DIAVIK GEOTECHNICAL REVIEW BOARD

REPORT NO 1A

DIAVIK GEOTECHNICAL REVIEW BOARD MEETING
JUNE 28th TO JULY 1st, 2004

REVIEW OF A418 DYKE

Submitted to:

Jeff Reinson
Manager - Geotechnical Engineering Department

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November 10, 2004
DIAVIK GEOTECHNICAL REVIEW BOARD

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1.0 INTRODUCTION

Diavik Diamond Mines Inc. (DDMI) maintained a Diavik Dyke Review Board (DDRB) during the design, construction and dewatering of the A154 dyke. The last meeting of the DDRB was held on July 17 to 19, 2003. The DDRB has now been disbanded and replaced by a new Board consisting of three past members of the DDRB.

The terms of reference of the new Board are still being formalized. However it is the understanding of the members of the new Board that it will maintain dyke performance oversight, as required by regulators, it will advise on new dyke developments and it will extend its review function to all geotechnical aspects of Diavik’s operations including pit stability, pit depressurization, waste and water management, and closure. Accordingly the new Board has been designated the Diavik Geotechnical Review Board (DGRB).

This Report No. 1A provides the observations, conclusions and recommendations of the DGRB regarding the initial investigations and evaluations and future investigation and design proposed for the A418 dyke.

The DGRB convened in Yellowknife on the evening of June 27, 2004, and flew to the mine site the next morning. June 28 was devoted to an inspection of the A154 Dyke, pit and other facilities with briefings on the monitoring function. The Board returned to Yellowknife that evening. The next three days were spent in receiving presentations related to the A154 Dyke performance and A418 Dyke design status. A brief presentation was also made on current planning to evaluate underground mining at A418 and A154. Time was available for Board report preparation and the Board briefed DDMI on its main findings prior to departure from Yellowknife on July 1, 2004.

The Agenda for the meeting is included as Attachment A. A list of documents presented for the meeting is appended as Attachment B.
The conclusions of the Board are included in the text of the report and the recommendations of the Board that require actions by DDMI, or their Consultants, are highlighted, by formatting them in *italics*.

The Board wishes to acknowledge the planning and arrangements for this meeting by Mr. Reinson that was essential for its success and the excellent presentations made by the DDMI and NKSL team. The highest standards are being met.

### 2.0 FIELD INSPECTION A418 DYKE

The Board viewed/inspected a number of items related to the A418 dyke including:

- A418 dyke alignment from the A154 dyke peninsula where the northern abutment will tie into the existing A154 dyke.

- Rock core and logs from select holes along the A418 alignment to inspect rock fracturing and assess needs for water seepage control. The A418 dyke rock foundation permeabilities were generally somewhat higher than those for the A154 dyke at comparable depths based on packer test work.

- Optical and acoustic televiewer plots developed by Golder for select holes along the dyke alignment and abutment. These provide useful information as to fracture aperture and structural orientation and are supported by the Board to assist in future seepage control application, but *should only be used in combination with, and to support, downhole packer tests*. Apertures greater than 10mm were limited to 17 m below the top of bedrock and the openings narrow dramatically and are practically eliminated below this level, as noted by decreasing flows in packer test data.

### 3.0 DYKE A418

#### 3.1 Site Investigation

The characterization for the A418 dyke benefits from the geological model established for the design of dyke A154. At A418 seismic refraction surveys have been undertaken, sonic and diamond drill holes have been completed. A number of test pits have been excavated to study the composition of the till deposits and the till/bedrock contact within the A154 excavation. The Board inspected diamond drill cores, from selected holes.

For all practical purposes, the site characteristics at A418 replicate those found at A154. The only significant difference so far is the deeper extent of moderately fractured near surface bedrock, which will have to be considered in the design of the grout curtain.
Cone testing of the lake sediments is planned from the ice next winter. With this additional program, the Board confirms that site characterization is sufficient to support final dyke design.

