CHRISTINA LAKE REGIONAL PROJECT

HYDROLOGY
ENVIRONMENTAL SETTING REPORT

Prepared For:
MEG Energy Corp.

Prepared By:
Matrix Solutions Inc.

February 2005

EXECUTIVE SUMMARY

MEG Energy Corp. (MEG) is proposing the development of the Christina Lake Regional Project (the Project) including facility construction and operation of a modified Steam Assisted Gravity Drainage oils sands project. The operation is designed to produce up to 25,000 barrels per day (bpd) of bitumen near Christina Lake in northeastern Alberta. The MEG lease area is located approximately 150 km south of Fort McMurray on the north side of Christina Lake. Facilities will be constructed in Townships 76, 77 and 78, Ranges 4, 5 and 6, W4M, in the Christina Lake watershed area.

This report presents the methods and results of the surface water hydrology environmental setting study for the Project focusing on the Christina River watershed regional area upstream from its confluence with the Winefred River. The Project is almost entirely located within the Christina Lake watershed within two sub-basins that drain into the lake from the north and east sides of the lake. The Project also intends to withdraw groundwater for its operation from wells within an adjacent northeast draining sub-basin of the Winefred River watershed.

The purpose of this study is to characterize the surface water hydrologic conditions of the Project study areas, including physical settings and climatic conditions that affect hydrology. Information collected and presented in this hydrology environmental setting is to be used to support the Environmental Impact Assessment (EIA) for the Project.

Climatic variables analyzed in this study include air temperature, precipitation, lake evaporation and evapotranspiration. Primary sources of climatic data compiled by Environment Canada include the long-term monitoring station data at Fort McMurray and Cold Lake and seasonal precipitation data from local forestry lookouts.

Hydrologic information presented includes stream flows, Christina Lake levels, basin water yields and local stream geomorphic descriptions. Sources of hydrologic data include records of the long-term monitoring stations by Water Survey Division of Environment Canada, local flow data collected in 2002 for the Devon Jackfish Project and spot flow measurements acquired in 2004 on local streams in the Project area. Relevant annual, seasonal, monthly and daily values for the climatic and hydrologic variables were estimated from the available data. Stream flow analyses considered flood and low flow conditions in the Project area.

The key climatic and hydrologic parameters derived for the Project area follow.

Mean annual temperature:	1.2 C
Mean annual precipitation:	441 mm
Mean annual rainfall:	332 mm
Mean annual snowfall (water equivalent):	109 mm
Maximum 1:25 Year, 24 hour Rainfall:	66.4 mm
Areal Evapotranspiration (local sub-basins):	355 mm
Mean annual runoff from local sub-basins:	66 mm
Mean annual runoff from Christina Lake:	53 mm

Hydrologic parameters of streams and rivers in the study area are summarized below.

Name	Mean Annual Discharge (m^3/s)	10-Year Maximum Daily Discharge (m^3/s)	10-Year, 7-Day Low Flow (m^3/s)*
Christina River near Chard	12.9	160	9.8
Jackfish River below Christina Lake	2.1	42.4	1.1
Northern Unnamed Tributary to Christina Lake at its mouth	0.22	7	0.02
Eastern Unnamed Tributary to Christina Lake at its mouth	0.41	12	0.04

* Open water March-October season

The key hydrologic statistics of Christina Lake are summarized below.

Hydrologic Parameter	Value
Lake Area	21.3 km^2
Lake Volume	369,000 dam^3
Mean Residence Time	4.5 years
Mean Annual Lake Surface Inflow	2.6 m^3/s
Mean Annual Lake Surface Outflow	2.1 m^3/s
Typical Water Level Fluctuation	0.6 m
Maximum / Minimum Recorded Lake Level	555.12 m / 553.65
Mean Water Level	554.1 masl

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ACKNOWLEDGEMENTS

The field surveys were carried out by Dave Cooper with assistance provided by Will Alook and Earnest Quintal of Conklin, Alberta. The report was prepared by Don Ramsey and Dave Cooper. Maps and figures were prepared by Gary Evenson. The report was reviewed by Tod Collard and Phil Ulman. Readily available data sources provided at no cost by Environment Canada and Alberta Environment are gratefully acknowledged.

1 INTRODUCTION

1.1 PROJECT DESCRIPTION

MEG Energy Corp. (MEG) is a Calgary-based, private energy company focused on the development and recovery of bitumen, shallow gas reserves and the generation of power in northeast Alberta. MEG is proposing to develop the Christina Lake Regional Project (the Project) on part of the 52 sections of oil sands leases that it holds in the area of Christina Lake, Alberta. The Project would be located within the Regional Municipality of Wood Buffalo in northeastern Alberta, approximately 15 km southeast of local Secondary Highway 881 and 20 km northeast of Conklin.

MEG is proposing to develop its oil sands lease area by building and operating the Project utilizing a steam assisted gravity drainage (SAGD) oil recovery technology. The Project would consist of a central processing facility, SAGD wells, co-generation facilities and additional infrastructure. The proposed central processing facility and the co-generation unit would be located adjacent to MEG's Pilot facilities located in NE¼ 9 and SE¼ 16, Township 77, Range 5, W4M. The Project would be designed and built to produce 22,000 barrels per day of bitumen (approximately 3,500 m^3 per day). This production, which would be in addition to the 3,000 barrels of bitumen per day from the pilot operation, would result in a total production of 25,000 barrels of bitumen per day (approximately 4,000 m^3 per day).

This report is one of a series of reports prepared to support the Application and Environmental Impact Assessment for the Project.

1.2 STUDY OBJECTIVES

This report contains a description of the climate and existing surface water hydrology within the Project study area. As one of the specific items identified in the terms of reference (TOR) established for the Hydrology component of the environmental impact assessment, this report provides "available local and regional surface flow baseline data, including low, average and peak flows for key creeks, river locations, and low, average and peak levels for key lakes". Data and information presented are based upon site specific field surveys conducted in 2004 in the Local Study Area (LSA), historical data available in the Regional Study Area (RSA) and information from previous studies in the region.

1.3 STUDY AREAS

1.3.1 Regional Study Area

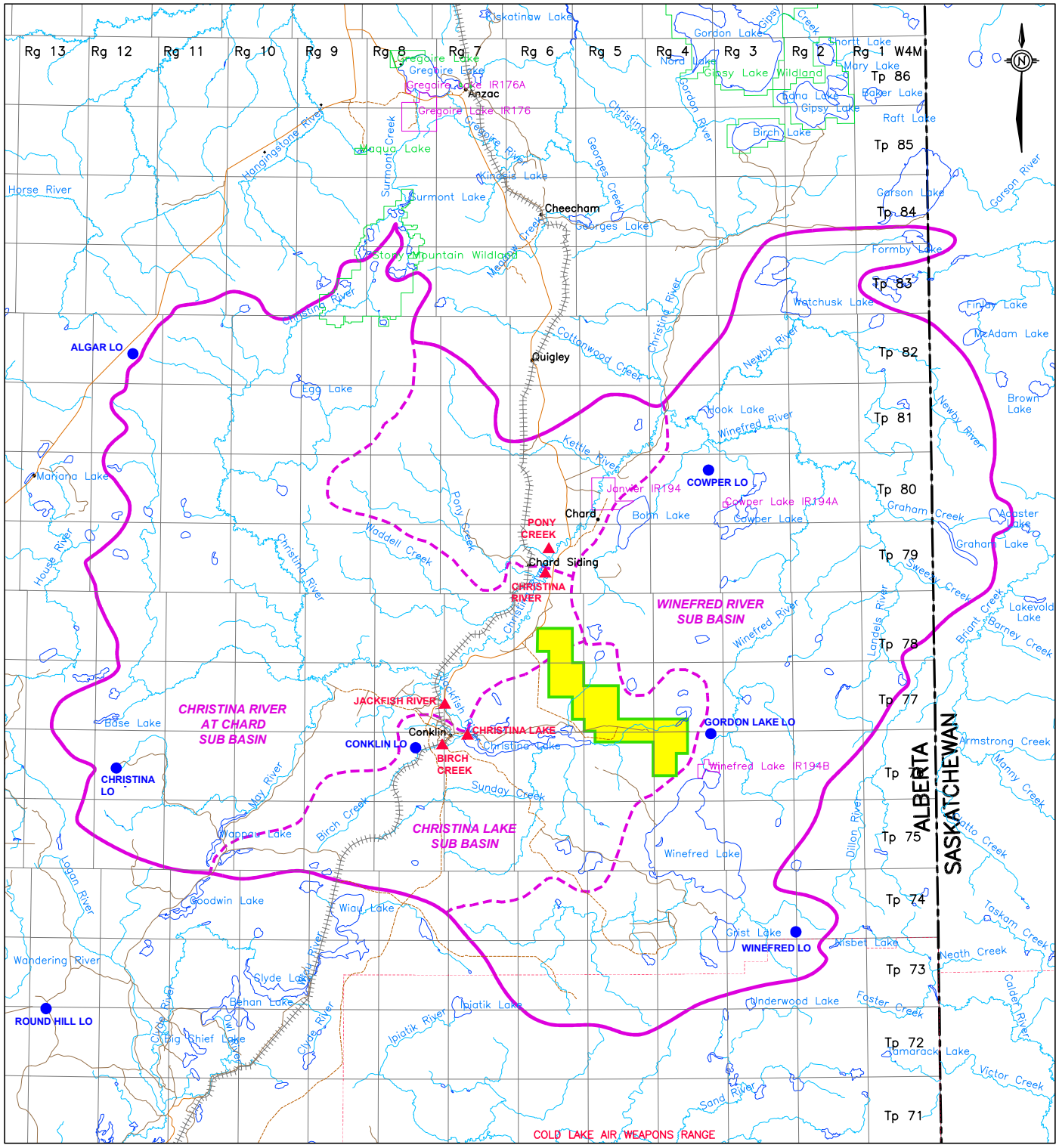
The Project is located immediately northeast of Christina Lake and lies almost entirely within the Christina Lake watershed. The Aquatic Resources Regional Study Area (RSA), as shown in Figure 1-1, has been defined to include the Christina River watershed upstream from its confluence with the Winefred River (drainage area of 5,630 km^2) and the Winefred River watershed (drainage area of 4,270 km^2). In addition to the Christina and Winefred rivers, the RSA encompasses Christina Lake (surface area of 21.3 km^2) and Winefred Lake (surface area of 150 km^2).

The total area of the RSA is approximately 9,900 km^2. Most of the RSA lies within Alberta, with only 2% extending into Saskatchewan within the Winefred River watershed. However, most of the potential effects on aquatic resources are expected to be limited to the Christina Lake sub-basin (drainage area of 1,270 km^2) in the Christina River watershed. The RSA was established to also include the Winefred River watershed because it encompasses several regionally important lakes and groundwater resources.

The majority of licensed surface water usage in the RSA is from Christina Lake for municipal purposes, as well as minor amounts of surface water from several other sources for industrial (oil and gas) purposes. The majority of groundwater use is for industrial (oil and gas) purposes, with minor amounts licensed to municipal and agricultural users.

1.3.2 Local Study Area

The Aquatic Resources Local Study Area (LSA) (Figure 1-2) was established to assess the potential for localized effects on water quality, hydrology, hydrogeology and fish and fish habitat, and was delineated based on the Project lease and footprint area, and local drainage basin boundaries. The LSA includes the Central Plant, the proposed water source and disposal wells, associated pipelines and other facilities. The LSA consists of two sub-basins draining into Christina Lake from the north and east, Christina Lake, and a small area in the northeast portion of the LSA between the two Christina Lake sub-basins that drains into a northeast flowing tributary of the Winefred River. The three sub-basin areas encompass the entire Project footprint area; Christina Lake is situated outside the footprint area. Small portions of the Project lease area in the north-west and south-east corners were excluded from the LSA because the footprint area did not extend into these portions of the lease.



LEGEND

- MEG OIL SANDS LEASE
- REGIONAL STUDY AREA (CHRISTINA RIVER DRAINAGE BOUNDARY)
- SUB BASIN DRAINAGE BOUNDARY
- WATER SURVEY OF CANADA STATION
- METEOROLOGICAL SURVEY OF CANADA STATION
- ROADWAY

REFERENCE

ALBERTA NTDB DIGITAL DATA OBTAINED FROM GEOMATICS CANADA, AUGUST 2001. DATUM: NAD 83 PROJECTION: UTM ZONE 12

PROJECT

CHRISTINA LAKE REGIONAL PROJECT

TITLE

REGIONAL STUDY AREA

MEG ENERGY CORP.

