Tables

Table ES-1. Summary of studies by media

Lead Organization	Study Type	Citation	Study Dates	Environmental Media				Biological Media											
								Plant								Animal			
				Soil	Water	Sediment	Air	Algae	Moss	Lichen	Willow	Salmonberry	Blackberry	Sourdock	Plant Communities	Invertebrates	Fish	Caribou	Human Blood
Pre-Mine/Baseline																			
Teck Cominco	Environmental baseline study	Dames & Moore (1983)	1981–1983		A											O	A		
General Crude Oil and Minerals	Environmental baseline study	Ward and Olson (1980)	1978–1979		A												A		
Alaska Department of Environmental Conservation	Aquatic baseline study	EVS and Ott Water (1983)	1982														A		
U.S. Fish and Wildlife Service	Baseline study for Selawik NWR	Mueller et al. (1993)	1987–1988		A	A											A		
Post-Mine																			
Teck Cominco	Port site monitoring	ENSR (1990, 1991, 1993, 1996); RWJ (1997)	1990–1996	A	A	A													
	Transportation corridor monitoring	ENSR (1991)	1991–1992	A	A														
	Port site air monitoring		1997–present				A												
	Vegetation and soil monitoring	RWJ (1997)	1992, 1993, 1997	A											O				
	Fugitive dust study	Exponent (2002)	2001	A	A				A	A	A	A							
	Kivalina drinking water study	RWJ (1997); DHSS (2001)	1991–2001		A														
Alaska Industrial Development and Export Authority	Sediment quality survey	Cominco, RWJ, and PN&D (1999)	1998	A		A													
	Marine biota survey	RWJ (2001)	2000													O	O		
Alaska Department of Environmental Conservation	Subsistence foods investigation	ADEC (2001); DHSS (2001)	2001		A							A	A	A					
Alaska Department of Fish and Game	NPDES monitoring	Weber-Scannell and Ott (2001)	1991–1994														O		
	NPDES monitoring, expanded scope	Weber-Scannell and Ott (2001)	1994–2001		A			O								O	A		
	Juvenile fish tissue study	Morris and Ott (2001); DHSS (2001)	1993, 1998–2001														A		
	Caribou monitoring	Pollard (1994)	1993–1994															O	
	Caribou tissue study	DHSS (2001)	1996															A	
National Park Service	DMTS road dustfall study	Ford and Hasselbach (2001)	2000	A					A										
		Ford and Hasselbach (2002)[a]		A					A										
Kivalina Village	Kivalina drinking water sampling	DHSS (2001)	1995, 1996, 2001		A														
Alaska Department of Health and Social Services	Public health evaluation	DHSS (2001)	1992–2001																A

Note: A - analytical data available
O - other data types available

[a] Study release is pending.

Table 2-1. Composition of Red Dog lead and zinc concentrates

	Concentrate		
Element/Compound	Lead	Zinc	Units
Aluminum oxide	0.26	0.13	percent
Antimony	0.16	0.04	percent
Arsenic	0.04	0.02	percent
Barium	0.24	0.27	percent
Cadmium	0.12	0.33	percent
Calcium oxide	0.06	0.05	percent
Copper	0.06	0.14	percent
Iron	5.3	5.0	percent
Lead	57.9	3.2	percent
Manganese oxide	0.01	0.01	percent
Silicon oxide	3.8	3.5	percent
Sulfate	0.40	0.45	percent
Sulfur (total)	20.5	31.7	percent
Zinc	10.8	55.2	percent
Gold	0.20	0.19	g/T
Silver	381.9	124.6	g/T
Bismuth	6	8	ppm
Chloride	50	50	ppm
Chromium	677	537	ppm
Cobalt	77	98	ppm
Fluoride	64	56	ppm
Gallium	11	26	ppm
Germanium	17	79	ppm
Manganese	12	10	ppm
Mercury	18	94	ppm
Molybdenum	43	20	ppm
Nickel	45	16	ppm
Selenium	28	3	ppm
Strontium	11	10	ppm
Thallium	70	19	ppm
Tin	23	49	ppm
Vanadium	23	13	ppm

Note: Values expressed in percent are based on dry weight; actual lead and zinc concentrates contain approximately 8.5 and 9.5 percent water, respectively.