### 3.2 Design

The design criteria proposed for the A418 dyke are the same as those adopted for the A154 dyke. The Board agrees with these and notes that they should apply to seismic design although this may appear to be in conflict with ready acceptance of GSA seismic characterization of stable cratons. GSC’s position is not widely accepted by the dam design community. As before, a design check at higher earthquake loads will reveal that they are likely not consequential for the design of the dyke without adopting them as a primary criterion.

The Board accepts the alignment as proposed and notes that the layout involves a setback to the pit of 100m. DDMI’s position has been to fix the dyke alignment on a relatively economic location and adjust the pit in the future as required. The implications of this pit design are discussed elsewhere in this report.

In addition to somewhat more pervious bedrock at A418, when compared with A154, the only significant difference is a greater water depth of 25 m at the maximum section. NKSL propose the same dyke section for A418 as was adopted at A154. The Board agrees.

The Board comments on various components of design and construction as follows:

i) Dredging - improvements are planned to the silt curtain and the cutter suction dredge will need a longer ladder for the deeper section. There are plans to investigate removal of the lakebed sediments by means of Toyo pumping. The Board has reservations whether the sediments will flow to the pumps to make the process efficient. Clearly a field trial, as proposed, is essential.

The Board recommends that the criteria for removal of the lakebed sediments be reviewed. Some are moderately dense granular deposits that are difficult to dredge and removal may not actually be necessary. Cone signatures may be adequate to identify the dense deposits in advance. A review of past experience will be helpful prior to undertaking the next cone-testing program.

ii) Materials - All construction materials are produced by crushing mine waste. The demand is a small percentage of mine production and it should be practical to establish quarry access where special blasting would produce enhanced fragmentation that would result
in more economical crushing. *This merits discussion with mine operations.*

The Board agrees with the use of identical gradations for Zone 1 and 1A. Discussions revealed that it will be necessary to provide for washing equipment in the construction plan. The final fines criterion can be established once the Zone 1 material is being produced.

### iii) Zonation

*The Board recommends that placement methods to steepen the inclination of the Zone 1/Zone 2 and 3 interface be explored with the contractor.* This could lead to savings of Zone 1 volume in the deeper sections.

*The Board supports the proposal for a field trial to assess segregation of Zone 1 material when placed in deeper water.* NKSL recognize this need for extra blanket thickness in deeper sections if this proves to be a problem.

### iv) Vibrocompaction

The Board concurs with NKSL that probes with maximum energy available should be specified for the vibrocompaction.

### v) Cut-off

The Board concurs with the recommendation that the same type of cut-off used for the A154 dyke be adopted at A418. No advantages in alternative concepts have been identified.

The proposed penetration criteria for the diaphragm wall is acceptable

*In terms of sequencing, the Board favors diaphragm wall followed by jet grouting, followed by curtain grouting.* This provides the best opportunity for achieving closure at the top of the bedrock.

*With regard to jet grouting, while some economies may be made in reducing cement content following A154 experience, the Board cautions against being very aggressive.* The performance record of the cut-off is still very short. Following the favorable experience with triple jet grouting, *the Board recommends that the specifications adopt best triple jet grouting practice, but allow double jet grouting as an alternative, subject to review.*

Revisions are proposed to the depth and spacing of grout holes in response to Lughen testing. The Board accepts this proposal as adequate for dyke design criteria, while providing some contribution to reducing deeper mine inflow. Additional assessment of mine dewatering might require even deeper
grouting, possibly based on results from primary hole grouting. A modification to the grout mix is proposed which is also acceptable to the Board.

vi) Analytical Studies – The Board confirms that the results of the stress analyses for the cut-off are acceptable.

