Report to the Quinsam Coal Environmental Technical Review Committee:

Mine Permit (C-172) Amendment, Coarse Coal Rejects Management, and 7-South Mine.

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LIST OF ABBREVIATIONS

Abbreviation	Full Name
ABA	acid base accounting
ARD	acid rock drainage
BC	British Columbia
CCR	coarse coal rejects
CWN/RCE	Canadian Water Network/Réseau Canadien de l'Eau
HLB	Hillsborough Resources Limited
NP	neutralization potential
PAG	potentially acid generating
ppm	parts per million; equivalent to μg/g (microgram of substance per gram of soil or sediment sample) and ppm (milligrams of substance per litre of aqueous solution)
QCC	Quinsam Coal Corporation
UBC	University of British Columbia

I. INTRODUCTION

The mine permit (C-172) amendment (QCC, 2009a) is a new request from Hillsborough Resources Limited (HLB), Quinsam Coal Corporation, to develop the 2-North pit sump and the 2-South pit areas of the mine for subaqueous disposal of potentially acid generating coarse coal rejects (PAG-CCR) and at the same time develop a new underground mine in the 7-South area. An earlier 7-South open-pit mining proposal was abandoned because of environmental concerns. The location of the mine is shown in Map I-1, and Map I-2 provides an overview of the mine property and proposed development sites.

This report is based on the experience gained in the course of preparing our first report to the Canadian Water Network, "An Environmental Investigation of the Quinsam Watershed" (UBC, 2010). We will not comment directly on the 2-North pit proposal because it will not have a direct effect on Long Lake and we have not studied that area of the mine. In addition, because we are not engineers, we will try to limit our comments to chemistry and issues of environmental concern. This report will first discuss concerns associated with mining the 7-South area and will then follow with concerns about the plans to handle the mine wastes associated with the mine development.

***General Comments**:*

The Executive Summary of the proposal states: "In March, 2009 HLB provided a Project Description of the 7-South Mine development to the Environmental Assessment Office for a determination of the environmental assessment requirement of the project. The determination made was the 'development does not constitute a reviewable project under the Act.' The proposed developments will not increase the area of disturbance footprint of the mine and do not represent an increase to the mine's annual production rate."(QCC, 2009a)

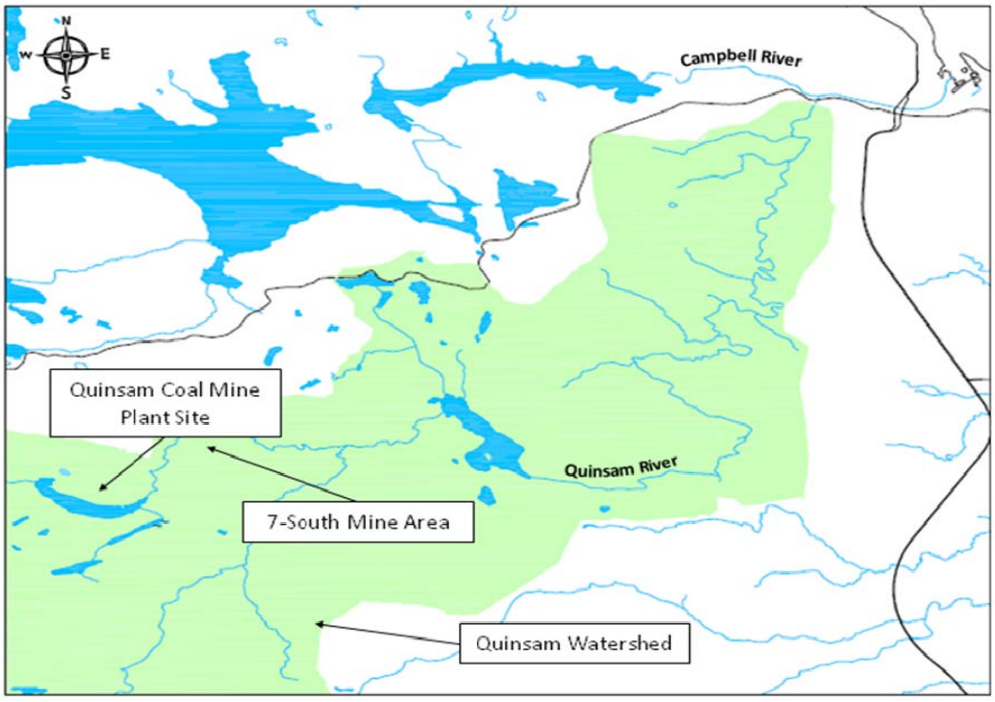
Increase in mine production rate. In 2009, the total residues PAG plus nPAG (potentially acid generating or not PAG) amounted to 64,000 m^3. This is scheduled to increase in 2010 to 140,000 m^3 and remain above 100,000 m^3 from 2010 to 2014. It is hard to see how these figures "do not represent an increase to the mine's annual production rate."

Area of disturbance. The 7-South mine proposal states that the "development increases the area of disturbance footprint of the mine by seven hectares (for the portal

