Surface Coal Mine and Reclamation Project-
Prince Mine Site
Point Aconi, Nova Scotia
Volume II Appendices

Submitted by: Pioneer Coal Ltd.

May 2005

APPENDIX A

RELEVANT PROJECT CORRESPONDENCE

Natural Resources
Office of the Minister

PO Box 698, Halifax, Nova Scotia, Canada B3J 2T9 • Telephone 902 424-4037 Fax 902 424-0594 • www.gov.ns.ca

May 21, 2004

Mr. John Chisholm
President
Pioneer Coal Limited
P.O. Box 1328
3098 Post Road
Antigonish, Nova Scotia
B2G 2L7

Re: Call for Proposals for Exploration, Development and Reclamation of Selected Areas of the Sydney Coalfield - Point Aconi Resource Block

Dear Mr. Chisholm

Thank you for submitting a proposal expressing your interest to obtain mineral rights to the Point Aconi Resource Block as defined in the Department's Call for Proposals which closed March 5, 2004

The Department received a total of six (6) proposals in response to the Call for Proposals for the four (4) resource blocks offered in the Call. Of the six (6) proposals received, two (2) were submitted for the Point Aconi Resource Block, one from yourself and the other from Thomas Brogan & Sons Construction Company Ltd. / Cape Crushing Company Ltd.

The Department has completed its evaluation and has rated the proposals based on the detailed requirements set out in the Call for Proposals. Your proposal was selected as the most comprehensive proposal submitted for the Point Aconi Resource Block. Therefore I am pleased to inform you that your proposal has been accepted and your company may now make application for the mineral rights for coal in the defined resource block.

The Department of Natural Resources will retain your bid deposit of $25,000.00, in accordance with the terms of the Call for Proposals. The Call for Proposals specifically noted that the successful proponent is required to obtain mineral tenure within one year of acceptance of the proponent's proposal. Failure to obtain mineral tenure within one year of the date of this letter will result in: (1) forfeiture of your bid deposit and (2) termination of the period during which you have the exclusive right to apply for mineral tenure in the Point Aconi Resource Block.

All requirements of the *Mineral Resources Act* must be satisfied by your application for a Special Lease and/or a Special Licence for the Point Aconi Resource Block. Issuance of a Special Lease or Special Licence is subject to the approval of the Governer in Council as provided in Section 22 of the *Mineral Resources Act*. Acceptance of your proposal by the Minister of Natural Resources is not to be construed as an acknowledgment that the requirements of the *Mineral Resources Act* have been met or that a Special Lease or Special Licence will be issued.

If you would like more information regarding the proposal review process or the process to obtain mineral tenure, Department staff are available to answer questions you may have. Please contact Dr. Don Jones, Director of Mineral Management at (902) 424-5618 for further information.

On behalf of the Department of Natural Resources, thank you for your interest in the Cape Breton coal industry and specifically for the proposal you submitted.

Sincerely,

Richard Hurlburt
Minister

APPENDIX B

BASELINE MONITORING DATA

PRINCE MINE - GROUNDWATER METAL AND GENERAL CHEMISTY DATA - PR-1

GENERAL CHEMISTRY	UNITS	Guidelines[1]	PR-1 23-Jun-89	PR-1 21-Sep-89	PR-1 26-Jan-90	PR-1 17-Jul-90	PR-1 28-Sep-90	PR-1 18-Jan-91	PR-1 27-Jun-91	PR-1 20-Sep-91	PR-1 28-Apr-92	PR-1 16-Jun-92	PR-1 21-Aug-92	PR-1 28-Jun-93	PR-1 27-Sep-93	PR-1 30-Mar-94	PR-1 20-Dec-99	PR-1 17-Jan-00
Alkalinity	mg/L			150			150			140			133				162	182
Bicarbonate	mg/L						148			139			133					
Carbonate	mg/L						2.2			0.52								
Calcium	mg/L		26.4	24			27.9			31.2	26		25	21.7		31.7	29.87	34.5
Chloride	mg/L	250	11	12	11	12	11	11	11	11.3	17	10.9	10.8	10.9		11.5	10.4	13.4
Conductance	uMHOS/CM		335	320	330	302	340	297	330	339	321	324	366	298		367	414	496
Color	TCU	15		4			3			3							62	<5
F/Cond	uMHOS/CM				235	236	233	200						299	112	360		
F/pH	UNITS		7.5	6.98	6.33	7.87	7.56	7.59						7.8	6.71	7.49		
F/Temp	CEL			13.1	7	9.8	9	8.2							8.3	7.6		
Hardness	mg/L		93.4	89.5			101			109			92.9				106.94	131.61
L/Cond	uMHOS/CM																	
L/pH	UNITS		8.4	8.3	8.3	7.56	8.2	7.99	8	7.6	8.1	8.1	7.7	8		8.1	7.9	7.9
Magnesium	mg/L		6.7	7.2			7.6			7.6	6.5		7.4	5.9		7.5	7.9	11.04
Nitrate+Nitrite	mg/L			0.05			0.05			0.05							0.02	0.02
NH3	mg/L																0.13	0.16
NH4	mg/L			0.08			0.07			0.09								
Ortho Phosphate	mg/L			0.1			0.01			0.01							0.01	0.01
Potassium	mg/L			5.6			4.3			4.8	1		5.1	3.7		4.7	5.3	5.7
Sodium	mg/L	200		40			33			30.6	20		23.5	21.9		28.8	23.8	37.1
Silica	mg/L			11			11			10.5							13.4	12.7
SO4	mg/L	500	12	15	14	15	15	14	16	14	8	16.2	14.9	16.4		13.3	4.9	14.2
Suspended Solids	mg/L										0.5		3.3	0.05		0.5		
Total Dissolved Solids	mg/L	500									204		160	152		184	180	237.86
Total Organic Carbon	mg/L			1.6			0.8			0.7							0.5	3.5
Total Solids	mg/L																	
Turbidity	NTU	5		0.8			0.24			0.4							15	2.3
METALS	**UNITS**	**Guidelines[1]**	**PR-1 23-Jun-89**	**PR-1 21-Sep-89**	**PR-1 26-Jan-90**	**PR-1 17-Jul-90**	**PR-1 28-Sep-90**	**PR-1 18-Jan-91**	**PR-1 27-Jun-91**	**PR-1 20-Sep-91**	**PR-1 28-Apr-92**	**PR-1 16-Jun-92**	**PR-1 21-Aug-92**	**PR-1 28-Jun-93**	**PR-1 27-Sep-93**	**PR-1 30-Mar-94**	**PR-1 20-Dec-99**	**PR-1 17-Jan-00**
Aluminum	mg/L		0.05	0.05	0.13		0.19			0.1							0.01	
Antimony	mg/L	0.006	0.05	0.05			0.05			0.05							0.001	
Arsenic	mg/L	0.025																0.0005
Barium	mg/L	1.0	0.143	0.146			0.117			0.12							0.165	
Beryllium	mg/L		0.005	0.005			0.005			0.005							0.001	
Boron	mg/L	5	0.02	0.02			0.05			0.1							0.05	
Cadmium	mg/L	0.005	0.01	0.01			0.01			0.01							0.001	
Chromium	mg/L	0.005	0.02	0.01			0.01			0.02							0.001	
Cobalt	mg/L		0.01	0.02			0.01			0.05							0.001	
Copper	mg/L	1	0.01	0.01			0.01			0.01			0.05				0.001	0.001
Iron	mg/L	0.3	0.09	0.02			0.08			0.02	0.14		0.14	0.5		0.2	0.56	0.154
Lead	mg/L	0.01	0.05	0.05			0.05			0.05			0.001				0.001	
Lithium	mg/L																	0.001
Manganese	mg/L	0.05	0.1	0.09			0.09			0.08	0.09		0.11	0.1		0.1	0.132	0.138
Mercury	mg/L	0.001																0.0001
Molybedium	mg/L																	0.001
Nickel	mg/L		0.02	0.02			0.02			0.02							0.001	
Selenium	mg/L	0.01	0.1	0.1			0.1			0.1							0.001	
Silver	mg/L																	0.001
Strontium	mg/L																	0.446
Thallium	mg/L																	0.001
Tin	mg/L		0.03	0.03			0.03			0.05							0.001	
Uranium	mg/L	0.02																0.001
Vanadium	mg/L		0.01	0.01			0.01			0.01							0.001	
Zinc	mg/L	5	0.02	0.01			0.01			0.01			0.02				0.001	0.001

[1]**CDWQ** **Guidelines for Canadian Drinking Water Quality (April 2003)**

(shaded) **Denotes Exceedences**

PRINCE MINE - GROUNDWATER METAL AND GENERAL CHEMISTY DATA - PR-2

GENERAL CHEMISTRY	UNITS	CDWQ	PR-2 25-Apr-89	PR-2 24-May-89	PR-2 23-Jun-89	PR-2 21-Sep-89	PR-2 12-Oct-89	PR-2 15-Nov-89	PR-2 13-Dec-89	PR-2 26-Jan-90	PR-2 26-Feb-90	PR-2 9-Mar-90	PR-2 12-Apr-90	PR-2 23-May-90	PR-2 17-Jul-90	PR-2 28-Sep-90	PR-2 31-Oct-90	PR-2 26-Nov-90	PR-2 12-Dec-90	PR-2 18-Jan-91	PR-2 28-Feb-91
Alkalinity	mg/L					210					190	173				161					
Bicarbonate	mg/L										187	170				159					
Carbonate	mg/L										2.79	3.18				1.88					
Calcium	mg/L				24.7	33			38		30	26				28.3					
Chloride	mg/L	250	34	48	68	89	65	50	58	61	63	57	68	44	38	52	50	72	54	43	71
Conductance	uMHOS/CM		390	593	640	840	680	600	750	660	670	590	745	529	447	545	556	685	765	413	607
Color	TCU	15				3										4					
F/Cond	uMHOS/CM							360	445	330			425	360	330	370		405	405	310	
F/pH	UNITS		7.5	8	8	7.61	7.2	6.92	6.26	6.98		8.15	7.92	7.92	7.8	7.58		7.96	7.67	7.62	
F/Temp	CEL		9	9.3		9.6	9.3	8.5	8.6	8	7.5	8		9.8	10	9.8		8.3	7.5	8	7.8
Hardness	mg/L				87.2	123.1			135		104	90				100					
L/Cond	uMHOS/CM																				
L/pH	UNITS		8.2	7.9	8.4	8.3	8.2	8.5	7.9	8.2	8.2	8.3	8	7.79	7.28	8.1	7.9	8	8	7.96	8.1
Magnesium	mg/L				6.2	9.9			9.76		7.1	6.1				7.2					
Nitrate+Nitrite	mg/L					0.05										0.17					
NH3	mg/L																				
NH4	mg/L					0.16										0.05					
Ortho Phosphate	mg/L					0.1										0.01					
Potassium	mg/L					8.1					6.2	5.7				4.7					
Sodium	mg/L	200				119					97	83				78					
Silica	mg/L					12										12					
SO4	mg/L	500	19	25	29	73	27	25		42	32	26	76	46	45	35	30	35	81	22	31
Suspended Solids	mg/L										4	2									
Total Dissolved Solids	mg/L	500																			
Total Organic Carbon	mg/L															0.8					
Total Solids	mg/L										350	322									
Turbidity	NTU	5				3.1										29					

METALS	UNITS	Guidelines[1]	PR-2 25-Apr-89	PR-2 24-May-89	PR-2 23-Jun-89	PR-2 21-Sep-89	PR-2 12-Oct-89	PR-2 15-Nov-89	PR-2 13-Dec-89	PR-2 26-Jan-90	PR-2 26-Feb-90	PR-2 9-Mar-90	PR-2 12-Apr-90	PR-2 23-May-90	PR-2 17-Jul-90	PR-2 28-Sep-90	PR-2 31-Oct-90	PR-2 26-Nov-90	PR-2 12-Dec-90	PR-2 18-Jan-91	PR-2 28-Feb-91
Aluminum	mg/L				0.05	0.05			0.05	0.11						0.2	0.05	0.05			
Antimony	mg/L	0.006			0.05	0.05			0.05							0.05					
Arsenic	mg/L	0.025																			
Barium	mg/L	1.0			0.419	0.631			0.367							0.331					
Beryllium	mg/L				0.005	0.005			0.005							0.005					
Boron	mg/L	5			0.03	0.02			0.03							0.1					
Cadmium	mg/L	0.005			0.01	0.01			0.05							0.01					
Chromium	mg/L	0.005			0.02	0.01			0.01							0.01					
Cobalt	mg/L				0.01	0.01			0.01							0.01					
Copper	mg/L	1			0.01	0.01			0.01		0.06	0.01				0.01					
Iron	mg/L	0.3			0.03	0.09			0.02		0.14	0.02				13.2					
Lead	mg/L	0.01			0.05	0.05			0.05			0.002				0.05					
Lithium	mg/L																				
Manganese	mg/L	0.05			0.23	0.63			0.67		0.49	0.33				0.44					
Mercury	mg/L	0.01																			
Molybdenum	mg/L																				
Nickel	mg/L				0.02	0.02			0.02							0.02					
Selenium	mg/L	0.01			0.1	0.1			0.1							0.1					
Silver	mg/L																				
Strontium	mg/L																				
Thallium	mg/L																				
Tin	mg/L				0.04	0.07			0.03							0.03					
Uranium	mg/L	0.02																			
Vanadium	mg/L				0.01	0.01			0.01							0.01					
Zinc	mg/L	5			0.04	0.05			0.07		0.07					1.07					

[1]CDWQ **Guidelines for Canadian Drinking Water Quality (April 2003)**

Denotes Exceedences (shaded cells)

PRINCE MINE - GROUNDWATER METAL AND GENERAL CHEMISTY DATA - PR-2

GENERAL CHEMISTRY	UNITS	CDWQ	PR-2 27-Mar-91	PR-2 23-Apr-91	PR-2 16-May-91	PR-2 27-Jun-91	PR-2 10-Jul-91	PR-2 23-Aug-91	PR-2 20-Sep-91	PR-2 15-Nov-91	PR-2 18-Dec-91	PR-2 31-Mar-92	PR-2 28-Apr-92	PR-2 16-Jun-92	PR-2 21-Aug-92	PR-2 28-Sep-92	PR-2 28-Oct-92	PR-2 28-Jun-93	PR-2 27-Sep-93	PR-2 30-Mar-94	PR-2 31-Mar-95
Alkalinity	mg/L								190			170.2			174.3						
Bicarbonate	mg/L								189						174.3						
Carbonate	mg/L								1.41												
Calcium	mg/L								30.8			28.2			24			23.7		61.5	
Chloride	mg/L	250	56	19	54	51	76.5	51.4	69	63.4	53.2	54.8	49	62.3	81.5	62.7	62.7	46.7		37	
Conductance	uMHOS/CM		558	319	540	580	551	531	675	616	509	578	577	631	742	635	635	450		592	
Color	TCU	15							4												
F/Cond	uMHOS/CM		584	512								611			721	685	607	460	130	870	72
F/pH	UNITS		7.91	7.47								7.74			7.82	7.7	7.47	7.42	6.88	6.92	6.97
F/Temp	CEL		9.3	9.3								8.6			9	9	8.57		9.7	8.7	8.5
Hardness	mg/L								106						89.17						
L/Cond	uMHOS/CM																				
L/pH	UNITS		7.8	7.82	7.8	8.1	7.99	8.1		7.66	7.78	7.6	7.4	7.5	7.3	7.6	7.6	8		7.7	
Magnesium	mg/L								7.2			8		0.35	7.1			6		13.6	
Nitrate+Nitrite	mg/L								0.14			1.9									
NH3	mg/L																				
NH4	mg/L								0.05			0.1									
Ortho Phosphate	mg/L								0.01			6.08									
Potassium	mg/L								5.6			6.2			7.2			4		5.8	
Sodium	mg/L	200							97.7			80			85			43.6		47.7	
Silica	mg/L								11.6			19.5									
SO4	mg/L	500	27	16	28	36	26	27	34	34	32	32	25.2	39.5	38.4	27.5	27.5	34.2		82.8	
Suspended Solids	mg/L											191						5		<0.5	
Total Dissolved Solids	mg/L	500																266		262	
Total Organic Carbon	mg/L								0.1			1									
Total Solids	mg/L																				
Turbidity	NTU	5							1.84			58									
METALS	**UNITS**	**Guidelines[1]**	**PR-2 27-Mar-91**	**PR-2 23-Apr-91**	**PR-2 16-May-91**	**PR-2 27-Jun-91**	**PR-2 10-Jul-91**	**PR-2 23-Aug-91**	**PR-2 20-Sep-91**	**PR-2 15-Nov-91**	**PR-2 18-Dec-91**	**PR-2 31-Mar-92**	**PR-2 28-Apr-92**	**PR-2 16-Jun-92**	**PR-2 21-Aug-92**	**PR-2 28-Sep-92**	**PR-2 28-Oct-92**	**PR-2 28-Jun-93**	**PR-2 27-Sep-93**	**PR-2 30-Mar-94**	**PR-2 31-Mar-95**
Aluminum	mg/L								0.1			0.04			0.02						
Antimony	mg/L	0.006							0.05			1			0.01						
Arsenic	mg/L	0.025										0.5									
Barium	mg/L	1.0							0.381			300.4									
Beryllium	mg/L								0.005			1			0.01						
Boron	mg/L	5							0.1												
Cadmium	mg/L	0.005							0.01			1			0.01						
Chromium	mg/L	0.005							0.02			0.01			0.01						
Cobalt	mg/L								0.05			1			0.01						
Copper	mg/L	1							0.01			0.01			0.01						
Iron	mg/L	0.3							0.28			13.8		0.33	0.25			0.2		0.7	
Lead	mg/L	0.01							0.05			2.8			0.01						
Lithium	mg/L																				
Manganese	mg/L	0.05							0.28			0.3						0.4		1.4	
Mercury	mg/L	0.01																			
Molybdenum	mg/L																				
Nickel	mg/L								0.02			0.01			0.01						
Selenium	mg/L	0.01							0.1						0.001						
Silver	mg/L											1									
Strontium	mg/L																				
Thallium	mg/L																				
Tin	mg/L								0.05			10.7			0.01						
Uranium	mg/L	0.02																			
Vanadium	mg/L								0.01			1			0.01						
Zinc	mg/L	5							0.13			0.11			0.05						

