SRK Consulting
Engineers and Scientists

Memorandum

To:	File	Date:	June 14, 2005
cc:	Christoph Wels	From:	John Chapman
Subject:	Faro Tailings Source Term Calculations	Project #:	RGC501

1 Introduction

1.1 Terms of Reference

The purpose of this memorandum is to estimate the solute concentrations in percolate that may be released from the base of the Rose Creek tailings storage facility over time.

The scope of work that was undertaken was defined in a memorandum to Robertson GeoConsultants (RGC), which discussed by a working group that included staff of the Type II Mines Office, Environment Canada and Deloitte, during a series of conference calls. The agreed scope of work was presented in a memorandum from SRK to Christoph Wels of RGC, dated October 14, 2004.

1.2 Background

During deposition, the pore water in the tailings would have approximated process water. Exposure to oxidizing conditions and percolating meteorological water over time modified the pore water and displaced the process water. Previous investigations (GLL, 2002) have shown that a number of fronts have developed in the tailings which include i) an acid front which has a low pH and elevated metal concentrations, ii) an elevated zinc concentration front, and, iii) a neutral high TDS front containing elevated concentrations of sulphate and some metals. There is also evidence of an oxidation front that has developed, which is shallow compared to the TDS and acidic fronts. The development of these fronts will have been influenced by the method and timing of tailings deposition, which will have led to segregation (particle size) and inundation of pre-existing fronts. The following review of the deposition history provides some insight into these effects.

1.2.1 Original Tailings Impoundment

Tailings were deposited in the Original Impoundment until 1975. However, there is evidence that suggests that tailings were deposited in this impoundment intermittently at least until 1979 (as evidenced in aerial photographs). A recent review (Golders, 2004) suggests that tailings may have been deposited as recently as 1982. Because tailings were deposited from both sides of the impoundment, generally inter-layering of fine and coarse tailings resulted across this tailings deposit.

Intermittent tailings discharge after 1979 would have resulted consecutively in the oxidation of the surface tailings, formation of a high TDS/Zn front, and, possibly an acid front. Following deposition of a fresh layer of tailings, the existing oxidation zone would have been inundated by process water, probably neutralizing the acid front, and likely accelerating the rate of transport of the TDS/Zn front.

A new oxidation front would develop at the surface of the newly deposited tailings and the process would be repeated. The net result is that several fronts could have been formed during the period of intermittent deposition which are not necessarily associated with the current oxidation zone. This may also explain some of the 'smaller' fronts that have been detected in the tailings.

1.2.2   Secondary Tailings Impoundment

Tailings were deposited in the Second Impoundment from mid 1975 to 1982, at which time production ceased. Tailings deposition occurred again in 1986 (from June to October), which likely raised the tailings surface by between one and two meters.

Various deposition strategies were utilized, including coarse tailings spigoted from the crest of the secondary dam and various discharges at the toe of the original dam. The result would have been to push the fines to the centre of the impoundment.

As for the Original Impoundment, the period of inactivity between 1982 and 1986 would have led to the oxidation of surface tailings and the concurrent formation of TDS/Zn and acid fronts. Inundation occurred in 1986 and the oxidation front would have been re-adjusted to the current surface of the tailings deposit.

1.2.3   Intermediate Tailings Impoundment

Tailings were deposited in the Intermediate Impoundment from 1986 to 1992. Tailings discharge to the impoundment occurred predominantly from the north east corner just below the secondary dam, which resulted in a long beach with fines generally deposited against the intermediate impoundment. A pond remains against the intermediate dam, indicating that the fines are fully saturated.

As noted, the long beach which resulted from the deposition strategy consists predominantly of coarse tailings. These exposed tailings will have been oxidizing since deposition in the impoundment ended. The seasonally variation of the pond size will have affected the extent of oxidation. CPT testing (Golders, 2004) and drill logs (GLL, 2002) have also shown that while the upstream tailings are coarser, some coarse-fines interlayering is evident in these tailings.

1.3   Approach

A series of steps were undertaken to estimate the solute release rates from the tailings as follows:

Estimate Rate of Front Propagation. The historical tailings properties, leach extraction and paste parameter data were reviewed in the context of when tailings deposition occurred to each of the impoundments. The results from the various programs were compared on a proximity and depth basis. Rates at which fronts are being propagated through the tailings were then estimated and from which rates of infiltration were extracted.

Complete Bounding Calculations. Simple one dimensional oxygen diffusion calculations were undertaken to assess the range of sulphate production rates that can be expected for the tailings and the estimate the rates of oxygen entry to the tailings in the future.

Physical Properties of Tailings Deposit. First, the tailings were subdivided into coarse and fine tailings areas. Then, for each area the isopachs for the tailings deposit were used to estimate incremental surface areas at the contact between the tailings and the natural ground surface. These surface areas were then used to estimate the breakthrough curves for the tailings porewater.

Porewater Quality. The existing porewater quality within the tailings were estimated from the solute release determined in the leach extraction tests that have been completed on the tailings, corrected based on measured moisture contents. Average depth profile concentrations were determined for each of the tailings areas (coarse and fines) for each tailings impoundment, and then displaced through the tailings at the estimated rates of propagation to determine solute releases to the Rose Creek aquifer.

This memorandum presents the results from these evaluations.

2   Release of Contained Solutes

2.1   Source Areas

According to RGC's division of the tailings into distinct 'source areas', the average thickness of the tailings and the depth to the water table were determined as shown in Table 2.1.

Table 2.1
Summary of Zone Areas, Thickness and Depth of Water from Surface

Sub-domain	Area	Area	Volume	Average Thickness	Average Depth to Water Table
	m²	ha	m³	m	m
Original Impoundment					
IN-c	114,989	11.5	1,435,133	12.48	11.9
IN-f	271,687	27.2	5,065,763	18.65	10.9
Second Impoundment					
IS-c	91,949	9.2	1,408,759	15.32	5.8
IS-f	185,136	18.5	2,975,008	16.07	4.6
IIN-c	58,092	5.8	970,616	16.71	12.5
IIN-f	117,837	11.8	1,806,868	15.33	10.5
IIS-c	0	0.0	0	n/a	n/a
IIS-f	113,345	11.3	2,493,309	22.00	9.2
Intermediate Impoundment					
IIIN-c	112,869	11.3	850,206	7.53	4.2
IIIN-f	215,049	21.5	2,136,293	9.93	4.5
IIIS-c	72,984	7.3	853,666	11.70	4.2
IIIS-f	368,311	36.8	5,498,602	14.93	4.5
TOTAL	1,722,248	172.2	25,494,223	-	-

2.2   Rates of Porewater Advancement

2.2.1   Original Tailings Impoundment

Deposition History

Tailings were deposited in the Original Impoundment until 1975. However, there is evidence that suggests that tailings were deposited in this impoundment intermittently at least until 1979 (as evidenced in aerial photographs). A recent review (Golders, 2004) suggests that tailings may have

been deposited as recently as 1982. Tailings were deposited from both sides of the impoundment, resulting in inter-layering of fine and coarse tailings across this deposit.

Intermittent tailings discharge after 1979 would have resulted consecutively in the oxidation of the surface tailings, formation of a high TDS/Zinc zone, and, possibly an acidic zone. Following deposition of a fresh layer of tailings, the existing oxidation zone would have been inundated by process water, probably neutralizing the acidity, and likely accelerating the downward transport of the TDS/Zinc zone. A new oxidation front would then have developed at the surface of the newly deposited tailings and the process would be repeated. The result is that several fronts could have been formed during the period of intermittent deposition, which are not necessarily associated with the current oxidation zone. This may also explain some of the 'smaller' fronts that have been detected in the tailings.

Porewater Observations

Drill holes and test pits within the fines zone of the Original Impoundment include A1-1(P01-10), A2-1(P01-08), and P03-07. Auger drill hole A7 and test pit (TP10) were excavated in the coarse zone of the Original Impoundment. Paste parameter and leach extraction results and observations are summarised in Table 2.2. For the purpose of the calculations it was assumed that the uppermost zone of high conductivity commenced developing in 1982; the second in 1979, and the third in 1975. Generally, only data above the water table were considered. Some salient points include:

- Distinct peaks in conductivity, sulphate and acidity are encountered with depth, which were used to calculate the propagation rates shown in Table 2.2;
- Sodium has been flushed from the tailings to low levels which indicate that there is no residual process water remaining in the tailings;
- By 2001 partial breakthrough of the deepest high conductivity front to the water table had occurred for one of the three boreholes located in the fine tailings; breakthrough had also already occurred for the borehole located in the coarse tailings;
- All of the surface tailings have acidified to a low pH, no magnesium dissolution is observed in this zone. Below the acidic zone different buffering zones can be identified which can be broadly defined as follows. The first buffering zone is located immediately below the acidic zone and has a pH in the 3 to 4 range. Conditions are likely oxidizing and pH is controlled by iron precipitation, however, magnesium generally increases suggesting some residual neutralization is occurring. A second buffering zone with a pH between 4 and 6 is located below this where clearly carbonate buffering is occurring. The lower pH is likely due to the presence of excess carbon dioxide. This zone likely represents the extent of the influence of acid release from the acidic zone. Below this a neutral to alkaline pH zone is encountered, where magnesium concentrations drop off again;
- Zinc has been preferentially leached from the near surface tailings. Within the acidic zone, porewater typically has elevated iron concentrations, with lower zinc concentrations. Below this, in the first buffer zone, zinc is elevated probably from oxidation. Iron concentrations are low probably as a result of the precipitation of iron oxy-hydroxides. The solids analyses show zinc depletion from the near surface tailings;
- A slight peak in sodium concentration was detected in drill hole P01-08 (A2-1) at 6.1 m (18.1 mg/L), which coincides with a layer of wet plastic silty tailings, and at 13.7 m (26 mg/L) in drill hole P01-10 (A1-1), also associated with a layer of wet plastic silty sand tailings. These concentrations are below the anticipated process water concentrations, however, below these peaks sodium remained above the detection limit suggesting some residual process water remains in the tailings. Assuming these peaks coincide with the last deposition event, the travel times suggest permeabilities in the order of 1 to 2 x 10^{-6} cm/s, which is in reasonable agreement with field measured values.

As shown in Table 2.2, the estimated rates of propagation of the conductivity and sulphate fronts are in good agreement for the fine tailings locations, ranging typically from about 0.050 to 0.060 m/year. At a porosity of about 48 % and field moisture content of 16 % (from field measurements) this equates to a net annual infiltration rate of about 17 mm per year. Note that this represents a vertical infiltration rate and does not address any lateral flow that may occur due to layering.

Table 2.2
Summary of Original Impoundment Parameter Depth Profiles and Propagation Rates

Parameter	Description	2001			2003
		P01-10	P01-08	P01-A7	P03-07
Zone		Fines	Fines	Coarse	Fines
Conductivity	Peak 1 (m)	1	1.2	2	0.6
	Peak 2 (m)	2.4	2.8	5.5	4.5
	Peak 3 (m)	4.8	4.4	9	6
	Depth of add. peaks [m]	-	-	-	8, 9.5, 12
	Max [µS/cm]	6550	2360	3900	2436
	Rate [m/year] 1982 front	0.053	0.063	0.105	0.029
	Rate [m/year] 1979 front	0.064	0.073	0.159	0.163
	Rate [m/year] 1975 front	0.092	0.062	0.135	0.054
pH	Depth of Acid < 3 (m)	1.2	1	1.4	0.6
	1st Buffering (3 to 4) (m)	5	4	2.4	2
	2nd Buffering (4 to 6) (m)		8.4	> 9	13
	neutral pH (>6) (m)	8	9.4	n/a	13
	Minimum	2.21	2.93	2.3	1.97
	Rate [m/year] 1st Buffering	0.063	0.053	0.074	0.029
	Rate [m/year] 2nd Buffering	0.17	0.14	0.045	0.058
	Rate [m/year] Neutral		0.17	> 0.27	0.039
Acidity	Peak 1 (m)	1	1.2	2	-
	Peak 2 (m)	4.8	2.8	5.5	-
	Peak 3 (m)	12.4	4.4	9	-
	Depth of add. peaks [m]		7.6		-
	Max [pH 8.3, mg CaCO3/L]	9320	1325	2330	-
	Depth [m] - close to 0	13	9.5		-
	Rate [m/year] 1982 front	0.053	0.063	0.105	-
	Rate [m/year] 1979 front	0.173	0.073	0.159	-
	Rate [m/year] 1975 front	0.292	0.062	0.135	-
Sulphate	Peak 1 (m)	1	1.2	2	-
	Peak 2 (m)	2.4	2.8	5.5	-
	Peak 3 (m)	4.8	4.4	9	-
	Depth of add. peaks [m]				-
	Max [mg/L]	13000	2790	3080	-
	Rate [m/year] 1982 front	0.053	0.063	0.105	-
	Rate [m/year] 1979 front	0.064	0.073	0.159	-
	Rate [m/year] 1975 front	0.092	0.062	0.135	-
Magnesium	Depletion (m)	2.4	1	2	-
	Zone 1 (m)	7	2.4	6	-
	Zone 2 (m)		4.4	9	-
	Depth of add. Zones				-
	Max [mg/L]	400	285	240	-
	Rate [m/year] 1982 front	0.126	0.053	0.105	-
	Rate [m/year] 1979 front	0.209	0.064	0.182	-
	Rate [m/year] 1975 front		0.077	0.115	-
Zinc	Peak 1 (m)	2.5	1	2	-
	Peak 2 (m)	4.5	3	4	-
	Peak 3 (m)		4.5	9	-
	Depth of add. peaks [m]		7.6		-
	Max [mg/L]	2270	407	1220	-
	Rate [m/year] 1982 front	0.132	0.053	0.105	-
	Rate [m/year] 1979 front	0.091	0.091	0.091	-
	Rate [m/year] 1975 front		0.058	0.192	-

