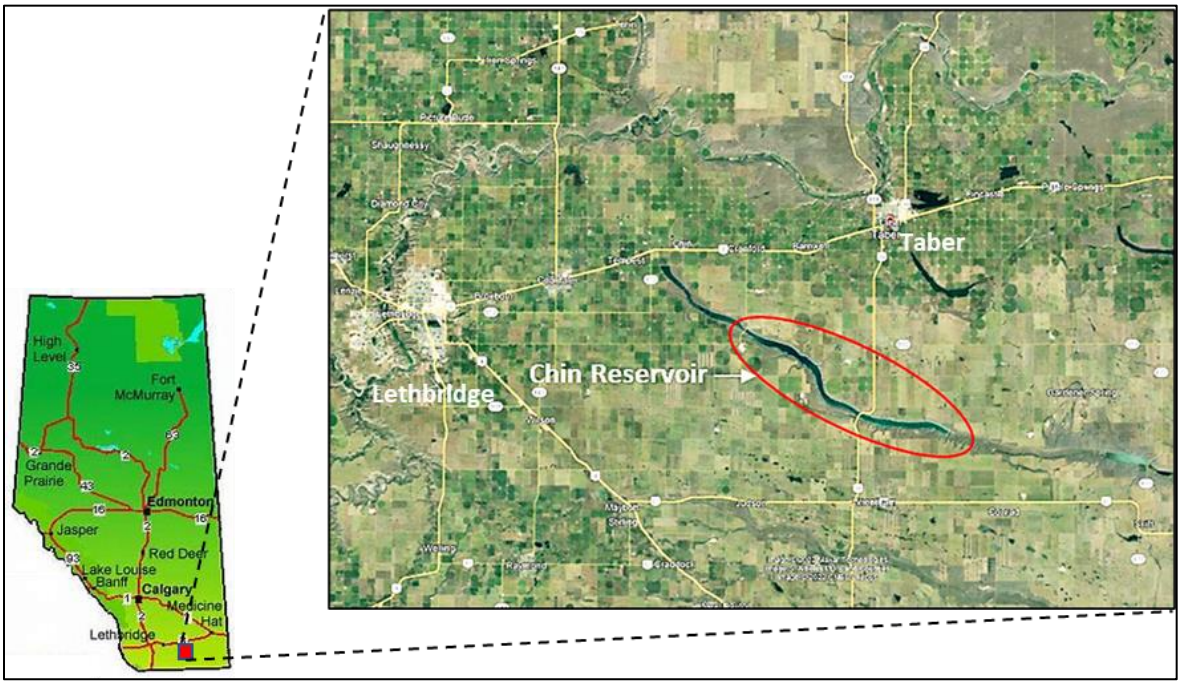

Figure 1. Location of Chin Reservoir.

Chin Reservoir is a key water storage reservoir for irrigation development within the Raymond Irrigation District (RID), SMRID, and the Taber Irrigation District (TID) (Figure 2). In 2022, the TID amalgamated with the SMRID, and the amalgamated district will be known as the SMRID. As a result, the remainder of this report will mainly refer to the RID and SMRID.

This reservoir provides irrigation water to some of the most diverse, and intensively farmed irrigated lands in Alberta. More than 60 different irrigation crops are grown within this region of the province, including specialty crops such as potatoes, sugar beets, seed canola, dry beans, and several varieties of fresh vegetables. An economic study carried out in 2021 indicated that irrigation development in the irrigation districts generated about $5.4 billion to the provincial GDP, $3.2 billion in labour income, and about 46,000 FTEs. The study also showed that the region and province received 80% of the benefits from irrigation development, and irrigation producers received 20%. This study assesses the socio-economic impacts of expanding the size of Chin Reservoir and adding new irrigation acres in the RID and SMRID.

1.1 Agricultural Development

Primary agricultural production in Alberta is practiced on about 50 million acres, which is about 33% of the total land area of the province. There were 41,505 farms in Alberta in 2021 (Statistics Canada, 2021a), and this is a slightly higher number than the 40,638 farms reported in 2016

(Statistics Canada, 2016). This is a reversal to the continued decline in the number of farms that occurred from 2001 to 2016 – from 53,652 in 2001 to 40,638 in 2016 (Statistics Canada, 2021a). However, the number of farm operators continues to decline, from 76,195 in 2001 to 57,201 in 2021. The average age of producers continues to increase, from 49.9 years in 2001 to 56.5 years in 2021 (Statistics Canada, 2021a).

Crop production makes up about 54% of the farm types, while animal production makes up about 46%. Nearly all agricultural production in Alberta is practiced under dryland conditions, where producers depend on natural precipitation for their crop and livestock production. Irrigation development, which predominantly takes place in portions of southern Alberta, makes up about 4.4% of the total cultivated agricultural land in the province.

Most irrigation development is in the organized irrigation districts, which are located within a rough triangle between Calgary, Lethbridge, and Medicine Hat (Figure 2). Water supply for the irrigation districts is diverted from the Bow and Oldman River Sub-basins and stored in more than 50 on-stream and off-stream reservoirs. The assured water supply allows irrigation producers to grow more than 60 crop varieties in Alberta's irrigation districts, including 29 specialty crops (AAF, 2021). This compares with about 25 crop varieties that are grown under dryland conditions in Alberta. The increased diversity of irrigated crop production led to the establishment of several food processing companies in Alberta, which process crops such as potatoes, fresh vegetables, dry beans, seed canola, plus hogs and feeder cattle. These products are shipped to consumers in Canada and to markets in North America and the world.

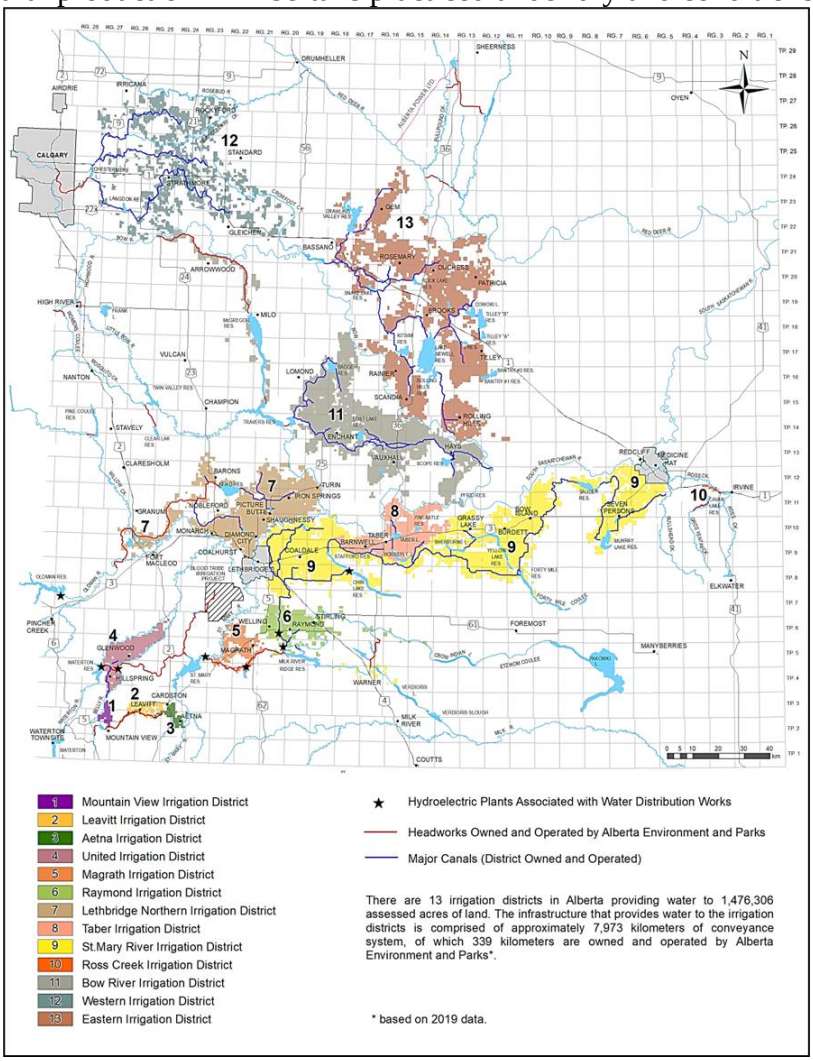

Figure 2. Location of the 13 irrigation districts in southern Alberta prior to the amalgamation of the Taber and St. Mary River irrigation districts.

1.2 Irrigation Expansion in Alberta

Irrigation in southern Alberta began in the 1890s and has continued to expand since then at varying rates. In the past the uptake of irrigation was based on factors such as changes in the climate, drought events, improvements in irrigation technology, and changes in demand for specific crops and livestock. A significant increase in the adoption of irrigation took place from 1980 to 2000 due in part to the introduction of pivot irrigation systems (Figure 3), prolonged dry weather conditions and, most importantly, the opportunity for irrigation producers to grow high value specialty crops. It was during this period that two new potato processing companies came to Alberta, plus seed canola and dry bean processing companies, and expansion of the cattle feeding industry.

Figure 3. Pivot irrigation system irrigating canola.

Irrigation acres increased by approximately 24% (from 1,037,173 to 1,300,982 acres) during this period. From 2000 to 2010, irrigation expansion slowed somewhat, with only about a 5% increase in the total irrigation acres (1,300,982 to 1,364,965). This period was wetter and new markets for established irrigation crops were limited. The second and probably most important reason for the limited growth in irrigation acres was because irrigation districts had almost reached their 1991 legislated limits for expansion.

However, near the end of this period, irrigation districts were able to expand by demonstrating water-use efficiency gains through improvements to water supply infrastructure and on-farm irrigation systems. This allowed irrigation districts, through a plebiscite vote of their irrigation water users, to increase their expansion limits. From 2010 to 2020 the number of irrigation acres again increased substantially, with approximately 10% more acres added to the assessment role of the districts (1,364,965 to 1,496,200). This increase was driven by improved markets, increased food processing opportunities, and the drive by producers to optimize their agricultural output.

During this latest period of growth, significant increases in the value of dryland and irrigation land took place. The value of irrigation land, with an existing modern irrigation system, has increased to approximately $16,000/acre during the past 10 years – an increase of more than 100%. The price of dryland, which has the potential to be irrigated, is priced at approximately $6,500/acre, which is also an increase of close to 100% in the past 10 years. Discussions with corporate and sole-proprietor irrigation producers indicate that the high cost of land has made it difficult to generate a reasonable return on investment, if assessed on a parcel-by-parcel basis. There are few crops grown in Alberta that provide sufficient revenue to cover the investment cost for the land. And when factoring in other farm equipment costs, the net return on investment is increasingly negative. As a result, the number of sole-proprietor irrigation producers is decreasing, and larger family corporate farms, with sufficient land bases to establish equity, are

increasing. These larger operations, because of their size, can work more closely with specialty crop processors to grow crops such as potatoes, seed canola, sugar beets, dry beans, and fresh vegetables on large-scale rotations. This allows the producers to maximize the revenue generated on the acres they farm.

1.3 Urban and Rural Population

Urban and rural population in and adjacent to the irrigation districts generally increased between 2016 and 2021 (Statistics Canada, 2021d). Table 1 provides an overview of population changes for towns and rural municipalities in proximity to the RID and SMRID. For the three Census Divisions in the region, Census Division 1 showed a slight decline in population from 2016 to 2021, while Census Divisions 2 and 3 show an average increase of about 4.5%.

Table 1. Population changes for towns and rural municipalities in proximity to the RID and SMRID.

Place	Year		Change (%)
	2016	2021	
Census Division 1	82,627	82,513	-0.1
Census Division 2	16,9513	17,8513	+5.2
Census Division 3	38,956	42,768	+9.8
Barnwell Village	947	978	+3.3
Bow Island	1,983	2,036	+2.7
Cardston	4,481	4,856	+8.4
Coaldale	8,331	8,771	+5.3
Foremost	541	630	+16.5
Fort MacLeod	2967	3,297	+11.1
Forty Mile County*	3,581	3471	-3.1
Lethbridge (City)	92,729	98,406	+6.1
Lethbridge (County)*	10,237	10,120	-1.1
Medicine Hat	63,260	63,271	0.0
Milk River	827	824	-0.4
Raymond	3,713	4,199	+13.1
Stirling	978	1,164	+19
Taber Town	8,428	8,862	+5.1
Municipal District (MD) of Taber*	7,098	7,447	+4.9
Vauxhall	1,222	1286	+5.2
Vulcan County*	3,984	4,237	+6.4
Warner (Village)	373	364	-2.4
Warner (County)*	3,942	4,290	+8.8

* Denotes rural municipalities

1.4 Study Objectives

This study assesses socio-economic impacts of expanding the size of Chin Reservoir and adding new irrigation acres in areas associated with the RID and SMRID. This study assessed the overall benefits of the Chin Reservoir expansion by creating two regional economies: one that includes irrigation and one that is dryland. Dryland production is considered the current baseline economy in the proposed expansion area, and irrigation production is the economy resulting from the proposed Chin Reservoir expansion. These two economies were assessed and

contrasted to reveal the potential value of the expanded irrigation area related to the proposed Chin Reservoir expansion project.

This study did not assess the economic impacts of climate change. A modelling study for that component of the overall Chin Reservoir Expansion Project was being carried out by Watersmart Solutions Ltd. concurrently with our study. Discussions between our teams allowed us to assume that future climate change scenarios would not negatively impact the potential development of the increased irrigation acres (46,500 acres) identified in this study.

1.5 Study Components

This study links the socio-economic impacts of the proposed Chin Reservoir Irrigation expansion. Some of these impacts are supported by the irrigation expansion directly, while others are more indirect. The study methodology includes a combination of qualitative and quantitative methods. The following are key components of the study.

- **Economic Model Development:** The following computer models were developed and used to conduct the required economic analyses for this study (Chapter 2).
    - Farm Level Simulation Model: Estimates the farm level profitability of irrigation expansion in the region.
    - Alberta Input-Output Model: Analyzes the economic impacts on other sectors of the Alberta economy.
    - Fiscal Impact Analysis Model: Assesses impacts on government revenues and costs resulting from the expanded irrigation activity.
    - Benefit-Cost Analysis Models: Includes the Farm Financial Benefit-Cost Model and Societal Benefit-Cost Model.
- **Economic Analyses –** Were carried out to assess the value of the proposed Chin Reservoir Expansion Project for:
    - On-farm producer investments (Chapter 2)
    - Primary agricultural (crops and livestock) production, including direct, backward linkages and forward linkages (Chapter 3);
    - Flood mitigation (Chapter 4);
    - Drought mitigation (Chapter 4);
    - Hydropower generation (Chapter 4);
    - Recreation enhancement (Chapter 4);
    - Government fiscal revenues (Chapter 5);
- **Cumulative impacts:** Summarized the total cumulative economic impacts of proposed Chin Reservoir Expansion Project (Chapter 6);
- **Cost-Benefit Analyses:** Assessed on-farm financial cost-benefits, and societal cost-benefits related to the proposed Chin Reservoir Expansion Project (Chapter 7).
- **Study Conclusions:** (Chapter 8)

CHAPTER 2 STUDY AREA AND METHODS

Proposed expansion of the existing Chin Reservoir is being considered to improve irrigation water supply for existing irrigation development in the region, allow for additional irrigation development to meet ongoing demand by dryland producers associated with the RID and SMRID and provide stormwater storage capacity to reduce the impacts of future flood events (Figure 4). An average of 489,227 acres of land were irrigated within these three irrigation districts from 2011 to 2020 (Appendix A, Table 43).

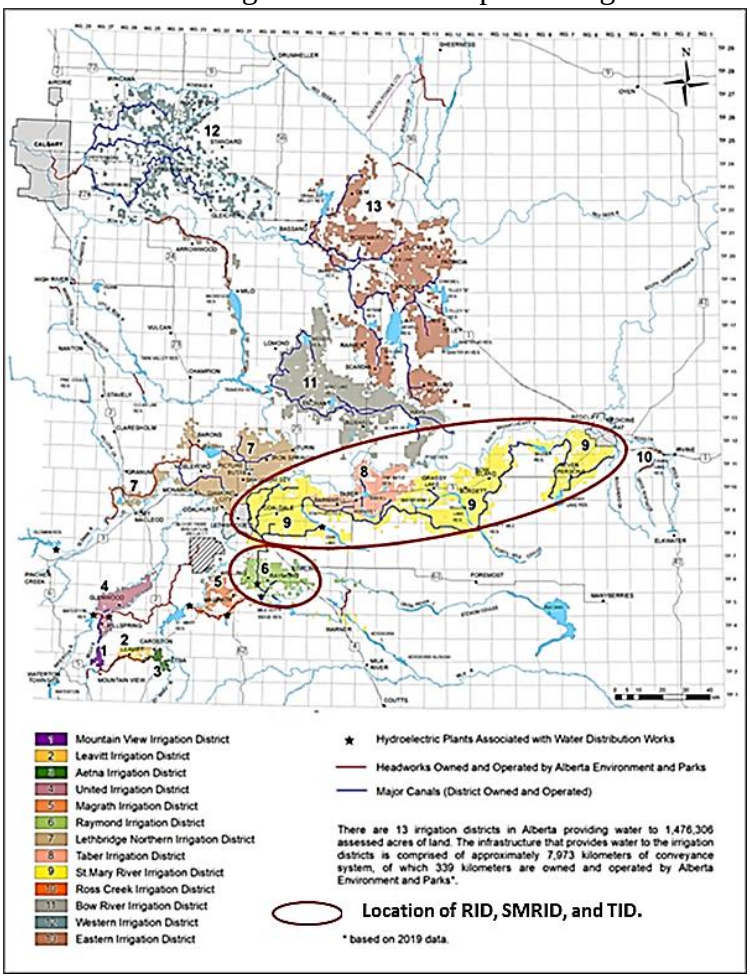

Figure 4. Location of RID, SMRID, and TID.

2.1 Farm Characteristics

Possible expansion areas may take place in several counties associated with the RID and SMIRD (TID and SMRID combined) (Figure 4), including Cypress County, County of Forty Mile, MD of Taber, Lethbridge County, Warner County, and Cardston County. The MD of Taber and Lethbridge County currently have significant areas of irrigated land, while the remaining counties contain predominately dryland farms.

Table 2 shows the number of farms in each county, and the change in the number of farms from 2016 to 2021 (Statistics Canada, 2021a). Four of the six municipalities experienced an increase in the number of farms in 2021, which is similar to provincial results. The MD of Taber and the County of Forty Mile experienced slight reductions in the number of farms from 2016 to 2021.

Table 2. Number of farms in counties associated with the Chin Reservoir expansion area.

County /MD	Cypress		Forty Mile		Taber		Lethbridge		Warner		Cardston	
	Year	Year	Year	Year	Year	Year	Year	Year	Year	Year	Year	Year
	2016	2021	2016	2021	2016	2021	2016	2021	2016	2021	2016	2021
# of Farms	805	842	498	490	633	610	906	1014	462	489	475	528

Table 3 provides an overview of total farm revenues (Statistics Canada, 2021b) and farm ownership (Statistics Canada, 2021c) for these municipalities. From 26 to 51% of farms in these

counties reported annual total revenues less than $100,000. Discussions with leading producers in the region indicate that farms with total revenues less than $100,000/year are not considered financially viable as a stand-alone operation. Given current increases in input costs (fertilizer, seed, herbicides, machinery), this revenue figure may be considered low. An average of about 10% of the farms in these six counties had total farm revenues that exceeded $2.0 million. This is significantly above the 2020 Alberta average, which shows that 4.0% of farms in the province had at least $2.0 million in revenue and accounted for 61.7% of total farm revenues in Alberta (St. Pierre and McComb, 2022).

Table 3. Farm proprietorship and proportional total farm revenue for counties associated with the RID and SMRID.

Cypress County – 842 Farms (2021)				**County of Forty Mile – 490 Farms (2021)**			
Farm Revenue ($)	**% of Total**	**Proprietorship**	**No.**	**Farm Revenue ($)**	**% of Total**	**Proprietorship**	**No.**
<$100,000	50.7	Sole Proprietor	426	< 100,000	25.7	Sole Proprietor	174
100,000 to 500,000	31.0	Partnership	164	100,000 to 500,000	32.0	Partnership	44
500,000 to 1 Million	9.0	Family Corporation	223	500,000 to 1 Million	32.4	Family Corporation	245
1 to 2 Million	4.8	Non-Family Corporation	27	1 to 2 Million	12.2	Non-Family Corporation	24
>2 Million	4.6	Other	2	>2 Million	13.1	Other	3
MD of Taber – 610 Farms (2021)				**Lethbridge County – 1014 Farms (2021)**			
Farm Revenue ($)	**% of Total**	**Proprietorship**	**No.**	**Farm Revenue ($)**	**% of Total**	**Proprietorship**	**No.**
< 100,000	34.7	Sole Proprietor	246	< 100,000	42.0	Sole Proprietor	436
100,000 to 500,000	30.0	Partnership	92	100,000 to 500,000	25.7	Partnership	163
500,000 to 1 Million	9.3	Family Corporation	247	500,000 to 1 Million	8.2	Family Corporation	377
1 to 2 Million	10.2	Non-Family Corporation	22	1 to 2 Million	10.2	Non-Family Corporation	35
>$2 Million	15.7	Other	3	>2 Million	14.1	Other	0
County of Warner – 489 Farms (2021)				**Cardston County – 528 Farms (2021)**			
Farm Revenue ($)	**% of Total**	**Proprietorship**	**No.**	**Farm Revenue ($)**	**% of Total**	**Proprietorship**	**No.**
< 100,000	43.2	Sole Proprietor	240	< 100,000	61.1	Sole Proprietor	304
100,000 to 500,000	32.1	Partnership	72	100,000 to $500,000	22.5	Partnership	109
500,000 to 1 Million	10.8	Family Corporation	162	500,000 to 1 Million	6.6	Family Corporation	110
1 to 2 Million	6.1	Non-Family Corporation	14	1 to 2 Million	4.2	Non-Family Corporation	5
>2 Million	7.8	Other	1	>2 Million	5.5	Other	0

For all rural municipalities, farm proprietorship is mainly through a partnership and/or family corporation arrangement. This appears to follow the provincial trend, which shows a declining number of farms under a sole proprietorship (-12.8% from 2011 to 2016), and an increase in

farm corporations (+32.9% from 2011 to 2016) (AAFRED, 2021). This data is supported by discussions with leading producers associated with the RID and SMRID, who consistently indicate that high costs for land and farm inputs (machinery, seed, herbicides, fertilizer) make it increasingly difficult for sole proprietors to continue farming. Partnerships and/or family corporations are becoming increasingly popular, where land and input costs are shared to optimize crop and livestock production.

2.2 Socio-Economic Methodologies

This study assessed the overall benefits of the Chin Reservoir expansion by creating two regional economies: one that includes irrigation and one that is dryland. The dryland production is considered the current baseline economy in the proposed expansion area, and the irrigation production is the proposed economy resulting from the Chin Reservoir expansion. These two economies were assessed and contrasted to reveal the potential value of the expanded irrigation area related to the proposed Chin Reservoir expansion project.

This study links the total economic impacts of the Chin Irrigation expansion. Some of these impacts are supported by the irrigation expansion directly, while others are more indirect. The study methodology includes a combination of qualitative and quantitative methods. An overview of the scope of the analysis is presented in Table 4.

The Chin Reservoir Expansion Project influences three types of change to the economy.

- **Direct Impacts –** Money spent by irrigation producers on goods and services.
- **Indirect Impacts –** Economic activities triggered by purchases of goods and services from other local businesses (fertilizer, herbicides, banking services, and other professional services).
- **Induced Impacts –** Expenditures of income, which results in higher demand for goods and services.

The following impacts were assessed in this study.

- **Direct Impacts of Farm-Level Irrigation Activities –** Direct contributions were measured using the following two criteria:
    - Value of sales (measured as gross farm income); and
    - Employment.
- **Indirect Impacts of Further Value-Added Activities (Generated Through Forward Linkages) –** Relates to additional economic activity created by provincial industries through further processing of products from the irrigation expansion area.
- **Induced Impacts (Created Through Backward Linkages) –** Businesses that sell goods and services to irrigation producers see additional demand for their products, and therefore invest money to hire more people to meet this demand. This leads to more money being spent on goods and services within the province of Alberta, leading to an increase in economic activity.
- **Induced Impacts (Created Through Forward Linkages) –** Relates to the additional economic activity created by the industries (above) that pay wages and salaries to workers, and dividends to shareholders. When these additional incomes are spent, additional demand for local goods and services is supported, thereby leading to an increase in provincial economic activity.