[1]CDWQ **Guidelines for Canadian Drinking Water Quality (April 2003)**

Denotes Exceedences

PRINCE MINE - GROUNDWATER METAL AND GENERAL CHEMISTY DATA - PR-7

GENERAL CHEMISTRY	UNITS	Guidelines[1]	PR-7 25-Apr-89	PR-7 24-May-89	PR-7 23-Jun-89	PR-7 25-Aug-89	PR-7 21-Sep-89	PR-7 13-Oct-89	PR-7 15-Nov-89	PR-7 13-Dec-89	PR-7 26-Jan-90	PR-7 26-Feb-90	PR-7 9-Mar-90	PR-7 12-Apr-90	PR-7 23-May-90	PR-7 21-Jun-90	PR-7 17-Jul-90	PR-7 28-Sep-90	PR-7 31-Oct-90	PR-7 26-Nov-90	PR-7 12-Dec-90	PR-7 18-Jan-91	PR-7 28-Feb-91	PR-7 27-Mar-91	PR-7 23-Apr-91	PR-7 16-May-91	PR-7 27-Jun-91
Alkalinity	mg/L						140					120	127					128									
Bicarbonate	mg/L											119	125					127									
Carbonate	mg/L											1.12	1.48					1.19									
Calcium	mg/L				34		34			31		37	40					32.8									
Chloride	mg/L	250	16	17	20	26	27	32	22	20	29	21	26	38	21	20	19	25	27	24	26	22	43		50	49	43
Conductance	uMHOS/CM		290	294	341	390	380	400	375	330	360	340	350	418	313	417	281	342	373	348	376	292	417	412	378	420	440
Color	TCU	15					3											3									
F/Cond	uMHOS/CM								236	224				275	220		213	225		225	219	232	421	421	428		
F/pH	UNITS		8	7.5	7.8	7.7	7.69	6.7	6.71	6.47	7.12		7.87	7.55	7.58	7.53	7.63	7.91		7.52	7.67	7.5	7.65	7.61	7.35		
F/Temp	CEL			9.4		0.3	11.1	9.4	8.5	8.5		8.5	8.3	10	9	10	10	9.8		9.2	8.5	8.5	7.8	9.1	9.5		
Hardness	mg/L				107.4		109.9			99.3		119	122					105									
L/Cond	uMHOS/CM															270											
L/pH	UNITS		8.1	7.9	8.1	8.1	8	8	8.6	7.8	8.1	8	8.1	7.9	7.7	8.07	7.36	8	7.8	7.8	7.8	7.82	7.8	7.7	7.58	7.7	7.9
Magnesium	mg/L				5.5		6.1			5.34		6.5	5.5					5.6									
Nitrate+Nitrite	mg/L						0.05											0.05									
NH3	mg/L																										
NH4	mg/L						0.07											0.06									
Ortho Phosphate	mg/L						0.1											0.01									
Potassium	mg/L						4.8					3.7	3.9					3.5									
Sodium	mg/L	200					36					24	28					27									
Silica	mg/L						11											11									
SO4	mg/L	500	10	9.5	27	10	21	15	17	9.8	13	14	13	17	15	28	12	9.5	18	13	12	12	14		12	17	17
Suspended Solids	mg/L											2	0.7														
Total Dissolved Solids	mg/L	500																									
Total Organic Carbon	mg/L						2											0.5									
Total Solids	mg/L											265	191														
Turbidity	NTU	5					0.4											0.13									

METALS	UNITS	Guidelines[1]	PR-7 25-Apr-89	PR-7 24-May-89	PR-7 23-Jun-89	PR-7 25-Aug-89	PR-7 21-Sep-89	PR-7 13-Oct-89	PR-7 15-Nov-89	PR-7 13-Dec-89	PR-7 26-Jan-90	PR-7 26-Feb-90	PR-7 9-Mar-90	PR-7 12-Apr-90	PR-7 23-May-90	PR-7 21-Jun-90	PR-7 17-Jul-90	PR-7 28-Sep-90	PR-7 31-Oct-90	PR-7 26-Nov-90	PR-7 12-Dec-90	PR-7 18-Jan-91	PR-7 28-Feb-91	PR-7 27-Mar-91	PR-7 23-Apr-91	PR-7 16-May-91	PR-7 27-Jun-91
Aluminum	mg/L				0.05		0.05			0.05	0.13	0.43	0.05		0.05			0.2	0.05	0.05							
Antimony	mg/L	0.006			0.05		0.05			0.05								0.05									
Arsenic	mg/L	0.025																									
Barium	mg/L	1.0			0.24		0.236			0.207								0.2									
Beryllium	mg/L				0.005		0.005			0.005								0.005									
Boron	mg/L	5			0.02		0.02			0.02								0.05									
Cadmium	mg/L	0.005			0.01		0.01			0.01								0.01									
Chromium	mg/L	0.005			0.03		0.01			0.01								0.01									
Cobalt	mg/L				0.01		0.02			0.01								0.01									
Copper	mg/L	1			0.01		0.01			0.01		0.06	0.01					0.03									
Iron	mg/L	0.3			0.07		0.11			0.02		0.14	0.04					0.05									
Lead	mg/L	0.01			0.05		0.05			0.05			0.002					0.05									
Lithium	mg/L																										
Manganese	mg/L	0.05			0.46		0.44			0.35		0	0.37					0.34									
Mercury	mg/L	0.001																									
Molybedium	mg/L																										
Nickel	mg/L				0.02		0.02			0.02								0.02									
Selenium	mg/L	0.01			0.1		0.1			0.1								0.1									
Silver	mg/L																										
Strontium	mg/L																										
Thallium	mg/L																										
Tin	mg/L				0.03		0.03			0.03								0.03									
Uranium	mg/L	0.02																									
Vanadium	mg/L				0.01		0.01			0.01								0.01									
Zinc	mg/L	5			0.05		0.05			0.01		0.07						0.02									

[1]**CDWQ** **Guidelines for Canadian Drinking Water Quality (April 2003)**

Denotes Exceedences

PRINCE MINE - GROUNDWATER METAL AND GENERAL CHEMISTY DATA - PR-7

GENERAL CHEMISTRY	UNITS	Guidelines[1]	PR-7 10-Jul-91	PR-7 23-Aug-91	PR-7 20-Sep-91	PR-7 15-Nov-91	PR-7 18-Dec-91	PR-7 31-Mar-92	PR-7 28-Apr-92	PR-7 21-Aug-92	PR-7 28-Sep-92	PR-7 28-Oct-92	PR-7 28-Jun-93	PR-7 27-Sep-93	PR-7 30-Mar-94	PR-7 29-Jun-94	PR-7 23-Sep-94	PR-7 16-Dec-94	PR-7 31-Mar-95	PR-7 30-Jun-95	PR-7 20-Dec-99	PR-7 17-Jan-00	PR-7 17-Jan-00
Alkalinity	mg/L				130					115.2						129.94	148.3				133	136	139
Bicarbonate	mg/L				129					115.2						129.82							
Carbonate	mg/L				0.48											0.12							
Calcium	mg/L				43.2					39					44.5	45.3	45.3	49.2		54.3	43.3	41.6	46.9
Chloride	mg/L	250	41.8	40.4	41.9	37.9	35.1	91.5	50.5	37.6	48.1	48.1			47.7	48.84	48.1	48.3		60.93	51	48	47
Conductance	uMHOS/CM		378	412	449	351	339	566	416	428	474	474				432	457	426		473	561	580	620
Color	TCU	15			3												5				11	17	6
F/Cond	uMHOS/CM									504	443	458	407	114	138	446	430	424	73	520			
F/pH	UNITS					7.81		7.33		7.61	7.78	7.49	7.08	7.38	6.46	7.28	7.9	5.8	7.18	6.64			
F/Temp	CEL							8.8		9.9	9.3	9.7		10.9	8.3	10.1	12.1	10	8.3	9.8			
Hardness	mg/L				135					125.39						139.26					141.48	132.7	156.68
L/Cond	uMHOS/CM							589															
L/pH	UNITS		7.93	7.9	7.6		7.72	7.3	7.6	7.5	7.4	7.4			7.7	7.6	7.9	7.8		7.9	7.7	7.6	7.7
Magnesium	mg/L				6.6					6.8					6.3	6.35	6.55	6.6		8.81	8.1	7	9.61
Nitrate+Nitrite	mg/L				0.05												0.32				0.02	0.02	0.02
NH3	mg/L																0.21				0.1	0.13	
NH4	mg/L				0.09																		
Ortho Phosphate	mg/L				0.01												0.02				0.01	0.01	0.01
Potassium	mg/L				4.3					4.3					3.8	3.86	4.12	4.3		5.78	4.2	5.18	4.21
Sodium	mg/L	200			40			60		23.5					25.9	27.6	36.3	27.5		32.3	34.1	35.7	47.9
Silica	mg/L				11.5												11.8				11.9	11.9	
SO4	mg/L	500	18	15	30	17	14	14	13.5	13.6	19.2	19.2			14.9	16.12	18.8	17.6		17.85	29.4	29.3	28.8
Suspended Solids	mg/L														0.5	0.5		3.3		0.5			
Total Dissolved Solids	mg/L	500													192	220		189		224	122.35	260.3	279.74
Total Organic Carbon	mg/L				0.5												1.6				1.2	2.9	2.8
Total Solids	mg/L																						
Turbidity	NTU	5			0.69												1.8				2	5	3
METALS	**UNITS**	**Guidelines[1]**	**PR-7 10-Jul-91**	**PR-7 23-Aug-91**	**PR-7 20-Sep-91**	**PR-7 15-Nov-91**	**PR-7 18-Dec-91**	**PR-7 31-Mar-92**	**PR-7 28-Apr-92**	**PR-7 21-Aug-92**	**PR-7 28-Sep-92**	**PR-7 28-Oct-92**	**PR-7 28-Jun-93**	**PR-7 27-Sep-93**	**PR-7 30-Mar-94**	**PR-7 29-Jun-94**	**PR-7 23-Sep-94**	**PR-7 16-Dec-94**	**PR-7 31-Mar-95**	**PR-7 30-Jun-95**	**PR-7 20-Dec-99**	**PR-7 17-Jan-00**	**PR-7 17-Jan-00**
Aluminum	mg/L				0.1					0.02						0.12	0.02				0.01		
Antimony	mg/L	0.006			0.05					0.01							0.01				0.001		
Arsenic	mg/L	0.025																			0.0005		
Barium	mg/L	1.0			0.221												0.14				0.195		
Beryllium	mg/L				0.005					0.01							0.1				0.001		
Boron	mg/L	5			0.1												0.01				0.04		
Cadmium	mg/L	0.005			0.01					0.01							0.01				0.001		
Chromium	mg/L	0.005			0.02					0.01							0.01				0.001		
Cobalt	mg/L				0.05					0.01							0.01				0.001		
Copper	mg/L	1			0.01					0.01						0.01	0.01				0.006	0.001	0.001
Iron	mg/L	0.3			0.03					0.11					0.2	0.22	0.05	0.07		0.59	0.23	0.427	0.308
Lead	mg/L	0.01			0.05					0.01						0.05	0.05				0.001		
Lithium	mg/L																				0.002		
Manganese	mg/L	0.05			0.43					0.4					0.6	0.64	0.24	0.56		0.86	0.635	0.779	0.913
Mercury	mg/L	0.001																			0.0001		
Molybedium	mg/L																				0.001		
Nickel	mg/L				0.02					0.01							0.01				0.001		
Selenium	mg/L	0.01			0.1					0.001							0.001				0.001		
Silver	mg/L																				0.001		
Strontium	mg/L																				0.413		
Thallium	mg/L																				0.001		
Tin	mg/L				0.05					0.01							0.01				0.001		
Uranium	mg/L	0.02																			0.001		
Vanadium	mg/L				0.01					0.01							0.01				0.001		
Zinc	mg/L	5			0.02					0.02						0.03	0.01				0.001	0.008	0.004

[1]CDWQ — Guidelines for Canadian Drinking Water Quality (April 2003)

(grey shading) Denotes Exceedences

PRINCE MINE - SURFACE WATER METAL AND GENERAL CHEMISTY DATA - JIM MacDONALD BROOK (U) - UP-GRADIENT

GENERAL CHEMISTRY	UNITS	Guidelines[1]	Jim MacDonald (U) 28-Apr-92	Jim MacDonald (U) 12-May-92	Jim MacDonald (U) 16-Jun-92	Jim MacDonald (U) 28-Sep-92	Jim MacDonald (U) 30-Nov-92	Jim MacDonald (U) 16-Dec-92	Jim MacDonald (U) 23-Apr-93	Jim MacDonald (U) 16-Dec-93	Jim MacDonald (U) 30-Mar-94	Jim MacDonald (U) 29-Jun-94	Jim MacDonald (U) 16-Dec-94
Acid	mg/L		5.9										
Alkalinity	mg/L												
Bicarbonate	mg/L												
Carbonate	mg/L												
Calcium	mg/L		3.2										
Chloride	mg/L		33	15.1	25.7							20.8	
Conductance	uMHOS/CM		164.6	83.3	119.5							92.8	
Color	TCU		0										
F/Cond	uMHOS/CM						148	137	66	108	109	84	142
F/pH	UNITS	6.5-9.0				7.18	4.25	4.62	4.77	4.22	4.33	3.13	5.9
F/Temp	CEL					12.4	4.1	2.1	1	3.9	0.3	14.2	1.5
Hardness	mg/L												
L/Cond	uMHOS/CM												
L/pH	UNITS	6.5-9.0	3.9	4	4.2	4.3	4.3	4.4	4.5	4.1	4.5	4.6	4.5
Magnesium	mg/L		3.5										
Nitrate+Nitrite	mg/L		0.09										
Nitrate	mg/L												
Ammonia	mg/L		0.03										
Ortho Phosphorous	mg/L		0.05										
Potassium	mg/L												
Sodium	mg/L		21										
Silica	mg/L		1.75										
Sulfate	mg/L		1.8	4	3.7								
Suspended Solids	mg/L		0.5	2	131.3	0.5	0.5	0.5	13	0.5	0.5	0.5	3
Total Dissolved Solids	mg/L		106	218.8								56	
Total Organic Carbon	mg/L		7.3										
Total Solids	mg/L					0.03							
Turbidity	NTU		0.6										

Metals	UNITS	Guidelines[1]	Jim MacDonald (U) 28-Apr-92	Jim MacDonald (U) 12-May-92	Jim MacDonald (U) 16-Jun-92	Jim MacDonald (U) 28-Sep-92	Jim MacDonald (U) 30-Nov-92	Jim MacDonald (U) 16-Dec-92	Jim MacDonald (U) 23-Apr-93	Jim MacDonald (U) 16-Dec-93	Jim MacDonald (U) 30-Mar-94	Jim MacDonald (U) 29-Jun-94	Jim MacDonald (U)
Aluminum	mg/L	0.005/0.1	0.27	0.23	0.22							0.64	
Antimony	mg/L		0.01										
Arsenic	mg/L	0.005	0.5			0.0001	0.0003	0.0001	0.0005	0.0001	0.0002	0.0003	0.0002
Barium	mg/L		0.03										
Beryllium	mg/L		0.01										
Boron	mg/L												
Cadmium	mg/L	0.000017	0.01										
Chromium	mg/L	0.0089	0.01										
Cobalt	mg/L		0.01										
Copper	mg/L	0.002-0.004	0.01			0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Iron	mg/L	0.3	0.38	0.26	0.3								
Lead	mg/L	0.001-0.007	1			0.01	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Lithium	mg/L												
Manganese	mg/L		0.8										
Mercury	mg/L	0.0001											
Molybedium	mg/L	0.73											
Nickel	mg/L	0.025-0.15	0.01			0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01
Selenium	mg/L	0.001	0.6										
Silver	mg/L	0.001											
Strontium	mg/L												
Thallium	mg/L	0.0008											
Tin	mg/L		0.01										
Uranium	mg/L												
Vanadium	mg/L		0.01										
Zinc	mg/L	0.03	0.03			0.03	0.02	0.01	0.01	0.02	0.02	0.07	0.03

Notes:

[1]**CCME** **Canadian Water Quality Guidelines for the Protection of Aquatic Life (Update 2002)**

(shaded) **Denotes Exceedences**

APPENDIX C

SITE PHOTOGRAPHS AND AERIAL PHOTOGRAPHS

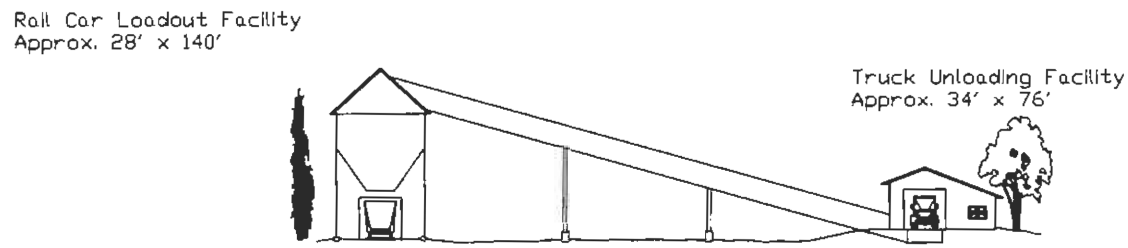
Oblique aerial photo of site.