The results for the coarse tailings are more difficult to interpret because it is apparent that they drain down very rapidly. Also, the influence of direct oxidation would extend much deeper due to the low level of saturation. There are clear peaks or fronts that exist in the coarse tailings, but because breakthrough has already occurred, it is difficult to correlate the peaks with any specific deposition period. Based on the assumed years when the peaks started developing, the estimated rates of propagation of the fronts are in the order of about 0.15 to 0.2 m per year, or about three to four times that in the fine tailings. This corresponds to a net infiltration to the coarse tailings of about 26 to 35 mm per year.

Although the exact locations of the samples are uncertain, paste pH results from a 1988 investigation indicate acidification below pH 3 to a depth of about 0.5 m. Below this the pH was above 4 but below 6 to a depth of about 3 to 5 m. Below this the tailings remained neutral. Based on these results the initial rate of propagation of the acidic front is in the order of 0.083 m per year; the corresponding initial rate of propagation of the buffering zone is in the order of 0.25 to 0.50 m per year. It is not unreasonable that the initial rates of propagation should be higher than those estimated over the longer term because initially drain-down and rapid oxidation near the surface would have assisted in the development of the fronts.

Field observations

A series of test pits were excavated as part of a separate investigation to obtain tailings samples from near surface. The observations for the test pits excavated in the Original Impoundment near P03-07 and P01-10 (both located within the Fines Zone) are as follows:

- Depth of oxidation, as characterized by iron oxy-hydroxides, extends to a depth of between 0.8 and 1.1 m;
- Immediately below the oxidation zone there is an accumulation of 'ice-blue' crystals, which occurs in the transition to 'fresh' tailings; and,
- Oxidation cap is cemented together to form a 'hardpan'.

While the composition of the crystals is uncertain, they do not appear to be rapidly soluble in water. The reason for the accumulation at this depth is not clear. The test pits were excavated during the late fall.

2.2.2   Secondary Tailings Impoundment

Deposition History

Tailings were deposited in the Second Impoundment from mid 1975 to 1982, at which time production ceased. Tailings deposition occurred again in 1986 (from June to October), which likely raised the tailings surface by between one and two meters.

Various deposition strategies were utilized, including coarse tailings spigoted from the crest of the secondary dam and various discharges at the toe of the original dam. The result would have been to push the fines to the centre of the impoundment.

As for the Original Impoundment, the period of inactivity between 1982 and 1986 would have led to the oxidation of surface tailings and the concurrent formation of TDS/Zn and acid fronts. Inundation occurred in 1986 and a new oxidation front would have formed at the current surface of the tailings deposit.

Porewater Observations

Drill holes and test pit within the fines zone include P01-07 from the 2001 program, and P03-02, and drill holes P03-05 and P03-06 from the 2003 program (limited to paste parameters only). Drill holes P01-09 as well as P03-01, P03-03 and P03-06 were drilled in the coarse zone of the Secondary Impoundment. Paste parameters and leach extraction test results are summarised in Table 2.3. For the purpose of the calculations it was assumed that the first peak (from surface) commenced developing in 1986; the second in 1982. There is evidence to suggest a third peak and, in some cases, additional peaks. However, these generally appear to be at or below the water table. It is possible that these are the result of lateral transport of contaminants from upstream and therefore they were not included in the evaluation. Observations are similar to those described above for the Original Impoundment, with the following additional comments:

- Evidence of residual process water was found at a depth of about 10.7 m in P01-07 (fine tailings) as indicated by an elevated sodium concentration of about 76 mg/L, and a concentration of about 13 mg/L at 13.7 m for P01-09 (coarse tailings). Assuming the process water originated at surface in 1986, and was transported under saturated conditions, the transport rate indicate saturated permeabilities of about 4.4×10^{-6} cm/s for the fine tailings and about 7.7×10^{-6} cm/s for the coarse tailings.

A comparison of rates between the Original and Second Impoundments further shows that the rates of propagation of the various fronts are similar. However, results for P01-09, P03-03 and P03-06, which are considered to be within the coarse tailings zone, are comparable to the rates observed for the fine tailings. This suggests that these results may be affected by fine tailings inter-layering. The rate of propagation observed for the fine tailings was about 0.033 m/year, which correlates with a net infiltration of about 12 mm/year. The results for the coarse tailings ranged from as low as 0.020 m/year to 0.216 m/year, which correlates to an upper bound net infiltration of about 37 mm per year.

Field observations

The observations for the test pits excavated in the Secondary Impoundment near P01-07 (fines zone) and P03-06 (coarse zone) are as follows:

- Depth of oxidation extends to 0.3 to 0.4 m, characterized by multiple thin bands (order of centimetres) oxy-hydroxides
- Immediately below the oxidation zone there is an accumulation of 'ice-blue' crystals, which occurs in the transition to 'fresh' tailings;
- Oxidation cap is cemented together to form a 'hardpan'; and,
- Tailings are slightly moist and some evidence of oxidation is present.

Table 2.3
Summary of Secondary Impoundment Parameter Depth Profiles and Propagation Rates

Description		2001		2003				
Location		P01-07	P01-09	P03-01	P03-02	P03-03	P03-05	P03-06
Zone		Fines	Coarse	Coarse	Fines	Coarse	Fines	Coarse
Conductivity	Peak 1	0.5	0.5	1.7	0.5	0.9	0.5	0.3
	Peak 2	2.5	3	3	2.3	5	2	1.4
	Peak 3	4.5	-	5.6	6.1	7.3	5	3
	Depth of add. peaks [m]	9.1, 15.2	-	11.1	11.7	8.7, 11.3	8.1	6.7
	Max [uS/cm]	4950	6240	3630	2734	5370	2910	4180
	Rate [m/year] 1986 front	0.033	0.033	0.10	0.030	0.053	0.030	0.018
	Rate [m/year] 1982 front	0.105	0.132	0.062	0.086	0.195	0.072	0.053
	Rate [m/year] 1975 front	0.077		0.093	0.136	0.082	0.107	0.057
pH	Depth of Acid < 3	1	1.8	1.5	0.5	1.2	0.8	0.5
	1st Buffering (3 to 4)	3	8	3	n/a	6.4	n/a	1.5
	2nd Buffering (4 to 6)	8	14	7	10.5	13.8	9.6	9.6
	neutral pH (>6)	9	n.a.	8	11	14	9.8	10
	Min	2.75	2.42	1.67	2.06	1.96	1.89	2.62
	Rate [m/year] 1986 front	0.067	0.12	0.088	0.029	0.071	0.047	0.029
	Rate [m/year] 1982 front	0.11	0.32	0.32	n/a	0.247	n/a	0.047
	Rate [m/year] 1975 front							
Acidity	Peak 1	0.5	0.5					
	Peak 2	2.5	3					
	Peak 3	4.5	6					
	Depth of add. peaks [m]	18.3, 22.9	-					
	Max [mg CaCO3/L]	5300	9390					
	Depth [m] - close to 0	13	14					
	Rate [m/year] 1986 front	0.033	0.033					
	Rate [m/year] 1982 front	0.11	0.13					
	Rate [m/year] 1975 front	0.077	0.115					
Sulphate	Peak 1	0.5	0.5					
	Peak 2	2.5	3					
	Peak 3	4.5	-					
	Depth of add. peaks [m]	15.2, 18.3	-					
	Max [mg/L]	6520	11100					
	Rate [m/year] 1986 front	0.033	0.033					
	Rate [m/year] 1982 front	0.11	0.13					
	Rate [m/year] 1975 front	0.077	-					
Magnesium	Depletion	0.1	0.1					
	Zone 1	2	5					
	Zone 2	6	9					
	Depth of add. peaks [m]	15.2, 18.3	-					
	Max [mg/L]	200	360					
	Rate [m/year] 1986 front	0.007	0.007					
	Rate [m/year] 1982 front	0.10	0.26					
	Rate [m/year] 1975 front	0.154	0.154					
Zinc	Peak 1	1	3					
	Peak 2	2	12.2					
	Peak 3	7.5	-					
	Depth of add. peaks [m]	15.2, 18.3	-					
	Max [mg/L]	920	2950					
	Rate [m/year] 1986 front	0.067	0.20					
	Rate [m/year] 1982 front	0.053	0.48					
	Rate [m/year] 1975 front	0.212	-					

Note: Shaded cells at or below water table

2.2.3   Intermediate Tailings Impoundment

Deposition History

Tailings were deposited in the Intermediate Impoundment from 1986 to 1992. Tailings discharge to the impoundment occurred predominantly from the north-east corner just below the secondary dam, which resulted in a long beach with fines generally deposited against the intermediate impoundment. A pond remains against the intermediate dam, indicating that the fines may be fully saturated.

As noted, the long beach, which resulted from the deposition strategy, consists predominantly of coarse tailings. These exposed tailings will have been oxidizing since deposition in the impoundment ended. The seasonal variation of the pond size will have affected the extent of oxidation. CPT testing (Golders, 2004) and drill logs (GLL, 2002) have also shown that while the upstream tailings are coarser, some inter-layering of fines is evident in these tailings.

Porewater Observations

In general the porewater quality of the Intermediate Impoundment is less well developed than that of the Original and Secondary Impoundments. However, the results are indicative of trends similar to those observed in the other impoundments. In general, however, the depth to water is shallow, and consequently the depth of oxidation is limited. The corresponding results for the fronts, assumed to have developed in 1986 and in 1992 respectively are shown in Table 2.4. Based on sodium concentrations, it appears that process water has been displaced to a depth of about 7.8 m, which corresponds to a permeability of about 4.8×10^{-6} cm/s.

Field observations

The observations for the drill holes completed in the Intermediate Impoundment near P01-08 (fines zone) and P03-05 (coarse zone) are as follows:

- Depth of oxidation extends to about 0.3 m in the fine tailings and to about 0.45 m in the coarse tailings, characterized by multiple thin bands of oxy-hydroxide stained tailings that coincide with coarser tailings;
- Within the coarser tailings, immediately below the oxidation zone, an accumulation of 'ice-blue' crystals, which occurs in the transition to 'fresh' tailings, was observed; and,
- Oxidation cap is cemented together to form a 'hardpan'.

Table 2.4
Summary of Intermediate Impoundment Water Quality Profiles

Location	Description	2001 P01-05	2003 P03-08
	Zone	Coarse	Fines
Conductivity	Peak 1	0.5	0.7
	Peak 2	4	2.5
	Max [uS/cm]	4510	348
	Rate [m/year] 1992 front	0.056	0.064
	Rate [m/year] 1986 front	0.23	0.11
pH	Depth of Acid < 3	0.1	0.2
	1st Buffering (3 to 4)	0.5	1
	2nd Buffering (4 to 6)	1	2
	neutral pH (>6)	2	2
	Minimum	2.55	3.61
	Acidification	0.01	0.02
	Buffer 1	0.056	0.090
	Buffer 2	0.033	0.058
Acidity	Peak 1	0.5	-
	Peak 2	4	-
	Max [pH 8.3, mg CaCO3/L]	3660	-
	Depth [m] - close to 0	5	-
	Rate [m/year] 1992 front	0.056	-
	Rate [m/year] 1986 front	0.23	-
Sulphate	Peak 1	0.5	-
	Peak 2	4	-
	Max [mg/L]	4310	-
	Rate [m/year] 1992 front	0.055	-
	Rate [m/year] 1986 front	0.23	-
Magnesium	Peak 1	1	-
	Peak 2	2	-
	Max [mg/L]	356	-
	Rate [m/year] 1992 front	0.11	-
	Rate [m/year] 1986 front	0.067	-
Zinc	Peak 1	0.5	-
	Peak 2	1	-
	Max [mg/L]	704	-
	Rate [m/year] 1992 front	0.056	-
	Rate [m/year] 1986 front	0.033	-

2.3   Summary

Initially, the tailings pore water would have corresponded to process water.

