Monitor Trial Covers at Rose Creek Tailings Impoundment

2004/05 Task 16b

Prepared for

Deloitte & Touche Inc.

On behalf of

Faro Mine Closure Planning Office

Prepared by

SRK Consulting
Engineers and Scientists

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Deloitte & Touche Inc.

On behalf of

Faro Mine Closure Planning Office

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1 Introduction & Scope of Report

1.1 General

Deloitte & Touche Inc. (D&T) was appointed Interim Receiver of the property, assets and undertaking of Anvil Range Mining Corporation (ARMC), and its subsidiaries, Anvil Range Properties Inc., (collectively "Anvil") pursuant to an Order of Mr. Justice Blair of the Ontario Court (General Division) dated April 12, 1998. SRK Consulting (Canada) Inc. (SRK) was retained by D&T to assist in the development of a Final Abandonment and Reclamation Plan for the Anvil Range Mining Complex. This Plan will be submitted to the relevant regulating authorities by late 2005; however, engineering studies are being undertaken in the interim to provide necessary scientific background information required to develop the plan.

This report has been prepared as part of the ongoing technical evaluation for the closure planning of the Faro Mine and documents the results of 2004/05 Task 16b – monitoring of trial covers at the Rose Creek Tailings Impoundment, as stipulated in an SRK proposal dated July 16, 2004 (Appendix A). Aspects of this report have been superceded by subsequent technical studies.

1.2 Background of the Project

Lead-zinc tailings from the ARMC were deposited hydraulically in the Rose Creek tailings complex, which consist of a series of dams within the Rose Creek valley. The complex has a surface area of approximately 196 ha, and as a result of depositing behind a series of dams, the surface is not single continuum. Tailings deposition strategies changed over the life of the mine, resulting in fairly random tailings consistency from coarse beach areas which are readily accessible to slimes areas which are not trafficable. Currently, there are also large sections of the tailings covered by permanent and/or seasonal water.

Two closure strategies are being considered for the Rose Creek tailings complex; (a) complete relocation to the Faro pit, and (b) cap (cover) tailings in place. The tailings relocation options are being evaluated as a separate Task, and do not form part of the scope of work presented in this report.

SRK completed a preliminary cover assessment study (SRK, 2003) that discussed what could be achieved by covering the Rose Creek tailings impoundment with a cover consisting of locally available soils and/or benign waste rock. A workshop was held in February 2004, in Vancouver, during which time the results of the preliminary cover assessment was discussed, together with the results of site wide engineering studies completed in 2003 as part of the final reclamation planning. The workshop attendees agreed that if the Rose Creek tailings were to be covered, the cover should be a "terrestrial" cover. The conceptual design for this cover presented at the workshop was a layer of "run-of-mine" benign waste rock (such as the calc-silicate). It was envisioned that the thickness of this cover be limited to the minimum that could practically be placed.

The objectives of the "terrestrial" cover would be threefold; (a) to prevent wind erosion; (b) to limit access to exposed tailings by human and animal contact, and; (c) to prevent vegetation from establishing on the tailings. The objectives of limiting infiltration and shedding runoff were not considered to be important, and limiting oxygen ingress was considered to be unnecessary.

Actual construction of any type of cover, including the proposed "terrestrial" cover poses significant constructability challenges, including;

- trafficability of the tailings, and
- settlement of the final cover.

In, addition to these constructability issues, there are also some long-term sustainability issues, including;

- increased waste load as a result of increased release of pore water during settlement,
- potential for tailings fines to migrate upwards through the cover (both under normal conditions, freeze-thaw cycles and as a result of infrequent but potentially severe seismic action),
- phytotoxicity in vegetation that does establish on the cover, and
- physical changes in the cover properties over time.

It was subsequently agreed at the February 2004 workshop, that trial covers would be constructed on the Rose Creek tailings impoundment to obtain site specific data regarding some of these constructability and sustainability issues. These trial covers were constructed in April 2004, and monitoring data for these trial covers was collected between April and September 2004.

1.3 Scope of Work

This report summarizes the design, construction, and subsequent monitoring results for the two trial covers on the Rose Creek tailings impoundment. These results provide engineering data that is essential to the development and optimization of the design of a "terrestrial" cover for the Rose Creek tailings complex.

This report provides discussion of the 2004 monitoring results. However, the development of a detailed final cover design for the Rose Creek tailings complex is outside the scope of work.

1.4 Methods

Two trial covers, each measuring approximately 80 cm thick and 625 m^2, were constructed between April 8 and 17, 2004. Construction was carried out by Tim Moon Construction, assisted by ARMC personnel and equipment. Gerry Ferris, M.Sc., P.Eng. a Geotechnical Engineer from BGC Engineering Inc. (BGC) provided on-site engineering support on behalf of SRK, who designed the trial covers. An "as-built" report on the trial covers was submitted to D&T and SRK on June 11, 2004 (BGC, 2004).

Following construction, BGC trained ARMC personnel to conduct monthly surveys of 70 points on the two trial covers, such that progressive settlement could be evaluated. Monthly survey results were faxed to SRK between May and September, 2004. No data beyond September was collected due to the presence of snow on the trial covers.

The trial covers were visually inspected five times by various SRK personnel (John Chapman, M.Eng., P.Eng., Dylan McGregor, M.Sc., GIT, and Maritz Rykaart, Ph.D., P.Eng.) between April and September 2004. The purpose of these inspections was to observe and document any physical changes in the trial covers. In September, 2004 three test pits was excavated on each trial cover to inspect whether there was any indication of tailings fines migrating up through the tailings. The test pit excavation was supervised by Maritz Rykaart, Ph.D., P.Eng., a Senior Geotechnical Engineer with SRK.

2 Design and Construction of Trial Covers

2.1 General

The as-built report for the trial covers (BGC, 2004) contains details of their design and construction, important aspects of which are reiterated here to facilitate the reader's understanding of the results.

2.2 Design

The trial covers were designed to specifically evaluate the following;

- The magnitude of settlement of the cover.
- If, and to what extent tailings would migrate upwards through the cover.
- If placement of a geotextile would be beneficial to alleviate the problem of potential tailings migration.

Based on the primary objectives for a "terrestrial" cover, as stipulated in Section 1.2 of this report, SRK determined that the suitable cover material should be (a) geochemically benign (especially if waste rock is to be used), (b) be easily harvested, with a close haul distance, and (c) be a well graded gravel to gravel sand mixture (GW) with little to no fines, such that vegetation would be restricted. The calc-silicate waste rock was subsequently selected as the material to use for the test pads. Particle size distribution data for the calc-silicate waste rock has not been obtained, and no samples were collected for analysis during cover construction. Visual inspection indicated that the waste rock varied in size from boulders larger than 200 cm in diameter to silt and clay (fines). The bulk of the material would however be classified as well graded, silty to clayey gravel (GM-GC), with boulders less than 60 cm in diameter. Occasionally, pockets of the material were encountered with little or no fines. Based on these properties, it was reasoned that the practical minimum cover thickness using this material would be between 60 cm and 100 cm. The target design thickness for the cover trial areas was set at 80 cm, with a 10 cm tolerance on either side. The as-built survey confirmed that, for the most part, the pads were constructed to this specification (BGC, 2004).

The trial covers were supposed to allow for representative evaluation of settlement potential of the cover material, and therefore had to be of sufficiently large scale. To achieve this, the design test pad dimensions called for base dimensions of 29.8 x 29.8 m, and crest dimensions of 25 x 25 m. The as-built test pad dimensions are presented in Table 1. Figure 1 illustrates the test pad location, and Figure 2 presents the general layout of the two test pads.

Table 1: As-Built Trial Cover Dimensions

Test Pad	Geotextile Separation	Base Dimension (m)	Top Dimension (m)	Volume of Material in Pad (m^3) Based on Survey
East Pad	No	30.0 x 26.0	24.0 x 24.0	615
West Pad	Yes	32.0 x 31.0	27.5 x 27.5	695

One of the concerns related to cover construction was the possibility of fines migrating through the "terrestrial" cover due to capillary action associated with the shallow water table within the tailings, or as a result of trapped pore pressure during seismic loading. This physical migration of fines can be prevented by placing an appropriately designed filter between the tailings surface and the cover, and the simplest form of such a filter is a non-woven geotextile. Subsequently one of the test pads was constructed directly onto the tailings surface (East Pad), and the second pad was constructed on top of a non-woven geotextile (West Pad).

The specified geotextile was Armtec 350, which has an apparent opening size (AOS) of 0.15 mm. There was insufficient quantity of this material on site, and a small portion of the pad was underlain by Armtec 250, with an AOS of 0.18 mm (detail provided in BGC, 2004). The purpose of the geotextile is to retain the tailings, and based on the most conservative empirical method described in Koerner (1986), assuming the tailings can be classified as silty sand (SM) with a d_{50} of 0.15 mm and a coefficient of uniformity of 12.4, the geotextile should have an AOS of 0.22 mm or smaller. Both geotextiles used are therefore within the desired specification.

2.3 Construction

A significant concern associated with construction of covers on the Rose Creek tailings is trafficability. Large sections of the Rose Creek tailings impoundment contain fine tailings and slimes, with high moisture content and a high water table. It is therefore not possible to put construction equipment directly on these tailings under unfrozen conditions. Placement of a "terrestrial" waste rock cover onto unfrozen tailings would require that the cover material be placed from the perimeter of the impoundment using end-dumping from the edge of the working platform. This method of cover material placement has three potential drawbacks; (a) since the cover material is essentially a working platform, substantial mixing of the tailings and cover material may occur, which could lead to larger cover volumes being required; (b) access routes based on the use of fill thicknesses significantly greater than 80 cm will be required for vehicle access, which would lead to larger cover volumes and possibly geotextiles being required; and, (c) a bow wave of tailings can develop in front of the working platform, which would again result in more cover material being required, as well as potential re-grading of the surface.

The cold winter climate at the Anvil Range Mining Complex offers an opportunity to alleviate the trafficability problem. During winter, the tailings surface becomes completely frozen, and can generally support large construction equipment. Under these conditions, the cover material can be placed optimally with good control over the volume of material that would be required. Therefore, a cover placed in winter would effectively eliminate trafficability issues. Unfortunately, actual test pad construction was carried out late in the winter season, specifically mid April when the maximum daily ambient air temperatures for the period were between -1°C and 8°C, and the minimum ambient night-time temperatures were between -4°C and -14°C. The tailings in the test pad area were frozen prior to construction, at least to a depth of 60 cm as confirmed by driving steel bars into the surface. Throughout daily construction the upper surface of the tailings thawed each day, leading to the development of ruts in the surface. These ruts averaged between 10 and 50 mm deep at the East Pad and up to 100 mm deep at the West Pad. The West Pad area was generally less trafficable than the East Pad as a result of the tailings surface thawing. In some areas, it appeared that trucks had caused localized settlement of more than 200 mm, but upon closer inspection it was clear that those areas were snow-filled depressions in the tailings surface that had been created when the snow was cleared prior to the start of construction. The as-built report (BGC, 2004) provides a complete photo log illustrating these conditions.

Pad construction was intended to mimic, to the extent practical, full-scale construction conditions, including the use of large construction equipment (e.g. CAT 777 haul trucks and D9 to D11 dozers). This was however not practical for such a small trial cover, and standard tandem axle road dump trucks and a D8 dozer were used to construct the trial covers. This difference in construction equipment should not impact cover performance assuming the full scale closure cover is placed on frozen tailings. However, based on the surface thawing that was observed during placement of the trial covers, it was probably beneficial to have lighter equipment for their construction.