Access road to proposed load-out facility location.

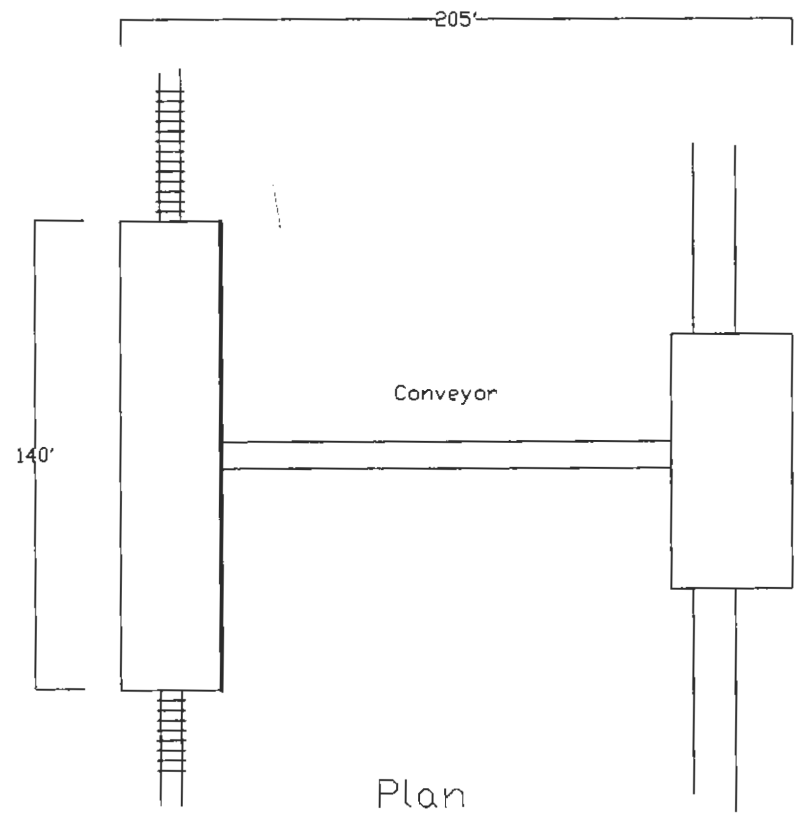
Proposed location of load-out facility.

Proposed location of load-out facility.

COAL LOADOUT FACILTY SKETCH AND PLAN



Profile



Plan

APPENDIX D

NOVA SCOTIA ENERGY STRATEGY
“SEIZING THE OPPORTUNITY” PART V COAL

Part V

Coal

Seizing the

Opportunity

Volume 2

Nova Scotia's Energy Strategy

NOVA SCOTIA

Part V Coal

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Coal

Statement of Principle

Recognizing that coal will remain the principal fuel for electricity generation in the near term, Nova Scotia will encourage the use of indigenous coal where environmentally and economically appropriate, promote reclamation mining in lands previously disturbed by mining, and encourage development of clean coal technologies.

Coal will continue to be a primary fuel source for North America and Nova Scotia in the foreseeable future. The current coal-fired thermal plants in Nova Scotia have a remaining economic life of between 5 and 20 years, and it is economically preferable that they continue to operate for the duration of their economic lives if this can be achieved in the context of environmental constraints. However, additional coal-generating capacity will depend on the development of economically feasible and technically efficient forms of clean coal technology that deal with concerns about both air pollutants and greenhouse gas emissions.

Nova Scotia still has significant reserves of coal in the ground. Coal mining, when done in an environmentally responsible manner, can provide significant economic benefits to the province and to the communities near the resource. Nova Scotia will continue to support the development of indigenous sources of coal where environmentally and economically feasible, and will encourage responsible surface coal development projects, particularly those that assist in the reclamation of land affected by historical mining.

Burning coal to produce electricity has environmental impacts. Technology can significantly reduce the emission of some harmful substances, and development work is underway to increase the scope and efficiency of these technologies. Nova Scotia will encourage and support research and development related to clean coal technologies that can lead to better environmental performance and increased cost efficiency.

Government Role and Responsibility

The province owns the coal resources in Nova Scotia. It acts as promoter of the resource to the private sector, maintains a geoscience database and resident expertise in matters related to coal geoscience, manages the exploration, development and mining of coal under a system of licences and leases, and collects royalties on coal production, all under the authority of the Mineral Resources Act. The province also regulates the environmental performance of coal mines through the Environment Act and matters related to occupational health and safety in mines through the Occupational Health and Safety Act, with the exception of the Cape Breton Development Corporation (CBDC) operations which are subject to federal regulations for occupational health and safety.

The province has a role to play in helping to provide for the reclamation of lands disturbed by coal mining, including enforcing reclamation, establishing and holding reclamation bonds, and encouraging reclamation mining, which can restore large tracts of land in Nova Scotia coalfields from an unsafe, variably derelict state to a productive state that can benefit the community.

The federal and provincial governments share responsibility for environmental standards related to air pollution through the Canadian Environmental Protection Act (federal) and the Environment Act (provincial). The federal government also has responsibilities under international agreements, such as the 1991 Canada-U.S. Air Quality Agreement, the 1994 UN-ECE Second Sulphur Protocol, and the Kyoto Protocol on climate change, as well as federal-provincial initiatives such as the Canada-wide Acid Rain Strategy Post-2000. The federal government is moving toward national standards for most air pollutants and is engaged with provinces and territories in a national process to determine the costs and benefits of ratifying the Kyoto Protocol and implementing its provisions. The province has a role to work with Ottawa in developing these standards and implementation plans.

Strategy Objectives

- To meet environmental air quality standards in economically efficient ways that minimize stranded costs.
- To support the development of indigenous coal sources for use in Nova Scotia where economically feasible and environmentally appropriate.
- To encourage land reclamation in present and former coal mining areas through reclamation mining, recovery of coal from previously disturbed mine sites, and restoration of the land following removal of the coal.
- To support the development of clean coal technology to enhance opportunities for coal use while managing environmental impacts on the atmosphere.

Actions to Achieve Objectives

2001-2005

- Work with Nova Scotia Power Inc. (NSPI) on its plans to meet environmental targets and on establishing the role for indigenous coal in future electricity generation in Nova Scotia.
- Work within the national climate change process to ensure that Nova Scotia's interests with respect to coal-fired thermal electrical generation are taken into account.
- Maintain an up-to-date, publicly available inventory of the province's coal resources, including available information on coal quality and parameters affecting its use and environmental impacts.
- Inform the public, through a public awareness campaign, of the value of coal mining and the opportunities it presents for land reclamation in and around communities, and local economic development.
- Ensure the orderly surrender of the CBDC mining lease.

- Establish a development plan for surface coal in the Cape Breton coalfield and a process to licence or lease the coal resources to new private sector operators.
- Work with CBDC to establish a reclamation plan for CBDC lands with environmental liabilities.
- Work with NSPI and Nova Scotia universities to monitor the existing technology and new developments in clean coal technology, and opportunities for research and development in Nova Scotia.
- Provide research and development credits for clean coal technologies that address environmental issues.

2006-2010

- Monitor research, and implement developments in clean coal technology.
- Monitor developments in alternate or unconventional means of coal utilization (e.g. *in situ* gasification).
- Encourage indigenous coal production, including reclamation mining in previously disturbed lands.

Links to Energy Strategy Themes

Developing clean coal technology, including methods to reduce CO_2 emissions, will allow Nova Scotia to meet environmental standards while continuing to maintain coal as a component in an increasingly diverse energy mix, thereby helping to **Secure our Future**. Requiring any new coal-fired plants to use clean coal technology to reduce emissions of pollutants and greenhouse gases, and encouraging reclamation mining to restore damaged lands to productive use and correct environmental problems related to past mining practices, will help **Improve the Environment**. By encouraging development of indigenous coal resources, we provide for continuing economic opportunity for our coal mining areas and reduce the export of jobs and money to offshore coal producers. In doing these, we help to **Power the Economy**.

Background

Nova Scotia's Coal Mining Industry

Coal is the dominant fuel for electrical power generation in North America and in the world. It is an abundant energy source, safe, often domestically produced, relatively stable in price, easily transported, and widely distributed and available. It is a lower-cost energy source than any other fossil or nuclear fuel alternative, and is thereby particularly suited for base-load power generation.

Coal mining is conducted in five provinces in Canada (British Columbia, Alberta, Saskatchewan, New Brunswick and Nova Scotia), with a total annual production of 75 million tonnes (t). In 2000, Nova Scotia produced approximately 1.1 million t, or 1.5% of coal production in Canada. Coal is consumed in each of the five producing provinces; Ontario and Manitoba, which do not produce coal, also consume significant quantities.

Nova Scotia's abundant coal resources have been used to fuel the industrial and economic growth of the province since coal mining started in Cape Breton in the 1720s. Between 1863 and 2000, more than 400 million t have been produced from the major coalfields of Nova Scotia which include:

- Sydney coalfield (Port Morien district, Glace Bay district, New Waterford district, Sydney Mines district, New Campbellton district),
- Inverness County coalfields (Port Hood, Mabou, Inverness, St. Rose-Chimney Corner),
- Pictou coalfield (Westville, Thorburn, Coalburn, Stellarton),
- Cumberland County coalfields (Springhill coalfield, Joggins-River Hebert coalfield),
- Kemptown-Debert coal area,
- Richmond County coal area, and
- Glengarry (Loch Lomond) coal area.

Between the early 1900s and the mid 1960s, Nova Scotia's annual coal production was between 4 and 6 million t, reflecting a strong demand from robust iron and steel, transportation, and energy industries within the province, as well as a significant coal export market. Although traditional markets declined in the 1960s, by the early 1970s a world oil crisis resulted in significant increases in fuel oil prices and renewed demand for coal. Concerns over the price and security of fuel supply for electrical power generation in the province led the provincially owned electrical utility to construct new coal-fired power generating plants, which provided increased coal markets for Nova Scotia's mining industry. The development of new mines in the Cape Breton coalfield (Prince, Lingan, Phalen) led to a strong coal supply in the province between 1975 and 1995. However, by the early 1990s, the original CBDC mines had closed or were approaching the end of their planned economic life. The corporation's newest mine, Phalen Colliery, experienced serious technical difficulties and eventually closed in 1999. In 2001 CBDC announced that it would close its last remaining underground coal mine, Prince Colliery, by the end of the year. These mine closures have resulted in a steady decline in the province's coal production since 1995. In 1996 NSPI started importing coal to meet its fuel requirements, only the second time in a century that coal was imported into Nova Scotia.

Nova Scotia depends on coal to fuel approximately 80% of its electricity generation. The value of coal mining to the province in 1999 was $103.5 million and the industry provided approximately 1,000 jobs. NSPI currently has the capacity to generate 1,238 MW from coal-fired generators in four locations (Table 1) that collectively represent an annual demand for about 2.8 million tonnes of coal. Coal generators typically are considered to have a useful life of about 40 years, and capital costs are amortized over this time period. The oldest units of the current NSPI coal generators have a remaining useful life of about 5 years (Trenton 5); the youngest, approximately 30 years (Point Aconi).

Table 1. NSPI Thermal Generation Capacities

NSPI power generating stations	No. units	Net Operating Capacity (MW)	Coal Consumed (t) *
Trenton #5 (coal)	1	150	400,0000
Trenton #6 (coal)	1	155	430,000
Point Tupper #2 (coal)	1	148	426,000
Point Aconi (coal) (petroleum coke)	1	165	189,000 (coal) 213,000 (coke
Lingan #1, 2, 3, 4 (coal)	4	620	1,663,000
Tufts Cove (heavy fuel oil/natural gas)	3	332	n/a
Total		1,228 (coal/coke) 332 (HFO/gas)	3,108,000 (coal)* 213,000 (coke)

*Coal consumption in 2000 was higher than normal (2.5-2.8 million t) due to high fuel oil costs to NSPI.

Nova Scotia's coal industry currently comprises seven small-scale, privately owned surface mines with a combined annual production of 300,000-400,000 t. The province's last underground coal mine, Prince Mine, closed in November, 2001 (Table 2).

Surface coal mines in Nova Scotia are typically small-scale operations. They provide jobs and economic activity for the community in which they operate, as well as the opportunity to remediate and reclaim lands that have previously been disturbed by mining. In many areas previous mining activities, both legal and illegal, have left a legacy of mine openings, subsidence, waste that can produce acid drainage, and abandoned infrastructure that render the land derelict. In many historically mined areas, there is a coal resource remaining near the surface that can be recovered by small surface mines. When the land is reclaimed after mining, this reclamation corrects not only the impacts of the recent mine but also the impacts of historical activities. Reclamation mining projects have the potential to reclaim large tracts of land disturbed by historical coal mining, and because the reclamation is carried out by the operator as part of the project cost, there is little or no cost to the province or the municipality.

Coal Resources

After 250 years of coal mining Nova Scotia still has significant indigenous coal resources that could be developed by conventional mining methods to supply the provincial coal demand. Some of these resources are identified in Table 3. This listing is not an exhaustive inventory. The largest single coal resource remaining in the province that can be mined by underground methods is the Donkin resource. A large number of available surface coal resources remain, many of which are in historically mined areas and provide opportunities for reclamation mining. Opportunities for reclamation mining are particularly prevalent in the Sydney coalfield, most of them areas included in the CBDC mining lease. These resources will return to the Crown when the corporation surrenders its lease, expected in late 2001 or 2002.

Table 2. Nova Scotia Coal Production, 2001.

Company	Mine	Operation Type	Ann. Capacity (t)
CBDC	Prince Mine (closed Nov. 2001)	underground colliery	1,500,000
Pioneer Coal Company (and related companies)	Stellarton Mine	reclamation open pit	210,000
	Evans Mine	reclamation open pit	50,000
	Coalburn Mine	open pit	50,000
	Thorburn	reclamation open pit	final reclam
Brogan Mining Limited	Little Pond	reclamation open pit	50,000
Cape Crushing Limited	Cape Crushing	reclamation open pit	24,000
Hill Reclamation Limited	Springhill	reclamation Railbed	14,000
Total			1,898,000*

*This value represents the cumulative annual capacity of all mines, not annual production.

It is possible that research now underway into unconventional methods of mining coal, such as *in situ* gasification, may in the future render feasible the development of coal resources that are too deep or of too low a quality to be considered for conventional mining. These coal resources could also be prospective for coal-bed methane. In the event that new mining technologies are developed that can exploit such resources, there are potentially much larger reserves in Nova Scotia than those summarized in Table 3.