There is evidence that sodium concentrations were elevated in the process water. Sodium is not generated at elevated concentrations from the oxidation or neutralization processes. Therefore, residual sodium can be used to infer the presence of residual process water. The results suggest that the process water was displaced through the tailings at approximately the same rate as the saturated permeability of the tailings. Draindown has likely occurred in all of the coarse tailings whereas some residual process water remains in the fine tailings.

The review of the deposition history for the original and secondary impoundments indicated that there was at least one inactive period in each of the impoundments during which tailings were deposited over tailings that had been allowed to oxidize for some time. During this time, it s expected that elevated sulphate and zinc concentrations would have been generated in the tailings porewater.

The depths of the peaks encountered in the tailings appear to coincide with the likely sequence of tailings deposition. There are too few peaks, and the passage of the peaks is too slow to be a result of seasonal effects.

The second inference from the distribution of process water in the tailings is that the intermittent deposition (especially in the Second Impoundment) did not lead to the complete displacement of solutes generated during the period that the tailings were allowed to oxidize. Otherwise only one peak would have been detected in the tailings. This suggests that solutes are attenuated in the tailings, even when saturation occurs, as evidenced by the fact that intermittent deposition did not remove all of the solutes generated and stored in the tailings. This effect could be an artefact of lateral movement of porewater. However, the expectation would then have been that process water would not have been displaced from the tailings to the extent that it has occurred to date. However, since there s evidence that not all of the process water has been displaced from the tailings, it is reasonable to expect that multiple peaks would remain in the tailings column. This means that the rates of displacement of all but the most recently formed peak would have been dictated by the saturated permeability of the tailings, and to some extent by the lateral movement of porewater due to the layered nature of the tailings.

The leach extraction results further indicate that zinc is preferentially leached from the surface layer of the tailings. This is supported by solids analyses, which show that zinc is depleted from the solids in the near surface tailings. Preferential leaching of zinc has certain long-term implications. In particular, the rate at which zinc is generated from the surface layer will decrease. This means that the water composition is likely to change with time resulting in lower zinc concentrations in the tailings porewater.

From the above analysis, rates of advance of the fronts and the estimated rates of infiltration have been estimated. The rates adopted for use in further calculations are summarised in Table 2.5 below. These estimates were derived from the first peak data, i.e. they represent the rates if advance of for the peak most recently established and that has not been affected by subsequent deposition. The summary rates represent the average of the conductivity, sulphate, magnesium and zinc rates averaged for each location and then averaged for the coarse and fine tailings respectively. This approach was adopted to minimise the potential error that could be associated with a single parameter (sulphate only) analysis, since all these parameters under ideal conditions should move through the tailings at a similar rate. This approach also allows inclusion of the 2003 conductivity data.

Table 2.5
Summary of Rates of Advance and Infiltration

Area	Average Advance			Maximum Advance		
	Unsaturated m/year	Saturated m/year	Infiltration mm/year	Unsaturated m/year	Saturated M/year	Infiltration mm/year
Coarse	0.203	0.083	34	0.444	0.181	75
Fine	0.047	0.036	16	0.074	0.056	26

2.4　Leach Extraction Test Results

Porewater quality has been obtained for saturated tailings from the wells installed in the tailings. However, to date, actual porewater from the unsaturated tailings, which is of interest for this evaluation, has not been extracted and analyzed. Therefore, the primary source for estimating solute concentrations in porewater are the results from the leach extraction tests completed in 2001. The results from these tests together with measured moisture contents at corresponding depths were used to estimate the porewater concentrations. It should be noted that the leach extraction tests reflect oxidizing conditions, whereas below the oxidation zone in the tailings anoxic conditions prevail

which will effect the concentrations of some parameters including iron. It should also be noted that these calculations are sensitive to the moisture content and hence are likely prone to error, but nonetheless serve as a 'starting point' for estimating porewater concentrations.

The results for the Original impoundment are shown in Table 2.6, those for the Second Impoundment in Table 2.7 and the results for the Intermediate Impoundment are shown in Table 2.8. The tables show a corrected sulphate concentration, which has been corrected for gypsum precipitation; however, only the original calcium concentrations are shown. The following observations can be drawn from these tables and graphs:

- The presence of residual process water is clearly evident from the sodium concentrations, which has been discussed in the preceding section. Depending on the sodium concentrations in the process water, it is possible that the porewater concentrations may have been overestimated by a factor of 2 or more in some cases.
- The acid fronts and associated metal concentrations in the Original Impoundment are very similar and appear to be "mature", i.e. concentrations have peaked and are unlikely to exceed the concentrations shown.
- Iron concentrations are elevated only in the acidic zone, which is an artefact of the leach extraction testing (i.e. oxidizing conditions) since porewater for example in X21A has elevated iron concentrations at depth. The reducing conditions at depth maintain iron as ferrous and prevent oxy-hydroxide formation.
- Maximum zinc concentrations in the porewater appear to be on the order of about 40,000 to 50,000 mg/L. If indeed the porewater concentrations are overestimated by a factor of 2, then the maximum concentrations would be in the order of about 20,000 to 25,000 mg/L.

Solute concentration profiles with depth were obtained by back-calculating the porewater concentrations from leach extraction tests and the measured moisture content of the sample. The average profile for each of the source areas was obtained by averaging the concentrations at approximately the same depth. This profile was then allowed to propagate through the tailings at the solute propagation rates previously obtained. The propagation rates, for unsaturated and saturated conditions, and the corresponding infiltration rates that were adopted are shown in Table 2.5.

Table 2.6
Summary of Calculated Porewater Concentrations in the Original Impoundment

Location		pH	Sulphate (mg/L)	Sulphate Corrected (mg/L)	Calcium (mg/L)	Iron (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Zinc (mg/L)
P01-10 - Original – Fines									
A1-1	0.5	1.1	92321	81348	4972	26509	311	0	1274
A1-1	1	1.0	662278	632671	12736	293440	2802	0	42691
A1-1	1.5	2.2	153497	140795	5693	8031	4134	0	46761
A1-1	2.5	2.3	86128	81737	2230	2489	6169	0	34665
A1-1	3.5	2.4	71005	65607	2649	16659	2130	0	12836
A1-1	4	2.4	72231	70439	1147	27335	1558	0	7819
A1-1	4.5	2.6	100529	90838	4438	20678	4040	0	18133
A1-1	7.6	5.3	27451	15057	5564	1	2311	95	2374
A1-1	12.2	2.9	12052	9058	1647	629	315	287	2731
A1-1	13.7	5.9	6849	2280	2304	0	181	224	626
A1-1	15.2	6.6	5039	1084	2048	0	182	211	45
A1-1	16.8	6.5	1904	764	875	0	124	159	14
P01-08 - Original – Fines									
A2-1	0.5	1.3	123717	103497	8825	9403	4512	0	15836
A2-1	1	0.8	224401	202497	9527	39237	3803	0	32115
A2-1	1.5	1.9	184678	152003	14015	8186	21218	0	16765
A2-1	3	2.3	327267	265448	26158	7789	32961	0	47741
A2-1	4	2.3	211862	177579	14685	6950	26230	0	16478
A2-1	4.5	3.1	411750	367472	18849	20862	52155	1464	34404
A2-1	6.1	4.5	25324	23351	1222	918	3588	317	1864
A2-1	7.6	3.2	47283	40558	3202	1826	5216	483	5747
A2-1	9.1	5.3	6229	3885	1376	0	756	83	210
A2-1	10.7	6.2	2137	743	981	0	92	57	44
A2-1	12.2	7.0	2157	235	1200	0	193	53	8
A2-1	13.7	6.5	3118	980	1291	0	57	99	66
A2-1	15.2	6.1	4380	1771	1487	1	208	41	89
Original Coarse									
A7-1	0.5	0.59	136187	117733	8089	38655	937	0	4838
A7-1	2	1.01	196122	167937	12144	23768	974	0	44550
A7-1	2.5	1.87	164081	140663	10157	4818	10591	0	39761
A7-1	4	2.83	88334	76285	5421	4417	3470	0	34990
A7-1	6.1	2.67	85466	71834	6080	25611	2401	0	5707
A7-1	7.6	2.99	46462	40401	2925	685	6654	0	3614
A7-1	9.1	2.93	67398	55624	5306	1007	6969	115	9981

Table 2.7
Summary of Estimated Porewater Concentrations in the Second Impoundment

Location		pH	Sulphate (mg/L)	Sulphate Corrected (mg/L)	Calcium (mg/L)	Iron (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Zinc (mg/L)
P01-09 Second Impoundment Coarse									
A3-1	0.5	1.1	213120	202514	4819	79488	1096	0	8448
A3-1	1.5	1.8	83632	80230	1817	6546	2187	0	24446
A3-1	2	2.4	141708	134732	3307	4760	6335	0	59686
A3-1	3	2.3	85756	80977	2391	1763	4248	0	39405
A3-1	4	2.8	67507	62197	2612	835	4656	0	22502
A3-1	6.1	3.0	33550	32118	997	4972	1276	0	10296
A3-1	7.6	2.9	19484	18149	956	5160	1024	0	1828
A3-1	9.1	3.4	20047	15468	2308	126	2282	53	2229
A3-1	10.7	3.2	36429	30360	2929	886	3191	119	6381
A3-1	12.2	3.2	31201	24461	3208	977	1484	118	7977
A3-1	13.7	3.7	10306	6028	2182	49	375	495	1020
P01-07 - Second – Fines									
A4-1	0.5	1.58	95818	92439	1808	39238	1054	0	4335
A4-1	1	2.19	79255	73010	3002	17412	1397	0	13825
A4-1	1.5	1.81	157978	148303	4431	34789	4078	0	26946
A4-1	2	2.87	76675	73577	1690	18263	2460	0	12497
A4-1	2.5	1.23	164391	146466	7869	15086	10124	0	39043
A4-1	3	2.34	37228	34609	1491	5087	2197	0	5145
A4-1	4	4.81	13452	12397	840	1345	1370	65	2087
A4-1	4.5	5.27	12417	9515	1609	118	1229	76	1432
A4-1	6.1	4.03	11155	3823	3455	2	913	117	586
A4-1	7.6	4.48	7400	5173	1328	1	674	145	380
A4-1	9.1	6.79	5895	2157	1958	0	290	247	50
A4-1	10.7	6.77	2812	2111	692	0	87	414	7
A4-1	13.7	7.08	2951	1064	1186	0	161	304	7
A4-1	15.2	4.56	17003	7413	4396	18	441	329	2492
A4-1	16.8	5.22	1700	1409	522	0	49	88	98
A4-1	18.3	3.33	8830	5883	1628	115	330	304	1218
A4-1	19.8	5.98	4835	2356	1433	0	154	416	17
A4-1	22.9	4.22	5052	3505	1045	2	149	190	978
A4-1	24.4	6.38	3683	1876	1153	0	143	274	15

Table 2.8
Summary of Estimated Porewater Concentrations in the Intermediate Impoundment

Location		pH	Sulphate (mg/L)	Sulphate Corrected (mg/L)	Calcium (mg/L)	Iron (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Zinc (mg/L)
P01-05 Intermediate – Coarse									
TP-7	0	0.8	179705	168673	4997	80893	1229	0	5376
TP-7	0.5	2.6	54940	41889	5838	286	5910	0	2572
TP-7	1	5.4	374174	299084	31688	1641	30906	0	61118
TP-7	1.5	5.1	10382	7006	1807	0	1004	0	860
TP-7	2	5.2	8661	5822	1583	0	1305	57	233
TP7	3.5	6.2	8604	3362	2584	0	789	86	30
A5-1	4.5	5.7	2577	1586	813	0	112	42	79
A5-1	6.1	3.1	1886	2264	243	166	105	28	351
A5-1	7.6	5.7	2825	1813	822	0	135	117	92
A5-1	10.7	3.2	4817	3691	869	215	322	85	520
A5-1	12.2	7.0	2590	1399	896	0	196	125	6
A5-1	13.7	6.7	5188	1983	1735	0	259	141	20

2.5   Solubility Constraints

At the elevated concentrations, the activity coefficients of the aqueous species should be calculated from Pitzer's equations. However, unfortunately the Pitzer database available for the EQ3/6 model does not contain data for a number of relevant minerals, including goslarite and the various hydrated zinc sulphates that may control zinc solubility. Hence, only a preliminary assessment of the potential solubility limits was completed using MINTEQA2.

