TABLES

Table 1a

Mine Site Mount Egerton - Tailings Assay Data

Sample No.	Au (ppm)	Cu (ppm)	Pb (ppm)	Ag (ppm)	As (ppm)	Fe (%)	Ca (ppm)	Mg ppm)	Mn (ppm)	Sb (ppm)	Hg (ppm)
B3	2.34	25	100	<1	590	1.28	120	870	50	<5	2.30
B4	2.17	50	95	<1	690	2.27	60	720	290	<5	2.50
B8	1.36	35	110	<1	480	1.50	360	950	35	<5	2.90
B9	2.38	30	95	<1	590	1.08	250	1050	30	<5	2.00
B11	2.75	50	160	<1	510	1.41	70	1500	45	<5	6.60
B12	2.54	45	130	<1	590	1.26	40	1100	45	<5	5.20
B5	2.24	30	110	<1	720	1.13	80	910	35	<5	1.60
CL 1-R	0.33	20	100	<1	660	1.14	390	1050	30	<5	1.05
C/S Comp	0.60	15	30	<1	200	2.18	220	470	55	<5	0.45
Detection Limit :	0.01	5	5	1	1	0.01	10	10	10	5	0.05

"B" samples are composites of tailings from one hectare ore blocks No.s 3, 4, 5, 8, 9, 11 and 12

C/S Comp is a composite of samples taken below the tailings of natural soil

CL1-R Represents a composite of the leach residue, after gold extraction (cyanide leaching)

Laboratory - Australian Laboratory Services

Table 1b

Progressive Cyanide Leach Data on Composite Sample from Block B5

Sample Location	Au (mg/l)	Cu (mg/l)	Pb (mg/l)	Ag (mg/l)	As (mg/l)	Fe (mg/l)	Ca (mg/l)	Mg (mg/l)	Mn (mg/l)	Sb (mg/l)	Hg (mg/l)
CL1 - 1	12.1	54	0.02	1.30	<0.1	310	780	16	0.78	<0.01	3.00
CL1 - 2	3.88	28	0.03	0.53	6.8	270	420	13	1.00	0.01	3.00
CL1 - 3	0.88	6	0.21	0.10	38	160	97	4.9	2.10	0.01	<1.00
CL1 - 4	0.36	2.7	0.14	0.07	69	76	46	2.6	0.02	0.02	<1.00
CL1 - 5	0.21	1.8	0.15	<0.01	89	53	36	2.5	0.02	0.02	<1.00
CL1 - 6	0.17	1.7	0.12	<0.01	88	38	32	2.2	0.03	0.03	<1.00
B5		<0.01	<0.01		0.3						0.001
CL1-R		<0.01	<0.01		0.15						0.0006

CL1 -(1 to 6) represents the progressive leachate obtained from successive column leach test runs on sample B5

The B5 sample is the result of an elutriation test on Sample B5 before any cyanide leaching was carried out.

CL1-R Represents the result of an elutriation test on a composite of the leach residue, after gold extraction (cyanide leaching)

Lab - Australian Laboratory Services

Table 2
Soil Sampling at Mt Egerton by EPA (July 1995)

Sample ID	Location	Moisture	Probe ID	Se mg/kg	As mg/kg	Hg mg/kg
Sample #1	S1	52.4	950938/1	17	1140	4.8
Sample #2	S2	21.6	950938/2	3	550	1.3
Sample #3	S3	18.7	950938/3	10	240	4.0
Sample #4	S4	32.7	950938/4	7	114	2.8
Sample #5	S5	28.3	950938/5	5	890	5.4
Sample #6	S6	23.0	950938/6	3	330	0.71
Sample #7	S7	17.4	950938/7	6	670	0.74
Sample #8	S8	23.5	950938/8	4	380	8.4
Sample #9	S9	27.0	950938/9	10	610	7.3
Sample #10	S10	25.3	950938/10	6	113	5.2
Sample #11	S11	17.6	950938/11	5	<4	<0.05
Sample #12	S12	25.5	950938/12	<3	405	6.4
Sample #13	S13	25.3	950938/13	<3	<4	<0.05
Sample #14	S14	2.9	950938/14	<3	<4	<0.05

Probe Analytical - 26 July 1995, Ref. 950938

NB : all results determined on a dry weight basis

Table 3
Soil Samples - Collected by J Larsen 7/3/95 (Lot 5)

