KINROSS Kettle River – Buckhorn

Echo Bay Minerals Company
A Kinross company
363 Fish Hatchery Road
Republic, WA, USA 99166

phone: (509) 775-3157
fax: (509) 775-3447

Certified Mail # 7012 0470 0001 5668 8908

June 20, 2017

Mr. Pat Hallinan
Department of Ecology
Eastern Regional Office
4601 North Monroe Street, Suite 202
Spokane, WA 99205-1295

Re: K2 Infiltration Gallery Monitoring Plan Revised

Dear Pat,

Thank you for the comments provided on the K2 Infiltration Gallery Monitoring Plan on June 8, 2017. This revised plan provides additional information as requested. Crown proposes to start the test at some point after receipt of Ecology's approval. Echo Bay will notify Ecology prior to start-up and initiation of the one-year evaluation period.

Please contact me at 509-775-8530 if you have any questions or require additional information.

Sincerely,

Gary Johnson

Gary Johnson
Environmental Engineer
Echo Bay Minerals Company

TECHNICAL MEMORANDUM

Date:	June 20, 2017	**Project No.:**	133-93003-22
To:	Gary Johnson, Senior Environmental Engineer	**Company:**	Kinross Gold Corporation – Kettle River Operations
From:	Jay Pietraszek		

RE: K2 – INFILTRATION GALLERY CAPACITY ASSESSMENT – REVISED MONITORING PLAN

The purpose of this technical memorandum is to present a monitoring plan to evaluate infiltration performance at the existing infiltration basin at the K2 mine. Average effluent discharge rates up to 200 gallons per minute (gpm) are planned during the testing.

1.0 INTRODUCTION

The infiltration system at K2 was constructed in 2005 and is currently permitted to receive up to 100 gpm. A hydrogeological evaluation was performed in 2012, which included the installation of eight piezometers/monitoring wells down-gradient and adjacent to the existing infiltration basin. Slug testing and water level monitoring during periods of short-term effluent discharges suggested that discharges above the current 100 gpm Permit Limit are feasible.

The testing and monitoring is planned for one year to determine if infiltration can be conducted at rates of up to an average of 200 gpm during different seasonal conditions without adverse effects. Based upon Ecology review of the assessment and monitoring, Ecology may authorize a higher permitted discharge limit or extend the test period.

2.0 DISCHARGE RATES

The monitoring will be conducted during an operational startup period. Golder Associates Inc. (Golder) recommends a stepped increase in the effluent discharge rates as follows:

- 100 gpm average during the first seven days of discharge (Week 1)
- 150 gpm average during Week 2
- 200 gpm average during and after Week 3

Monitoring data (Section 3.0) will be reviewed and evaluated at the end of each of the 3 weeks of startup. Effluent discharge rates will be increased if the monitoring data indicate that potential increases can be sustained without adverse effects. Discharge rates will be decreased based on action levels described in Section 3.1.2.

Golder Associates Inc.
18300 NE Union Hill Road, Suite 200
Redmond, WA 98052 USA
Tel: (425) 883-0777 Fax: (425) 882-5498 www.golder.com

3.0 MONITORING PLAN

The monitoring program will focus on water level measurements in the eight monitoring wells/piezometers in the vicinity of the infiltration basin that were installed by Golder in 2012. Monitoring well and piezometer details are provided in Table 1 (attached) and locations are shown on Figure 1. Water levels will be monitored using manual measurements or automated pressure transducers or a combination of the two. If pressure transducers are implemented, then it is recommended to set the data loggers to record data at an hourly frequency. Additionally, the toe of the slope will be visually inspected for signs of seepage. The general "walk over" area is shown on Figure 1 and will generally focus on the small, natural swales to the north of the infiltration basin. Photographs will be collected. If seepage is observed, adaptive management actions described in Section 3.1.2 will be implemented. Monitoring locations and frequencies are presented in Table 2.