Based on the preliminary MINTEQA2 results, zinc concentrations of up to 65,000 mg/L are possible based on the solubility of goslarite and/or $Zn_2(OH)_2SO_4$. Similarly, based on the solubility of melanterite, iron concentrations in excess of 70,000 mg/L could be possible. While the solubility of epsomite is very high, it is unlikely that it would form since the magnesium concentration will likely be limited by the magnesium released from the solids. It is however considered that these 'upper limits of solubility' indicated by MINTEQA2 are likely high. In contrast, the highest zinc concentration that was detected in tailings porewater (P01-09A, 11.2 m) was 5,500 mg/L, with a sulphate concentration of about 77,000 mg/L and an iron concentration of about 36,000 mg/L. Furthermore, the highest zinc concentration detected during the site seepage monitoring program was 10,900 mg/L (from the low grade ore stockpiles), the maximum sulphate concentration was 59,000 mg/L and the maximum iron concentration was 15,100 mg/L. (It should be noted that the low grade ore stockpiles are acid generating and contain zinc grades similar to the tailings.)

In the loading calculations presented in Section 3, calculated porewater concentrations were used directly to estimate zinc loadings. However, in light of the precipitates that have been observed in the tailings, it is considered that by neglecting the potential effects of secondary mineralization, the loading estimates may be overly conservative.

2.6   Oxidation and Oxygen Diffusion

Infiltration modelling to the tailings was undertaken as part of the cover assessment program. Outputs of that modeling include moisture content profiles within the tailings over time. The results are shown in Figure 2.1 for fine tailings and in Figure 2.2 for coarse tailings. These simulations represent a complete season of infiltration for a tailings layer of 7 m above the water table. As shown, the results suggest that the influence of a single season infiltration should extend to a depth of about 1.5 m for fine tailings and up to 2.5 in coarse tailings. This is somewhat deeper than suggested by estimated rates at which the solute fronts are propagating through the tailings, which suggest that the modelling overestimates the rates at which infiltration is occurring. (The results suggested infiltration rates of 28 mm per year and 92 mm per year respectively for fine and coarse tailings.) Nonetheless, of significance are the saturation profiles that are predicted to occur within the tailings, which govern the rate of oxygen diffusion into the tailings. Again, it appears that the measured field moisture contents are lower than the predicted levels of saturation in the tailings. It is however possible that some loss of moisture had occurred from the tailings during sampling, handling and testing which would result in an underestimation of the saturation levels in the tailings. (This also has bearing on the estimated porewater concentrations calculated in the previous section.) For the purpose of estimating oxygen diffusion, the modeled rather than field measurements of moisture content were utilized. Estimated oxygen flux with time for fine tailings are shown in Table 2.9; the results for the coarse tailings suggest that oxygen flux rates may be as high as five times that estimated for the fine tailings.

Table 2.9
Summary of estimated Oxygen Flux into Fine Tailings

Time Year	Oxygen Flux $(mol/m^2/s)$	SO$_4$ Production $(kg/m^2/year)$
1	2.71E-06	7.9
5	1.43E-06	4.2
10	8.03E-07	2.3
15	7.09E-07	2.1
20	5.94E-07	1.7
30	5.15E-07	1.5
60	3.58E-07	1.0
120	2.49E-07	0.7
180	1.99E-07	0.6
240	1.62E-07	0.5
300	1.37E-07	0.4
400	1.13E-07	0.3

To verify these estimates, overall sulphate productions were estimated from the sulphate that has accumulated in the tailings. The results are shown in Table 2.10. Based on the oxygen flux derived from the diffusion calculations, the cumulative sulphate productions over 10, 15 and 20 years are 42, 53 and 62 kg/m^2 respectively. The actual sulphate production in the fines in the last column of Table 2.10 compare well with those suggested by the diffusion calculations. The production in the coarse tailings is however only 2 to 3 times that of the fines, which is lower than the diffusion calculations suggested. It should be noted that the modelling did not consider the effects of layering. The presence of a layer of fine tailings within the coarse tailings near the surface will have a significant impact on oxygen diffusion.

Overall, however, the oxygen diffusion calculations show a slowing in the rate of acid generation. This also means that solute production rates will slow down in the future, which means that the current estimates of porewater concentration represent maximum concentrations that will occur in the porewater. It is therefore concluded that it is reasonable to estimate future solute release rates based on the estimated current rates of propagation of solute fronts. The diffusion calculations further suggest that defining the source concentrations as a step function is conservative, and that the solute concentrations are likely to show a logarithmic decay with time. This expected decay has been taken into consideration in long-term predictions where the effects of ongoing oxidation were examined (see Section 3.2).
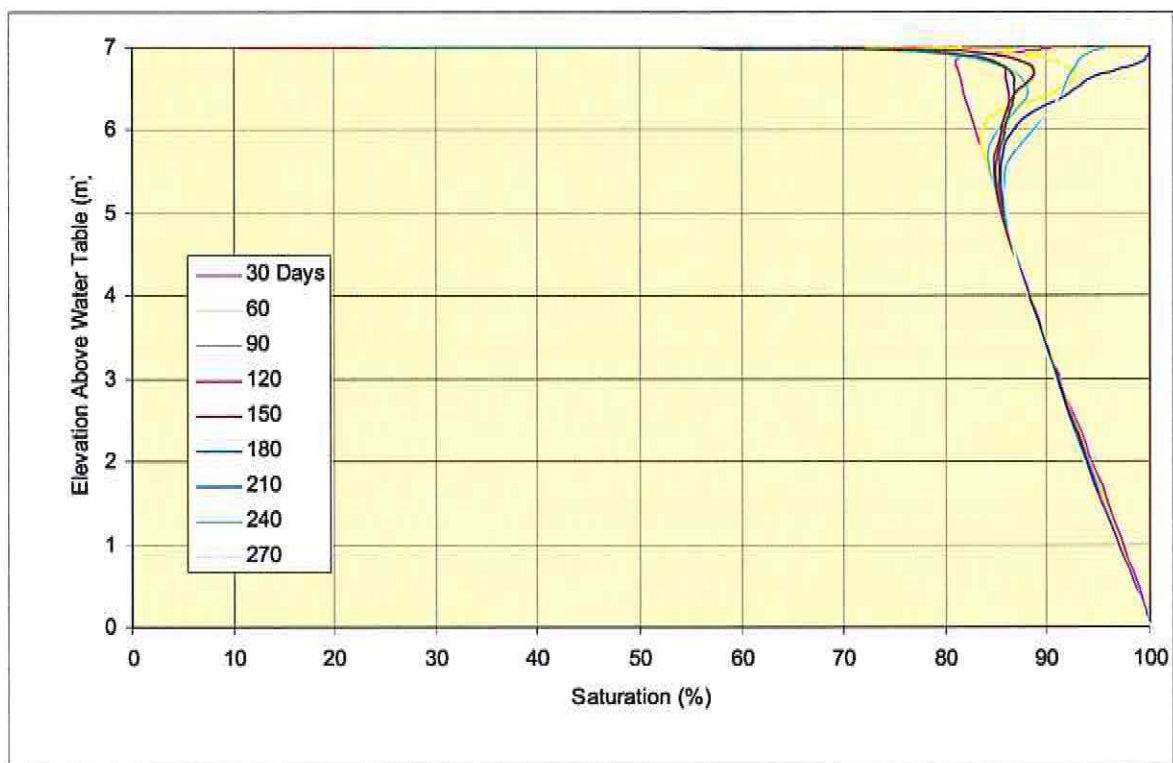
Figure 2.1 Estimated Saturation Profiles in Fine Tailings (Note: Tailings surface 7 m above water table)
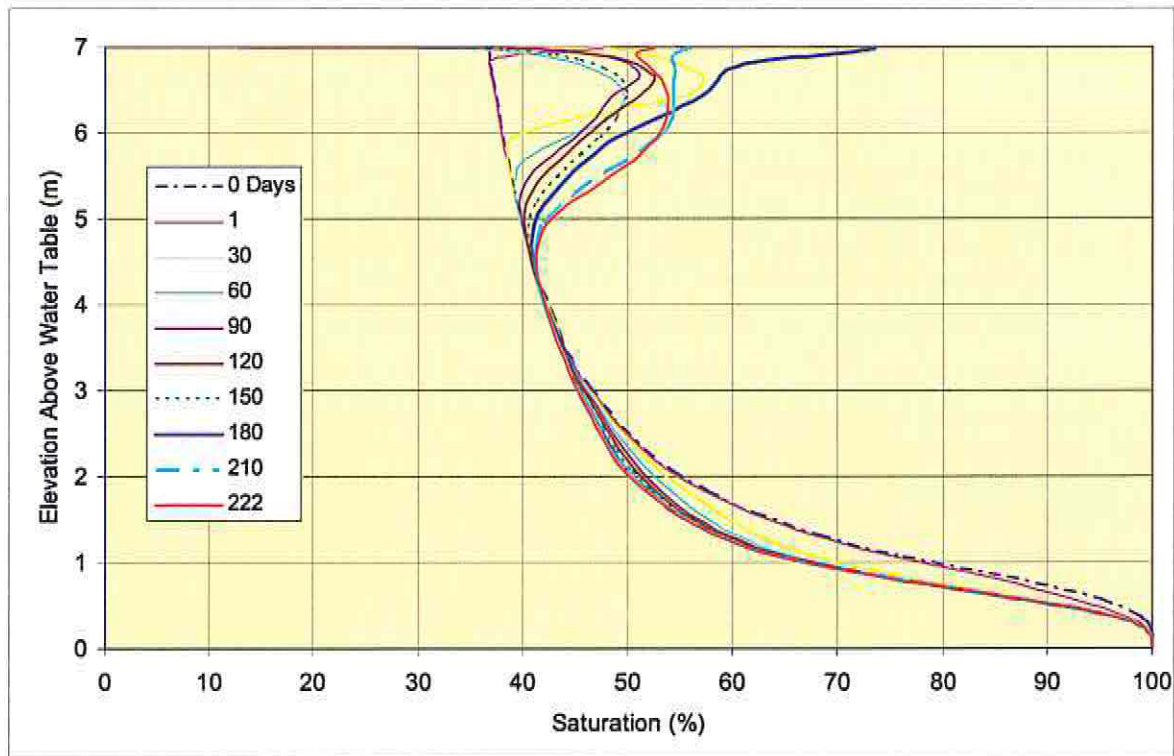
Figure 2.2 Estimated Saturation Profiles in Coarse Tailings (Note: Tailings surface 7 m above water table)

Table 2.10
Summary of Sulphate Production

Impoundment	Location		Zone	Sulphate		2001 tonnes	Time Oxdtn. years	Cumulative Production kg/m²
				Depth m	Avg. %			
Original	P01-10	A1-1	Fines	4.50	1.12	28,645	20	105
	P01-08	A2-1	Fines	7.6	0.33	14,147	20	52
		A7-1	Coarse	6	0.55	8,131	20	71
Second	P01-09	A3-1	Coarse	6.1	1.13	21,655	15	144
	P01-07	A4-1	Fines	4.5	0.78	37,344	15	73
Intermediate	P01-05	TP7/A5-1	Coarse	1	1.16	4,514	10	24
			Fines	1	1.16	14,127	10	24

3 Results

3.1 Estimated Release of Contained Solutes

The cumulative release of sulphate and zinc assuming no future oxidation are shown in Table 3.1. There is a minor difference between the two estimates as a result of rounding errors that occur as the peaks pass through the base of the tailings deposit. The total cumulative release shown in Table 3.1 represents our best estimate of the current "inventory" of sulphate and zinc in the various impoundments.

Table 3.1
Summary of Estimated Cumulative Releases of Sulphate and Zinc to Base of Tailings Assuming No Future Oxidation.