Sample ID	Location	Description	As mg/kg	Cd mg/kg	Cu mg/kg	Fe mg/kg	Pb mg/kg	Zn mg/kg
L1	Lot 5	South Boundary	825	<0.001	45	20600	205	85
L2	Lot 5	Adjacent Wattle Tree	315	<0.001	1.5	8500	1.9	17
L3	Lot 5	Creek Drain	600	<0.001	12	7800	150	21
L4	Lot 5	Creek Drain	130	<0.001	9.8	3600	105	21
L5	Lot 5	Vegetable Garden	80	<0.001	6.2	2300	19	65

Laboratory - Centaur International, Hamilton

Table 4
Samples of Sand Collected from Tailings near Recreational Reserve

Sample	Sample No.	Description	Pb mg/kg	As mg/kg	Hg mg/kg
12264/95	x 2	Mt Egerton Sand No. 2	70	260	<0.1
12265/95	x 1	Mt Egerton Sand No. 1	56	290	<0.1

State Chemistry Laboratory 28 September 1995

Table 5a

Water Samples Mt Egerton Tailings Dams

Field No.	Lab No.	Sample Type	Pb (mg/l)	As (mg/L)	Hg (mg/L)
UBD	1	Water	0.02	<0.01	0.0009
BD	2	Water	<0.01	0.04	0.0012
SW2	3	Water	<0.01	0.08	0.0011
VD1	4	Water	<0.01	0.01	0.0008
VD1R	5	Water	0.03	2.70	0.0017
VD2	6	Water	0.02	0.10	0.0006
VD2BD	7	Water	0.01	0.06	0.0009
VD2R	8	Water	<0.01	0.07	0.0009

Source: TechSol Resources - Lab: Australian Laboratory Services
18 October 1990

Table 5b

Water Samples - Collected by J Larsen 7/3/95 (Lot 5)

Sample ID Water Sample	Location	Description	As mg/L	Cd mg/L	Cu mg/L	Fe mg/L	Pb mg/L	Zn mg/L
WL	Lot 5	Small Dam	0.58	ND	ND	7.22	ND	0.003

Laboratory - Centaur International, Hamilton
ND: Reported by J Larsen as "below detection limits".

Table 5c

Ground Water Samples from Boreholes 7/6/95

Sample	Sample ID	Hg (mg/l)	As (mg/l)	CN (mg/l)
1	Lot 1	<0.00005	<0.001	<0.1
2	Lot 7	<0.00005	<0.001	<0.1

Laboratory: Water Ecoscience for Department of H&CS

Table 5d

Water Samples - Drinking Water Lot 5 (15/2/96)

Sample No.	Location	Source	As mg/L
1A	Lot 5	Sink (5 sec)	<0.002
2A	Lot 5	Sink (3 min)	<0.002
3A	Lot 5	Tank (10 sec)	<0.002
4A	Lot 5	Tank (3 min)	<0.002

(5 sec) Indicates run time before sample collected

Table 6

Summary of Water Quality Criteria

Source	Guideline	As mg/L	Pb mg/L	Cu mg/L	Cd mg/L	Fe mg/L	Hg mg/L	Zn mg/L	CN mg/L
NH&MRC	Potable Water Criteria	0.007	0.01	## 1 - 1.5	0.002	0.3	0.001	3	0.07
ANZECC	Raw Water for Drinking	0.05	0.05	1	0.005	0.3	0.001	5	0.1
ANZECC	Aquatic Eco-systems **	0.05	0.01-0.05	0.002 - 0.005	0.0002 - 0.002	1	0.0001	-	0.005
ANZECC	Irrigation water Criteria	0.1	0.2	0.2	0.01	1	0.002	2	-
ANZECC	Livestock Criteria	0.5	0.1	0.5	0.01	-	0.002	2	-
ANZECC	To protect consumers of fish	0.00002#					0.0005*		
EPAV	SEPP Waters of Victoria	0.5	0.1	0.2	0.1	2-5	0.005	0.5	-

\# Potential carcinogen - risk level 1 in 1 million
* To protect wildlife in food chain
** Depends on hardness of water where range indicated
\#\# Aesthetic considerations

PLATES

Table 7

Fish and Vegetable Results for H&Cs

Sample Number	Sample Description	Category	Inorganic Arsenic mg/kg	Arsenic mg/kg	Mercury mg/kg	Cyanide (as HCN) mg/kg
01-A	Big Fish (redfin) - Tailings dam	Fish/flesh sample	<0.1	0.1`	0.8	<1
01-B	Big Fish (redfin) - Tailings dam	fish/ stomach sample	2.0	4.1	0.2	<1
02-A	Little Fish (redfin) -Tailings dam	Fish	<0.1	0.1	0.6	<1
03-A	Yabbies-Property dam. Down stream from tailings dam (Lot 5)	Yabby	1.1	2.2	0.2	<1
1*	Potatoes. Lot 5 (Washed and homogenised)	Potatoes		<0.01		
2*	Carrots. Lot 5 (Washed, tops removed and carrots homogenised)	Carrots		<0.01		