The location of the test pads was specifically selected to coincide with soft, saturated slimes, since they are expected to hold the greatest potential for settlement and upwards migration of tailings through the cover. The selected site (Figure 1) appeared to have these characteristics based on drill hole logs. Subsequent visual inspection has confirmed that the site is reasonably representative of "worst" case conditions with respect to settlement and upward migration of fines.

2.4 Monitoring

The primary monitoring objective of the trial covers was settlement. For this purpose survey control was set up in two ways; (a) primary survey beacons monitoring the base (foundation) settlement of the pads, and (b) secondary survey beacons monitoring the surface settlement of the pads. Details of these beacons are described in the as-built report (BGC, 2004).

Three primary survey beacons were installed in each test pad as indicated on Figure 2. The objective of these beacons was to measure the pad foundation settlement. The secondary survey beacons consisted of 16 boulders placed in a fixed grid pattern on each test pad surface to monitor the pad surface settlement. As a backup, in case the boulders became unstable, a conventional survey pin (30 cm long) was also installed immediately adjacent to each boulder. The pins were labelled with a "Y" prefix to the station number, and the rocks were labelled with an "R" prefix.

A permanent benchmark was established at the time of the as-built survey (due south of the test pads, on the Rose Creek Diversion embankment), and all monthly settlement surveys were referenced from this benchmark.

3 Post Construction Monitoring

3.1 Surveying

The as-built survey for the test pads was carried out by Yukon Engineering Services (YES). ARMC staff carried out monthly settlement surveys using a “dumpy” level. Levelling was done from a fixed benchmark (Y6600) installed by YES. The levelling data was reduced to actual elevations by ARMC staff and faxed to SRK. Table 2 summarizes details of the settlement surveys, and Appendix B contains complete data tables for all the surveys.

Table 2: Details of the monthly settlement surveys

Date	Surveyed By	Comments
April 20, 2004	Yukon Engineering Services	as-built survey
May 28, 2004	C. McKinnon & R. Meiers	
June 16, 2004	C. McKinnon & R. Meiers	Rock beacons 6587 and 6596 is wobbly
July 16, 2004	C. McKinnon & R. Meiers	Beacons 6566, 6574 and 6578 were disturbed
August 20, 2004	C. McKinnon & R. Meiers	
September 23, 2004	C. McKinnon & R. Meiers	Last survey for 2004
October 22, 2004	No survey possible – pads covered in snow	

On June 17, 2004 ARMC was excavating a test pit approximately 10 m west of the West Pad using the ARMC CAT 235 tracked excavator. The excavator got stuck during this excavation and the ARMC D9 Dozer had to be used on the West Pad to allow recovery of the excavator, and upon recovery, the excavator crawled across the pad. This resulted in disturbance to the south-east corner of the pad as well as to secondary survey beacons 6566, 6574 and possibly 6578. The damage on the trial cover is presented schematically on Figure 3.

During test-pitting carried out on the test pads on September 23, 2004, care was taken not to disturb any of the survey beacons, however, secondary beacon Y6585 (the 30 cm pin) on the East Pad was found to be covered in dirt after the pit was backfilled. The pin was carefully cleared by hand, and it appeared that the dirt may have been present prior to the test pitting. However, data from this pin should be viewed cautiously when monitoring resumes in 2005.

3.2 Inspections

Visual inspections of the trial covers were carried out five times between April and September 2004. The details of these inspections are listed in Table 3.

Table 3: Details of the visual inspections conducted on the trial cover areas

Date	Inspected By	Comments
April 28, 2004	John Chapman	No notable elements of concern
June 7, 2004	Dylan MacGregor	Slight surface cracking evident on both pads
June 24, 2004	Dylan MacGregor & John Chapman	Damage on West Pad as a result of the retrieval of an excavator stuck in the tailings
August 29, 2004	Maritz Rykaart	Abundant surface cracking on East pad; Minor surface cracking on West Pad
September 27, 2004	Maritz Rykaart	Basically unchanged from August inspection; Test pits excavated

With the exception of the damage sustained to the West Pad as a result of the excavator extraction incident, the only noticeable feature during the inspections was surface cracking. A schematic of the extent of the cracks as observed during the August 29 site inspection is presented in Figure 4 and Appendix D contain photos of these features taken at the time. The surface cracks are randomly spaced across the pad surface, and vary in size from a few millimetres wide to more than 2 cm wide and approximately 10 cm deep (as probed from the surface). Surface cracks were first observed during the June 7 site inspection, and although a schematic similar to Figure 3 was not developed at the time, the inspector's field notes and photos (Appendix C) suggest that cracking was less severe and slightly more common on the West Pad than on the East Pad. This trend was reversed during the August inspection, with significantly more cracks on the East Pad.

3.3 Test Pits

Three shallow tests pits were excavated into each of the trial covers on September 27, 2004. The test pits were excavated with a rubber-tired Case 580 Super-M backhoe belonging to ARMC. The backhoe was equipped with a 60 cm wide sand bucket. Photographs of the test pits are included in Appendix E and the logs are summarized in Table 4. The approximate test pit locations are presented in Figure 2.

Table 4: Summary of test pit results

Test Pit	Pit Profile	Comments
East Pad – TP-TTC-04-01	0 to 80 cm – calc-silicate waste rock cover material	Mixed zone dominated by presence of angular boulders. Nature of mixing suggests it probably started during construction. Beyond mixed zone there are no signs of tailings migrating upwards. Boulders up to 50 cm in diameter present in cover matrix. Cover material is very moist to wet and test pit side slopes have no strength – progressively failing with time. Cover material consistency is loose. There is no apparent variance in moisture with depth in the cover material. Tailings are very moist to wet, but firm, and unfrozen.
	80 to 100 cm – undulated mix of calc-silicate waste rock cover material and tailings	
	100 cm onwards – undisturbed tailings	
East Pad – TP-TTC-04-02	0 to 100 cm – calc-silicate waste rock cover material	
	100 to 120 cm – undulated mix of calc-silicate waste rock cover material and tailings	
	120 cm onwards – undisturbed tailings	
East Pad – TP-TTC-04-03	0 to 70 cm – calc-silicate waste rock cover material	
	70 to 90 cm – undulated mix of calc-silicate waste rock cover material and tailings	
	90 cm onwards – undisturbed tailings	
West Pad – TP-TTC-04-04	0 to 75 cm – calc-silicate waste rock cover material	Undulated surface at geotextile contact, dominated by original tailings surface. Limited signs of boulders penetrating beyond original tailings profile. Tailings and cover moisture and consistency similar to East Pad test pits. No signs of tailings migrating though geotextile.
	75 - 80 cm – minor undulations in geotextile surface	
	80 cm onwards – undisturbed tailings	
West Pad – TP-TTC-04-05	0 to 70 cm – calc-silicate waste rock cover material	
	70 to 90 cm – minor undulations in geotextile surface	
	90 cm onwards – undisturbed tailings	
West Pad – TP-TTC-04-06	0 to 75 cm – calc-silicate waste rock cover material	
	75 to 80 cm – minor undulations in geotextile surface	
	80 cm onwards – undisturbed tailings	

Excavation of the test pits confirmed that, on average, the cover was within the specified thickness of 70 to 90 cm, as measured from the surface to the point where mixing of tailings and cover material starts to take place. There is a distinct mixed zone of tailings and cover material at the base of the East Pad. This mixed zone is approximately 20 cm thick on average; however, some large boulders were depressed up to 40 cm deep into the tailings. The mixed zone appears to be driven by large boulders, as opposed to a complete homogenous settlement and blending of the two materials. Beyond this mixed zone, there appears to be no signs of upwards tailings migration.

The test pits on the West Pad were excavated only to the geotextile, and each pit was targeted to intercept a section where the geotextile overlapped. In general the interface between the cover and tailings was significantly less undulating than for the East Pad, averaging around 5 cm, with localized areas reaching 10 cm. In all cases there was no sign of tailings migration through the textile, and in fact in the overlapped sections, the upper surface of the bottom geotextile was completely clean. In the first test pit, the geotextile was inadvertently ripped during excavation, which allowed a comparison of the upper and lower surface of the geotextile as further evidence of this observation. The targeted geotextile overlap was reached in two of the test pits, and there was no sign of the overlap being reduced through differential settlement. The geotextile was generally completely flat, mimicking the underlying tailings surface. However, in one pit some irregularities were observed, which appear to be a result of rutting created by the dump truck backing up over the geotextile during construction (BGC, 2004). There was, however, no sign of tears or punctures in the textile, or in any of the other test pits.

There was no discernable difference between the moisture regimes in the test pits. Both the tailings, which can be classified as predominantly a silty sand (SM), and the cover material which can be classified as well graded silty gravel (GM) was “very moist” to “wet” and unfrozen. The moisture distribution in the cover was consistent throughout the profile. The geotextile was damp but no moisture could be expressed by wringing it.

4 Discussion of Results

4.1 Settlement

4.1.1 Theoretical Settlement

Over time, the tailings will undergo settlement due to consolidation under their own weight. Incremental settlement will occur if a cover is placed on the tailings surface. Using basic consolidation and settlement theory (Holtz & Kovacs, 1981), the theoretical estimated range of settlements associated with the Rose Creek tailings is calculated to be between 28 and 74 mm, as presented in Table 5, Case #1, to #3. These calculations present a possible range of settlements based on the Rose Creek tailings properties and physical layout. In all calculations, the tailings is assumed to be saturated, i.e. water table is at the surface. Case #4 in Table 5, presents the most likely conditions at the test pad location, and the calculated theoretical settlement is therefore approximately 51 mm.

Table 5: Theoretical settlement calculation for tailings test pads

Description	Case #1	Case #2	Case #3	Case #4 (Test Pad Location)
Assumed tailings thickness (m)	5.0	15.0	25.0	22.5
Assumed tailings specific gravity, G_s (-)	4.5	4.0	3.8	4.0
Assumed tailings compression index, C_c (-)	0.16	0.18	0.20	0.18
Assumed tailings initial void ratio, e_0 (-)	1.1	1.0	0.9	1.0
Assumed cover thickness (m)	0.7	0.8	0.9	0.8
Assumed cover material unit weight (kN/m^3)	18	20	22	20
Predicted Settlement (mm)	28	50	74	51

A non-woven geotextile may act as a filter when placed between tailings and a cover material. However, the geotextile will not change the total settlement (Koerner, 1981) exclusive of any "mixing" of waste rock and tailings as the tailings thaw. Therefore, these theoretical settlement calculations are expected to apply equally to the East and West test pads.

4.1.2 Actual Settlement

Monthly surveys were completed on the primary and secondary survey beacons on each test pad. Figures 5 and 6 present the reduced raw data for these surveys. There is no logical explanation for the sudden increase in settlement and subsequent "rise" of the test pads indicated by the July 16, 2004 survey data. It is therefore reasonable to assume that a survey error has resulted in the anomalous data of July 16th. Therefore this dataset has been excluded from the final settlement analysis presented in this report. If, on continued survey monitoring during 2005, this anomalous trend is again observed, a re-evaluation of the data would be warranted.