Area	Average Advance (720 years)		Maximum Advance (470 years)	
	SO4 Load	Zn Load	SO4 Load	Zn Load
	tonnes	tonnes	tonnes	tonnes
Original Impoundment	153,459	25,838	152,679	25,541
Second Impoundment (East)	75,309	12,435	75,297	12,461
Second Impoundment (West)	93,174	14,790	110,704	17,384
Intermediate Impoundment	131,044	21,257	178,893	29,057
TOTAL	452,985	74,320	517,573	84,443

Breakthrough curves for average advance rates were produced for each as shown in Figure 3.1 (sulphate) and in Figure 3.2 (zinc). As shown the total zinc release peaks at about 2028 at a loading of about 110 tonnes per year as the loading from the northern source area of coarse tailings of the Original Impoundment breaks through. A second peak is reached in about 2150 of 220 tonnes per year, when the southern area of the coarse tailings of the original impoundment breaks through together with the remainder of the coarse areas. The breakthrough curves of the fine tailings are delayed and peak at about 140 tonnes at year 2380.
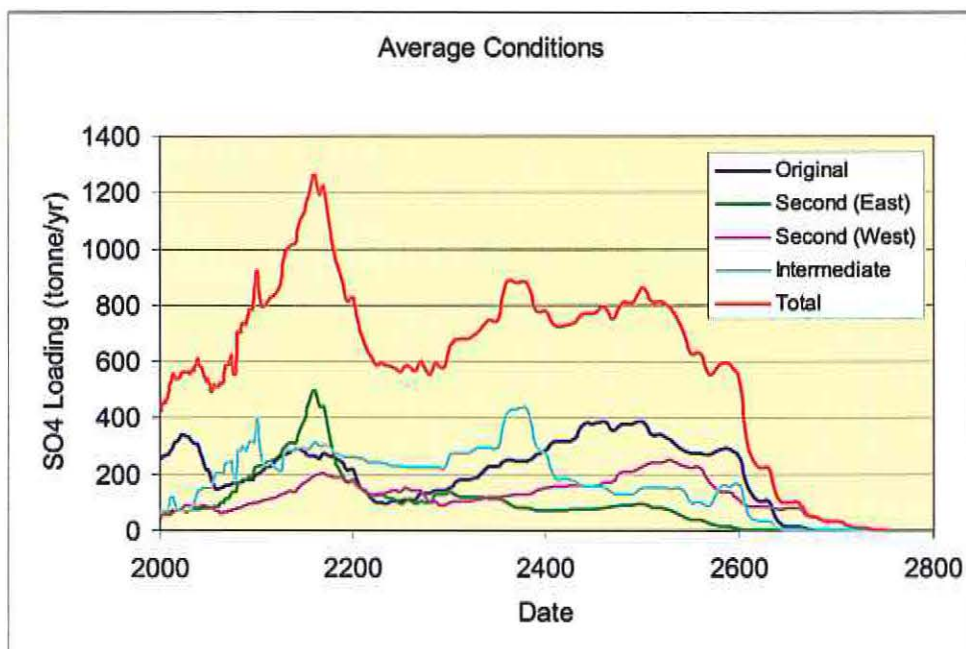
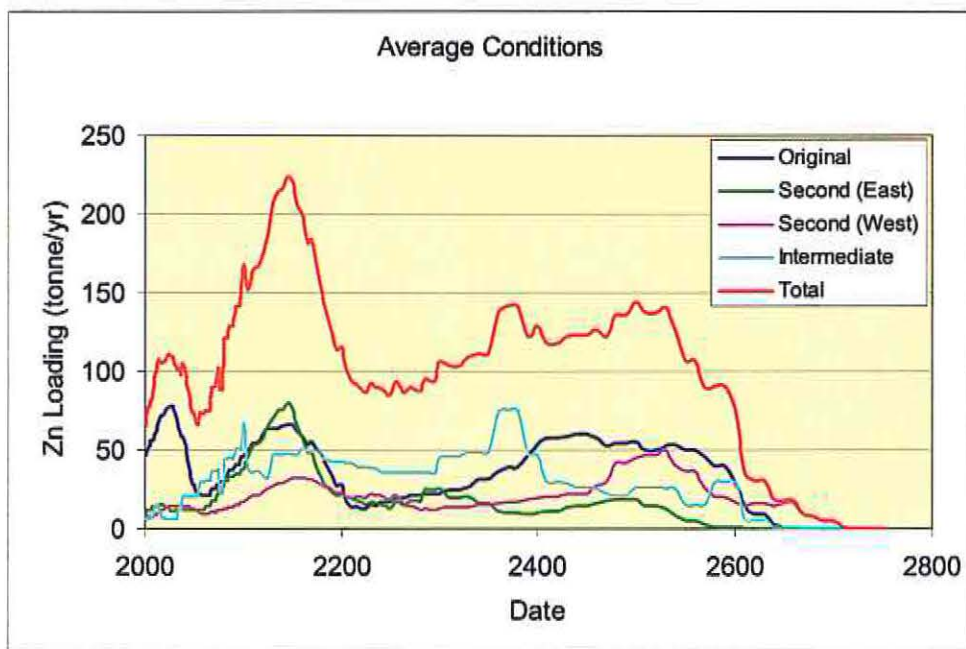**Figure 3.1 Estimated Sulphate Loadings for Average Advance Rates**

Figure 3.2 Estimated Zinc Loadings for Average Conditions

The estimated loadings for maximum rates of advance are shown in Figure 3.3 and Figure 3.4 for sulphate and zinc respectively. Increasing the rates of advance has two effects. First, the first and second peaks in zinc loading occur much sooner (2012 and 2068 as opposed to 2028 and 2150). Second, the first two peak loadings increase to 240 and 420 tonnes respectively, or about double the estimates for average conditions.

Maximum Conditions
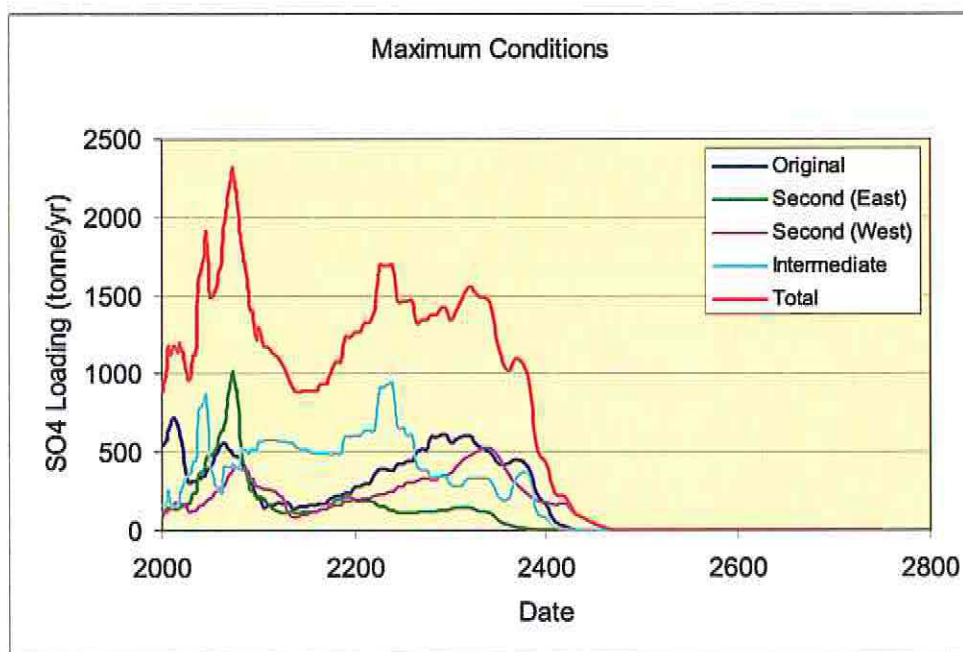
Figure 3.3 Estimated Sulphate Loadings at Maximum Rates of Advance

Maximum Conditions
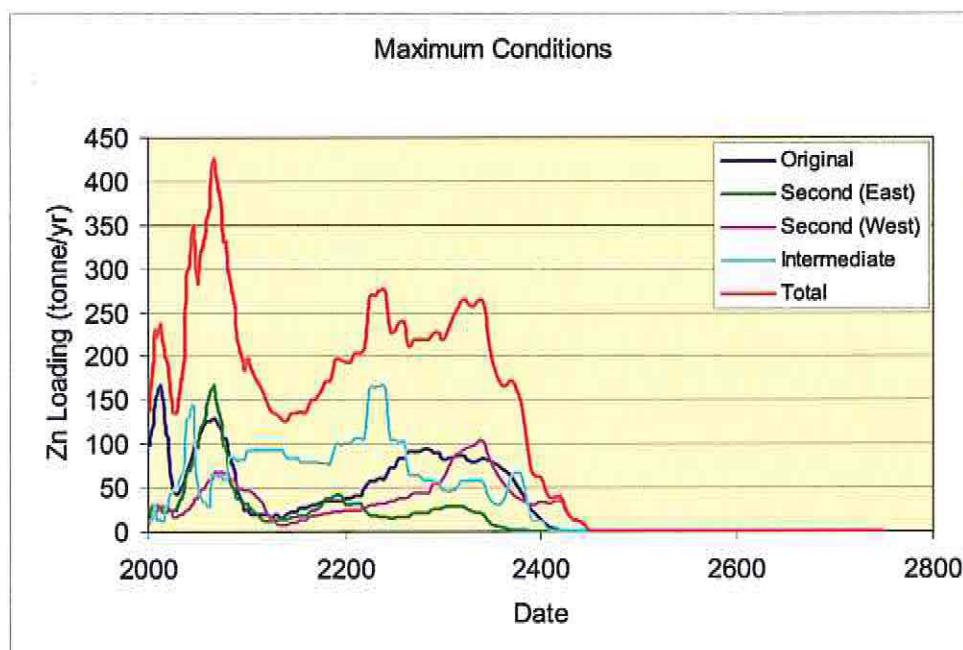
Figure 3.4 Estimated Zinc Loadings at Maximum Rates of Advance

3.2   Ongoing Oxidation

The potential effects of ongoing oxidation were assessed by fitting a simple curve to the estimated change in oxidation rate shown in Table 2.9. The curve that best fits the data is as follows:

$$R(t) = R_0 * t^{-0.532}$$

Where $R(t)$ is the production rate at time t

R_0 is the production rate at time $t = 0$

Using this equation and the current sulphate and zinc production rates at the surface, the future production was estimated and allowed to 'propagate' through the tailings as before. The results are summarized in Table 3.2

Table 3.2
Summary of Estimated Cumulative Releases of Sulphate and Zinc to Base of Tailings Assuming Ongoing Oxidation.