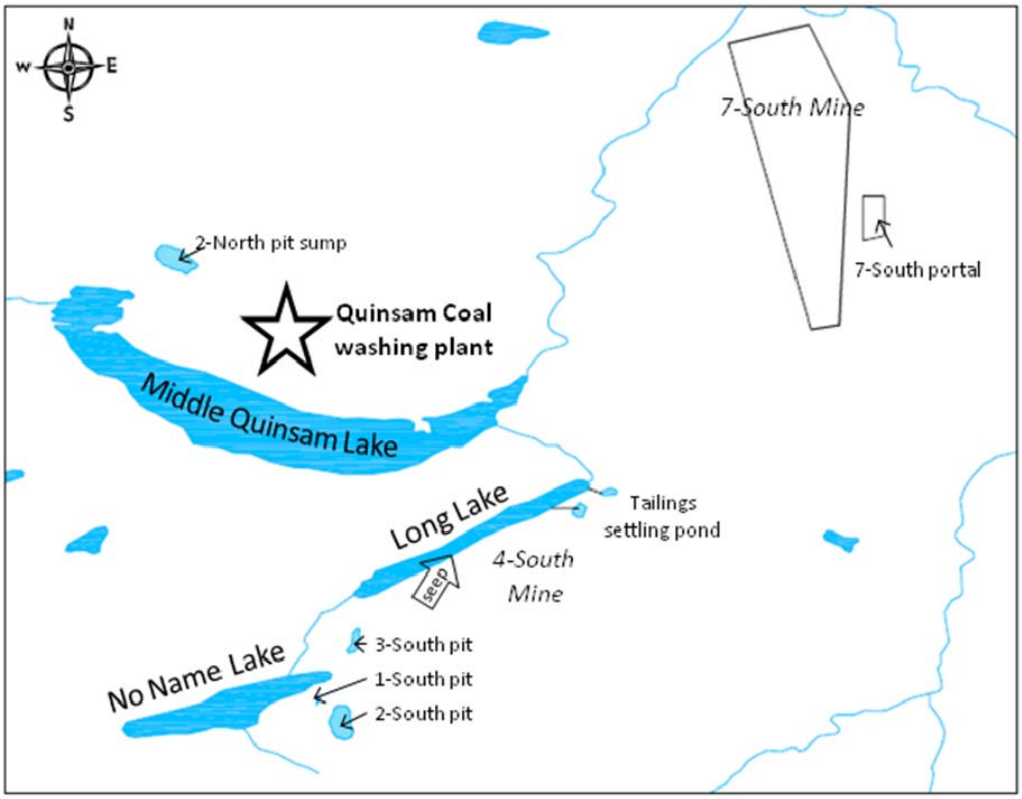
site)," and the proposal includes topsoil and overburden dumps (see Figure III-1) as well as a large tailings pond. The proposed 2-South pit tailings pond will have a capacity of 500,000 m^3 (The 3-South pit now in use has a capacity close to one tenth of this, around 50,000 m^3).

Table I-1 (Table 1-3 Proposal). Coarse coal rejects (CCR) management plan. PAG indicates potentially acid generating, while nPAG indicates non-potentially acid generating rejects.

CCR Management								
Production (m^3)		2009	2010	2011	2012	2013	2014	Total
2-North	nPAG	16,724	21,305					38,029
	PAG		21,305	22,756	42,000	8,400	0	94,462
5-South P1	nPAG	47,059	12,417					59,476
	PAG		12,417	11,864	11,626	0	0	35,907
5-South P2	nPAG	0	0	0	0	0	0	0
	PAG		70,075	54,415	1,582	0	0	126,071
7-South	nPAG	0	0	0	0	0	0	0
	PAG		0	38,182	38,182	68,727	61,345	206,436
4-South	nPAG	0	0	0	0	0	0	0
	PAG		0	0	20,000	25,455	25,455	70,909
242 - Mine	nPAG	0	0	0	0	0	0	0
	PAG		0	0	0	0	15,273	15,273
Total	nPAG	63,783	33,723	0	0	0	0	97,505
	PAG	0	103,797	127,216	113,390	102,582	102,073	549,058
CCR Management								
Disposal (m^3)		2009	2010	2011	2012	2013	2014	Total
Tailings Embankment	nPAG	63,783	33,723					97,506
3-South	PAG		50,000					50,000
2-North Sump	PAG		53,797	26,203				80,000
2-South Pit	PAG			101,013	113,390	102,582	102,073	419,058
Sub-Total	PAG	0	103,797	127,216	113,390	102,582	102,073	549,058



Map I-1: Overview of where the 7-South Project is occurring.



Map I-2: Location of proposed 2-South pit and 7-South mine, and locations of 3-South pit and 2-North pit sump.

II. THE 7-SOUTH MINE

A. Proposed Development

The 7-South Mine will be operated as a satellite operation from the mining in 2-North and 5-South pits, with the coal extracted from the mine being transported by surface haulage to the coal preparation plant. The mine plan includes a portal pit, an external overburden dump to receive material mined from the portal pit, two topsoil storage stockpiles, and a sediment control pond, shown in Figure II-1. The total area of surface disturbance is about seven hectares (QCC, 2009a).