PROJECT 04-1334-001.6100			FILE No. 3459-05-12-03-A1	
DESIGN	DGR	02/02/05	SCALE AS SHOWN	REV. 0
CADD	GDE	02/02/05		
CHECK	DLC	04/02/05	**FIGURE 1-1**	
REVIEW	TC	06/02/05		

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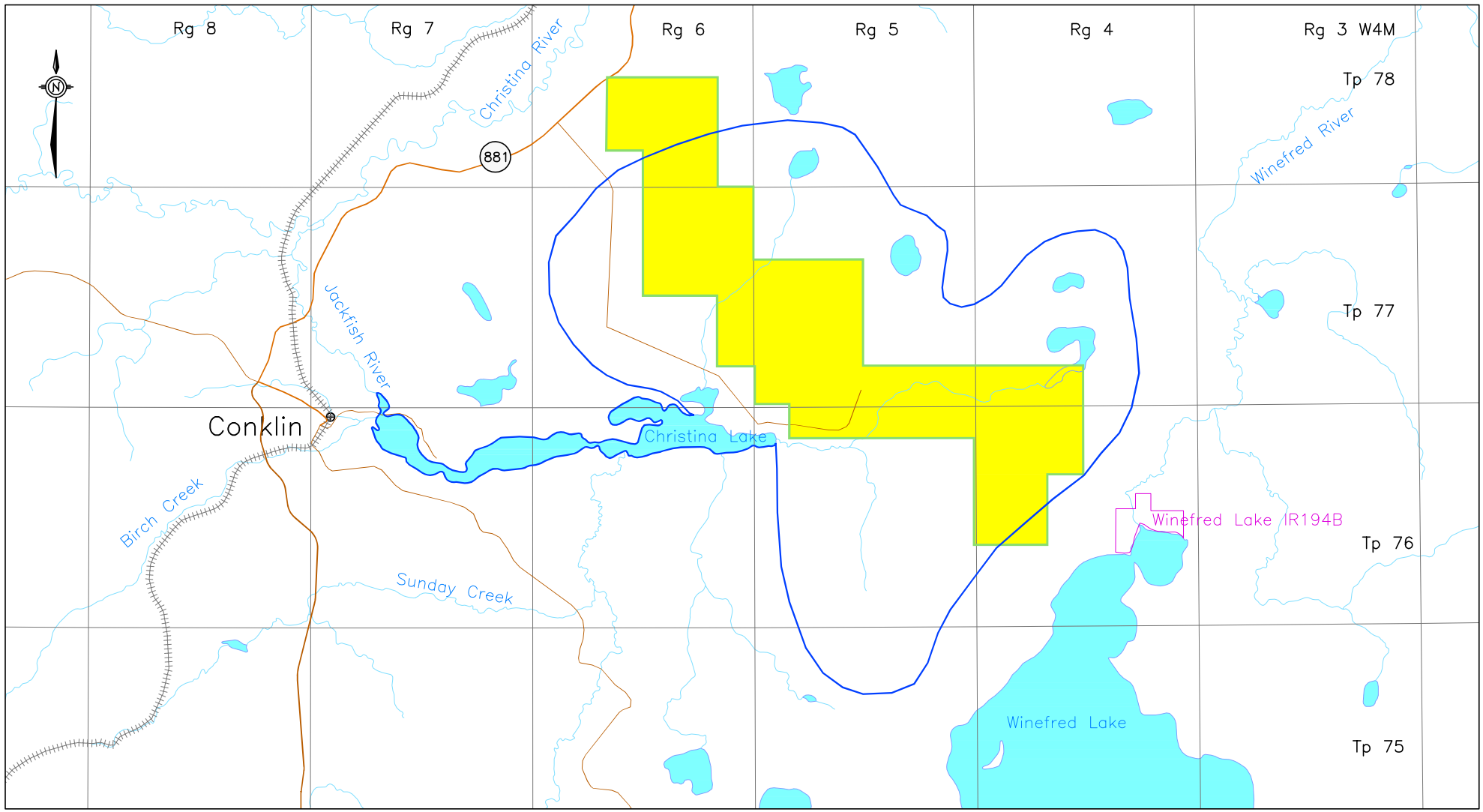
R:\CAD\2004\1322-EA\1334\04-1334-001 MEG\Stand Alones\Hydrology\Fig 1-2 3459-05-02-02-A1.dwg Jul 27, 2005 - 3:19pm



LEGEND

- MEG OIL SANDS LEASE
- LOCAL STUDY AREA

REFERENCE

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DATUM: NAD 83 PROJECTION: UTM ZONE 13
OIL & GAS AND ENVIRONMENTAL DATA PROVIDED BY VERITAS GeoSERVICES LTD., CURRENT AS OF MAY 2001.

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SCALE KILOMETRES

PROJECT
CHRISTINA LAKE REGIONAL PROJECT

TITLE
LOCAL STUDY AREA

MEG ENERGY CORP.

PROJECT 04-1334-001.6100			FILE No. 3459-05-02-02-A1	
DESIGN	DGR	02/02/02	SCALE AS SHOWN	REV. 0
CADD	GDE	02/02/05		
CHECK	DLC	04/02/05		
REVIEW	TC	06/02/05		

FIGURE: 1-2

Four sub-areas of the LSA were defined as follows (Figure 1-3):

- Christina Lake (surface area of 21.3 km²);
- tributary to Christina Lake from the north (drainage area of 104 km²);
- tributary to Christina Lake from the east (drainage area 195 km²); and
- the sub-basin draining to the northeast (area of 37 km²).

Additional local drainage around the lake accounts for the remaining area of the LSA, which is approximately 390 km² in total. The LSA is entirely encompassed by the RSA. The LSA has an undulating terrain with extensive low-lying wetland areas. Total relief ranges only 70 m, from 554 m at Christina Lake to about 625 m at the sub-basin headwaters.

Rg 8 | Rg 7 | Rg 6 | Rg 5 | Rg 4 | Rg 3 W4M

Tp 78 | Tp 77 | Tp 76 | Tp 75

Gas Field | Christina River | Winefred River | Conklin | Conklin (Airstrip) | Fire | Christina Lake | Winefred Lake | Winefred Lake IR194B | Sunday Creek

LEGEND

- MEG OIL SANDS LEASE
- WATERSHED BOUNDARY
- GENERAL DRAINAGE DIRECTION
- LOCAL SPOT FLOW MONITORING SITE

REFERENCE

ALBERTA NTDB DIGITAL DATA OBTAINED FROM GEOMATICS CANADA, AUGUST 2001. SASKATCHEWAN NTDB DATA OBTAINED FROM ISC, AUGUST 2001.
DATUM: NAD 83 PROJECTION: UTM ZONE 13
OIL & GAS AND ENVIRONMENTAL DATA PROVIDED BY VERITAS GeoSERVICES LTD., CURRENT AS OF MAY 2001.
NTS TOPO MAP 73 M.

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SCALE KILOMETRES

PROJECT
CHRISTINA LAKE REGIONAL PROJECT

TITLE
LOCAL AREA DRAINAGE BASINS

MEG ENERGY CORP.

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CADD	DGE	02/02/05	**FIGURE 1-3**		
CHECK	DLC	04/02/05			
REVIEW	TC	06/02/05			

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2 METHODS

2.1 DATA SOURCES

The surface water and climatic environmental setting is primarily a compilation of existing long-term regional data supplemented with short-term site specific information on streams in the LSA. Historical long-term regional data with site specific data comparisons, where appropriate, provide the basis for characterizing the climate and hydrology in the study areas.

Climatic data were compiled from long term Meteorological Services of Canada (Environment Canada, 2004) station data in the region including Canadian Climate Normals (1971-2000) reported data and forestry lookout station data compiled by Environment Canada. These lookouts, as shown in Figure 1-1 primarily collect summer rainfall and temperature data. Year round stations that collect a more complete range of climatic parameters are at Cold Lake and Fort McMurray. The climatological information was compiled from the following sations:

- Cold Lake Airport (A) (3081680) – year-round hourly data since 1954
- Fort McMurray A (3062693) – year-round hourly data since 1953
- Algar Lookout (LO) (3060110) – seasonal daily data since 1959
- Christina Lake LO (3061580) – seasonal daily data since 1954
- Conklin LO (3061800) – seasonal daily data since 1954
- Cowpar LO (3061930) – seasonal daily data since 1957
- Gordon Lake LO – seasonal daily data since 1964
- Round Hill LO (3065560) – seasonal daily data since 1951
- Winefred LO (3067590) – seasonal daily data since 1957

Hydrologic data were compiled from the regional Environment Canada, Water Survey of Canada (WSC) stations and Christina Lake levels measured by Alberta Environment (AENV). The stations summarized are shown in Figure 1-1. Table 2-1 summarizes the period of record available on these stations located in the RSA. Other regional station data were also reviewed for comparison purposes.

Table 2-1 Streamflow and Water Level Monitoring Stations

Station Name	WSC ID Number	Period of Record	Drainage Area (km^2)		Comments
			Gross	Effective	
Christina River near Chard	07CE002	Since 1982	4,860	4,830	Real time station Seasonal (Mar to Oct)
Pony Creek near Chard	07CE003	Since 1982	278	278	Real time station Seasonal (Mar to Oct)
Jackfish River below Christina Lake	07CE005	1982-1995	1,290	1,270	Discontinued Seasonal (Mar to Oct)
Birch Creek near Conklin	07CE006	1984-1995	232	232	Discontinued Seasonal (Mar to Oct)
Christina Lake near Conklin	07CE903	1985-2001	1,270		Spot lake level, AENV
Christina Lake near Winefred Lake	07CE906	Since 2001	1,270	NA	Real time station Continuous

No streamflow data are available within the LSA. Therefore, an overview reconnaissance of streams and hydrologic conditions was conducted in the region to define hydrologic and geomorphic channel features of the local streams plus collect site specific spot flow measurements on two occasions on May 20 and September 15, 2004.

Other data sources include the Atlas of Alberta Lakes (Mitchell and Prepas, 1990) and several previous hydrologic studies from other project Environmental Impact Assessments. These include data from the Devon Canada Corporation Jackfish Project EIA (Devon, 2004), ConocoPhillips Surmont Project (Gulf, 2002), Petro-Canada Meadow Creek Project (Petro-Can, 2001), Husky Energy Tucker Thermal Project (Husky, 2003).

2.2 ANALYSES

Statistical analyses, summaries and comparisons were conducted to describe and predict the variability of climatic and hydrologic data that is relevant to the study area. Climatic and hydrological variables including temperature, precipitation, evaporation rates, lake water levels, local and regional stream flows, and surface water withdrawal licenses, and other projects were analyzed to establish baseline trends and conditions within the LSA and RSA.

2.3 EXISTING AND PLANNED DEVELOPMENTS

Oil sands developments, either existing or approved within the project study areas are assumed as part of the baseline case. These projects include:

- PanCanadian Christina Lake Thermal Project – an existing project located immediately south of the MEG lease area and partly within the LSA (PanCanadian, 1998).
- ConocoPhillips Surmont – the most southern end of this SAGD project is located in the Kettle River watershed. The Kettle River discharges into the Christina River in the northern portion of the RSA. This project commenced development in 2004 (Gulf, 2002).
- Devon Canada Jackfish SAGD Project – an approved development to the south of the EnCana project outside of the LSA but within the Christina Lake drainage area in the north draining watersheds of the lake (Devon, 2004).
- Orion Whitesands Pilot Project – located to the west of the community of Conklin and within a tributary watershed to Jackfish River (Orion, 2003).

Other existing developments in the study areas include various oil and gas industry facilities including wells, buried pipelines and associated access roads. The main community developments and camps are at Conklin, near the outlet of Christina Lake and Janvier near the downstream northern limit of the Christina River basin in the RSA. The other principal linear facilities in the RSA include Secondary Highway 881 and the railway traversing the RSA north to south. The Cold Lake Air Weapons Range is located in the southern most extent of the RSA outside of the Christina Lake watershed.

3 RESULTS

3.1 REGIONAL AND LOCAL CLIMATE

The climate in the study area is characterized as continental with four distinct seasons. The summers are typically warm and moist as a result of air masses advancing from the south. The winter months are frequently under the influence of cold, arctic air from the north.

The Project lies approximately midway between Cold Lake and Fort McMurray. Long term average monthly and annual air temperature and precipitation data from Canadian Climate Normals (1971 to 2000) for these two stations provides a good bracket of climatic conditions at the Project. The summer (May to August) precipitation averages from the lookout monitoring stations in the region were compared to the average of the Cold Lake and Fort McMurray values. There is less than one percent difference between the average of the Cold Lake-Fort McMurray normal precipitation and the regional results. Therefore, an averaging of the Cold Lake and Fort McMurray climate data was used throughout the analysis to describe the climate at the Project site.

3.1.1 Air Temperature

Monthly air temperatures estimated by averaging the Canadian Climate Normals (1971 to 2000) for Cold Lake and Fort McMurray are provided in Table 3-1.