- **Other Quantitative Impacts –** These include benefits to municipalities, industries, power generation, recreation, and the public-at-large. These impacts were assessed quantitatively using a combination of market and non-market methods.

Table 4. Summary of assessments of economic benefits related to the Chin Reservoir Expansion Project.

Stakeholder	Direct Impacts	Indirect Impacts	Employment and Induced Impacts	Qualitative Assessment
Producers	Improvement in net income of producer			
Supply Firms to Irrigation Producers	Improvement in net income of business	Backward indirect linked impacts	Backward induced impacts (including employment)	
Firms Purchasing Goods from Irrigation Producers	Improvement in net income of the business	Backward indirect linked indirect impacts	Backward induced effects (includes employment)	
Government of Alberta (GOA)	Net fiscal revenue to Alberta	Backward linked impacts		
Government of Canada (GOC)	Cost-sharing of irrigation infrastructure			
Stakeholders	Quantitative assessment			• Municipalities and other non-irrigation water users. • Irrigation producers (drought mitigation). • Recreation users. • Electricity users.

In addition to improvements in the incomes of businesses (and people), irrigation development also brings changes in the economic status of the GOA and GOC. These institutions, through taxes and levies, increase their fiscal revenues, and this results in higher expenditures on public goods and improve the well-being of the residents.

Major stakeholders receiving benefits from the expanded reservoir include the following.

- Existing irrigation producers wishing to expand their irrigation land base to take advantage of enhanced contracts with food processors.
- Dryland producers wishing to develop irrigation to increase crop diversification and revenues.
- Existing irrigation and dryland producers that do business with new irrigation producers.
- Industries that sell farm inputs to irrigation producers.
- Industries that purchase products from irrigation producers for processing.

- Local businesses that directly or indirectly depend on the irrigation industry.
- Rural residents that use irrigation works for water supply.
- GOA and GOC.
- Recreation users.

2.2.1 Computer Model Development

A combination of qualitative and quantitative methods of analysis was utilized to assess the socio-economic impacts of the Chin Reservoir Expansion Project. The qualitative methods were based on established analytical systems employed in other economic studies. The quantitative methods utilized numeric and statistical data, including development of four computer models (Figure 5).

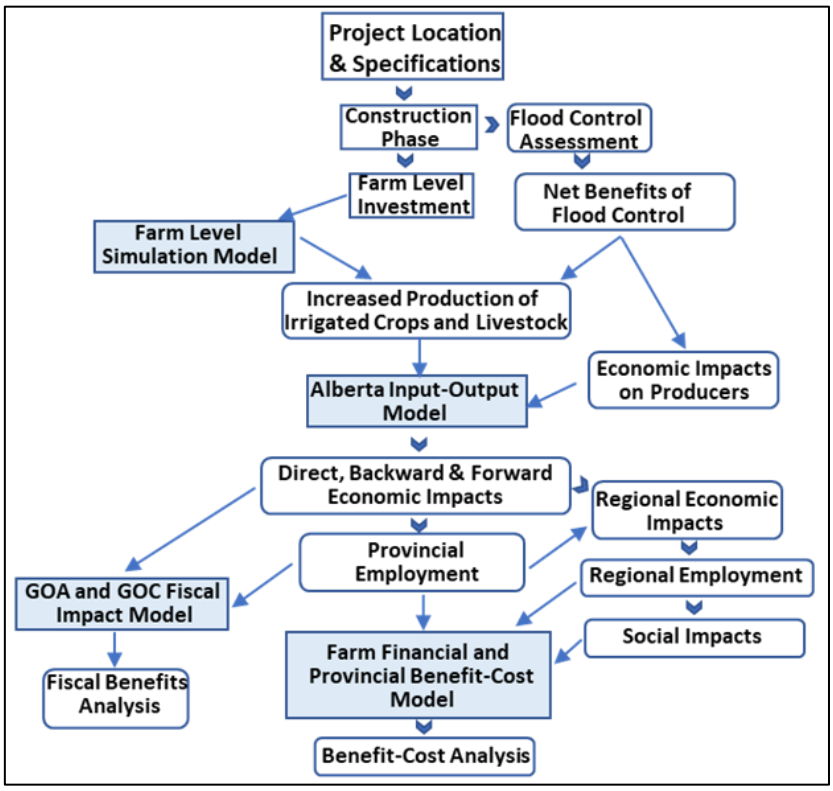

Figure 5. Methodology overview for evaluation of economic impacts of Chin Reservoir Expansion Project.

Farm Level Simulation Model: This model examines the farm level profitability of irrigation expansion in the region. The analyses considered crop mix, location of new acres, and irrigation adoption rates, combined with economic analyses (cost, prices and yield) of various crops and livestock enterprises in the region. The model estimates the total farm level income (benefits) generated by the potential Chin Reservoir expansion.

The model consists of eight worksheets, which are linked where applicable.

- **New Irrigation Adoption:** Identifies the targets for irrigation development related to the Chin Reservoir expansion areas associated with the RID and SMRID.
- **Area:** Identifies the current average irrigated area and crop varieties grown within the RID and SMRID for 2011, 2015, and 2020.
- **Crop Yields:** Identifies the yield of selected crops grown in the project area, under irrigated and dryland conditions. Alberta Financial Services Corporation (AFSC) yield data for Risk Areas 2, 3, and 4 were used to represent the irrigated and dryland crops grown in the RID and SMRID regions. Where regional data is not available, provincial yield data may be used.
- **Cost of Production:** Identifies the cost of production for crops under irrigated and dryland conditions. Data from the 2021 study "Economic Value of Alberta's Irrigation Districts" (Acera Consult Inc., 2021) was adapted for this study.

- **Net Revenue Crops:** Data on cropped area, yields, and prices were used to determine estimated gross and net revenues generated from crops produced under irrigated and dryland conditions in the Chin Reservoir expansion area.
- **Net Revenue Livestock:** Determines the net revenue generated from livestock production in the study area under irrigated and dryland conditions.
- **Farm Income Irrigation:** It was estimated that full irrigation development in the 46,500-acre expansion area take place over 10 years, and the total project period was estimated to be 50 years. Crop and livestock revenues were converted into present value using a discount rate of 4%.
- **Farm Income Dryland:** Farm income and related expenditures are provided for dryland crops and livestock for the 50-year project period, for comparison to the irrigation development.

Additional information on this model is provided in Appendix B.

Alberta Input/Output Model: The economic impacts on other sectors of the Alberta economy were estimated using an established input-output model. This model used data from the Farm Level Simulation Model and supplemented by other sets of transactional information from irrigation and other sectors. The Alberta Input/Output Model is based on a disaggregated transactions matrix created by Statistics Canada. Since the matrix for public consumption is only available at a highly aggregated level, further disaggregation for the irrigation and dryland sector, and the agricultural processing sector was carried out using a combination of expert opinion and available secondary data. The base transactions matrix for 2016, purchased from Statistics Canada, was used to populate this model. More information on this model is provided in Appendix C.

GOA and GOC Fiscal Impact Analysis Models: These models assessed impacts on government revenues and costs resulting from the expanded irrigation activity. This model assesses information from the Farm Level Simulation Model and the Alberta Input/Output Model. Changes in the regional economy, as reflected by the above two models, were used to make estimates of changes in government revenues and expenditures. Where necessary, these results were supplemented with known policy decisions and other factors.

Benefit-Cost Analysis Models: Two models were employed to assess:

- The Farm Financial Benefit-Cost related to the Chin Reservoir Expansion Project; and
- The Societal Benefit-Cost of developing the Chin Reservoir Expansion Project.

2.2.2 Assessment of Forward Linkages

Forward linkages exist when one firm sells its product to another firm for the purpose of adding value to the final product. For irrigation, there are two types of forward linkage examples.

- Irrigation producers sell grain and forage to other producers (irrigation and dryland) in Canada and overseas, creating additional benefits to the region through expansion of livestock production.
- Major forward linkages exist between irrigation producers and the agricultural processing sector, particularly the meat slaughtering and processing industry. Other industries were also included in this category of forward linkages and were identified using Statistics Canada data

and expert opinion. This information was used in the Alberta Input/Output Model to determine additional benefits to Alberta. Benefits were measured in terms of additional income and gross domestic product generated by these firms resulting from the above transactions.

2.2.3 Assessment of Backward Linkages

Every industry depends on goods and services that are bought from other firms in the region or outside the region. These industries will see expanded demand for their goods and services because of irrigation. Irrigation activities promote additional economic benefits over dryland activities. These irrigation impacts were estimated using the Alberta Input/Output Model.

2.2.4 Assessment of Irrigation Infrastructure

Irrigation infrastructure related to the RID and SMRID is currently valued at about $1.25 billion (AAF, 2021). Operation, maintenance, and replacement of this infrastructure are ongoing requirements. The Chin Reservoir expansion will result in the addition of new infrastructure that may require additional operation and maintenance.

In the past, the GOA provided significant cost-shared funding to assist irrigation districts with rehabilitation and upgrading of water storage and distribution infrastructure. This funding has declined over the past decade, and irrigation districts are starting to use long-term loans through the Canada Infrastructure Bank for large projects such as the Chin Reservoir Expansion Project.

Irrigation benefits to the GOA and GOC related to the Chin Reservoir expansion were estimated through the Alberta Government Fiscal Impacts Model, which was linked to the Alberta Input/Output Model. Goods, services, and manpower costs are involved in these activities, which generate benefits to Alberta. Although the above infrastructure will be developed primarily for irrigation, spin-off benefits were assessed. These include the following.

- **Processing and Manufacturing Sector:** Irrigation development could lead to expanded or additional livestock and crop processing in Southern Alberta. This benefit was assessed using the Alberta Input-Output Model.
- **Recreation:** Assessed current and potential recreational activities to residents in the region related to the Chin Reservoir expansion.
- **Flood Mitigation:** Assessed the potential benefits of the Chin Reservoir Expansion project to reduce the impacts of floods on agriculture producers, businesses and residents.
- **Climate Change:** This study did not assess the economic impacts of climate change. A modelling study for that component of the overall Chin Reservoir Expansion Project was being carried out by Watersmart Solutions Ltd. concurrently with this study. Discussions between our teams allowed us to assume that future climate change scenarios would not negatively impact the potential development of the increased irrigation acres (46,500 acres) identified in this study.

2.2.5 Agricultural Benefits

Several other agriculture activities may benefit, either directly or indirectly, from the Chin Reservoir Expansion project

- **Dryland Producers:** Cow/calf operators in the prairie provinces and Montana depend on feedlots associated with irrigation districts to purchase calves. Feed grain for the cattle feeding industry is also purchased from rainfed producers in these regions.
- **Drought Mitigation:** Irrigation is recognized as having a significant impact related to risks associated with climate-induced water shortages in Canada's South Saskatchewan River Basin (AAFC, 2014). A qualitative and quantitative assessment was carried out to compare the incidences and impacts of drought resiliency in dryland areas and the Chin Reservoir expansion areas associated with the RID and SMRID.

2.2.6 Non-Agricultural Benefits

Non-agricultural activities also benefit directly or indirectly from the operations carried out in the RID and SMRID.

Rural Development: Irrigation provides several types of non-agricultural benefits of irrigation.

- Irrigation development attracts new businesses, which will lead to increased regional and rural economic development.
- The availability of a qualified, stable workforce helps attract new industries to the region.
- Communities associated with irrigation are more stable in terms of population growth, industrial development, and increased tax base.

Enhanced Habitat Development: This study did not attempt to assess the potential for development of additional wildlife habitat to replace and possibly enhance existing habitat impacted by the Chin Reservoir expansion. This work was carried out under a separate contract by Klohn Crippen Berger Ltd.

Renewable Energy Production: The RID and SMRID, through Irrican Power Ltd., operates hydroelectric power plants with a generating capacity of almost 39 megawatts of clean, renewable electricity, which helps reduce the impacts of thermal power generation in Alberta. These plants also generate additional revenue for the Irrigation Districts. The potential impacts of the Chin Reservoir Expansion Project on revenues were assessed, using information from Irrican Power Ltd.

CHAPTER 3.0 FARM-LEVEL CROP AND LIVESTOCK DEVELOPMENT

Modelling work carried out by WaterSmart Solutions Ltd. (2021) indicated that expansion of Chin Reservoir could support up to 63,333 new acres of irrigated land. Assessments by the RID and SMRID concluded that a somewhat more conservative number of about 46,500 acres of new irrigated land related to the reservoir expansion would be considered for the Chin Reservoir Expansion Project.

The Farm Level Simulation Model was used to estimate the economic changes at the farm level, by converting from dryland farming to irrigation farming in the 46,500-acre Chin Reservoir expansion area. It estimates the relationship between irrigated production and livestock numbers, economics of crop and livestock production, and overall returns to producers by investing in the irrigation expansion.

3.1 New Irrigation Development

It is estimated that the Chin Reservoir expansion will allow for an area of 46,500 acres of new irrigation development. Of this total, 6,500 acres are proposed to be allocated to the RID and the remaining 40,000 acres to be distributed throughout the SMRID. Based on our evaluations, it is recommended that the irrigation expansion take place in four areas of land located within or adjacent to the RID and SMRID.

- **Area 1:** Includes 11,500 acres of potential irrigation land upstream of the proposed expanded Chin Reservoir (includes RID - 6,500 acres and SMRID West – 5,000 acres.
- **Area 2:** Includes 16,000 acres of potential irrigation land served directly from the proposed Chin Reservoir expansion.
- **Area 3:** Includes 9,000 acres of potential irrigation land downstream of Chin Reservoir in the Taber-Grassy Lake area. Most of the water is expected to come off the main canal as infill potential is limited.
- **Area 4:** Includes 10,000 acres of potential irrigation land downstream of Chin Reservoir in the Bow Island to Medicine Hat area. Most of the water is expected to be delivered from the main canal.

3.1.1 Crop Mix

The selected irrigated crop mix was based on an assessment of existing and future crop production in the four proposed expansion areas and included: Cereals – 35%; Forages – 27%; Oilseeds – 15%; and Special Crops – 24% (Table 5). A detailed breakdown of the specific irrigation crops used for the assessment is shown in Table 43, Appendix A (RID and SMRID) and Table 44, Appendix B.

Table 5. Projected irrigation crop mix related to the Chin Reservoir expansion.

Irrigated Crop Mix (46,500 acres)								
Expansion Area (acres)	**Cereals**		**Forages**		**Oilseeds**		**Special Crops**	
	%	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**	**Acres**
Area 1 - 11,500	32	3,630	35	4,070	20	2,260	13	1,540
Area 2 - 16,000	37	5,920	22	3,520	16	2,560	25	4,000
Area 3 - 9,000	32	2,880	26	2,340	10	900	32	2,880
Area 4 - 10,000	37	3,700	27	2,700	10	1,000	26	2,600
Total - 46,500	35	16,130	27	12,630	15	6,720	24	11,020

* May not add to exactly 100% because of rounding.

The grouping of crop varieties grown under dryland production used provincial data, since specific regional data were not available. The estimated dryland crop mix is shown in Table 6. For the dryland area, cereals, forages, and oilseeds dominate, with a relatively small area devoted to specialty crops. A detailed breakdown of specific dryland crops used for this assessment is shown in Table 45, Appendix B.

Table 6. Dryland crop mix related to Chin Reservoir expansion.

Dryland Area Crop Mix									
Cereals		**Forages**		**Oilseeds**		**Special Crops**		**Total**	
%	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**	**Acres**	**%**	**Acres**
36	16,553	37	16,974	23	10,462	5	2,511	100	46,500

* May not add to exactly 100% because of rounding.

3.1.2 Chin Reservoir Expansion Capital Investments

Producers interested in converting dryland to irrigation as part of the Chin Reservoir Expansion Project are required to make two capital investments before producing their first irrigation crop. These include a capital asset charge, and a capital investment expense.

3.1.2.1 Capital Asset Charge

Irrigation districts charge producers wishing to add new irrigation acres a capital assets charge for every acre added to the irrigation district roll. This charge ensures that producers adding new acres fairly compensate existing irrigation producers who have helped pay for the existing water delivery infrastructure. The SMRID currently charges new irrigation producers a capital asset charge of $4,000/acre, and the RID charges new irrigation producers $2,000/acre. The total capital asset charge for the proposed expansion area is estimated to be $173,005,000 (Table 7). For this study, it was assumed that each pivot irrigation system will consist of the basic pivot circle system, which irrigates about 132 acres in each 160-acre quarter section. If producers choose to install corner-arm systems on their pivots, the effective irrigation area can increase to about 155 acres (97% of a 160-acre quarter section). It is assumed that over time producers will irrigate the entire 46,500 acres within the expansion area, through the addition of pivot corner arm systems on new or existing pivots.

3.1.2.2 Capital Equipment Cost

Dryland producers selected to participate in the Chin Reservoir expansion will need to purchase all equipment required to sustainably convert their dryland farms into fully functioning irrigation farms. Based on discussions with irrigation dealers in southern Alberta, the capital cost for on-farm irrigation development is estimated to be about $2,270/acre. The total capital equipment cost for the four expansion areas is estimated to be $105,605,000 (Table 7).

Participating producers in the 46,500-acre Chin Reservoir irrigation expansion area will have to pay a combined total of $278,610,000 (Table 7) in capital asset charges and infrastructure capital costs before the first irrigation crop is produced.

Table 7. Capital asset charges and infrastructure capital costs for the expansion areas related to the Chin Reservoir Expansion project.

Expansion Area	Acres	Irrigation System#	Capital Asset Charge/ Acre	Total Capital Asset Costs	Infrastructure Capital Cost/Acre	Total Infrastructure Capital Costs
Area 1*	11,500	Pivot	$2,870	$33,005,000	$1,970	$22,655,000
Area 2**	1,6500	Pivot	$4,000	$64,000,000	$2,550	$40,800,000
Area 3*	9,000	Pivot	$4,000	$36,000,000	$2,350	$21,150,000
Area 4*	10,000	Pivot	$4,000	$40,000,000	$2,100	$21,000,000
Total (All Areas)	**46,500**			**$173,005,000**		**$105,605,000**

*Assume one, 132-acre pivot per delivery point
**Assume 16, 132-acre pivots (2112 acres) per delivery point
Assume each pivot irrigates 132 acres.

3.1.3 Irrigation Systems Operation and Maintenance Costs

Operation and maintenance are ongoing requirements to ensure each irrigation system continues to function properly and remains capable of supplying the correct volume of water to meet growing crop needs during the hot, dry summer growing season. Table 8 summarizes the estimated operation and maintenance costs for the irrigation systems associated with the Chin Reservoir Expansion Project.

Table 8. Irrigation operation and maintenance costs associated with Chin Reservoir expansion areas.

Expansion Area	Expansion Acres	Annual Operating Cost/Acre*	Annual Maintenance Cost/Acre	Annual O&M Cost/Acre	Total O&M Cost
Area 1*	11,500	$46.00	$39.00	$85.00	$977,500
Area 2**	16,000	$103.00	$55.00	$158.00	$2,528,000
Area 3*	9,000	$52.00	$38.00	$90.00	$810,000
Area 4*	10,000	$60.00	$40.00	$100.00	$1,000,000
Total	**46,500**	**N/A**	**N/A**	**N/A**	**$5,315,500**

*Includes electricity and irrigation water charges.

3.1.4 Crop Yields

Crop yields under irrigated and dryland production systems were obtained from various sources (Table 9). More crop varieties are grown under irrigated conditions than for dryland, and crop yields under irrigation were almost twice the yields under dryland production. This results in higher gross returns to the producer, although the cost of production may also be higher.

Table 9. Average irrigation and dryland crop yields (2011-2018).

Crop Type	Crop	Unit of Measure	Irrigation Yields	Dryland Yields	Irrigated Yield (Relative to Dryland Yield)
Cereals	Wheat	bu/acre	85	37	2.3
	Barley	bu/acre	100	48	2.1
	Oats	bu/acre	80	43	1.9
	Grain Corn	bu/acre	155	N/A	N/A
	Triticale	bu/acre	N/A	27	N/A
	Rye	bu/acre	N/A	N/A	N/A
Oilseeds	Canola	bu/acre	59	29	2.1
	Flaxseed	bu/acre	41	18	2.3
	Mustard	bu/acre	N/A	16	N/A
Specialty Crops	Peas	bu/acre	58	32	1.8
	Lentils	lbs/acre	2,549	1,226	2.1
	Faba beans	lbs/acre	3,589	1,780	1.9
	Dry Beans	bu/acre	20	N/A	N/A
	Sugar Beets	tons/acre	30	N/A	N/A
	Chickpeas	lbs/acre	2,865	1,208	2.4
	Sunflower	lbs/acre	1,865	N/A	N/A
	Alfalfa Seed	lbs/acre	763	N/A	N/A
	Canola Seed	lbs/acre	766	N/A	N/A
	Hemp	lbs/acre	1,603	N/A	N/A
Forages	Alfalfa	tons/acre	4	N/A	N/A
	Barley Silage	tons/acre	12	N/A	N/A
	Corn Silage	tons/acre	18	N/A	N/A

N/A Indicates that the crop is not grown.

3.1.5 Cost of Production for Crops

Cost of production for irrigated and dryland crops were generated from cost of production data from Alberta Agriculture, Forestry, and Rural Economic Development (AAFRED), Manitoba Agriculture Food and Rural Development (MAFRD), and Saskatchewan Irrigation Crop Diversification Corporation (ICDC) databases. The cost of production included all fixed and variables costs, except unpaid labor cost. Tables 51 to 53, Appendix C provide detailed cost of production information for irrigated crops. Table 54 (Appendix C) provides cost of production information for representative dryland crops.

3.1.6 Net Crop Revenue

The net crop revenue per acre was estimated using Equation 1. This value was multiplied by the area for a given irrigated or dryland crop, and then summed together to obtain total net revenue from irrigation and dryland production using Equation 2.

$NR_C = (YLD_C)\ (PRC_C) - COP_C$ ……..(1)

Total Net Revenue = $\Sigma_{c=1}\ (NR_C)\ (AREA_C)$……..……(2)

Where: NRc – Net Revenue of crop; YLDc – Yield of crop; PRCc – Price of crop; COPc – Cost of Production for crop; and AREAc – Area of crop.

The estimated gross and net revenues for irrigation and dryland crops related to the Chin Reservoir expansion are shown in Table 10. The analysis shows that irrigation development on the 46,500 acres of land generates a net annual revenue of about $12.9 million, compared with about $1.1 million for the same dryland acreage in this area, and is about 11 time greater. This difference is driven by yield and the significantly higher proportion of higher value specialty crops grown under irrigation.

Table 10. Gross and net revenue (per acre) for irrigated and dryland crop production.

Revenue and Cost	Irrigation		Dryland		Increment Difference of Irrigation over Dryland	
	Per Acre	Total*	Per Acre	Total*	Per Acre	Total*
Gross Revenue	$817.79	$38,027,235	$232.62	$10,816,830	$585.17	$27,210,405
Cost of Production	$541.28	$25,169,520	$207.92	$9,668,280	$333.36	$15,501,240
Net Revenue	**$276.51**	**$12,857,715**	**$24.70**	**$1,148,550**	**$251.81**	**$11,709,165**

* 46,500 acres related to the Chin Reservoir Expansion

3.2 On-Farm Livestock Development

Representative portions of the following Statistics Canada census divisions were used to reflect livestock and egg production associated with the RID, SMRID, and TID (Figure 6).

- **Census Division 1**—Cypress County and County of Forty Mile.
- **Census Division 2**—Lethbridge County, Warner County, and MD of Taber.
- **Census Division 3**—Cardston County.

Livestock and egg production potential was then calculated for the proposed Chin Reservoir expansion area, using the proportion of the Chin Reservoir expansion area relative to the average total acreage (actually irrigated) in the RID and SMRID for 2011, 2015, and 2020, which was 489,227 acres (Table 43, Appendix A).

Figure 6. Alberta census divisions and municipalities.

Table 11 shows the relative livestock numbers and egg production within:

- The RID and SMRID;
- The proposed irrigated area associated with the Chin Reservoir expansion; and
- Dryland areas in proximity to the proposed irrigation expansion areas.

Table 11. Livestock and egg production associated with proposed Chin Reservoir Expansion Project.