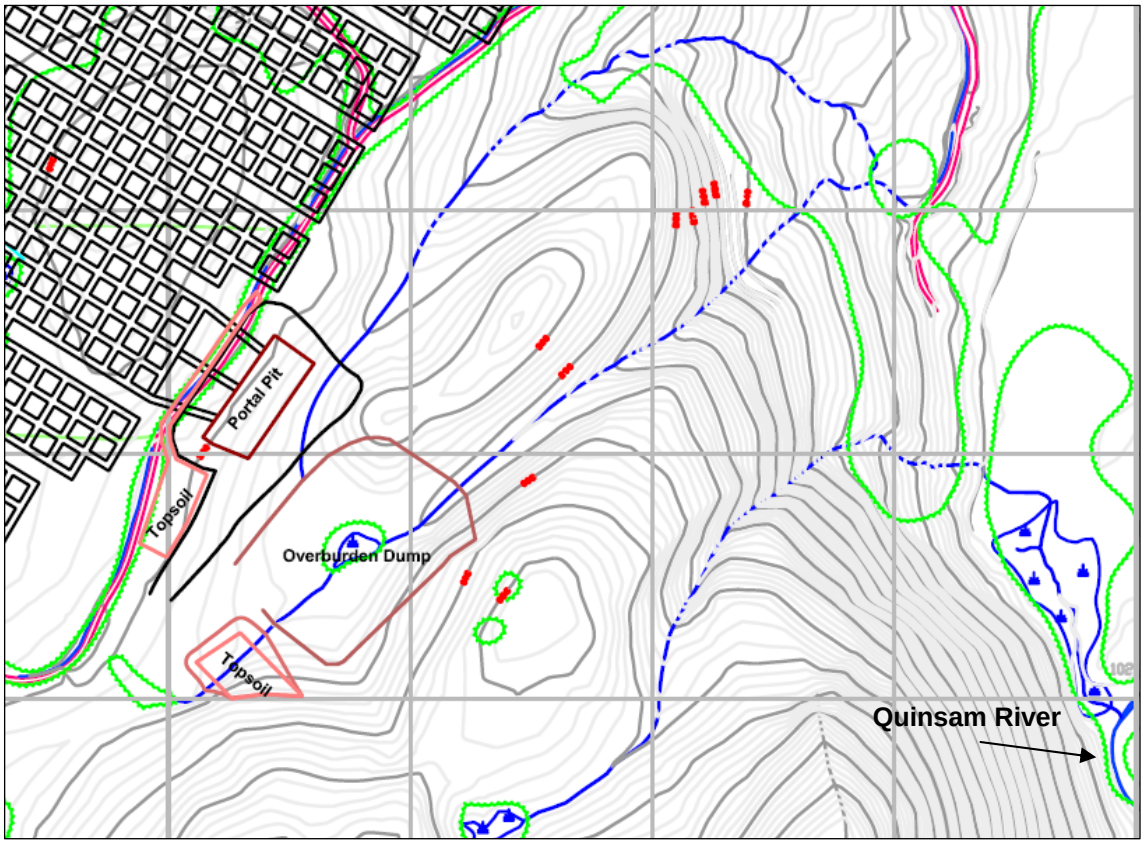


Figure II-1: A closeup of the portal pit of 7-South which will be the surface disturbance and overburden dump location.

The proposed 7-South Mine will remove coal from the No.4 coal seam that is sandwiched between sandstone layers. Selected analytical data for the strata in the 7-South mining area are given in Table A-1 in Appendix A. Sulphur concentrations, mainly pyritic sulphur, are much higher – above 2 ppm – than encountered in any previously mined sections and "elements that are consistently enriched in the No. 4 seam include the metalloids arsenic, bismuth and selenium (QCC, 2009a)".

The topography of the area is generally flat to gently sloping. "The topography over the pit area ranges in elevation from 292 to 304 [m] and slopes towards the southeast. The topography over the waste rock storage area ranges from 290 to 305 and slopes towards the northwest. These slopes join to form a gully that trends downward to the northeast, eventually to wetlands in the Quinsam River floodplain some 650 metres away. From observations this gully experiences seasonal flow." (QCC, 2009a) It seems that runoff, which will inevitably contain sulphate and arsenic (see unsaturated column results, Figures III-4 and III-5), will be released to the Quinsam River without treatment. A temporary (one- to two-day) raw coal stockpile is to be developed in the pit that will further contribute to runoff contamination.

As outlined above in Table 1, the CCR produced from the 7-South pit is expected to be PAG. The proposal claims that; "Sampling and testing during mining and coal processing will ensure the material is properly classified (PAG or nPAG) and managed accordingly. The PAG-CCR will be disposed of subaqueously." Any material that is found to be nPAG will be used for construction as fill for the embankments of the tailings pond. Thus it will be exposed to the elements and will weather and oxidize. We will discuss some of the problems associated with this plan in the section dealing with CCR.

B. Closure Plan

The proposal states "The closure plan for the mine involves removal of all underground mining fixtures and infrastructure, sealing the portal entrances and allowing the underground workings to flood. The entire extent of the underground workings will be flooded within three to four years (based on assisting the flooding process by pumping water from some other source) of mining being completed. The surface disturbance will be reclaimed by re-surfacing with cover soil and re-vegetating" and under post-mining conditions groundwater levels will recover to levels similar to the baseline conditions and all underground workings will remain flooded with the exception of the portals and possibly the extreme southeast corner of the mine."

However, we also see that “The raw coal and the exposed coal faces are expected to be potentially acid generating but will contain sufficient neutralization potential (NP) to initially maintain pH neutral conditions,” and “Due to the higher sulphur content of the 7-South coal deposits, it is understood that some of the wall rock is potentially acid generating. Therefore, flooding of the 7-South underground workings within an approximate three to four year time frame following completion of mining is recommended.” (QCC, 2009a)

Again the emphasis is only on acid release, ignoring other releases that could end up in the Quinsam River via the portals.

III. COARSE COAL REJECTS (CCR) MANAGEMENT

A. 2-South Pit

1. The site

The 2-South pit was previously mined and is located within the No Name Lake watershed (see Map I-2 and Figure III-1) and will be used for PAG-CCR storage. The pit receives surface runoff from areas to the southeast, south and southwest. Water entering the pit drains away, either through a rock drain located at the north edge of the pit connected to the 2-South sump, or into the underground workings that are no longer in use. There is some evidence for subsidence on the hillside to the north of 2-South pit. The portals have been covered and the waste dump located to the northwest (backfilling the 1-South pit) partially reclaimed. No other reclamation work has been done to the 2-South pit.