Royalty

Nova Scotia's royalty rate for coal, prescribed in section 174 of the Mineral Resources Regulations (SNSN 1990 c.18) at $0.25/ton ($0.276/tonne), is the second-lowest in Canada. The province also collects revenue in the form of an annual mining lease rental fee, which mining companies pay for the privilege of maintaining "exclusive right" to the lease area for some specified period of time (usually 20 years). The mining lease rental rate in Nova Scotia is currently set in the Mineral Resources Regulations at $80/claim/year (1 claim = 40 acres, or approx. 16 ha).

Environmental Impacts

The use of any hydrocarbon for power generation carries an environmental cost. Specifically, burning coal produces emissions of sulphur dioxide (SO_2), particulates, nitrogen oxides (NO_x), carbon dioxide (CO_2), and trace metals that may include mercury, lead, and cadmium, depending on the composition of the coal. SO_2 and NO_x emissions contribute to acid rain, particulate matter and NO_x contribute to smog, and CO_2 is a greenhouse gas (GHG) believed to be a cause of global climate change. Trace metals (mercury in particular), NO_x, and particulates affect air quality and pose health concerns.

Table 3. Selected Nova Scotia Coal Reserves Suitable for Conventional Mining.

Coal Resources	Mining Method	Status	Reserves (million tonnes)	Sulphur (approx. %)	Ash (approx. %)
Prince Colliery (Point Aconi)	Underground	inactive, CBDC	15	3.5	12
Donkin Resource Block	Underground	inactive, resource available	>200	4.5	12
Sydney Coal Field	Surface (reclamation)	2 active, resource available	11.5	3-6	8-18
Pictou Coal Field	Surface (reclamation)	2 active, 1 complete resource available	5.3	0.8-3	12-30
Western Cape Breton	Surface (reclamation)	inactive	1.2	1-7	6-15
Springhill Coal	Surface (reclamation)	inactive, resource available	>2	1-3	10-15
Total underground			>215		
Total surface			>20		

The GHG emissions issue is currently being addressed by Canada's National Climate Change Process, by which the Canadian federal and provincial governments are assessing the opportunities and costs of ratifying the Kyoto Protocol. There are two opportunities for the release of GHG during the coal cycle: methane trapped in coal can be released to the atmosphere during mining, and burning coal emits CO_2. The continued use of coal for electricity generation may be affected by any steps that Canada eventually takes to address global climate change, or by any fiscal instruments that are enacted nationally to encourage GHG emission reductions.

Coal mining can create environmental benefits, including site reclamation and positive socio-economic impacts. It can also cause negative environmental impacts, including changes to surface water and groundwater, terrestrial and aquatic habitat loss, air pollution, noise pollution, and archaeological impacts. These environmental impacts can be minimized through proper planning and design.

Clean Coal Technology

Coal accounts for 38% of the electricity generated worldwide (more than double any other single fuel source) and more than half (56%) of the electricity generated in the United States, a figure that has remained fairly consistent over the last five years. Recent reports from the U.S. Department of Energy (DOE) suggest that by 2020 the United States may consume about 22% more coal than today. The recently released U.S. energy strategy includes the construction of 1,900 new power plants, many of which will be fired by coal.

The resurgence in coal generation in the United States, and the expected continued increase in demand for coal worldwide, is expected to encourage research and development of clean coal technologies. “Clean coal technology” is defined by the World Coal Institute as “technology designed to enhance both the efficiency and environmental acceptability of coal extraction, preparation and use.”

Many of these technologies are commercially viable and in use worldwide; others are still in research and development stages.

The scope of research into clean coal technology is worldwide and substantial. The U.S. DOE has leveraged funding of over US$5.3 billion for research into clean coal technology in the last 15 years, and the recent American energy strategy commits a further $2 billion in funding over the next 10 years. Clean coal technology research programs are prominently featured at a number of universities, and many developed countries that include coal in their energy mix sponsor clean coal technology programs. Industry associations also recognize the need for new clean coal technologies and are sponsoring research and development to improve existing technologies and develop new methods for meeting the environmental challenges of burning coal.

In general there are three types of opportunities for reducing emissions from conventional coal-fired generating plants:

- pre-combustion (e.g. using low-impurity coal and treating coal to remove sulphur, moisture, ash, and other impurities),
- combustion (e.g. high-efficiency burners and low-NO_x burners reduce emissions during combustion), and
- post-combustion (e.g. flu gas treatment using sulphur scrubbers or electrostatic precipitators to contain particulates).

Flue gas treatment methods and cleaner combustion technology have led to the substantial reduction of emissions from coal-fired power generation in the last 30 years. In the United States emissions of SO_2 have been reduced by 40% since 1970, even as coal consumption tripled. The unit emissions of sulphur pollutants have been reduced by more than 80%. This has been achieved by burning low-sulphur coals, using scrubbers to remove sulphur from the stack (flue-gas desulphurization), and increasing generating unit efficiency. Emission of particulates and other gases that affect air quality has also been reduced substantially.

The electricity generation industry has made significant gains in efficiency, which reduce the quantity of coal required to produce a unit of power, and consequently reduce emissions. Most of today's power plants burn pulverized coal, and achieve 33-38% thermal efficiency. Recently developed closed-cycle processes recover heat previously lost in exhaust gases and can increase efficiency to the 45% range. Generating unit designs using supercritical steam temperature technologies operate at efficiencies in the 42-45% range. In the future, the use of new advanced materials in coal-fired generating plants may enable efficiencies up to 55%.

Along with treatment methods to control emissions of conventional coal-fired plants, advanced coal combustion technologies have been developed. Fluidized-bed combustion, for example, in which the coal is mixed with a sorbent (usually limestone dust) prior to combustion in a bed fluidized on a stream of hot air, is the method used by the NSPI Point Aconi plant. Another promising technology is Integrated Coal Gasification Closed Cycle (IGCC), in which the coal is turned into a gas (syngas), which is combusted in a gas turbine. Heat is recovered from the gas turbine exhaust gas and used in a steam turbine generator, thus forming a combined cycle. The IGCC process substantially reduces emissions and operates at higher efficiency (approaching 45%) than typical pulverized-coal generating plants. Advances in gas turbine technologies have the potential to increase efficiency to levels above 50%. There are three commercial-scale IGCC demonstration plants now operating in the United States and four in Europe.

Research is also underway into the development of a closed cycle coal-coal gas hybrid system, in which the residual "char" after gasification of the coal is burned to produce steam. Efficiencies of over 50% may be achievable using this technology.

Significant research is being carried out to reduce greenhouse gas emissions from coal combustion. Increasing the thermal efficiency substantially reduces CO_2 emissions (an increase from 35% to 45% in thermal efficiency can typically reduce CO_2 emissions by 20-30%). Alternatives for reducing greenhouse gas emissions include capturing and storing CO_2 emissions from coal-fired generating stations and sequestering the gas, for example in geological formations.

Gasification of coal may eventually provide a source of hydrogen for fuel cell applications. As well, there has been some work done on *in situ* gasification of coal, primarily in Russia where the method is successfully employed. This may ultimately provide a means of recovering coal resources that are either too deep or too low quality to be recovered by conventional mining methods.

One interesting research program is the Zero Emission Coal Plant currently being researched by the Los Alamos National Laboratory and the Zero Emission Coal Alliance. The process involves the anaerobic production of hydrogen gas from a coal/water slurry, the hydrogen then being used to produce electricity in a solid oxide fuel cell. Excess CO_2 is captured and sequestered. Mercury, lead, arsenic, and cadmium are of concern in coal-fired flue-gas emissions. Concentrations of these and other metals vary substantially by coal seam and by coalfield. Electrostatic precipitators can recover over 95% of cadmium and arsenic, but are less effective for mercury. Fabric filters (baghouses) are effective in controlling some trace metals, particularly when sorbents are used. Wet scrubbers, in combination with sorbents, can also be effective in mercury capture. Cleaning coal before burning can also reduce the emissions of heavy metals.

The installation of clean coal technologies to reduce emissions and improve efficiency generally comes at a price: additional operating and/or capital costs. These costs may limit the use of the technologies in applications where cleaner burning fuels such as natural gas are available at a competitive cost. There will always be a trade-off between cost and emissions; however, expectations are that the next generation of clean coal power plants will cost significantly less than the early pioneers and, depending on the cost of other energy sources, the application of even the more expensive clean coal technologies may be economically viable.

Public Advice

Nova Scotians are aware of the importance of coal to our economy. The majority of respondents to questions about the future of coal in Nova Scotia's energy mix expressed the opinion that coal is still a competitive alternative to other fuel sources and that as long as environmental standards can be met, coal should remain part of the province's energy mix. Arguments included the desirability of maintaining a diversity of energy sources and the need to keep electricity costs stable. Many respondents also felt that we should attempt to maximize the use of local coal resources and look for alternative methods of using coal-as a source of coalbed methane for example. The importance of research and development in the field of clean coal technology was emphasized.

A number of respondents and submissions were not in favour of the continued use of coal to generate electricity, mainly because of the impacts of coal burning with respect to air pollution and greenhouse gas emissions. They pointed out that if one considers full life-cycle environmental and health costs, then coal may not be the most economic fuel.

Analysis

Worldwide, coal is by far the most abundant source of fossil-fuel energy. Proven global coal resources are widely dispersed geographically, and are estimated to hold more than 200 years' reserves at present production rates. In contrast, some 70% of oil and gas reserves are in the Middle East and the former Soviet Union, and can provide 45 to 60 years at current production rates. Coal prices are typically among the lowest of hydrocarbon fuels, and the widespread and abundant coal reserves provide for both price stability and long-term price efficiency.

Clean Coal Technology

Coal is likely to be a fuel of choice in many parts of the world for the foreseeable future, and it will continue to present significant environmental challenges for the planet. Recognizing the importance of coal to future energy needs, many countries have initiated measures to mitigate the environmental impacts by investing significantly in clean coal technology. Clean coal technology may be particularly important to Nova Scotia, because of the relatively high sulphur contents of some of our coal, and the possibility of future requirements to reduce greenhouse gas emissions from electricity generation. Application of clean coal technology could potentially allow indigenous fuel sources to continue to contribute to our energy future. Generating at least some of our electricity from coal-fired plants will contribute to the diversity and overall price efficiency of our generation sources.

The downside of implementing clean coal technology at present is cost and, in some cases, incomplete technology development. Installing new clean coal technology on an existing plant can represent a significant capital investment in a plant that may have a limited life span. In Nova Scotia, additional capital costs would have to be recovered through the utility's rate base, putting upward pressure on the price of electricity.

It is recognized that technological solutions for one problem can exacerbate another. For example, installing SO_2 scrubbers in a plant such as Lingan may decrease the overall efficiency of the unit, thereby increasing CO_2 emissions. Current action to reduce SO_2 emissions in such a facility might, therefore, conflict with future actions to reduce CO_2 emissions, potentially stranding the costs of the SO_2 scrubbers, with attendant overall cost to the utility and, eventually, to consumers.

Technology to clean up the pollutants is available and, though currently expensive, likely to become cheaper as the technology finds increasingly wider application. For example, the Point Aconi plant is a fluidized-bed unit that can burn high-sulphur fuel with minimal SO_2 emissions. Clean coal technology is currently the subject of intensive research and testing, particularly in the United States, Japan, and Europe, and several large plants are under construction. However, technology to capture and sequester the greenhouse gasses is not as advanced, and economic solutions to the release of GHG are probably still some distance in the future. Proven, cost-competitive technology will be required to address all air issues related to coal-fired generation, both pollutants and GHG. For Nova Scotia to meet its environmental goals, new coal-fired generation in the province will require such technology.

Alternatives

The most economically efficient option for the existing coal-fired generation plants is to allow them to operate to the end of their economic life cycle. Early retirement of any coal-fired unit would result in stranded costs, the magnitude of which would depend on the size of the unit and the length of its remaining life. Any such action would also require early capital costs for construction of new generation capacity to replace the lost units. Adding these costs to the utility's rate base would translate into upward pressure on electricity rates. Similarly, converting coal-fired units to alternative fuels such as natural gas would be both capital intensive and potentially more expensive with respect to the fuel source. Natural gas is most competitive when it is used in specially designed and built combined-cycle plants rather than converted coal plants. Therefore, even a staged and planned move from coal to natural gas would result in additional costs rather than savings to energy consumers.

Nonetheless, action is required with respect to air emissions from coal-fired thermal plants. The measures in the energy strategy will make a real difference to our environmental performance, providing a clear signal that Nova Scotia takes its responsibilities seriously and expects other jurisdictions to do the same. The targets can be met without forcing either early closure or major new capital expenditures on the utility. Reductions in air contaminants can be accomplished by a combination of switching to cleaner-burning gas where feasible and using imported coal that contains less sulphur and generates lower levels of air contaminants than many indigenous coals.

The principal uncertainty in this scenario is the national climate change process which may mandate actions to meet national greenhouse gas emission-reduction targets. Any actions to reduce GHG in Nova Scotia will necessarily involve significant changes to the way we generate our electricity. Any steps that the federal government takes to reduce GHG emissions nationally will certainly affect the Nova Scotia economy, because generation of electricity by coal burning is a significant emitter of GHG. It is critical that the province continue to work within the national climate change process to ensure that the burden of national targets for GHG reductions is shared fairly across jurisdictions, and that Nova Scotia's interests are protected in any such process. Actions to reduce GHG emissions should, if possible, be staged so as to take full advantage of the natural economic cycle of the current coal-fired generation plants and, to the extent possible, minimize upward pressure on utility electricity rates.

Research and Development

Nova Scotia is unlikely to be a major player on the global stage of clean coal technology. However, any long-term future for coal in the Nova Scotia electricity industry, particularly new investment in coal generation (whether re-powering of existing generators or construction of new capacity), will depend on the development and implementation of appropriate technology to allow the industry overall to meet the province's economic and environmental goals. In the short term, the province should develop and support a capability in targeted research areas that can contribute to the development of these technologies, particularly areas that can directly benefit Nova Scotia. This could be done through making use of existing expertise in Nova Scotia universities, supported by public and private sector partnering, and incentives for clean coal research and development. In the longer term, the province must continue to monitor international efforts in this area and promote the use of any new technology that can contribute to environmental goals. To ensure opportunities to maintain coal as part of a diverse energy mix, our longer-term goals must allow for the flexibility to incorporate new technology when it is environmentally and economically feasible.

Indigenous Coal

Until fairly recently, Nova Scotia was self-sufficient in coal. This is no longer the case. Nonetheless, there are still opportunities for coal mining to contribute to the province's economy and to community development over the short and medium terms. Environmental targets should not be relaxed in favour of indigenous coal, nor should government financially support non-economic mining operations. However, where coal mining can provide a net benefit to the province and to the communities where it occurs, and where it is economically feasible and environmentally appropriate, the province will facilitate business opportunities in this sector.

An important factor in planning for the optimum utilization of the coal resource in the province is knowledge of its extent, quality, and characteristics. The province already has developed a significant geoscience database and in-house expertise on its coal resources. This database will be maintained, enhanced where necessary, put in digital format to the extent practical, and made available to any member of the public who requires information on the province's coal resources.

A second important factor is public acceptance of the continuation of a coal mining sector in Nova Scotia. The general public and community development agencies should be aware of the opportunities and benefits offered by coal mining. To this end, the province will renew public education and awareness initiatives.

Any future coal mining industry needs a regulatory regime that is fair, efficient, and non-discriminatory. The Department of Natural Resources already works cooperatively with the Department of Environment and Labour through the one-window process to expedite the processing of permits for mining operations. Government will continue to try to find ways to ensure that the regulatory regime meets the needs of industry, while protecting the environment and the safety of workers and the general public. The province has a role in this process to address public concerns with unbiased advice and technical information.

Probably the most significant opportunity for change in the mining sector will occur when the CBDC mining leases are surrendered to the province, expected in late 2001 or 2002. One significant remaining coal resource remains that can be mined by underground methods (the Donkin Block) and a number of coal seams could be recovered through surface mining. The province will develop a strategic plan and manage the process by which exploration licences and mining leases for the former CBDC lands can be granted. The plan will aim for maximum utilization of the remaining resource.

With the cessation of operations by CBDC, significant environmental liabilities will remain throughout the coalfield. The province is determined that CBDC and the federal government address these liabilities as part of their closure of CBDC operations. The parties have been meeting to reach agreement on which sites require remediation, and the extent of CBDC's responsibility. The province will continue to work to ensure that remediation of these lands is done properly, and to standards acceptable to the province.

Nova Scotia coal producers currently pay among the lowest coal royalties in Canada. In a national context, there is room for increasing coal royalties to a level that would give the province a return on the resource in line with other provinces. Increasing coal royalties to levels currently in place in Alberta and British Columbia (i.e., doubling the current Nova Scotia rate) would result in a net increase in revenue to the province of about $75,000 at anticipated (2002) production rates. Increasing them to comparable levels for Saskatchewan (quadrupling the Nova Scotia rate) would increase revenue by about $225,000.