State Chemistry Laboratory 3/8/95 (95-08-015) 01-A-03-A

Dunn, Son & Stone, Melbourne Analytical Laboratory 25/5/1995 for DH&CS

Table 8

Horse Data From Lot 5

Sample No.	Horses Name	Age (years)	Hair Arsenic Mg/kg)	GSH-Px (U/GHB)	CK (U/L)	1-Kidney As (ppm)	1-Liver As (ppm)	1-Stomach Content As (ppm)
1	Queenie	5.5	700*	30	427*			
2	Leo	8	170*	65	313*			
3	Sugar	2	550*	34	153			
4	Missy	2.5	55*	15	160			
5	Jack (died)	1.5	205*	6#	298*			
6	Shadow		<16	9#	1030*			
7	Princess (died)	0.5	250*	38	115			
(8)	Dead Horse (Princess)					negative	negative	Approx 0.5

* higher than normal - comments on Laboratory Report

\# lower than normal - comments on Laboratory Report

Centaur International Samples sent by Dr J Larson, Dept. of Agr. Vet 8/3/95, except (8) sent 10/10/95

Table 9

Anzecc Animal Daily Water Intake Ranges

Animal	ANZECC - Daily Water Intake litres	
Sheep	3 - 7	
Dairy Cattle	46 - 91	
Beef Cattle	32 - 68	
Horses	36 - 91	

Table 10
Animal Soil Ingestion Data

Author	Date	Location	Animal	Reported or Typical Bodyweight (Adults) (kg)	Daily Food DM Intake kg/day	Soil Ingestion Reported Total kg/day	Seasonal Intake per Animal kg	Annual Intake kg/pa	Ingestion Rate
Larsen (verbal)	1996	Victoria	Horses	(450)		up to 4 to 5*			up to 10 - 12.5(g)/kg/day
Healey & Drew	1970	NZ	Cattle (dairy)			0.4-1.8			
Healey et al	1967	NZ (Humid)	Dairy cattle			0.25 - 1.25 (up to 1.6)			up to 1600g/day
		NZ (Humid)	Sheep (humid)			(up to 0.4)			up to 400g/day peak
Healey	1968	NZ	Cattle			0.5-0.87			
McGrath et al	1982	Eire	Sheep	60					
Statham & Bray	1975	Tasmania	Sheep		940 - 1.4 (up to 60g/Kg/day)		up to 400g/kg from May to November	up to 75 (estimated)	(up to 205g/day) or (3.5g/kg/day)
Thornton & Abrahams	1981	UK (England)	Cattle					(up to 400g/day quoting Healey)	
Langlands et al	1982	Australia	Sheep	29 - 59		0.46-0.78			Selenium found to be mostly unavailable to sheep
Mayland et al	1977	Nevada USA (desert scrub)	Cattle	350 average	8.6 - 10.4	0.73-0.99			
Mayland et al	1975	Idaho (USA) (semidesert)	Cattle	300 - 450	7 - 9	0.1 - 1.5 (median 0.5) early season to late season			
Olsen (quoted by Mayland)	1971	Idaho USA (as above)	Cattle – steers	222 - 274	5-6.8				
Grace & Healey	1973	NZ	Sheep		0.6-0.9				
Healey & Ludwig	1965	NZ	Sheep		1 (estimate)			up to 20/pa	
						0.01-0.07-0.22	August	Drier (grazing short)	
						0.005	Dec-April	(colder wet months)	
						0.005-0.05-0.125	July-Sept		
							0.5-5-11.4* kg/per animal/per season	July-Oct period only	
Fries & Marros	1982	Michigan (USA)							
		Unpaved lots (sparse vegetation)	Lactating Cows						0.6-1% of DM intake
		(sparse vegetation)	Heifers-Dry Cows						1.6-3.8% of DM
		Pasture							1.4-2.4% of DM
Vaithiyanathan	1974	Rajasthan, India (tropical arid region)	Sheep		0.9-2.7	0.07-0.163	Annual Range	up to 39pa	
						0.07 - 0.1	April-Oct (drier hotter months)		
						0.1 - 0.16	Nov-March (wetter cooler months)		

DM = Dry Matter Intake
* = ranges reflect variations in pasture, soils & stocking rates