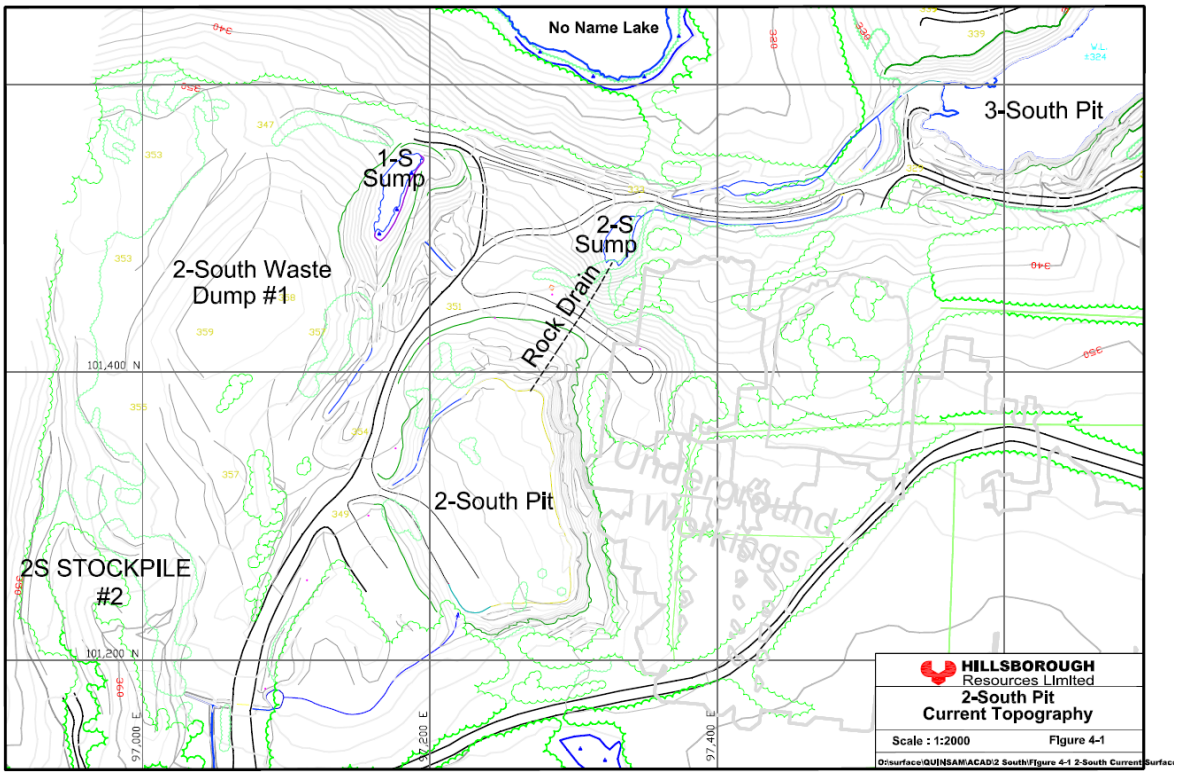


Figure III-1: (Figure 4-1 from Proposal). Closeup of drainage for proposed 2-South pit.

2. Concerns

In our earlier report (UBC, 2010), we established that Long Lake sediments are affected by the Mine. We noted in particular the high arsenic concentrations, up to 630 ppm arsenic in Long Lake sediments. QCC reports sulphate concentrations above the permit level of 100 ppm in Long Lake water, Figure III-2.