It is recognized that most coal mined in Nova Scotia is sold to NSPI for electricity generation and increases in royalties can be passed on to the utility. Because the Utility and Review Board has traditionally considered such costs to be valid components of the utility's rate base, significant extra royalties on coal could result in upward pressure on electricity rates. As well, an increase in the royalty rate for domestic coal might result in a price disadvantage compared with imported coal, which currently supplies about half of Nova Scotia's demand. The higher royalties could return significant revenue to the province. If a significant coal industry with export potential develops, this policy should be reconsidered.

The legacy of 250 years of coal mining in Nova Scotia includes a large number of sites that have been left in a non-productive state following cessation of mining. In some cases, the land is not only derelict but hazardous, as a result of openings, acid-generating or metal-bearing waste, and near-surface subsidence. Whether legal or "bootleg" many operations have left land that cannot be used productively in its present state. There are now good examples of surface mining, where a company has recovered a remaining coal resource and in the process of reclaiming the land after mining, has returned derelict land to a productive state. This is a good model for environmental remediation. Everyone gains: the operator is able to recover a coal resource that would otherwise not contribute to the province's and the community's benefit, with accompanying direct and indirect jobs and spin-off economic activity; the community gets newly productive land and is relieved of the liability of potential hazards; and government gets royalties for the recovered mineral.

The province encourages reclamation mining, will facilitate this activity where economically, socially, and environmentally appropriate, and will consider reclamation potential as a determinant when processing tenders for coal resources in the province.

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APPENDIX E

NOVA SCOTIA MUSEUM - ENVIRONMENTAL SCREENING INFORMATION

5009 0A

NOVA SCOTIA

Tourism, Culture & Heritage

Heritage Division

1747 Summer Street
Halifax, Nova Scotia
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Dartmouth

DEC 1 7 2004

Memorandum

TO: Heather Sutherland
MGI Limited

FROM: Bob Ogilvie

RE: **Environmental Screening 04-11-22 (50090A)**
Boularderie Island

DATE: December 15, 2004

Further to your request of November 22, 2004, staff of the Heritage Division have reviewed their files for reference to the presence of known botanical resources in the study area. Please be aware that our information is not comprehensive, in that it is incomplete and of varying degrees of accuracy with respect to the precise location and condition of heritage resources.

It should be noted that the amount and degree of disturbance from previous developments could have a significant role in establishing the presence, absence or condition of heritage resources in this area.

Archaeology

This large area has one recorded pre-contact First Nations archaeological either on or near the eastern border of the study area (attached plan). There is a high probability that other First Nations sites are, or were, located within the study area. It is difficult to definitively establish the potential for post-contact archaeological resources at this location.

We suggest that an archaeological impact assessment should be conducted consisting of the following components:

a) determining the archaeological potential for the various landform components within the study area,
b) background documentary research to determine the potential for significant Post-Contact Period archaeological resources, and
c) archaeological fieldwork to locate archaeological resources present.

A Mi'kmaq traditional knowledge study would provide additional information on First Nations use of the area.

Natural Heritage

The staff of the Nova Scotia Museum of Natural History have reviewed their records and make the following observations:

Zoology

Staff suggest the proponent refer to the baseline documents generated for the Point Aconi Power Generation project for a comprehensive definition of species and species assemblages within or near the study area.

From the supplementary zoological perspective we offer the following new information that has been generated since that project was undertaken.

Marine intertidal habitats along the coastline under consideration may harbour the marine bristletail, (*Petrobius brevistylis*) - reported from only a handful of sites within Nova Scotia.

The following three uncommon species are noted from adjacent areas relating to the Sydney River. They are not recorded from the study area, but should be noted in any discussion of the site under consideration.

The freshwater Isopod (*Caecidotea communis*)
Delicate Lamp Mussel (*Lampsilis ochracea*)
Yellow Lamp Mussel (*Lampsilis cariosa*)

The following nesting bird species of concern are reported from habitats near the proposed site:
Bobolink (*Dolichonyx oryzivorus*)
Atlantic Puffin (*Fratercula arctica*)
Razorbill (*Alca torda*)
Merlin (*Falco columbarius*)
Osprey (*Pandion haliaetus*)
Leach's Storm Petrel (*Oceanodroma leucorhoa*).

The presence of freshwater wetland habitats within this area provides habitat for a number of species of Dragonflies and Damselflies. There are currently 13 species of dragonflies and damselflies listed in Nova Scotia with elevated status indicating heightened conservation concern, These habitats should be investigated for the presence of such species.

We do not offer any comments on potential marine species that may be impacted, but note that any development that may impinge on marine habitats may have a direct or indirect impact on a suite of other species be they marine fish and invertebrates, to marine mammals.

Botany

The following plant species-at-risk are known form the proposed area within the boundary given (marked with an *), or adjacent to it. Their provincial status rank is also shown, with Red-listed species being of the highest priority. The plants' presence/absence should be ascertained prior to development and during their growing season.

Asplenium viride Yellow-listed
**Cardamine parviflora, var. arenicola* Red-listed
Cypripedium calceolus Yellow-listed, 2 vars.
Cypripedium reginae Red-listed
Isoetes acadiensis Yellow-listed
**Isoetes prototypus* Red-listed
Lobelia kalmii Yellow-listed
Ophioglossum pusillum Yellow-listed
Potamogeton zosteriformis Yellow-listed
**Senecio pseudo-arnica* Yellow-listed

Special Places or Ecological Reserves
There are no designated protected natural areas or known candidate ecological sites within the study area.

I have attached an invoice for the staff time spent reviewing our records and compiling this response.

If you have any questions, please contact me at 424-6475.

NOVA SCOTIA

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Tourism, Culture & Heritage

Heritage Division

Memorandum

TO: Heather Sutherland
MGI Limited

FROM: Bob Ogilvie

RE: **Environmental Screening 04-11-22 (50090A)**
Boularderie Island
Revision to Archaeological Response

DATE**:** April 4, 2005

Further to your request of November 22, 2004, staff of the Heritage Division reviewed their files for reference to the presence of known heritage resources in the study area. It has come to my attention that the archaeological information was not accurate, as the archaeologist inadvertently referred to the wrong site file. The following revision should replace that included in my earlier response. I will copy this to Bruce Stewart, Cultural Resource Management, for his information.

Archaeology

This large property has one recorded 18C. archaeological site, the Boularderie Brothers ca. 1732 settlement. This settlement supplied fish and lumber to Louisbourg until it was burned in about 1747. It is located near the eastern border of the study area at Alder Point. In 1973, Royal Ontario Museum archaeologist Donald Webster noted structural features from this establishment.

An archaeological impact assessment should be conducted consisting of the following components:

a) determining the archaeological potential for the various landform components within the study area,
b) background documentary research to determine the potential for other Pre-Contact and Post-Contact Period archaeological resources, and
c) archaeological fieldwork to locate archaeological resources present.

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Heritage Division

A Mi'kmaq traditional knowledge study would provide additional information on First Nations use of the area.

We apologize for any complications that may have arisen from our earlier response. If you have any questions, please contact me at 424-6475.

APPENDIX F

ARCHAEOLOGICAL SCREENING INFORMATION

PIONEER COAL LIMITED

POINT ACONI OPEN PIT MINE
CAPE BRETON REGIONAL MUNICIPALITY
ARCHAEOLOGICAL SCREENING

ARCHAEOLOGICAL SCREENING REPORT

Submitted to:
Pioneer Coal Limited
and the
Heritage Division - Nova Scotia Museum

Prepared by:
Cultural Resource Management Group Limited
6040 Almon Street
Halifax, Nova Scotia
B3K 1T8

Consulting Archaeologist: W. Bruce Stewart
Report Preparation: Mike Sanders & W. Bruce Stewart

Heritage Research Permit Number A2005NS41

CRM Group Project Number: 2005-0005

MAY 2005

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POINT ACONI OPEN PIT COAL MINE
ARCHAEOLOGICAL SCREENING

1.0 INTRODUCTION

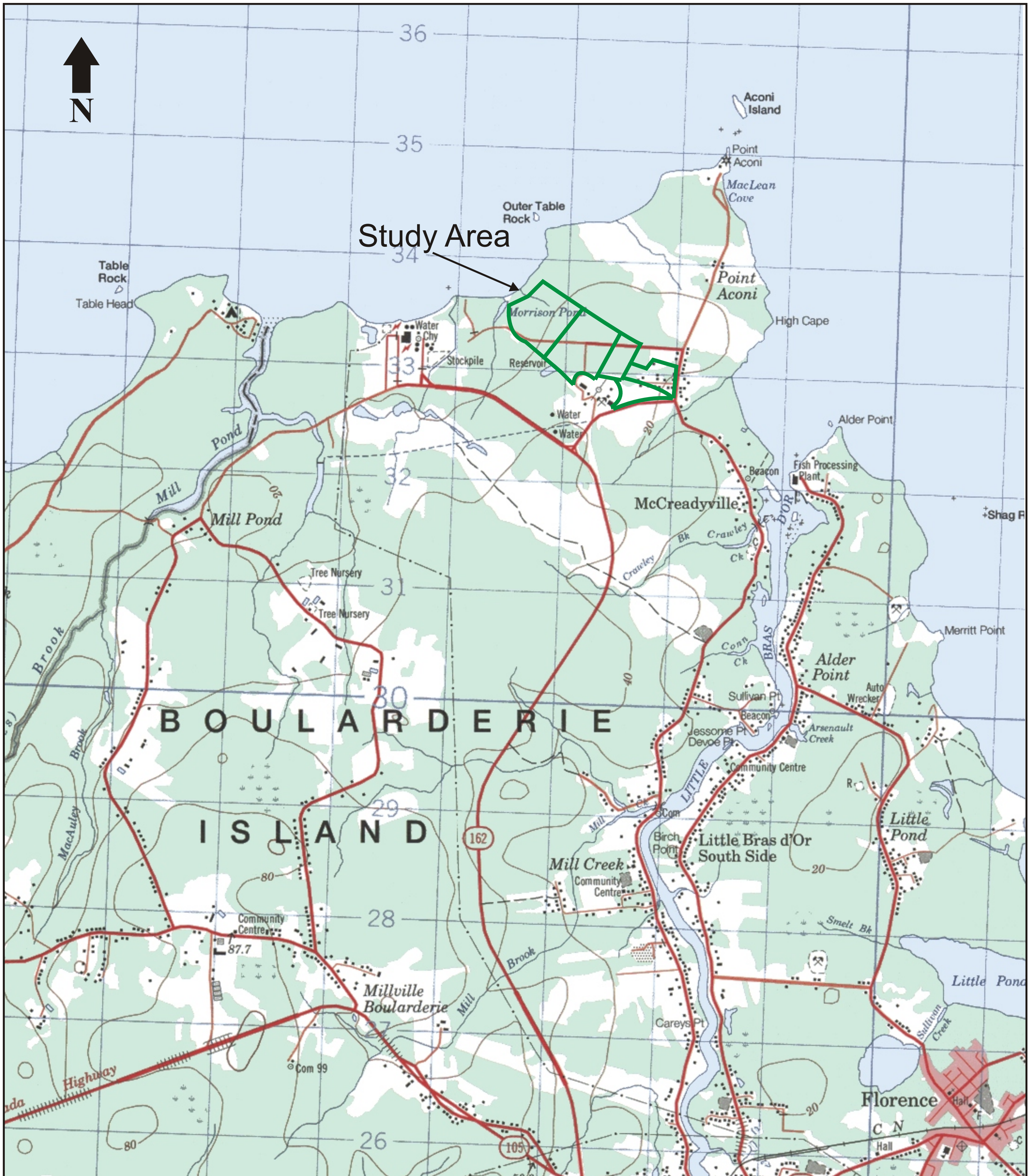
Pioneer Coal Limited is planning to undertake a surface coal mine and reclamation project at the Prince Mine site in Point Aconi, Cape Breton Regional Municipality (CBRM). In preparation for permitting, MGI Limited also directed an environmental screening of the proposed impact area. Cultural Resource Management (CRM) Group was retained by MGI Limited in January, 2005 to undertake an archaeological screening as part of the overall environmental screening. The goal for CRM Group was to evaluate archaeological potential within the proposed development limits by conducting archival research and on-site visual assessment.

The archaeological screening was conducted according to the terms of Heritage Research Permit A2005NS41 (Category "C"), issued by the Heritage Division - Nova Scotia Museum (HD-NSM) to W. Bruce Stewart, CRM Group President and Senior Consultant. This report describes the screening, presents its results and offers resource management recommendations.

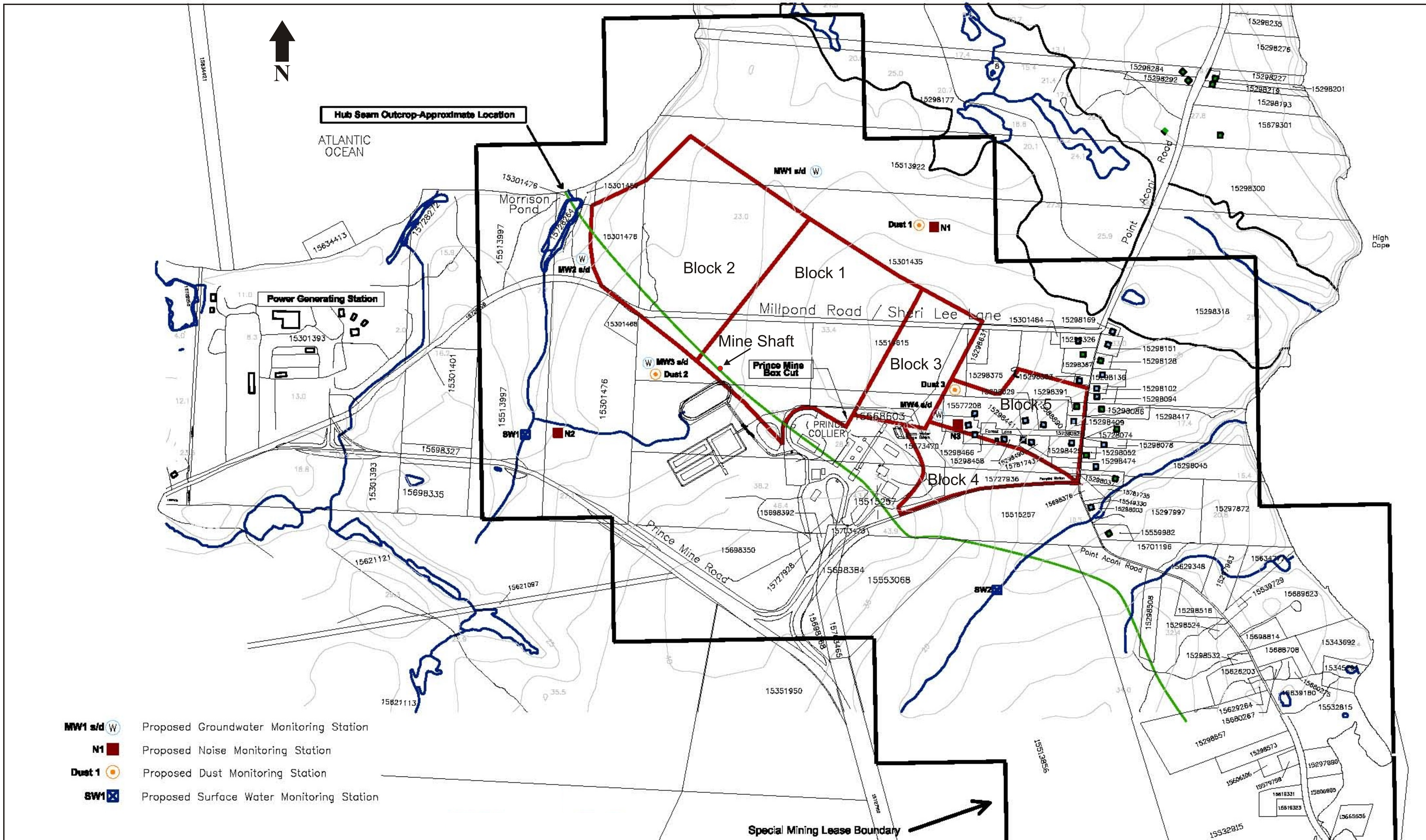
2.0 STUDY AREA

The proposed development area at Point Aconi is located north of the existing Prince Colliery and east of the Point Aconi Generating Station, between the communities of McCreadyville and Point Aconi (***Figure 1***). The 75 hectare study area addressed by the archaeological screening consists of five contiguous mining blocks, which together extended approximately 1.7 kilometres east/west by 450 metres north/south (***Figure 2***). This area is bounded on the east by Point Aconi Road and on the south by the existing Prince Colliery facility and the Hub Seam outcrop. The western boundary lies approximately 50 to 75 metres east of Morrison Pond and the nearby ocean shoreline.