Area	Average Advance (720 years)		Maximum Advance (470 years)	
	SO4 Load	Zn Load	SO4 Load	Zn Load
	tonnes	tonnes	tonnes	tonnes
Original Impoundment	176,208	26,916	208,666	28,203
Second Impoundment (East)	104,851	13,872	150,412	16,146
Second Impoundment (West)	113,597	15,739	169,137	20,047
Intermediate Impoundment	161,310	23,115	259,846	34,027
TOTAL	555,966	79,643	788,062	98,422

The results for average conditions with ongoing oxidation are shown in Figure 3.5 and Figure 3.6 for sulphate and zinc respectively. As shown, the ongoing oxidation does not affect the peak release rates; it only extends loadings into the future.
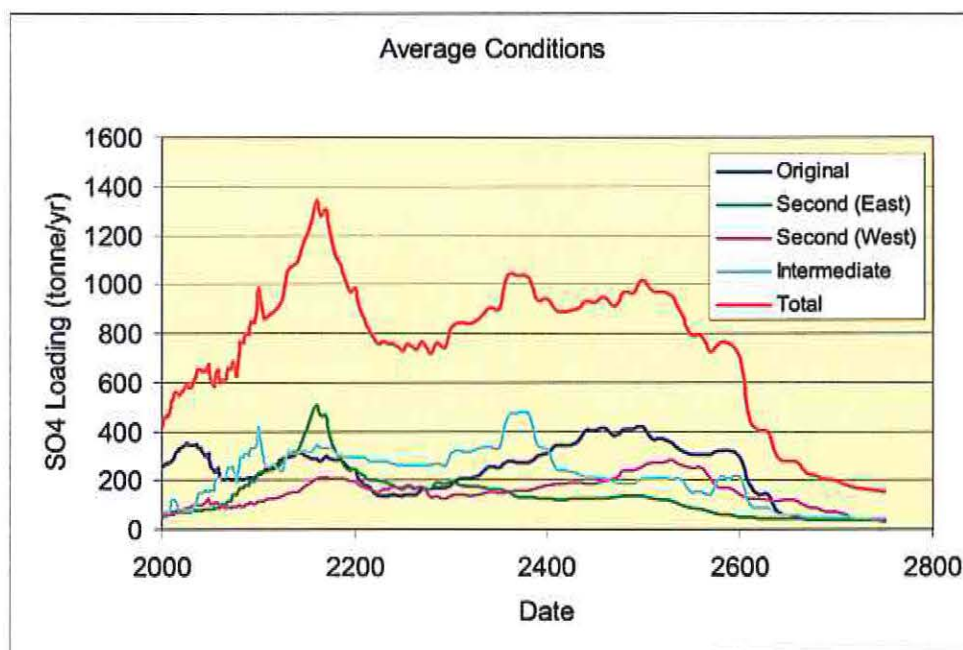
Figure 3.5 Estimated Sulphate Loadings with Ongoing Oxidation for Average Conditions
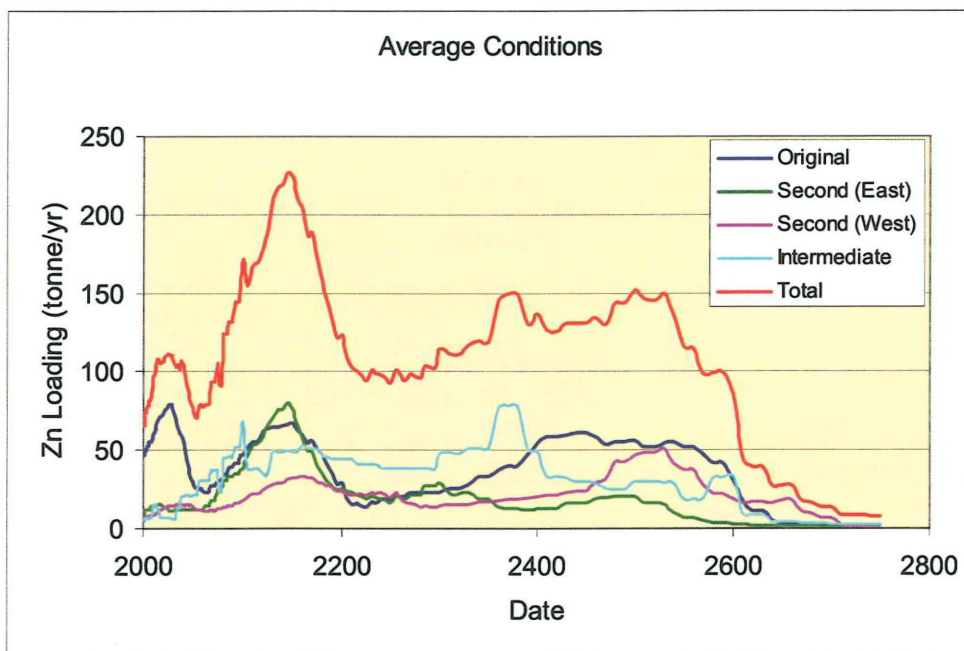
Figure 3.6 Estimated Zinc Loadings with Ongoing Oxidation for Average Conditions

The corresponding plots for maximum propagation rates are shown in Figure 3.7 and Figure 3.8 for sulphate and zinc at maximum rates of advance. The observations are the same as for the average conditions.
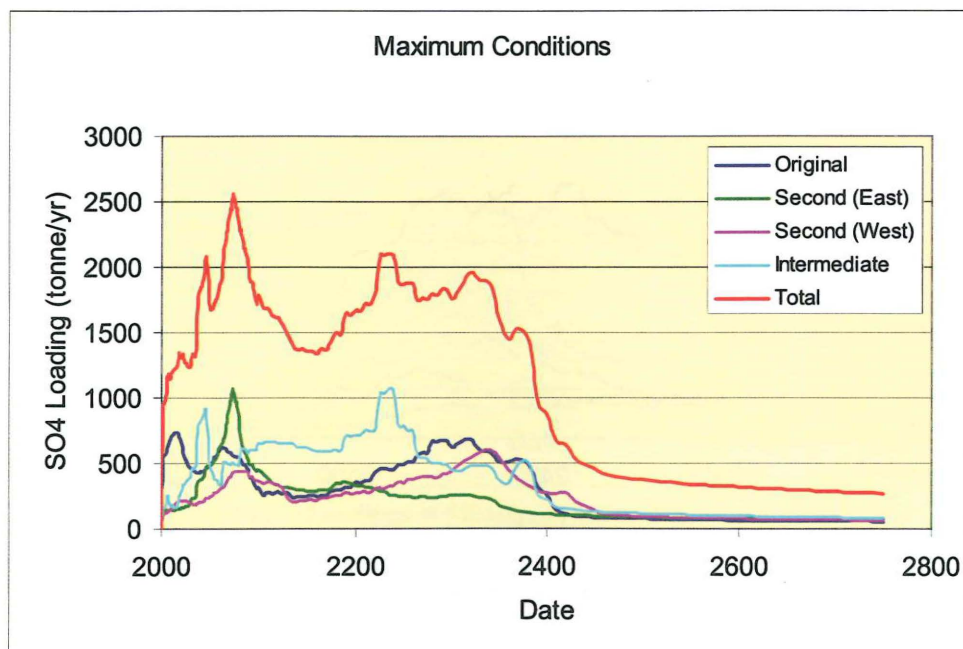
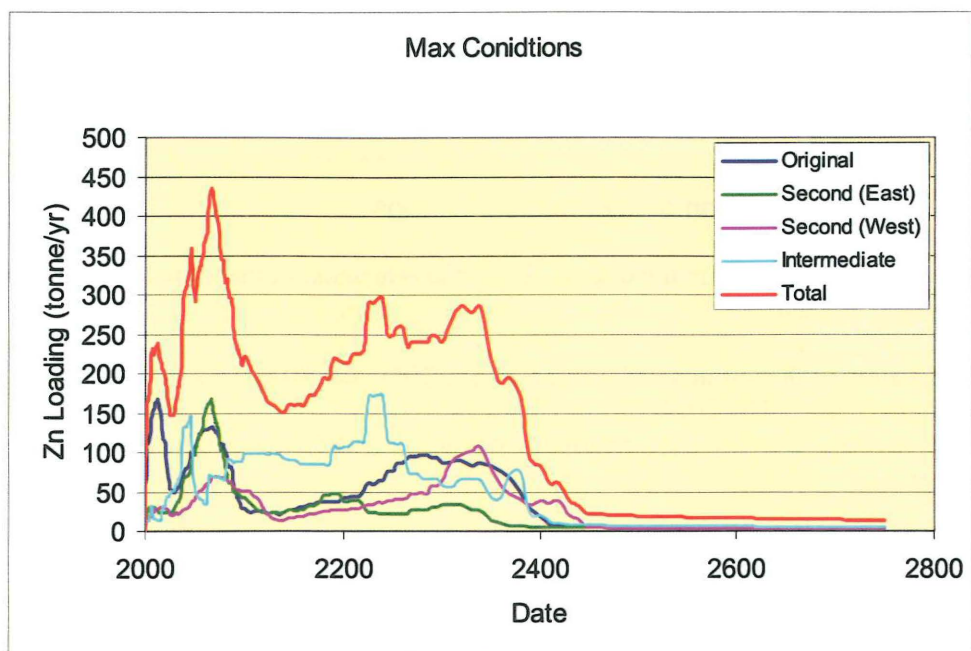**Figure 3.7 Estimated Sulphate Loadings with Ongoing Oxidation and Maximum Rates of Advance**

Figure 3.8 Estimated Zinc Loadings with Ongoing Oxidation and Maximum Rates of Advance

3.3   Effects of Remediation Alternatives

A series of runs were also completed to assess the potential source loadings that may result from various rehabilitation approaches. These are presented below.

3.3.1   Partial Relocation – Relocation of Intermediate Tailings

In order to estimate loadings from the tailings for partial relocation of the tailings, the following assumptions were adopted:

- Relocation of the tailings will occur between 2008 and 2014, with the Intermediate Tailings removed by 2014;
- Dry covers will be placed concurrently on the Secondary and Original Tailings by end of 2010.

The results are illustrated in Figure 3.9 and Figure 3.10.

3.3.2   Partial Relocation and Establish Water Cover

The source loadings were estimated for partial relocation of the tailings down to an elevation of 1064 m ASL. A water cover was then assumed to be established over the remaining tailings. It was assumed that the Original Impoundment would be removed to a depth of about 22 m from surface by about 2010, the Second Impoundment to a depth from surface of 19 m by 2014, and the Original Impoundment tailings would be removed to a depth of about 4 m from surface by 2018. The water cover (about 3 m deep) was assumed to be established by about 2020.

The results are illustrated in Figure 3.11 and Figure 3.12 respectively for average and maximum propagation rates.

3.3.3   Complete Water Cover

Source loadings were estimated in the event that the Intermediate Impoundment is raised to establish a water cover to a depth of 3 m over the entire tailings deposit. The results are illustrated in Figure 3.13.

3.3.4   Dry Low Infiltration Covers

The placement of dry covers over the entire tailings deposit were assessed assuming that low infiltration or store and release covers would reduce the net infiltration to the tailings to about 5 mm per annum. It was assumed that the covers would be completed by about 2010. The results are shown in Figure 3.14 and Figure 3.15.
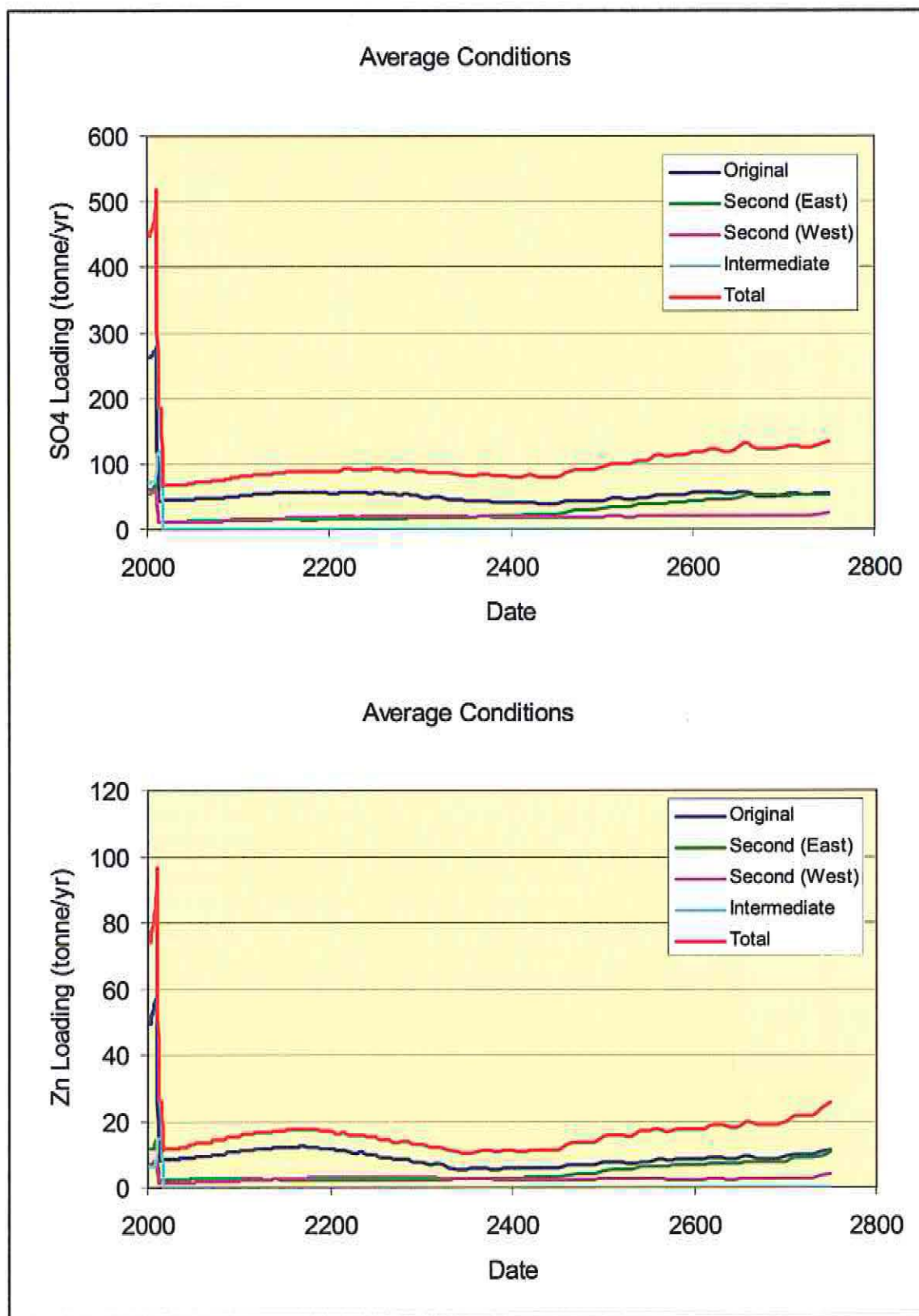
Average Conditions