Table 2-2. Chemical reagent consumption and storage

Reagent	Consumption (tons/year)	Use	Container	Storage/ Compatibility
Copper sulfate ($CuSO_4$)	4,948	Activator in the zinc circuit	2,205-lb plastic tote bag/box	Stored with $ZnSO_4$
Zinc sulfate ($ZnSO_4$)	362	Depressant in the lead circuit	2,205-lb plastic tote bag	Stored with $CuSO_4$
Sodium cyanide (NaCN)	200	Depressant	2,205-lb plastic tote bag/box	Incompatible: isolated or stored with lime
Methyl isobutyl carbinol (MIBC)	77	Frother	2,000-lb, 330 U.S. gal poly tote	Stored with other chemicals
Potassium amyl xanthate (PAX)	664	Collector in zinc circuit	750-kg bag/box	Stored apart from acidic materials
Potassium ethyl xanthate (PEX)	446	Collector in lead circuit	750-kg bag/box	Stored apart from acidic materials
Sodium meta bi-sulfite (SMBS)	306	Scavenger	2,205-lb plastic tote bag	Stored with other chemicals
Lime	8,389	pH modifier, flotation and water treatment	4,500-lb plastic tote bag	Stored with other chemicals (hydrated form)
Sodium sulfide (Na_2S)	249	Precipitation agent	700-kg plastic tote bag	Stored with other chemicals
Magnafloc	69	Clarification in water treatment and thickening	1,543-lb plastic tote bag	Protected from temperature extremes
Nalco antiscalent	38	Dispersant for process water	6,000 U.S. gal ISO tanks	Stored in holding yard

Table 3-1. Air permitting history

July 9, 1986	Teck Cominco Alaska Incorporated (then Cominco Alaska, Incorporated) submits a Prevention of Significant Deterioration (PSD) permit application to the Alaska Department of Environmental Conservation (ADEC) for emission sources at the Red Dog Mine and DMTS port.
July 17, 1988	ADEC issues Permit No. 8732-AA001 for emission sources at the Red Dog Mine and the DMTS port.
November 4, 1988	ADEC issues Permit No. 8832-AA001 for emission sources at the Red Dog Mine and the DMTS port. This permit makes minor amendments, rescinds, and replaces Permit No. 8732-AA001.
December 27, 1988	ADEC issues Permit No. 8832-AA002 for emission sources at the Red Dog Mine and the DMTS port. This permit makes minor amendments to and rescinds Permit No. 8832-AA001.
July 21, 1993	ADEC extends Permit No. 8832-AA002 through January 30, 1994, and acknowledges that the Red Dog Mine and the DMTS port will be permitted separately.
October 11, 1993	ADEC amends Permit No. 8832-002 to allow simultaneous operation of four of five Wartsila engines at the Red Dog Mine.
April 4, 1994	ADEC issues Permit No. 9332-AA004 for emission sources at the DMTS port. ADEC determines that the Red Dog Mine and the DMTS port are separate facilities and that the DMTS port is not subject to PSD review.
May 17, 1994	ADEC issues Permit No. 9432-AA001 for emission sources at the DMTS port. This permit makes numerous amendments, rescinds, and replaces Permit No. 9332-AA004.
July 27, 1994	ADEC issues Permit No. 9332-AA003 for emission sources at the Red Dog Mine. This permit allows the installation of a sixth Wartsila engine and other changes to new and existing emission sources.
September 29, 1994	ADEC issues Amendment No. 1 to Permit No. 9432-AA001 for emission sources at the DMTS port, incorporating minor permit changes.
October 26, 1994	ADEC issues Amendment No. 1 to Permit No. 9332-AA003 for emission sources at the Red Dog Mine, incorporating minor permit changes.
July 15, 1996	ADEC issues Permit No. 9632-AA001 for emission sources at the DMTS port. This permit makes numerous amendments, rescinds, and replaces Permit No. 9432-AA001, as amended.
July 29, 1996	ADEC issues unilateral amendment to Permit No. 9632-AA001 for administrative corrections.
December 4, 1996	ADEC issues Amendment No. 2 to Permit No. 9332-AA003 for emission sources at the Red Dog Mine, incorporating minor permit changes.
February 8, 1998	Teck Cominco submits an air construction permit application to amend Permit No. 9632-AA001 for emission sources at the DMTS port. This application is pending to allow for the resolution of an ambient air boundary issue.
June 26, 1998	Teck Cominco submits an air construction permit application to amend Permit No. 9332-AA003 for emission sources at the Red Dog Mine.