Table 2: Monitoring Locations and Frequencies

Well / Location	Monitoring Type	Manual Measurement Frequency	Justification
Discharge Rates	Flow Meter	Totalizing flow meter	Measurement of effluent discharge rates
K2-1	Pressure Transducer and/or Manual	Once prior to start-up. Once per week during start-up, and for the first 4 weeks after 200 gpm is reached. Once per month for remainder of test.	Down-gradient, shallow alluvium, monitoring well
K2-2	Pressure Transducer and/or Manual	Once prior to start-up. Once per week during start-up, and for the first 4 weeks after 200 gpm is reached. Once per month for remainder of test.	Down-gradient, shallow alluvium, monitoring well
K2-5	Pressure Transducer and/or Manual	Once prior to start-up. Once per week during start-up, and for the first 4 weeks after 200 gpm is reached. Once per month for remainder of test.	Down-gradient, bedrock / alluvium monitoring well
K2-6	Pressure Transducer and/or Manual	Once prior to start-up. Once per week during start-up, and for the first 4 weeks after 200 gpm is reached. Once per month for remainder of test.	Down-gradient, bedrock / alluvium monitoring well
K2-7D	Pressure Transducer and/or Manual	Once prior to start-up. Once per week during start-up, and for the first 4 weeks after 200 gpm is reached. Once per month for remainder of test.	Up-gradient monitoring well
K2-7S	Pressure Transducer and/or Manual	Once prior to start-up. Once per week during start-up, and for the first 4 weeks after 200 gpm is reached. Once per month for remainder of test.	Up-gradient monitoring well
K2-8D	Pressure Transducer and/or Manual	Once prior to start-up. Once per week during start-up, and for the first 4 weeks after 200 gpm is reached. Once per month for remainder of test.	Cross-gradient monitoring well

Well / Location	Monitoring Type	Manual Measurement Frequency	Justification
K2-8S	Pressure Transducer and/or Manual	Once prior to start-up. Once per week during start-up, and for the first 4 weeks after 200 gpm is reached. Once per month for remainder of test.	Cross-gradient monitoring well
K2-9D	Pressure Transducer and/or Manual	Once prior to start-up. Once per week during start-up, and for the first 4 weeks after 200 gpm is reached. Once per month for remainder of test.	Down-gradient monitoring well
K2-9S	Pressure Transducer and/or Manual	Once prior to start-up. Once per week during start-up, and for the first 4 weeks after 200 gpm is reached. Once per month for remainder of test.	Down-gradient monitoring well
K2-10D	Pressure Transducer and/or Manual	Once prior to start-up. Once per week during start-up, and for the first 4 weeks after 200 gpm is reached. Once per month for remainder of test.	Down-gradient, bedrock / alluvium, monitoring well
K2-10S	Pressure Transducer and/or Manual	Once prior to start-up. Once per week during start-up, and for the first 4 weeks after 200 gpm is reached. Once per month for remainder of test.	Down-gradient monitoring well
Toe of slope	Visual/Photo-Point	Once prior to start-up. Once per week during start-up, and for the first 4 weeks after 200 gpm is reached. Once per month for remainder of test.	Down-gradient of infiltration basin

Note: 1. Pressure transduces would be set at a one-hour recording frequency if used.

Baseline water level measurements will be collected in the wells and piezometers prior to the start of discharge. Manual measurements will be take once per week during start-up, and for the first 4 weeks after the discharge rate reaches 200 gpm. Thereafter, measurements will be taken monthly for the remaining duration of the test. Automated pressure transducers may be installed to record data throughout the duration of the monitoring program where feasible.

3.1.1 Monitoring Details

In the event that water is not being discharged for a period of time greater than 24 hours, the inspections and manual measurements will not be conducted until the discharge has resumed. An extended period of non-discharge due to operational or non-environmental needs does not require starting the test over at 100 gpm and ramping up again. Discharge may resume at average rates up to 200 gpm.

3.1.2 Adaptive Management of Discharge Rates

Discharge rates will be reduced in a step-wise manner if the following conditions are observed during the test:

1. Seepage is observed on the slope below the infiltration basin that may be related to the discharge to the infiltration system. If seepage is observed Crown will perform the following:
   A. Seepage rates and the aerial extent of the seepage will be estimated through visual observation.
   B. Changes in the estimated extent and rate of seepage will be compared to changes in the discharge rate (i.e. reduction in discharge) in order to determine the relationship between discharges and seepage.
   C. Specific conductance measurements or other site conditions may also be used to confirm that the seepage is the result of the infiltration basin discharges.
2. Groundwater levels in the down-gradient or cross-gradient monitoring wells rise to within 10 feet of ground surface.
3. Surface water ponding is observed in the bermed area of the infiltration basin.