RID, SMRID, TID		Chin Expansion Area Irrigation (46,500 acres)		Chin Expansion Area Dryland (46,500 acres)	
Livestock Type	**Number**	**Livestock Type**	**Number**	**Livestock Type**	**Number**
Hogs	154,389	**Hogs**	14,674	**Hogs**	1,565
Sheep/Lambs	16,086	**Sheep/Lambs**	1,529	**Sheep/Lambs**	219
Poultry	1,135,485	**Poultry**	107,925	**Poultry**	13,903
Cattle/Calves	475,675	**Cattle/Calves**	45,212	**Cattle/Calves**	5,312
Eggs (dozen)	3,822,089	**Eggs (dozen)**	363,282	**Eggs (dozen)**	65,517
Feeders	280,583	**Feeders**	26,669	**Feeders**	1,519
Dairy	6,186	**Dairy**	588	**Dairy**	87

3.2.1 Gross Livestock Revenue for RID and SMRID

This analysis utilized the following three types of data: (1) Number of livestock/livestock products (by type) associated with irrigation and dryland in the study region (RID and SMRID); (2) Gross value of live animals or livestock products sold; and (3) Cost of production of various types of livestock and livestock products. For this study, seven types of livestock operations were included (Table 12).

Livestock data were estimated for the two irrigation districts for 2011 and 2016, using Statistics Canada databases. It was assumed that the same mix of livestock and egg production in the two irrigation districts would also occur in the proposed 46,500-acre expansion area related to the Chin Reservoir expansion. This assumption was based on the location of the proposed expansion areas adjacent to, and upstream and downstream of the Chin Reservoir. It is also assumed that the value and cost of production for irrigation and dryland livestock and eggs is the same.

Table 12. Livestock and egg production related to RID and SMRID.

Unit Type	Average Number of Units	Value/Unit	Total Product Sales
Cattle and Calves	475,675	$844.90	$401,897,808
Feeders	280,583	$1,829.30	$513,270,482
Hogs	154,389	$278.55	$43,005,056
Sheep and Lamb	16,086	$123.73	$1,990,321
Poultry	1,135,485	$20.84	$23,663,507
Eggs (dozen)	3,822,089	$1.31/dozen	$5,006,936
Dairy	6,186	$7,114.03	$44,007,390
Total Sales			**$1,032,841,500**

3.2.2 Livestock Revenue for Chin Reservoir Expansion Area

Table 13 shows the estimated per unit value and cost of production for livestock produced under irrigation in the proposed irrigation expansion area.

Table 13. Irrigated livestock and eggs in the proposed Chin Reservoir expansion area.

Unit Type	Estimated Units in Expansion Area	Value per Unit	Cost of Production per Unit
Cattle and Calves	45,212	$844.90	$777.00
Feeders	26,669	$1,829.30	$1,824.00
Hogs	14,674	$278.55	$222.00
Sheep and Lamb	1,529	$128.37	$55.00
Poultry*	107,925	$20.84	$9.00
Eggs (dozen)*	363,282	$1.31/dozen	$0.34
Dairy*	588	$7,114.03	$5,771

* Assumed that "supply managed" livestock and livestock products will result from relocation from another area, or expansion related to population growth in the province.

Net revenue was calculated by linking gross sales with the estimated cost of production for each livestock type and eggs produced. Since region specific data were not available, provincial cost of production estimates were used. The cost of production excluded any charge for the unpaid labor, like that completed for crops. Table 14 shows the net revenue estimates for the irrigated livestock and eggs produced.

Table 14. Gross sales, cost of production and net revenue for irrigation livestock operations related to the Chin Reservoir expansion.

Unit Type	Number of Units	Gross Sales*	Cost of Production*	Total Net Returns*
Cattle and Calves	45,212	$38,199,543	$35,129,655	$3,069,889
Feeder	26,669	$48,785,283	$48,643,938	$141,345
Hogs	14,674	$4,087,540	$3,257,706	$829,835
Sheep & Lamb	1,529	$189,176	$84,092	$105,084
Poultry	107,925	$2,249,167	$971,329	$ 1,277,838
Eggs (dozen)	363,282	$475,899	$123,516	$352,383
Dairy	588	$4,182,810	$3,393,154	$789,656
Total		**$98,169,418**	**$91,603,389**	**$6,566,029**

***** Values may not add up exactly because of rounding.

It is estimated that total sales of irrigation-produced livestock and eggs would be about $98 million/year, and total net revenue is estimated to be about $6.6 million. Cattle and calves were the largest net revenue livestock component in the Chin Reservoir expansion area (Figure 7).

3.2.3 Livestock Revenue for Dryland Area

Net revenue was also calculated for estimated livestock and egg production in a 46,500-acre comparable dryland area, by linking gross sales with estimated cost of production for each livestock type and eggs produced. Sales and cost of production values used for the dryland livestock and egg production were the same as used for the irrigated area. The cost of production

excluded any charge for the unpaid labour, like that completed for the crops. Table 15 shows the gross revenue and net revenue estimates for the dryland livestock types and eggs produced. Total annual gross and net revenue for the dryland livestock and egg production were estimated to be about $8.7 million and $817,000, respectively. This compares with $98.2 million in total sales and about $6.6 million in net revenue for livestock produced under irrigated conditions.

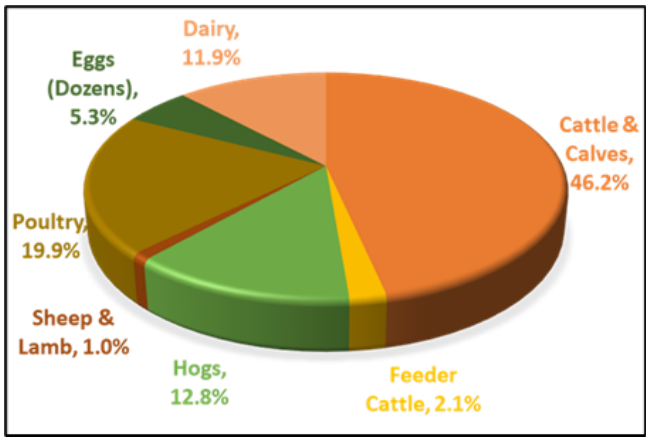

Figure 7. Proportion of livestock and livestock product net returns for the Chin Reservoir irrigation expansion area.

Table 15. Gross sales, cost of production, and net revenue for dryland livestock production related to the Chin Reservoir expansion.

Unit Type	Number of Units	Value/Unit	Gross Sales	Cost of Production	Net Revenue
Cattle and Calves	5,312	$844.90	$4,488,109	$4,127,424	$360,685
Feeder Cattle	1,519	$1,829.30	$2,778,707	$2,770,656	$8,051
Hogs	1,565	$278.55	$435,931	$347,430	$88,501
Sheep & Lamb	219	$123.73	$27,097	$12,045	$15,052
Poultry	13,903	$20.84	$289,739	$125,127	$164,612
Eggs (dozen)	65,517	$1.31/dozen	$85,827	$22,276	$63,551
Dairy	87	$7,114.03	$618,921	$502,077	$116,844
Total			**$8,724,330**	**$7,907,035**	**$817,296**

3.3 Backward Linkages Related to the Chin Reservoir Expansion

3.3.1 Investment in On-Farm Machinery and Equipment

For this study, it was assumed that all producers would adopt pivot irrigation technologies to supply water to crops. The average cost for pivot irrigation systems was estimated to be $2,270 per irrigated acre. Total expenditures on pivot systems for the Chin Reservoir expansion area are estimated to be $105,235,680. This investment would generate about $40 million to the provincial GDP, $25 million as labour income (household income) in Alberta, and 391 FTEs (Table 16). Since many of the pivot systems and parts are imported, total imports into the region would increase by $79 million. Because of this, their contribution to the Alberta economy is smaller than many other goods producing sectors.

Table 16. Total (direct, indirect, and induced) economic impacts of producers' expenditures on pivot irrigation systems.

Economic Impacts	Unit	Amount
GDP (Market Prices)	$Million	39.5
Labour Income	$Million	25.5
Imports	$Million	56
Employment	FTEs*	391

* Full-time equivalents

The average annual cost of specialized equipment, not required for dryland operations, is estimated to be $108.64 per acre, or $5.05 million for the 46,500-acre Chin Reservoir irrigation expansion area. These expenditures would increase the provincial GDP by $1.89 million, generate $1.22 million in labour income, and create 19 FTEs (Table 17). Because some of the specialized equipment needs to be imported, imports would increase by $3.78 million.

Table 17. Total (direct, indirect, and induced) economic impacts of producers' expenditure on specialized farm equipment.

Economic Impacts	Unit	Amount
GDP (Market Prices)	$Million	1.89
Labor Income	$Million	1.22
Imports	$Million	3.78
Employment	FTEs*	19

* Full-time Equivalents

3.3.2 Expenditures for Crop Production

Irrigation producers purchase several types of inputs needed for crop production. An average mix of irrigated crops inputs is estimated to cost $541.28/acre, compared with $207.92/acre for an average mix of dryland crops. Based on these costs, irrigation's direct support to the local economy is about 2.3 times higher than dryland crop production, and this leads to greater economic impacts through backward linkages. These expenditures are estimated to increase the Alberta GDP by $44.1 million, generate about $30.5 million in labour income and create 336 FTEs (Table 18).

Table 18. Direct and backward-linked economic impacts of irrigated crop production related to the Chin Reservoir expansion area.

Economic Sector	Net GDP ($ Million)	Net Labour Income ($ Million)	Net Employment (FTEs)
Agriculture	20.6	15.5	139
Utilities	0.9	0.5	5
Construction and Other Primary Industries	1.6	0.8	7
Manufacturing	1.6	0.5	7
Trade	3.1	2.0	41
Transportation and Storage	1.1	0.6	9
Services	12.5	8.9	114
Government Sectors	2.7	1.7	14
Total*	**44.1**	**30.5**	**336**

* Values may not add up to total due to rounding

The same analysis was undertaken for the dryland production. Results (Table 19) indicate a lower level of economic impacts for all dryland sectors, including agricultural production. Total GDP (in market prices) is about $9.3 million, labour income is about $4.9 million, and increased employment of 74 FTEs.

Table 19. Direct and backward-linked economic impacts of dryland crop production for a comparable area as the Chin Reservoir expansion area.

Economic Sector	GDP ($ Million)	Labour Income ($ Million)	Employment (FTEs)
Agriculture	4.1	1.8	34
Utilities	0.1	0.1	1
Construction and Other Primary Industries	0.3	0.2	2
Manufacturing	0.7	0.2	1
Trade	0.9	0.6	12
Transportation and Storage	0.3	0.1	2
Services	2.3	1.6	20
Government	0.4	0.3	2
Total*	**9.3**	**4.9**	**74**

*Values may not add up to the total due to rounding

For the same land base, irrigation generates a GDP of $44.1 million compared with $9 million for dryland farms. This is an increase of $34.8 million, more than three times the level that dryland farms generate (Table 20). The same trend is exhibited for employment numbers, with irrigated crop production showing an increase of 336 FTEs, compared with 74 FTEs for dryland production, also more than three times the level of dryland employment levels. The sectors affected by the increased crop production include, in addition to agriculture, service sectors, trade sectors, and government sectors (Figure 8).

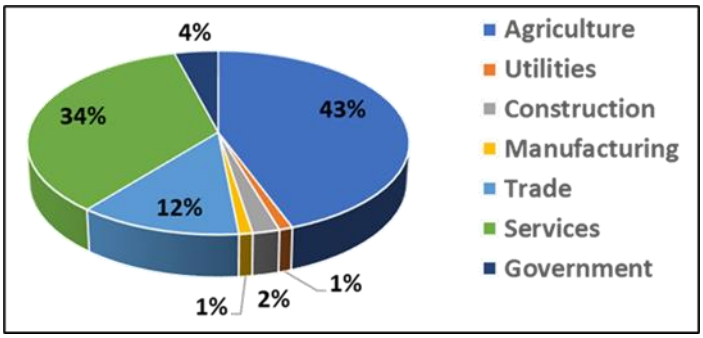

Figure 8. Distribution of employment related to the Chin Reservoir irrigated expansion area.

Table 20. Net economic impact of irrigated and dryland crop production in the Chin Reservoir expansion area.

Production System	GDP* ($ Million)	Labour Income ($ Million)	Employment (FTEs)**
Irrigated Crop Production	44.1	30.5	336
Dryland Crop Production	9.3	4.9	74
Increase of Irrigation over Dryland	34.8	25.6	262

* Market prices
**Full-time Equivalents

3.3.3 Expenditures for Livestock Production

Irrigation and dryland producers purchase several types of inputs needed for livestock and egg production. An average mix of irrigated livestock and egg production inputs are estimated to cost $2,007/acre, compared with $2,047/acre for a representative mix of dryland livestock/egg production. Irrigated and dryland costs of production for livestock are similar, since the inputs are essentially the same. The total economic impacts (direct, indirect, and induced) on the provincial GDP of irrigation livestock production in the Chin Reservoir expansion area indicates that trade, services, and government are the most affected sectors (Figure 9).

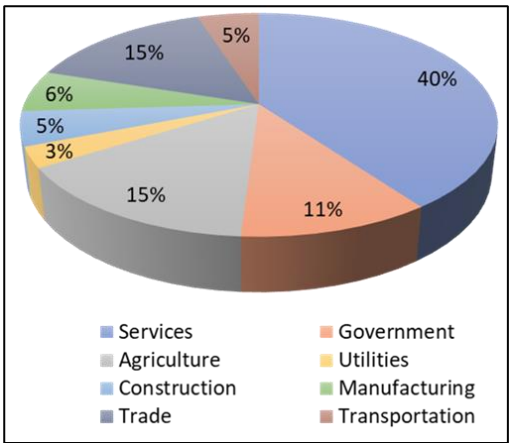

Figure 9. Distribution of GDP impacts of irrigation livestock production.

Irrigated livestock production in the Chin Reservoir expansion area generates about $66.5 million for the provincial GDP, $43.6 million in labour income and 785 FTEs (Table 21).

Table 21. Direct, indirect, and induced economic impacts of irrigation livestock production related to the Chin Reservoir expansion area.

Sector	Provincial GDP* ($ Million)	Labour Income ($ Million)	Employment (FTEs)**
Primary Agriculture (Except Crop Production)	9.8	8.1	307
Utilities	2.1	1.1	11
Construction and Other Primary Industries	3.5	1.7	19
Manufacturing	4.2	1.6	17
Trade	9.7	6.3	126
Transportation and Storage	3.7	1.9	31
Services	26.4	18.4	241
Government	7.1	4.4	33
Total* **	**66.5**	**43.6**	**785**

* Market prices
**Number of full-time equivalents
*** Values may not add up to the total due to rounding

A similar analysis for dryland livestock production was completed to estimate the net additional economic impact resulting from the introduction of irrigation in the Chin Reservoir expansion area. A summary of these impacts is shown in Table 22. Since dryland livestock production allows for a fewer number of livestock per acre than irrigation, the economic impact is less. The total GDP generated by the dryland livestock production is $3.9 million, $2.7 million in labour income, and 58 FTEs.

Table 22. Total economic impacts of dryland livestock production related to Chin Reservoir expansion area.

Economic Impact	Unit	Amount*
GDP	$ Million	3.9
Labour Income	$ Million	2.7
Employment	FTEs	58

* Values may not add up to the total due to rounding

Economic activity from irrigation production on the Chin Reservoir expansion area is significantly higher than dryland activity (Table 23). Irrigation livestock production increases the provincial GDP by 17 times, labour income by 16 times, and employment by 14 times.

Table 23. Net economic impact of irrigated and dryland livestock production in the Chin Reservoir expansion area.

Production System	GDP* ($ Million)	Labor Income ($ Million)	Employment (FTEs)**
Irrigated Livestock Production	66.5	43.6	785
Dryland Livestock Production	3.9	2.7	58
Net Increase of Irrigation over Dryland	62.6	40.9	727
Relative Increase of Irrigation over Dryland	**17 Times**	**16 Times**	**14 Times**

3.3.4 Direct and Backward Linked Impacts of Chin Reservoir Expansion

The total economic impact of irrigation crop and livestock development (net of dryland production) in the Chin Reservoir expansion area is estimated to increase the Alberta GDP (market prices) by about $139 million annually, and labour income by $93 million (Table 24). Upon full project completion, the annual employment is estimated to increase by 1,398 FTEs. Most employment changes (47%) will relate to indirect linkages through the purchase of inputs by irrigation producers for crop and livestock production. Induced impacts (those created by spending labour income on goods and services) constitutes about 30% of total employment impacts (Figure 10).

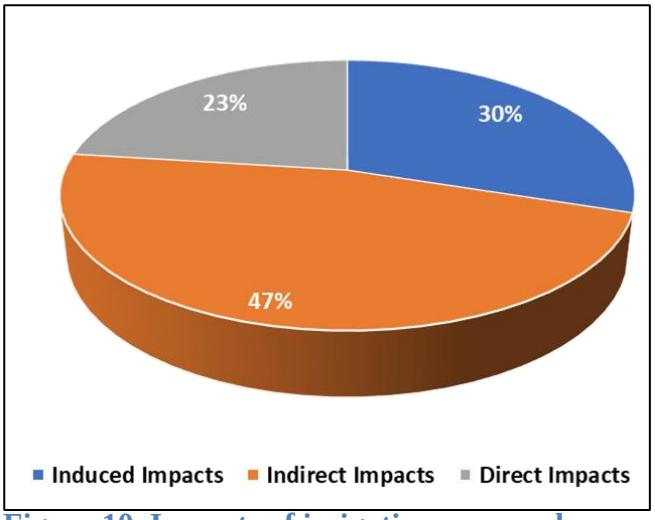

Figure 10. Impacts of irrigation crop and livestock development on employment (FTEs) for the Chin Reservoir expansion area.

Table 24. Distribution of total (direct, backward, and induced) annual impacts of irrigation crop and livestock development in Chin Reservoir expansion area.

Economic Activity	GDP ($ Million)	Labor Income ($ Million)	Employment FTEs
Investment for Pivot Systems			
Direct	1.0	0	0
Indirect	27.6	18	292
Induced	10.9	7.5	99
Total	**39.5**	**25.5**	**391**
Investment for Specialized Machinery			
Direct	0.05	0	0
Indirect	1.3	0.9	14
Induced	0.5	0.4	5
Total	**1.9**	**1.3**	**19**
Crop Production (Net over Dryland)			
Direct	16.2	13.6	107
Indirect	4.9	2.6	30
Induced	13.7	9.4	124
Total	**34.8**	**25.6**	**261**
Livestock Production (Net over Dryland)			
Direct	8.7	7.9	201
Indirect	32.1	17.5	328
Induced	21.8	15.4	198
Total	**62.6**	**40.8**	**727**
Total Economic Impacts of Irrigation Crop and Livestock Development			
Direct	26.0	21.5	308
Indirect	65.9	39	664
Induced	46.9	32.7	425
Total	**138.8**	**93.2**	**1,398**

3.4 Forward Linkages (Food Processing) of Irrigation Development

A portion of the irrigated production is sold to agricultural processing industries in the province. These processing industries add further value to the irrigated agricultural production. It was assumed that all agricultural processing industries that are associated with irrigation would be affected by the 46,500-acre irrigation expansion.

The largest increase (76% of total) would be related to the slaughter and meat processing industries (Figure 11). Other processing industries affected by this expansion could include potatoes, corn, sugar beets, dry beans,

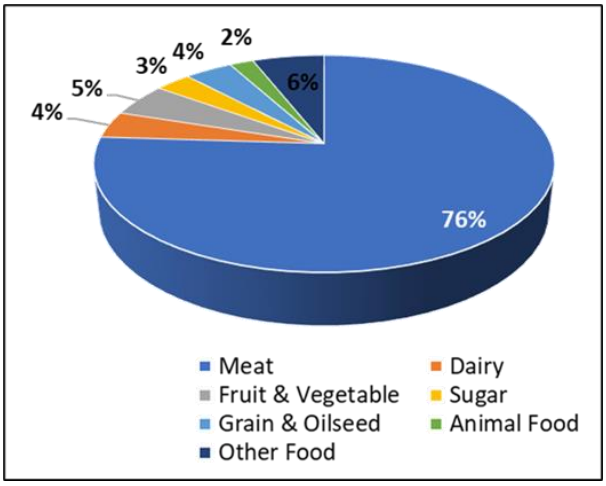

Figure 11. Relative impact of agriculture processing industries related to Chin Reservoir irrigation expansion area.

and canola seed. The total impact of these forward linkages would be $83 million on the GDP, $30 million as labour income, and 630 FTEs (Table 25).

Table 25. Economic impacts (direct, indirect, and induced) of food processing (net of irrigation production) related to the Chin Reservoir expansion area.

Activity	GDP* ($ Million)	Labor Income ($ Million)	Employment (FTEs)*
Slaughter and Meat Processing	64	22	478
Grain Processing and Bakeries	3	1	25
Animal Food Processing	2	1	13
Fruits and Vegetable Processing	4	2	32
Sugar Manufacturing	2	1	19
Dairy product Manufacturing	3	1	25
Other Food Processing	5	2	38
Total	**83**	**30**	**630**

*These values relate to the total provincial GDP and/or employment.

CHAPTER 4.0 OTHER POTENTIAL IMPACTS OF THE CHIN RESERVOIR EXPANSION PROJECT

4.1 Flood Mitigation

The RID and SMRID operate numerous off-stream water storage reservoirs as well as thousands of miles of water supply canals and pipelines as part of their irrigation infrastructure system. All district-owned and operated water storage reservoirs are supplied by the SMRID main canal, which originates at the Milk River Ridge Reservoir (south of Raymond), flows in a north-easterly direction for approximately 280 km., and terminates south of the city of Medicine Hat. This canal and reservoir system was originally constructed in the 1950s and underwent extensive rehabilitation and upgrading during the 1980s and 1990s.

4.1.1 Impact Area

The SMRID main canal generally follows the natural geographic contour of the land, and as a result acts as a divide between higher lands to the south, and much of the irrigated lands to the north. During intensive rainstorm or snow melt events, water from the higher elevation lands tends to drain into the main canal and is transported downstream. As with all irrigation delivery canals, the SMRID main canal system flow capacity is largest at the upper end and decreases downstream as water is diverted for irrigation. Because of this continual decrease in canal capacity, there is increased potential for the canal to overflow or breach during storm runoff events, unless there are:

- Control structures constructed to prevent water from entering the canal;
- Diversion spillways constructed to release the excess stormwater back to the river; or
- Additional reservoir storage capacity to retain excess runoff flows for a period of time.

Using existing irrigation reservoirs to store excess stormwater runoff is challenging, since the main purpose of these reservoirs are to store the maximum amount of water during the spring melt period, when water flowing in the rivers are at their highest, to provide the necessary irrigation water during the drier summer months.

4.1.2 Flood Events

The area served by the SMRID main canal has experienced five significant stormwater runoff events from 2010 to 2020 – an average of one event every two years. In 2010, 2011, 2013, 2014, and 2018 precipitation events within the basin resulted in flooded residences, infrastructure, croplands, and the breach of an off-stream water storage reservoir (Figure 12). The 2010 flood event, because of record spring rainfall, caused extensive flooding throughout much of rural southern Alberta. Part of the Trans-Canada highway east of Medicine Hat was washed away, and the Canadian Pacific Railway was forced to shut down sections of its rail line. This flood resulted in millions of

Figure 12. Flooding near Coaldale (2011).

dollars in damage to irrigation and transportation infrastructure, plus loss of crops and food processing capabilities.

Because of these and other stormwater runoff events, irrigation districts have attempted, when possible, to store stormwater flows to lessen the impacts on residences, industries, and agricultural producers. However, irrigation districts recognize it is critical for the safety of the reservoir infrastructure that sufficient surge capacity within the reservoirs is available to safely store stormwater without fear of overtopping the reservoir. Constructing additional storage capacity within existing reservoirs may help sustain ongoing irrigation development and alleviate some of the pressures during future stormwater runoff events. The Chin Reservoir Expansion Project may be an important part of the irrigation and flood water management strategy being considered for the area served by the SMRID main canal.

In 2014 the Regional Drainage Committee was formed to assess potential alternatives to better manage stormwater runoff events. MPE Engineering Ltd. was engaged to assess potential infrastructure options and provide recommendations to minimize excess stormwater runoff on existing irrigation districts' infrastructure, adjacent municipal lands, and other infrastructure. This assessment resulted in the development of recommendations for a Regional Stormwater Mitigation Plan (MPE Engineering Ltd., 2014). The Regional Drainage Committee adopted this plan and approached municipalities and other funding agencies for support to implement the plan. The plan area includes diverse geographic terrain, demographics, irrigated and dryland agriculture, and industrial uses.