On each test pad there is 16 survey points set out in a pre-determined grid pattern, as illustrated in Figure 2. After excluding the July 16, 2004 data set, as well as specific data points which are not representative due to disturbance by the excavator reclamation on June 17, 2004, the survey data was reduced as follows. All data are presented in a normalized fashion, i.e. the as-built survey data is the reference data against which all settlement is measured. Initially these survey points were supposed to consist of boulders only. However, when the as-built survey was completed, a standard survey pin was installed adjacent to each boulder, in case a boulder moves as a result of physical disturbance. All monthly surveys subsequently included data for both the 16 boulders and the 16 survey pins on each pad. These two data sets on each test pad are thus essentially duplicates of the same data. The average pad surface settlement was calculated separately for the boulder data and the survey pin data, and then the average of these two datasets was calculated to determine the overall surface settlement for each pad as illustrated in Figure 7. Considering the survey equipment, the experience of the operators and the technique in general, it is probably reasonable to assume that the surveys are accurate to ± 10 mm, as indicated by the error bars in Figure 7. The apparent anomalous “rise” of the surface in September as depicted in Figure 7, is thus probably within the inherent accuracy of the monitoring methodology, and has no physical explanation.

The pad foundation settlement, as presented by the three primary survey beacons installed in each test pad are presented in Figure 8, and again the apparent anomalous “rise” data is probably a reflection of the inherent degree of accuracy of the monitoring technique.

Figure 9 presents the overall settlement for both the East and West Pads. This data was reduced by averaging the settlement from the three primary survey beacons in each test pad, and then calculating the overall average between the average surface settlement presented in Figure 7 and the primary survey beacon average. Overall settlement for the East Pad, which has no geotextile, was approximately 80 mm compared to approximately 30 mm for the West Pad, which is underlain by geotextile.

The shape of the settlement curves suggest most settlement occurred early in summer as the tailings profile thawed out, and by late summer the settlement rate appeared to slow down. This trend is reasonable, indicating primary consolidation of the underlying tailings followed by the onset of secondary consolidation. At this stage it is not clear how much additional settlement will occur, however, considering the magnitude of settlement in the East Pad compared to the theoretical calculations, it is possible that the bulk of settlement has already occurred.

The differences in overall settlement and settlement rate between the East and West Pads were not expected. The single layer of geotextile, should not impact the settlement to any degree, but the data shows a distinct difference in settlement. Several factors may be influencing the results. It is possible that the geotextile has clogged with fine tailings, showing the rate of consolidation and, therefore, the rate of settlement. In this case, the same total settlement would be observed in the longer term. Another possibility is that the geotextile is providing the separation between the tailings and waste rock, which might not be the case at the East Pad. It is possible that the waste rock and bases of the primary beacons are penetrating into the tailings as they thaw. Continued monitoring will hopefully provide a better understanding of these differences.

4.2 Migration of Fines

4.2.1 Theoretical

A number of physical processes take place when the cover material is placed directly onto the tailings surface. Firstly, the fine tailings attempt to enter the voids of the waste rock, and secondly the waste rock actually penetrates the fine tailings surface. Both these processes takes place simultaneously and results in a layer of mixed tailings at the interface of the two materials. In addition, the fine tailings sometimes tend to continue to migrate up through the cover material, in a process not dissimilar to capillary water moving up through the void spaces in a soil in the vadose zone. The process of physical fines migration is not well understood, and therefore there are no tools to determine what the likely potential would be for it to occur, or even what the likely triggers are. However, one well documented case where fines migration in the form of boils occurs through waste rock is at the Beaverlodge Project in northern Saskatchewan (SRK, 1995). In this case, the cause of the tailings boils was piezometric levels that spiked upwards each spring in response to seasonal thawing.

Geotextiles are routinely used to separate fine and coarse materials in filter applications, and provided the geotextile meets appropriate filter criteria, it can prevent this “pumping” of tailings solids from occurring.

4.2.2 Actual

Physical inspection of each cover by test pitting indicated there is a zone approximately 20 cm thick at the base of the East Pad where tailings and the waste rock have been intimately mixed. It is not clear whether this zone formed during construction, or after construction as the tailings thawed. During construction the tailings surface did thaw, but rutting was reported to be 2 to 5 cm at most, suggesting that significant embedding and mixing of material during this time was probably not happening. This can however not be definitively stated since no inspection on imbedding was done after dumping took place and the pads were flattened with the dozer.

Irrespective of when this mixing occurred, inspection of the test pits at the East Pad does not show any indication of tailings migration upwards in any of the three test pits. There was also no sign of tailings migrating through the geotextile, or between seam overlaps in the West Pad.

5 Conclusions & Recommendations for Further Work

Approximately 80 mm of settlement was observed for the East Pad, and 30 mm for the West pad. The settlement curve in both cases suggests significant rapid primary consolidation followed by secondary consolidation. The 80 mm settlement for the East pad is close to the theoretical maximum settlement, suggesting that more settlement over time is probably limited. The reason for the reduced settlement of the West Pad cannot be definitively explained. Factors which could contribute to the differences include a slower rate of consolidation due to clogging and penetration of the waste rock (and beacon) into the tailings as they thaw. It is hypothesised that total settlement will ultimately match that of the East Pad, but that the rate of settlement has been impacted by the presence of the geotextile.

There is a definite mixed zone of tailings and cover material present at the base of the East Pad. However, there does not appear to be any indication of tailings fines physically migrating up beyond this zone. No material mixing has been observed for the West Pad, with the geotextile effectively separating the tailings and cover material.

The test pads should continue to be monitored in 2005 to determine whether the settlement has in deed reached its peak as suggested by the shape and magnitude of the settlement curve. Furthermore, continued monitoring will indicate if fines migration is likely to be a problem in the longer term.

Based on the current information, it would be reasonable to conclude that construction of a 80 cm thick “terrestrial” cover over the Rose Creek tailings impoundment could result in up to approximately 80 mm of total settlement, provided that the cover in constructed under frozen conditions. This amount of settlement is not likely to impact the cover objectives, since runoff shedding and infiltration control are not critical components.

A conclusive statement as to whether or not a geotextile separator would be required to ensure that tailings do not migrate to the cover surface over time cannot be made at this time. However, preliminary data suggested that fines migration through an 80 cm thick cover is unlikely.

This report, **"Monitor Trial Covers at Rose Creek Tailings Impoundment – 2004/05 Task 16b"** has been prepared by SRK Consulting (Canada) Inc.

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6 References

BGC Engineering Inc. (2004). Tailings Test Cover Construction As Built Report, Faro Mine, YT. Final Report submitted to Deloitte & Touche Inc. and SRK Consulting, Authored by G. Ferris. June 2004, 10 Pages plus appendixes.

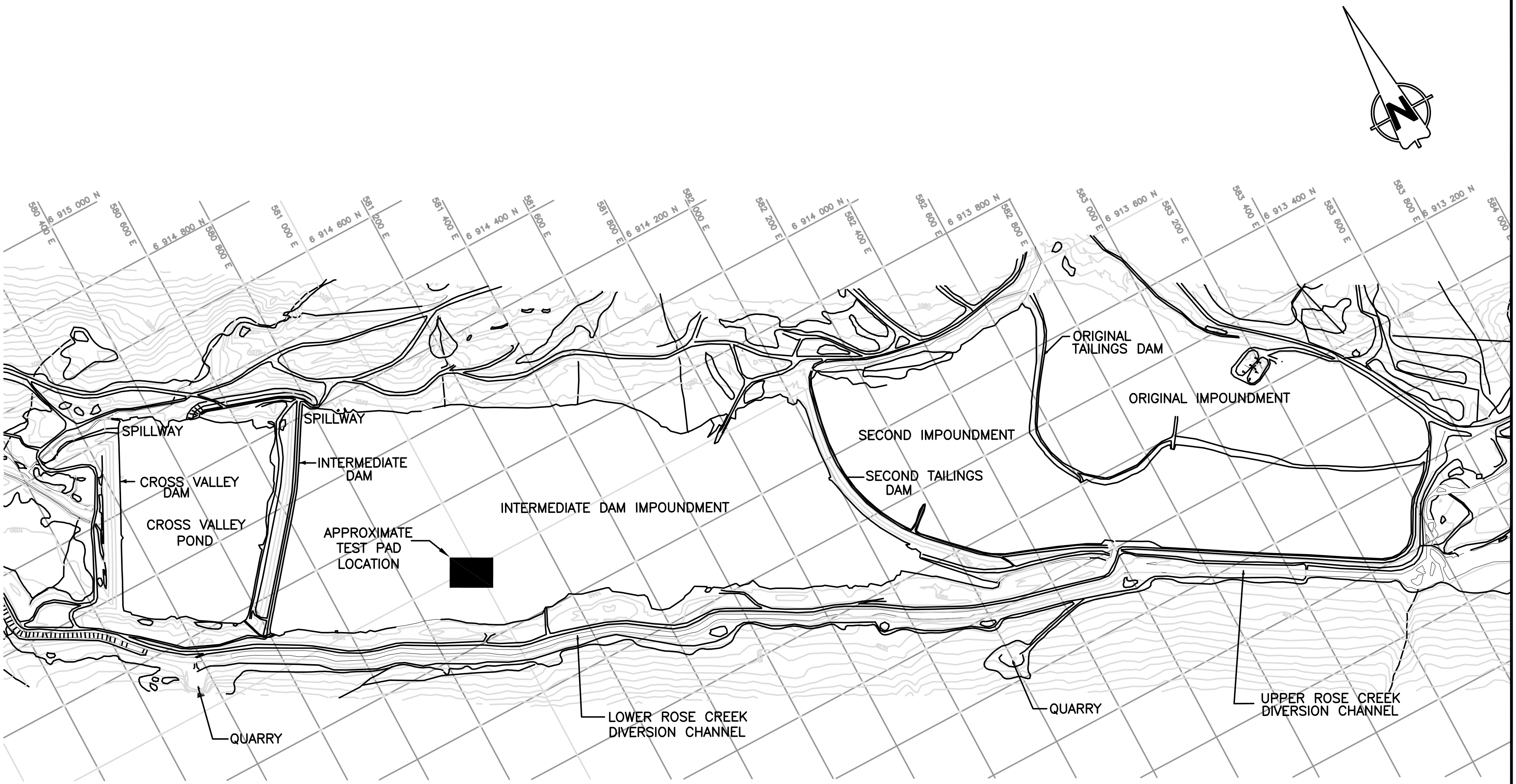
SRK Consulting (Canada) Inc. (2004). Waste Rock Pile and Tailings Covers for the Anvil Range Mining Complex, Projects 16(a) & 18(b), Faro, Yukon, Canada. DRAFT Report submitted to Deloitte & Touche Inc., February 2004.

SRK Consulting (Canada) Inc. (1995). Report on Proposed Remedial Measures to Counter Sand "Boils" Adjacent to Fookes Lake. Project Number C101101, Beaverlodge Project, Saskatchewan. Consultants Report to Cameco Corporation, September.

Koerner, R.M. (1981). Designing With Geosynthetics. Prentice-Hall, Englewood Cliffs, NJ 07632, 424 Pages.

Holtz, R.D., Kovacs, W.D. (1981). An Introduction to Geotechnical Engineering. Prentice-Hall Inc. Englewood Cliffs, NJ, 733 Pages.