Mining Blocks 1 to 3 constitute the majority of the study area and lie northwest of Prince Colliery. These blocks are largely wooded, but can be easily accessed by following Sheri Lee Lane / Mill Pond Road, which passes through the study area on an east/west alignment. Block 5, at the east end of the study area, is more open and consists primarily of private residences and their associated yards. Forest Lane provides easy access to Block 5 off of Point Aconi Road. Block 4, immediately to the south, consists of a fallow field that extends northward from the edge of Millpond Road.



CRM Group Cultural Resource Management Group Ltd.	*Location of Study Area*	*Figure 1*
	POINT ACONI OPEN PIT MINE ARCHAEOLOGICAL SCREENING REPORT POINT ACONI, CAPE BRETON REGIONAL MUNICIPALITY	May 2005 1:50 000



CRM Group

Study Area

POINT ACONI OPEN PIT MINE
ARCHAEOLOGICAL SCREENING REPORT
POINT ACONI, CAPE BRETON REGIONAL MUNICIPALITY

Figure 2

May 2005

Scale in metres

0 50 150 300 400 500

3.0 METHODOLOGY

The archival research component of the archaeological screening was designed to explore the land use history of the study area and its environs, providing the information necessary to evaluate the property's archaeological potential. To achieve this goal, CRM Group utilized the resources of Cape Breton University's Beaton Institute (BI) in Sydney and several provincial facilities in Halifax. Copies of historic maps were obtained from BI, the Department of Natural Resources Library and the Public Archives of Nova Scotia (PANS). Historic documents and written histories examined at BI and PANS also proved to be useful. Records of previous archaeological discoveries in the Point Aconi area were noted using Maritime Archaeological Resource Inventory information provided by the HD-NSM. Modern maps (1:10 000 and 1:50 000 topographic) and aerial photographs (1993 and 1999) were obtained at the Provincial Land Information Centre. Earlier aerial photographs (1931) were examined at the Department of Natural Resources Library.

Fieldwork consisted of a brief visual inspection of the study area conducted on May 10 by CRM Group archaeologists Mike Sanders and Ben Pentz. This limited pedestrian survey utilized and remained restricted to the network of existing permanent roads, abandoned roads and power line corridors that criss-cross the study area. The ground search did not involve sub-surface testing. The researchers were watchful for topographic or vegetative anomalies that might indicate the presence of buried archaeological resources. The process and the results were documented in field notes and photographs.

4.0 RESULTS

4.1 Background Research

HD-NSM records indicated that there are no recorded archaeological sites within the study area, but that the area had not previously been subjected to archaeological investigation. The nearest reported archaeological site is CbCb-1, a French settlement established by Antoine le Poupet de la Boularderie prior to 1730.

The registered portion of the Boularderie site is located on the east side of the Little Bras d'Or on Alder Point. There, Boularderie built his own house and oversaw the establishment of a small group of fishermen's houses, cowsheds, stables and a large area of cultivated fields (Dawson 1988:56). An eighteenth century map of the settlement (Boucher 1742) indicates that the majority of the settlement was, however, situated on terraces on the west side of the Little Bras d'Or - hence the name Boularderie Island. None of the settlement's features are depicted within the study area. The nearest feature is a coal mine located on the channel shore approximately 650 metres east of the study area and about 250 metres south of the tip of High Cape. The location of this mine is confirmed by maps made later in the century (Anonymous n.d. [c. 1750s]; Miller 1794).

French occupation at Boularderie is believed to have ended in 1747 when the settlement was burned (Dawson 1988:56; Ogilvie 2005).

The eighteenth century map of the Boularderie settlement also indicates the presence of a Mi'kmaq encampment on the east bank of the Little Bras d'Or opposite the Conn Creek outlet (Boucher 1742), approximately 2.3 kilometres southeast of the study area. That site and other water-side locations close to the study area were likely inhabited by the Mi'kmaq long before the arrival of the French. In contrast, the lands within the study area, being set back from the shore, are considered to have low potential for either Precontact or early historic First Nations archaeological resources.

Available historic maps dating from the mid 1700s to the mid 1800s do not depict any settlement or even road development within the study area (Anonymous 1751; Anonymous c. 1750s; Miller 1794; MacKay 1834; Wyld 1845). The entire study area remained Crown Land until l833. In that year, Richard Smith, who later became Mining Engineer for the General Mining Association (GMA), was granted a 100 acre lot across the known coal seam at Point Aconi (Grant Book R, page 46). Much of this large lot is still intact as PIN 15301435. The adjacent 50 acre lot to the north (now PIN 15513922) was granted directly to the GMA in the following year.

Sometime before 1857, the GMA established exploratory mines at Point Aconi that yielded a few hundred tons of coal a year (Horsnby 1992:98). Presumably located on the Smith or GMA properties, north of the Millpond Road / Sheri Lee Lane alignment, these small mines were likely situated near the east coast to facilitate coal transportation. Inland road development was probably still insufficient for the creation of mines within the study area.

By 1877, Point Aconi Road, Millpond Road / Sheri Lee Lane and Forest Lane were all established in their present alignments (Church 1877). Mill Pond Road / Sheri Lee Lane developed along the southern border of the old Smith lot. A 94 acre lot on the south side of this boundary (including PIN 15514615 and PIN 15298391 within the study area), was previously granted to James Bonner, in 1843 (Grant Book X, page 23).

The next parcel to the south, which now includes part of the Prince Colliery facility and the lots around Forest Lane, was granted to John Forest in 1843 (Grant Book Y, page 22). On Church's map, published in 1877, a residence labelled "J. Forest" is depicted on the north side of Forest Lane, within Block 5 of the study area (Church 1877). This appears to correspond with an older house that still stands at PIN 15577208. Also on the 1877 map and within Block 5 is the residence of "G. Stubbert", on the south side of the lane. This appears to correspond with the older house that still stands at PIN 15298458. The map also depicts the residence of "J. Stubbert" at the historic west end of the lane. That site, well beyond the current limit of the *cul-de-sac*, was vacant in 1931 (aerial photograph) and was later completely impacted by the development of the Prince Colliery.

The property constituting the west corner of Block 2 (PIN 15301476), near Morrison Pond, remained Crown Land until 1868, when it was granted to Boularderie Island farmer Murdoch Battleman (Grant Book 38, page 8263). Lying beyond the limits of the GMA grants and at least 50 metres from the coal seam exposure on the Point's western shore, this area was not likely affected by commercial mining developments in the 1700s or 1800s.

4.2 Field Investigations

Field reconnaissance revealed that the ground surface in Blocks 1 to 3, on either side of Mill Pond Road / Sheri Lee Lane, is riddled with small coal pits. Too small to be part of any commercial mining operation, these "boot-leg" surface mines are typically shallow (less than 2 metres deep) and just a few metres in diameter. However, one boot-leg mine, located a short distance north of the Prince Colliery reservoir, is about 30 metres in diameter. The presence of targets and bullet casings indicate that this pit has recently been used as a gun range (***Plate 1***). The mine features are most abundant near roads and trails, either active or abandoned (***Plate 2***). Many have been used as repositories for refuse, building materials and even automobiles. Most

PLATE 1: **Large coal pit south of Millpond Road / Sheri Lee Lane. Facing west.**

PLATE 2: **Abandoned road and adjacent coal pits north of Millpond Road / Sheri Lee Lane. Facing south.**

have been at least partially in-filled - many with the spoil from the subsequent excavation of adjacent pits. Virtually all are obscured by forest growth.

An infilled mine shaft was found near the southwestern corner of Block 1, approximately 50 metres northeast of the Prince Colliery reservoir, on the east side of a prominent trail off of Millpond Road / Sheri Lee Lane (***Figure 2***). The shaft opening, largely concealed by forest litter and the decayed remains of a log cover or cap, is less than a metre in diameter and is braced on all sides by a cribwork of vertical and horizontal logs (***Plates 3 & 4***). The shaft appear to have been in-filled with sediment to within a metre of the surface.

This mine shaft is not considered to be an archaeological feature. Its cribwork is largely intact and unlikely to predate the twentieth century.

Visual inspection of Block 5, from Point Aconi Road and Forest Lane revealed no evidence of significant heritage resources. The "J. Forest" and "G. Stubbert" residences that appear on Church's 1877 map are likely still standing at PIN 15577208 and PIN 15298458, respectively (***Plates 5 & 6***). Both houses have steeply pitched roofs and high facades typical of 1860s or 1870s construction. Neither appear likely to have been built c. 1845 when the encompassing historic property was granted to John Forest. If John Forest did build within the study area c. 1845, it was likely at the original western terminus of the lane bearing his name - an area that is now completely disturbed by the construction of the Prince Colliery facility.

Visual inspection of Block 4 from Millpond Road revealed that the entire block has been heavily impacted by modern landscaping (***Plate 7***).

PLATE 3: **Mine shaft near Prince Colliery reservoir, south of Millpond Road / Sheri Lee Lane. Facing northeast.**

PLATE 4: **Mine shaft near Prince Colliery reservoir. Facing north.**

PLATE 5: Possible "J. Forest" residence (PIN 15577208), depicted on 1877 map. Facing northwest.

PLATE 6: Possible "G. Stubbert" residence (PIN 15298458), depicted on 1877 map. Facing northwest.

PLATE 7: Modern landscaping in Mining Block 4 (right). Facing west.

5.0 CONCLUSIONS AND RECOMMENDATIONS

On the basis of the archaeological screening program, which combined archival research and limited field reconnaissance, low archaeological potential is ascribed to the entire Point Aconi Open Pit Mine study area, as defined in this report. The development of Mining Blocks 1 to 5, as currently planned, is not likely to affect significant archaeological resources.

Based on that result, CRM Group offers the following management recommendations for the study area:

1. Given the low archaeological potential ascribed to Mining Blocks 1 to 5, it is recommended that they be cleared of any further archaeological investigation prior to development.

2. In the event that archaeological deposits or human remains are encountered during construction, all work in the associated area(s) should be halted and immediate contact should be made with the Nova Scotia Museum (David Christianson: 424-6461).

6.0 REFERENCES CITED

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Boucher

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APPENDIX G

MI'KMAW KNOWLEDGE STUDY STATUS REPORT

Status Report: Mi'kmaw Knowledge Study

Point Aconi Mine Development

Prepared for Pioneer Coal Ltd.

The Confederacy of Mainland Mi'kmaq
Mi'kmaq Environmental Services

May 2005

INTRODUCTION

Mi'kmaq Environmental Services (MES) is a program of the Lands, Environment, and Natural Resources section of The Confederacy of Mainland Mi'kmaq (CMM). CMM is a Tribal Council that provides advisory services to six Mi'kmaw communities in the province of Nova Scotia – the Paq'tnkek First Nation, Annapolis Valley First Nation, Bear River First Nation, Glooscap First Nation, Millbrook First Nation, and Pictou Landing First Nation. The six chiefs of the member communities form CMM's Board of Directors.

CMM is pleased to submit a status report for the ongoing preparation of a Mi'kmaw Knowledge Study for the Point Aconi Mine Development upon the invitation of MGI Ltd. on behalf of Pioneer Coal Limited. A proposal was submitted to MGI Ltd. in December, 2004 with work commencing in early January 2005. This status report describes the purpose and scope of the Mi'kmaw Knowledge Study (MKS), methodology, provides a summary of work to date.

BACKGROUND

Governments and industry are increasingly aware of the need for Mi'kmaw Knowledge Studies for major projects in Nova Scotia. MKS benefit proponents, government, and the Nova Scotia Mi'kmaq by identifying potential interactions between projects and Mi'kmaq land and resource use and constitutional rights. MKS have been completed for several projects in Nova Scotia including transportation, mining, and oil and gas projects.

DESCRIPTION OF MKS

The purpose of the Mi'kmaw Knowledge Study is to support the integration of Mi'kmaw knowledge of use and occupation of Mi'kma'ki (traditional Mi'kmaq territory) into development decisions via the environmental assessment process.

The MKS includes:

- a study of historic and current Mi'kmaq land and resource use;
- an evaluation of the potential impacts of the Project on Mi'kmaq use and occupation and constitutionally based rights;
- an evaluation of the significance of the potential impacts of the Project on Mi'kmaq use and occupation; and
- recommendations to proponents and regulators that may include recommendations for mitigation measures, further study, or consultation with Mi'kmaq.

However, due to the disturbed nature of site, the proposed project description, an initial screening of the project and land resource use information held at the TARR Centre, CMM proposed to modify the MKS methodology to focus on historic Mi'kmaq land and resource use and conduct informal reconnaissance discussions with knowledgeable Mi'kmaw participants. If the review of historic Mi'kmaq land and resource use revealed, or the informal reconnaissance discussions provided information that may indicate that further study is required, a recommendation to that effect would follow.

METHODOLOGY

A review of written records will be undertaken to establish **historic Mi'kmaq land and resource use** in the Point Aconi area. The study of historic land and resource use paints a broad portrait of Mi'kmaq use and occupation of Mi'kma'ki in centuries past via an in depth review of written sources on archaeology, natural history, and accounts of Mi'kmaw use and occupation. This information will be used to identify Mi'kmaq occupation in and around the project area and provide data that can be used during the archaeological impact assessment for the project.

CMM has initiated a **reconnaissance program** to have informal discussions with Mi'kmaw participants to determine potential Mi'kmaq land and resource use concerns.

If the historic review or reconnaissance program provides site-specific information on use and occupation within the project area, a site visit may be undertaken.

The MKS will analyze the **potential impacts** of the Project on historic Mi'kmaq land and resource use, provide an **evaluation of significance** of the potential impacts, and provide **recommendations** for mitigation or action to the Proponent.

As stated above, if the historic review provides information that may suggest that a review of current Mi'kmaq land and resource use may be required, a recommendation for the completion of this work will be included in the final report.

STATUS

Data collection, research, and analysis of historic Mi'kmaq land and resource use in the study area began in April, 2005 and is expected to be completed by May 26, 2005.

CMM has initiated a reconnaissance program to have informal discussions with Mi'kmaw participants since April, 2005. CMM will be meeting with the Un'amaki Institute of Natural Resources on May 26, 2005 to determine potential Mi'kmaq land and resource use concerns.

A site visit will be undertaken in the spring of 2005 if warranted. Date to be determined and efforts put forward to coordinate the site visit with archaeological investigations.

APPENDIX H

PUBLIC INFORMATION SESSIONS

Surface Coal Mine and Reclamation Project

THE PROCESS

Once a resource has been identified and the mineral rights secured, the development of a surface coal mine progresses through several distinct stages.

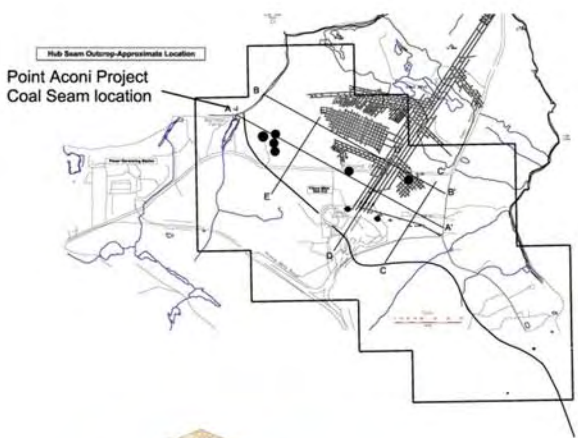
Stages

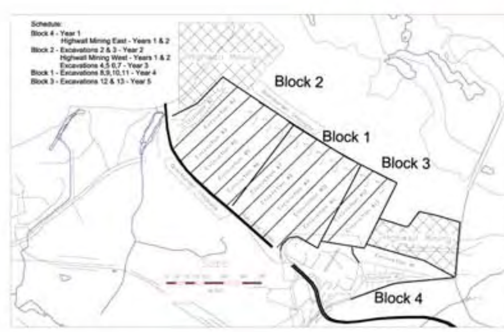
Design and preconstruction activities:
Pioneer Coal gathered geotechnical, environmental and socio-economic information to assess feasibility and complete a design of the mining plan.

Preparation:
Site activities before resource extraction occurs include:
- erosion and sedimentation control
- clearing and grubbing
- surface water management
- constructing temporary detours
- preparing stock piles
- contingency planning

Operations and Maintance:
Active surface coal mining includes:
- excavation and stockpiling of overburden waste
- the excavation, blending, stockpiling and transportation of coal
- backfilling of waste rock and overburden
- monitoring and maintenance

Decommissioning and Reclamation:
Mining facilities and infrastructure will be decommissioned and removed. Final reclamation will be completed with the approval of the applicable regulatory authority.





[1] Waste rock is drilled and blasted on each bench so it can be removed to expose the coal pile. [2&3] Large excavators load the waste rock into trucks for removal to a spoil in mined areas or another area of the mine which does not contain coal. [4] While dozers "clean" the coal seam, a hydraulic shovel. [5] Places the coal into trucks equipped with specially designed coal boxes for transport to the rotary breaker. The mining sequence starts again as each bench level is completed.