PLATES

Table 11

Arsenic And Mercury Concentrations In Tailings Material

Tailings Samples			EPA Samples		
Sample No.	**As**	**Hg**	**Sample No.**	**As**	**Hg**
B3	590	2.3	1	1140	4.8
B4	690	2.5	2	550	1.3
B5	720	1.8	3	240	4
B8	480	2.9	4	114	2.8
B9	590	2	5	890	5.4
B11	510	6.6	6	330	0.71
B12	590	5.2	7	670	0.74
			8	380	8.4
			9	610	7.3
			10	113	5.2
			12	405	6.4
Mean	596	3.3		495	4.3
SD	87	1.8		320	2.6
95% UCL	665	4.8		678	6.1

NOTES:
1. EPA Samples 11,13 and 14 excluded - probably not tailings material.
2. 95% UCL - 95% Upper Confidence Limit
3. SD - Standard Deviation

Table 12

Exposure Parameters

Parameter	Value	Rationale
Contaminant Intake	mg/kg/day	Calculated
Contaminant Concentration	Arsenic 495mg/kg Mercury 4.3.mg/kg	Arithmetic mean of EPA samples (Table 11)
Contaminant Concentration in Drinking Water	Arsenic 0.002mg/L	Assumed drinking water guideline values for sensitivity assessment
Contaminant Concentration in Local Fish and Yabbies	Arsenic 0.3 mg/kg Mercury 0.5 mg/kg	Values weighted 80:20 fish to yabbies in diet. (FRDC,1993). Inorganic arsenic only.
Soil Ingestion Rate	Adult 25mg/day Child 100 mg/day	ANZECC & NHMRC, 1992 Child with pica excluded
Drinking Water Ingestion Rate	Adult 2L/day Child 0.66L/day	ANZECC & NHMRC, 1992
Consumption of Local Fish	Adult 30g/day Child 5g/day	Langley & Sabordo, 1996
Breathing Rate	Adult 20m^3/day Child 5m^3/day	ANZECC and NHMRC, 1992
Dust Concentration in Air	0.02mg/m^3	Assumed maximum for sensitivity assessment
Body Weight	Adult 70kg Child 13.2kg	ANZECC and NHMRC, 1992
Factor for Bioavailability in soil	Arsenic 0.2 Mercury 0.1	Freeman et al, 1995 and Groen et al, 1994 Barnett & Turner, 1996

Table 13

Toxicity Parameters

Chemical	Max. Tolerable Daily Intake mg/kg/day
Arsenic	0.002
Mercury	0.00033

Notes:

1. Parameters from WHO / Australian Drinking Water Guidelines (NHMRC, AWRC, 1994).
2. Parameter for mercury applies to the more toxic methyl mercury species.

Table 14
Human Health Risk Assessment Results

Scenario	Case	Contaminant	Receptor	Soil Concentration mg/kg	Includes Local Fish & Yabbies	Ratio Total Intake/TDI
A	1	Arsenic	Adult	495	Yes	0.40
	2	Mercury	Adult	4.3	Yes	0.87
	3	Arsenic	Child	495	Yes	0.94
	4	Mercury	Child	4.3	Yes	0.77
B	5	Arsenic	Adult	495	No	0.33
	6	Mercury	Adult	4.3	No	0.22
	7	Arsenic	Child	495	No	0.88
	8	Mercury	Child	4.3	No	0.20
	9	Arsenic	Child	650	No	1.00
	10	Mercury	Child	350	No	1.00

Table 15

Exposure Parameters - Animal Health Risk

Parameter	Value		Rationale
Contaminant Intake	mg/kg/day		Calculated
Contaminant Concentration in Soil	Arsenic Mercury	495mg/kg 4.3mg/kg	Arithmetic mean of EPA samples (Table 11)
Contaminant Concentration in Water	Arsenic Mercury	0.58mg/L 0.0012mg/L	Table 5A (Tech-Sol)
Soil Intake	Horses Cattle Sheep	1kg/day 0.7kg/day 0.1kg/day	Table 10
Food Intake	Horses Cattle Sheep	9kg/day 8kg/day 1kg/day	Table 10
Water Intake	Horses Cattle Sheep	60L/day 70L/day 5L/day	Table 9
Factor for Plant Uptake of Contamination	Arsenic Mercury	0.04 0.90	Baes et al (1984)
Factor for Bioavailability in Soil	Arsenic Mercury	0.11 0.50	David et al (1992) Professional judgement
Factor for Bioavailability in Food and Water	Arsenic Mercury	1.0 1.0	Professional judgement
Body Weight	Horses Cattle Sheep	400kg 350kg 40kg	Table 10

Table 16

Toxicity Parameters

Chemical	Max. Tolerable Daily Intake (mg/kg/day)
Arsenic	0.46
Mercury	0.18

Notes: TDI for arsenic (Puls)
TDI for mercury (Hudson et al, 1984)
For further details of derivation see Appendix B