4.1.3 Flood Mitigation

The Regional Stormwater Mitigation Plan includes the corridor linking Lethbridge to Medicine Hat, which is an important economic region in Alberta. The plan identified several inter-related infrastructure alternatives, including expansion of water storage reservoirs, construction of drainage spillways, and development of drainage pumping systems to help mitigate future stormwater issues (Figure 13).

The study estimated that the area potentially impacted by excess stormwater events has an assessed value of about $10.9 billion. This total includes $3.7 billion for residential properties, $1.6 billion for industrial/commercial properties, and $5.6 billion for irrigation and dryland farms. The area that could be directly impacted by stormwater flooding includes about 8,000 acres of municipal properties and 1.3 million acres of farmland, including approximately 500,000 acres of irrigated land and 800,000 acres of dryland. Approximately 49,000 residents could be directly impacted. It is also recognized that if a stormwater event resulted in failure of the irrigation water supply system, the impact on food processing companies, livestock producers, and the transportation industry would be significant.

The MPE Engineering Ltd. report identified nine inter-related infrastructure improvements which, when implemented, are expected to significantly mitigate the impacts of future excess stormwater runoff events. These improvements would be constructed at key locations along the entire length of the SMRID main canal, from Ridge Reservoir in the west to Medicine Hat in the east. Several of the recommended stormwater runoff mitigation structures have or are being

constructed. A key component of the regional plan is increasing the storage capacity of Chin Reservoir.

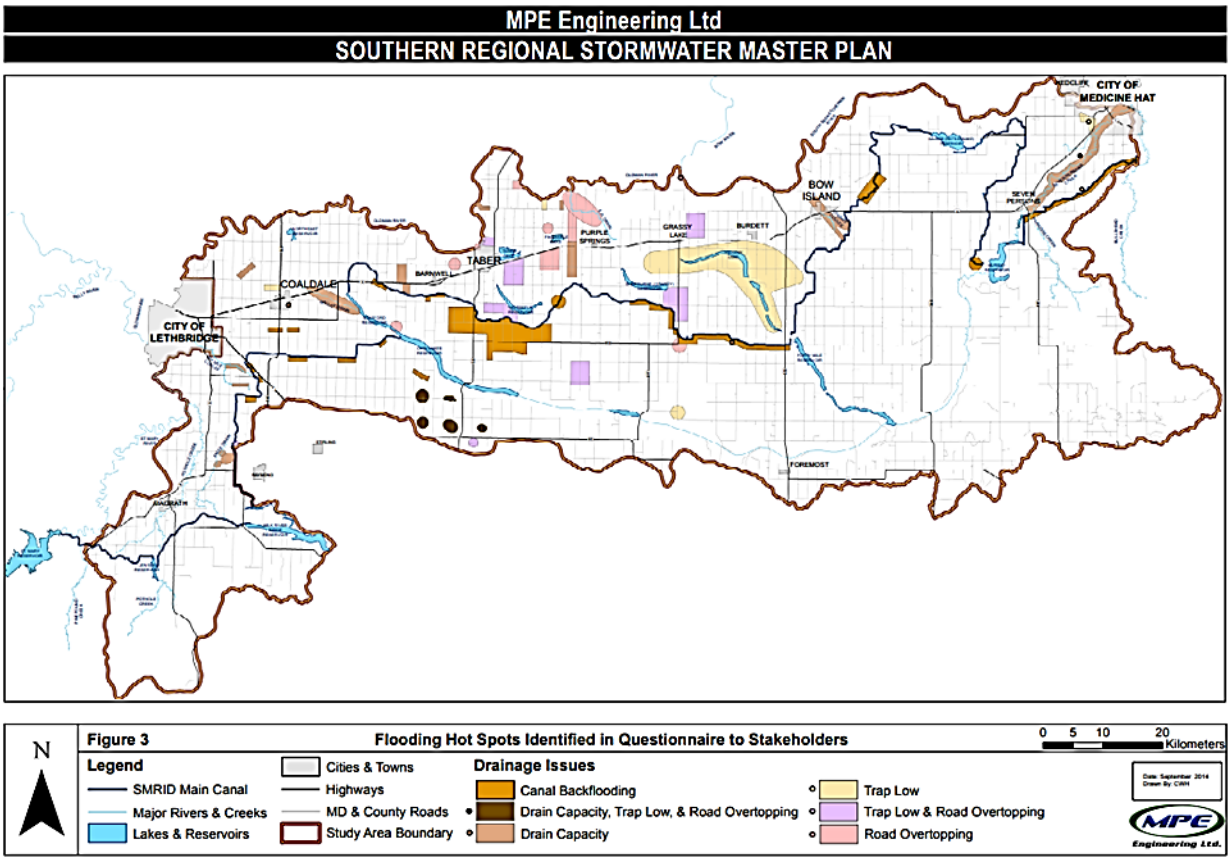

Figure 13. Southern regional stormwater master plan – flooding issues (MPE Engineering Ltd., 2014.

The existing Chin reservoir has an estimated storage capacity of 168,120 acre-feet. This includes about 13,000 acre-feet for storage of stormwater runoff between the full supply operating elevation and maximum design capacity elevation. The proposed Chin Reservoir Expansion Project includes construction of a new dam 6 miles east of the existing east dam, plus increasing the height of the existing west dam.

The resulting expanded Chin Reservoir could have a design capacity of approximately 243,630 acre-feet, an increase of about 75,421 acre-feet. This would increase the potential stormwater runoff storage by 26,600 to 35,000 acre-feet, depending on the final design capacity and dam safety operating guidelines. With this expanded stormwater retention capability, it is estimated that all stormwater runoff entering the main canal between Ridge Reservoir and Chin Reservoir could be stored, with zero outflow downstream of Chin Reservoir. This added capacity would allow the SMRID main canal downstream of Chin Reservoir to accept downstream runoff without overflowing, and this would also allow for a reduction in the size of other downstream flood control infrastructure. Based on the total costs associated for the nine inter-related mitigation projects, the Chin Reservoir expansion is estimated to mitigate future stormwater

runoff impacts for up to $3.8 billion (35%) of the original $10.9 billion worth of potentially impacted infrastructure and lands.

In addition to the 2014 MPE Engineering Ltd. report, MPE Engineering Ltd. carried out a more specific analysis in 2010 to assess flood impacts and develop mitigation alternatives related to a 2005 flood event in the Lethbridge to Taber area, with specific focus on the Malloy Drain. This drainage system encompasses the town of Coaldale and surrounding areas in Lethbridge County.

Using data from these two reports (MPE Engineering Ltd., 2010 and 2014), a flood mitigation economic impact assessment was completed for the proposed Chin Reservoir expansion. The assessment was based on a 1-in-10-year flood event probability for the region. The annual benefits of the Chin Reservoir expansion are divided into two categories:

1. Lost revenues and incurred expenses resulting from overland flooding of irrigated and dryland farms; and
2. Repair and re-construction costs to rehabilitate or replace infrastructure (residences, municipalities, and SMRID water supply infrastructure) damaged by flood waters.

Specific information related to costs related to industries was not found.

4.1.3.1 Lost Revenues and Cost of Production Expenses (Farmland)

Using data from the 2010 MPE Engineering Ltd. report, it is estimated that the 2005 flood event impacted about 144,000 acres of irrigated farmland and 16,000 acres of dryland, either through direct flood damage or reduced irrigation because of infrastructure damage. Using gross revenue calculations developed in Section 3.1.4 of this report, it is estimated (based on 100% loss) that about $117,761,760 of potential revenue would be lost on irrigated farms, and $3,721,920 of potential revenue would be lost on dryland farms during the flood event, for a total revenue loss of $121,483,680.

In addition, it is estimated that about $62,355,456 of incurred cost of production expenses would be lost on the irrigated lands, and about $2,661,376 of incurred cost of production expenses on dryland farms – for a total of $65,016,832. These incurred expenses are expenses that irrigation and dryland producers have already spent for land preparation, seed, fertilizer, pesticides, fuel, etc.

The total impact of an overland flood event for irrigated and dryland farms, including lost revenues and incurred cost of production expenses, was estimated to be about $186,500,512. Table 26 provides a breakdown of the cost analysis related to the lost revenues and expenses for impacted farmland.

Construction of the Chin Reservoir expansion, which is a key part of the overall flood mitigation network for the region, is estimated to mitigate 35% of the total farmland revenue and expense losses during a flood event, which would be $65,275,179. During the 50-year project life, the Chin Reservoir expansion project would result in a total savings of revenue and expenses of about $326,375,896 for irrigated and dryland farms in the region, assuming a 1-in-10-year flood event (Table 26).

Table 26. Impact of flooding on revenues and expenses for irrigation and dryland farms.

Gross Revenues			Expenses Incurred*		
Description	**Irrigation**	**Dryland**	**Description**	**Irrigation**	**Dryland**
Area Impacted (Acres)	144,000	16,000	**Area Impacted (Acres)**	144,000	16,000
Gross Revenue (Per Acre)	$817.79	$232.62	**Cost of Production (Per Acre)**	$541.28	$207.92
Total Revenue Lost	$117,761,760	$3,721,920	**Total Expenses**	$62,355,456	$2,661,376
Combined Total Revenue Lost	$121,483,680		**Combined Total Expenses**	$65,016,832	
Total Revenue Lost + Incurred Expenses on Irrigation and Dryland Farms				$186,500,512	
Total Revenue + Expenses Saved by Chin Reservoir Expansion**				$65,275,179	
Total Revenue + Expenses Saved by Chin Reservoir Expansion Over 50-year Project Life (assuming a 1-in-10-year flood event.				$326,375,896	

***** Assumed about 80% of on-farm expenses would be spent at the time of the June floods.
** Chin Reservoir Expansion responsible for 35% of total mitigation

4.1.3.2 Infrastructure Repair and Replacement Costs

The MPE Engineering Ltd. (2010) study estimated the impacts of the 2005 flood event in the region on the Town of Coaldale and surrounding areas. Table 27 shows the estimated physical damages within the County of Lethbridge, Town of Coaldale, and SMRID, based on Disaster Recovery Funding provided by the Alberta Emergency Management Agency, and assumed costs related to insured flood losses.

Information related to insured losses was not available for residences, municipalities, and agencies. For this analysis, it was assumed that insured losses were equal to the Disaster Recovery Funded losses (Table 27). It was assumed that the SMRID did not have any insured flood losses. The combined information was used to assess the overall impact of major flood events on individual, municipal, and agency infrastructure in the region served by the SMRID main canal.

Table 27. Impact of 2005 flood on individuals, municipalities and the SMRID.

Disaster Recovery Funded Flood Losses			
Affected Entities	**Lethbridge County**	**Town of Coaldale**	**SMRID**
Individuals	$230,718	$166,770	-
Municipal/Agency	$112,299	$27,827	$502,222**
Insured Flood Losses*			
Affected Entities	**Lethbridge County**	**Town of Coaldale**	**SMRID**
Individuals	$230,718	$166,770	-
Municipal/Agency	$112,299	$27,827	$0.00
Total Flood Losses	**$686,034**	**$389,194**	**$502,222**

*****Assumed insured losses were to Disaster Recovery Funded costs, except for the SMRID.
**Total cost related to all SMRID infrastructure.

The relative costs identified for Lethbridge County, Town of Coaldale, and the SMRID were extrapolated for the region served by the SMRID main canal. This included the towns of

Coaldale, Barnwell, Taber, Purple Springs, Grassy Lake, Burdett, Magrath, Bow Island, Foremost, Seven Persons, and Medicine Hat. It also included the rural areas in the counties of Lethbridge, Forty Mile, Cardston, Cypress, and the MD of Taber. The extrapolated costs were determined based on the relative area of each County, MD, and Town, and compared with the costs in Table 27. For the SMRID, the cost shown in Table 27 was for the entire length of the SMRID Main Canal.

Based on these calculations, it was estimated that the total infrastructure repair or replacement costs related to the 2005 flood event were $11,111,546. The Chin Reservoir expansion, assuming it could mitigate about 35% of the total flood damage for a single event, could reduce the infrastructure damage costs by about $3,889,041. During the 50-year project life, the Chin Reservoir expansion would result in a total savings of about $19,445,206.

It is recognized that the infrastructure repair and replacement cost estimates are likely low, for the following reasons.

- The costs shown in Table 27 do not account for damages related to industries in rural municipalities and towns.
- The 2005 flood event, while serious, was not considered as severe as the 2002 flood event (MPE Engineering Ltd., 2010). However, cost figures related to the 2002 flood event are not available.

4.1.4 Secondary Impacts of Flood Mitigation

Flood mitigation related to the Chin Reservoir expansion would generate an increased level of economic activity in Alberta, not only for those who are directly affected by flood events, but also for others who are indirectly impacted. Flood mitigation would result in the increased production of goods and services by $155,926,700. This would result in the provincial GDP increasing by $98,593,500, including $77,126,000 in labour income, and 546 FTEs (Table 28). Over the 50-year project life, the Alberta GDP would increase by about $493 million, and labour income by $410 million.

Table 28. Total economic impact of the Chin Reservoir expansion on flood mitigation.

Type of Flooding Losses	Output (Sales)	GDP**	Labour Income	Employment (FTEs)
Irrigated Farms*	$147,532,800	$94,019,400	$74,133,900	508
Dryland Farms*	$5,087,900	$3,022,000	$2,383,100	21
Residential Property	$1,543,000	$771,000	$252,000	9
Municipal/Other Agency Property	$1,763,000	$781,000	$357,000	8
Total Impact on the Alberta Economy	**$155,926,700**	**$98,593,400**	**$77,126,000**	**546**

* Assumes that land impacted by flooding does not include new irrigated areas in the Chin Reservoir expansion. Also assumes that flood damages to irrigated and dryland areas occur after the crops have been seeded and are actively growing.

** Market prices

4.2 Drought Mitigation

Droughts are a common phenomenon on the Canadian prairies. From 1901 to 2001, there were eight major droughts in western Canada – a probability recurrence of 8% in any given year. In

addition to the prairie-wide drought of the 1930s, droughts also occurred in 1961, 1984, 1985, 2001, and 2002 (Wheaton et al., 2004). Droughts have also occurred in Alberta in 2009 and 2010 (Bow River Water Management Committee, 2017). The 2001 and 2002 droughts were among the first general droughts throughout Canada, with Alberta and Saskatchewan being affected the hardest (Wheaton et al., 2005). It was estimated that agricultural production in Canada decreased by $3.6 billion for the 2001 and 2002 drought years, and the GDP was reduced by about $5.8 billion (Wheaton et al., 2005). About 80% of those losses were in Alberta and Saskatchewan. Alberta's lost crop production was estimated at about $413 million in 2001 and $1.3 billion in 2002.

In the future, drought frequency is expected to increase because of increased temperatures and changing precipitation patterns (Bonsal et al., 2013) (Table 29).

Table 29. Past and projected drought frequencies in western Canada.

Period	Drought Duration (mean)	Frequency of Droughts per 100 Years		
		≥ 3 Years	≥ 5 Years	≥ 10 Years
1901–2005	2.4 years	5.7	1.9	1.0
2011–2105	8.4 years	4.2	4.2	3.1

Source: Bonsal et al. (2013)

Samarawickrema and Kulshreshtha (2008) assessed the value of irrigation water for crop production during the 2001–2002 drought in southern Alberta, and they estimated that the current value of water is about $0.055/m^3 in the Bow River and Oldman River Sub-basins. For the 46,500 acres in the Chin Reservoir expansion area, it is estimated that about 60 million m^3 of irrigation water will be required annually to meet crop needs and is estimated to be worth about $3.3 million in a drought year.

Based on an 8% drought probability in any given year, the annual irrigation benefits are estimated to generate about $3.3 million to the provincial GDP and $3.3 million in labour income. No FTEs are supported. Climate change studies suggest that the likelihood of droughts will increase in this area, although there is little specific data on the probability. If the probability were to double, to 16%, the annual irrigation benefits related to the Chin Reservoir expansion area would also double.

These impacts likely underestimate the true value of irrigation during a drought.

- They only account for losses in crop production during a drought year, and exclude losses related to livestock production because of feed shortages.
- They exclude any additional impacts to forward linked industries (e.g., food processing companies) during a drought period when shortages of inputs may increase their costs to source alternate locations for crop products.

4.3 Hydropower Generation

The RID and SMRID consortium own Irrican Power Ltd., which operates three small hydropower generating stations on the SMRID main canal near Raymond (two locations), and Chin Reservoir. The total cost of these plants was about $59.4 million (Table 30) (SMRID, 2021). They operate throughout the spring to fall period each year when sufficient water is

flowing in the SMRID main canal. Irrigation-related hydropower generation helps Alberta reduce its carbon footprint, supports economic activity, and provides employment opportunities.

Total capacity of the three hydroelectric plants is about 39 megawatts (MW). Average annual net revenue generated from these three plants averaged about $1.866 million from 2013 to 2019 (Table 30) (SMRID, 2014 to 2019).

Table 30. Capacity, revenues, and expenses for Irrican hydroelectric plants (2013-2019).

Irrican Hydropower Plants	Initial Cost to Construct ($ Million)	Date Plant Came Online	Capacity (MW)
Raymond	26.80	May, 1994	20.5
Chin	17.80	June, 1994	11.4
Drops 4, 5 & 6	14.80	July, 2004	6.9
Total	**59.40**		**38.8**
Cost of Production (All Plants)			
Year	**Revenue ($)**	**Expenses ($)**	**Net ($)**
2013	7,147,063	4,210,135	2,936,928
2014	5,009,161	3,808,892	1,200,269
2015	5,856,164	3,425,194	2,430,970
2016	1,831,450	2,422,874	-591,424
2017	2,688,067	2,449,517	238,550
2018	7,409.036	3,542,281	3,866,755
2019	6,141,631	3,159,387	2,982,244
Average	**5,154,635**	**3,288,326**	**1,866,327**

A study carried out by WaterSmart Solutions Ltd. (2021) indicated that expansion of the reservoir by 103,500 acre-feet does not appear to have a significant influence on hydropower generation at the Chin Chute hydropower station. Although additional water may flow through the system because of increased irrigation acres, the combination of lower head due to raising the dam height and lake level, and the power plants traditionally operating at near capacity. Modelling different irrigation expansion acreages did show greater variation in hydropower generation at this site, but no specific trends were identified.

4.4 Recreation Enhancement

Chin Reservoir is a popular regional destination for several water sports, including fishing, wind surfing, water skiing, and swimming. The County of Warner operates and maintains a boat launch facility (Figure 14) at the south-west corner of Chin Reservoir, and close to the Stafford Reservoir development. The number of recreation day-users at Chin Reservoir is not known, but 2013 data indicates that about 2,846 day-users per year make use of Stafford Reservoir, which is adjacent to Chin Reservoir (Acera Consult Inc., 2021). Considerable spill-over of Stafford

Figure 14. Boat launch facility at entrance on Chin Reservoir.

Reservoir-day users could be expected for the expanded Chin Reservoir.

Discussions with the SMRID indicate that additional recreational facilities are not planned for the expanded Chin Reservoir at this time. However, the existing boat launch facility will need to be replaced because of the increased water level in the expanded reservoir. For this study, it was assumed that the replacement cost for the boat launch facility would be included in the $190 million construction cost for the expanded reservoir.

CHAPTER 5.0 FISCAL IMPACTS OF CHIN RESERVOIR EXPANSION PROJECT ON GOVERNMENT REVENUES

Every development activity will lead to increased revenues for different levels of government. The Chin Reservoir Expansion Project will impact municipal governments, the GOA, and the GOC. The estimation of these impacts utilizes the GOA and GOC Fiscal Impact Analysis Model, which were developed for this study (Chapter 2). The lack of available data did not permit the analysis of fiscal impacts at the municipal government level.

Fiscal Revenue: Revenues collected by government, and includes direct and indirect taxation and other government income.
Fiscal Costs: Expenditures by public agencies.
Net Fiscal Revenue: Difference between fiscal revenues and fiscal expenditures.

5.1 Government Revenues

Both levels of governments have similar sources of fiscal revenues. The major distinction between the two levels of government is the nature of money transfers. The GOC transfers funds to the GOA. Similarly, a portion of the GOA revenues is transferred to municipal governments. Details that constitute these GOA revenues are shown in Table 55, Appendix D.

Income tax is the highest source of fiscal revenue, accounting for 23% of total revenues in the province. Following this are transfers from the GOC, and investment income. Similar results take place for the GOC (Table 56, Appendix D), with income taxes being the highest source of revenue, followed by taxes on products (Goods and Services Tax), and corporate taxes.

5.2 Computer Model Development

Two fiscal impact models were developed to forecast the fiscal impacts of the Chin Reservoir Expansion Project – one for the GOA and the second one for the GOC. Estimating the fiscal impacts of the Chin Reservoir Expansion Project assessed the changes in the economic variables through a regression analysis. Typical economic variables include:

- Personal or household income;
- Other operating surplus (as a proxy for the business profits);
- Economic activity, such as sales of goods and services; and
- GDP.

The fiscal changes associated with the Chin Reservoir Expansion project were estimated using direct, indirect, and induced impacts. More details on the model are presented in Appendix D.

5.3 GOA Fiscal Revenues

Table 31 summarizes the fiscal impacts of the Chin Reservoir Expansion project on the GOA. Total fiscal revenues generated for the GOA by this project are estimated to be about $65.3 million or 34% of the original investment cost of $190 million for construction of the Chin Reservoir expansion. Some of these fiscal impacts are short-lived, and others occur only in specific years during the 50-year life of the project.

Short-term impacts are generated by the construction of the expanded Chin Reservoir, which is estimated to span 3 years. The total fiscal revenue generated by this activity is estimated to be about $22 million.

Periodic fiscal impacts are related to:

- Investment by irrigation producers for farm machinery (replaced every 10 years) and irrigation equipment (replaced every 15 years);
- Drought events – expected to occur about 8% of the years; and
- Flood events – expected to occur about 10% of the years.

Total fiscal revenue related to these periodic events are estimated to be about $15.8 million.

Table 31. Fiscal revenues generated for the GOA related to the Chin Reservoir Expansion Project.

Economic Activity	Personal Income Tax	Corporate Tax	Production & Products Tax	Transfers from GOC	Investment Income	Other Income	Total Fiscal Revenue
	Short-Term Impacts ($'000)						
Reservoir Construction	3,088	1,137	3,955	4,586	7,081	2,145	21,992
	Periodic Impacts ($'000)						
Investment Machinery & Equipment	103	18	103	129	199	60	612
Drought Mitigation	143	0	31	76	117	35	402
Flood Protection	4,344	332	1,793	2,761	4,262	1,292	14,784
	Annual Impacts ($'000)						
Direct Impacts for Crop Production	718	30	297	455	702	213	2,415
Backward Linkages for Irrigation Crop Production	637	123	364	522	806	244	2,696
Direct Impacts Livestock Production	406	351	1,082	243	375	114	2,571
Backward Linkages for Livestock Production	1,756	225	1,260	1,509	2,330	706	7,786
Food Processing	1,597	844	2,597	2,314	3,572	1,082	12,006
Total Revenue	**12,792**	**3,060**	**11,482**	**12,595**	**19,444**	**5,891**	**65,264**

Annual activities related to the irrigated production of crops, livestock, and food processing, generate fiscal revenues each year of the project life. The total fiscal revenues related to these

activities are estimated to be about $27.5 million and represent the highest level of fiscal revenue generated from the Chin Reservoir Expansion project.

Figure 15 shows the distribution of GOA fiscal revenues related to the Chin Reservoir Expansion Project. Investment income is the highest source in fiscal income (30%) for the GOA, followed by personal income taxes (20%), transfers from the GOC (19%), and production/product taxes (18%).

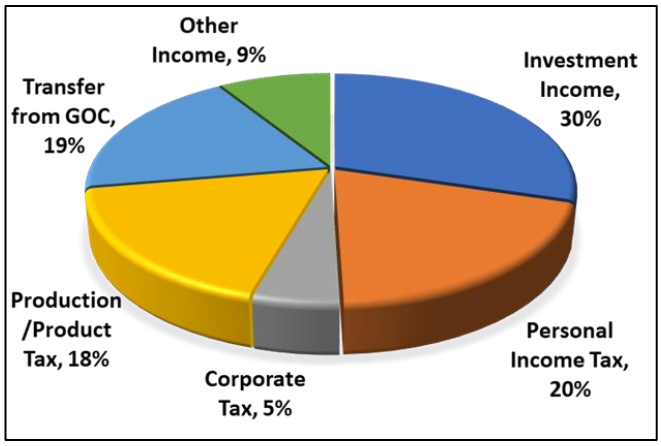

Figure 15. GOA fiscal revenues related to the Chin Reservoir Expansion project.