Table 3-1 Monthly Air Temperature Summary for the Project Area (1971 to 2000)

Month	Temperature (°C)				
	Daily Average	Daily Maximum	Daily Minimum	Extreme Maximum	Extreme Minimum
January	-17.7	-12.5	-22.9	11.9	-49.2
February	-13.1	-7.2	-18.9	14.6	-46.7
March	-5.9	0.4	-12.1	18.4	-42.8
April	3.8	10.1	-2.6	29.8	-34.4
May	10.6	17.3	3.7	33.7	-10.6
June	14.8	21.2	8.3	35.9	-3.9
July	16.9	23.1	10.6	35.9	-1.7
August	15.6	22.0	9.1	36.6	-2.2
September	9.7	15.7	3.7	32.6	-12.5
October	3.4	8.5	-1.8	28.0	-24.0
November	-7.6	-3.4	-11.8	18.9	-37.3
December	-15.6	-10.8	-20.3	10.4	-45.8
Annual	**1.2**	**7.0**	**-4.6**	**36.6**	**-49.2**

The annual daily average air temperature in the Project area is estimated at 1.2°C ranging from an average daily maximum of 23.1°C in July to an average daily minimum of -22.9°C in January. Extreme mid-summer values of about 36°C are expected to be recorded in the June to August period. A winter extreme temperature of - 49.2°C is shown for January.

3.1.2 Precipitation

In addition to the Cold Lake and Fort McMurray station data, the precipitation data available at the seven fire lookouts in the vicinity of the Project are summarized in Table 3-2. Figure 3-1 shows the average summer (May to August) precipitation at each of the nine stations plotted against the elevation at the station. This figure shows a trend between station elevation and average summer precipitation. This figure predicts an average summer precipitation of 260 mm based upon a mean elevation of 580 m for the LSA. This value is only 0.9% less than the average of the Cold Lake and Fort McMurray station data or well within the error of estimate to accept the average of the precipitation measurements at Cold Lake and Fort McMurray as being representative of the precipitation in the Project area. The comparisons were made for the 1971 to 2000 period as this coincides with the calculation period for the Canadian Climate Normals values for Cold Lake and Fort McMurray and is within the

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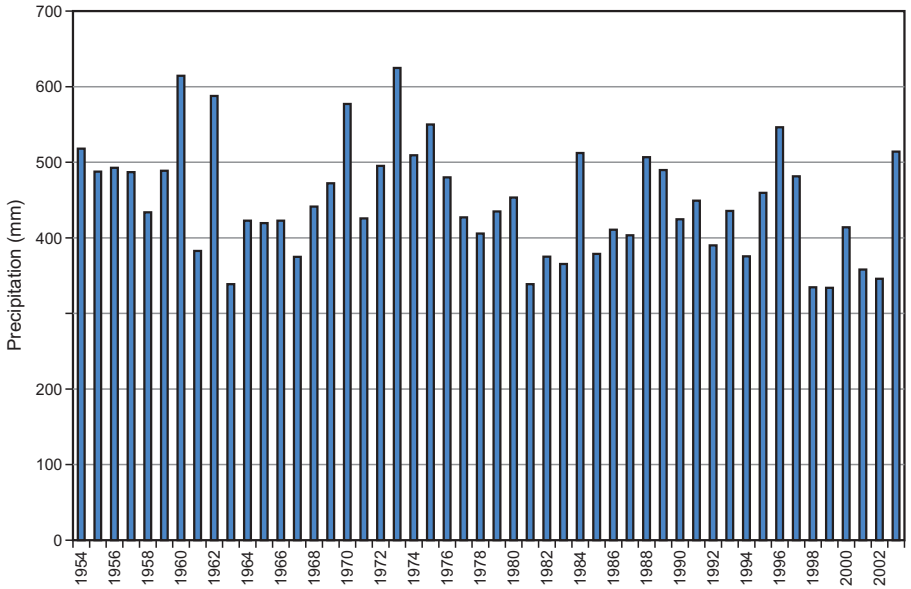
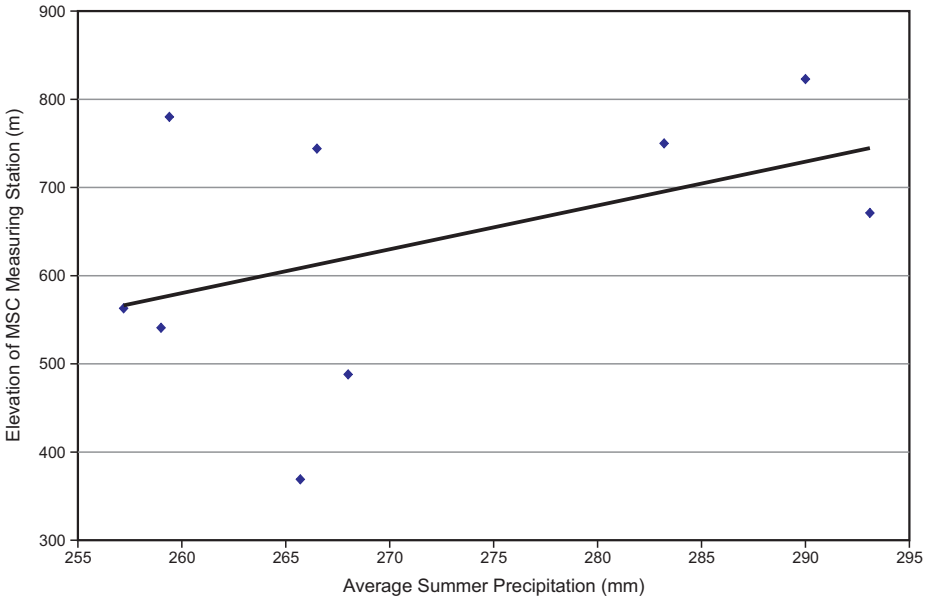
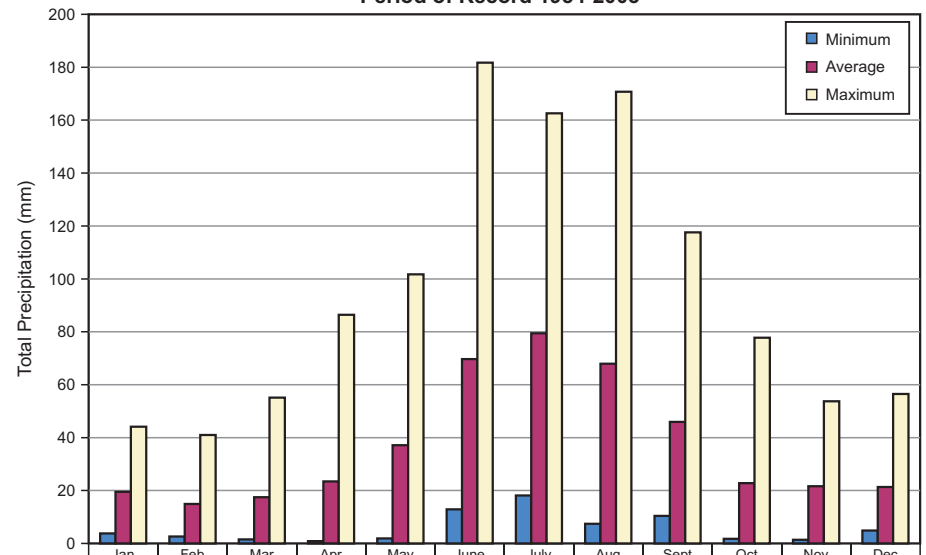
Cold Lake and Ft. McMurray Average Total Annual Precipiation (1953-2003)



Average Summer (May-August) Precipitation at the Regional MSC Measuring Stations Period 1971-2000



Averaged Historical Cold Lake and Ft. McMurray Precipitation Data Period of Record 1954-2003



	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Minimum	3.8	2.6	1.6	0.9	1.9	12.9	18.1	7.5	10.4	1.8	1.4	4.9
Average	19.5	14.9	17.5	23.5	37.1	69.7	79.4	67.9	45.9	22.8	21.7	21.3
Maximum	44.1	41.0	55.2	86.5	101.7	181.7	162.6	170.8	117.6	77.8	53.7	56.5

PROJECT

CHRISTINA LAKE REGIONAL PROJECT

TITLE

REGIONAL PRECIPITATION

MEG ENERGY CORP.

PROJECT 04-1334-001.6100			FILE No.	3459-05-02-02-A2
DESIGN	DGR	02/024/05	SCALE	REV. 0
CADD	GDE	02/02/05		
CHECK	DLC	04/02/05		FIGURE 3-1
REVIEW	TC	04/02/05		

reporting period of the other stations. The mean annual precipitation for this period at Cold Lake is 427 mm compared with 456 mm at Fort McMurray.

Table 3-2 Regional Precipitation Stations

Station Name	Length of Record	Type of Record	Station Elevation (m)	Average Summer Precipitation (mm)
Algar LO	Since 1959	Seasonal	780	259.4
Christina LO	Since 1954	Seasonal	823	290.0
Cold Lake A	Since 1954	Continuous	541	259.0
Conklin LO	Since 1954	Seasonal	671	293.1
Cowpar LO	Since 1957	Seasonal	563	257.2
Fort McMurray A	Since 1953	Continuous	369	265.7
Gordon Lake LO	Since 1964	Seasonal	488	268.0
Round Hill LO	Since 1951	Seasonal	750	283.2
Winefred Lake LO	Since 1957	Seasonal	744	266.5

Note: A – Airport; LO – Lookout

Resulting monthly average and extreme precipitation data for the Project area are provided in Table 3-3 and a plot of the total annual precipitation is provided in Figure 3-1 for the full period of common record at the Cold Lake and Fort McMurray stations, 1954 through 2003. This plot shows that annual precipitation has ranged from 334 to 624 mm. Monthly average, minimum and maximum values are also provided in Figure 3-1.

Table 3-3 Monthly Precipitation Summary for the Project Area (1971 to 2000)

Month	Monthly Totals			Daily Extremes		
	Rainfall (mm)	Snowfall (cm)	Precipitation (mm)	Rainfall (mm)	Snowfall (cm)	Precipitation (mm)
January	0.6	25.0	18.6	8.4	18.6	18.4
February	0.6	18.5	13.7	3.8	15.7	12.0
March	1.4	18.6	15.6	8.2	26.8	26.3
April	11.8	13.1	23.3	22.5	34.0	34.6
May	35.9	3.6	39.3	41.4	21.0	41.9
June	73.5	0.0	73.5	71.9	0.2	71.9
July	79.4	0.0	79.4	52.7	0.0	52.7
August	70.1	0.1	70.3	72.7	2.1	72.7
September	41.7	2.0	43.4	53.6	19.9	53.6
October	14.7	10.1	23.6	34.7	18.0	34.7
November	2.0	26.8	21.2	10.1	24.3	23.1
December	1.0	25.3	19.6	7.5	19.8	18.9
Annual	**332.3**	**142.9**	**441.1**	**72.7**	**34.0**	**72.7**

Of the estimated annual total precipitation of 441 mm, 75% will fall as rain and the remaining 25% as snowfall (water equivalent). Daily extreme rainfalls in excess of 70 mm have been experienced and daily snowfalls up to 34 mm have been recorded. July is the wettest month and November has the highest snowfall.

Rainfall intensity duration frequency values, as summarized in Table 3-4, were estimated in a similar manner. Although individual storm rainfall events may be highly localized and variable, various regional statistical comparisons of rainfall intensities show these values to be appropriate for the Project area.

Table 3-4 Estimated Rainfall Intensity-Duration Frequency Data for the Project Area

Duration	Return Period			
	2 year	10 year	25 year	100 year
30 minutes	12.2	22.1	27.0	34.3
1 hour	14.6	25.7	31.2	39.5
6 hour	25.4	40.8	48.5	59.9
12 hour	32.0	52.6	66.4	78.2
24 hour	38.9	63.9	76.5	96.0
2 day	46.1	74.2	89.5	122
5 day	50.5	82.0	100	134
10 day	63.5	101	122	157

Note: All values in mm. Based upon average of Cold Lake and Fort McMurray IDF values.

3.1.3 Evaporation and Evapotranspiration

Evaporation and evapotranspiration account for the largest loss of water from Alberta's watersheds. Evaporation is the direct transformation of liquid water to water vapour. Transpiration is the release of water vapour to the air from plants. Evapotranspiration is the combination of evaporation and transpiration from an area (usually terrestrial). Evapotranspiration processes are important hydrologically as they have a direct effect on the amount of runoff from a watershed.

Monthly mean evaporation and evapotranspiration data are available for Fort McMurray from 1971 to 1992 and for Cold Lake from 1973 to 1992 (Bothe and Abraham, 1987, 1993). The data have been extended at Fort McMurray to 2003 based upon climatic records at the station and using the Morton evaporation model. Overall, long-term differences in the average statistics of computed evaporation and evapotranspiration are minor. Averaging the data at Cold Lake and Fort McMurray provides the evaporation and evapotranspiration values for the Project area as listed in Table 3-5.