PLATES

Table 17

Animal Health Risk Assessment Results

Case	Contaminant	Receptor	Soil Concentration	Water Concentration	Ratio Intake/ TDI	Principal Risk	% of Total Risk
1	Arsenic	Horses	495	0.58	1.45	Food	66
2	Arsenic	Cattle	495	0.58	1.47	Food	67
3	Arsenic	Sheep	495	0,58	1.53	Food	70
4	Mercury	Horses	4.3	0.0012	0.49	Food	
5	Mercury	Cattle	4.3	0.0012	0.50	Food	
6	Mercury	Sheep	4.3	0.0012	0.54	Food	
7	Arsenic	Horses	317	0.58	1.00	Food	
8	Mercury	Horses	8.4	0.0012	1.00	Food	

Note: Highlights indicate intakes exceed tolerable intake

Table 18

Possible Management Measures Priority Rankings

Item	Proposed Action	Location	Cost A	Effectivness B	Community Acceptance C	Desirability D	Cost Benefit A*B*C*D	Pirority Ranking
1	Community Consultation	Affected Parties only	10	6	5	10	3000	1
18	Fish & Water qualtiy studies	Bostock Dam/Paddock Creek	8	8	6	7	2688	2
3	Fence off Tailings/dams	Affected Properties only	7	7	5	10	2450	3
2	Community Consultation	Whole Community	6	8	5	10	2400	4
16	Further assessment to define extent	Tailings on affected properties	8	6	5	9	2160	5
17	Further assessment to define extent	Water quality in dams/creek	8	6	5	9	2160	6
5	Warning Signs	All Areas	10	3	5	10	1500	7
4	Fence off Tailings/dams	Mine Site only	5	5	8	7	1400	8
10	Cover affected soils with clean fill	All affected properties	3	7	8	7	1176	9
19	Speciation, toxicity, bio-availiability study	General data to refine HRA	6	6	4	8	1152	10
13	Cut off for leachate interception	North boundary Mine Site	3	5	8	8	960	11
15	Treatment of surface waters	Affected Properties	4	5	6	8	960	12
11	Excavate & remove tailings	Affected Properties	1	10	9	10	900	13
9	Install alternative water supplies	All affected properties	4	4	6	9	864	14
12	Divert paddock Creek past taillings	Mine Site	2	5	8	10	800	15
7	Remove people from affected areas	Lot 5 only	4	5	6	6	720	16
8	Re-subdivide to excise tailings areas	All affected properties	4	7	5	5	700	17
14	In-situ leaching remediation of Tailings	Affected Properties	3	6	5	6	540	18
6	Remove people from affected areas	All five lots with tailings	2	7	4	8	448	19
20	Do Nothing further	N/A	10	1	2	10	200	20

Notes: High Cost =- 1
Low Cost = 10

Effective or high acceptance/desirability = 10
Relatively ineffective or low acceptance/desirability = 1

APPENDIX C

Lot 5 - History

LOT 5 - HISTORY

The following is the history up to February 1996 of animals that have been present on Lot 5 Gains Road, Mount Egerton during some part of their management. This section of the report is presented without comment or interpretation in the form as provided by the owners of Lot 5, and Dames & Moore takes no responsibility for the accuracy or completeness of any data or comments included.

HORSES

Venus - 22 years old, here since May 1989. Since moving here all her foals (4) have been stunted, last two (Shadow and Missie) had "epiphysitis" (bone deformities). Venus developed severe deficiencies herself despite correct diet and supplements. In her next two pregnancies she miscarried. In the last 2 years she had to be treated by the vet for colic, oedema (swelling of the legs) and debilitation. She was put down in 1995 before we became aware of contamination problems.

Queenie - 6 years old, here since October 1989. She was also born too small and never filled out until removed from tailings area in 1995. After 6 months on agistment (off-site) with good feed and care she picked up. She is now overweight. Her first foal was normal except for "umbilical hernia", but she was kept on agistment during pregnancy and 6 months after birth. Her next foal was small and also suffered "epiphysitis". Both failed to develop (fill out) as normal and were very poor during drought 1994-95. Blood tests revealed many problems: malnutrition, raised muscle enzymes (muscle wasting) overburden of worms, infections. Both did not respond to treatment. Both suffered stomach ulcers and debilitation despite expert care. *Jack* died at 18 months of age after being administered a drug by a vet after he was injured (anaphylactic shock?). *Princess* died at 12 months after colic (impaction of caecum), which may have been caused by damage to gut from stomach ulcers. Queenie miscarried her last foal during drought, but is now in foal (5 months) after agistment and confinement from contaminated area.