The Board also confirms that the results of the stability analyses are acceptable. Stability issues might arise when placing the filter blanket on the steep southwest abutment. They can be accommodated during construction.

vii) Thermal Analyses – Thermosyphon layouts are proposed as per the A154 dyke. Site-specific optimization, based on A154 experience may be achievable.

viii) Instrumentation – The Board agrees with the proposed instrumentation plan. The following additions are recommended:

- upstream piezometers nests into fill, till and rock.
- A downstream inclinometer in the deeper section.

NKSL should assess whether fibre optic piezometers have any advantage for DDMI.

The Board notes that additional instrumentation might arise for mine needs.

4.0 NEXT MEETING

The recommended timing for the next DGRB meeting is in the first quarter of 2005. The next meeting could be held in Yellowknife, Calgary or Vancouver to suit participant’s facilities.

This report respectfully submitted by:

Norbert R Morgenstern  Andrew M Robertson  Zavis M Zavodni

November 10, 2004
Attachment A – Agenda

DIAVIK DIAMOND MINES - A154 / A418 DYKES

DYKE REVIEW BOARD MEETING

AGENDA - JUNE 28TH – JULY 1ST 2004

<table>
<thead>
<tr>
<th>Time</th>
<th>Location</th>
<th>Subject / Activity</th>
<th>Presenter(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Sunday, June 27th</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Location</strong></td>
<td><strong>Subject / Activity</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>DRB Members arrive in Yellowknife</td>
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<tr>
<td></td>
<td></td>
<td><strong>Monday, June 28th - Site Visit</strong></td>
<td></td>
</tr>
<tr>
<td>6:00</td>
<td>G&amp;G Hangar</td>
<td>Check-in at G&amp;G Hangar</td>
<td>Jeff / Dave E.</td>
</tr>
<tr>
<td>7:00</td>
<td></td>
<td>Charter leaves Yellowknife</td>
<td></td>
</tr>
<tr>
<td>8:30</td>
<td></td>
<td>DRB arrives at Diavik Mine Site</td>
<td>Safety Superintendent</td>
</tr>
<tr>
<td>9:00</td>
<td>Accommodation Complex</td>
<td>Short orientation session</td>
<td></td>
</tr>
<tr>
<td>9:30</td>
<td>Accommodation Complex</td>
<td>Welcome, opening remarks, discussion of the agenda</td>
<td>Jeff</td>
</tr>
<tr>
<td>10:30</td>
<td>A154 Pit</td>
<td>Pit Tour (depending on blast schedule)</td>
<td>Jeff / Gaston</td>
</tr>
<tr>
<td>12:00</td>
<td>Accommodation Complex</td>
<td>LUNCH</td>
<td></td>
</tr>
<tr>
<td>13:00</td>
<td>A154 Dyke</td>
<td>Dyke Tour and Inspection</td>
<td>Jeff / Gaston</td>
</tr>
<tr>
<td>16:00</td>
<td>A418 Dyke</td>
<td>Visit of West Abutment (Optional)</td>
<td>Jeff / Gaston</td>
</tr>
<tr>
<td>17:00</td>
<td>South Camp Office</td>
<td>Visit to core shack (Optional)</td>
<td>Jeff / Gaston</td>
</tr>
<tr>
<td>17:30</td>
<td></td>
<td>Presentation of Delta-V (pumped flow) and Geomation (piezometers) alert management system. Presentation of Golder’s software for blast optimization. Videos of previous blasts.</td>
<td>Dan / Clarence</td>
</tr>
<tr>
<td>18:00</td>
<td>Accommodation Complex</td>
<td>SUPPER</td>
<td></td>
</tr>
<tr>
<td>18:45</td>
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<td>Bus leaves Accommodation Complex</td>
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</tr>
<tr>
<td>19:00</td>
<td></td>
<td>Charter leaves Diavik Mine Site</td>
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</tr>
<tr>
<td>20:00</td>
<td></td>
<td>Charter arrives in Yellowknife</td>
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## Tuesday, June 29th - A154 Dyke Presentations