Average Conditions

Figure 3.9 Estimated Loadings for Relocation of Intermediate Tailings, Assuming Average Propagation Rates
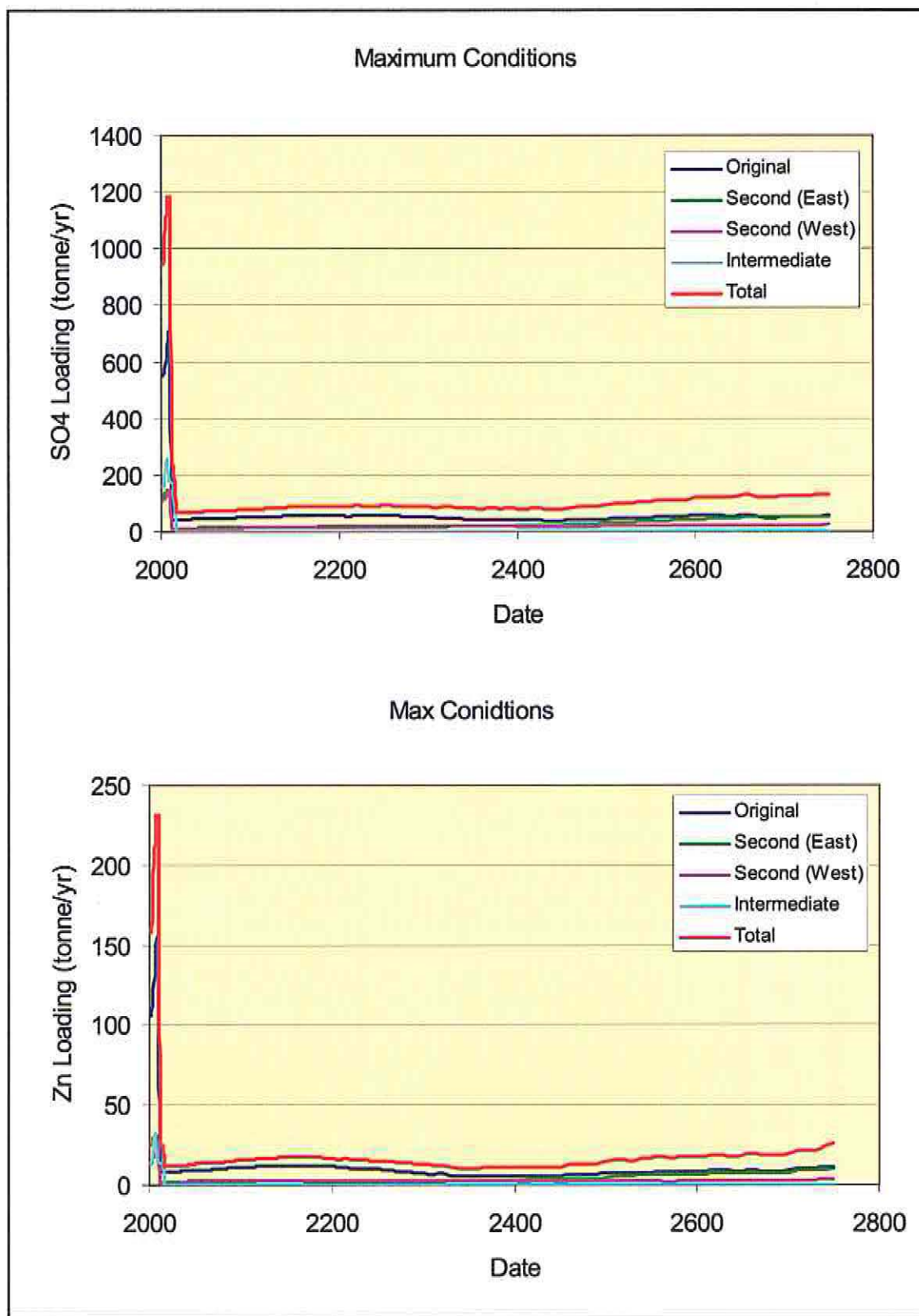
Figure 3.10 Estimated Loadings for Relocation of Intermediate Tailings, Assuming Maximum Propagation Rates
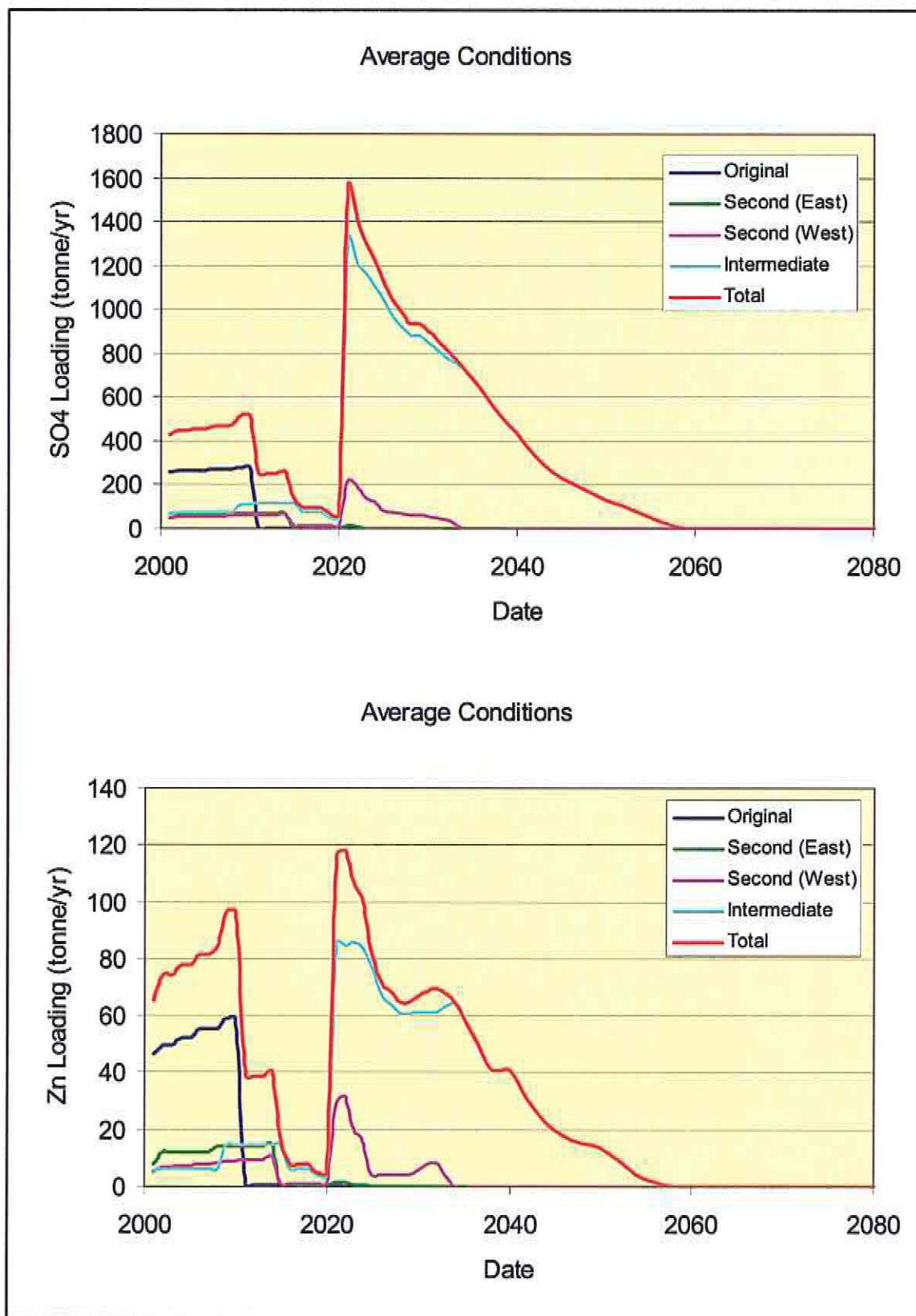
Figure 3.11 Estimated Loadings for Partial Tailings Relocation, Establishing a Water Cover and Assuming Average Propagation Rates
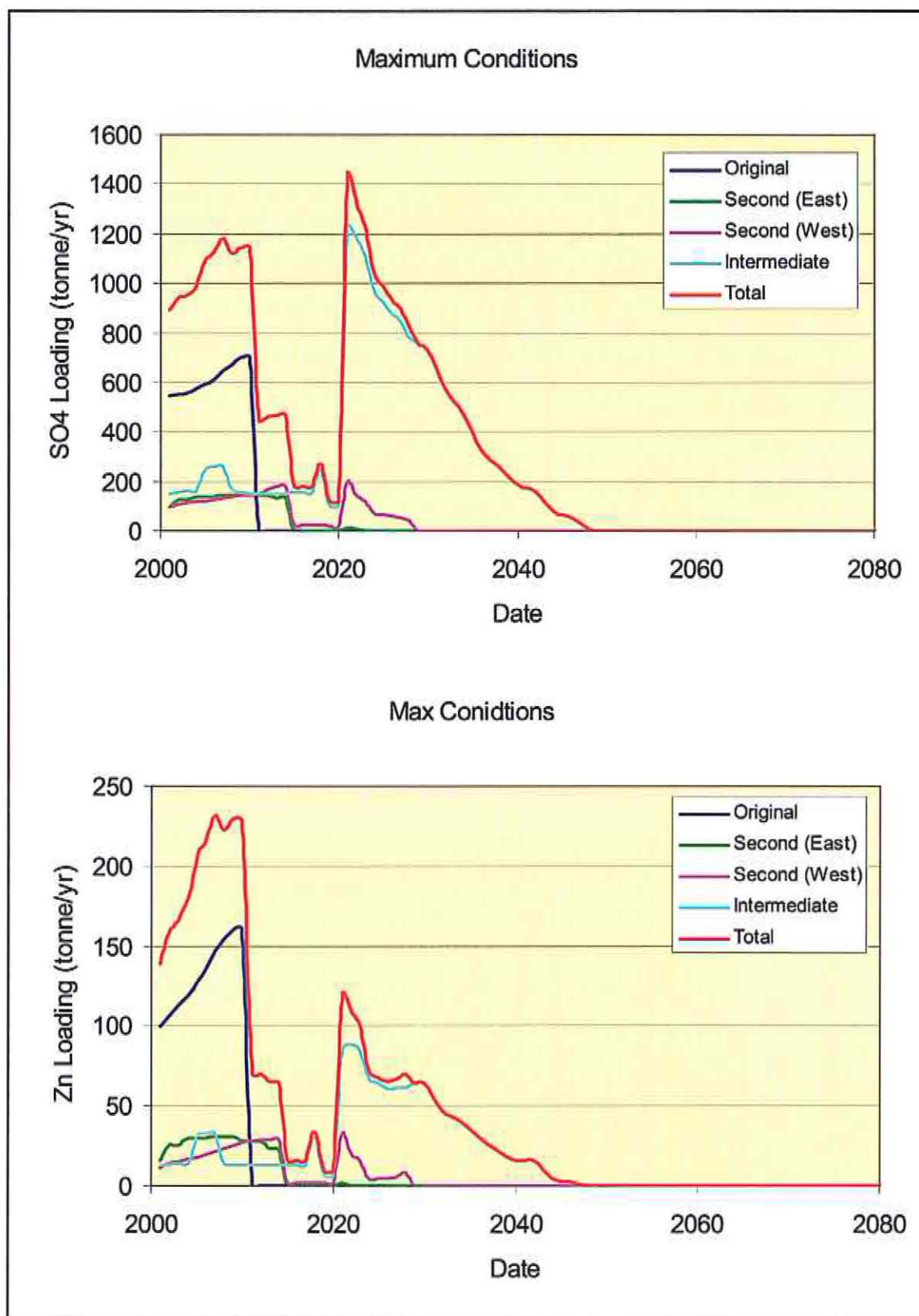
Figure 3.12 Estimated Loadings for Partial Tailings Relocation, Establishing a Water Cover and Assuming Maximum Propagation Rates
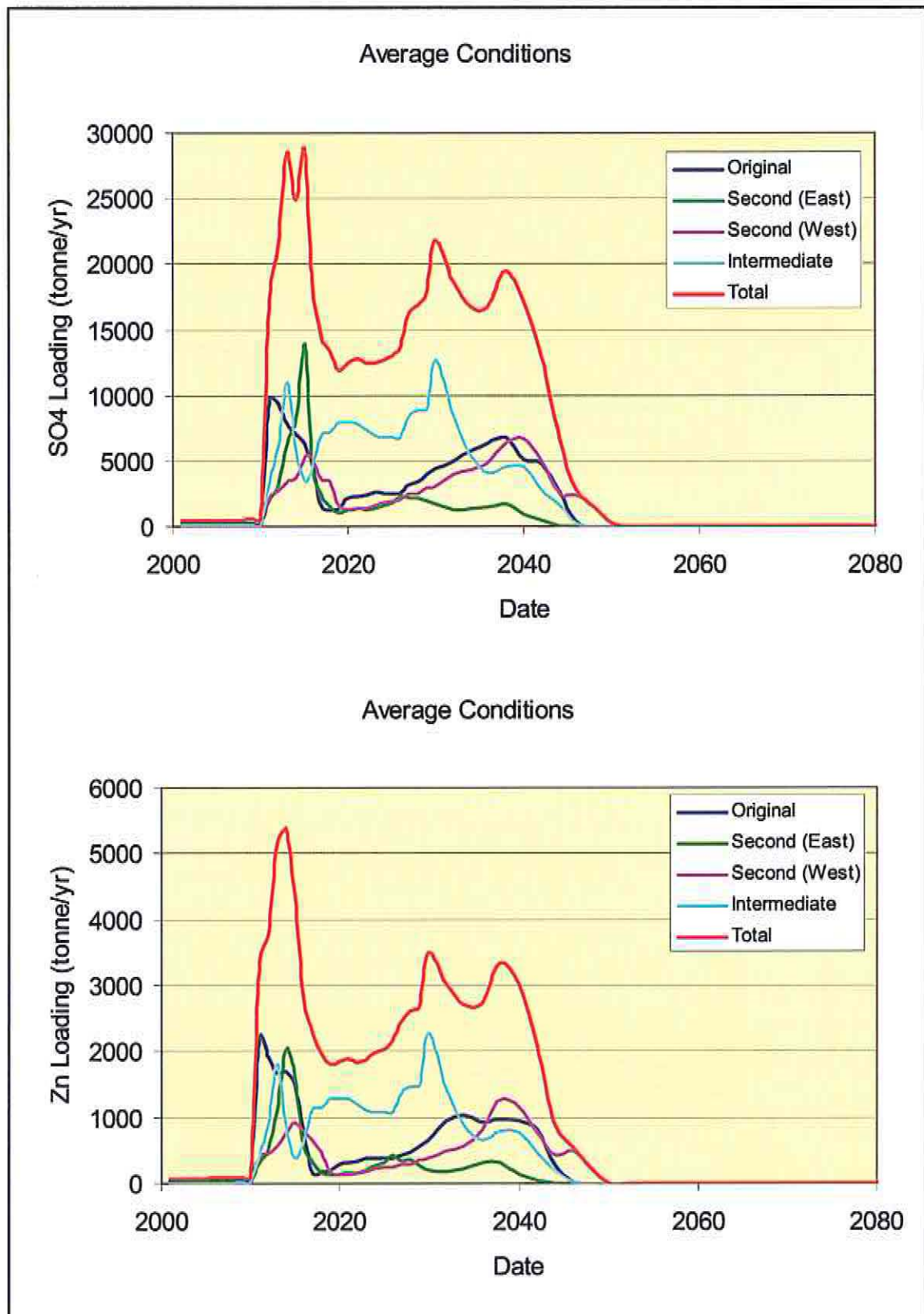
Figure 3.13 Estimated Loadings for Establishing Water Cover Over the Entire Tailings Deposit
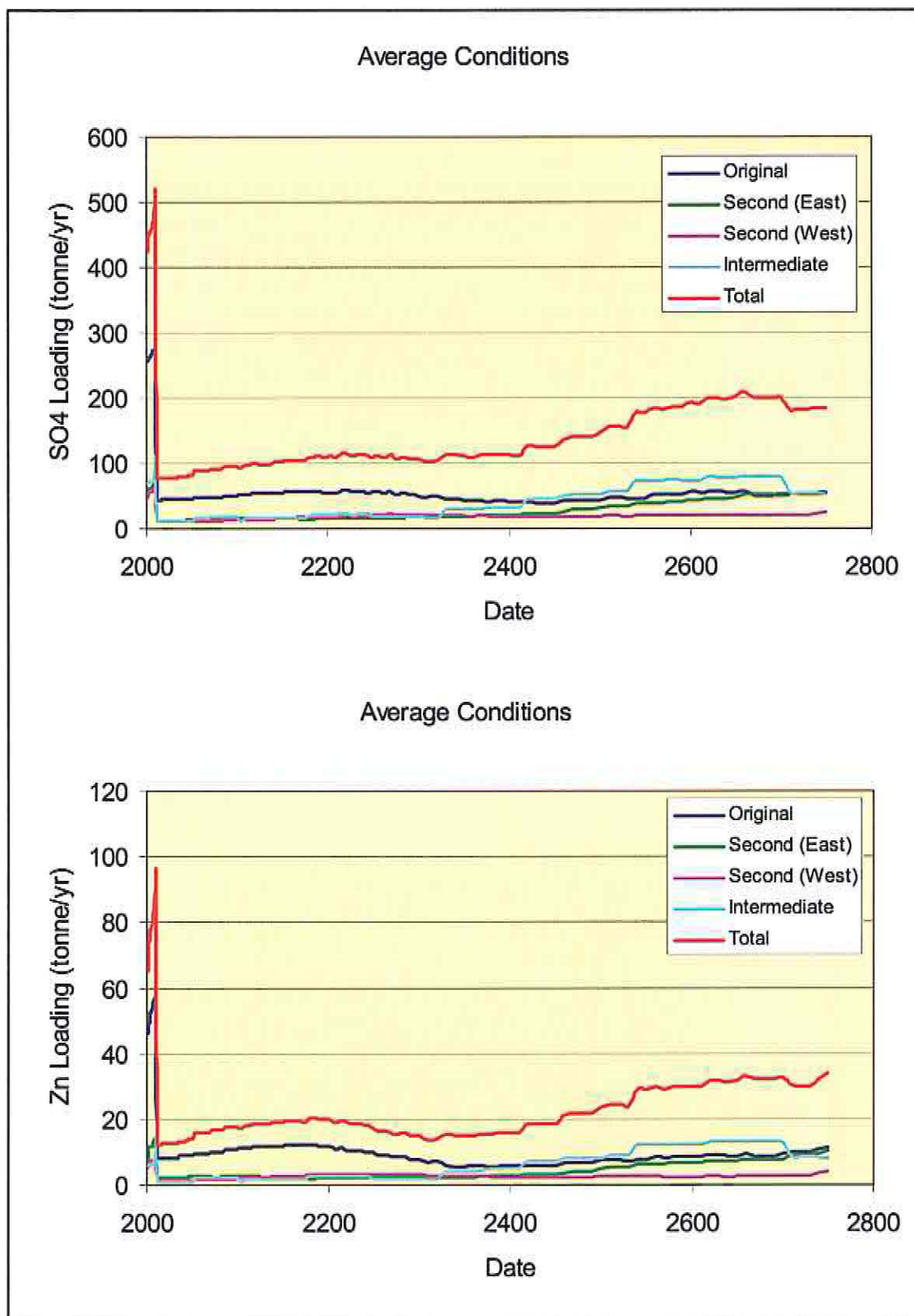
Figure 3.14 Estimated Loadings for Establishing Dry Covers Over the Entire Tailings Deposit Assuming Average Propagation Rates

