SUPPLEMENTARY INFORMATION ON:

DORIS NORTH PROJECT
DORIS LAKE OUTFLOW SENSITIVITY ISSUES

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Prepared for:
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INTRODUCTION

As part of the response to regulatory concerns regarding discharge of tailings decant water from Tail Lake to the Doris Lake outflow channel, an examination of the natural seasonal and annual variability of the Doris Lake outflow, as well as sensitivity to climate change, has been requested. These issues are addressed in the following paragraphs.

AVAILABLE DATA

The Meteorology and Hydrology Baseline Study (AMEC 2003) for the Doris North Project derived estimated annual runoff from the Doris and Tail Lake outflows for mean, 10-year wet and dry, and 100-year wet and dry conditions. It also provided a monthly breakdown of runoff under mean conditions. These were derived based on the correlations between gauging data from the Environment Canada station on the Ellice River (10QD001) and data collected at the Doris and Tail Lake outflow channels during the Project baseline study.

The Doris Lake Water Level Impact Analysis (Golder 2003) used the weekly data series that was used to derive the preceding data, as well as the derived monthly precipitation series and Doris Lake outflow channel stage-discharge rating curve, to derive mean and extreme monthly discharges from Doris Lake for a 13-year simulation period.

DISCUSSION OF SEASONAL VARIATION UNDER MEAN CONDITIONS

The Doris Lake Water Level Impact Analysis (Golder 2003) presents the derived mean monthly discharges from Doris Lake. These are presented in Table 1, for operating conditions (Tail Lake closed-circuited and Project water supply from Doris Lake). This shows that under mean conditions, most of the outflow from Doris Lake (68%) occurs during the months of June and July, and very little (6%) in the month of October.

Table 1 Derived Mean Monthly and Annual Discharges from Doris Lake under Operating Conditions[a]

Month[b]	Mean Discharge	Portion of Annual Discharge
June	1.805 m^3/s	40.0%
July	1.221 m^3/s	27.9%
August	0.541 m^3/s	12.4%
September	0.635 m^3/s	14.1%
October	0.246 m^3/s	5.6%
June-October	0.885 m^3/s	100%

(a) Extracted from Table 5 of Golder (2003)
(b) No discharge is expected for the months of November to May

DISCUSSION OF ANNUAL VARIATION

During the Doris Lake Water Level Impact Analysis (Golder 2003), monthly discharges from Doris Lake (wet and dry conditions) were derived for the 13-year simulation period. The data for the months of June to October were subject to a frequency analysis to derive the 10-year wet and dry discharges. Wet and dry condition annual discharges with 10-year and 100-year return periods were also derived based on the water yields presented in the baseline study (AMEC 2003). These are presented in Tables 2 and 3, respectively. In these tables, the values are also presented relative to the annual and monthly mean discharges.

Table 2 Derived Extreme Wet Monthly and Annual Discharges from Doris Lake under Operating Conditions

Return Period	Month[a]	Mean Discharge	Portion of Mean Discharges	
			Annual	Monthly
10-Year	June	2.339 m^3/s	51.8%	130%
	July	2.081 m^3/s	47.6%	170%
	August	1.026 m^3/s	23.5%	190%
	September	1.215 m^3/s	26.9%	191%
	October	0.458 m^3/s	10.5%	186%
	June-October[b]	1.271 m^3/s	144%	-
100-Year	June-October	2.094 m^3/s	237%	-

(a) No discharge is expected for the months of November to May
(b) The weighted average of monthly discharges, and the sum of portions of the mean annual discharge, do not equal the annual value because "wet" and "dry" conditions may not be sustained over the entire year.

Table 3 Derived Extreme Dry Monthly and Annual Discharges from Doris Lake under Operating Conditions

Return Period	Month[a]	Mean Discharge	Portion of Mean Discharges	
			Annual	Monthly
10-Year	June	1.334 m^3/s	29.5%	74%
	July	0.598 m^3/s	13.7%	49%
	August	0.206 m^3/s	4.7%	38%
	September	0.222 m^3/s	4.9%	35%
	October	0.075 m^3/s	1.7%	30%
	June-October[b]	0.658 m^3/s	74%	-
100-Year	June-October	0.599 m^3/s	68%	-

(a) No discharge is expected for the months of November to May
(b) The weighted average of monthly discharges, and the sum of portions of the mean annual discharge, do not equal the annual value because "wet" and "dry" conditions may not be sustained over the entire year.