Table 3-5 Evaporation and Evapotranspiration in the LSA (1974-1992)

Month	Evaporation (mm)		Evapotranspiration (mm)	
	Potential	Lake	Potential	Areal
January	-3	-3	-2	-2
February	0	0	1	1
March	24	19	21	14
April	99	64	98	21
May	153	104	152	44
June	166	124	163	73
July	170	133	165	87
August	137	103	134	60
September	71	45	66	17
October	21	17	21	11
November	-1	-1	-1	-1
December	-3	-3	-3	-3
Annual	**835**	**602**	**817**	**322**

Notes:

1) Negative values denote condensation
2) Potential evaporation is the amount of water that would evaporate from a very small area with an unlimited supply of water
3) Potential evapotranspiration relates to the amount of water that could pass from the soil-water interface under ideal conditions and an unlimited supply of water

The actual evaporation from shallow lake surfaces averages 602 mm annually which is 72% of the potential of 835 mm annually. Approximately 77% of actual lake evaporation occurs in the May-August period peaking at 133 mm in July. The timing of peak lake evaporation rates is a function of lake depth. The greater heat capacity of a deep lake delays seasonal warming and cooling, typically resulting in higher evaporation rates later in the summer season.

Mean annual potential evapotranspiration is comparable to potential evaporation at 817 mm. Actual areal evapotranspiration averages only 322 mm per year or 39% of the potential because of less than saturated conditions at times in a basin and the cooling effect of moving air. Approximately 82% of areal evapotranspiration occurs in the May to August period peaking in July.

3.2 SURFACE WATER WITHDRAWAL LICENSES

Registered surface water and groundwater licenses within the RSA are shown in Table 3-6. These license data are based upon AENV database records and indicate assumed consumption, losses and surface water return flows. The three

oil sands projects listed in the footnote have applied for licenses but were not on the database at the time the information was requested from AENV. Most industrial user's record actual monthly uses and report to AENV on an annual basis. However, these records are not typically readily available for compilation and were not requested. Additional information on groundwater licenses are provided in the Hydrogeology report (Westwater, 2005).

Table 3-6 Surface and Groundwater Licenses in the RSA

Applicant	Source	License Quantity (m^3)	Consumed (m^3)	Losses (m^3)	Returned to Water Body (m^3)
Surface Water					
BP Canada Energy Company	Unnamed Lake - Unclassified	2,460	2,460	0	0
Schuller, Martin	Unnamed Stream - Unclassified	372	372	0	0
G & E Maunder Enterprises Ltd	Winefred Lake	1,230	1,230	0	0
V S P North Holdings Ltd	Grist Lake	1,230	1,230	0	0
Fort McMurray Advisory Council	Christina Lake	20,960	20,960	0	0
Fort McMurray Advisory Council	Christina River	66,610	11,100	3,700	51,810
Janvier First Nation	Christina River	0	0	0	0
Groundwater					
Harpe, Richard	Unnamed Aquifer - Unclassified	516	516	0	0
EnCana Corporation	Unnamed Aquifer - Unclassified	1,825,000	1,825,000	0	0
EnCana Corporation	Unnamed Aquifer - Unclassified	3,650	3,650	0	0
Fort McMurray Advisory Council	Unnamed Aquifer - Unclassified	1,230	1,230	0	0

Source: Alberta Environment, March 4, 2004. Jackfish (Devon, 2004), Surmont (Gulf, 1996) and Whitesands (Orion, 2003) projects, not shown here, all will rely upon groundwater supply sources.

3.3 WATERSHED DESCRIPTION AND HYDROLOGY

3.3.1 Surface Water Drainage Patterns

The Project lease and footprint area lies entirely within the Christina River watershed with the majority of the Project within the Christina Lake drainage basin and particularly in the two sub-basins to the north and east of Christina Lake.

Christina Lake drainage basin is 1,270 km² in area. Figures 1-1 and 1-3 show the Christina Lake basin with five major inflowing tributaries - Birch Creek in the southwest which was gauged by WSC, Sunday Creek (with limited spot flow measurements taken by Devon in 2002), an Unnamed tributary on the south draining Hay and Kirby Lakes, and the eastern and northern tributaries which encompass the Project area. Table 3-7 summarizes the sub-basin areas of the Christina Lake basin.

Table 3-7 Christina Lake Drainage Basin Area Summary

Sub-basin	Gross Drainage Area (km²)
Birch Creek	232
Sunday Creek	400
South Unnamed Creek (Kirby & Hay Lake)	149
East Unnamed Creek (at mouth)	195[(a)]
North Unnamed Creek (at road)	104
Other Minor tributaries/local drainage	169
Lake Area	21.3
Jackfish River at Lake Outlet	1,270

(a) estimated drainage area at flow monitoring site is 169 km².

The outlet of Christina Lake is located at the western tip of the lake and flows into Jackfish River which joins the Christina River about 8 km downstream and northwest of the lake outlet. The Jackfish River drainage basin has a gross area of 1,290 km² at the WSC flow measurement station near Secondary Highway 881. According to the Atlas of Alberta Lakes (Mitchell and Prepas, 1990), the Christina Lake basin is part of a till plain that slopes gently downward to the northeast. Land in the northeast portion of the watershed is level to nearly level, and the remainder is gently undulating to gently rolling. Generally, the area is poorly drained and muskeg covers up to 80% of the land.

The Christina River originates about 60 km south of Fort McMurray, near Surmont Lake. It flows south for about 60 km before turning north to discharge into the Clearwater River about 30 km upstream from Fort McMurray. The May River, Jackfish River, Waddell Creek, Pony Creek and the Kettle River are major tributaries in the RSA that flow from the west and south. The Winefred River is the principal tributary in the RSA that flows from the east. The Christina River drainage area is 9,300 km² below the Winefred River confluence. The basin consists largely of low-relief topography with considerable muskeg wetlands and small lakes that regulate runoff. The Cold Lake Air Weapons Range lies to the south of the drainage basin.

The other major river sub-basins in the RSA, as shown in Figure 1-1, are the Christina River at Chard and Winefred. The Christina River sub-basin at Chard is shown because of the WSC monitoring station at this location. The gross drainage basin area at this location is 4,860 km² including the upper Christina River basin area to the west of the project. Pony Creek, which is gauged, joins the Christina River just downstream of Chard.

The Winefred River basin originates in the northern portion of the Cold Lake Air Weapons Range. The river flows basically north for some 65 km before it turns west for another 25 km to join the Christina River. Landels River and Newby River are the principal tributaries and flow from the east. Of the total 4,270 km² Winefred River drainage area, approximately 6.8% lies in Saskatchewan. Winefred Lake is the largest lake in the RSA at 150 km². It is located in the upper part of the Winefred River watershed along with Grist Lake. Other lakes in the watershed include: Bohn Lake, Cowper Lake, Watchusk Lake and Formby Lake.

Watershed areas are based on WSC reported values or determined from 1:250,000 and 1:50,000 NTS mapping.

3.3.2 Regional Streamflows and Basin Yields

There are no streamflow monitoring stations in the LSA. Therefore, regional monitoring stations are used to define hydrologic characteristics combined with regional and site specific hydrologic information available from previous studies within the Christina Lake watershed.

A hydrologic summary of the data available on the gauged streams in the RSA is presented in Figures 3-2 to 3-5. These figures summarize mean, maximum and minimum monthly flows, annual peak flows over the period of record, typical wet, dry and average year hydrographs, average seasonal runoff, estimated mean annual runoff estimates based on correlation infilling for missing winter flow data, mean annual streamflow and 1:10 year 7-day low flow estimates for the open water seasonal data.

Streamflows typically peak in May followed by a gradual recession. Christina River near Chard in Figure 3-2, as the largest watershed, has the highest seasonal runoff at 77.3 mm with flows typically peaking later in July. The sample hydrographs show that high streamflows can occur in August and September due to significant storm events.

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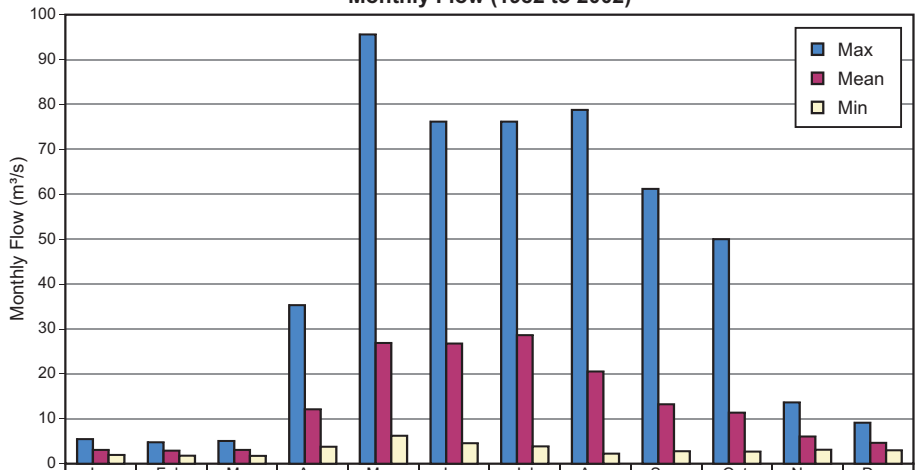
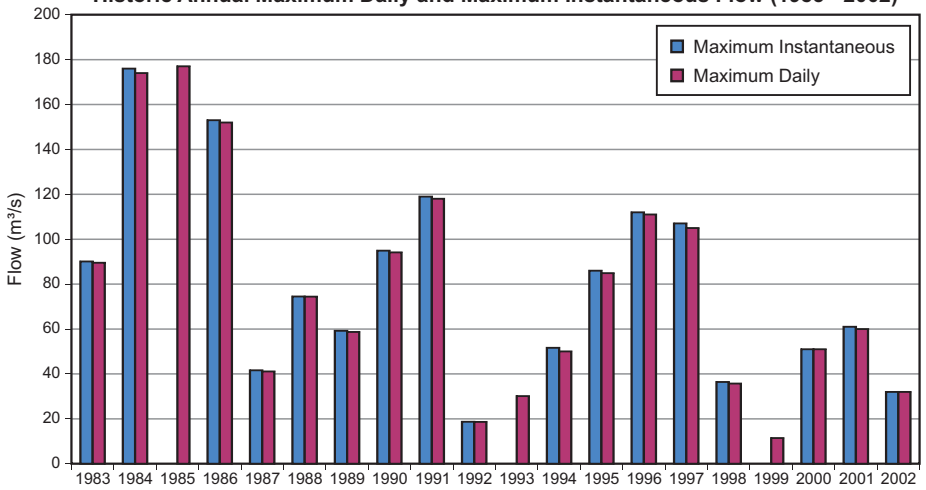
Monthly Flow (1982 to 2002)



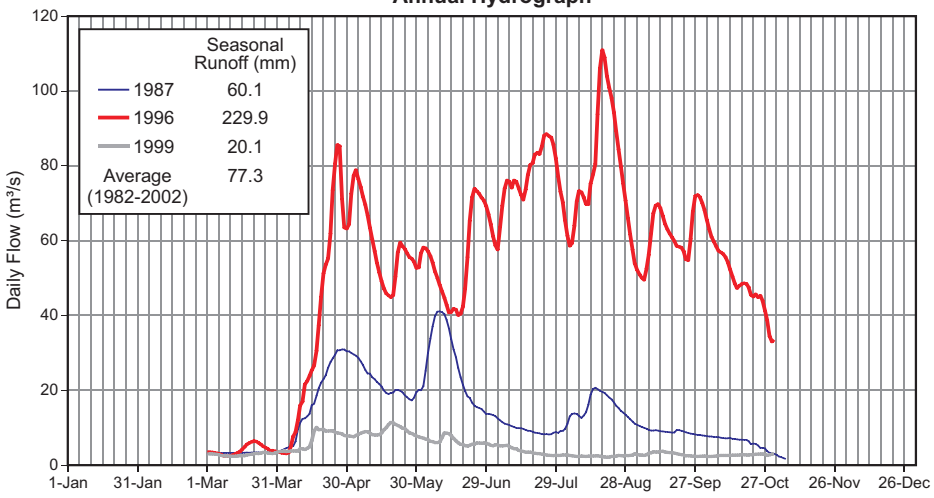
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly Flow	Max	5.5	4.8	5.1	35.3	95.6	76.2	76.2	78.8	61.2	50.0	13.7	9.1
	Mean	3.1	2.9	3.1	12.1	26.9	26.8	28.6	20.6	13.2	11.4	6.1	4.7
	Min	2.0	1.8	1.7	3.8	6.2	4.6	3.9	2.2	2.8	2.7	3.1	3.0
Runoff l/s/km²	Max	1.1	1.0	1.	7.3	19.8	15.8	15.8	16.3	12.7	10.4	2.8	1.9
	Mean	0.6	0.6	0.6	2.5	5.6	5.5	5.9	4.3	2.7	2.4	1.3	1.0
	Min	0.4	0.4	0.4	0.8	1.3	1.0	0.8	0.5	0.6	0.6	0.7	0.6

Note: Infilling winter months (Nov - Feb)

Historic Annual Maximum Daily and Maximum Instantaneous Flow (1983 - 2002)



Annual Hydrograph



Station Summary

Station Name	Christina River near Chard
Station No.	07CE002
Period of Record	1982 - 2002 (Seasonal, 21 Years)
1:10, 7-Day Low Flow (m^3/s)	9.8 (Open Water)
Drainage Area (km^2)	
Gross	4860
Effective	4830
Mean Annual	
Streamflow (m^3/s)*	12.9
Runoff (mm)*	84.0

* Based on 1982 - 2002 record (infilling winter months from Nov - Feb)

PROJECT

CHRISTINA LAKE REGIONAL PROJECT

TITLE

CHRISTINA RIVER NEAR CHARD HYDROLOGIC SUMMARY

MEG ENERGY CORP.