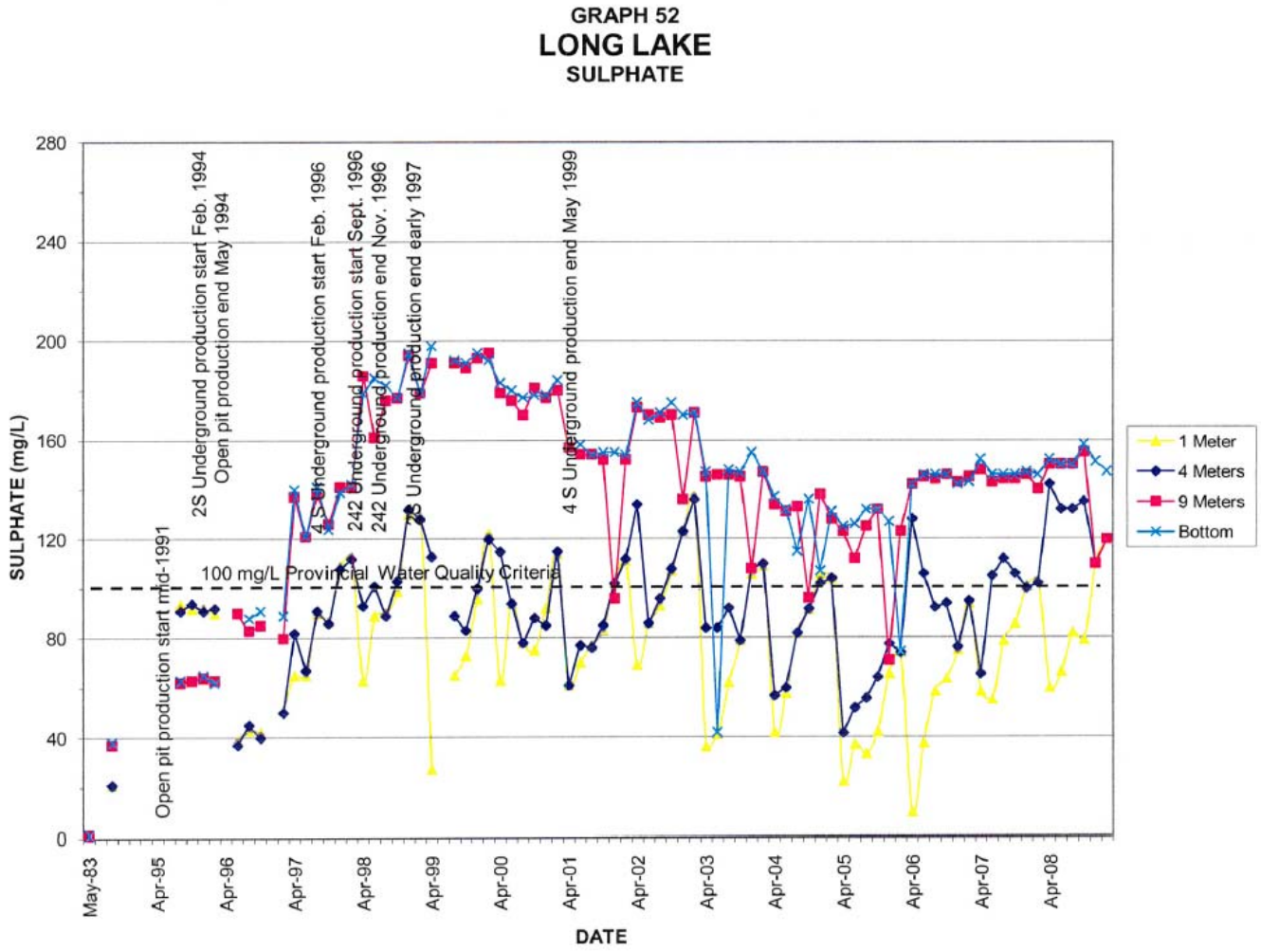


Figure III-2: (Graph 52 annual report QCC, 2009b). Sulphate concentrations in Long Lake, consistently above the 100 mg/L Provincial Water Quality Criteria (shown on the graph as a dotted line) for more than 10 years.

Sulphate is an indicator of metal sulphide oxidation, and is being released to the mine water system (along with any associated arsenic) from rock surfaces, mine residues, and overburden exposed by mine disturbances. Particular sources suggested by QCC include:

- surface runoff affected by the 2-South and 3-South rock walls;
- the Long Lake seep;
- dewatering from the 4-South mine and runoff from that portal site and runoff from the south slope;
- tailings pond seepage; and
- abandoned underground 2-South mine workings located to the east of the 2-South pit.

QCC has been aware of this situation for a number of years, yet it seems that little attempt has been made to address the issue as judged by the record of sulphate concentration in Long Lake (refer to Figure III-2). Ongoing mitigating measures described by QCC include (QCC, 2009a):

- testing cells containing sulphate reducing bacteria (since 2002) to see if the technology can be used to remove sulphate from mine water. Some cells in the North Mine are still active and are demonstrating an effective reduction in sulphate in the 25-50 percent range;
- ensuring proper management (subaqueous) of the PAG-CCR disposed in the 3-South pit; and
- redirecting runoff water from the 3-South “77” Pit (a pre-mining bulk sample location) into the 4-South underground mine.

In response, we note that it seems that the test treatment cells are not offering much hope for implementation and the other measures are not working. Two concerns in particular are:

1. The new work in the 1/2/3-South area will expose fresh material to the atmosphere and is likely to enhance the release of sulphate, etc. from the area into Long Lake and/or No Name Lake. The work involves "developing a borrow pit to the northwest of the pit (in the 2-South waste dump, see Figure III-1) to provide the construction material needed for the containment embankments, and construction of containment embankments to the north and west sides of the pit to create the storage capacity required and expanding the current catchment area by constructing permanent swales south of the pit to intercept water." (QCC, 2009a)

2. The PAG-CCR produced from the proposed 7-South mine will contain more sulphur than the residues previously dumped into the 3-South pit, so is likely to release more sulphate and arsenic into the environment (we will discuss this in more detail the next section).

Finally, engineers have noted (QCC, 2009a): "There is the potential for settlement that could compromise the lined integrity at the Pit 2 South PAG CCP storage facility. Additional site investigation work is required to complete an evaluation of the settlement and to conduct a risk assessment, to identify outstanding residual issues and to develop mitigative measures as necessary." Also, "The Pit 2 storage facility is classified as having "high" downstream consequences in the event of a dam breach."

B. Coal Refuse from the 7-South Mine

As outlined earlier (UBC, 2010), the mine uses acid-base accounting (ABA) to classify material with respect to its potential to be PAG and to undergo acid rock drainage. The data shown in the proposal (QCC, 2009a) indicate that most of the material tested (coal, coarse rejects, tailings, sand stone, etc.) from 7-South pit would be designated as PAG. ABA provides no information on reaction rates (UBC, 2010) so other rudimentary tests are sometimes performed to provide some information about long term

"stability." QCC has reported some results involving saturated and unsaturated columns of test material, summarized below.

1. Saturated column tests

A saturated column (kinetic) test on a composite of the CCR expected from the 7-South Mine should give an indication of the potential benefits and improvement drainage chemistry if the material if it is placed in subaqueous storage. QCC comments on the results as follows:

- Saturating the CCR has the potential to reduce pyrite oxidation rates by more than 100 times relative to those observed in unsaturated conditions and

- Over the duration of 11 cycles of testing, metal concentrations either decreased from the initial pulse of elevated metal (As, Cd, Co, Mn, Ni and Zn) concentrations or remained low. *Only arsenic has remained above its chronic guideline* (emphasis added). This is seen in Figure III-3.