Figures



MAPPING COMPILED BY THE ORTHOSHOP, CALGARY, ALBERTA, JANUARY, 1991. BASED ON AERIAL PHOTOGRAPHY, SEPTEMBER 17, 1990, AT A SCALE OF 1 : 10 000. SURVEY CONTROL WAS SUPPLIED BY CURRAGH RESOURCES INC.
CONTOUR INTERVAL = 5 METRES.
COORDINATES ARE UTM IN METRES.
ELEVATIONS ARE RELATIVE TO MEAN SEA LEVEL (NAD27)

0 100 200 300 400 Metres

SCALE 1 : 16 000

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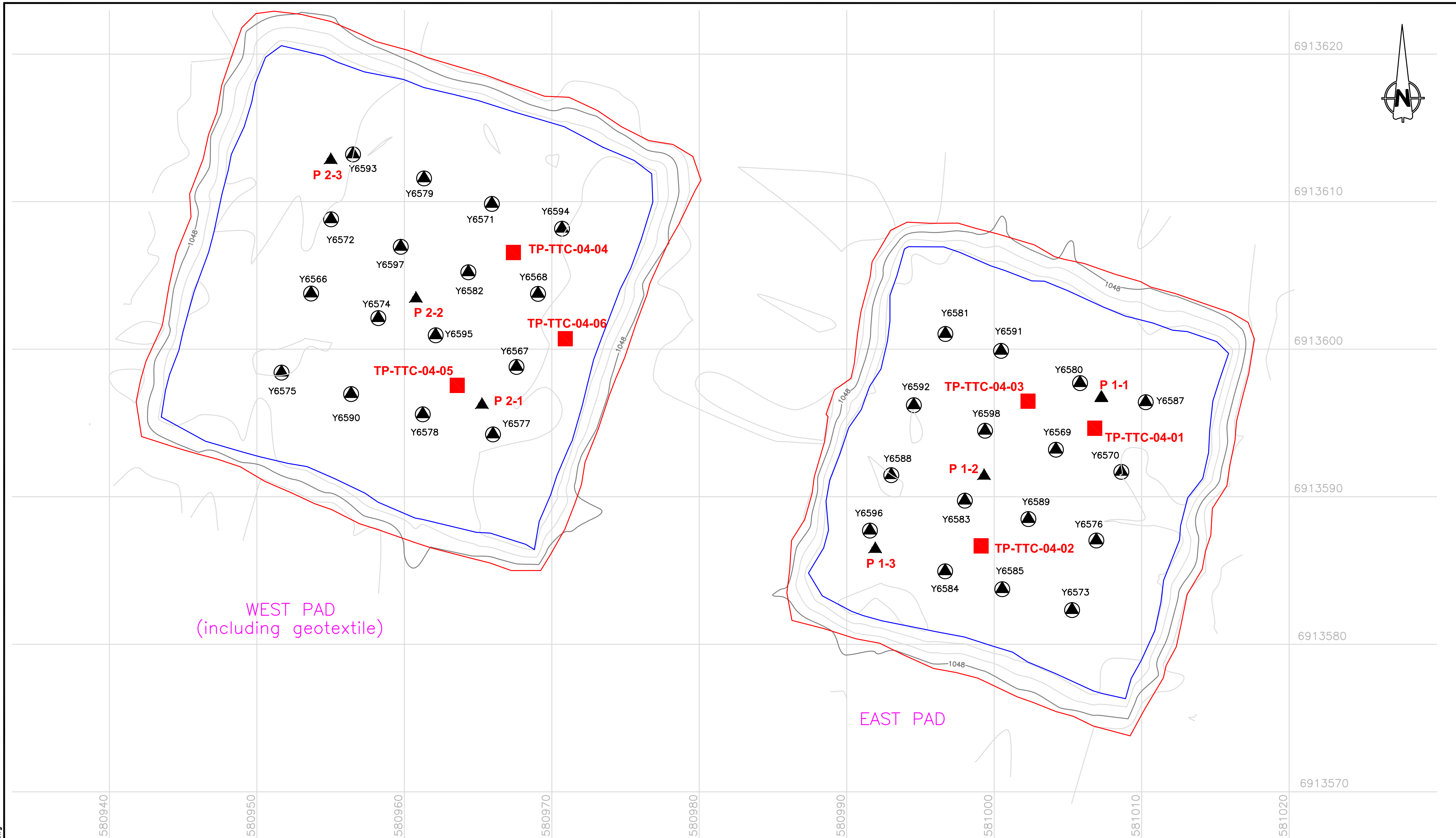
ANVIL RANGE MINING COMPLEX

LOCATION PLAN FOR TRIAL COVERS

PROJECT NO.	DATE	APPROVED	FIGURE
1CD003.058	Nov.2004	EMR	1



0 2 4 6 8 10 Metres

1 : 250

LEGEND

▲ PRIMARY SURVEY BEACONS

SECONDARY SURVEY BEACONS

■ SEPT. 27, 2004 TEST PIT LOCATION

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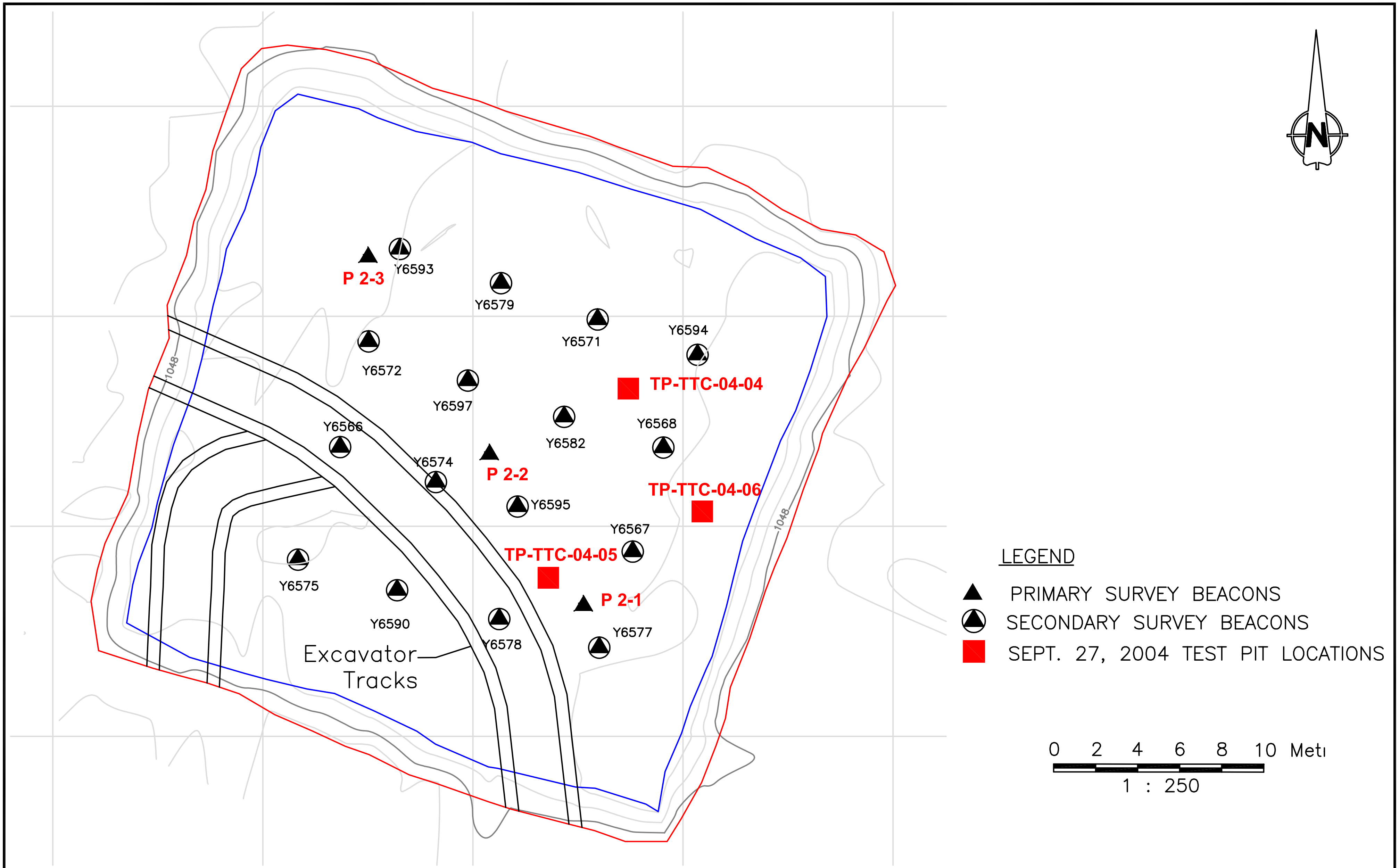
ANVIL RANGE MINING COMPLEX

GENERAL LAYOUT OF TRIAL COVERS

PROJECT NO.	DATE	APPROVED	FIGURE
1CD003.058	Nov. 2004	EMR	2

File Ref: Sample_plan-NAD27.dwg



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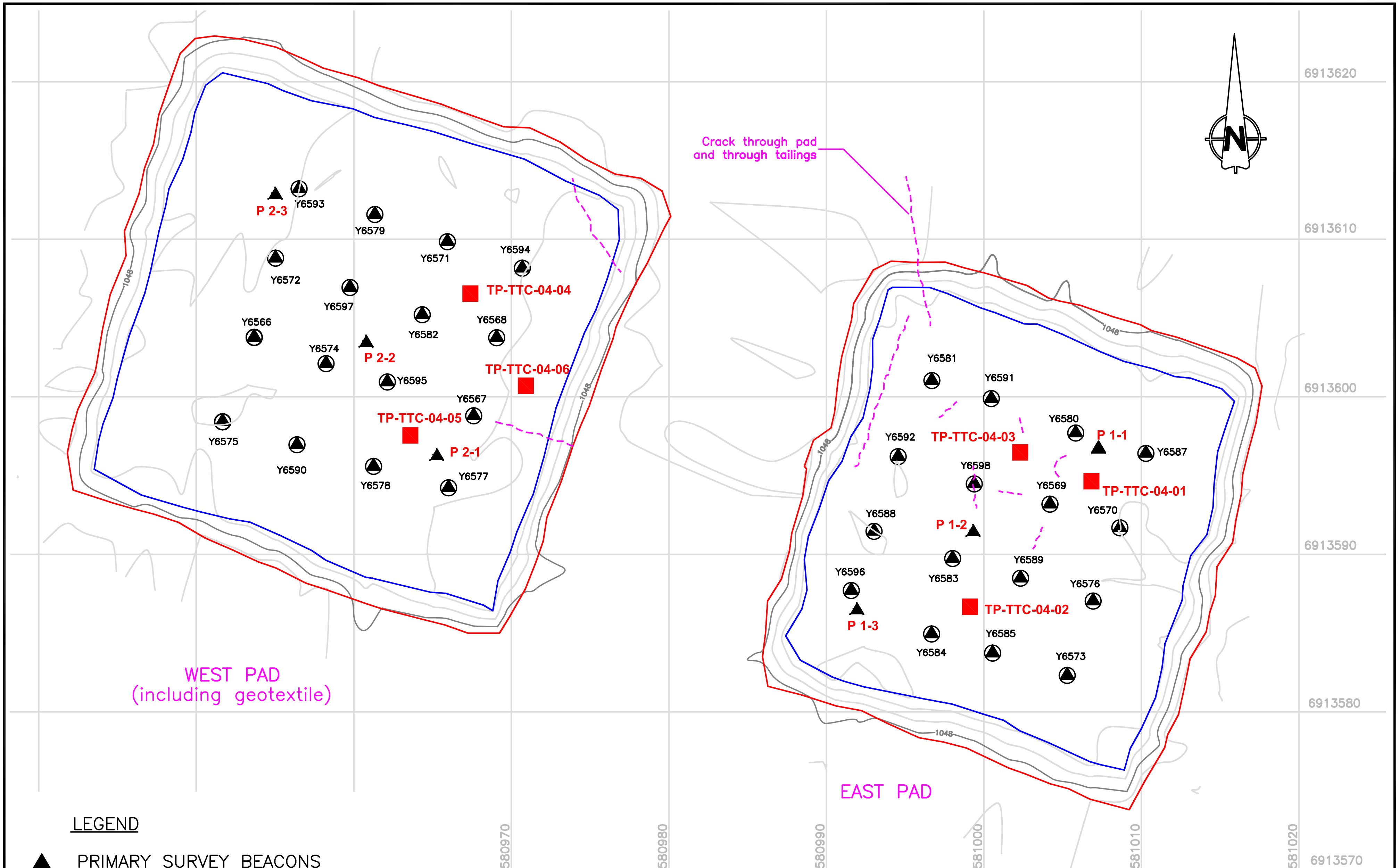
ANVIL RANGE MINING COMPLEX