PROJECT 04-1334-001.6100			FILE No.	3459-05-02-02-A2	
DESIGN	DGR	02/024/05	SCALE	REV.	0
CADD	GDE	02/02/05	FIGURE 3-2		
CHECK	DLC	04/02/05			
REVIEW	TC	04/02/05			

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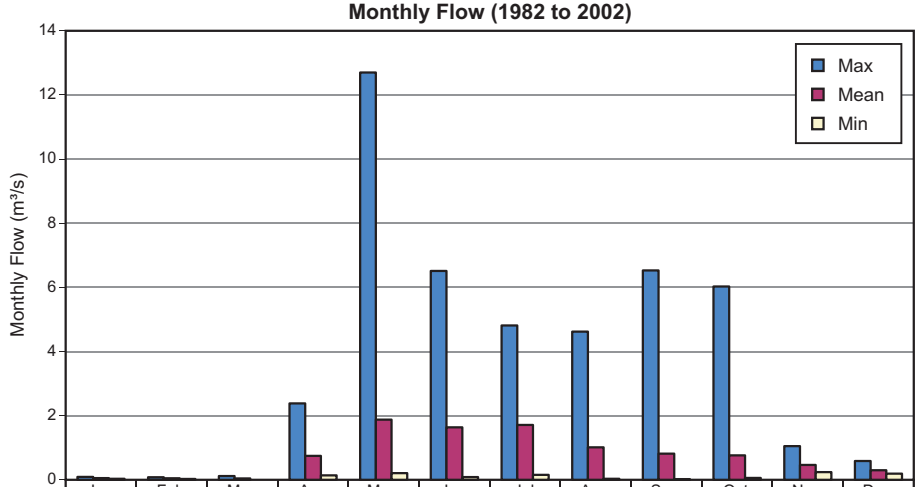
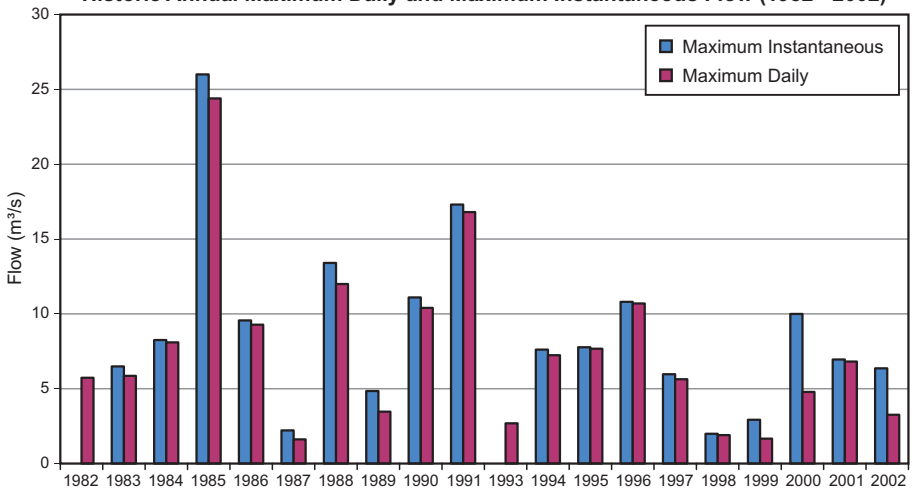
Monthly Flow (1982 to 2002)



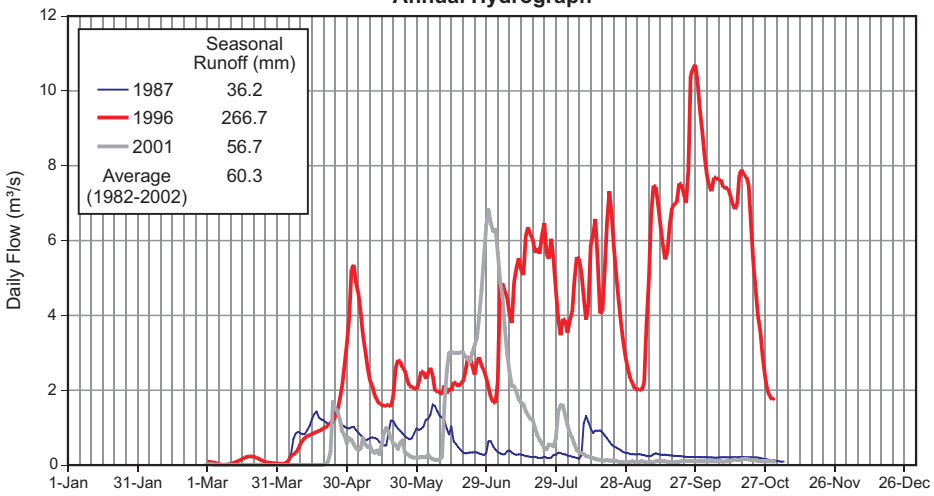
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly Flow	Max	0.1	0.1	0.1	2.4	12.7	6.5	4.8	4.6	6.5	6.0	1.1	0.6
	Mean	0.1	0.1	0.0	0.8	1.9	1.6	1.7	1.0	0.8	0.8	0.5	0.3
	Min	0.0	0.0	0.0	0.1	0.2	0.1	0.2	0.0	0.0	0.1	0.2	0.2
Runoff l/s/km²	Max	0.3	0.3	0.4	8.6	45.7	23.4	17.3	16.6	23.5	21.7	3.8	2.1
	Mean	0.2	0.2	0.2	2.7	6.8	5.9	6.2	3.6	2.9	2.7	1.7	1.2
	Min	0.1	0.1	0.0	0.5	0.8	0.3	0.6	0.1	0.1	0.2	0.9	0.7

Note: Infilling winter months (Nov - Feb)

Historic Annual Maximum Daily and Maximum Instantaneous Flow (1982 - 2002)



Annual Hydrograph



Station Summary

Station Name	Pony Creek near Chard
Station No.	70CE003
Period of Record	1982 - 2002 (seasonal, 21 Years)
1:10, 7-Day Low Flow (m^3/s)	0.02 (Open Water)
Drainage Area (km^2)	
Gross	278
Effective	278
Mean Annual	
Streamflow (m^3/s)*	0.6
Runoff (mm)*	66.0

* Based on 1982 - 2002 record (infilling winter months)

PROJECT

CHRISTINA LAKE REGIONAL PROJECT

TITLE

PONY CREEK NEAR CHARD HYDROLOGIC SUMMARY

MEG ENERGY CORP.

PROJECT 04-1334-001.6100			FILE No.	3459-05-02-02-A2	
DESIGN	DGR	02/024/05	SCALE	REV.	0
CADD	GDE	02/02/05			
CHECK	DLC	04/02/05			
REVIEW	TC	04/02/05			

FIGURE 3-3

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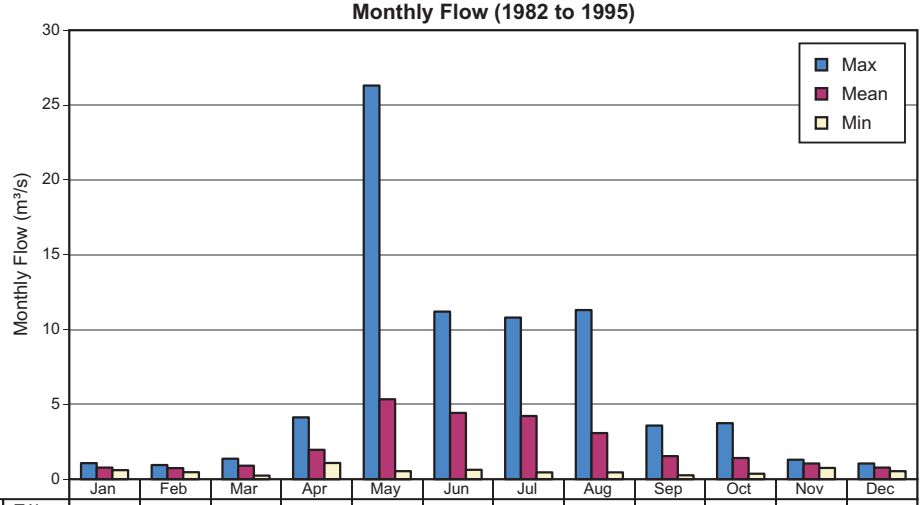
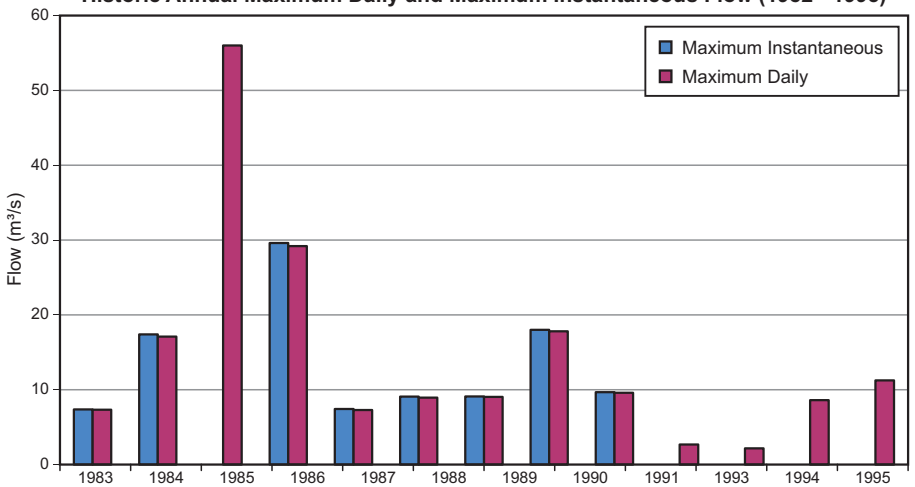
Monthly Flow (1982 to 1995)



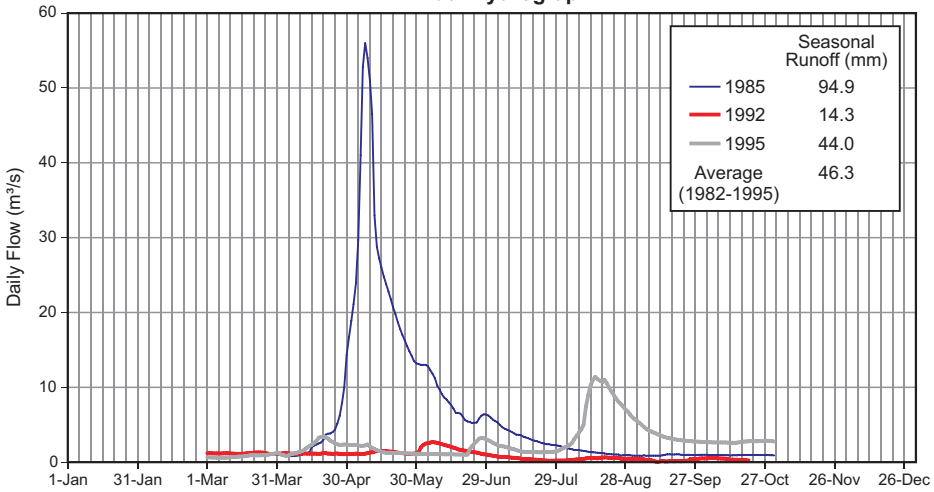
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly Flow	Max	1.1	0.9	1.4	4.1	26.3	11.2	10.8	11.3	3.6	3.8	1.3	1.1
	Mean	0.8	0.7	0.9	2.0	5.4	4.4	4.2	3.1	1.5	1.4	1.1	0.8
	Min	0.6	0.5	0.2	1.1	0.5	0.6	0.5	0.5	0.3	0.4	0.8	0.5
Runoff l/s/km²	Max	3.9	3.4	4.9	14.9	94.6	40.3	38.9	40.7	12.9	13.5	4.7	3.8
	Mean	2.8	2.7	3.2	7.1	19.2	15.9	15.2	11.1	5.5	5.1	3.8	2.8
	Min	2.2	1.7	0.9	3.9	1.9	2.3	1.7	1.7	0.9	1.3	2.7	1.9

Note: Infilling winter months (Nov - Feb)

Historic Annual Maximum Daily and Maximum Instantaneous Flow (1982 - 1995)



Annual Hydrograph



Station Summary

Station Name	Jackfish River below Christina Lake
Station No.	07CE005
Period of Record	1982 - 1995
(seasonal/discontinued, 14 Years)	
1:10, 7-Day Low Flow (m^3/s)	1.1 (Open Water)
Drainage Area (km^2)	
Gross	1,290
Effective	1,270
Mean Annual	
Streamflow (m^3/s)*	2.10
Runoff (mm)*	52.26

* Based on 1982 - 1995 record (infilling winter months)

PROJECT

CHRISTINA LAKE REGIONAL PROJECT

TITLE

JACKFISH RIVER BELOW CHRISTINA LAKE - HYDROLOGIC SUMMARY

MEG ENERGY CORP.