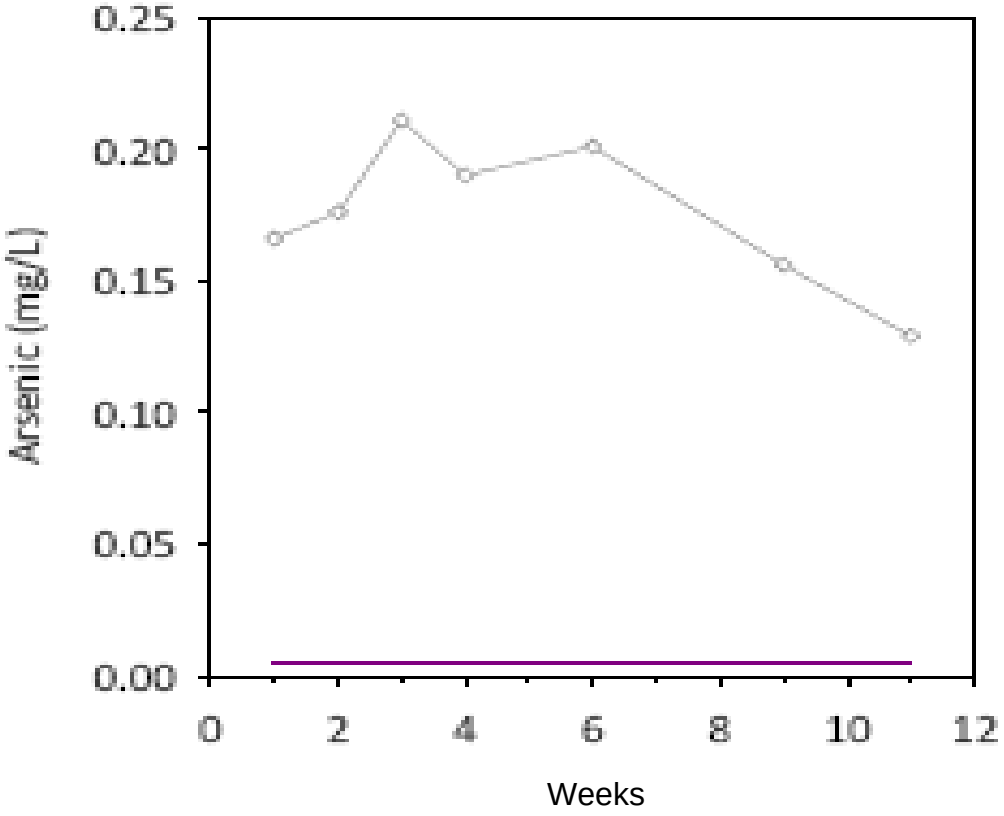


Figure III-3: (Figure 11-14 Proposal). Arsenic release for the saturated column from blended coarse coal residues. Purple line corresponds to BC chronic arsenic exposure water guideline.

Elsewhere in the proposal (QCC 2009 Summary and Implication) we find:

"Coarse rejects are expected to be PAG. Column testing has demonstrated that sulphate concentrations are expected to decrease with time. Similarly for elemental concentrations except for arsenic which will have significant elevated concentration in the saturated coarse reject pore water."

However, even if the suggested trends are seen in a real situation (*e.g.* in PAG residues dumped into the 3-South pit), we must remember that fresh material is being added at regular intervals so there is always material in the pit in the initial release phase.

2. Unsaturated column tests

These tests are carried out to see if the material is stable to cycles of leaching with water. Some results for coal and coarse rejects are shown in Figures III-4 and III-5. Sulphate in particular is high in the washings, above both BC guidelines for acute and chronic exposure.

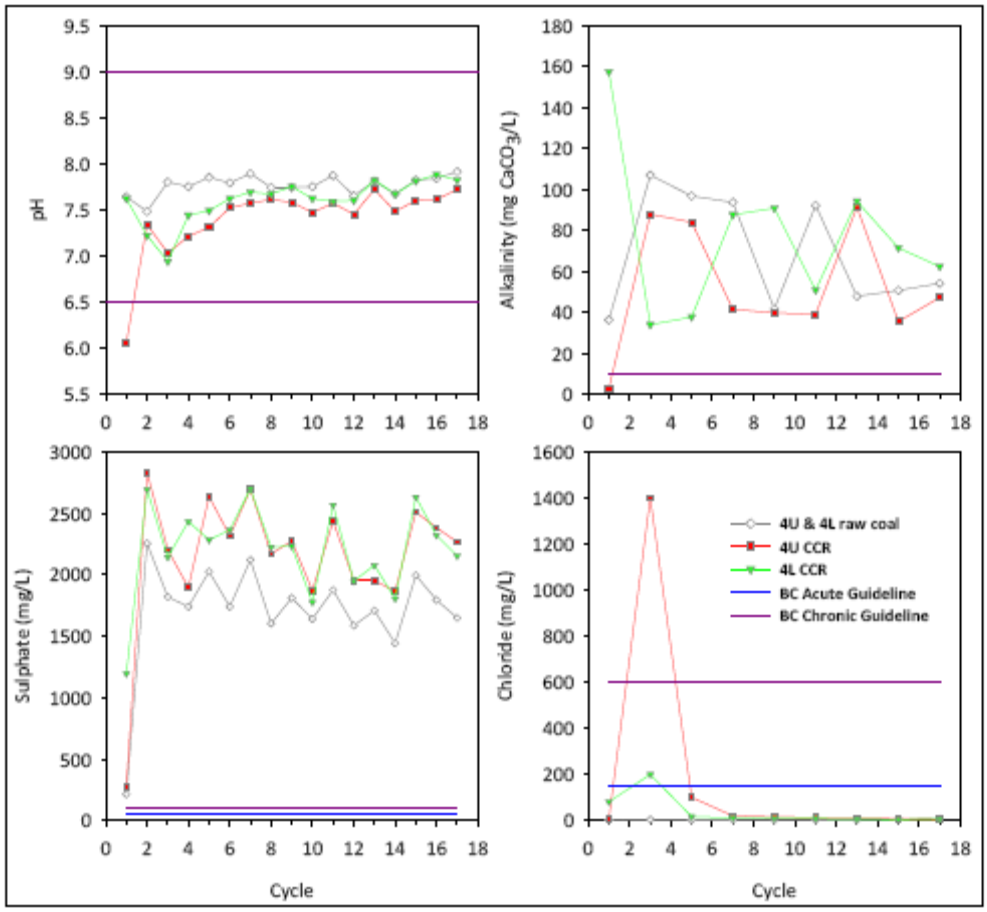


Figure III-4: (Figure 11-11 from Proposal). Unsaturated column leachate pH, alkalinity, sulphate and chloride concentrations. Red indicates coarse coal refuse (CCR) from 4 Upper (4U), green line indicates results for CCR from 4-Lower (4L), and grey line indicates results from a mixture of both CCR sources from the 7-South area. The purple line corresponds to the BC chronic exposure guideline, while the blue line corresponds to the BC acute exposure guideline.