SCHEMATIC PRESENTATION OF DAMAGE TO WEST PAD ON JUNE 17, 2004

PROJECT NO.	DATE	APPROVED	FIGURE
1CD003.058	Nov.2004	EMR	3



LEGEND

- PRIMARY SURVEY BEACONS
- SECONDARY SURVEY BEACONS
- SEPT. 27, 2004 TEST PIT LOCATIONS
- CRACKS

0 2 4 6 8 10 Metres

SCALE

Dwg Ref: HEIGHT-CAP.DWG

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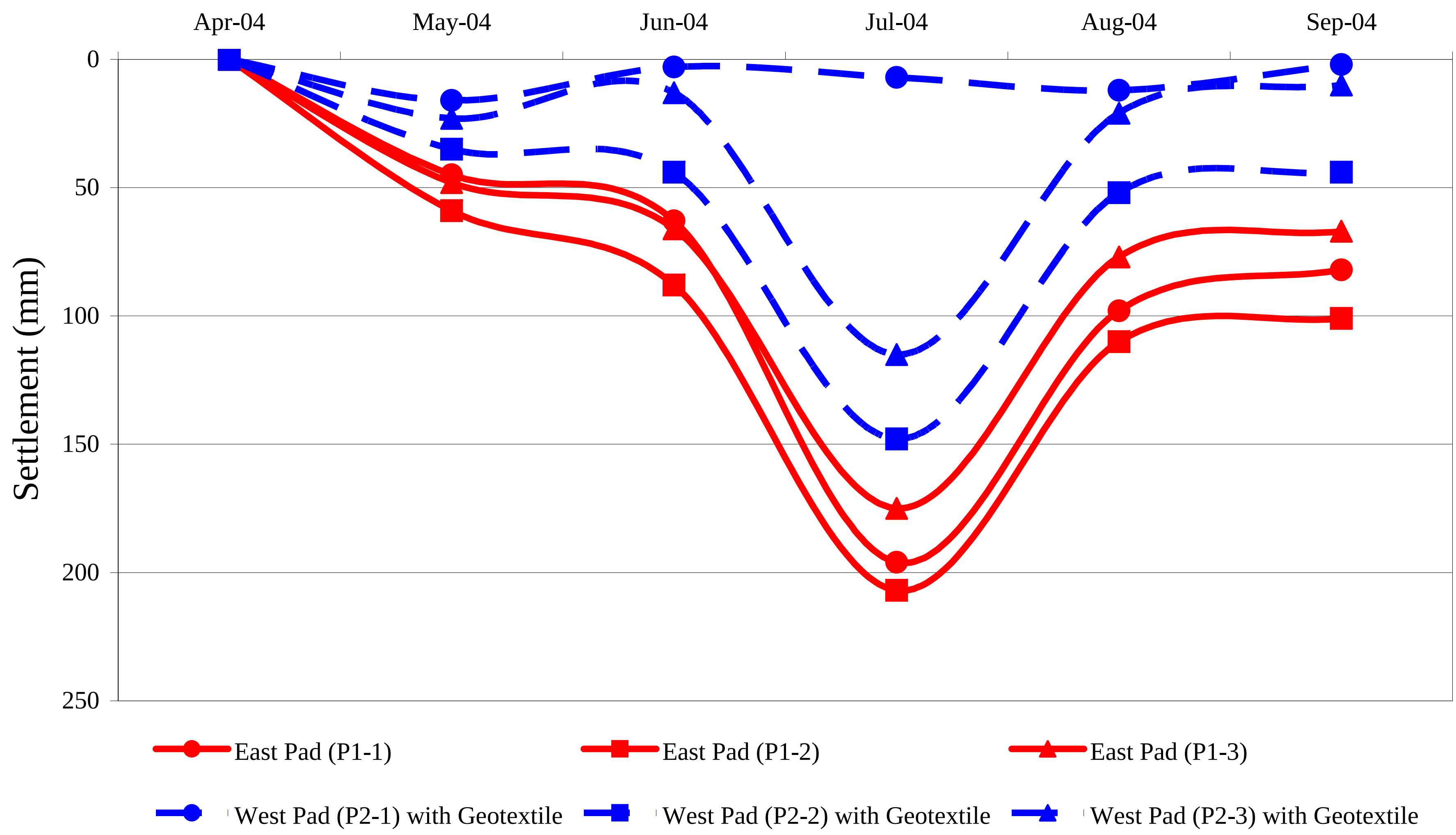
ANVIL RANGE MINING COMPLEX

SCHEMATIC PRESENTATION OF SURFACE CRACKS DURING AUGUST 29, 2004 SITE INSPECTION

PROJECT NO.	DATE	APPROVED	FIGURE
1CD003.058	Nov.2004	EMR	4



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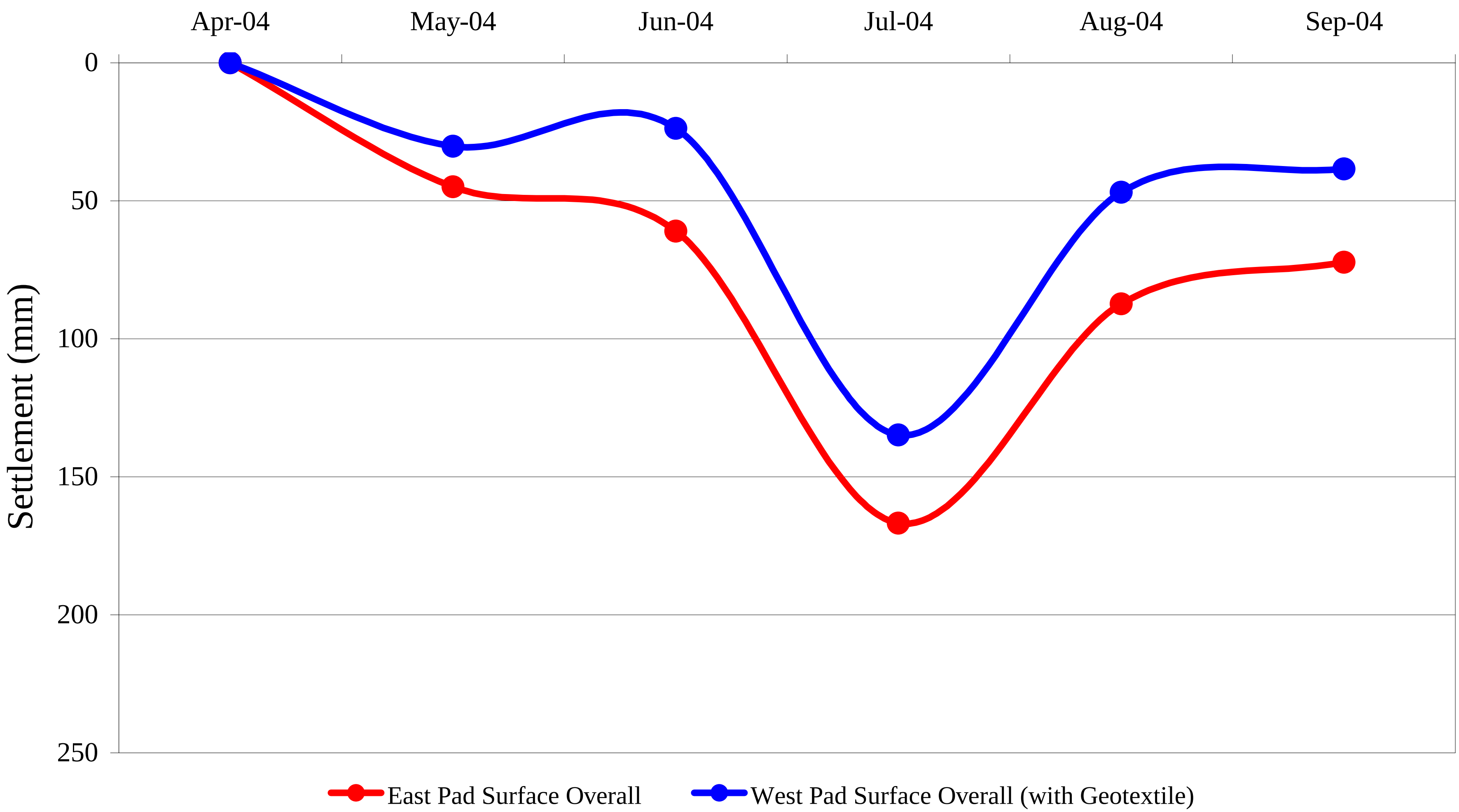
Anvil Range Mining Complex
Tailings Trail Covers