Table 3-1. (cont.)

December 10, 1999	ADEC issues Permit No. 9932-AC005 to amend, but not rescind, Permit No. 9332-AA003 for emission sources at the Red Dog Mine. Major changes include the installation of a seventh Wartsila engine and removing operating hour restrictions from the existing six Wartsila engines.
July 13, 2000	Teck Cominco submits an air construction permit application to amend Permits No. 9332-AA003 and 9932-AC005 for emission sources at the Red Dog Mine.
April 26, 2001	ADEC issues Permit No 0032-AC018 to amend, but not rescind, Permits No. 9332-AA003 and 9932-AC005 for emission sources at the Red Dog Mine. The major change is the installation of an eighth Wartsila engine for backup operation when one of the existing Wartsila engines is offline.
July 5, 2001	Teck Cominco submits an air construction permit application to amend Permit No. 0032-AC018 to allow for simultaneous operation of all Wartsila engines for brief periods of time during generator shutdowns at the Red Dog Mine. This application is pending to allow for the resolution of an air quality analysis error that ADEC inadvertently made.
September 4, 2001	Teck Cominco submits an air construction permit application for numerous minor changes to Permit No. 9932-AC005 for emission sources at the Red Dog Mine. This application is pending to allow for a more detailed ambient air quality analysis.

Table 3-2. Compliance order actions

Operational improvements made in response to enforcement actions:

- Enclosure of the concentrate truck loading bay at the mine mill site
- Construction of a rigid enclosure around the course ore stockpile at the mine
- Intensification of watering and application of dust-suppressant chemicals to plant and pit roads
- Enclosure of entire length of port site conveyor system
- Control of dust emissions at transfer points along the port site conveyors through the use of bag houses
- Installation of controls on air vents on the mine-site concentrate storage building.

Additional actions that have been required and are planned or in progress include the following:

- Completion and implementation of Teck Cominco's Environmental Management Systems
- Adoption of DMTS road policies designed to minimize the risk of future truck spills
- Further investigation of environmental conditions at past truck spill sites to confirm that present applicable cleanup objectives have been achieved
- Conducting ambient air monitoring for 1 year each at Noatak and Kivalina
- Funding a drinking water study at Kivalina
- Providing funding to enhance the role of the Subsistence Advisory Committee in its oversight of mine operations
- Implementation of other operational procedures and controls to avoid future violations of the air permit.

Table 3-3. Chronological summary of fugitive dust control measures

Summer 1990

- Added vibrators to concentrate trailers to reduce carry-out from truck unloading building (TUB)
- Tested additions of calcium chloride for dust control

Spring 1991

- Added drop-tubes at discharge of P11 shiploader to minimize fugitive dust while loading lightering barges

Summer 1991

- Installed additional dust collection in gallery and transfer points
- Enclosed all transfer points
- Added floor to first level of surge bin
- Improved truck unloading station ventilation
- Installed equipment wash bay
- Installed new doors for existing CSB
- Installed improved doors for truck unloading station

Fall 1991

- Began adding calcium chloride for dust control on port road

Spring 1992

- Began adding calcium chloride for dust control at port site

Summer 1992

- Installed fabric covers over conveyors P7, P8, and P10
- Installed module over P10 conveyor drive unit
- Installed plywood covers over tail ends of P8 and P10 conveyors

Fall 1992

- Installed Phase I of P11 shiploader boom conveyor

Summer 1993

- Installed Phase II of P11 shiploader boom conveyor

1994

- Installed additional siding to enclose P9-A and P9-B (surge bin) conveyors
- Enclosed the bottom of the surge bin

1996–1998 Port Site upgrade[a] (production rate increase)

- Upgraded conveyor system (all new conveyors enclosed in steel tubes and additional baghouses[b] at P22, P22-A, P23, P23-A, P27, P28)
- Enclosed P7/P8 transfer point in steel building

Table 3-3. (cont.)