5.4 GOC Fiscal Revenues

Table 32 summarizes the total fiscal impacts on the GOC related to the Chin Reservoir Expansion project. Total fiscal revenues generated for the GOC are estimated to be about $56.6 million. Short-term fiscal revenues generated for the GOC by the 3-year construction of the expanded Chin Reservoir is estimated to be about $13.4 million. Periodic fiscal impacts related to investment in farm machinery and irrigation equipment, drought and flood mitigation are estimated to be about $15.3 million. Activities related to the irrigated production of crops, livestock, and food processing, generate fiscal revenues of about $27.9 million each year.

Table 32. Change in GOC fiscal revenues resulting from the Chin Reservoir Expansion project.

Economic Activity	Personal Income Tax	Corporate Tax	Production and Products Tax	Transfer from Households	Investment Income	Other Income	Total Fiscal Revenue
	Short-Term Impacts $'000						
Reservoir Construction	4,736	3,495	3,754	24	250	1,166	13,425
	Periodic Impacts $'000						
Investment Machinery/ Equipment	218	80	142	1	11	47	499
Drought Mitigation	303	0	43	1	6	28	381
Flood Protection	9,231	1,476	2,464	21	226	1,016	14,434
	Annual Impacts $'000						
Direct Impact for Crop Production	1,525	134	408	3	37	167	2,274
Backward Linkages of	1,353	546	500	4	43	192	2,638

Economic Activity	Personal Income Tax	Corporate Tax	Production and Products Tax	Transfer from Households	Investment Income	Other Income	Total Fiscal Revenue
	Short-Term Impacts $'000						
Crop Production							
Direct Impact of Livestock Production	862	1,564	1,487	2	20	89	4,024
Net Backward Linkages of Livestock Production	3,731	1,003	1,731	11	123	555	7,154
Food Processing	3,393	3,754	3,569	17	189	851	11,773
Total Revenue	**25,352**	**12,052**	**14,098**	**84**	**905**	**4,111**	**56,602**

Figure 16 shows the distribution of GOC fiscal revenues related to the Chin Reservoir Expansion Project. Personal income taxes represent about 45% of the fiscal revenues generated for the GOC, followed by production/product taxes (25%) and corporate taxes (21%).

The combined fiscal revenues for the GOA and GOC are shown in Table 33. The two levels of government would receive annual total fiscal revenues of about $146.4 million, which includes $14.6 million in transfer payments from the GOC to the GOA.

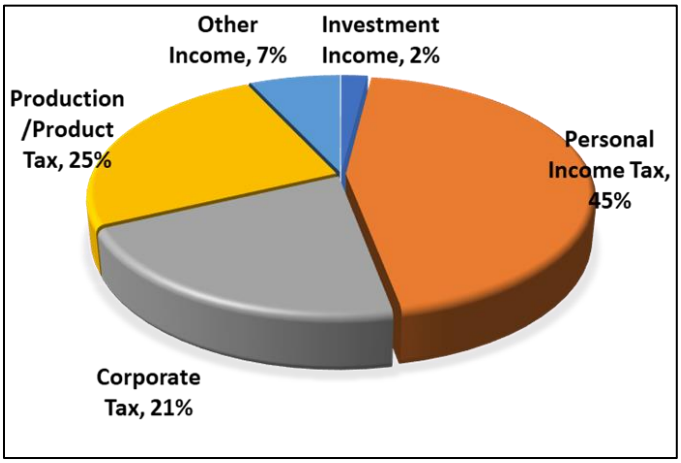

Figure 16. Distribution of GOC fiscal revenues associated with the Chin Reservoir Expansion Project.

Table 33. Combined GOA and GOC fiscal revenues – Chin Reservoir Expansion Project.

Government	Fiscal Revenues	Transfers	Net Fiscal Impact
GOA	$65,264,000	0	$65,264,000
GOC	$56,602,055	$12,595,000*	$44,007,055
Total	$121,866,055	$12,595,000*	$109,271,055

***Transfer of funds from GOC to GOA.

Considering the short, periodic, and annual timeframes when fiscal revenues are generated, it is estimated that about 45% of the total $121.9 million in combined annual revenues for the GOA

and GOC will be generated each year after the project comes to full operation. This equates to about $54.9 million/year (Table 34). The remaining $67.0 million would be generated only during specified years during the 50-year life of the project.

Table 34. Frequency of fiscal revenue generation for the GOA and GOC related to the Chin Reservoir Expansion project.

Frequency of Revenue Generation	GOA	GOC	Total Fiscal Revenues	Source of Fiscal Revenue
	$'000			
Short-Term	21,992	13,425	35,417	Construction of expanded reservoir
Periodic: Only during specific years	15,798	15,314	31,112	Purchase of farm machinery and equipment.
	0	0	0	Drought and flood mitigation events
Annually: After full maturity of the project	4,986	6,298	11,284	Crop and livestock production.
	22,488	21,565	44,053	Backward and forward linkages of crop and livestock production.
Total Fiscal Revenues	**65,264**	**56,602**	**121,866**	

CHAPTER 6.0 CUMULATIVE ECONOMIC IMPACTS OF CHIN RESERVOIR EXPANSION PROJECT

The previous chapters assessed the economic value of several activities related to development of the Chin Reservoir Expansion Project. Each activity resulted in increased sales of goods and services that positively impacted the province's GDP, income levels, and employment. These include:

- Irrigation crop production;
- Irrigation livestock production;
- Backward and forward linkages to irrigation crop and livestock production;
- On-farm investment in machinery and equipment;
- Construction of infrastructure;
- Drought mitigation; and
- Flood mitigation;
- Recreation; and
- Other non-irrigation water uses.

The economic impacts of these activities are affected by the timeframes when these expenditures take place. Three categories include: (1) Activities creating short-lived economic impacts; (2) Activities that are somewhat periodic; and (3) Activities that generate continuous annual economic impacts (Table 35).

Table 35. Category of economic activities related to the Chin Reservoir Expansion project.

Short-Term Impacts	Periodic Event-Based Impacts	Annual Impacts
Construction expenditures.	Farm machinery investment by agricultural producers. Drought mitigation. Flood mitigation.	Crop production. Livestock production. Backward linkages - crop production. Backward linkages - livestock production. Forward linkages.

This chapter summarizes the economic impacts of each irrigation-related activity and provides the combined economic impacts of all activities.

6.1 Short-Term Economic Impacts

Short-term economic impacts are created through construction expenditures for the Chin Reservoir expansion, estimated to be about $190 million. This is expected to increase the provincial GDP by about $163.7 million, generate about $61.4 million in labour income, and create about 865 direct FTEs. The total number of FTEs in the province would increase by 1,528. These impacts will only be experienced during the construction period, which is estimated to last for 3 years.

6.2 Periodic Impacts

Periodic economic activities are those whose timings are not fixed, including:

- Drought mitigation;
- Flood mitigation; and
- On-farm machinery and equipment investments.

The timing of incidence of these impacts cannot be determined precisely, and the impact is therefore estimated based on the past occurrences and occurrence probability.

6.2.1 Drought Mitigation

The value of irrigation in a drought year was estimated at $3.3 million. This estimate was based on an 8% drought probability in any given year. These events are estimated to increase the provincial GDP by $3.3 million and labor income by $3.3 million. No FTEs are supported. These impacts would only be realized during a drought period.

6.2.2 Flood Mitigation

As noted in Chapter 4, historically, irrigated and dryland farms in southern Alberta have experienced overland flooding on a regular basis. These flood events have also damaged private and municipal properties. Total damage in a typical a flood year includes loss of production and loss of incurred expenses for irrigated and dryland areas. In addition, significant expenses have been required to repair damages to private and municipal properties.

It is estimated that a flood event in 2005 impacted about 144,000 acres of irrigated farmland and 16,000 acres of dryland, either through direct flood damage or reduced irrigation because of infrastructure damage. In the June 2005 flood event, damages occurred on about 144,000 acres of irrigated land, and 16,000 acres of dryland areas. The total loss of agricultural production was estimated at $65.3 million. In addition, loss of private and municipal properties was estimated at $1.6 million, for a total of about $66.9 million. Construction of the Chin Reservoir expansion, combined with other infrastructure development along the SMRID main canal, are expected to significantly reduce the damaging impacts of the overland flooding. Construction of the Chin Reservoir expansion alone is expected to increase the provincial GDP by about $99 million, generate $77 million in labour income, and create an additional 546 FTEs.

6.2.3 On-Farm Investment in Machinery and Irrigation Equipment

To initiate irrigation production, producers will need to invest in water supply equipment (pivots) standard farming equipment (tractors, cultivators, combines), and specialized machinery for operations related to speciality crop production. Irrigation development on the 46,500-acre irrigation expansion area is expected to require on-farm investments totaling about $110.3 million during project development. This will include about $105.2 million for on-farm irrigation systems, and $5.1 million for specialized farm machinery. This investment is estimated to take place once every 15 years for the on-farm pivot systems, and every 10 years for the specialized farm machinery. These investments are estimated to generate about $41.4 million to the Alberta GDP, $26.7 million in labor income, and about 410 FTEs.

6.3 Annual Impacts

Annual economic impacts result from activities that are undertaken each year after the completion of the Chin Reservoir expansion.

6.3.1 Primary Crop Production – Direct and Backward Linked Impacts

For the total irrigated area of 46,500 acres in the expansion area, the gross sales of irrigated crop production are estimated to be $38 million annually. In contrast, for the same area of dryland, the gross sales of crop production are estimated to be $10.8 million. The irrigated croplands are estimated to produce a total net revenue of about $12,857,570 ($276.51/acre) for the 46,500

acres, compared with $1,148,799 ($24.70/acre) under dryland conditions – about 11 times higher.

Completion of the Chin Reservoir expansion would result in an increase in the total (direct, indirect, and induced) value of crop production by $59.4 million. This is expected to increase the provincial GDP by $34.8 million, generate $25.6 million as labour income, and create 261 FTEs.

6.3.2 Primary Livestock Production – Direct and Backward Linked Impacts

Since a portion of the new irrigated crop area is expected to support the production of forages and feed grains, irrigation farmers are expected undertake livestock production on their own farms or on the neighbouring farms. Total annual sales of livestock products related to the Chin Reservoir expansion are estimated to be about $98.2 million, compared with dryland livestock sales of about $8.7 million. The total (direct, indirect, and induced) irrigated livestock production is estimated to be about $220.4 million. This is expected to increase the provincial GDP by $62.6 million, generate $40.9 million in labour income, and create 727 FTEs.

6.3.3 Food Processing (Forward Linkages)

A proportion of the irrigation crop and livestock products related to the 46,500-acre Chin Reservoir expansion is expected to be processed in Alberta. The net value (direct) of processed crop and livestock products is estimated to be about $66 million. This is expected to increase the provincial GDP by $82.6 million, generate about $30 million in labour income, and create 630 FTEs. Note these impacts are over and above the value of the primary irrigated crop and livestock production.

6.4 Fiscal Revenues

The Chin Reservoir Expansion project is expected to annually generate about $121.9 million to the GOA and GOC, and this includes $12.6 million in transfer payments from the GOC to the GOA. About 45% ($54.9 million) of the total will be generated each year after the project comes to full operation, and the remaining 55% ($67.0 million) will be generated only during specified years during the 50-year life of the project.

6.5 Socio-Economic Impacts

The proposed Chin Reservoir expansion has the potential to promote direct and indirect benefits within and adjacent to the Chin Reservoir and the 46,500-acre irrigation expansion areas. Because the irrigation expansion areas are located along the length of the SMRID main canal, benefits will accrue to several communities such as Raymond, Magrath, Lethbridge, Coaldale, Taber, Bow Island and Medicine Hat. These benefits will potentially include:

- Expanded services related to supply of fertilizer, seed, herbicides, forage production supplies, and livestock supplies and services;
- Additional supply of machinery and on-farm irrigation equipment and supplies;
- Additional or expanded food processing companies, resulting in increased employment and support of local and regional families. This will increase the stability of rural communities throughout southern Alberta; and
- Increased tax base for rural communities to support schools, hospitals, and recreational facilities.

- Increased flood control will provide improved relief for communities and citizens, and reduce the resulting mental, physical and financial stress on individuals and families.

6.6 Summary of Key Impacts

The total economic impacts expected to be generated over the 50-year productive life of the Chin Reservoir Expansion project are shown in Table 36.

The 3-year construction period impacts are expected to increase the provincial GDP by about $163.7 million, labour income by about $61.4 million, and create 1,528 FTEs over the 3-year construction period. Following the construction period, irrigation producers are projected to complete irrigation development on the 46,500 acres over a 10-year period.

Irrigated crop and livestock production, and their associated backward and forward linkages, are expected to increase the provincial GDP by about $180 million annually, create about $96.7 million in labour income, and create 1,618 FTEs.

Increased investment in farm machinery and equipment by irrigation producers, increased irrigation income during the drought periods, and increased protection of farm and non-farm properties during overland flood events are estimated to increase the provincial GDP by $143 million, generate about $107 million in labour income, and about 956 FTEs.

Table 36. Summary of all economic impacts related to the Chin Reservoir Expansion Project.

Description	Output (Goods and Services) ($'000)				GDP ($'000)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
SHORT-TERM IMPACTS								
Construction Expenditures	190,000	100,337	53,582	343,919	74,741	55,933	32,999	163,673
Subtotal Short-Term Impacts	**190,000**	**100,337**	**53,582**	**343,919**	**74,741**	**55,933**	**32,999**	**163,673**
PERIODIC IMPACTS								
Investment in Pivot Systems	105,555	47,418	17,958	170,931	1,014	27,594	10,912	39,520
Farm machinery and Equipment	5,052	2,269	859	8,180	48	1,321	522	1,891
Drought Mitigation	3,300	0	0	2,700	3,300	0	0	3,300
Flood Mitigation	66,853	20,227	68,846	155,927	46,024	10,732	41,837	98,593
Subtotal Periodic Impacts	**180,760**	**69,914**	**87,663**	**338,337**	**50,386**	**39,647**	**53,271**	**143,304**
ANNUAL IMPACTS								
Crop Production-Direct and Backward Linkages*	27,210	9,498	22,667	59,375	16,200	4,900	13,700	34,800
Livestock Production-Direct and Backward Linkages*	89,445	67,650	63,271	220,366	8,700	32,100	21,800	62,600
Forward Linkages-Direct and Backward Linkages*	66,205	57,652	28,880	152,737	34,110	30,857	17,665	82,632
Sub-Total Annual Impacts	**182,860**	**134,800**	**114,818**	**432,478**	**59,010**	**67,857**	**53,165**	**180,032**

Description	Labour Income ($'000)				Employment (FTEs)			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
SHORT-TERM IMPACTS								
Construction Expenditures	3,902	34,717	22,792	61,410	865	370	293	1528
Subtotal Short-Term Impacts	**3,902**	**34,717**	**22,792**	**61,410**	**865**	**370**	**293**	**1528**
PERIODIC IMPACTS								
Investment in Pivot Systems	0	17,966	7,491	25,457	0	292	99	391
Farm Machinery and Equipment	0	860	359	1,219	0	14	5	19
Drought Mitigation	3,300	0	0	3,300	0	0	0	0
Flood Mitigation	42,520	5,886	28,720	77,126	102	68	376	546
Subtotal Periodic Impacts	**45,820**	**24,712**	**36,570**	**107,102**	**102**	**374**	**480**	**956**
ANNUAL IMPACTS								
Crop Production-Direct and Backward Linkages*	13,600	2,600	9,400	25,600	107	30	124	261
Livestock Production-Direct and Backward Linkages*	7,935	17,546	15,419	40,900	201	328	198	727
Forward Linkages-Direct and Backward Linkages*	14,586	3,453	12,149	30,188	224	247	159	630
Subtotal Annual Impacts	**36,121**	**23,599**	**36,968**	**96,688**	**532**	**605**	**481**	**1618**

*Net over dryland

Development of the Chin Reservoir Expansion project, over the 50-year project life, is estimated to increase the provincial GDP by about $487 million, generate about $265 million in labour income, and create 4,102 FTEs (Table 37).

Table 37. Summary of economic impacts related to Chin Reservoir Expansion Project.

Economic Activity	GDP	Labour Income	FTEs
Net Irrigation Crops – Direct	$16,200,000	$13,600,000	107
Net Irrigation Crops – Indirect and Induced	$18,600,000	$12,000,000	154
Net Irrigation Livestock – Direct	$8,700,000	$7,935,000	201
Net Irrigation Livestock – Indirect and Induced	$53,900,000	$32,965,000	526
Irrigation Crops and Livestock - Forward Linkages	$82,632,000	$30,188,000	630
Total Farm Level Investment	$41,411,000	$26,676,000	410
Construction of Infrastructure	$163,673,000	$61,410,000	1,528
Drought Mitigation	$3,300,000	$3,300,000	0
Flood Mitigation	$98,593,000	$77,126,000	546
Total Economic Impacts	**$487,009,000**	**$265,200,000**	**4,102**

7.0 Benefit-Cost Analyses

Two different types of analyses were developed for the Chin Reservoir Expansion Project:

1. Benefit - cost analysis from a private accounting standpoint (Financial Analysis); and
2. Social Benefit-Cost Analysis.

Results of the financial analysis and benefit-cost analysis are presented in this Chapter using the methodology presented in Appendix E.

7.1 Farm Financial Analysis

Financial analysis of the Chin Reservoir Expansion Project was undertaken on the assumption that producers pay all on-farm costs including the capital assets charge. The present value of all benefits and costs to the producers are shown in Table 38. Over the 50-year project life, the total benefits were estimated at about $1.83 billion, compared with total costs of about $1.83 billion.

Table 38. Present value of benefits and costs related to Chin Reservoir expansion.

Particulars	Costs ('000)
Benefits	
Gross Income from Crop Production	$425,029,863
Gross Income from Livestock Production	$1,398,639,293
Benefits from Drought Mitigation	$6,125,558
Total Benefits	**$1,829,794,714**
Costs	
Cost of Production - Crops	$242,131,270
Cost of Production - Livestock	$1,308,007,124
Investment in On-Farm Pivot Systems	$143,912,520
Investment in Specialized Farm Machinery and Equipment	$9,647,641
Capital Asset Charge	$124,742,633
Total Costs	**$1,828,441,188**

The above estimates were used to assess the project's economic desirability, and the results are shown in Table 39. The net present value (NPV) for irrigation development on the 46,500-acre expansion area over the 50-year project life is estimated to be $1.35 million.

The analysis indicates that the financial benefit-cost ratio for the Chin Reservoir irrigation expansion is about 1.00, which shows the project to be financially neutral. The internal rate of return is 3.63% which is slightly less than the 4% discount rate used in the analysis. Producers would be expected to see the benefits of this investment within 27 years.

Table 39. Financial analysis results for the Chin Reservoir Expansion Project.

Indicators	Results
Net Present Value	$1,353,526
Financial Benefit-Cost Ratio	**1.00**
Internal Rate of Return (%)	3.63
Return Period (Years)	27

The financial Benefit-Cost Ratio is somewhat influenced by the SMRID $4,000/acre capital asset charge for all new irrigation development in the Chin Reservoir expansion area. Combined with the $2,000/acre capital asset charge by the RID, new irrigation producers in the 46,500-acre Chin Reservoir expansion area will need to pay about $173 million before any irrigation development takes place. Without this capital asset charge, the Cost-Benefit Ratio is 1.07, which is somewhat more financially positive.

This study assumed that full irrigation development of the 46,500-acre expansion area would take place within ten years after construction of the Chin Reservoir expansion was complete. Discussions were held with key irrigation producers in southern Alberta to assess issues that might influence new irrigation development in the Chin Reservoir expansion area. The following are key conclusions from those discussions.

- **Acceptance of Capital Asset Charge:** Producers generally understand the need for the $4,000/acre capital asset charge and recognize there will be long-term benefits accruing from irrigation development in the Chin Reservoir expansion area.
- **Land Values:** Producers recognize that investing in new irrigation development immediately increases the value of dryland acres from about $6,500/acre to $16,000 - $20,000 per acre. This provides a significant incentive to participate in the Chin Reservoir expansion area.
- **Crop Prices:** Relatively high crop prices currently support investment in the irrigation expansion. However, most producers expect these prices to decline to more historic levels within the next 2 to 3 years.
- **Interest Rates:** Increasing interest rate charges will significantly impact annual loan payments, and some producers may delay committing to new irrigation development until they better understand interest rate trends and crop/livestock pricing.
- **RID Participation:** Large and small producers will likely commit early to take advantage of the irrigation expansion opportunity within the RID because of the reduced ($2,000/acre) capital asset charge.
- **SMRID Participation:** Producers with large irrigation land bases are more likely to participate early in the Chin Reservoir expansion area, because they have sufficient irrigation acres to support interest payments related to the new irrigation development. New and/or smaller irrigation producers may have difficulty front-ending the funds required for the $4,000/acre capital asset charge, plus the $2,270/acre irrigation infrastructure costs.
- **Participation Rate:** Irrigation uptake in the 46,500-acre Chin Reservoir expansion area may take longer than projected in this report because of increasing interest rates, and current limits to irrigation development, which are currently set at 160 acres per producer. This policy was enacted to ensure that as many producers as possible can participate in the expansion. However, this may result in a slowdown in the rate of new irrigation development if smaller producers are unwilling to participate because of the high front-end costs and increasing interest rates.

7.2 Social Benefit-Cost Analysis

The social benefit-cost analysis was undertaken using benefits of all economic entities in the province of Alberta. Benefits accruing to all regions outside the boundaries of the province were

excluded. The following adjustments were made in the results of the financial analysis of the project.

- Benefits were estimated for changes in income for workers and owners of unincorporated businesses.
- Total income generated included private income of irrigation producers, as well as other entities affected by this development (external benefits).
- Construction costs were included during the first three years of the project.

This analysis was also conducted using two additional scenarios:

- Benefits were measured only as direct income to the various economic entities; and
- Benefits were estimated as a sum of direct, indirect, and induced incomes.

Results of the present value of all costs and benefits are shown in Table 40, and the economic analysis indicators are presented in Table 41. When all members of society are included, the project generated an NPV of about $389 million (direct benefits), and $1.2 billion if all benefits (direct, indirect, and induced) are considered (Table 40).

The Benefit-Cost Ratio related to direct benefits is estimated to be 2.16 (Table 41), and increases to 4.71 if direct, indirect, and induced benefits are considered. Both Benefit-Cost Ratios indicate that undertaking the Chin Reservoir Expansion Project is economically positive. The Internal Rate of Return increases from 10.5% (direct benefits) to 19.6% (direct, indirect, and induced benefits). This conclusion is supported by the payback period estimates, which show that Alberta society will realize the benefits of this investment within 14 years (if only direct benefits are included) or 9 years (if all benefits are included). In conclusion, the project is socially positive for the Alberta economy.

Table 40. Estimated net present value of societal benefits and costs related to the Chin Reservoir Expansion Project.

Particulars	Direct Benefits/Costs	Direct, Indirect and Induced Benefits/ Costs
Benefits		
Net Benefits from Crop Production	$221,118,456	$418,213,164
Net Benefits from Livestock Production	$114,026,895	$605,296,546
Benefits from Drought Mitigation	$6,125,558	$6,125,558
Food Processing (Forward Linkages) Benefits	$227,836,983	$271,503,986
Benefits to Irrigation Equipment Dealers	$0	$772,741
Benefits to Specialized Machinery and Equipment Dealers	$0	$50,055
Benefits of Mitigated Flood Damage	$155,919,525	$282,818,656
Total Benefits	**$725,027,417**	**$1,584,780,706**
Costs		
Construction Costs*	$177,489,901	$177,490,000
Investment in Pivot Systems/Specialized Farm Equipment	$158,638,696	$158,638,696
Total Costs	**$336,128,597**	**$336,128,696**
Net Present Value	**$388,898,820**	**$1,248,652,008**

* Construction costs of $190 million

Table 41. Economic indicators for the Chin Reservoir Expansion project.