Shadow - 2 years old, born here November 199, from Venus - her last foal. Almost died during drought. Blood test showed chronic infection, malnutrition, worm burden, muscle wasting. Agricultural Department wanted her at Hamilton for testing and autopsy but we refused. Failed to respond to treatment. Vet was afraid to treat her after Jack died as it was now obvious that something unusual was going on and if anything, the horses reacted adversely to drugs. Even worm medication was ineffective, as were food additives, ie. calcium, etc. She was agisted away and recovered slowly.

Leo - 9 years old, brought here as a 5 year old, sold off property in November 1995. Showed no outward signs except itching lumps (hives?) which did not respond to treatment, eg. cortisone injections, medicated wash ointments. He did not have as much access to contaminated area. His rashes went away slowly after he was denied access.

Sugar - 3 years old, bought as a 2 year old at start of drought (November 1994). She developed ill-thrift, worms, rough coat, muscle wasting very quickly on exposure to tailings. She has now recovered after being denied access (agisted) and is in foal (4 months).

General

All animals had abnormal blood tests - re Agricultural Department and our own vet report. All (except Leo) had ill-thrift, harsh dry coats, and muscle wasting. All had itchy rashes, malnutrition and worm burdens. All horses had no response to drugs and feed supplements. All (except Leo) would not put on weight and had voracious appetites.

Hair samples (Agricultural Department) showed all horses to have "Chronic Arsenic Poisoning". Urine samples, done a few months after horses removed from tailings showed minimal arsenic levels. Horses seem to be OK now but we don't know if there could be any permanent internal damage.

CATTLE

Dopey - 4 years old, here since 1988. Died of malnutrition after about 12 months, even though she was being hand fed and was given vitamin/mineral tonic by vet.

Generally, all the cows would not gain weight and would not get in calf (or aborted). We now have only one cow *Pixie* who has been here since February 1995 but has been confined from tailings area. Her calf, 11 months old, was butchered on 18 February 1996. Liver and kidneys are stored in our freezer and look normal. Remaining meat from beast will be stored from 24 February 1996.

RECENT HISTORY (up to September 1996)

28/4/96	Bobby (15 year old, on property since Christmas). Colic after being ridden.
14/6/96	Spy (7 month old foal of above). Colic - surgery in June 1996. Diagnosis - right dorsal displacement of large colon. Cause unknown, but happened after weaning and access to pasture. Now stabled and hand fed. In good condition as of September 1996.
Ongoing	Shadow (2½ year old, born on property). Behavioral disorder? This filly is generally quiet and sweet natured. After being broken-in she becomes aggressive when under stress, eg. when floated and ridden at a different location.
	Lee (9 year old, on property since March 1996). Ongoing colicky symptoms, this happened after weaning her foal and access to pasture (same area Spy was in). This horse will not put on weight.

OTHER HISTORICAL DATA FROM DIARY

May 1990	Supered all paddock with 5-2-1 and 5kg super NV1 rye, 5kg white clover, 2kg shafted
26 November 1994	Dolomite, 1½ tonne per acre gypsum ½ tonne per acre

Typical Horse Diet

Daily

1 part oaten chaff
1 part lucerne
1 part bran
½ part soaked barley
1 dessertspoon dolomite
1 dessertspoon sulphur
1 dessertspoon seaweed meal
½ level teaspoon copper sulphate
100ml apple cider vinegar

Weekly

1 tablespoon cod liver oil)

APPENDIX D

APPENDIX D

Bioavailability of Arsenic & Mercury
for Human Health Risk Assessment

BIOAVAILABILITY OF ARSENIC & MERCURY IN HUMAN HEALTH RISK ASSESSMENT

Oral Relative Absorption Factors for Arsenic and Mercury

Once released into a soil system, metals may precipitate in the form of insoluble minerals, adsorb onto soil exchange sites, or be taken up by plants (*eg.*, Woolson, 1977; Sadiq, 1986; Davis et al. 1996; Gasser et al. 1996). The toxicological significance of these soil-bound residues necessarily depends upon their bioavailability - the percentage of metal in soil that is absorbed following exposure via inhalation, ingestion or dermal contact. Available data indicate that soil adsorption can significantly reduce the bioavailability of metals to both plants and animals (including humans). For example, an epidemiological study conducted by the EPA, CDC, and State of Montana determined that children living near the former copper smelter in Anaconda, MT showed no elevation of urinary arsenic levels despite average arsenic soil concentrations of greater than 100mg/kg (Binder *et al.*, 1987). The authors concluded that "the lack of demonstrable exposure in children in the town of Anaconda suggests that mean soil arsenic levels of about 100ppm are not associated with excess exposure in young children," and established a "no epidemiologically detectable exposure level" (NEDEL) of 100mg/kg (Binder *et al.*, 1987).