PROJECT 04-1334-001.6100			FILE No.	3459-05-02-02-A2	
DESIGN	DGR	02/024/05	SCALE	REV.	0
CADD	GDE	02/02/05			
CHECK	DLC	04/02/05			
REVIEW	TC	04/02/05			

FIGURE 3-4

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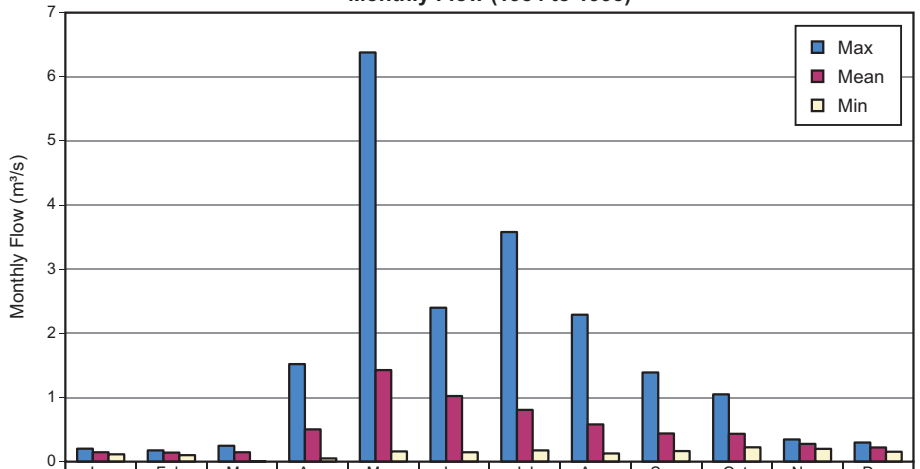
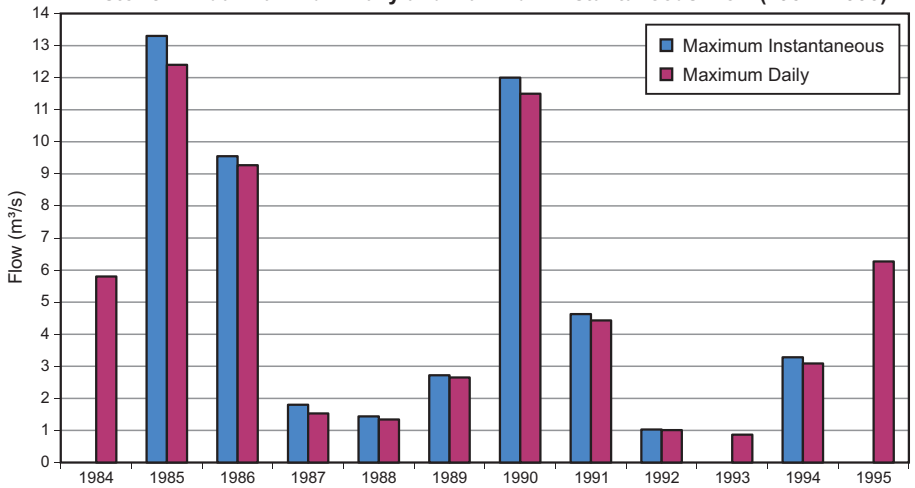
Monthly Flow (1984 to 1995)



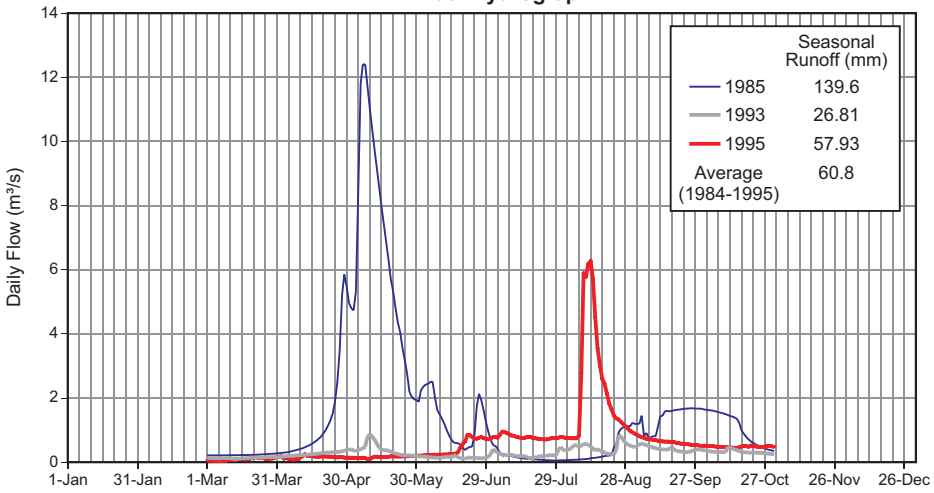
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly Flow	Max	0.2	0.2	0.3	1.5	6.4	2.4	3.6	2.3	1.4	1.1	0.4	0.3
	Mean	0.2	0.1	0.2	0.5	1.4	1.0	0.8	0.6	0.4	0.4	0.3	0.2
	Min	0.1	0.1	0.0	0.1	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2
Runoff l/s/km²	Max	0.7	0.6	0.9	5.5	23.0	8.6	12.9	8.2	5.0	3.8	1.3	1.1
	Mean	0.5	0.5	0.5	1.8	5.1	3.7	2.9	2.1	1.6	1.6	1.0	0.8
	Min	0.4	0.4	0.0	0.2	0.6	0.5	0.6	0.5	0.6	0.8	0.7	0.6

Note: Infilling winter months (Nov - Feb)

Historic Annual Maximum Daily and Maximum Instantaneous Flow (1984 - 1995)



Annual Hydrograph



Station Summary

Station Name	Birch Creek near Conklin
Station No.	07CE006
Period of Record	1984 - 1995 (Seasonal/discontinued, 12 Years)
1:10, 7-Day Low Flow (m^3/s)	0.17 (Open Water)
Drainage Area (km^2)	
Gross	232
Effective	232
Mean Annual	
Streamflow (m^3/s)*	0.49
Runoff (mm)*	66.0

* Based on 1984 - 1995 record (infilling winter months)

PROJECT

CHRISTINA LAKE REGIONAL PROJECT

TITLE

BIRCH CREEK NEAR CONKLIN HYDROLOGIC SUMMARY

MEG ENERGY CORP.

PROJECT 04-1334-001.6100			FILE No.	3459-05-02-02-A2	
DESIGN	DGR	02/024/05	SCALE	REV.	0
CADD	GDE	02/02/05			
CHECK	DLC	04/02/05			
REVIEW	TC	04/02/05			

FIGURE 3-5

Pony Creek near Chard (Figure 3-3) and Birch Creek (Figure 3-5) are the two closest small basins to the LSA that are gauged and are considered to be most representative of flow conditions in the Christina Lake tributary streams. Average seasonal runoff from these basins is similar at 60.3 and 60.8 mm recognizing the different period of record available at each site. Although the Birch Creek (Figure 3-5) and Jackfish River stations were discontinued after 1995, they were monitored in 2002 for the Jackfish Project and compared with data collected on the Sunday Creek – the southern tributary to Christina Lake. The Jackfish River seasonal runoff is much lower than the other sites at 46.3 mm. This partly reflects the increased evaporative loss effect of Christina Lake but suggests that runoff may be lower from the other tributaries to the lake. Winter flows (November to February) are estimated to represent approximately 5% to 8% of the total annual runoff based upon review of regional year round station data.

Figure 3-6 shows average monthly unit runoff for the common recording period (March 1984 to October 1995) at the four WSC streamflow monitoring stations in the RSA. This figure demonstrates that the unit rate of runoff is similar but tends to increase downstream from Christina Lake as exemplified by the higher unit rate of runoff at both the Pony Creek and the Christina River stations near Chard.

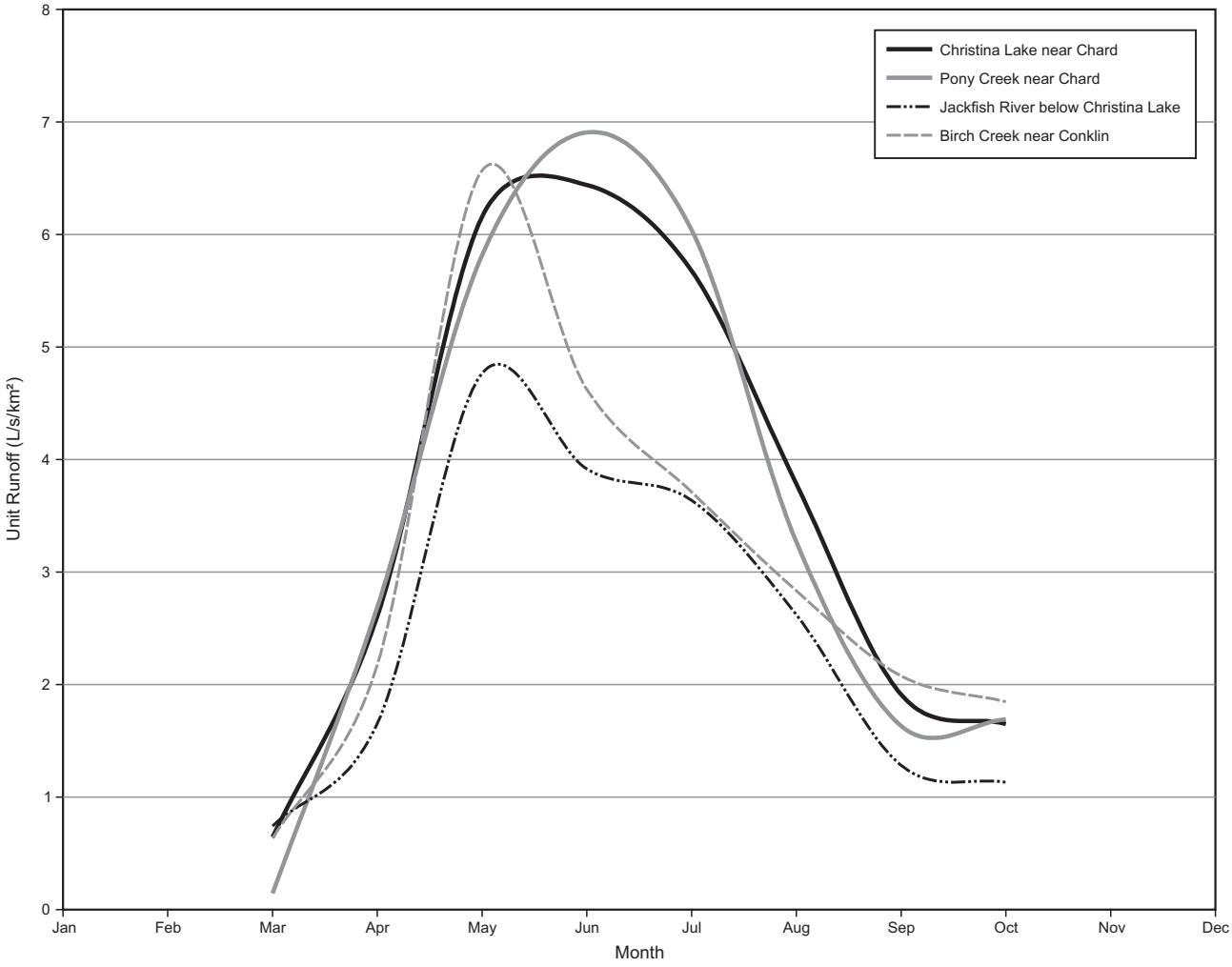
3.3.3 Local Streamflows and Basin Yields

Northern Unnamed Tributary to Christina Lake

This unnamed south flowing stream, has a drainage area of 104 km² near its mouth in a bay (local name Sawbones Bay) in the northeast end of Christina Lake. Runoff from the basin is regulated by extensive wetlands and ponds in its headwater branches. The estimated area of ponds is about 3% of the basin area and wetlands account for nearly 40% of the basin area. The rolling hill upland areas are largely composed of well drained sandy and gravelly outwash material.