Surface Coal Mine and Reclamation Project

The Environment

Environmental Protection is a key component to the work completed by Pioneer Coal. Ongoing environmental monitoring is and will be completed and reported to the Nova Scotia Department of the Environment and Labour. Baseline information on environmental conditions from previous operations was used for planning this project.

Air Quality

Although emissions of dust from the site are a concern, impacts can be successfully mitigated. Process operations to control dust (such as spraying water) will be incorporated into daily procedures when needed.

Noise

Similarly, site operations will create noises that can be mitigated to an acceptable level. Use of a conveyor for waste rock (where feasible) and equipment maintenance are some processes that reduce noise.

Surface Water and Aquatic Habitat

Mitigative measures will successfully protect the receiving water. All site water will be treated prior to discharge. Wastewater treatment and erosion and sediment control will protect the aquatic receiving environment.

Terrestrial Habitat

No sensitive or rare species of plants or animals are known on the site. Potential impacts to the surrounding terrestrial environment primarily include dust and noise. The site development will be planned with terrestrial habitats in mind.

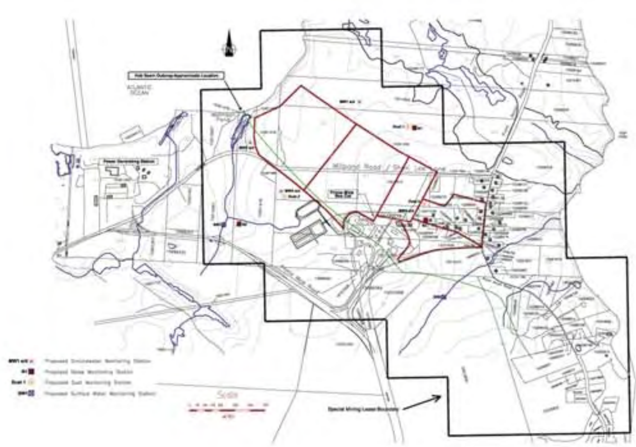
Human Health and Safety

Worker health and safety will be a part of operations at the site. Monitoring will take place to ensure the safety of the workers and the surrounding community. Final reclamation of the site will be completed by Pioneer Coal. This will increase the safety of the site in the long term.

Mill Pond

Overburden Pile

Former Access Road



Surface Coal Mine and Reclamation Project

PRODUCT TRANSPORTATION

Coal will be transported from the site in standard 35 tonne tractor trailers via local roads to markets and possibly to rail facilities for transport. Measures will be taken to limit dust emissions and tracking of site materials on local roads.

Transportation Options

Option 1
Coal will be trucked from the site to Nova Scotia Power's Point Aconi generating facility.

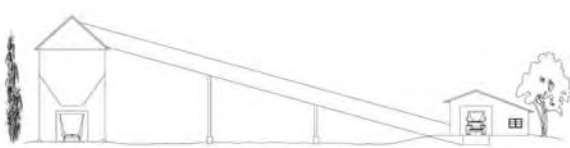
Option 2
Coal will be trucked from the site to Nova Scotia Power's Trenton generating facility.

Option 3
Coal will be trucked to Sydney Mines and transported by rail to Nova Scotia Power's Trenton generating facility.

Option 1

Option 2

Option 3



Coal Loadout Facility Sketch

PIONEER COAL LIMITED

Surface Coal Mine and Reclamation Project

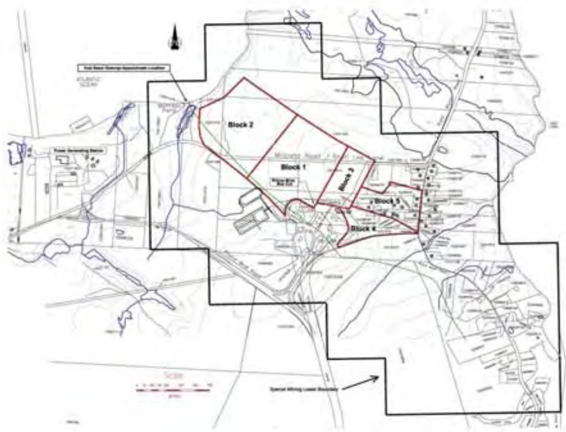
THE PROJECT

Pioneer Coal proposes to operate a surface coal mine in the area of the former Prince Mine site at Point Aconi, Cape Breton County, Nova Scotia.

Facts:

- The site has been mined historically – both organized and bootleg. Currently, the site is not suitable for other uses until reclamation occurs.
- The lands are unsafe due to subsidence (see photos below for examples of subsidence)
- The expected recovery of coal from the site is 2 million tonnes.
- Duration of mining activities at the site is about seven years with a daily production rate of 1,350 tonnes.
- Through this operation, Pioneer Coal will provide employment for 40 to 50 people.
- Recovery of the coal from this site allows Nova Scotia companies to buy local coal for use in their facilities.

Oblique Air Photo of Site



Public Information Session

Pioneer Coal Limited is holding a Public Information Session to present information to local residents and solicit their comments on our proposed project.

Surface Coal Mine & Reclamation Project
Prince Mine Site

Date	Time
Tuesday, April 5	Noon to 9:00 pm
Wednesday, April 6	Noon to 9:00 pm

Location: Office facility at CBDC Entrance
Prince Mine

Location of public consultation sessions.

Issues raised at public consultation sessions.

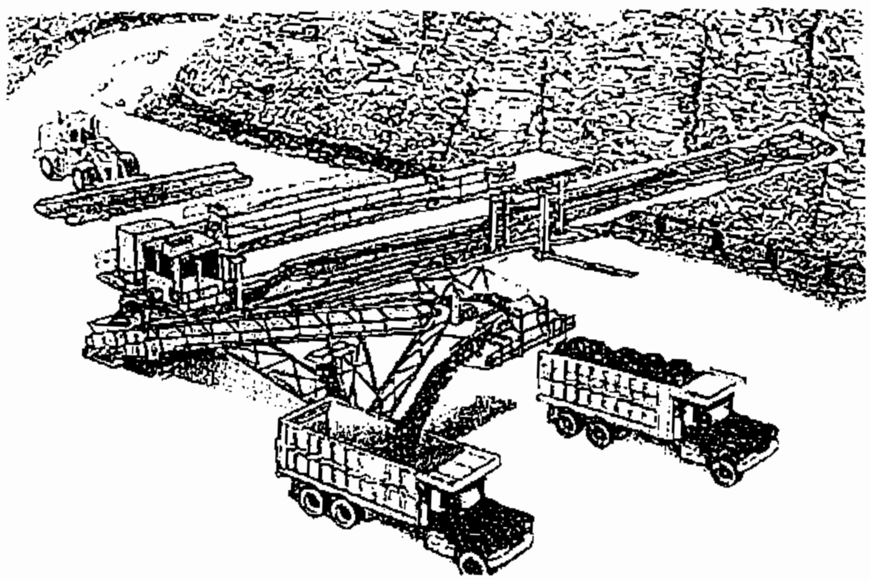
Participants attending public consultation sessions.

An example of information presented at public consultation.

APPENDIX I

NOVAMINER 2000 - HIGHWALL MINING SYSTEM

Introduction to a Typical Highwall Mining System



The Highwall Mining System operates on Benches that provide access to exposed highwall coal seams. It is capable of exceptional productivity operating in entries as deep as 305 m (1000 ft) in length. The small bench required to gain access to the coal seam minimizes surface land reclamation costs. The bench is not only economically attractive, but offers minimal disturbance to surrounding land thus making mining possible on small properties.

The system comprises: a launch vehicle with integral 48" belt Conveyors, a continuous miner, operator's cab, launch platform, and hydraulic power pack. Power can be supplied to the system by either a 2000 KVA portable diesel generator set or, where available, utility power. A crew operates this entire mining system from the launch vehicle's sheltered and protected work platform - a highly productive, relatively dust free environment in which to work.

After leveling and proper positioning, the continuous miner drives directly off the launch vehicle into the coal seam. Depending upon the continuous miner selected, a variety of seam heights can be mined ranging from 864 mm (34 in) to 4.9 m (16 ft). JOY offers an unparalleled selection of continuous miners with extensive customization available.

As the continuous miner progresses down the coal seam, 40 foot cascading belt Conveyors with a 1.2 m (48 in) wide belt are attached to the continuous miner to convey the coal up to the launch vehicle. Once started, the mining process is continuous.

Once positioned on the launch platform, staging cylinders drive the newly placed Conveyor forward. Pins lock the Conveyors together to form a rigid cascading belt system. Hydraulically-powered propulsion cylinders provides the systems foreword movement. The operator varies, depending upon floor conditions, the degree of thrust provided to the system. Each Conveyor has push/pull connectors to which the propulsion cylinders are attached. Once the cylinder's push-arms moves the Conveyor forward to their full stroke, the arms retract to push on the second set of connectors.

The rear most Conveyor discharges coal onto the Launch Vehicle's lower deck. The front end loader collects the next Conveyor to be added. The addition of further Conveyors is routine and frequent until the final depth is reached.

Three cables and a water hose passes from storage on the Launch Vehicle's upper deck through openings onto the Conveyors. One cable supplies power to the continuous miner, a second supplies power to the Conveyors and a third bundles the cameras and continuous miner's control cables together.

The system operates in the comfort of a climate-controlled cab mounted at the rear of the Launch Vehicle. Up to six remote television monitors provide the operator with excellent visual information. Cameras mounted on each side of the continuous miner provide a better field of view than that of an operator positioned on a conventional continuous miner. Periodic jet-washing of the camera box with water preserves picture quality and clarity. Methane monitors mounted on the continuous miner provide constant information, to the operator, of the presence of methane.

The removal of the system from a completed hole is simply the mining sequence in reverse. First, the rear most Conveyor fully retracts onto the launch platform. The electrical power supply cable is disconnect via a plug and receptacle connection. Each Conveyor receives power from the preceding Conveyor making continuous operation possible. This permits the removal of Conveyors without interrupting the power supply to all the Conveyors simultaneously.

Typically, a diesel front end loader loads and unloads Conveyors. During the loading maneuver it lifts these Conveyors, each weighing 9000 kg (9.9 tons), to a height of approximately 1.8 m (6 ft). The front end loader collects Conveyors from the Launch Vehicle and stores them for use in the next hole. Conveyors can be stacked upon each other for storage on the bench when not in use. Since the Conveyors are interchangeable, they can be stored in any order.

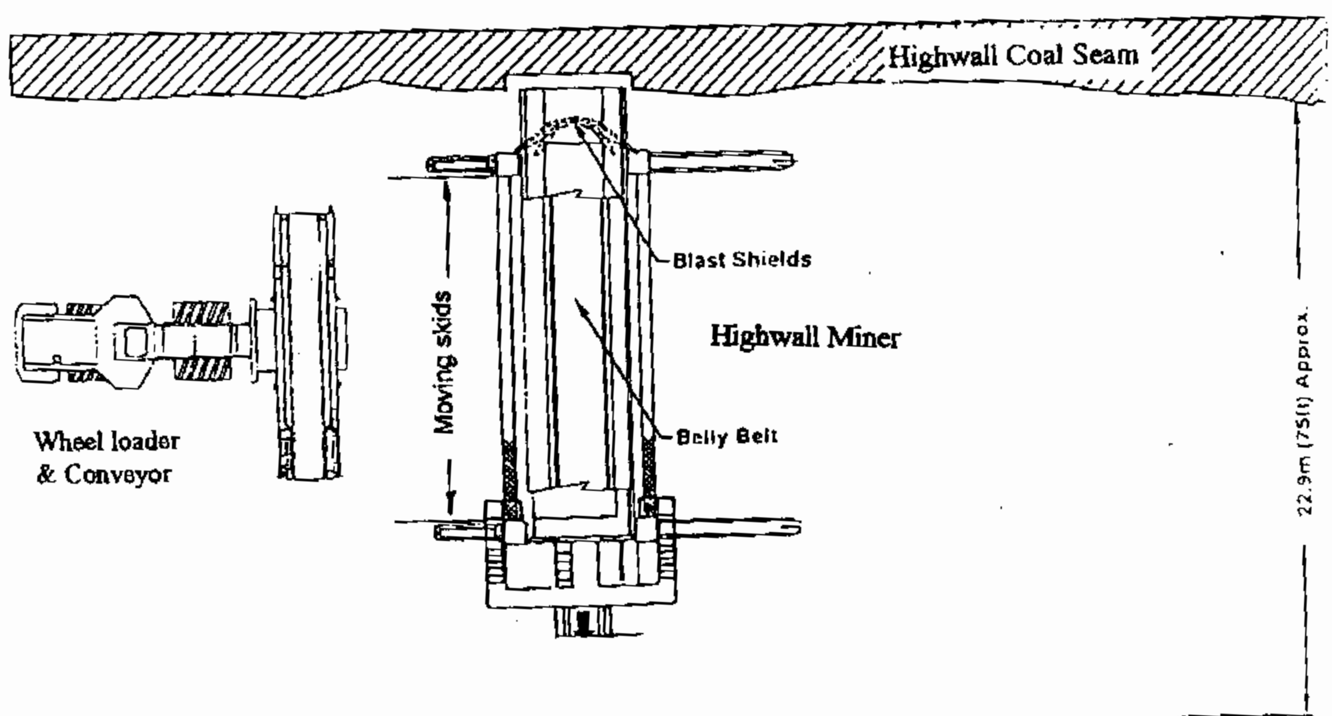
Routine servicing and maintenance of the system is possible even while the unit is in production. However, when the miner pulls back onto the Launch Vehicle, regular maintenance begins before the next hole starts. Maintenance can be carried out in a clean, sheltered environment with ready access to tooling, lifting and welding equipment, and supplies. Having such unhindered access to the continuous miner and belt Conveyors in well lit conditions minimizes the time required to conduct routine, on-going maintenance.

Relocating the Highwall Miner to an adjacent hole may take fewer than twenty minutes. The operator, who has an unobstructed view of the whole machine from a control console, relocates the Launch Vehicle. With the Launch Vehicle lowered, the heavy duty slide-skids move to a fully extended position in the intended direction of travel. Each corner of the Launch Vehicle is then raised with the lifting cylinders. With the Launch Vehicle raised to a level in which debris can be cleared, it is pulled across the skids hydraulically. The process of "walking" the Launch Vehicle in steps continues until the machine is correctly positioned.

The skid system has proven to be reliable in a variety of environments. The skids have successfully operated in dry, hot and dusty conditions, as well as in flooded or frozen ones. The skids also provide a stable base for the Launch Vehicle.

A member of the crew assists in aligning the Launch Vehicle with the aid of a transit. After repositioning, the mining cycle starts again with the continuous miner driving into the coal seam directly off the Launch Vehicle.