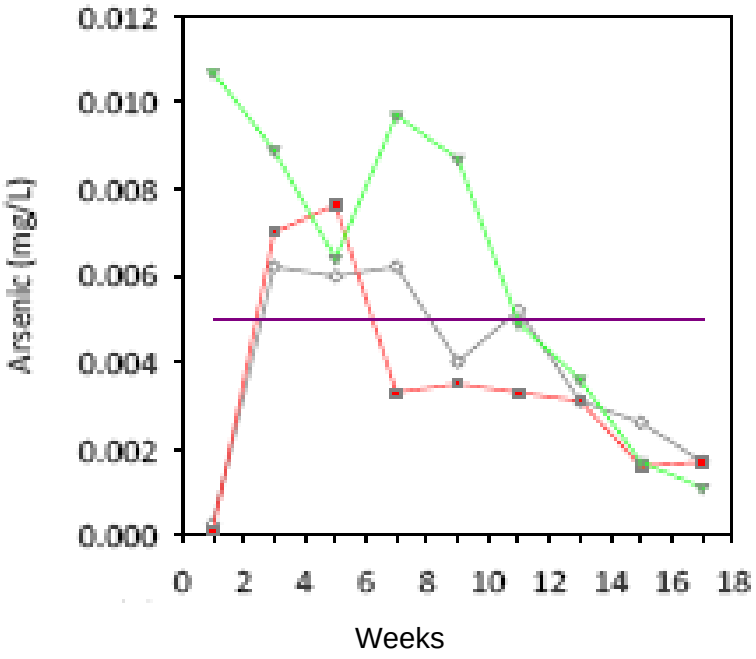


Figure III-5: (from QCC, 2009a). Arsenic leachate concentration from unsaturated column samples over time. Purple line indicates the BC guideline for chronic exposure to arsenic.

QCC comments on these results as follows: "High sulphate concentrations in the observed range indicate that the pyrite contained in the No.4 Seam coal and partings oxidizes at an accelerated rate" (QCC, 2009a). The remark about accelerated rate needs some comment. We pointed out (UBC, 2010) that any rate increase would require a catalyst and this strongly suggests that bacteria such as *Thiobacillus ferrooxidans* are assisting the processes. Although the leachate is not acidic (see Figure III-4 for results) – considered to be good news by QCC – the pyrite will continue to be oxidized and any associated arsenic will be released. This is seen in Figure III-5, where the release of arsenic (and other elements, not shown) exceeds the BC Chronic Guidelines for Aquatic Life.

IV. SUMMARY OF CONCERNS

We believe that the proposal outlined by QCC (2009a) requires a second look in the form of a thorough environmental review for the following reasons:

- QCC has been aware for some time that that arsenic concentrations in Long Lake sediments are above Provincial guidelines, yet little has been done to establish the source or duration of this problem. No real attempts at mitigation have been made and the future is unsure.

- The proposal involves major construction in the 1/2/3-South area that is probably one of the sources of the high concentrations of sulphate and arsenic found in Long Lake. This surface disturbance can only increase the release of oxidation products from the area to the environment.

- The proposal involves moving material rich in pyritic sulphur into this same area for subaqueous disposal, even though the area is already having problems with the release of sulphate and arsenic from more benign residues.

- The plans for the 7-South mine say little about the fate of the anticipated runoff from the portal, the piles of topsoil and overburden, and the stockpile of raw coal. The also say little about any leakage of contaminated water from the flooded mine on closure.

REFERENCES

Quinsam Coal Corporation (QCC), 2009a. Mine permit (C-172) Amendment, Volume II, Coarse Coal Rejects Management, and 7-South Mine, November, 2009.

Quinsam Coal Corporation (QCC), 2009b. Volume I. 2008/09 Annual Water Quality Monitoring and Reclamation Report: Covering Waste Management Permit PE-07008 and Reclamation Permit C-172, Reporting Period from April 01/08 to March 31/09, September, 2009.

University of British Columbia (UBC), Environmental Sciences Group (ESG), 2010. An Environmental Investigation of the Quinsam Watershed. Prepared for the Canadian Water Network, April, 2010.

APPENDIX A: DATA

Table A-1: Selected data from the 7 South strata (adapted from QCC, 2009)