Normalized raw settlement data for primary survey beacons

PROJECT:	DATE:	APPROVED:	FIGURE:
1CD003.58	Nov. 2004	EMR	5



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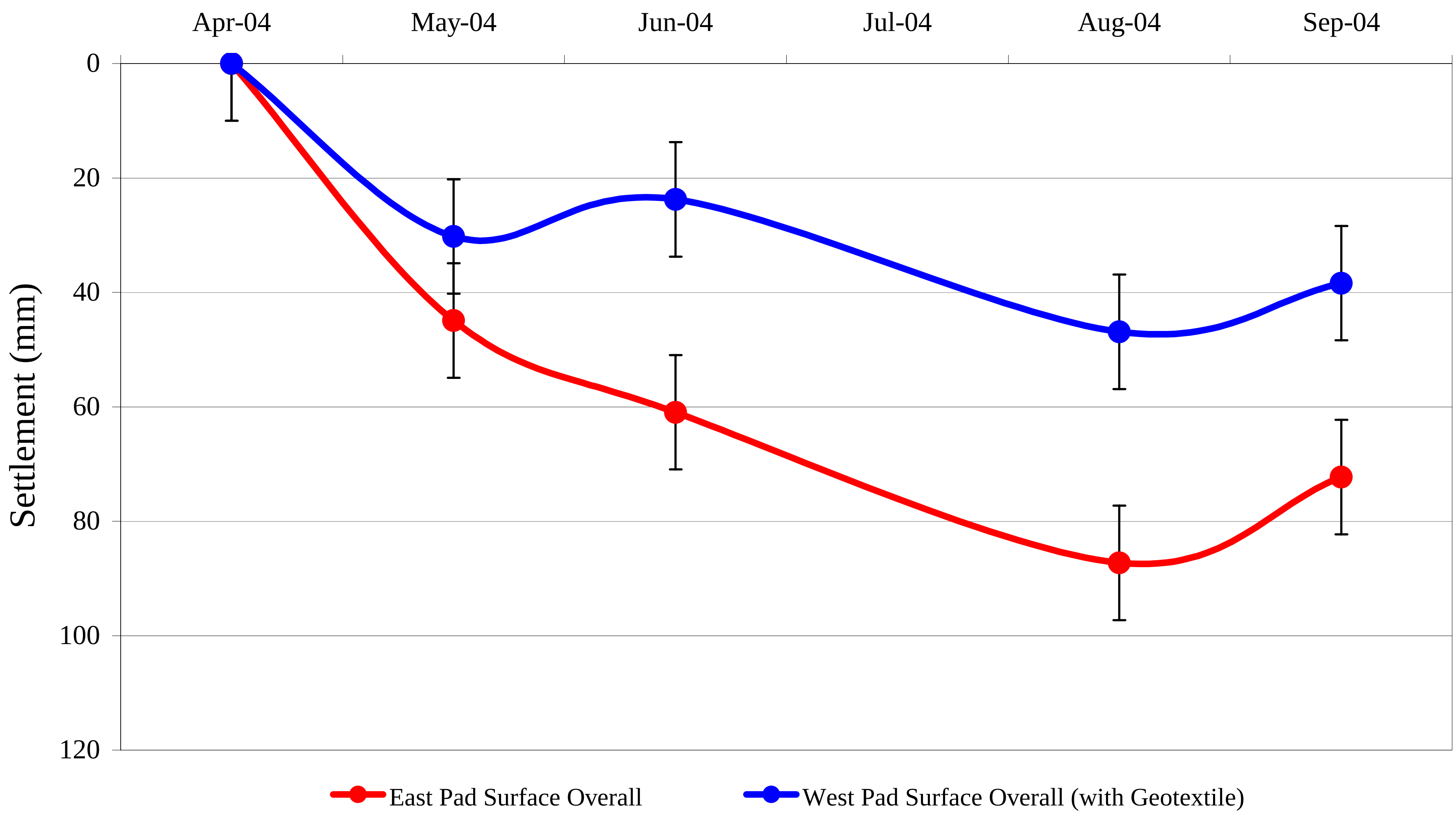
Anvil Range Mining Complex
Tailings Trail Covers

Normalized raw average settlement data for the secondary survey beacons

PROJECT:	DATE:	APPROVED:	FIGURE:
1CD003.58	Nov. 2004	EMR	6



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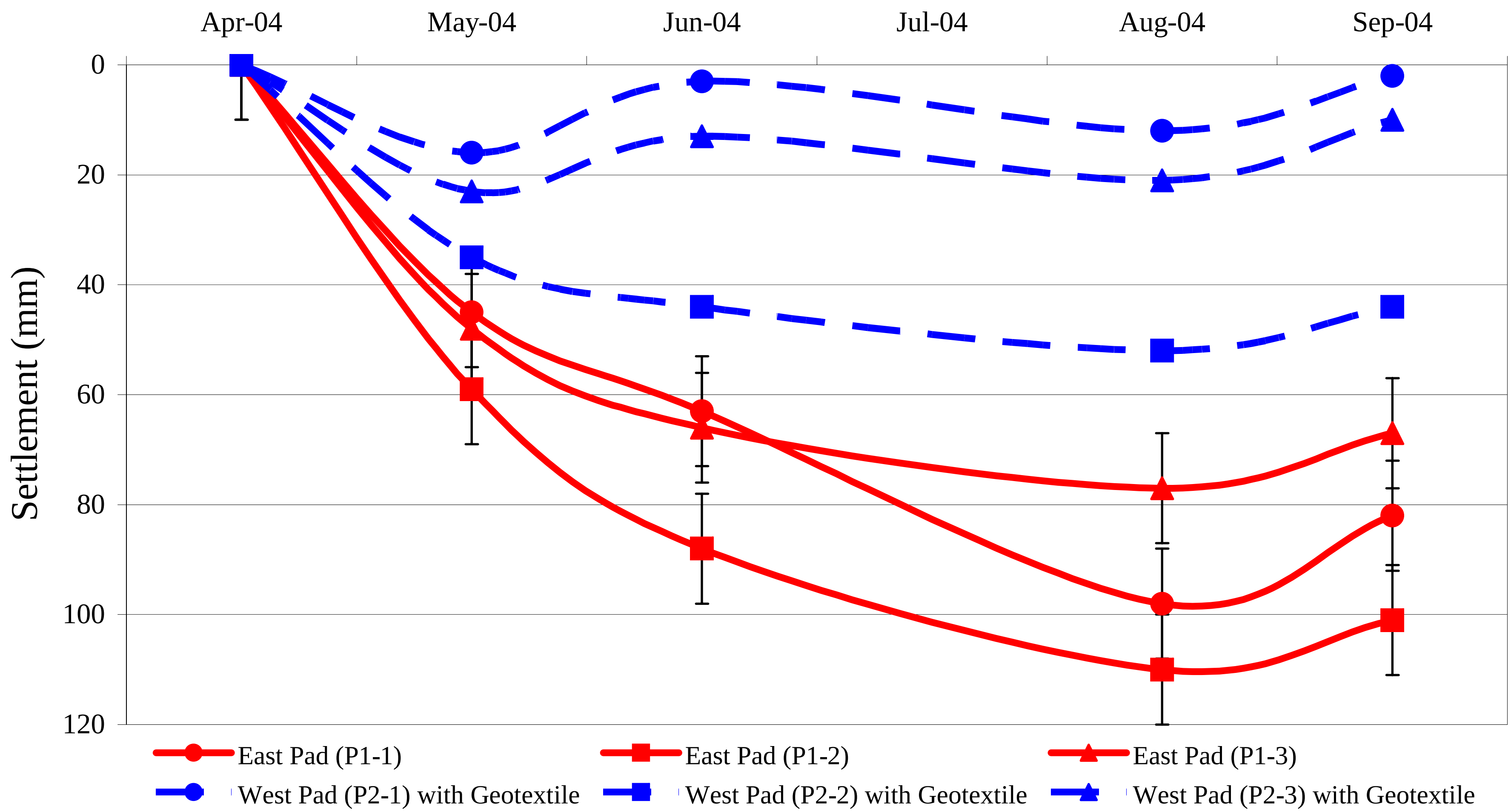
Anvil Range Mining Complex
Tailings Trail Covers

Normalized corrected average settlement data for the secondary survey beacons

PROJECT:	DATE:	APPROVED:	FIGURE:
1CD003.58	Nov. 2004	EMR	7



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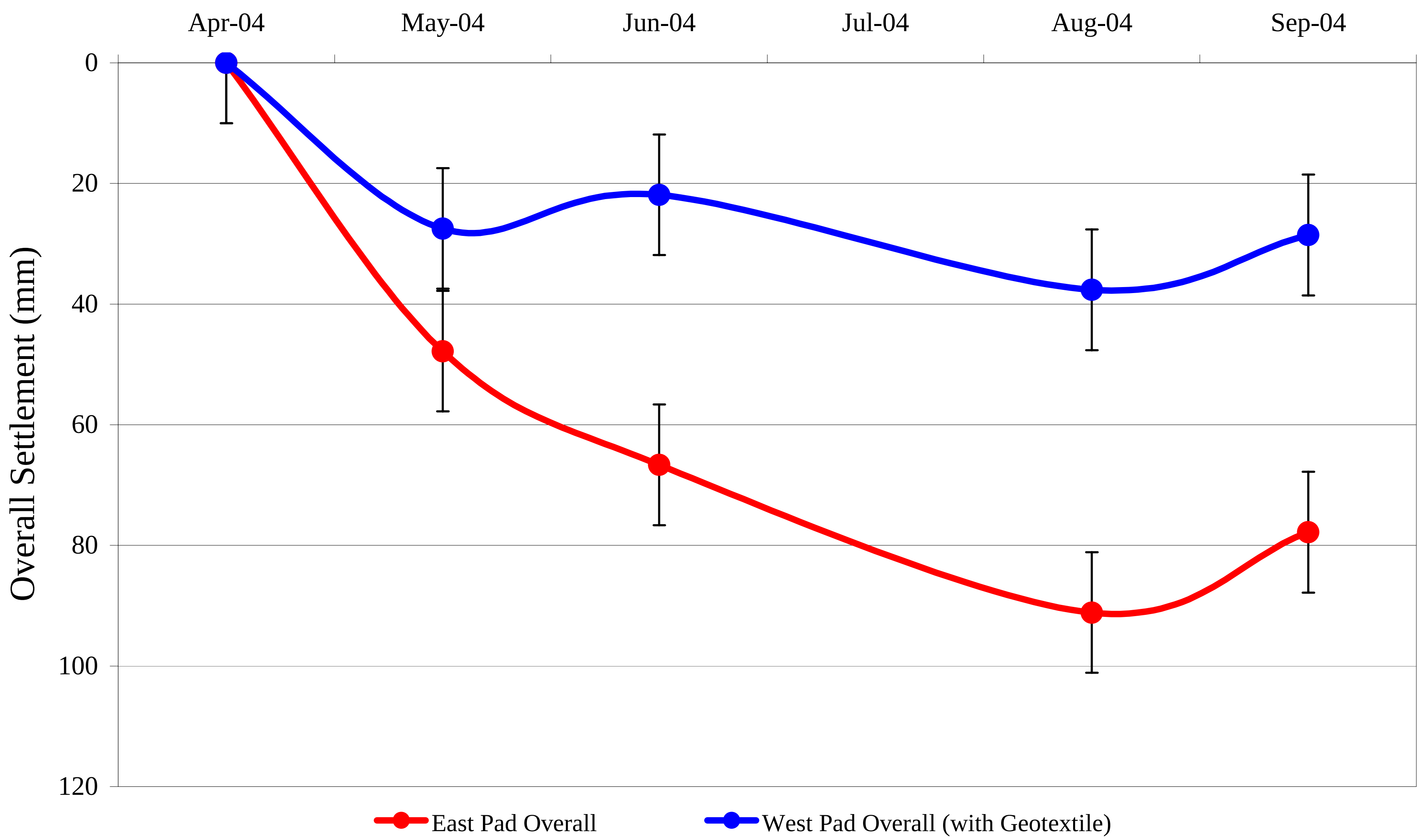
Anvil Range Mining Complex
Tailings Trail Covers

Normalized corrected settlement data for the primary survey beacons

PROJECT:	DATE:	APPROVED:	FIGURE:
1CD003.58	Nov. 2004	**EMR**	**8**



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Deloitte & Touche

Anvil Range Mining Complex
Tailings Trail Covers

Normalized overall average test pad settlement

PROJECT:	DATE:	APPROVED:	FIGURE:
1CD003.58	Nov. 2004	EMR	9

Appendix A

SRK Proposal for Task 16(b) Dated July 16, 2004

SRK Consulting
Engineers and Scientists

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Memorandum

To:	Valerie Chort	**Date:**	July 16, 2004
cc:	Daryl Hockley	**From:**	Maritz Rykaart/Cam Scott
Subject:	Scope of Work for Project 16(b) – Monitor Tailings Cover Trial Areas	**Project #:**	1CD003.26

1 Status of Tailings Test Cover

The construction of any form of cover over the ARMC tailings poses significant constructability challenges (Golder Associates, 2004; SRK, 2004). Two test covers were subsequently constructed in April 2004 (BGC, 2004) to specifically evaluate the following issues associated with the placing of a cover on the tailings:

- The magnitude of settlement of the cover,
- If, and to what extent tailings migrate upwards through the cover as time progresses, and
- If placement of a geotextile would be beneficial to alleviate the problem of potential tailings migration.