CLIMATE CHANGE EFFECTS

No detailed and reliable estimates of anticipated changes to water yields at the Doris North Project are available. Existing model predictions tend to be widely varied and are not applicable at the local scale. However, qualitative changes may include (IPCC 2001):

- A marginal increase in annual precipitation;
- A longer open-water season;
- Smaller spring snowmelt floods due to reduced snow accumulation; and
- Larger late summer floods due to increased rainfall.

These changes, if they occur, would enhance the dilution capacity of the Doris Lake outflow channel.

Regarding the potential for climate change to result in greater extremes of streamflow, a recent paper that examined data from 249 long-term hydrometric stations in Canada's Reference Hydrometric Basin Network (Zhang et al. 2001) concluded that "streamflow is not becoming more extreme with increasing temperature."

RECOMMENDED MONITORING

The greatest uncertainties in the volumetric capacity of the Doris Lake outflow channel to accommodate tailings decant water from Tail Lake are a lack of site-specific monitoring data, a lack of early freshet monitoring data, and the need to restrict decant water discharges to a specified proportion of the Doris Lake outflow during operations. Recommendations related to these issues are:

- Hydrometric monitoring at the Doris Lake outflow should continue during mine development and operations. A station was operated below the Doris Lake falls for the period 1996-1998 and 2000, and a new station was installed just below the lake outlet in 2003. Operation of the station is planned for 2004 and it is recommended that this be continued through the life of the mine. This will provide site-specific data to refine estimates of mean and extreme monthly discharges from the lake;
- Early freshet discharges in the Project area are characterized by the rapid release of water from the lake into an ice-affected outflow channel. This makes it impossible to measure the outflow discharge using a conventional hydrometric station where the flow is derived using a water level measurement and a stage-discharge rating curve. Attempts will be made in the spring of 2004 to estimate the early freshet discharge using continuous (data logged) measurements of the lake water level. Outflow

volumes will be calculated based on lake surface area and water level change, and divided by time to estimate discharge. Lake inflow during this time will also be estimated. This should provide a better indication of the distribution of discharge over the first month of flow, which typically occurs in June; and

- To ensure that decant water discharges do not exceed a specified proportion of the Doris Lake outflow discharge, and that they do not represent so small a proportion of the outflow discharge that not enough water is decanted, realtime hydrometric monitoring on the Doris Lake outflow during mine operations is recommended. This will allow the most efficient operation of the tailings facility while ensuring regulatory compliance.

DISCUSSION AND CONCLUSIONS

Discharge from Doris Lake normally occurs only during the months of June to October, since the channel is frozen to the bottom during the winter months. Flows typically commence with a rapid release of water when the ice dam that forms over the winter releases. In general, flows are largest in June (40% of annual discharge) and decrease throughout the open-water season, except for a mild increase in September due to late season rainfall.

Estimated monthly discharges under 10-year wet conditions vary from 130% to 190% of those under mean conditions. Annual discharges under 10-year and 100-year wet conditions are 144% and 237% of the mean annual discharge. Wet conditions would be favourable in the context of dilution of decant water from Tail Lake. Estimated monthly discharges under 10-year dry conditions vary from 30% to 74% of those under mean conditions. Annual discharges under 10-year and 100-year dry conditions are 74% and 68% of the mean annual discharge. Dry conditions would be unfavourable in the context of dilution of decant water from Tail Lake, but these estimates show that even under dry conditions, the Doris Lake outflow channel provides a dilution capacity equal to at least two thirds of that calculated for mean conditions.

Climate change effects, if any, would be expected to enhance the mixing capacity of the Doris Lake outflow channel.

Planned and recommended monitoring at the Doris Lake outflow will provide better data from which to refine estimates of mixing capacity, and provide data from which to specify maximum tailings decant water discharges during mine operations.

CLOSURE

The information in this report was prepared for the use of Miramar Hope Bay Ltd., the Nunavut Impact Review Board and participants in the NIRB review process relating to the Doris North Project. The material in it reflects Golder's best judgment in light of information available to it at the time of preparation. Any use of this report or any reliance on or decisions to be made based on it by any other third party, are the responsibility of such third party. Golder accepts no responsibility for damages, if any, suffered by any other third party as a result of decision made or action based on this report.

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