Overall System General Arrangement

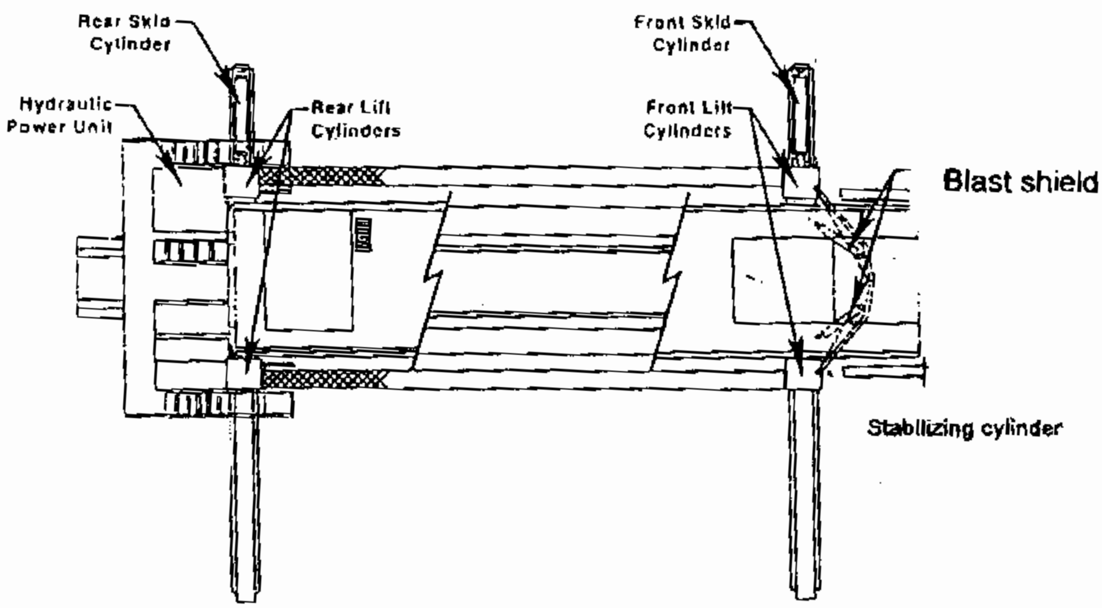


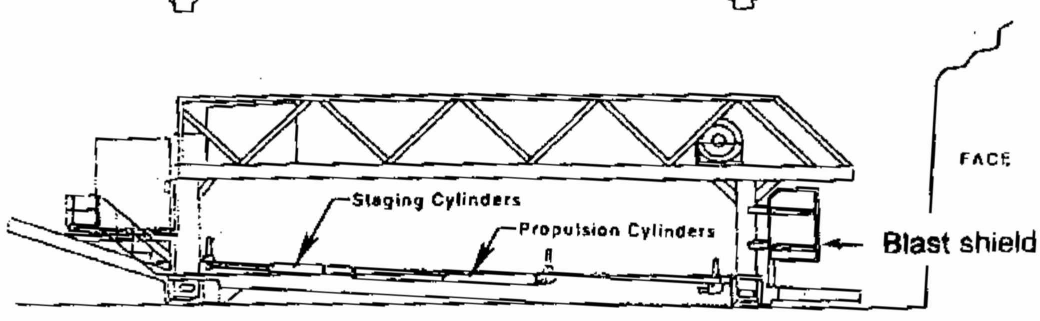
Surface Coal Mine

Launch Vehicle Blast Shield

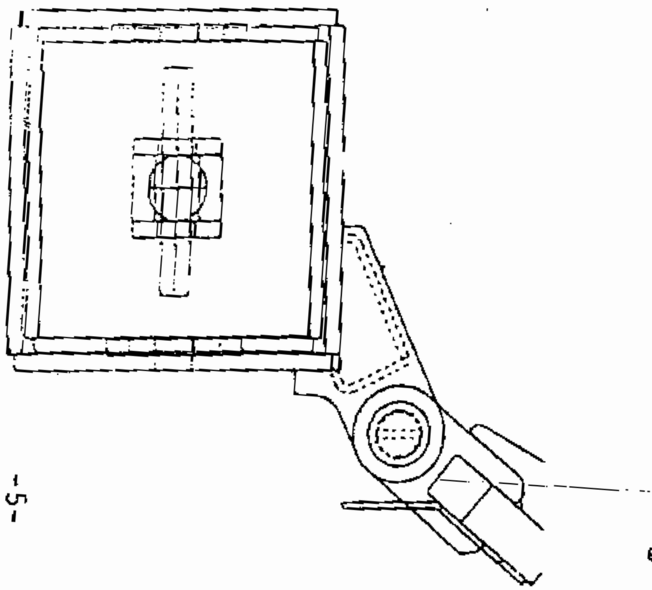
Introduction:

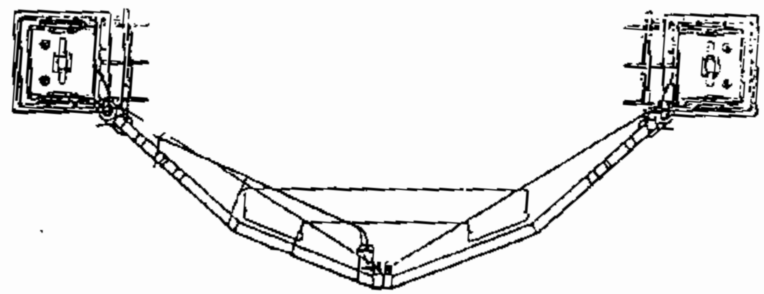
Blast shield is located between highwall an front of the Launch Vehicle



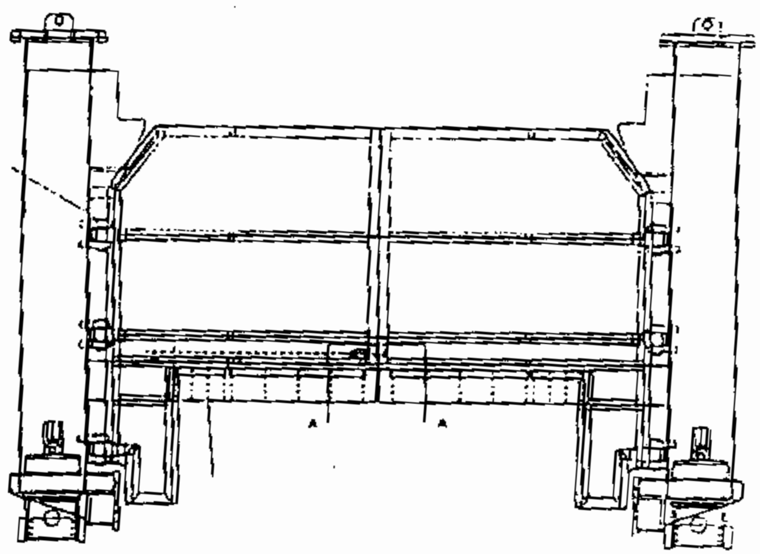


Launch Vehicle Blast Shield





Top view



Front view

Blast shield is located between highwall
an front of the Launch Vehicle

Note:
Final design and arrangement of Blast Shield
to be determined during construction of Launch Vehicle


NOVAMINER

APPENDIX J

CCME WATER SAMPLING PROCEDURES

SAMPLING WATER

There are many different types of waters that can be sampled, requiring different sampling equipment, but most of the samples are treated similarly once they have been collected. In the case of groundwater, the drilling of a well and the contaminants that may be associated with the materials used in well construction are considered to be a part of the overall sampling equipment and are discussed in the subsection on groundwater. The types of water that may be most commonly sampled at contaminated sites include surface waters (rivers, lakes, artificial impoundments, runoff, etc.), groundwaters and springwaters, wastewaters (mine drainage, landfill leachate, industrial effluents, etc.), and ice. Other types of water that may be sampled infrequently, if at all, include saline waters, estuarine waters and brines, waters resulting from atmospheric precipitation and condensation (rain, snow, for, and dew), process water, potable (drinking) waters, glacial melt waters, steam, water for subsurface injections, and water discharges including waterborne materials. The sampling of these latter water sources will not be addressed since most of them require special equipment that is not likely to be needed for the sources of water found at most contaminated sites.

Problems Unique to Sampling Water

Waters are usually very heterogeneous, both spatially and temporally, making it difficult to obtain truly representative samples. Solids with specific gravities only slightly greater than that of water are usually inorganic. They will remain suspended in the flow, but will also form strata in smoothly flowing channels. Oils and solids lighter than water (usually organic) will float on, or near, the surface. Some liquids, such as halogenated organic compounds, are heavier than water and will sink to the bottom (4). The chemical composition of lakes and ponds may also vary significantly depending on the season. The composition of flowing waters, such as streams, depends on the flow and may also vary with the depth.

Stratification within some bodies of water is common. In lakes shallower than about 5 m, wind action usually causes mixing, so neither chemical nor thermal stratification is likely for prolonged periods; however, both may occur in deeper lakes (28). Rapidly flowing shallow rivers usually show no chemical or thermal stratification, but deep rivers can exhibit chemical stratification with or without accompanying thermal stratification. Stratification may also commonly occur where two streams merge, such as the point where an effluent enters a river.

Stratification is also a problem with ocean sampling; various species may be stratified at different depths. In addition, the composition of near shore waters usually differs greatly from waters far from shore. Estuarine sampling is even more complex because stratifications move up rivers unevenly.

Water sample contamination is always a problem, and it increases in importance as the analyte concentration levels decrease. To some extent, contamination sources may depend on the body of water being sampled. For instance, in groundwater monitoring, contamination from well construction materials can be significant and material blanks become very important. However, many potential contamination sources are common to all water samples.

Groundwater vulnerability to contamination is affected by water depth, recharge rate, soil composition, and topography (slope), as well as other parameters such as the volatility and persistence of the analytes being determined. In planning groundwater sampling strategies, knowledge of the physical and chemical characteristics of the aquifer system is necessary (but almost never known). Groundwaters present special challenges for obtaining representative samples (4).

Reviewing Site Information and Reconnaissance

Site information should be reviewed for sources of possible water contamination in a manner similar to that described above for soils and sediments. The more background information that can be found, the better the sampling and analysis programs can be planned.

Also, as described in earlier sections, a preliminary site reconnaissance to inspect the potential locations where water samples will be taken will help significantly in planning the sampling efforts. Surprises can often be avoided and plans can be made to include any special sampling or safety equipment to overcome unusual physical barriers if an adequately planned site visit is made prior to the full sampling effort.

Representative Sampling Approaches

The following general principles apply to the collection of representative water samples (14):

- Do not include large nonhomogeneous particles, such as leaves and detritus, in the sample.

- In flowing waters, place the sampling apparatus upstream to avoid contamination. Sampling from the upstream side of a bridge enables the collector to see whether any floating material is coming downstream and aids in preventing contamination of the sample.

- Collect a sufficient volume to permit replicate analyses and quality control testing. If not specified, the basic required volume is a summation of the volumes required for analysis of all the parameters of interest.

The collection of representative water samples requires the use of a variety of sampling equipment depending on the station, the medium to be sampled, and the analyte list. The choice of sampler type must be closely related to the analyte list in order to avoid sample contamination. In addition to being analyte and station specific, the sampling equipment must also provide suitable sample volumes and be suitable for use in a wide variety of environmental conditions (21). Special guidelines, discussed later, apply to obtaining representative samples from groundwaters, rivers, and streams. Additional special guidelines apply to sampling all types of surface waters under winter conditions.

Collecting Representative Water Samples from Rivers and Streams

For water quality sampling sites located on a homogeneous reach of a river or stream, the collection of depth-integrated samples in a single vertical may be adequate. For small streams, a grab sample taken at the centroid of flow is usually adequate (14). When a single fixed intake point is used, it should be located at about 60% of the stream depth in an area of maximum turbulence, and the intake velocity should be equal to or greater than the average water velocity (27).

For sampling site located on a nonhomogeneous reach of a river or stream, it is necessary to sample the channel cross section at the location at a specified number of points and depths. The number and type of samples taken will depend on the width, depth and discharge; the amount of suspended sediment being transported; and aquatic life present. Generally, the more points that are sampled along the cross section, the more representative the composite sample will be. Three to five vertical sampling points are usually sufficient, and fewer are necessary for narrow and shallow streams (14).

Some practical sampling considerations related to location and season of sampling surface waters are outlines below (14).

Sampling Procedures from Bridges, Abutments, Boats, and Aircraft

- Attach sufficient rope to permit the sampler to reach the required maximum depth. The other end of the rope should be secured to a permanent fixture on the bridge, boat, or aircraft.

- Ensure that all of the lines that are suspending the samplers remain in the vertical position to enable the accurate estimation of the depth of sample. Depending on the sampler used, weights may be added; the greater the stream velocity, the heavier the weight required.

- When sampling from a boat, sample from the upstream side; if sampling from a float aircraft, sample from the upstream and outer side of the pontoons to minimize the chance of contamination from engine oil leaks.

- When sampling, it is important that the sampling bottle not be permitted to touch the bottom of the river or lake to avoid contamination from stirred-up sediment; predetermine the water depth to prevent this.

- Rinse the sampler three or four times with the water to be sampled unless the bottle contains a preservative or is sterile.

Sampling Procedures from Shores, Stream Banks, and Wharves

- A sampling iron is often used when water samples are collected from shores, stream banks, and wharves.

- Insert an open, clean sampling bottle into the metal holder, ensuring that the ring clamp is securely locked in the holder frame by a key ring or suitable pin. Attach sufficient rope to the holder to permit sampling at the desired depths. Secure the other end of the rope to a permanent fixture on the bank, wharf, etc. Sampling weights should be added as required, as dictated by stream velocity.

- Throw the bottle with holder well out into the stream. In case of very shallow streams (approximately 0.5 m), the sampler should collect the sample by hand, wading out if necessary, facing upstream, and making sure not to contaminate the sample with sediment, debris, and other floating materials.

- Pull the bottle and holder in quickly to prevent the bottle form touching or becoming snagged on the bottom of the stream.

- Rinse the sampling bottle three or four times with the water collected above. It is important that the sample bottle be well rinsed with the water to be sampled before the sample is collected unless preservative has been added to the sample bottle prior to sampling or the bottle is sterile.

Collecting Representative Groundwater Samples

In order to collect representative groundwater samples, temporal issues need to be considered such as the time of year sampling will be done, whether to sample before or after rainy seasons, etc., and other considerations, such as sampling after periods of high agricultural chemical usage. In constructing and using monitoring wells, alteration of the water being sampled must be minimized. Care must be taken during the drilling process not to cross-contaminate aquifers with loosened topsoil possibly laden with agricultural/industrial chemicals. Well construction and materials can profoundly influence the chemical composition of samples, so material blanks are important (4).

Purging wells before sample collection eliminates stagnant water. The method and rate of purging, time between purging and sampling, and sampling itself will depend on the diameter, depth and recharge rate of a well. Each well should be slug, pressure, or pump tested to determine the hydraulic conductivity of the formation and to estimate the extent and rate of purging prior to sampling (29). The standard purge volume obtains a stabilized concentration of the parameter of the interest. Purge volumes usually range from three to ten well volumes. Sometimes changes in pH, temperature, or conductance measurements can be monitored in consecutive samples to determine when a sample is representative, i.e., when surrogate values stop changing (4).

Select the material for well construction carefully. Cement used for polyvinyl chloride (PVC) pipe joints can leach into samples form wells; this can be prevented by using threaded pipes.

Equipment for monitoring wells should be constructed of stainless steel or other inert materials (30, 31).

Sampling devices and sample containers are always likely sources of contamination. Carryover between samples form the sampling device must also be prevented. Contaminant leaching from sampling devices and containers is very complex and requires serious attention. Table 11 shows the types of contaminations caused by materials used in sampling devices and well construction monitoring. Tin and lead are also common contaminants to water transported through soldered pipes. Water containing high calcium levels tends to extract lead preferentially, but tin is removed in small amounts for many years (28).

Sampling protocols often recommend that samples that analyze groundwater monitoring wells for metals be field-filtered under pressure before preservation and analysis. Samples collected for metals are usually acidified; acidification of unfiltered samples can lead to dissolution of minerals from suspended clays. Samples to be collected for organic compounds analyses, however, are never filtered (4).

As discussed above, blanks are used to assess contamination. Blank samples associated with groundwater samples should usually include equipment, field, and background blanks. Selections should be made by considering all likely sources of contamination for the specific situation.

Table 11: Potential Contaminants from Sampling Devices and Well Casings

Material	Contaminants prior to steam cleaning
Rigid PVC-threaded joints	Chloroform
Rigid PVC-cemented joints	Methyl ethyl ketone, toluene, acetone, methylene chloride, benzene, organic tin compounds, tetrahydrofuran, ethyl acetate, cyclohexanone, vinyl chloride
Flexible or rigid Teflon® tubing	None detectable
Flexible polypropylene tubing	None detectable
Flexible PVC plastics tubing	Phthalate esters and other plasticizers
Soldered pipes	Tin and lead
Stainless steel containers	Chromium, iron, nickel, and molybdenum
Glass containers	Boron and silicon

Analyte sorption is also a common problem. Polyvinyl chloride and plastics other than Teflon® tend to sorb organics and leach plasticizers and other chemicals used in their manufacture. In addition, some pesticides and halogenated compounds strongly adsorb to glass. When analyzing these substances in water samples, therefore, it is important not to pre-rinse the glass sample bottle with sample before collection. It is equally important at the laboratory to rinse the sample containers with portions of extraction solvent after the water sample has been quantitatively transferred into the extraction apparatus.

Tubing material used in automatic sampling devices is important; depletion of halocarbons from water depends more on the tube material than on the tubing diameter (surface area). However, when a constant flow rate is used, losses are more likely to occur with and increase in tubing diameter. Thermoplastic materials (e.g., polypropylene) appear to sorb many organic analytes efficiently, so they should be avoided in sampling devices (28).

Polyvinyl chloride reportedly containing zinc, iron, antimony, and copper may leach these metals into water samples. Polyethylene has been reported to contain antimony, which may also leach into water (28). Flexible PVC and plastics other than Teflon® usually contain phthalate esters, which may also leach into water samples (30). Phthalate esters interfere with instrument sensitivity by masking other contaminants.

Sorption of metals at low concentrations on container walls depends on the metal species, concentration, pH, contact time, sample and container composition, and presence of dissolved organic carbon and complexing agents. Preserving metals samples with acid usually prevents this problem (28).

Variations in the permeability of an aquifer can affect the representativeness of groundwater samples. If the wells have varying recovery rates, varying concentrations of the analytes will result. Vertical gradients of flow between permeable strata within an aquifer can result in samples from multiple zones within one well (30).