Construction on the test covers was undertaken between April 8 and April 16, 2004 and the final as-built survey of the test cover surface was measured on April 20, 2004.

2 Format of this Scope of Work

This scope of work is intended to illustrate how the post-construction monitoring of the test cover will be carried out. The individual tasks listed are the proposed work packages that each has specific interim deliverables that could be tracked for progress. Each task item includes a description of the proposed work and the deliverables.

3 Task 010 – Project Management

This task will involve the day-to-day management of the project, including communication with the client.

4 Task 070 – Surveying

The test pad surface will be surveyed once a month until freeze-up occurs, probably late October 2004. The survey will entail taking readings at 76 specified stations on the two pads, as measured from a dedicated control point. The settlement of the test covers will be based on the relative variances at these points. The survey can be performed by Deloitte and Touche (DT) staff. Upon completion of the monthly survey, the results will be sent to SRK for analysis. SRK will produce short memo style reports to document the findings of each survey.

If there are any signs of substantial movement, the survey frequency may be increased to bi-weekly, or even weekly to track the progress.

5 Task 080 – Site Inspection

In late August 2004, a geotechnical engineer will inspect the test covers and excavate test pits into them to evaluate how much, if any, tailings has migrated up into the cover. Preferably, the test pits will be dug using the tracked excavator; however, if site access is a problem, the pits will have to be dug by hand. It is expected that at least three pits on each cover would be required.

6 Task 130 – Phase 2 Cover Report

The findings of the test cover trial will be analysed and documented in the phase 2 cover report (which will be part of the Project 14a report). This report will also make recommendations for cover designs on the tailings based on the findings.

7 Schedule & Cost Estimate

Table 1 summarize the tasks described above, complete with the estimated budget and project completion target dates. Construction and instrumentation costs are estimates based on the preliminary cover trial concepts only, and therefore may change as the design is finalized and input from all the interested parties has been received.

Table 1: Summary of tasks, completion date and budget cost estimate

Task Number	Task Description	Completion Date	Cost Estimate (excl. GST)
Task 010	Project management	Ongoing	$ 8,500
Task 020	Surveying by site staff and followup memoranda	Monthly	$ 11,000
Task 030	Site inspection	Aug 2004	$ 13,700
Task 040	Phase 2 cover design report	Dec 2004	$ 11,700
		TOTAL PROJECT COST	$ 44,900

8 References

SRK Consulting (Canada) Inc. (2004). Waste Rock Pile and Tailings Covers for the Anvil Range Mining Complex Projects 16(a) and 18(b), Faro, Yukon, Canada. Draft report to Deloitte & Touché Inc., February 2004.

BGC Consulting (2004). Tailings Test Cover Construction As-Built Report. DRAFT report to SRK Consulting, May 18, 2004.

Golder Associates (2004). Rose Creek Tailings Impoundment Geotechnical Issues Related to Cover Viability. Technical Memorandum to SRK Consulting, March 25, 2004, 2 pages.

Appendix B

Survey Settlement Data for 2004

Settlement Monitoring of Covers (Raw Survey Data)

Monitoring Point #	Elevation of MP (m)	Elevation of MP (m)	Elevation of MP (m)	Elevation of MP (m)	Elevation of MP (m)	Elevation of MP (m)
Date of reading	20-Apr-04	28-May-04	15-Jun-04	16-Jul-04	20-Aug-04	23-Sep-04
Y6604	1048.033	1048.025				
Y6573	1048.538	1048.507	1048.509	1048.381	1048.476	1048.497
R6573	1048.719	1048.687	1048.689	1048.564	1048.657	1048.671
Y6576	1048.454	1048.410	1048.388	1048.217	1048.317	1048.331
R6576	1048.633	1048.593	1048.563	1048.401	1048.497	1048.510
Y6570	1048.378	1048.335	1048.337	1048.226	1048.317	1048.331
R6570	1048.532	1048.485	1048.479	1048.376	1048.468	1048.481
Y6587	1048.463	1048.415	1048.379	1048.246	1048.327	1048.343
R6587	1048.618	1048.573	1048.539	1048.396	1048.487	1048.503
East Pad (P1-1)	1049.113	1049.068	1049.050	1048.917	1049.015	1049.031
Y6580	1048.411	1048.345	1048.311	1048.187	1048.285	1048.301
R6580	1048.627	1048.545	1048.512	1048.391	1048.485	1048.494
Y6603	1048.111	1047.893				
Y6569	1048.460	1048.405	1048.377	1048.258	1048.352	1048.365
R6569	1048.688	1048.632	1048.591	1048.476	1048.507	1048.581
Y6589	1048.473	1048.425	1048.421	1048.316	1048.409	1048.421
R6589	1048.711	1048.664	1048.655	1048.544	1048.637	1048.651
Y6585	1048.442	1048.413	1048.417	1048.315	1048.408	1048.421
R6585	1048.639	1048.605	1048.609	1048.504	1048.597	1048.611
Y6584	1048.562	1048.536	1048.547	1048.441	1048.537	1048.551
R6584	1048.847	1048.830	1048.830	1048.826	1048.822	1048.831
Y6583	1048.523	1048.445	1048.409	1048.300	1048.397	1048.403
R6583	1048.741	1048.667	1048.634	1048.626	1048.618	1048.631
East Pad (P1-2)	1049.172	1049.113	1049.084	1048.965	1049.062	1049.071
Y6598	1048.471	1048.417	1048.391	1048.276	1048.367	1048.381
R6598	1048.665	1048.615	1048.597	1048.458	1048.555	1048.563
Y6591	1048.421	1048.375	1048.340	1048.318	1048.315	1048.331
R6591	1048.685	1048.633	1048.594	1048.464	1048.557	1048.568
Y6581	1048.464	1048.425	1048.411	1048.296	1048.395	1048.406
R6581	1048.703	1048.655	1048.633	1048.621	1048.616	1048.631
Y6592	1048.480	1048.430	1048.399	1048.286	1048.384	1048.391
R6592	1048.665	1048.613	1048.579	1048.465	1048.557	1048.571
Y6588	1048.348	1048.334	1048.349	1048.244	1048.337	1048.351
R6588	1048.623	1048.605	1048.610	1048.506	1048.599	1048.613
Y6596	1048.535	1048.505	1048.510	1048.404	1048.497	1048.510
R6596	1048.698	1048.655	1048.657	1048.551	1048.645	1048.660

Monitoring Point #	Elevation of MP (m)	Elevation of MP (m)	Elevation of MP (m)	Elevation of MP (m)	Elevation of MP (m)	Elevation of MP (m)
Date of reading	20-Apr-04	28-May-04	15-Jun-04	16-Jul-04	20-Aug-04	23-Sep-04
East Pad (P1-3)	1049.403	1049.355	1049.337	1049.228	1049.326	1049.336
Y6577	1048.400	1048.378	1048.387	1048.283	1048.377	1048.404
R6577	1048.543	1048.519	1048.533	1048.526	1048.521	1048.528
West Pad (P2-1) with Geotextile	1049.133	1049.117	1049.130	1049.126	1049.121	1049.131
Y6567	1048.344	1048.305	1048.300	1048.196	1048.289	1048.301
R6567	1048.617	1048.573	1048.569	1048.464	1048.559	1048.567
Y6568	1048.361	1048.337	1048.349	1048.244	1048.341	1048.349
R6568	1048.579	1048.555	1048.559	1048.456	1048.548	1048.559
Y6594	1048.320	1048.275	1048.268	1048.161	1048.254	1048.263
R6594	1048.461	1048.414	1048.405	1048.299	1048.394	1048.401
Y6601	1048.211					
Y6571	1048.279	1048.230	1048.232	1048.126	1048.222	1048.231
R6571	1048.428	1048.375	1048.387	1048.278	1048.375	1048.383
Y6582	1048.274	1048.255	1048.267	1048.164	1048.259	1048.266
R6582	1048.460	1048.433	1048.439	1048.336	1048.432	1048.441
Y6595	1048.321	1048.272	1048.271	1048.165	1048.259	1048.268
R6595	1048.573	1048.525	1048.518	1048.414	1048.507	1048.517
Y6578	1048.323	1048.292	1048.306	1048.208	1048.302	1048.309
R6578	1048.474	1048.440	1048.452	1048.244	1048.338	1048.349
Y6590	1048.265	1048.243	1048.254	1048.149	1048.239	1048.241
R6590	1048.444	1048.423	1048.432	1048.328	1048.422	1048.427
Y6574	1048.205	1048.179	1048.185	1048.016	1048.111	1048.119
R6574	1048.435	1048.410	1048.417	1048.022	1048.117	1048.124
West Pad (P2-2) with Geotextile	1049.062	1049.027	1049.018	1048.914	1049.010	1049.018
Y6597	1048.228	1048.206	1048.218	1048.116	1048.207	1048.216
R6597	1048.514	1048.493	1048.501	1048.398	1048.493	1048.501
Y6579	1048.272	1048.245	1048.254	1048.147	1048.242	1048.251
R6579	1048.467	1048.448	1048.460	1048.356	1048.447	1048.455
Y6593	1048.383	1048.345	1048.357	1048.251	1048.344	1048.356
R6593	1048.626	1048.593	1048.604	1048.496	1048.590	1048.603
West Pad (P2-3) with Geotextile	1049.073	1049.050	1049.060	1048.958	1049.052	1049.063
Y6602	1047.922					
Y6572	1048.353	1048.334	1048.349	1048.242	1048.337	1048.345
R6572	1048.630	1048.595	1048.601	1048.496	1048.589	1048.599
Y6566	1048.270	1048.247	1048.249	1048.171	1048.266	1048.261
R6566	1048.481	1048.453	1048.451	1048.376	1048.474	1048.481
Y6575	1048.128	1048.114	1048.129	1048.124	1048.117	1048.123
R6575	1048.362	1048.346	1048.357	1048.252	1048.347	1048.353

Appendix C

Field Notes and Photos of June 7 and June 24, 2004 Site Inspections

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Memo

To:	Maritz Rykaart, SRK	**Date:**	July 19, 2004
cc:		**From:**	Dylan MacGregor
Subject:	Faro Tailings Cover Trials- Record of June 2004 Inspections	**Project #:**	1CD003.26

During June 2004, Dylan MacGregor (GIT) of SRK Consulting conducted two inspections of the two tailings test covers recently constructed as part of the cover trials program. The following summarizes the observations of the two inspections.

1 Inspection 1

Inspection of the two tailings test covers was first conducted on June 7, 2004. Weather at the time of inspection was partially overcast, calm, and dry. No significant precipitation had been observed during site work by the inspector at the Anvil Range Mining Complex during the preceding 10 days.

1.1 East Test Cover

The east test cover was found to be generally in good condition. Minor undulation was noted in the pad surface- it is unknown whether this is a remnant of construction, or is a post-construction feature related to differential settlement. No ponded water or evidence of previously ponded water was observed. Minor surface cracking was noted along the eastern edge of the test cover (Figure 1). Orange marker stones appeared to be undisturbed. Two of the three vertical orange-painted steel columns appeared undisturbed; the southwestern-most column was leaning slightly to one side (Figure 2). This may have resulted from a lack of care during installation/ post-installation construction rather than differential settlement or heaving. Figures 3 through 8 show the general condition of the east test cover on June 7, 2004.