The correction of intake equations for the reduced bioavailability of soil-bound metals is therefore clearly important for decreasing uncertainty in exposure assessment. An accepted method for converting both field exposures and toxicity criteria to absorbed doses is incorporation of a chemical-specific oral *relative absorption factor* (RAF_o) in the soil ingestion exposure equation (EPA, 1989a & b). The RAF_o is defined as the ratio of the fraction of soil-associated chemical that is likely to be absorbed to the fractional absorption of the same chemical as administered in the study used to establish the oral toxicity criterion (EPA, 1989a & b):

(1)

$$RAF_o = \frac{\text{Oral absorption of metal from soil}}{\text{Oral absorption of metal from exposure medium in toxicity study}}$$

Arsenic

Several recent studies have focused on the bioavailability of arsenic in natural soils. Davis *et al.* (1992) showed that only 11% of soil-associated arsenic was solubilized in rabbit small intestine. A subsequent study by the same group yielded an oral bioavailability of 48% for a single dose of arsenic relative to sodium arsenate solution (Freeman *et al.*, 1993). Groen *et al.* (1994) used dogs to compare urinary excretion of injected arsenate and arsenic in soil mixed with food, a more biologically realistic exposure method than the single-dose gavage protocol used in other studies. The resulting RAF_o from this study was 9%. The relative bioavailability of soil-associated arsenic was recently examined in the cynomologus monkey, a species with greater physiological and anatomical similarities to humans. The relative bioavailability of arsenic in this species was 20 - 28% (Freeman *et al.*, 1995). Based on these results, an oral RAF of 20% is considered conservative.

Failure to account for the reduced bioavailability of soil-associated arsenic will therefore overestimate exposure by the soil ingestion route (and hence risk) by a factor of approximately five. Inclusion of the RAF in calculating an allowable soil concentration for arsenic at Mount Egerton (Case 13) would result in a corresponding increase in that quantity, as follows:

(2)

$$Intake\left(\frac{mg\ As}{kg-day}\right) = \frac{I_{food} + I_{water} + \left(C_{soil} \times 10^{-6} kg/mg \times RAF \times \left[C_{dust} \times I_{air} + I_{soil}\right]\right)}{Body\ Weight}$$

where

I_{food}	=	Daily arsenic intake in food (0.012mg/day)
I_{water}	=	Daily arsenic intake in water (0.002mg As/L x 0.66 L/day = 0.00132mg/day)
C_{soil}	=	Concentration of arsenic in soil (mg/kg)
RAF	=	Relative absorption factor (0.2)
C_{dust}	=	Concentration of dust in air (0.02mg/m^3)
I_{air}	=	Daily inhalation rate (5 m^3/day)
I_{soil}	=	Daily soil intake rate (100mg/day)
BW	=	Body weight (13.2 kg)

To determine the acceptable concentration in soil, Equation [2] is rearranged to solve for C_{soil} when intake is set equal to the TDI for arsenic (0.002mg/kg-day):

(3)

$$Acceptable\ C_{soil}\left(\frac{mg}{kg}\right) = \frac{BW \times \left(TDI - \frac{I_{food} + I_{water}}{BW}\right)}{10^{6} kg/mg \times \left(C_{dust} \times I_{air} + RAF \times I_{soil}\right)}$$

$$= \frac{13.2kg \times \left(0.002mg/kg-day - \frac{0.012mg/day + 0.00132mg/day}{13.2kg}\right)}{10^{-6} kg/mg \times \left(0.02mg/m^3 \times 5m^3/day + 0.2 \times 100mg/day\right)}$$

$$= 651mg/kg$$

Mercury

Much less information is available regarding the oral bioavailability of mercury associated with soil or mine tailings. A recent study performed to evaluate the bioavailability of mercury in floodplain soils demonstrated an average RAF_o of 5.3% (0.053) (Barnett and Turner, 1996). Conservatively assuming an RAF_o of 0.1, failure to account for the reduced bioavailability of soil-associated mercury will overestimate exposure by the soil ingestion route (and hence risk) by a factor of approximately ten. Inclusion of the RAF in calculating an allowable soil concentration for mercury at Mount Egerton (Case 14) would result in a corresponding increase in that quantity, as demonstrated above for arsenic. To determine the acceptable concentration in soil, Equation [2] is rearranged to solve for C_{soil} when intake is set equal to the TDI for mercury (0.00033mg/kg-day):

(4)

$$Acceptable\ C_{soil}\left(\frac{mg}{kg}\right) = \frac{BW \times \left(TDI - \frac{I_{food} + I_{water}}{BW}\right)}{10^{6}\,kg/mg \times \left(C_{dust} \times I_{air} + RAF \times I_{soil}\right)}$$

$$= \frac{13.2kg \times \left(0.00033mg/kg - day - \frac{0.0005mg/day + 0.00033mg/day}{13.2kg}\right)}{10^{-6}\,kg/mg \times \left(0.02mg/m^{3} \times 5m^{3}/day + 0.1 \times 100mg/day\right)}$$

$$= 349mg/kg$$

Note that estimated intake via fish consumption (0.5mg/kg fish x 0.025kg/day ingested/13.2kg body weight = 0.00095mg/day) exceeds the TDI by a factor of 3. Thus, if fish consumption occurs, the acceptable concentration of mercury in soil is zero.