Indicators	Direct Benefits and Costs	Direct, Indirect and Induced Benefits
Net Present Value	$388,898,820	$1,248,652,008
Benefit-Cost Ratio (Financial Revenue-Cost Ratio)	**2.16**	**4.71**
Internal Rate of Return (%)	10.5	19.6
Return Period (Years)	14	9

CHAPTER 8 CONCLUSIONS

This study concludes that the proposed expansion of the Chin Reservoir can support sustained irrigation development on about $46,500 acres of existing dryland farms in the areas served by the RID and SMRID. The irrigation expansion, which is designed to allow participation by as many water users as possible, will take place in dispersed areas within or adjacent to the RID and SMRID. This is expected to:

- Optimize the number of producers that can participate in the new irrigation development; and
- Provide significant economic and societal benefits to rural and urban municipalities throughout southern Alberta.

8.1 Capital Costs

Dryland producers wishing to participate in irrigation development within the expansion areas will be required to make two capital investments before producing their first irrigation crop.

1. **Capital Asset Charge -** $4,000/acre in the SMRID and $2,000/acre in the RID for new irrigation development; and
2. **Capital Investment Expense -** Estimated to be about $2,271 per irrigated acre.

For irrigation development on the 46,500-acre Chin Reservoir expansion area, this will require that producers spend a combined (capital asset charge plus capital investment cost) total of $278,610,000 before the first irrigated crop is grown.

8.2 Economic Impacts

The economic impacts related to the Chin Reservoir expansion are affected by the timeframes when these expenditures are incurred. Three categories of activities were identified for this study:

- **Short-Term:** Create economic impacts for a limited period;
- **Periodic:** Occur periodically, and often without any predictability; and
- **Annual:** Generate continuous annual economic impacts.

8.2.1 Short-Term Economic Impacts

These impacts are created through the 3-year $190 million construction expenditure for the Chin Reservoir expansion. This is expected to increase the provincial GDP by about $163.7 million, generate about $61.4 million in labour income, and create 865 direct FTEs. The total number of FTEs would increase by 1,528. However, these impacts will only be experienced during the 3-year construction period.

8.2.2 Periodic Impacts

Periodic economic activities are those whose timing is not fixed, including:

- Drought mitigation;
- Flood mitigation; and
- On-farm machinery and equipment investments.

The timing of these impacts cannot be determined precisely, and the impact is therefore estimated based on the past occurrences and occurrence probability.

Drought Mitigation: The value of irrigation in a drought year was estimated at $3.3 million, based on 8% drought probability in any given year. Mitigating these events are estimated to increase the provincial GDP by $3.3 million and labour income by $3.3 million. No FTEs are supported.

Flood Mitigation: Significant areas of irrigated and dryland production in southern Alberta have experienced overland flooding on a regular basis. These flood events have also damaged private and municipal properties, and loss of production and loss of incurred expenses for irrigated and dryland areas. In addition, significant expenses have been required to repair damages to private and municipal properties. Construction of the Chin Reservoir expansion, combined with other infrastructure development along the SMRID main canal, are expected to significantly reduce the damaging impacts of the overland flooding. Construction of the Chin Reservoir expansion is expected to increase the provincial GDP by about $99 million, generate $77 million in labour income, and create an additional 546 FTEs.

On-Farm Investment in Machinery and Irrigation Equipment: Irrigation development on the 46,500-acre irrigation expansion area is expected to require on-farm investments totaling about $110.3 million during project development. This will include about $105.2 million for on-farm irrigation systems, and $5.1 million for specialized farm machinery. These investments are estimated to generate about $41.4 million to the Alberta GDP, $26.7 million in labor income, and about 410 FTEs.

8.2.3 Annual Impacts

Annual economic impacts result from activities that are undertaken each year after the completion of the Chin Reservoir expansion.

Primary Crop Production – Direct and Backward Linked Impacts: For the total irrigated area of 46,500 acres in the expansion area, gross sales of irrigated crop production are estimated to be $38 million annually. By comparison, the same area of dryland, generates about $10.8 million in crop production gross sales. The irrigated croplands are estimated to produce a total net revenue of about $12,857,570 ($276.51/acre) for the 46,500 acres, compared with $1,148,799 ($24.70/acre) under dryland conditions – about 11 times higher. Development of the Chin Reservoir Expansion project would increase in the total value of irrigation production by $27.2 million. This is expected to increase the provincial GDP by $34.8 million, generate $25.6 million as labour income, and create 261 FTEs.

Primary Livestock Production – Direct and Backward Linked Impacts: Total annual sales of livestock products related to the Chin Reservoir expansion are estimated to be about $98.3 million, compared with dryland livestock sales of about $8.7 million. The $89.6 million difference between irrigated and dryland livestock production is expected to increase the provincial GDP by $62.6 million, generate $40.9 million in labour income, and create 727 FTEs.

Food Processing (Forward Linkages): The net value of processed crop and livestock products is estimated to be about $66 million. This is expected to increase the provincial GDP by $82.6 million, generate about $30 million in labour income, and create 630 FTEs. Note these impacts are over and above the value of the primary irrigated crop and livestock production.

8.2.4 Fiscal Revenues

The Chin Reservoir Expansion project is expected to annually generate about $121.9 million to the GOA and GOC, which includes $12.6 million in transfer payments from the GOC to the GOA. About 45% ($54.9 million) of that total will be generated each year after the project comes

to full operation, and the remaining 55% ($67.0 million) will be generated only during specified years during the 50-year life of the project.

8.3 Summary of Key Impacts

The total economic impacts expected to be generated during the 50-year productive life of the Chin Reservoir Expansion Project are shown in Table 42. Development is expected to increase the provincial GDP by about $487 million, generate about 265 million in labour income, and add 4,102 FTEs.

Table 42. Summary of economic impacts related to Chin Reservoir Expansion Project.

Economic Activity	GDP	Labour Income	FTEs
Net Irrigation Crops – Direct	$16,200,000	$13,600,000	107
Net Irrigation Crops – Indirect and Induced	$18,600,000	$12,000,000	154
Net Irrigation Livestock – Direct	$8,700,000	$7,935,000	201
Net Irrigation Livestock – Indirect and Induced	$53,900,000	$32,965,000	526
Irrigation Crops and Livestock - Forward Linkages	$82,632,000	$30,188,000	630
Total Farm Level Investment	$41,411,000	$26,676,000	410
Construction of Infrastructure	$163,673,000	$61,410,000	1,528
Drought Management	$3,300,000	$3,300,000	0
Flood Mitigation	$98,593,000	$77,126,000	546
Total Economic Impacts	**$487,009,0000**	**$265,200,000**	**4,102**

8.4 Farm Benefit-Cost Ratio

The financial analysis of the Chin Reservoir Expansion Project shows that the present value of all benefits and costs to the producers over the 50-year project life were estimated at about $1.83 billion, compared with total costs of about 1.83 billion. Based on these estimates, the NPV for irrigation development on the 46,500-acre expansion area is estimated to be about $1.35 million. The financial benefit-cost ratio is about 1.00, which indicates that the project is financially neutral for the irrigation producers. The IRR is 3.63% which is slightly lower than the 4% discount rate used in the analysis. Producers should realize the benefits of this project investment within 27 years.

The financial Benefit-Cost Ratio is influenced by the SMRID's $4,000/acre capital asset charge for all new irrigation development in the Chin Reservoir expansion area. Combined with the $2,000/acre capital asset charge by the RID, new irrigation producers in the 46,500-acre Chin Reservoir expansion area will need to pay about $173 million before any irrigation development takes place. Without this capital asset charge, the Cost-Benefit Ratio is 1.07, which is somewhat more financially positive.

This study assumed that full irrigation development on the 46,500-acre expansion area would take place within ten years after construction of the Chin Reservoir expansion was complete. Discussions with representative irrigation producers in southern Alberta were held to identify

issues that might influence new irrigation development in the Chin Reservoir expansion area. Following are key conclusions from those discussions.

- **Acceptance of Capital Asset Charge:** Producers generally understand the need for the $4,000/acre capital asset charge and recognize there will be long-term benefits accruing from irrigation development in the Chin Reservoir expansion area.
- **Land Values:** Producers recognize that investing in new irrigation development immediately increases the value of dryland acres from about $6,500/acre to $16,000 - $20,000 per acre. This provides a significant incentive to participate in the Chin Reservoir expansion area.
- **Crop Prices:** Relatively high crop prices currently support investment in the irrigation expansion. However, most producers expect these prices to decline to more historic levels within the next 2 to 3 years.
- **Interest Rates:** Increasing interest rate charges will significantly impact annual loan payments, and some producers may delay committing to new irrigation development until they better understand interest rate trends and crop/livestock pricing.
- **RID Participation:** Large and small producers will likely commit early to take advantage of the irrigation expansion opportunity within the RID because of the reduced ($2,000/acre) capital asset charge.
- **SMRID Participation:** Producers with large irrigation land bases are more likely to participate early in the Chin Reservoir expansion area, because they have sufficient irrigation acres to support interest payments related to the new irrigation development. New and/or smaller irrigation producers may have difficulty front-ending the funds required for the $4,000/acre capital asset charge, plus the $2,270/acre irrigation infrastructure costs.
- **Participation Rate:** Irrigation uptake in the 46,500-acre Chin Reservoir expansion area may take longer than projected in this report because of increasing interest rates, and current limits to irrigation development, which are currently set at 160 acres per producer. This policy was enacted to ensure that as many producers as possible can participate in the expansion. However, this may result in a slowdown in the rate of new irrigation development if smaller producers are unable to participate because of the high front-end costs and increasing interest rates.

8.5 Social Benefit-Cost Ratio

The societal analysis indicated that the Chin Reservoir Expansion Project generated an NPV of $389 million (direct benefits), and $1.2 billion if all benefits (direct, indirect, and induced) are considered.

The benefit-cost ratio related to direct benefits is estimated to be 2.16, and increases to 4.71 if direct, indirect, and induced benefits are considered. The IRR increases from 10.5% (direct benefits) to 19.6% (direct, indirect, and induced benefits). Alberta society will realize the benefits of this project investment within 14 years (if only direct benefits are included) or 9 years (if direct, indirect, and induced benefits are included).

In conclusion, the project is considered positive for the Alberta economy.

8.6 Socio-Economic Impacts

The proposed Chin Reservoir expansion has the potential to promote direct and indirect benefits within and adjacent to the Chin Reservoir and the 46,500-acre irrigation expansion areas. Because the irrigation expansion areas are located along the length of the SMRID main canal, benefits will accrue to rural and urban municipalities throughout southern Alberta. These benefits will potentially include:

- Expanded services related to supply of fertilizer, seed, herbicides, forage production supplies, and livestock supplies and services;
- Additional supply of machinery and on-farm irrigation equipment and supplies;
- Additional or expanded food processing companies, resulting in increased employment and support of local and regional families. This will increase the stability of rural communities throughout southern Alberta;
- Increased tax base for rural and urban communities to help support schools, hospitals, recreational facilities, and law enforcement; and
- Increased flood control will provide improved relief for communities and citizens, and reduce the resulting emotional, physical and financial stress on individuals and families.

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APPENDICES

Appendix A. RID, SMRID, and TID Crop Data (2011, 2015, 2020)

Table 43. Crop acreage for the RID, SMRID, and TID (2011, 2015, 2020).

Crop Type		Districts			Total All Districts (2011)	Districts			Total All Districts (2015)	Districts			Total All Districts (2020)	Average All Districts (2011, 2015, 2020)
		SMRID	TID	RID		SMRID	TID	RID		SMRID	TID	RID		
		Year - 2011				Year - 2015				Year - 2020				
		Acres Actually Irrigated				Acres Actually Irrigated				Acres Actually Irrigated				
Cereals	Winter Wheat	6,036	510	1,125	7,671	13,299	751	1,872	15,922	13,389	1,540	595	15,524	13,039
	Spring Wheat	70,393	13,081	4,720	88,194	63,795	16,796	1,529	82,120	39,408	12,898	3,183	55,489	75,268
	Soft Wheat	3,407	355	-	3,762	10,926	797	261	11,984	11,658	499	-	12,157	9,301
	Durum Wheat	24,089	1,641	320	26,050	28,089	1,748	4,271	34,108	40,261	2,761	1,040	44,062	34,740
	CPS	130	28	-	158	-	479	343	822	3,792	-	1,800	5,592	2,191
	Oats	812	511	55	1,378	116	410	160	686	577	266	319	1,162	1,075
	Malt Barley	58	-	-	58			-	-	645	-	1,400	2,045	701
	Barley	18,636	9,628	7,936	36,200	15,862	5,754	7,168	28,784	27,607	5,604	2,247	35,458	33,481
	Rye	-	-	-	-	75	125	-	200	2,938	290	1,151	4,379	1,526
	Corn (Grain)	2,466	1,450	-	3,916	7,187	2,900	-	10,087	4,073	2,235	-	6,308	6,770
	Triticale	1,419	87	-	1,506	299	315	260	874	1,457	-	-	1,457	1,279
	Sub-Total	**127,446**	**27,291**	**14,156**	168,893	**139,648**	**30,075**	**15,864**	185,587	**145,805**	**26,093**	**11,735**	**183,633**	**179,371**
Oilseeds	Flaxseed	2,770	161	-	2,931	11,667	585	245	12,497	3,965	663	43	4,671	6,700
	Canola	54,974	3,330	8,684	66,988	40,436	2,371	5,192	47,999	34,571	2,788	9,113	46,472	53,820
	Mustard Seed	-	-	-	-	-	60	141	201	250	5	-	255	152
	Safflower	-	-	-	-	-	-	-	-	-	-	-	-	-
	Sub-Total	**57,744**	**3,491**	**8,684**	**69,919**	**52,103**	**3,016**	**5,578**	**60,697**	**38,786**	**3,456**	**9,156**	**51,398**	**60,671**
Specialty Crops	Seed Canola	12,746	4,623	-	17,369	13,251	3,274	-	16,525	14,394	3,637	-	18,031	17,308
	Peas, Dry	3,080	14	68	3,162	6,577	298	756	7,631	6,317	336	405	7,058	5,950
	Lentils	247	46	-	293	2,275	60	-	2,335	4,285	-	-	4,285	2,304
	Beans, Dry	18,915	1,694	-	20,609	27,746	3,066	-	30,812	29,069	5,656	-	34,725	28,715
	Fababeans	380	220	-	600	1,285	280	-	1,565	1,674	-	-	1,674	1,280
	Alfalfa Seed	-	-	-	-	209	-	-	209	2,096	132	-	2,228	812
	Processing Potatoes	16,863	9,973	-	26,836	15,800	10,429	-	26,229	19,384	9,908	-	29,292	27,452
	Fresh Peas	1,981	1,250	-	3,231	1,695	1,754	-	3,449	1,580	2,243	-	3,823	3,501
	Fresh Corn	1,415	1,706	-	3,121	1,304	1,445	-	2,749	631	2,537	-	3,168	3,013
	Hemp	1,925	150	-	2,075	7,665	130	165	7,960	5,603	136	251	5,990	5,342
	Sugar Beets	12,536	6,379	-	18,915	7,558	3,758	-	11,316	10,497	5,109	-	15,606	15,279
	Market Gardens	199	5	15	219	243	21	50	314	687	-	88	775	436
	Other Specialty Crops	9,137	1,182	82	10,401	11,925	1,988	-	13,913	9,364	2,434	43	11,841	12,052
	Sub-Total	**79,424**	**27,242**	**165**	**106,831**	**97,533**	**26,503**	**971**	**125,007**	**105,581**	**32,128**	**787**	**138,496**	**123,445**
Forages	Corn (Silage)	13,387	3,001	1,439	17,827	18,181	3,739	1,777	23,697	25,927	5,415	3,129	34,471	25,332
	Timothy Hay	4,797	1,770	-	6,567	5,190	1,895	585	7,670	8,940	**4,246**	700	13,886	9,374
	Tame Pasture	8,439	2,737	1,522	12,698	7,958	3,234	3,640	14,832	8,066	2,633	4,367	15,066	14,199
	Alfalfa (2-3 cuts)	15,471	-	-	15,471	16,212	5,481	5,800	27,493	13,791	3,118	10,432	27,341	23,435
	Alfalfa Hay	12,124	6,661	10,230	29,015	8,618	1,147	5,300	15,065	18,113	3,231	-	21,344	21,808
	Alfalfa Silage	2,256	523	96	2,875	1,677	175	90	1,942	260	175	189	624	1,814
	Barley Silage	10,335	1,127	721	12,183	7,823	776	1,844	10,443	6,446	535	3,093	10,074	10,900
	Other Forages	12,097	588	-	12,685	16,841	836	1,844	19,521	16,115	2,462	949	19,526	17,244
	Sub-Total	**78,906**	**16,407**	**14,008**	109,321	**82,500**	**17,283**	**20,880**	120,663	**97,658**	**21,815**	**22,859**	142,332	**124,105**
	Miscellaneous	995	136	-	1,131	1,507	238	42	1,787	1,776	211	-	1,987	1,635
	Sub-Total	**995**	**136**	**-**	**1,131**	**1,507**	**238**	**42**	**1,787**	**1,776**	**211**	**-**	**1,987**	**1,635**
Total Acres Actually Irrigated		**344,515**	**74,567**	**37,013**	**456,095**	**373,291**	**77,115**	**43,335**	**493,741**	**389,606**	**83,703**	**44,537**	**517,846**	**489,227**
Total Assessed Acres		**374,408**	**82,773**	**46,302**	**503,483**	**390,496**	**83,584**	**46,500**	**520,580**	**410,775**	**86,186**	**48,097**	**545,058**	**523,040**
% Actually Irrigated		**92**	**90**	**80**	**91**	**96**	**92**	**93**	**95**	**95**	**97**	**93**	**95**	**94**

Appendix B Farm Level Simulation Model

Estimating the economic impacts of the Chin Reservoir Expansion project required an assessment of changes at the farm level related to the new irrigation development. These changes were estimated using the Irrigation Benefits Simulation Model. It estimates the relationship between irrigated production and livestock numbers, the economics of crop and livestock production, and overall returns to new irrigation producers, over and above current of dryland production.

The model consists of 12 worksheets, which were linked together (where needed).

1. Title: "Chin Reservoir Irrigation Benefits Simulation".
2. Parameters: Lists the assumption and/or targets for irrigation development related to the Chin Reservoir expansion, includes the RID and SMRID.
3. Area: This worksheet identifies the average area irrigated in the two irrigation districts.
4. Crop Yield: Identifies yields for selected crops grown in the project region under irrigated and dryland conditions.
5. Cost of Production: Identifies the cost of production for crops under dryland and irrigated conditions.
6. Crop Mix: Identifies the crop mix assumed to be followed by irrigation producers in the region, based on the existing crop mix in the RID and SMRID. Tables 44 and 45 identify irrigation and dryland crops, respectively.
7. Livestock Production: Estimates livestock types and numbers on irrigation and dryland farms, and their economic value.
8. Net Revenue Crops: Data on the crop types, yields and prices are used to determine net revenue from crops grown under irrigated and dryland conditions.
9. Net Revenue Livestock: Presents the net revenue of livestock and livestock products produced under irrigated and dryland conditions.
10. Investment Costs: Includes investment in on-farm irrigation water supply equipment (pivot irrigation systems), specialized farm machinery, and equipment required for specialty irrigation crop production.
11. Farm Income (Irrigation): Assesses income over a specified timeline (50 years) and annual adoption rate (10%) for on-farm irrigation development for the proposed irrigation expansion areas.
12. Farm Income (Dryland): Assesses income over a specified timeline and adoption rate for on-farm dryland production for an area like the irrigation expansion areas.

Table 44. Potential irrigation crop mix for the Chin Reservoir expansion area.

Crop Type		Area 1	Area 2	Area 3	Area 4	Total
Cereals	Spring Wheat	1,700	2,370	1,210	1,480	6,760
	Soft Wheat	150	240	170	-	560
	Durum Wheat	870	1,660	750	890	4,170
	Barley	750	1,180	345	370	2,645
	Corn (Grain)	160	470	405	960	1,995
	Sub-Total	**3,630**	**5,920**	**2,880**	**3,700**	**16,130**
Oilseeds	Flaxseed	460	255	180	300	1,195
	Canola	1,800	2,305	720	700	5,525
	Sub-Total	**2,260**	**2,560**	**900**	**1,000**	**6,720**
Specialty Crops	Seed Canola	400	1,000	460	130	1,990
	Peas, Dry	400	1,040	575	650	2,665
	Lentils	-	-			-
	Beans, Dry	300	960	920	990	3,170
	Processing Potatoes	160	400	520	470	1,550
	Hemp	160	-			160
	Sugar Beets	120	600	405	360	1,485
	Sub-Total	**1,540**	**4,000**	**2,880**	**2,600**	**11,020**
Forages	Corn (Silage)	730	705	800	990	3,225
	Timothy Hay	210	180	140	-	530
	Tame Pasture	200	100		200	500
	Alfalfa (2-3 cuts)	2,360	2,040	1,120	1,250	6,770
	Barley Silage	570	495	280	260	1,605
	Sub-Total	**4,070**	**3,520**	**2,340**	**2,700**	**12,630**
Total Expansion Acres		**11,500**	**16,000**	**9,000**	**10,000**	**46,500**

Table 45. Estimated dryland crop mix related to the Chin Reservoir expansion area.

Category	Crop	Acres*	Share by Crop Category (%)
Cereals	**Spring Wheat**	9,486	36
	Durum Wheat	1,441	
	Other Wheats	186	
	Barley	4,603	
	Other Grains	837	
Total		16,553	
Oilseeds	**Canola**	10,462	22
Total		**10,462**	
Specialty Crops	**Peas, Dry**	2,511	5
Total		**2,511**	
Forages	**Corn Silage**	47	37
	Tame Pasture	9,068	
	Alfalfa	419	
	Tame Hay	7,440	
Total		**16,974**	
Total		**46,500**	**100**

* May not add exactly because of rounding

Appendix C

C.1. Alberta Input/Output Model

Irrigation development creates two types of changes: (1) Irrigation producers require more input to produce their goods than dryland farms; and (2) The value of output produced under irrigation is often of higher value than dryland farms. Some portion of the irrigation output may be used as input by value-added industries.

Total irrigation-related economic impacts are created through backward linkages and forward linkages. Backward linkages are related to purchase of inputs needed from other industries in the local region. Forward linkages are created by the firm selling its product to another industry for further value-adding (processing). Both linkages create three types of economic impacts: (1) Direct economic impacts; (2) Indirect economic impacts; and (3) Induced economic impacts. To estimate the total impacts of irrigation through backward and forward linkages the Alberta Input/Output Model was developed and used.

The Alberta Input/Output Model is a demand driven model, and supply constraints are not considered. The model is solved under the assumption that all required inputs are available in the region at the time of production. This model is a provincial scale model that is based on a rectangular input-output accounting of the economy. It is also called a 'commodity by sector' model by Statistics Canada. Display of the transactions for an economy is called transactions table, which is the heart of the model.

Data for the development of the Alberta Input/Output Model were obtained from Statistics Canada. This consisted of two basic tables: (1) Supply matrix, and (2) Make matrix. The input matrix shows trade in commodities by various sectors need for its own production. The second table shows the make-up of production of each sector in terms of commodities. The original set of data received from Statistics Canada was at the resolution of the provincial economy. Therefore, in the AEIAM, the number of sectors and commodities were reduced to a number considered more manageable.

The terminology used in the input-output impact analysis can be described as follows:

(1) **Commodity:** A name given to any good or service that is purchased or sold by a business (called a sector in this methodology). Goods and services with some common attributes are grouped into a given category. A typical model would have several commodities to be traded. All commodities in an economy are classified into two categories: Intermediate Commodities and Primary Commodities.

(2) **Sector:** Businesses (or firms) selling similar goods or services (commodities) are grouped as a sector. A sector includes several firms producing a similar mix of commodities. A given sector can purchase its inputs from other sectors as well as sell its output to other sectors for further processing or for final consumption.

(3) **Intermediate Commodities/Inputs (for sale or purchase):** Transactions made by one sector from another sector in the form of commodities. These are typically inputs required to produce commodities by that sector.

(4) **Primary Commodities / inputs:** These commodities are those that generate gross domestic product for a region. These typically include various components of the gross domestic product.

(5) **Final Demand Sector:** Sales of a commodity by sector for final consumption or use. These sales leave the economic system and do not enter back for any further processing by any goods and services producing sector.
(6) **Primary Sector:** A sector that contributes to the gross domestic product of the region. These sectors trade in primary commodities.