The stream at the main access road crossing about 1 km from its mouth is a 6 to 8 m wide meandering, low gradient (local slope of only 0.01%) channel that has been extensively modified by beaver activity. Downstream of the crossing, the silt bed channel has vertical to undercut grass banks with a total depth of 1.5 to 2 m from the bed to the overbank level. A well defined 50 to 70 m wide floodplain that has been affected by beaverdams is evident downstream of the road crossing. A breached beaverdam is located about 20 m upstream of the crossing. The maximum mid channel water depth was 1.1 m on May 20, 2004 with an average flow depth of 0.74 m. The estimated normal bankfull level was about 0.3 m higher or just below the overbank floodplain level.

Seasonal Average Monthly Unit Runoff in RSA
Common Period of Record (Mar 1984-Oct 1995)



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PROJECT

CHRISTINA LAKE REGIONAL PROJECT

TITLE

REGIONAL AVERAGE MONTHLY UNIT RUNOFF

MEG ENERGY CORP.

PROJECT 04-1334-001.6100			FILE No.	3459-05-02-02-A1
DESIGN	DGR	02/02/05	SCALE	REV. 0
CADD	GDE	02/02/05		
CHECK	DLC	04/02/05		
REVIEW	TC	04/02/05		

FIGURE 3-6

Although the flow measurement on May 20 was more than double that on September 15, the water level was over 20 cm higher on September 15 because of aquatic vegetation growth over the season creating backwater effects. This illustrates the difficulty in establishing water level stage–discharge relations and the futility of installing continuous recording equipment on such streams to monitor discharge on a continuous basis.

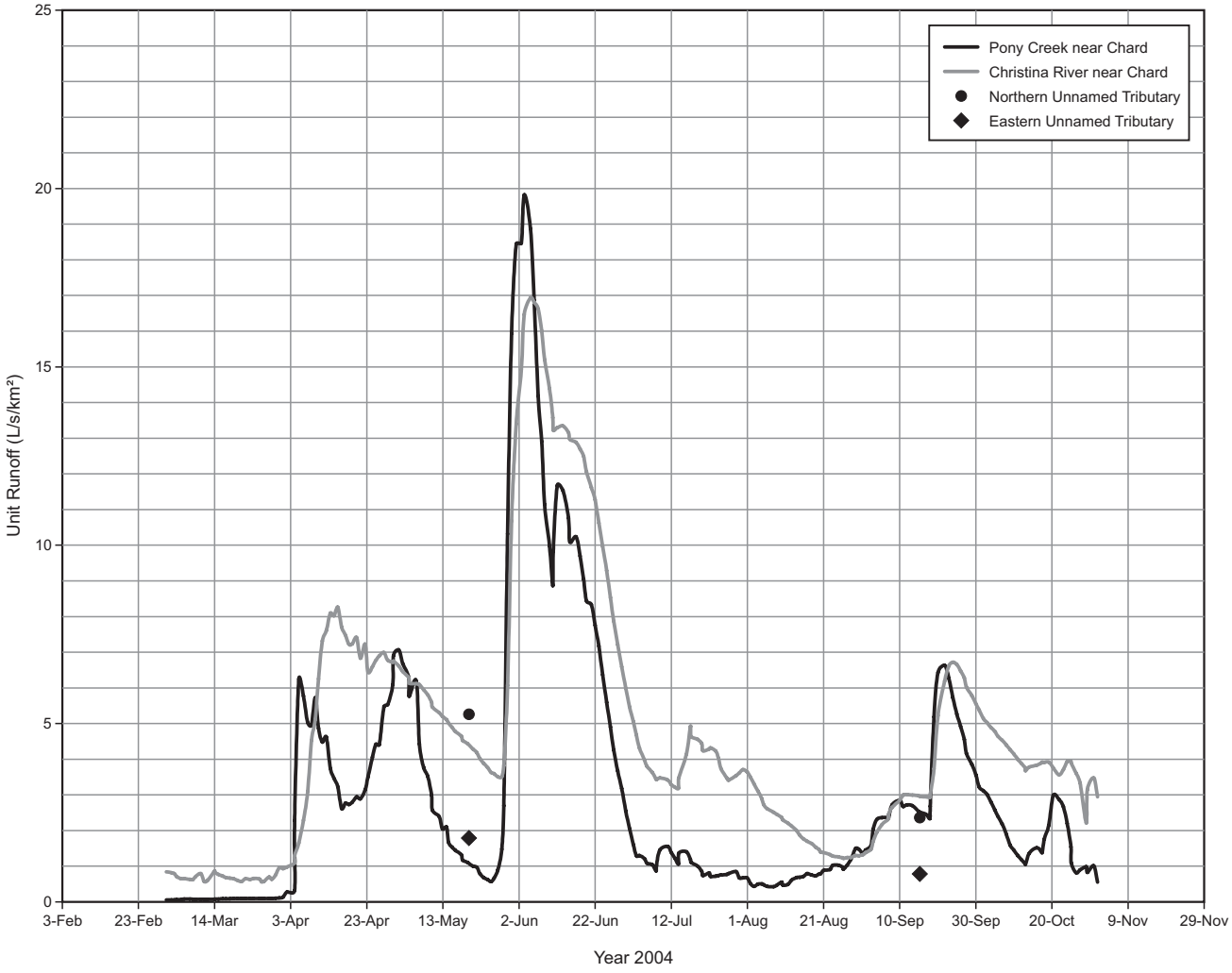
Eastern Unnamed Christina Lake Tributary

This unnamed stream has a drainage area of 169 km² at the monitoring location at a series of buried pipeline crossings (including the main Enbridge line). The site is located about 3 km upstream from its mouth at the eastern end of Christina Lake. At this site the stream meanders through a broad wetland area. It branches just upstream into north and south flowing streams. Runoff from the basin is extensively regulated by large wetlands and ponds in the headwaters of both branches. Ponds are estimated to account for 4% of the basin area with wetland muskeg terrain covering over one third of the basin.

The channel section at the monitoring site has an 8.8 m topwidth, a wetted width of 6.1 m and grass vegetated, frequently vertical or undercut banks 0.7 m high. In more confined natural sections (unaffected by the pipeline crossings), both upstream and downstream, the channel is 5 to 6 m wide with 1 m high banks. The silt bed channel has a low gradient of 0.11% at the site. Normal bankfull depth was estimated at 0.4 m above the May 20, 2004 water level. The water level was low with exposed mud flats along the channel with an average flow depth of 0.26 m. Former backup flooding appeared to have occurred from beaverdams or extensive old woody debris observed downstream. The field reconnaissance noted extensive beaver activity along upstream sections of this stream. Measured water levels were also higher in September on this stream with lower measured flows compared to May due to the extensive aquatic vegetation growth that occurred in this channel over the summer.

Local Runoff Comparisons and Basin Yield

The measured unit runoff from the two unnamed tributary streams, as summarized in Table 3-8, are compared with the 2004 unit runoff curves for Pony Creek near Chard and Christina River near Chard in Figure 3-7. The flow measurements were taken during moderately low to average runoff conditions and suggest that runoff is likely lower here on average than observed on Pony Creek and the Christina River (as expected from the previous comparison in Figure 3-6). The eastern tributary measured flows suggest a much lower yield possibly due to the extensive beaver activity observed upstream in the basin and the local wetland conditions at this monitoring site. A greater proportion of the



PROJECT

CHRISTINA LAKE REGIONAL PROJECT

TITLE

2004 REGIONAL UNIT RUNOFF COMPARISON

MEG ENERGY CORP.

PROJECT 04-1334-001.6100			FILE No.	3459-05-02-02-A1
DESIGN	DGR	02/02/05	SCALE	REV. 0
CADD	GDE	02/02/05		
CHECK	DLC	04/02/05		
REVIEW	TC	04/02/05		

FIGURE3-7

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runoff here may be going into charging the local wetland (particularly in September) than into the actual stream section.

Table 3-8 Flow Measurements and Unit Runoff Rates in the LSA

Date	Northern Unnamed Tributary		Eastern Unnamed Tributary	
	Flow (m^3/s)	Unit Runoff ($L/s/km^2$)	Flow (m^3/s)	Unit Runoff ($L/s/km^2$)
May 20, 2004	0.531	5.11	0.287	1.70
September 15, 2004	0.237	2.28	0.125	0.74

A mean annual runoff of 66 mm (61 mm March to October) is assumed to represent all the basins draining into Christina Lake based upon the Birch Creek station data with the monthly distribution as shown in Figure 3-6. Comparison of the annual precipitation data (the main variable influencing runoff) over the 1984 to 1995 period of record on Birch Creek suggests that this period was only slightly below the 30-year normal average annual precipitation rate. Wetter time periods, prior to 1981, may indicate higher runoff rates. However, the spot flow measurements and Jackfish River flow data also suggest much lower runoff rates in the LSA.

Estimates of groundwater recharge in the region have ranged from 20 to 30 mm (CNRL, 2000, BlackRock, 2001, Gulf, 2003) based upon annual water balance calculations. A lower recharge rate may be expected in the Christina Lake sub-basins due to the geology and low relief in this area. An average annual water balance for the tributary basins in the LSA is estimated as follows:

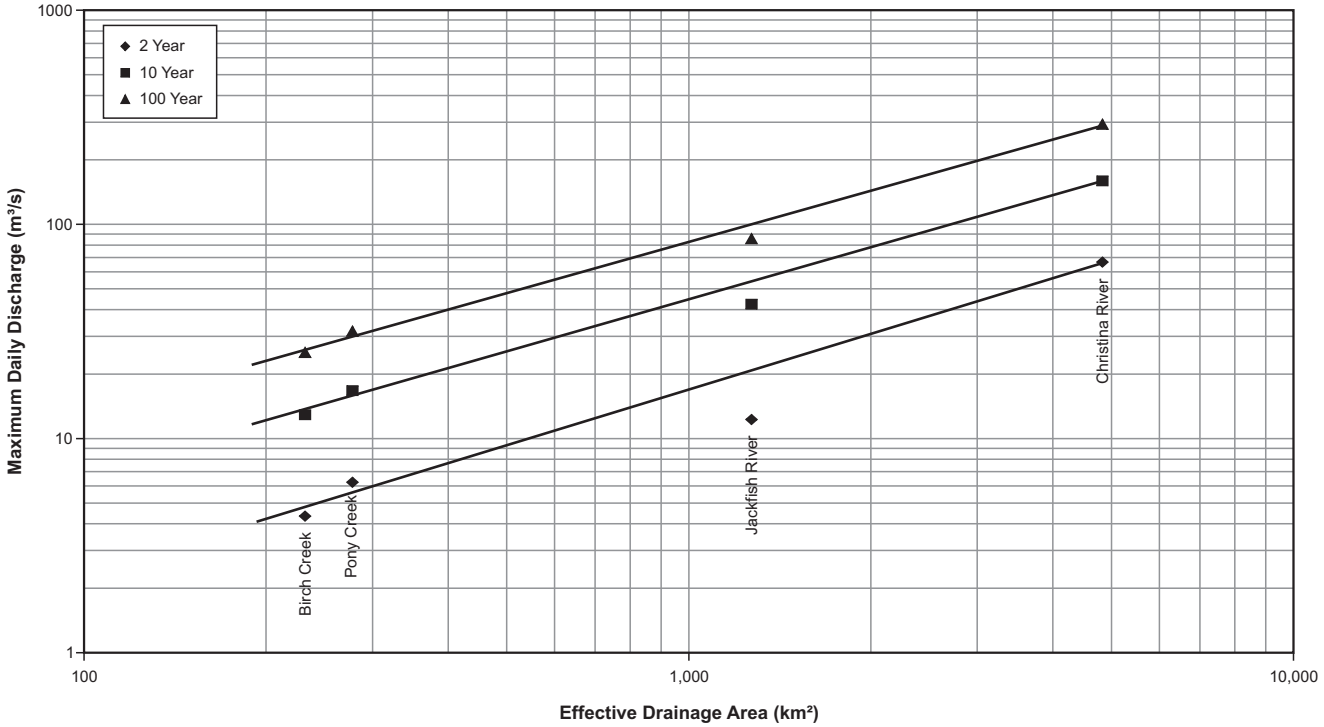
P (441 mm) = R (66 mm) + ET (355 mm) + GW (20 mm)

where:
P = precipitation
R = surface runoff
ET = evapotranspiration (from 88% of area) and shallow lake evaporation (from 12% of wetland/pond areas)
GW = groundwater recharge (computed as a balancing value in the above equation)