<table>
<thead>
<tr>
<th>Time</th>
<th>Location</th>
<th>Subject / Activity</th>
<th>Presenter(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:00</td>
<td>Main Conference Room DDMI (downtown YK)</td>
<td>Review of site activities since last DRB meeting. Matters arising from last meeting. Overview of Open Pit Mine</td>
<td>Jeff</td>
</tr>
<tr>
<td>9:00</td>
<td></td>
<td>Dyke Monitoring Activities</td>
<td>Dan / Clarence</td>
</tr>
<tr>
<td>10:00</td>
<td></td>
<td>Monitoring Data Analysis and Dyke Performance Review - First Session</td>
<td>Gaston</td>
</tr>
<tr>
<td>12:00</td>
<td></td>
<td>LUNCH – walk, stretch, and eat</td>
<td></td>
</tr>
<tr>
<td>13:00</td>
<td>Main Conference Room DDMI</td>
<td>Monitoring Data Analysis and Dyke Performance Review – Second Session</td>
<td>Gaston</td>
</tr>
<tr>
<td>17:00</td>
<td></td>
<td>Discussion period</td>
<td></td>
</tr>
<tr>
<td>18:00</td>
<td></td>
<td>Adjourn for the rest of the day</td>
<td></td>
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## Wednesday, June 30th - A154 Dyke Report / A418 Dyke Presentations

<table>
<thead>
<tr>
<th>Time</th>
<th>Location</th>
<th>Subject / Activity</th>
<th>Presenter(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:00</td>
<td>Main Conference Room DDMI</td>
<td>Presentation of the Board Report on A154 dyke</td>
<td>DRB</td>
</tr>
<tr>
<td>10:00</td>
<td></td>
<td>A418 Dyke – First session</td>
<td>Tony / Luc</td>
</tr>
<tr>
<td>12:00</td>
<td></td>
<td>LUNCH – walk, stretch, and eat</td>
<td></td>
</tr>
<tr>
<td>13:00</td>
<td>Main Conference Room DDMI</td>
<td>A418 Dyke – Second Session</td>
<td>Tony / Luc</td>
</tr>
<tr>
<td>18:00</td>
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<td>SUPPER at The Landing</td>
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<tr>
<td></td>
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<td>Adjourn for the night</td>
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## Thursday, July 1st - A418 Dyke Presentations / DRB Report

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<th>Time</th>
<th>Location</th>
<th>Subject / Activity</th>
<th>Presenter(s)</th>
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<tbody>
<tr>
<td>8:00</td>
<td>Main Conference Room DDMI</td>
<td>A418 Dyke – Third Session</td>
<td>Tony / Luc</td>
</tr>
<tr>
<td>12:00</td>
<td></td>
<td>LUNCH – walk, stretch, and eat</td>
<td></td>
</tr>
<tr>
<td>13:00</td>
<td></td>
<td>Discussion period</td>
<td></td>
</tr>
<tr>
<td>16:30</td>
<td>Main Conference Room DDMI</td>
<td>Presentation of the Board Report on A418 Dyke</td>
<td>DRB</td>
</tr>
<tr>
<td>17:30</td>
<td></td>
<td>Closure</td>
<td>Jeff</td>
</tr>
</tbody>
</table>
Attachment B - Document List

1. Matters arising from previous meeting
2. Overview of open pit
3. Dyke monitoring activities
4. Reference Drawing
5. Piezometric data
6. Seepage data
7. Temperature data
8. Deformation data
9. Monitoring of vibration and porewater pressure during blasting
10. Survey data


Diavik Diamonds Project drawings – A154 Pit Dyke Plan as of June 09, 2004, with Sections A'-A through A'-E.

EBA Engineering Consultants Ltd (undated). Water pressure test results to determine in-situ hydraulic conductivity; BH 539, 540, and 541.


EBA Engineering Consultants Ltd (undated). Packer test results; BH 539, 540, and 541.