The Alberta Input/Output Model includes a total of 61 sectors, of which seven account for primary inputs. The model includes agricultural production, which is sub-divided into irrigated and dryland production, and further sub-divided into crop production, livestock production, greenhouse production, non-cattle livestock production, and food processing.

C.2 Procedures for Economic Impact Analysis and Estimation

All economic impact assessments used an Economic Impact Analyzer (EIA), which has the capability of removing various margins and imports. Once the economic impacts are estimated, they are presented in the following forms.

- Disaggregated tables, which include:
    - Output (equivalent of sales of the sector;
    - Indirect taxes;
    - Subsidies;
    - Labour income (income of households);
    - Operating surplus (includes gross profits of the corporation before income tax, and includes capital consumption allowance, net investment income, dividends paid net of dividend received, and inventory valuation adjustment);
    - Interprovincial imports;
    - Foreign imports;
    - Other leakages; and
- Employment (FTEs). The aggregated table presents six type of impacts: (Output); (Gross Domestic Product at factor cost; (3) Gross Domestic Product at market prices; (4) Imports; (5) Labour Income; and (6) Employment. .
- Aggregated tables, which include:
    - Output;
    - Gross Domestic Product at factor cost;
    - Gross Domestic Product at market prices;
    - Imports;
    - Labour Income; and
    - Employment.

Each of the results are estimated at two levels of economic interaction:

- Type I Impacts, which include only backward linkages, excluding the effect of labour income; and
- Induced Impacts, which include, along with Type I impacts, the effects of consumer income being spent on goods and services produced in the province of Alberta.

Using the EIA involves the following steps.

1. Crop data (varieties, yield, and acreage) in the RID, SMRID, and TID were collected.
2. For each crop in Step 1, cost of production data were obtained from a variety of sources. Every attempt was made to utilize cost of production data for irrigated crops grown in

Alberta. However, where data were not available, cost of production data were obtained from Saskatchewan and Manitoba. Returns to owned labour were not included.

3. Gross revenue for each crop was estimated, using crop yield and price data.
4. Net returns per acre to produce each crop was determined (Gross Revenue minus Cost of Production).
5. Cost of production and net revenues were weighted by the proportion of each crop grown in the Chin Reservoir expansion area.
6. The values in Step 5 were multiplied by 46,500 acres (the suggested irrigated area of the Chin Reservoir expansion area).
7. Direct employment created by the irrigated crop production was estimated using data in the Acera Consult Inc., 2020 report and prorated to the size of the Chin Reservoir expansion area.
8. Various goods producing sectors resulting from the irrigated crop production were identified and inserted into an Input-Output commodity classification system (Table 46). The resulting commodities being purchased to produce the irrigated crops are shown in column 2 in Table 46. Total value of production from irrigated crops was estimated at $36.6 million annually (direct impact).

Table 46. Inputs and revenue of producers for irrigated crop production in the Chin Reservoir expansion area.

Commodities	Initial Demand Vector	Initial & Margins Removed	Margins & Imports Removed
Column 1	Column 2	Column 3	Column 4
1 Irrigated Other Crops	3,453,400	2,581,200	1,799,600
2 Dryland Other Crops		0.0	0.0
3 Irrigated Feed		0.0	0.0
4 Dryland Feed		0.0	0.0
5 Irrigated Cattle & Calves		0.0	0.0
6 Dryland Cattle & Calves		0.0	0.0
7 Irrigation Other Animals		0.0	0.0
8 Dryland Other Animals		0.0	0.0
9 Forestry Product		0.0	0.0
10 Crude oil		0.0	0.0
11 Energy production	730,700	625,900	361,200
12 Electricity	1,011,800	1,055,000	1,044,000
13 Mining ores	0	0.0	0.0
14 Sewage Disposal	730,700	730,700	730,700
15 Potash		0.0	0.0
16 Gravel Production		0.0	0.0
17 Non-Metallic Minerals		0.0	0.0
18 Seafood Production		0.0	0.0
19 Meat Production prod.		0.0	0.0
20 Dairy Production		0.0	0.0

Commodities	Initial Demand Vector	Initial & Margins Removed	Margins & Imports Removed
21 Animal Feeds		0.0	0.0
22 Other Food Production		0.0	0.0
23 Soft Drinks		0.0	0.0
24 Tobacco Production		0.0	0.0
25 Textile Production		0.0	0.0
26 Lumber Production		0.0	0.0
27 Pulp & Paper Production		0.0	0.0
28 Petroleum Production	1,104,400	705,700	354,500
29 Chemical Production	5,832,400	4,212,400	1,936,500
30 Iron Production		0.0	0.0
31 Agric. machinery & equipment	1,468,900	916,400	59,000
32 Other Machinery		0.0	0.0
33 Computers & parts		0.0	0.0
34 Communication Equipment		0.0	0.0
35 Electronic Production		0.0	0.0
36 Motor Vehicles		0.0	0.0
37 Aircrafts		0.0	0.0
38 Railway Production		0.0	0.0
39 Construction mat.		0.0	0.0
40 Published Production		0.0	0.0
41 Transportation	638,000	1,436,000	926,900
42 Warehouse & Storage		0.0	0.0
43 Commissions		2,536,700	2,030,200
44 Repair		0.0	0.0
45 Rental & Leasing (excluding real estate)		0.0	0.0
46 Real Estate Leasing		0.0	0.0
47 Buildings		0.0	0.0
48 Engineering Works		0.0	0.0
49 Intellectual Property		0.0	0.0
50 Mineral exploration		0.0	0.0
51 Software		0.0	0.0
52 Licensing		0.0	0.0
53 Support & custom services		0.0	0.0
54 Support service mining		0.0	0.0
55 Cons. & manufacturing services		0.0	0.0
56 Advertising		0.0	0.0
57 Communications		0.0	0.0
58 Financial services	691,800	689,000	473,300

Commodities	Initial Demand Vector	Initial & Margins Removed	Margins & Imports Removed
59 Insurance	976,600	976,400	517,300
60 Professional services		0.0	0.0
61 Other administration services		0.0	0.0
62 Accommodation		0.0	0.0
63 Personal care		0.0	0.0
64 Federal services		0.0	0.0
65 Provincial services		0.0	0.0
66 Municipal and aboriginal services		0.0	0.0
67 Residual commodities		0.0	0.0
68 Indirect taxes	1,360,800	1,641,000	1,641,000
69 Subsidies			
70 Labour income	15,272,900	15,272,900	15,272,900
71 Other operating surplus	3,194,100	3,194,100	3,194,100
72 Imports interprovincial (provincial models only)			2,791,600
73 Imports foreign			3,440,700
74 Other leakages			
75 Total employment	140,000	140,000	140,000
76 Total (not including employment)	**36,606,500**	**36,713,400**	**36,713,500**

C.3 Using the Economic Impact Analyzer

The EIA is a combination of data matrices and a sub-routine for preparation of a given simulation scenario. The following seven data matrices (or coefficients) are included.

(1) A base transactions matrix in a sector-by-sector dimension using revised Statistics Canada data (*Zfinal*).

(2) A matrix containing self-supply ratios (*smat*), which shows the proportion of the total production provided by the local economy, and the proportion that is imported.

(3) A *dmat* is included that contains the share of each commodity produced by a sector. This matrix is used to convert values in a commodity format into sector format.

(4) A vector of margins (*margins*) for various commodities (including wholesale and retail margins, transportation margins, storage margins, and tax margins).

(5) A vector containing an employment coefficient (*ecoef*) which identifies the relationship between employment and output for a given sector.

(6) A location quotient is included in the data tables to calculate sub-regional input-output coefficients. If impacts are for a whole region (such as Canada, Saskatchewan or Alberta), this step is skipped.

(7) A value identifying the average propensity to consume, which is required to estimate induced impacts. This value illustrates the proportion of labour income being spent on goods and services produced within the regional economy

Using this information, the economic impacts can be assessed for a given scenario, through the following steps.

Step One: The program can assess economic impacts for several regions, including: Canada, Canada – East, Canada – West, Alberta, and Saskatchewan. For this study, the province of Alberta was selected as the impact region.

Step Two: The scenario data developed in step eight (Section C.1) are manually transferred to Column 2 (Table 46).

Step Three: The next step removes the contribution of marketing intermediaries included in the retails value of goods and services by that sector and records the amount supplied by that sector only. These values are shown in Column 3 (Table 46).

Step Four: Since the values in Column 3 of Table 46 are total purchases, a portion of these values could be supplied through imports. Since imports are leakages from the local economy, the values need to be netted out for imported goods and services. The program does this and saves these values in Column 4 of Table 46.

Step Five: Since the transactions matrix is in a square format (sector by sector), and values in Column 4 of Table 46 are in commodity format, these values must be converted into sectors. The matrix *dmat* is used to do this conversion. Now the scenario is in the sector format.

Step Six: The last step is the "Estimate Impact". This step results in creation of several impact tables, all in a sectoral dimension.

The results are presented in the following six worksheets.

Worksheet One – Description: The region of impact, and date of impact assessment are recorded.

Worksheet Two – Initial: Records the values of the scenario in commodity as well as sectoral dimensions, and are the direct impact of the scenarios.

Worksheet Three – Multipliers: This presents the multiplier activity created by the scenario for each intermediate sector in the model. Type I (Direct and indirect) and Type II (Direct, Indirect and Induced) multipliers are included here for each sector.

Worksheet Four – Results I: Includes Type I impacts on a detailed level (nine economic criteria) for each of the goods producing sector except employment which is in full-time equivalents. These nine criteria are: (1) Output (sales of goods and services by the sector); (2) Indirect Taxes, that are paid to various levels of governments; (3) Subsidies, received by the sector from various levels of the governments; (4) Labour Income – Money earned by household for producing goods and services; (5) Operating Surplus – Which is undistributed surplus of the various corporations of the given sector; (6) Imports, Interprovincial – Value of total imports from other Canadian provinces for goods produced by that sector; (7) Imports, Foreign – Value of imported goods from other countries; (8) Other Leakages – Includes other adjustments (such as inventory adjustments); and (9) Employment – Number of full-time equivalents created under the given scenario.

Worksheet Five – Results II: Contains the same nine economic indicators listed in Results I, except these are Type II economic impacts.

Worksheet Six – Summary I: Is a more condensed form of economic impact indicators for each sector created by the scenario. The relationships of these are related to the indicators in Table 47, and the results of the Type II economic impacts are shown in Table 48.

Table 47. Relationship between detailed and summary form list of indicators of economic impacts.

Summary For Indicator	Detailed Indicator
Output	**Output**
Gross domestic product at factor cost	Labor income + operating surplus
Gross domestic product at market prices	Labor income + Operating surplus + Indirect taxes - Subsidies
Imports	Interprovincial imports + Foreign imports + Other leakages
Labour Income	Labour income
Employment	Employment

Table 48. Summary of Type II economic impacts on the Alberta economy from irrigated crop production in the Chin Reservoir expansion area, by sectors and impact indicators.

Sectors	Output	GDP (Factor Cost)	GDP (Market Price)	Imports	Labor Income	Employment
	$'000					'000
1 Irrigated Other Crop Production	163.7	84.7	86.2	30.6	36.3	0.3
2 Dryland Other Crop Production	16,80.9	828.0	842.1	336.2	352.3	2.7
3 Irrigated Feed Production	55.5	33.0	33.5	8.0	14.9	0.1
4 Dryland Feed Production	123.1	76.8	78.0	16.9	35.5	0.2
5 Greenhouse, Nursery and Floriculture (except cannabis)	45.0	20.4	21.0	8.8	14.6	0.5
6 Irrigated Cattle Production	13.2	1.6	1.2	3.7	1.6	0.1
7 Dryland Cattle Production	140.1	17.1	12.7	39.1	17.0	0.7
8 Irrigated Other Animal Production	4.1	0.5	0.4	1.1	0.5	0.0
9 Dryland Other Animal Production	47.0	5.7	4.3	13.1	5.7	0.1
10 Forestry and Logging	26.8	10.0	10.4	4.7	8.3	0.1
11 Mining & Quarry	1421.5	652.5	683.4	250.4	296.0	2.7
12 Utilities	1,451.1	805.2	873.0	191.0	456.9	4.6
13 Building Construction	0.0	0.0	0.0	0.0	0.0	0.0
14 Engineering Construction	0.0	0.0	0.0	0.0	0.0	0.0
15 Other Construction	636.1	278.6	283.9	160.5	228.0	2.5

Sectors	Output	GDP (Factor Cost)	GDP (Market Price)	Imports	Labor Income	Employment
16 Animal Food Manufacturing	42.2	8.6	8.8	16.6	3.8	0.1
17 Grain & Oilseed Milling	59.0	8.2	8.4	16.2	2.3	0.0
18 Sugar Production Manufacturing	2.6	0.9	0.9	1.0	0.5	0.0
19 Fruits & Veg. Processors	10.5	3.3	3.4	3.0	1.6	0.0
20 Dairy Production	26.8	6.4	6.5	4.8	3.2	0.0
21 Meat Production	140.5	31.3	31.6	29.8	13.4	0.2
22 Seafood Prod. Manufacturing	0.5	0.2	0.2	0.1	0.1	0.0
23 Other Food Production	38.4	20.0	20.2	9.4	7.4	0.1
24 Beverage & Tobacco Manufacturing	72.7	36.3	36.8	15.4	16.9	0.1
25 Textile Mills	3.7	1.5	1.6	1.2	1.3	0.0
26 Clothing Manufacturing	1.6	0.7	0.7	0.5	0.7	0.0
27 Paper Manufacturing	41.7	12.1	12.7	11.0	8.0	0.1
28 Printing	16.8	7.8	7.9	4.6	6.2	0.1
29 Petroleum & Coal Development	779.8	247.8	250.9	54.7	26.4	0.2
30 Chemical Manufacturing	2,590.4	991.1	1005.1	702.8	216.2	1.4
31 Plastic & Rubber Manufacturing	114.8	41.6	41.2	35.1	31.0	0.3
32 Metals & Minerals Manufacturing	209.6	76.8	78.5	70.5	53.0	0.1
33 Other Non-Food Manufacturing	105.8	39.9	40.6	22.3	28.0	0.6
34 Equipment Manufacturing	196.6	68.3	69.0	76.3	51.4	0.5
35 Vehicle Manufacturing	6.8	2.5	2.4	2.8	2.4	0.1
36 Wholesale Trade	2,359.3	1,445.9	1,499.2	273.0	908.5	10.1
37 Retail Trade	2,659.9	1,568.4	1,632.5	264.3	1,137.3	30.6
38 Air Transportation	305.5	125.3	126.7	77.6	72.8	0.9
39 Rail Transportation	209.5	133.3	139.2	22.5	58.2	0.4
40 Truck Transportation	762.5	280.1	306.3	174.3	208.8	4.2
41 Passenger Transportation	116.3	101.2	60.7	22.0	86.3	1.6

Sectors	Output	GDP (Factor Cost)	GDP (Market Price)	Imports	Labor Income	Employment
42 Pipeline Transportation	501.2	317.7	359.2	34.4	74.9	0.8
43 Couriers & Messengers	117.7	65.7	67.6	16.2	50.6	0.6
44 Warehousing & Storage	42.4	24.6	31.4	3.4	20.9	0.7
45 Publishing Industry	70.0	44.1	44.1	9.3	25.6	0.2
46 Motion Picture Industry	34.1	18.1	14.5	8.0	8.5	0.4
47 Broadcasting	786.7	450.7	468.5	141.9	120.8	0.2
48 Finance and Insurance	2,982.5	1,508.5	1,626.0	415.6	950.8	8.7
49 Professional and Personal Services	7,718.5	5,014.0	5,424.9	658.7	3,933.5	15.4
50 Administrative, Waste Management	426.9	208.0	214.1	69.6	124.7	6.0
51 Educational Services	1,784.7	1,393.3	1,401.9	129.2	1,116.6	17.5
52 Health Care & Social Assistance	3,144.3	2,244.5	2,257.2	279.6	1,810.3	32.6
53 Arts, Entertainment. & Recreation	311.6	153.0	157.4	49.3	128.2	4.8
54 Accommodation & Food	1,439.8	731.8	764.7	302.9	568.4	14.0
55 Other Non-Public. Administrative Services	334.0	158.9	163.5	51.3	143.9	13.9
56 Other Federal Government Services	573.3	351.7	360.2	54.1	304.0	2.5
57 Other Provincial Government. Services	1,983.6	658.9	667.2	211.8	447.3	4.2
58 Other Municipal & Aboriginal Services	2,437.8	1,683.0	1,689.7	199.6	998.6	7.0
Exogenous Industry Direct	36,573.4	18,467.0	20,108.0	6,232.3	15,272.9	140.0
Total Impacts	**77,944.7**	**41,567.5**	**44,142.2**	**11,843.3**	**30,513.8**	**335.9**

C.4 Using the Economic Impact Analyzer

Table 49 shows the operational structure of the EIA as it was applied to the Chin Reservoir Expansion Project. The information from Sheets 2 to 8 were used to develop net income from irrigation and dryland crop production (Sheet 9). An economic comparison of irrigation and

dryland crops is presented in Sheet 10. Annual returns from irrigation and dryland crops are presented in Sheet 11. The gross production value for all irrigation and dryland crops is shown in Sheet 12.

Table 49. Structure of the Economic Impact Analyzer.

Section	Worksheet	Description of Contents
Model Name	Sheet 1 Title	Title of the Module
Section 1: Crop Production	Sheet 2 FFM	Estimation of farm financial indicators by crops
	Sheet 3 Prices	Prices of various commodities in the model
	Sheet 4 Crop Yield	Irrigated and dryland yields of crops
	Sheet 5 Crop Mix	Average crop mix for the irrigated and dryland production system in the Alberta Irrigation Districts
	Sheet 6 COP Irrigation	Cost of production of major irrigated crops in Alberta
	Sheet 7 COP Dryland	Cost of production of major dryland crops in Alberta
	Sheet 8_Mustard	Yield and prices of mustard in Manitoba
	Sheet 9 Net Benefit Irrigation Districts	Net Income of producers from irrigation and dryland production
	Sheet 10 Net Benefit (By Crop)	Relative returns from irrigation in Alberta irrigation districts by crops
	Sheet 11 EC Irrigation vs Dryland	Annual returns from irrigated and dryland crops, 2018-2020
	Sheet 12 Sales	Average farm gate sales generated from irrigated and dryland crops (2011–2018)
Section 2: Livestock Production	Sheet 13 Cattle and Calves	Estimation of farm cash receipts for cattle and calves associated with the irrigation districts
	Sheet 14 Feeders	Estimation of Feeder Cattle farm cash receipts associated with Chin Reservoir expansion area
	Sheet 15 Sheep and Lambs	Estimation of sheep and lambs farm cash receipts on the Chin Reservoir expansion area
	Sheet 16 Hogs	Estimation of farm cash receipts for hogs associated with Chin Reservoir expansion area
	Sheet 17 Dairy	Estimation of farm cash receipts for dairy associated with Chin Reservoir expansion area
	Sheet 18 Poultry	Estimation of farm cash receipts for poultry associated with Chin Reservoir expansion area
	Sheet 19 Eggs_	Estimation of farm cash receipts for eggs associated with Chin Reservoir expansion area
	Sheet 20 Total Livestock	Value of livestock production associated with irrigation and dryland production - by Livestock category
Section 3: Aggregation	Sheet 21 Total Crops and Livestock	Average annual contribution of irrigation relative to dryland agricultural sales, (2011-2018)
Section 4: References	Sheet 23_References	AAFC, 2020 a,b,c,d,e,f AAF, 2020 AAF, 2019 a,b,c,d,e AAF, 2018 a,b,c AAF, 2017 a,b AAF, 2016 AAF, 2015 AAF, 2011 GOA, 2020 GOA, 2019 ICDC, 2017 Laate, 2014 ICDC, 2017 Laate, 2014 MAFRD, 2020a,b MAFRD, 2018a,b,c,d,e MAFRD, 2016 MAFRD, 2016 Statistics Canada, 2020 a,b,c,d,e Statistics Canada, 2016 Statistics Canada, Undated Statistics Canada, 2020 a,b,c Statistics Canada, 2016 Statistics Canada, Undated

The direct impact of livestock production associated with the Chin Reservoir expansion area was assessed by livestock category (Section 2, Table 49). Seven categories of livestock (Sheets 13 to 19) were identified and related to irrigation and dryland livestock production estimates in the Chin Reservoir Expansion area.

Livestock numbers were estimated, based on 2011 and 2016 Census data (Statistics Canada, 2016), using the following assessment steps.

1. The Census Divisions and counties/municipalities associated with the RID and SMRID were identified are located. These included the following.
    a. Cypress County
    b. County of Forty Mile
    c. County of Warner
    d. MD of Taber
    e. Cardston County
    f. County of Lethbridge
2. The total number of livestock in the selected counties for each category were obtained from the 2016 Statistics Canada database for 2011 and 2016.
3. For each county/municipality the total livestock numbers were adjusted to reflect the livestock number associated with the RID and SMRID. Table 50 shows the proportion of total livestock numbers used to determine the estimated number of livestock associated with the three irrigation districts. These estimates were based on discussions with leading livestock producers in the region, and experience with Acera Consult Inc. team members.

Table 50. Estimated percentage of livestock numbers in each county associated with the RID and SMRID.

County	Livestock in Counties Associated with RID and SMRID (%)					
	Hogs	Sheep/ Lambs	Cattle/ Calves	Poultry	Feeder Cattle	Eggs
Cypress	20	20	20	20	20	0
Forty Mile	30	30	30	30	60	0
Warner	30	30	30	30	60	30
Lethbridge	30	30	30	30	30	30
Taber	100	100	100	100	100	100
Cardston	30	30	20	30	60	30

4. The irrigated livestock numbers were compared with the provincial total to obtain a contribution percentage for the three irrigation districts.
5. The irrigated livestock contribution percentage was then used to calculate livestock sales relative to the total cash sales for the province.
6. The values for the different livestock categories were aggregated both for the Chin Reservoir expansion areas and similar dryland areas.

Sheet 20 summarizes the of value of livestock production by category. The aggregated values were added to the value of crop production in Sheet 21.

C.4.1 Crop Production-Related Tasks

Task 1: Estimate the value of production for various crops, based on the following three inputs.

- Prices producers receive for various crop categories. Market prices may also be used for these calculations.
- Yield of various crops under dryland and irrigated conditions (Table 9).
- Cost of production for major irrigated crops related to the RID and SMRID (Tables 51 – 53), and for major dryland crops (Table 54) in southern Alberta. In most cases, data for Alberta was available. However, data from Manitoba and Saskatchewan were used if data from Alberta was not available.

Task 2: Estimate unit values for irrigated and dryland crops. Use the data collected in Task 1 to calculate the per acre value of gross revenue, and net revenue for various irrigated and dryland crops.

Task 3: Unit values and area under irrigation and dryland production were used to create the total value of irrigation and dryland production associated with the proposed expansion areas (Table 55).

Table 51. Irrigation cost of production (average 2018–2020).

Costs	Barley	CPS Wheat	Durum	Spring Wheat	Soft Wheat	Alfalfa Hay
	($/acre)					
Seed	23.5	48.4	35.4	34.1	24.3	65.9
Fertilizer	78.3	98.8	96.4	97.2	102.9	23.8
Chemical	34.9	37.3	71.1	11.7	71.8	0.0
Crop Insurance	10.6	36.0	38.6	18.1	65.2	0.0
Trucking & Marketing	1.0	1.7	5.6	1.4	1.2	1.6
Fuel, Oil & Lube	17.5	32.2	28.9	22.8	33.9	21.6
Machinery Repairs	38.2	30.1	42.3	22.0	30.3	15.7
Building Repairs	3.7	2.7	4.9	9.0	12.9	11.5
Irrigation Fuel and Electricity	20.2	45.2	43.1	19.7	11.7	19.4
Custom Work	11.3	1.6	8.2	5.8	63.0	37.6
Paid Labor	23.9	12.9	22.9	29.2	21.1	35.2
Utilities & Miscellaneous	17.5	19.8	34.6	14.0	39.7	17.6
Operating Interest	14.7	7.8	9.2	32.6	10.2	5.2
Total Variable Costs	295.3	374.7	441.3	317.7	488.3	255.1
Taxes, Water Rates, License & Insurance	26.5	27.6	36.6	29.3	27.1	45.8
Equipment & Buildings (Depreciation)	19.5	79.6	98.1	28.5	58.5	45.0
Total Fixed Costs	46.0	107.2	134.7	57.8	85.5	90.8
Average Cost of Production (2018–20)	341.2	481.9	576.0	375.5	573.9	345.9
Av. COP/acre (Excluding Operating Interest)	326.6	474.1	566.8	342.9	563.6	340.7
Av. COP/acre (Excluding Irrigation Fuel and Electricity	306.3	428.9	523.7	323.1	551.9	321.3

Table 52. Irrigation cost of production (average 2018–2020).