Discharge would be first reduced by 25% of the average rate. A subsequent reduction will be to 50% of the original discharge rate if the conditions have not dissipated within 48 hours of measurements/observations. Discharge will be terminated if the conditions are present after 4 days of measurements/observations and there is no evidence of a decreasing trend either in the amount of seepage or the groundwater level.

Sincerely,

GOLDER ASSOCIATES INC.

David Banton, LHg, RG
Principal Hydrogeologist

Jay Pietraszek, LG
Senior Hydrologist

List of Tables

Table 1 On-site Monitoring and Piezometer Information
Table 2 Monitoring Locations and Frequencies (in text)

List of Figures

Figure 1 Monitoring Locations

TABLE

Table 1: On-site Monitoring Well and Piezometer Information

Kinross Well ID	Date Installed	Ecology Well ID	Latitude	Longitude	Ground Surface Elevation (ft amsl)	PVC Stick-up (ft ags)	Screened Interval (ft bgs)	Filter Pack Interval (ft bgs)	Total Well Depth (ft bgs)	Approximate Bedrock Depth (ft bgs)	Completion Details
K2-1	7/13/1993	AAV???	N48°52'47.849"	W118°40'12.987"	1825.66	1.91	25.0 - 45.0	23.0 - 45.0	45.00	NA	Top of Bedrock
K2-2	7/25/1994	AAV801	N48°52'45.866"	W118°39'59.871"	1839.16	1.79	39.0 - 49.0	36.5 - 49.0	49.00	NA	Glacial/Alluvial
K2-5	1/18/2012	BCA-929	N48°52'46.828"	W118°40'05.770"	1825.85	1.68	32.0 - 42.0	27.0 - 43.0	43.00	42.00	Top of Bedrock
K2-6	1/24/2012	BCA-928	N48°52'47.185"	W118°39'57.086"	1803.74	2.20	15.0 - 25.0	8.0 - 26.5	26.50	25.50	Top of Bedrock
K2-7D	6/5/2012	BCA-922	N48°52'43.207"	W118°40'11.036"	1892.75	1.77	31.4 - 36.4	31.0 - 37.6	36.40	35.00	Top of Bedrock
K2-7S	6/6/2012	BCA-923	N48°52'43.156"	W118°40'11.120"	1892.66	2.21	22.3 - 32.3	19.0 - 32.3	32.30	NA	Glacial/Alluvial
K2-8D	6/18/2012	BCA-916	N48°52'43.272"	W118°40'14.308"	1884.01	2.45	34.1 - 39.1	32.0 - 39.5	39.10	37.00	Top of Bedrock
K2-8S	6/18/2012	BCA-917	N48°52'43.369"	W118°40'14.285"	1883.67	2.27	20.5 - 25.5	17.0 - 25.7	25.50	NA	Glacial/Alluvial
K2-9D	6/11/2012	BCA-920	N48°52'44.550"	W118°40'13.474"	1871.97	1.63	49.7 - 59.7	46.7 - 59.7	59.70	59.00	Top of Bedrock
K2-9S	6/12/2012	BCA-921	N48°52'44.529"	W118°40'13.611"	1870.79	1.61	14.5 - 19.5	11.0 - 19.5	19.50	NA	Glacial/Alluvial
K2-10D	6/14/2012	BCA-918	N48°52'45.381"	W118°40'12.144"	1853.00	2.05	55.0 - 65.0	53.0 - 65.0	65.00	62.60	Top of Bedrock
K2-10S	6/15/2012	BCA-919	N48°52'45.430"	W118°40'12.195"	1852.40	1.80	44.2 - 49.2	42.2 - 49.2	49.20	NA	Glacial/Alluvial

Notes:

ft amsl - feet above mean sea level

ft bgs - feet below ground surface

ft ags - feet above ground surface

FIGURE