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Biotransfer of Arsenic in the Aquatic Food Chain

The initial accumulation of arsenic (and other metals) from sea water by phytoplankton and algae provides access to the marine food chain (*e.g.*, Bryan, 1979; Sanders, 1985). Through absorption and adsorption, these and other organisms may accumulate arsenic to concentrations significantly greater than those in surrounding waters and sediment. However, a variety of studies have shown no evidence of biomagnification along the marine food web (reviewed in Penrose, 1974; U.S. FWS, 1988; D'Itri, 1990). In fact, a growing body of evidence indicates that biomagnification of arsenic in the food chain is prevented by its conversion within organisms to organic forms that are readily excreted by the organism and also by predators (Lunde *et al.*, 1973a & b; Penrose *et al.*, 1977; Norin *et al.*, 1985; Phillips & Depledge, 1985). Rapid conversion of inorganic As to much less toxic organic forms has been documented for freshwater as well as marine fish (Penrose, 1975; Penrose *et al.*, 1977; Oladimeji *et al.*, 1979).

Potential Risk to Human Consumers of Aquatic Organisms

Some forms of arsenic are well known to be acutely toxic to humans, causing potentially fatal biochemical effects including the uncoupling of oxidative phosphorylation and interference with enzyme systems by binding to sulfhydryl groups. Chronic arsenic poisoning leads to a variety of circulatory and neurological disorders, and the U.S. Environmental Protection Agency and the International Agency for Research on Cancer classify arsenic as a known human carcinogen

(ATSDR, 1992). FDA tolerance levels for arsenic in food range from 0.5 - 2mg/kg, assuming that arsenic is in inorganic form (ATSDR, 1992). The fact that higher concentrations of arsenic may be found in commercially available seafoods has therefore raised concerns regarding potential health effects in human consumers.

Fortunately, as for organisms in the marine food chain, available evidence indicates that the organoarsenic forms present in seafood (chiefly arsenobetaine) are non-toxic and readily excreted by humans and other mammals. In fact, As is not considered in EPA's *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories* "because of insufficient evidence for the carcinogenicity of the organic arsenic compounds, which are predominant in edible fish . . . ." Early experiments showed that human volunteers who had consumed lobster and shrimp containing "naturally occurring" arsenic rapidly excreted almost all of the ingested arsenic without ill effect (*e.g.*, Coulson *et al.*, 1935). These results were corroborated in recent studies where arsenic ingested with fish was rapidly eliminated (Tam *et al.*, 1982; Brown *et al.*, 1990). In addition, populations consuming seafood with elevated concentrations of arsenic (up to 21.9mg/kg in shellfish and 5.95mg/kg in fish (dry weight in edible portions)) have manifested no adverse health effects referable to these dietary items (Santa María *et al.*, 1986). Similarly, rats fed diets of shrimp containing arsenic retained essentially no arsenic, while those fed diets with added sodium arsenite retained about one twentieth of the dose (Coulson *et al.*, 1935). Metabolic studies in rodents showed that pure arsenobetaine is excreted rapidly without conversion to other arsenic species (Vahter *et al.*, 1983; Yamauchi *et al.*, 1986).

These results are supported by *in vitro* studies indicating that arsenobetaine enters cells much less readily than does sodium arsenite (Bertolero *et al.*, 1987; Sabbioni *et al.*, 1991). Further, arsenobetaine is not retained in cells; it does not bind to cellular macromolecules (Sabbioni *et al.*, 1991), while sodium arsenite is known to form intracellular complexes (Bertolero *et al.*, 1981; Marafante *et al.*, 1982). In a recent study comparing the cytotoxicity and transforming ability of arsenobetaine and sodium arsenite in BALB/3T3 cells, high concentrations of the organoarsenical (up to 500 mM) showed neither toxic nor carcinogenic effects (Sabbioni *et al.*, 1991). Even higher concentrations (up to 10 mM) were non-toxic to rat hepatocytes (Christakopoulos *et al.*, 1988).

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