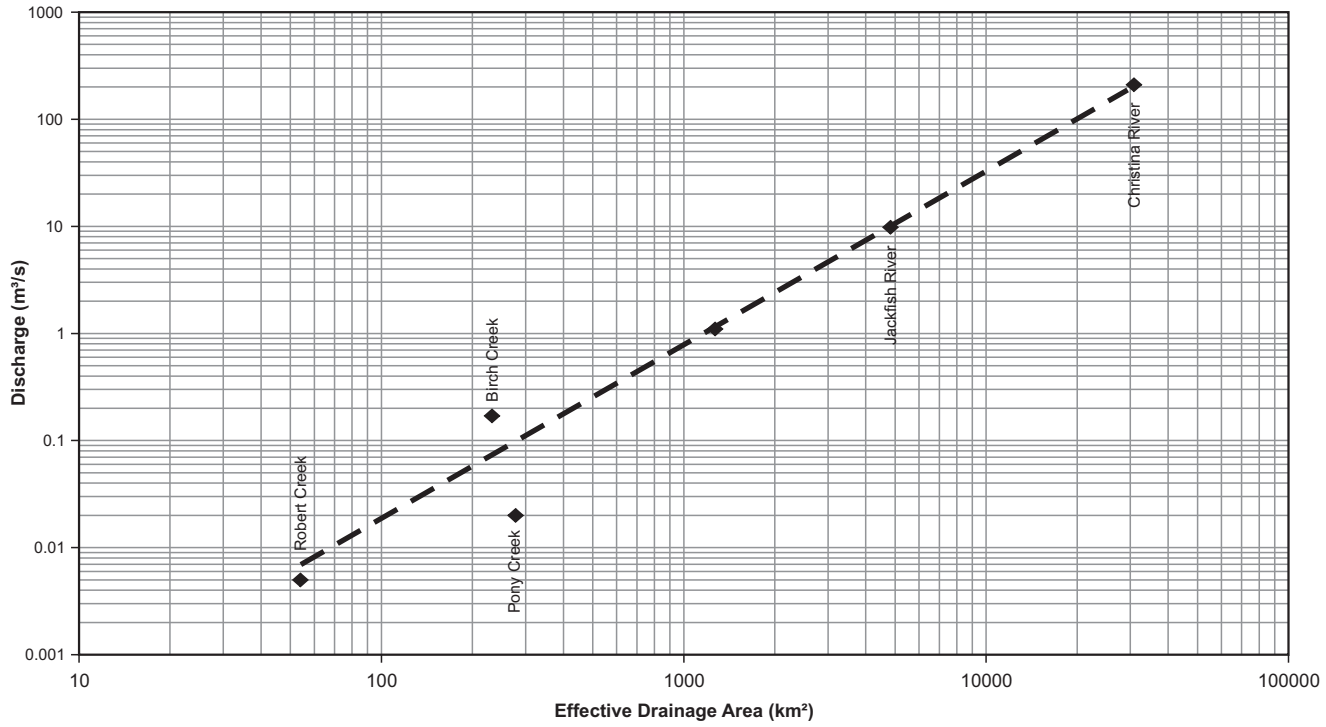
High and Low Flows

Regional relationships between annual maximum daily flows and their return periods versus effective drainage area are presented in Figure 3-8. These relationships provide approximate estimates for the basins in the LSA. More detailed site specific analyses may be required for site specific design purposes.

Regional Flood Frequeny Relations



Regional 7-Day 10-Year Low Flow Data (March-October Season)



PROJECT

CHRISTINA LAKE REGIONAL PROJECT

TITLE

REGIONAL HIGH AND LOW FLOW RELATIONS

MEG ENERGY CORP.

PROJECT 04-1334-001.6100			FILE No.	3459-05-02-02-A1
DESIGN	DGR	02/02/05	SCALE	REV. 0
CADD	GDE	02/02/05		
CHECK	DLC	04/02/05		
REVIEW	TC	04/02/05		

FIGURE3-8

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Peak runoff rates on the Jackfish River station are lower than the other stations, particularly at the more frequent flood events because of the regulating effect of Christina Lake. As noted earlier, annual peak flows typically occur in May due to snowmelt but can also occur in August and September due to storm rainfall events. The values plotted in Figure 3-8 are annual maximums and represent a mix of both rainfall and snowmelt flood events.

Regional low flow relations are less reliable than flood flow relations for small basins because the probability of low flows on small watersheds is highly variable and more dependent upon site specific conditions and because of the occurrence of zero flows. Zero flow has been recorded on both Pony and Birch Creeks. The daily low flow records for these smaller watersheds indicate that there is a high probability of zero flow from such small areas, even during the summer season. For example, zero daily summer flow in Pony Creek can be expected to occur once in two years on average. At Birch Creek, zero daily summer flow can be expected once every four to five years. The probability of similar or more frequent zero flow conditions on the smaller watersheds in the LSA is expected.

Figure 3-8 shows a plot of 7-day, 10-year low flows for the open water season. Another small basin – Robert Creek near Anzac, and a larger basin – Clearwater River at Draper are added to this plot. As is expected, there is significant scatter in the plots for the three smaller watersheds. Considering the above, the open water season minimum daily flow in the northern and eastern tributaries is estimated to average between 0.01 and 0.05 L/s/km^2 with the 7-day, 10-year low flow within this range at 0.02 L/s/km^2.

3.3.4 Christina Lake

Christina Lake is a long, narrow water body oriented in an east-west direction. It has three deep basins that drop off abruptly to maximum depths of 33, 26 and 24 m. In places, the lake is 12 to 15 m deep only 9 m from shore. A shallow constriction joins the west and central basins. In addition to the three deep basins, there are two shallower basins. They branch north from the east basin and reach maximum depths of 12.2 and 1.5 m. The lake has a surface area of 21.3 km^2, a mean depth of about 17 m and a volume of 369,000 dam^3 (Mitchell and Prepas, 1990).

The lake shoreline is generally steep and well armored with cobbles and boulders and dense vegetation to the banks. Typical shoreline observations on May 20, 2004 showed a normal high water line about 0.4 m above the water level at the time with a high bank break typically about 1.5 m above the water level. The three span bridge near the lake outlet (to Christina Lake Lodge) has a total span

of 40 m. This bridge structure also shows a normal high water line about 0.4 m above the water level and a maximum high water line about 0.9 m above the water level on May 20, 2004. The estimated lake outflow on May 20, 2004 was 9 to 10 m^3/s based upon a flow width of 39 m, an average depth of 0.6 m and an average channel velocity of 0.4 m/s through the bridge opening.

Lake levels have been recorded on a spot basis during the open water (May to October) season by AENV from 1986 to 2001. WSC started reporting water levels during the open water season on Christina Lake in September 2001. The lake level data plotted in Figure 3-9 show that levels have varied by nearly 1.5 m from a low of 553.65 m in 1999 to a high of 555.12 m in 1997. The annual lake level variation has ranged from less than 0.3 m to over 1.1 m and averages about 0.6 m. The average lake level is 554.1 m.

Based upon the previously estimated sub-basin runoff rates, estimated mean annual water balance components for Christina Lake are as follows:

- Surface runoff inflow = 82,400 dam^3 per year based on 66 mm applied over all sub-basins (this volume translates to a mean residence time of approximately 4.5 years).
- Net lake evaporative losses = 3,400 $dams^3$ per year based on deep lake evaporation at 600 mm and precipitation at 441 mm times the 21.3 km^2 lake area.
- Groundwater inflow / outflow = assumed to be zero.
- Surface Outflow = 79,000 dam^3 as the balance of the above values or equal to a runoff rate 62 mm.

The above surface outflow runoff rate is 18% higher than the average annual runoff rate based on the recorded flow data on the Jackfish River. Various reasons for this significant difference include: flow measurement error, different time periods considered in the values, variations in long-term averages, surface runoff rates are in fact lower than the 66 mm value assumed, or a net groundwater outflow from the lake. Assuming all the other inputs are correct, a groundwater outflow rate of 50 mm would need to be applied over the lake area to result in a balance with the recorded Jackfish River mean annual runoff rate. It is likely that a combination of the above reasons accounts for the difference.

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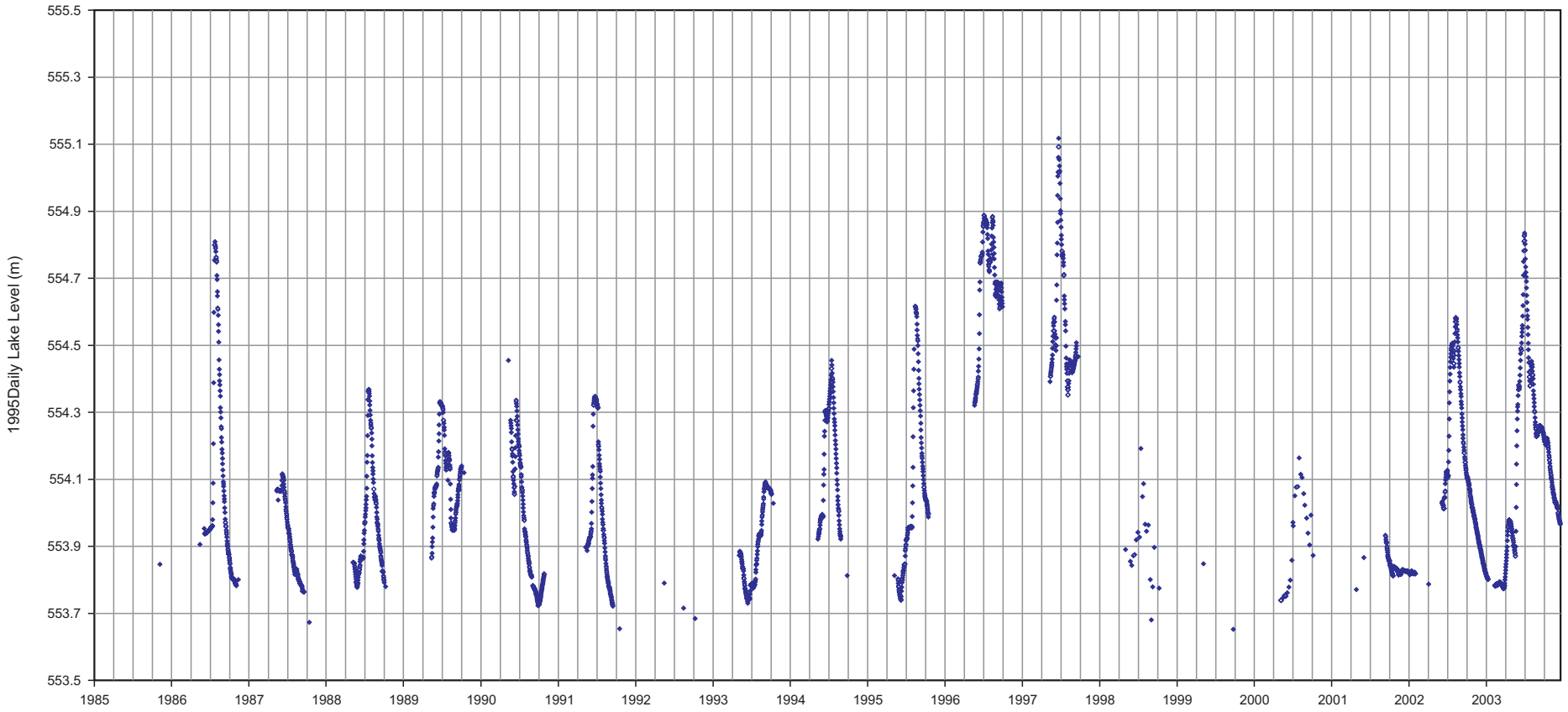

SOURCE:
ALBERTA ENVIRONMENT STATION 07CE903 (NOV. 7, 1985 - SEPT. 26, 2001)
WATER SURVEY OF CANADA, STATION 07CE906 (SEPT. 27, 2001 - DEC. 31, 2003).

PROJECT

CHRISTINA LAKE REGIONAL PROJECT

TITLE

CHRISTINA LAKE HISTORICAL WATER LEVELS

MEG ENERGY CORP.

PROJECT 04-1334-001.6100			FILE No.	3459-05-02-02-A2
DESIGN	DGR	02/024/05	SCALE	REV. 0
CADD	GDE	02/02/05		
CHECK	DLC	04/02/05		**FIGURE 3-9**
REVIEW	TC	04/02/05		

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