Costs	Corn Silage	Grass Hay	Canola	Beans	Potatoes	Sugar Beets
	($/acre)					
Seed	115.02	56.04	69.36	126.53	410.22	152.56
Fertilizer	107.35	49.1	118.40	52.06	130.96	119.30
Chemical	33.21	0.0	29.23	151.48	344.75	61.21
Crop Insurance	0.00	0.0	20.39	38.13	51.77	58.94
Trucking & Marketing	0.00	0.4	1.61	5.24	199.86	139.64
Fuel, Oil & Lube	7.59	15.6	16.92	21.62	66.89	76.93
Machinery Repairs	5.76	18.2	18.57	11.32	333.19	47.84
Building Repairs	0.00	12.3	4.02	0.00	113.16	29.08
Irrigation Fuel and Electricity	20.86	16.3	16.90	18.58	89.29	82.50
Custom Work	293.86	46.7	8.15	0.00	146.93	32.21
Paid Labor	0.00	4.8	24.71	0.00	408.14	50.75
Utilities & Miscellaneous	9.38	4.3	24.64	9.38	281.40	67.51
Operating Interest	12.38	2.9	20.13	8.88	54.13	19.62
Total Variable Costs	605.41	226.7	373.04	443.22	2,630.68	938.08
Taxes, Water Rates, License & Insurance.	27.79	45.8	24.72	27.49	45.77	32.07
Equipment & Buildings (Depreciation)	45.02	45.0	9.79	113.22	718.62	129.53
Total Fixed Costs	72.81	90.8	34.50	140.71	764.39	161.60
Average Cost of Production (2018–2020)	678.22	317.5	407.54	583.95	3,395.07	1099.68
Av. COP/acre Excluding Operating Interest	665.83	314.6	387.41	575.05	3,340.95	1080.07
Av. COP/acre Excluding Irrigation Fuel and Electricity	644.97	298.3	370.51	556.49	3,251.66	997.57

Table 53. Irrigation cost of production for selected specialty crops (average 2018–2020).

Costs	Dry Peas	Grass Seed	Fresh Corn	Grain Corn	Hemp
	$/acre				
Seed	58.58	10.66	58.57	95.033	76.27
Fertilizer	17.26	10.90	107.35	175.900	58.32
Chemical	33.80	17.27	13.56	31.189	34.63
Crop Insurance	31.78	5.80	65.02	38.313	45.08
Trucking & Marketing	2.31	8.38	654.84	13.806	16.41
Fuel, Oil & Lube	29.10	10.30	70.69	18.338	25.91
Machinery Repairs	22.09	10.47	52.39	23.008	39.41
Building Repairs	8.44	0.00	0.00	2.001	3.19
Irrigation Fuel and Electricity	14.15	44.12	83.28	30.011	44.12
Custom Work	7.59	3.67	51.20	38.36	34.14
Paid Labor	31.94	30.61	224.48	31.01	29.34
Utilities & Miscellaneous	17.59	7.91	311.40	19.51	37.06
Operating Interest	2.13	3.55	36.33	9.81	9.45
Total Variable Costs	276.75	163.64	1,729.11	526.29	453.33
Taxes, Water Rates, License & Insurance	26.63	45.77	27.79	27.79	45.77
Equipment. & Buildings (Depreciation)	15.16	45.02	45.02	45.02	120.60
Total Fixed Costs	41.78	90.78	72.81	72.80	166.37
Average Cost of Production (2018–2020)	318.53	254.43	1,801.91	599.10	619.70
Av. COP/acre Excluding Operating Interest	316.40	250.88	1,765.58	589.29	610.25
Av. COP/acre Excluding Irrigation Fuel and Electricity	302.27	206.76	1,682.30	559.28	566.14

*Source: Gabruch and Gietz, 2014.

**Assumed to be the same as sweet corn.

Table 54. Dryland cost of production (average 2018-2020).

Costs	Durum	Spring Wheat	Barley	Oats	Canola	Dry Peas	Alfalfa Hay
	($/acre)						
Seed	28.74	24.40	18.93	17.81	51.50	41.01	3.40
Fertilizer	39.35	39.35	47.35	40.67	56.35	16.81	10.67
Chemical	41.59	41.59	18.65	14.30	31.75	39.11	1.24
Crop Insurance	15.71	15.16	14.30	12.32	22.43	21.41	0.00
Trucking & Marketing	14.07	13.37	15.26	11.75	8.96	15.81	36.41
Fuel, Oil & Lube	14.43	15.01	13.88	15.16	16.50	14.81	7.20
Machinery Repairs	12.51	15.37	8.85	10.42	8.33	11.20	10.42
Building Repairs	1.30	1.56	1.04	2.60	1.56	2.30	3.13
Irrigation Fuel and Electricity	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Custom Work	3.57	4.08	4.08	2.55	6.80	2.00	2.04
Paid Labor	17.88	21.46	16.35	14.30	18.91	13.51	16.35
Utilities & Miscellaneous	9.42	10.34	8.96	6.27	8.96	9.00	5.41
Operating Interest	5.52	5.47	4.27	3.50	7.03	4.90	0.77
Total Variable Costs	204.11	207.16	171.94	151.68	239.10	192.11	97.07
Taxes, Water Rates, License & Insurance	6.88	8.91	7.42	11.47	7.53	6.75	1.34
Equipment & Buildings (Depreciation)	34.33	48.08	57.92	50.41	58.67	59.10	22.74
Total Fixed Costs	41.21	56.99	65.34	61.88	66.20	65.85	24.08
Average Cost of Production (2018–2020)	245.32	264.15	237.28	213.56	305.30	257.96	121.15

Table 55. Average sales of selected irrigation and dryland crops (2011–2018).

Crop	Irrigation Districts	Dryland	Province
	($ Million)		
Cereals			
Winter Wheat	$11.88	$30.72	$42.60
Spring Wheat	$115.88	$1,344.34	$1,460.22
Soft Wheat	$6.21	$0.00	$6.21
Durum Wheat	$38.76	$239.13	$277.89
Oats	$0.74	$47.55	$48.29
Barley	$38.68	$477.23	$515.91
Rye	$0.59	$6.48	$7.07
Corn (Grain)	$18.45	$2.21	$20.66
Triticale	$3.91	$1.68	$5.59
Mixed Grains	$0.00	$3.47	$3.47
Sub-Total Cereals	$235.10	$2,152.81	$2,387.92
Oilseeds			
Flaxseed	$17.89	$22.03	$39.92
Canola	$105.77	$2,123.12	$2,228.89
Mustard Seed	$0.12	$15.60	$15.72
Total Oilseeds	**$123.78**	**$2,160.74**	**$2,284.53**
Specialty Crops			
Seed Canola	$56.91	$0.00	$56.91
Peas, Dry	$11.49	$359.53	$371.02
Lentils	$1.60	$51.45	$53.06
Beans, Dry	$44.62	$0.00	$44.62
Faba Beans	$3.75	$15.97	$19.72
Alfalfa Seed	$47.33	$0.00	$47.33
Potatoes*	$197.90	$48.24	$246.14
Fresh Peas	$9.28	$0.00	$9.28
Fresh Corn	$5.02	$0.00	$5.02
Hemp	$9.18	$0.17	$9.35
Sugar Beets	$42.60	$0.00	$42.60
Market Gardens	$1.16	$5.95	$7.11
Other Specialty Crops	$69.46	$4.60	$74.06
Total Specialty Crops	**$500.31**	**$485.91**	**$986.21**
Forages			
Corn (Silage)	$52.52	$6.09	$58.60
Tame Hay	$5.75	$331.30	$337.05
Tame Pasture			
Alfalfa	$111.54	$72.51	$184.05
Barley Silage	$37.43	$0.00	$37.43
Other Forages	$9.78	$0.00	$9.78
Total Forages	**$217.02**	**$409.89**	**$626.91**
Total Cropped	**1,076.22**	**$5,209.36**	**$6,285.57**

* Source: MAFRD, 2018

Appendix D GOA and GOC Fiscal Impact Analysis Model

D.1 Model Description

The GOA and GOC Fiscal Impact Analysis Model is a disaggregate model where each of the components is explained using a regression equation. Each equation includes an economic variable plus a binary variable (named BY) for the incidence of COVID-19. The binary variable was added to all the equations to estimate any change in revenues or expenditures caused by the Covid-19 incidence.

Details of the selected GOA and GOC revenue and expenditure variables and the economic variables to explain changes are shown in Tables 56 and 57. All revenue sources were grouped under six categories (Table 58). The sum of these six categories total fiscal revenue of the level of the government.

Table 56. Components of fiscal revenues and expenditures for the Government of Alberta.

Revenues (Average 2016 – 2020)			Expenditures (Average 2016 – 2020)		
	$ Million	% of Total		$ Million	% of Total
Income Tax (Households)	11,189	23.2	Final Expenditure on Goods and Services	38,764	64.0
Income Tax (Corporations and Government Enterprises)	4,069	8.4	Current Transfers to Households	5,180	8.5
Contributions to Insurance plans	1,005	2.1	Current Transfers to Non-Profit Institutions Serving Households	1,312	2.2
Taxes on Production & Imports	4,034	8.4	Subsidies	1,351	2.2
Taxes on Products (Including GST)	4,923	10.2	Current Transfers to Local General Governments	8,527	14.1
Current Transfers from Households	976	2.0	Interest on Debt	1,990	3.3
Current Transfers from Non-Profit Institutions Serving Households	372	0.8	Other Expenditures	3,473	5.7
Transfers From GOC	8,641	17.9	General Government Expenditure	60,598	100.0
Investment Income	7,939	16.5	Average Fiscal Balance	-12,345	
Sales of Goods and Services	4,869	10.1	Balance as % of Total Revenues		25.6
Other Income	233	0.5			
General Government Revenue	48,253	100.0			

Table 57. Sources of fiscal revenues and expenditures for the Government of Canada.

Revenues (Average 2016-2020)			Expenditures (Average 2016-2020)		
	$ Million	% of Total		$ Million	% of Total
Income Tax on Households	158,841	49.1	Final Expenditure on Goods and Services	77,576	20.9
Income Tax from Corporations and Government Business Enterprises	52,456	16.2	Current Transfers to Households	133,135	35.8
Contributions to Insurance Plans	22,491	7.0	Current Transfers to Non-Profit Institutions	5,966	1.6
Taxes on Production and Imports	1,076	0.3	Subsidies	18,270	4.9
Taxes on Products (Including GST)	59,489	18.4	Current Transfers to Local Governments	91,626	24.7
Current Transfers from Households	132	0.0	Interest on Debt	22,713	6.1
Transfers from Governments	1,061	0.3	Other Expenditures	22,116	6.0
Investment Income	10,066	3.1	General Government Expenditures	371,402	100
Sales of Goods and Services	8,732	2.7	Average Fiscal Balance	-48,176	
Other Income	8,883	2.7	Balance as % of Total Revenues		14.9
General Government Revenue	323,226	100			

Table 58. Revenues and expenditures included in the Fiscal Impact Analysis Model.

Revenue Item	Economic Variable
Personal Income Tax (PTX)	Personal (Household) Income (PIN)
Corporation Income Tax (CTX)	Other Operating Surplus (OOS)
Tax on Production and Products (TPP)	Level of Output (Sales) of Goods and Services (OTP)
Transfers from Federal Government (TFG)*	Gross Domestic Product (GDP)
Investment Income (IVN)	Total Fiscal Revenues minus Total Fiscal Expenditures (BAL); Also lagged value of the same variable (BAL(-1))
Other Income (OTN)	Gross Domestic Product (GDP)
Total Revenue (TRV)	Gross Domestic Product (GDP)

*Modified to transfer from households and other agencies (THH) for the GOA and GOC Fiscal Impact Analysis Model.

D.2 Equations Developed for GOA Fiscal Impact Model

Equations were developed for the GOA Fiscal Impact Model (Table 59), which include two (or sometime less) variables.

1. Economic growth or progress of the region (typically measured in terms of GDP (or one of its components).
2. The effect of COVID-19. This variable was added to test whether the start of the COVID in the latter part of 2019 influenced 2020 fiscal revenues. All equations were based on data for 2007 to 2020. Data were obtained from Statistics Canada (2021) for 2007 to 2020. All monetary data were shown in millions of current dollars.

Table 59. Equations used for the Alberta Fiscal Impact Model.

Dependent Variable	Estimated Coefficients and (Standard Error)	R^2 (Adj-R^2)	F-Value
Personal Income Tax	451.38 + 0.0529** PIN + 495.99 BY (1412.30) (0.008) (695.66)	0.817 (0.784)	24.59**
Corporate Income Tax	2156.86 + 0.0209@ OOS – 1052.32 BY (1460.9) (0.125) (873.95)	0.346 (0.227)	2.91
Tax on Production and Products	1311.10 + 0.0115** OTP - 24.05 BY (2027.27) (0.0036) (954.20)	0.481 (0.387)	5.097*
Transfer from GOA	-1526.23 + 0.0238* GDP + 4227.06* BY (3302.4) (0.011) (1069.82)	0.699 (0.645)	12.80**
Investment Income	13026.7** + 0.6462** BAL – 0.2521** BAL(-1) (402.7) (0.075) (0.077)	0.909 (0.892)	50.49**
Other Income	2643.62 + 0.0131** GDP +1137.62 BY (1265.65) (0.0042) (552.27)	0.572 (0.444)	7.36**
Total Revenue	12339.34** + 0.1097** GDP + 2822.05** BY (2365.94) (0.0078) (766.46)	0.957 (0.949)	122.21**

@ Significantly different from zero at 10%
* Significantly different from zero at 5%
** Significantly different from zero at 1%

For the Alberta Fiscal Impact Model, the income tax on household income was related to the level of personal income created within the Alberta economy. For every $1.00 of income earned, an average of $0.112 goes to the GOA. The binary variable for COVID-19 did not affect the level of income tax from households.

The Corporate Tax equation showed a low R^2, and the Other Operating Surplus was not able to explain the variability. For this analysis it was therefore assumed that for every $1.00 of Other Operating Surplus, $0.021 would be added to the GOA fiscal revenues.

The relationship between the Production and Products Tax indicated that as the level of output of the Alberta economy increases by $1.00, $0.01 is added to fiscal revenue.

Transfers from GOC showed a relationship with economic growth in the province. For every $1.00 increase in the Alberta GDP an additional $0.024 are received by the GOA. However, it is recognized that transfer payment mechanisms are a complex process, and this approximation may not adequately represent this government revenue source.

Investment income for the GOA was very highly related to the province's balance between total fiscal revenues and total fiscal expenditures. As the GOA's current balance increases by $1.00, $0.64 are added through investment income.

To project the impact of the Chin Reservoir Expansion Project on the GOA fiscal balance, it was assumed that it would be related to total revenues generated from the project, since the GOA did not invest funds for Chin Reservoir Expansion Project. As the GDP of the province increases by $1.00, about $0.11 would be added.

D.3 Equations for the GOC Fiscal Impact Model

Equations generated for the estimated GOC fiscal revenue model are presented in Table 60. The structure of the GOC model was similar to the GOA model.

Table 60. Equations used for the Canada Fiscal Impact Model.

Dependent Variable	Estimated Coefficients & (Standard Error)	R^2 (Adj-R^2)	F-Value
Personal Income Tax	-6208.13 + 0.1124** PIN + 6.425 BY (11883.1) (0.0095) (6109.26)	0.842 (0.931)	89.89**
Corporate Income Tax	27495.09@ + 0.0930 OOS – 114483.83 BY (12907.68) (0.085 (8212.34)	0.269 (0.136)	2.02
Production and Products Tax	-675.31+0.0158** OTP + 5461.39* BY (7050.81 (0.0021) (2996.32)	0.856 (0.830)	32.80**
Transfer from GOA	1041.09+0.00021 GDP + 81.47 BY (1160.74) (0.00066) (489.98)	0.003 (-0.178)	0.003
Investment Income	9530.24** + 0.0089 BAL + 0.0127 BAL (-1) (642.51) (0.0087) (0.033)	0.119 (-0.056)	0.119
Other Income	2964.23 + 0.0103 GDP – 1607.43 BY (6797.49) (0.0038) (2869.43)	0.483 (0.389)	5.13*
Total Revenue	-36459.60 + 0.1059** GDP + 39297.75 BY (35994.1) (0.0203) (15194.19)	0.892 (0.872)	45.39**

@ Significantly different from zero at 10%
* Significantly different from zero at 5%
** Significantly different from zero at 1%

Estimated coefficients for the personal income tax indicated that for every $1.00 in household income in Canada, the GOC fiscal revenue increases by $0.112. There was a good R^2 between economic progress in Canada and its fiscal revenues through income taxes.

However, when examining Corporate Income Tax, economic progress made little difference. Although for every $1.00 earned by corporations as other operating surplus, the GOC corporate tax increased by $0.093, but the coefficient was not significantly different from zero.

Tax on Production and Products was impacted by the volume of output of goods and services in Canada. For every $1.00 increase, this tax increased by $0.018. The impact of transfers from households and other level agencies was difficult to predict. Although the coefficient for the GDP was positive, it was not significantly different from zero. The same situation was found for the investment income. This source of revenue was not related to the fiscal balance of the GOC, as the coefficients for the current and lagged balance were not significant. However, to predict the balance (when the GOC has no direct expenditures in the project), the estimated equation for total fiscal revenues to GOC showed a strong relationship with the national GDP.

D.4 Fiscal Impact of the Chin Reservoir Expansion

The net fiscal impact on the GOA and GOC by the Chin Reservoir Expansion project was estimated using Equation (D.1). The net fiscal impact of the project would be a difference between fiscal revenues of the government and any direct expenditure in funding the project.

$$NET\ FISCAL\ IMPACTS_i = TOTAL\ FISCAL\ REVENUES_i - TOTAL\ PROGRAM\ COSTS_i \quad \text{(Equation D.1)}$$

Where, *i:* Alberta and Canadian governments.

Since the GOA and GOC are not expected to fund the project directly, the net fiscal impact is the change in fiscal revenue of each level of the governments.

Appendix E Benefit-Cost Analysis Overview

E.1 Assumptions for the Financial Benefit-Cost Analysis

The financial analysis was based on several assumptions:

1. The life of the project was assumed to be 50 years after the completion of construction activities. It was assumed that construction would take place during the initial 3 years.
2. Irrigation activity was assumed to start in the fourth year.
3. An annual adoption rate of 10% was assumed for irrigation development on the 46,500-acre expansion area.
4. Benefits through drought proofing were assumed to take place with a probability of 8%.
5. Replacement of pivot irrigation systems were assumed to take place every 15 years.
6. Salvage value was estimated for the unused life of the new pivot expenditure. A straight-line depreciation method was used to estimate these values.
7. Replacement of specialized farm machinery and equipment was assumed to take place every 10 years.
8. Prior to irrigation development, producers were assessed an average charge of $2,430/acre by the irrigation district as a capital assets charge.
9. Discounted value used for this analysis was assumed to be 4%.

E.2 Assessment of Financial Costs and Benefits

All benefits and costs were evaluated at market prices, and an Excel based model was developed for this purpose. Costs and benefits in the analysis included crop and livestock products (Table 61) and included data from Chapter 3 of this report. Drought mitigation benefits utilized data from Chapter 4 of this report.

On the cost side, five items were included. Besides the crop and livestock cost of production, these also included producers' investment in pivot irrigation systems, specialized farm machinery and equipment, and the capital assets charge paid by the producers.

All benefits and costs were converted into present values using the discount rate of 4%.

Table 61. Structure of financial analysis for this study.

Benefits	Costs
Gross Revenue from Crop Production	Capital Assets Charge
Gross Revenue from Livestock Production	Investment in Pivot Irrigation Systems
Drought Mitigation Benefits	Investment in Specialized Farm Machinery and Equipment
	Cost of Production of Crops
	Cost of Production of Livestock

E.3 Assessment of Project's Economic Desirability

The Chin Reservoir Expansion Project's economic desirability was measured using four criteria.

1. **Net Present Worth of Project:** The difference between the present value of the financial revenues (benefits) and present value of costs. This measures whether producers are going to be better off economically during the life of the project by adopting irrigation on the farm.

2. **Financial Revenue Cost Ratio (Private Benefit-Cost Ratio):** Takes the present value of total financial benefits for the producer and divides it by the present value of the total costs to producers. A ratio of greater than one indicates the benefits are greater than the costs.
3. **Internal Rate of Return:** Measure of the return to all costs incurred through project adoption. A value of this return higher than the discount rate suggests a positive support for a decision.
4. **Project Payback:** The time it takes for the producer to recover total costs and make a zero or positive net return. The longer the time, the less economically desirable the project.

E.4 Benefit-Cost Analysis

The benefit-cost analysis shares some of the assumption made for the financial analysis of the project, including the nine assumptions for the financial analysis (above). For the benefit-cost analysis, the following assumptions were added:

1. Assumed that construction expenditures would be divided into 3 years as follows: Year 1 – 50%, Year 2 – 25%, and Year 3 – 25%.
2. In addition to the producers, the project would create externalities through benefitting the following economic entities: Farm processing of crop and livestock products, Pivot irrigation dealers, Specialized farm machinery and equipment dealers, Producers, (irrigation and dryland), and Private and municipal property owners through flood damage mitigation.
3. The social discount rate was maintained at 4%. The reason for this choice was that often this rate is lower than that used for the financial analysis. In this case, if the project is economically desirable at this rate, it would certainly qualify as a desirable project at a lower discount rate.
4. Flood damage mitigation was assumed to occur once every 10 years. The first flood year was determined using a random number table.

E.5 Assessment of Costs and Benefits

This analysis was based on three sources of private benefits and four external benefits (Table 62).

Table 62. Structure of the Benefit-Cost Analysis.

Private Benefits	Costs
Benefits Crop Production	Construction Cost of the Chin Reservoir Expansion Investment in Pivot Irrigation Systems Investment in Specialized Farm Machinery and Equipment
Benefits Livestock Production	
Drought Mitigation Benefits	
External Benefits	
Forward linkages (Food Processing)	
Income of Pivot Irrigation Dealers	
Income of Specialized Farm Machinery and Equipment Dealers	
Monetary Value of Flood Damage Mitigation (Producers and Private/Municipal Property)	

Symbols, Abbreviations and Metric Conversions

Symbols		Abbreviations for Irrigation Districts	
‘000	thousands	AID	Aetna Irrigation District
$‘000	thousands of dollars	BRID	Bow River Irrigation District
$ Million	million dollars	EID	Eastern Irrigation District
MW	megawatt	LID	Leavitt Irrigation District
		LNID	Lethbridge Northern Irrigation District
		MID	Magrath Irrigation District
		MVID	Mountain View Irrigation District
		RCID	Ross Creek Irrigation District
		RID	Raymond Irrigation District
		SMRID	St. Mary River Irrigation District
		TID	Taber Irrigation District
		UID	United Irrigation District
		WID	Western Irrigation District

Conversions	
1 hectare (ha)	2.47 acres (ac)
1 tonne (t) of wheat (or durum)	36.74 bushels (bu)
1 bushel of wheat (or durum)	0.027 tonnes or 0.3 tons (tn)
1 tonne of oats	64.84 bushels
1 bushel of oats	0.02 tonnes or 0.22 tons
1 tonne of barley	45.93 tonnes or 50.5 tons
1 bushel of barley	0.02 tonnes or 0.22 tons
1 tonne of rye, corn, flaxseed or dry peas	39.37 bushels
1 bushel of rye, corn, flaxseed or dry peas	0.03 tonnes or 0.33 tons
1 tonne of canola	44.06 bushels
1 bushel of canola	0.02 tonnes or 0.22 tons
1 kilogram (kg)	2.20 pounds (lb)
1,000 cubic metres (m^3)	0.81 acre-feet (ac-ft)
1 tonne (t)	2204.64 pounds (lbs)
1 tonne (t)	1.10 short tons
1 kilometre (km)	0.62 miles (mi)
1 cubic decametre (dam^3)	0.82 acre-feet
1 acre-foot (ac-ft)	1,233 cubic metres (m^3)
1 metre (m)	3.28 feet
1 centimetre	0.39 inches (in)
1 millimetre	0.04 inches