1.2 West Test Cover

The west test cover was found to be in generally good condition. The underlying filter fabric was exposed along the eastern edge. Minor cracking was noted along the eastern edge of the pad, as well as on the interior of the pad within the limits of the orange marker stones (Figure 9 and 10). The marker stones themselves appeared undisturbed. There was no evidence of ponded water, although the surface of the west test cover contained more obvious depressions than the east test cover. All three vertical orange painted steel columns were leaning slightly (Figure 11). Figures 12 through 20 show the general condition of the west test cover on June 7, 2004.

2 Inspection 2

The tailings test covers were inspected again on June 24, 2004. During the week prior to the investigation, an excavator had gotten stuck in the tailings immediately adjacent to the west tailings test cover. During efforts to extricate the mired machine, the west test cover experienced damage to its western edge from the extraction efforts. The tailings immediately adjacent to the west test cover were significantly disturbed as a result of these efforts. Following extraction, the excavator appeared to have climbed up onto the surface of the west test cover, and then crossed the southwest corner of the test pad. A number of the orange marker stones were disturbed as a result of this process, and the surface and southern edge of the west test cover were also disturbed.

The east test cover appeared to have been undisturbed as a result of this event. Conditions were as observed on June 7, 2004.

Figures 21 through 31 show the general condition of the west tailings test cover on June 24, 2004, following disturbance.

Figure 1. East test cover: Small cracks along eastern edge.

Figure 2. East test cover: Southwest steel column leaning to the southeast.

Figure 3. East test cover: Eastern edge, showing NE surface and marker stones.

Figure 4. East test cover: Eastern edge, showing SW surface and marker stones.

Figure 5. East test cover: Eastern edge, showing slightly undulating surface.

Figure 6. East test cover: Eastern edge, showing equipment access point and steel columns.

Figure 7. East test cover: Eastern edge, showing minor cracking.

Figure 8. East test cover: Looking SW at steel columns.

Figure 9. East test cover: Western edge, showing NW surface, steel columns, and marker stones.

Figure 10. West test cover: Eastern edge, showing NE surface and marker stones.

Figure 11. West test cover: Southeastern corner, showing SW surface, marker stones and steel columns.

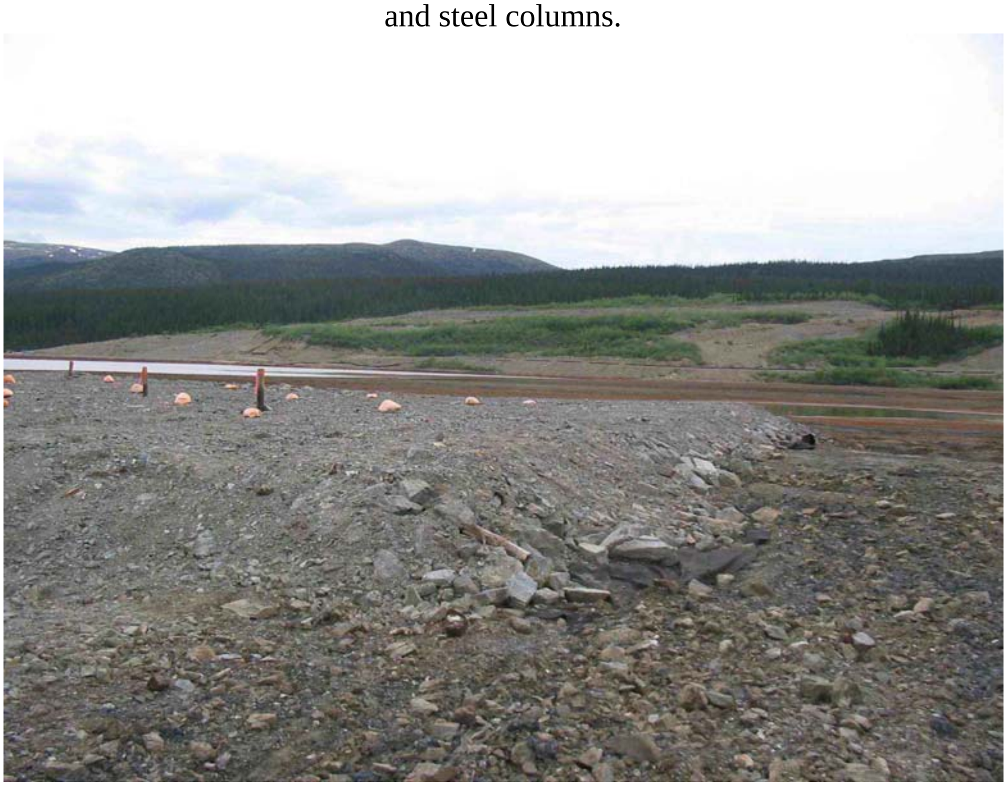

Figure 12. West test cover: Eastern edge, showing NE surface and marker stones.

Figure 13. West test cover: Southern edge, showing SW surface and marker stones.

Figure 14. West test cover: Minor cracking along eastern edge.

Figure 15. West test cover: Minor cracking near center of cover.

Figure 16. West test cover: Looking southeast at traffic surface of test cover.

Figure 17. West test cover: Southern edge, from center of cover, showing minor equipment tracks.

Figure 18. West test cover: Eastern edge from SE corner, showing regular profile.

Figure 19. West test cover: Looking NW from SE corner at vertical steel columns.

Figure 20. West test cover: Looking west from SE corner across surface of test cover.

Figure 21. West test cover: Damage to surface of cover by equipment. Note disturbed marker stone in center.

Figure 22. West test cover: Southern edge, showing equipment egress point.

Figure 23. West test cover: Southern edge, showing damage from equipment.

Figure 24. West test cover: Comparison of damaged SW and pristine NE portions of test cover.

Figure 25. West test cover: Eastern edge, showing undisturbed NE surface and marker stones.

Figure 26. West test cover: Western edge and adjacent disturbed tailings.

Figure 27. West test cover: Looking NE from SW corner, showing surface damage from equipment.

Figure 28. Location where excavator was stuck, adjacent to west test cover.

Figure 29. Looking from tailings at western edge of west test cover.

Figure 30. West test cover: Western edge, showing damage from equipment.

Figure 31. Western edge of west test cover showing equipment tracks in tailings and damage done to edge of cover by equipment.

Appendix D

Photos of August 29, 2004 Site Inspection

Photo 1: View of tailings trial cover areas from the Rose Creek diversion. The West Pad (including geotextile) is to the left and the East Pad is to the right.

Photo 2: North-east view across the West Pad (including geotextile) surface. Note the dozer tracks leading onto the pad as a result of the excavator retrieval on June 17, 2004.

Photo 3: Looking north towards the East Pad. Note the standing water in the background.

Photo 4: Panoramic view of the West Pad (including geotextile) from the south-west. Note the permanent pond in the background and the damage caused by the dozer in the foreground.

Photo 5: Panoramic of the East Pad from the south. Note the presence of standing water behind the pad. This water is not dammed up against the pad.

Photo 6: Looking north-east along the primary survey beacons of the East Pad.

Photo 7: Close-up view of a crack on the corner of the East Pad. Note the crack continues from the tailings and on through the pad.

Photo 8: Close-up view of a crack on the surface of the East Pad. The crack is curved and measures approximately 5 m long, 10 to 20 mm wide and 10 to 100 mm deep.

Appendix E

Photos taken during September 27, 2004 Test Pit Excavation

Photo 1: TP-TTC-04-01 Profile of test pit showing the undulated interface between tailings and cover material where mixing has occurred.

Photo 2: TP-TTC-04-01 Base of test pit excavation into tailings.

Photo 3: TP-TTC-04-01 View of complete test pit showing the range amount of fines present in the cover material.

Photo 4: TP-TTC-04-01 View of complete test pit showing range in grain size from fines to boulders measuring 50 cm in diameter.

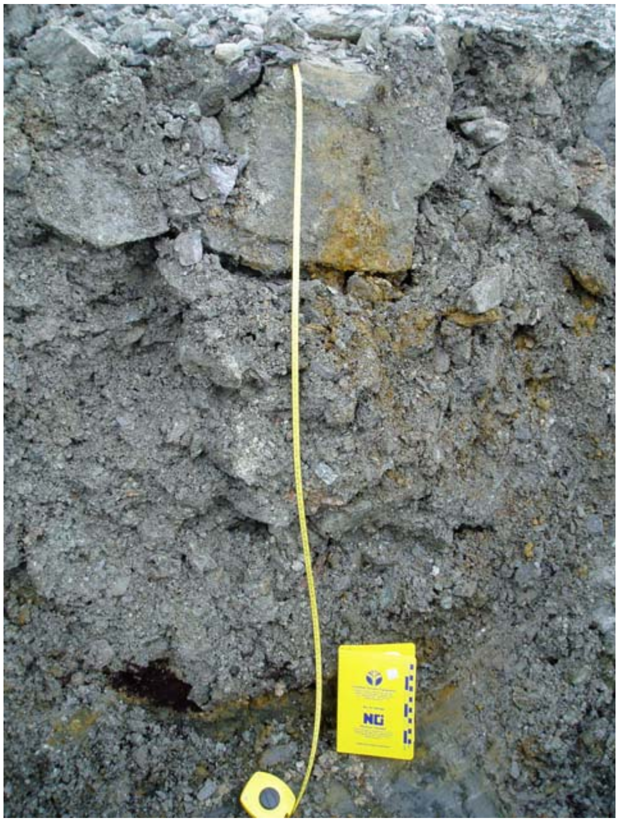

Photo 5: TP-TTC-04-02 Profile of test pit showing undulating bottom mixed zone.

Photo 6: TP-TTC-04-02 Profile of test pit showing range of article sizes in cover material.

Photo 7: TP-TTC-04-02 Overall view of test pit showing range in grain size distribution of cover material.

Photo 8: TP-TTC-04-02 Note the slope angle of the test pit walls. The material is very wet and the walls continuously caved in.

Photo 9: TP-TTC-04-03 Mixed zone of cover material and tailings of approximately 20 cm. The mixing appears to be dominated by larger boulders.

Photo 10: TP-TTC-04-03 Profile showing the range of particle sizes in the cover material.

Photo 11: TP-TTC-04-04 Minor undulating surface at contact between cover material and tailings.

Photo 12: TP-TTC-04-04 The tailings has not migrated through the geotextile. Although both the tailings and the cover material were very wet, the geotextile was relatively dry.

Photo 13: TP-TTC-04-04 The bottom of the geotextile is stained with tailings. It is possible that tailings is clogging the geotextile and subsequently slowing down the consolation time.

Photo 14: TP-TTC-04-04 Complete view of test pit showing the gradation of the cover material.

Photo 15: TP-TTC-04-05 Overlap section of the textile showing no signs of moving apart as a result of differential settlement. Also, no tailings are oozing through the seam opening.

Photo 16: TP-TTC-04-05 Complete view of test pit showing gradation of the cover material.

Photo 17: TP-TTC-04-06 Geotextile overlap showing no signs of tailings moving through the geotextile. The folds in the geotextile is as a result of rutting during construction caused by the trucks passing over the geotextile

Photo 18: TP-TTC-04-06 Complete view of test pit showing range in gradation of cover material.