Sample No.	Sample Information	Lithology	Sample Interval		Total Thickness (m)	As [ppm]	Fe %	Mn [ppm]	S %
			From (m)	To (m)					
Hole QU-0707-C			*Average Crustal Abundance*			1.8	5.63	950	0.035
0707-ARD1		Sandstone	9.65	10.33	0.68	25	1.33	634	0.97
0707-ARD2		Sandstone	10.33	12.99	2.66	63	2.74	271	2.22
0707-ARD3	No.5 Roof	Sandstone	12.99	13.89	0.90	89	4.65	429	4.25
0707-ARD4	No. 4 Floor	Mudstone-Sandstone			0.00	56	5.25	522	4.17
Hole QU-07-09-C									
0709-1		Sandstone	4.67	6.76	2.1	11	3.28	119	0.01
0709-2		Sandstone	6.76	9.94	3.2	16	3.96	140	0.01
0709-3		Sandstone	9.94	13.36	3.2	7	1.38	68	0.03
0709-4		Sandstone	13.36	18.73	5.4	7	2.36	264	0.02
0709-5		Sandstone	18.69	22.87	4.2	21	3.14	604	0.24
0709-6		Sandstone	22.87	25.54	2.7	110	6.58	672	4.31
0709-7	No. 5 Roof	Sandstone/ Mudstone	25.54	26.82	1.3	93	5.34	469	4.34
0709-8	No. 5 Floor	Sandstone	27.76	27.98	0.2	412	8.68	633	>5
0709-9		Sandstone	27.98	30.24	2.3	102	5.15	554	2.75
0709-10		Sandstone	30.24	32.94	2.7	28	2.01	360	0.25
0709-11		Sandstone	32.97	39.00	6.0	28	3.91	565	0.17
0709-12		Sandstone	39.00	44.74	5.7	20	2.65	1703	0.07
0709-13		Sandstone	44.74	47.31	2.6	20	5.12	1240	0.14
0709-14		Sandstone	47.29	50.11	2.8	43	6.42	648	1.27
0709-15	No. 4 Roof	Sandstone	50.11	50.84	0.8	131	8.06	957	>5
0709-16	No. 4 Floor	Mudstone/Coal	55.28	55.83	0.6	127	7.84	488	>5
QU-05-06A and QU-05-07									
05-6A/A/R1		Sandstone	16.71	17.6	0.89	103	6.95	721	4.94
05-6A/A/R2		Sandstone	13.635	16.61	2.975	80	5.48	712	3.73
07-7A/R1/R2/R3	Composite	Sandstone	44.51	47.05	2.54	77	4.45	381	2.97
Hole QU-08-22G									
1-5-09 A		Mudstone	15.20	15.24	0.04	10.2	1.47	32	1.31
1-5-09 B		Mudstone	15.24	15.45	0.21	39.8	5.6	120	4.34
1-5-09 C		Mudstone	15.45	16.05	0.60	16.8	7.96	300	5.42
1-5-09 D		Siltstone	16.05	16.85	0.80	9.1	7.77	483	4.4
1-5-09 E		Siltstone	16.85	18.33	1.48	7.9	9.1	963	1.14
1-5-09 F		Siltstone	18.33	20.09	1.76	7.2	8.85	1208	0.79
1-5-09 G		Siltstone	20.09	21.09	1.07	9.2	9.89	1481	0.96
1-5-09 H		Siltstone	21.09	22.14	1.05	14.7	6.93	475	2.47
1-5-09 I		Sandstone	22.14	23.97	1.83	10.9	5.54	668	1.11
1-5-09 J		Sandstone	23.97	25.26	1.29	7	5.97	1887	1.36
1-5-09 K		Siltstone	25.26	26.81	1.55	10.1	6.29	652	3.12
1-5-09 L		Siltstone	26.81	27.67	0.86	11.4	7.08	686	4.24
1-5-09 M		Siltstone	27.67	28.14	0.47	18.3	7.21	624	5.17

Table A-1 cont'd. Selected data from the 7 South strata (adapted from QCC, 2010)

Sample No.	Drill Hole	Description	Sample Composition	As [ppm]	Fe %	Mn [ppm]	S %
Coarse Reject Samples		*Average Crustal Abundance:*		1.8	5.65	950	0.035
Sample 1	QU-07-07	Coarse Reject	4-4L Comp	67.5	0.99	128	0.94
Sample 2	QU-07-09	Coarse Reject	4-4L Comp	43.6	2.1	180	1.68
81197	QU-08-03	Coarse Reject	4-4L Comp	188.3	4.2	189	4.94
81520	QU-08-05	Coarse Reject	4-4L Comp	27.8	1.55	139	1.82
81521	QU-08-07	Coarse Reject	4-4L Comp	135.8	2.73	175	2.74
81522	QU-08-08	Coarse Reject	4-4L Comp	192.7	3.16	154	3.32
80950	QU-08-04	Coarse Reject	4 (Main)	168	3.76	145	4.41
82417	QU-08-08	Coarse Reject	4L (Lower Plies Comp)	170.7	2.79	212	2.23
Parting Samples							
0707-02	Q/U-07-7	Ptg.	5L/4	243.7	7.36	134	8.45
80502	QU 08-5	Ptg.	5L/4	128.2	6.12	227	5.35
0707-04	Q/U-07-7	Ptg.	4/4L	42.3	0.30	25	0.11
0708-02	QU-07-8	Ptg.	4/4L	10.8	1.31	111	0.30
0709-03	QU-07-9	Ptg.	4/4L	4.8	0.89	202	0.06
80504	QU 08-5	Ptg.	4/4L	10.7	0.43	107	0.29
80702	QU 08-7	Ptg.	4/4L	12.1	1.00	164	0.29
81304	QU 08-13	Ptg.	4/4L	260.9	6.40	193	6.98
80803	QU 08-8	Ptg.	4/4L	56.2	1.20	222	0.26
80604	QU 08-6	Ptg.	4/4L	64.3	1.33	367	0.11
80903	QU 08-9	Ptg.	4/4L	11.8	0.45	95	0.17
81102	QU 08-11	Ptg.	4/4L	16.4	1.36	466	0.06
81202	QU 08-12	Ptg.	4/4L	85.2	3.47	409	2.78
Raw Coal, Coarse Reject and Railings Samples							
92050	QU-09-01	Raw Coal	Raw Coal	58.6	1.26	75	1.52
92051	QU-09-01	4 Upper	Coarse Reject + 100 mesh	92.2	3.25	163	3.56
92052	QU-09-01	4 Lower	Coarse Reject + 100 mesh	42	2.45	104	2.45
92053	QU-09-01	4 Upper & 4 Lower	Coarse Reject Saturated	59.7	2.79	148	2.9
92054	QU-09-01	4 Upper & 4 Lower	Coarse Reject Saturated	68.1	3.19	137	3.33
92055	QU-09-01	4 Upper & 4 Lower	Tailings Fines (-100 mesh)	86.1	1.73	224	1.69