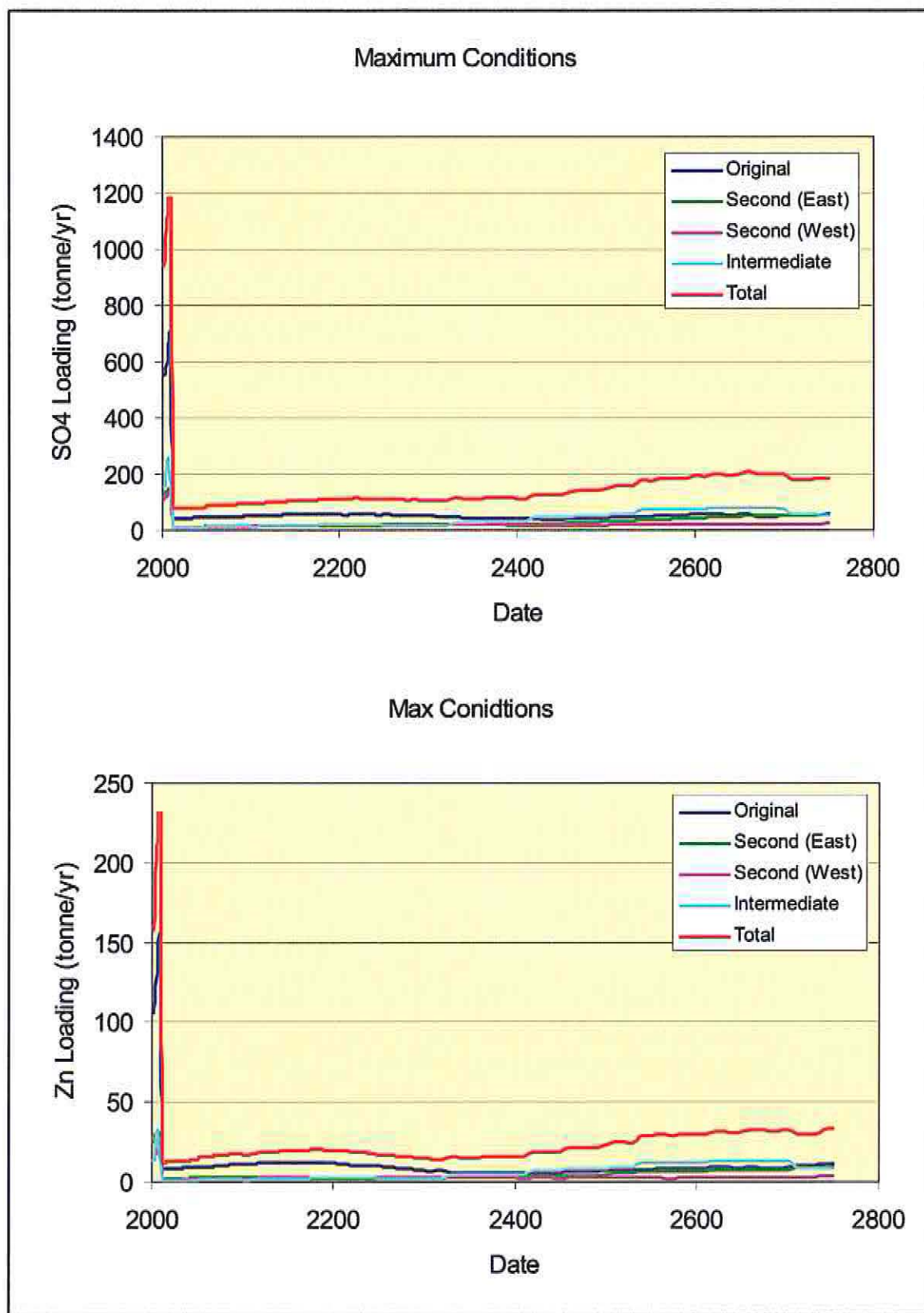## Maximum Conditions

Max Conidtions

Figure 3.15 Estimated Loadings for Establishing Dry Covers Over the Entire Tailings Deposit Assuming Maximum Propagation Rates