Winter 1996–1997

- Changed trailer wing deflectors to stainless steel for reduced adhesion and carry-out from TUB

1998–1999

- Switched to reinforced covers on concentrate trailers (for improved spill control)

Winter 1998–1999

- Began using Bobcat loader bucket to clean up TUB dumping platform between dump events (reduces concentrate track-out from TUB)
- Began using Chem-Loc® release agent in concentrate trailers to minimize residual concentrate and carry-out following dumping (reduced need for air-lancing trucks)

Spring 1999

- Added a spill deflector gate in TUB and removed deflector wings from concentrate truck trailers (to minimize carry-out from TUB)

Fall 1999

- Slab added to south door of TUB

1999–2000

- Upgraded to rotary valves on the baghouses

Spring 2000

- Added man-door to TUB control room (personnel can enter/exit building without opening large doors)

2000

- Completed steel tube enclosure of P8 conveyor

Winter 2000–2001

- Upgraded to motorized conveyor belt scrapers from standard blade scrapers

Spring 2001

- Replaced covers on P11 shiploader conveyor

Summer 2001

- Began installation of stilling curtains in TUB
- Added truck wash outside TUB

Fall 2001

- Switched to new self-dumping trailers with:
  - Hydraulically operated steel covers to minimize spills
  - Fewer exterior surfaces to minimize carry-out from the TUB
  - No side doors to eliminate potential for concentrate leakage
- Continued permitting process with ADEC to add baghouse to TUB hopper

Table 3-3. (cont.)

Winter 2001–2002

- Testing new type of bag in baghouses
- Updating standard operating procedures
- Truck unloading building improvements:
  - 26-ft extension to accommodate length of new trailers
  - Stilling curtains enhanced
  - Temporary baghouse (14,500 cfm) at truck dump hopper
  - Larger baghouse (50,000 cfm; being designed)
  - Air lancing of trucks has been eliminated
- Port CSBs
  - Loader exhaust particulate filters
  - Mobile hopper covers
- Mine CSB
  - Installed stilling curtains in concentrate truck loading stations
  - Test new air filtration unit on Caterpillar 988 concentrate loader
- Surge bin
  - Tightening of system
  - Improve baghouse ducting
- Shiploader
  - Extend hood to the tail pulley for full enclosure
- P7/P10 conveyors
  - Repair/replace covers
- Conduct a study on resurfacing the DMTS road (the “high-float” process)
- Design for summer construction of numerous improvements to the DMTS concentrate handling system (surge bin, conveyors, ship loader) for improved fugitives control
- Ongoing monitoring to track effectiveness of operational improvements

[a] A second concentrate storage building (CSB) was added during this upgrade.

[b] Baghouses are dust collection facilities located at each transfer point (e.g., between conveyors, etc.).

Table 4-1. Summary of studies by media

Lead Organization	Study Type	Citation	Study Dates	Environmental Media: Soil	Water	Sediment	Air	Biological Media: Plant: Algae	Moss	Lichen	Willow	Salmonberry	Blackberry	Sourdock	Plant Communities	Animal: Invertebrates	Fish	Caribou	Human Blood
Pre-Mine/Baseline																			
Teck Cominco	Environmental baseline study	Dames & Moore (1983)	1981–1983		A											O	A		
General Crude Oil and Minerals	Environmental baseline study	Ward and Olson (1980)	1978–1979		A												A		
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	Fugitive dust study	Exponent (2002)	2001	A	A				A	A	A	A							
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	Caribou tissue study	DHSS (2001)	1996															A	
National Park Service	DMTS road dustfall study	Ford and Hasselbach (2001)	2000	A					A										
		Ford and Hasselbach (2002)[a]		A					A										
Kivalina Village	Kivalina drinking water sampling	DHSS (2001)	1995, 1996, 2001		A														
Alaska Department of Health and Social Services	Public health evaluation	DHSS (2001)	1992–2001																A

Note: A - analytical data available
O - other data types available

[a] Study release is pending.