FIELD PERFORMANCE OF THE LES TERRAINS AURIFÈRES COMPOSITE DRY COVERS

MEND Report 2.22.4be

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555 Booth Street
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K1A 0G1

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SUMMARY

During the decommissioning of Les Terrains Aurifères (LTA-Barrick-Bousquet) site at Malartic, the preferred option for the rehabilitation of the acid-generating tailings impoundment was to construct a composite cover. The cover was started during the winter of 1995-1996 and completed in the fall of 1996. The site has been the subject of a MEND monitoring study, for almost three years, with the involvement of Barrick, the Ministère des ressources naturelles du Québec and CANMET through the Canada-Québec mineral development agreement. A first report on the construction and the instrumentation of the composite cover (MEND 2.22.4a 1999) is also available. Since the initial construction, a new set of monitoring stations had been installed on the site to get a better spatial representation of the in situ conditions, particularly in the slopes.

This present report reviews the performance of the cover during the period 1996 to 1998. The main findings was that, by capillary action, the cover remained practically saturated over a period of three years, on the slopes as well as on top. Also, the average tailings oxidation flux was reduced by 95 % over the three year observation period.

Some areas showed local water contents that were lower than the design objective, particularly on the outer slopes that have a significant drop in elevation. The performance observed with hydraulic barrier test cells indicate that this type of structure would be effective where supplementary intervention would be necessary in these dryer areas.

SOMMAIRE

Lors des travaux relatifs à la fermeture du site Les Terrains Aurifères (Barrick-Bousquet) à Malartic, l'option retenue pour la réhabilitation du parc à résidus potentiellement générateur d'acide a consisté en la construction d'une couverture multicouche. Celle-ci a été mise en place durant l'hiver 1995-1996 et complétée à l'automne 1996. Le site fait maintenant l'objet d'un suivi, dans le cadre du NEDEM 2000, depuis près de trois ans, avec la participation Barrick, du Ministère des Ressources Naturelles du Québec et du CANMET par le biais de l'entente Canada-Québec sur le développement minéral. Un premier rapport, traitant de la construction et de l'instrumentation de la couverture multicouche (NEDEM 2.22.4a 1999) est disponible. Depuis lors, une nouvelle série de stations de mesures a été installée sur le site afin d'obtenir une meilleure représentation spatiale des conditions présentes en place, particulièrement dans les pentes.

Le présent rapport traite de la revue du comportement du recouvrement pendant la période de 1996 à 1998. Les principales conclusions émanant du présent projet sont que, par effet capillaire, le recouvrement est resté pratiquement saturé sur une période de trois ans, aussi bien dans les pentes qu'au sommet, et que la réduction du flux d'oxydation moyenne des résidus s'est avérée être de 95 % en trois ans d'observation.

Certaines zones ont montré localement des teneurs en eau inférieures à l'objectif de design, particulièrement dans les pentes extérieures possédant un dénivelé important. La performance observée dans les cellules d'essai d'un bris hydraulique laisse toutefois envisager que ce type de structure serait efficace dans le cas où des interventions supplémentaires seraient nécessaires dans ces zones plus sèches.

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1.0 INTRODUCTION

The study site is located about 8.5 km east of the city of Malartic in Abitibi, Québec. Access to the site is via a 1 km gravel road from Route 117. The property consists of a mine, closed since 1965, a mill and a tailings impoundment. The site has an area of about 140 hectares. The property belongs exclusively to Barrick Gold Corporation and is called Les Terrains Aurifères (LTA).

The tailings impoundment of Les Terrains Aurifères is bordered in the East by an old mine tailings impoundment belonging to the Ministère des ressources naturelles du Québec (MNR). This site, known as "Malartic Goldfields", is the old Malartic Goldfields mine tailings impoundment. It should also be noted that the Malartic Goldfields impoundment underlies the existing LTA impoundment. The LTA impoundment is bordered on the west by a sand and gravel borrow pit.

The site of the tailings impoundment was selected because it was close to the mill (100 m to the south) and it took advantage of a natural topographic depression to maximize storage capacity and minimize the size of the the dykes that had to be constructed. The impoundment is surrounded on three sides (east, north and west) by dykes rising to a maximum height of 15 m and to the south by the natural ground. A north-south dyke separates the tailings storage area from two polishing ponds located to the west.

The site was operated during two distinct phases. During mining operations in the 1930's, roughly 10 Mt of non acid-generating tailings having a buffering capacity of 100 kg/t (eq. $CaCO_3$) were deposited in a 5 m layer over the whole site. The site reopened in 1977 and about 7.7 Mt of acid-generating tailings (200 kg/t eq. $CaCO_3$) were placed on top of half of the surface of the old site, to a thickness of 12 m above the 3-5 m of carbonaceous Malartic Goldfield tailings (Figure 1).

Based on preliminary geochemical modelling studies, an engineered multi-layer cover was selected as the preferred tailings impoundment decommissioning method. The possibility of using the alkaline tailings of the MNR site (the old Malartic Goldfields) as fine material lowered costs and made this scenario more feasible than simple covering and perpetual treatment (McMullen and al., 1997). The construction was started during the winter of 1995-1996 and was completed in the fall of 1996. The work performed is illustrated in Photographs 1 to 7 located at the end of the report. The site is now being monitored in this Barrick-CANMET joint project since 1996. A first report, pertaining to the construction and the instrumentation of the multi-layer cover (MEND 2.22.4a 1999) is also available.

The multi-layer cover consists of 0.5 m of sand (Zone 1), placed directly on the tailings and acts as a capillary barrier layer, 0.8 m of alkaline tailings (Zone 2) from the MNR property which acts as a barrier against the diffusion of oxygen, and finally, 0.3 m of sand and coarse gravel (Zone 3) serving as a protection and drainage layer. Figure 2 shows the stratigraphy of the cover.

This report reviews the meteorological data for 1996-1998, with respect to the recharge conditions of the cover's fine layer. Various *in situ* probe results are then presented and analyzed. The hydraulic barrier test cell is described, followed by comments concerning the behaviour of the cover. Finally, a general discussion regarding the conclusions of the monitoring study is presented, based on the applicability of a multi-layer cover with the capillary barrier concept as a function of the geochemical, geotechnical and economic aspects of decommissioning a mine tailings impoundment.

2.0 COVER WATER BALANCE

The calculation of the water balance in the cover puts in perspective the various results obtained from the instrument as well as the overall performance of the cover. The water balance was estimated using the HELP program supplemented with meteorological data since 1960 from the Val d'Or airport station (situated about 20 kilometres east). The main results are presented in Tables 1 and 2 and shown in Figures 3 to 6. Water balances presented in Figures 3 to 6 represent a simulation using the real meteorological data as well as the present geometry of the site.

The program HELP (Hydraulic Assessment of Landfill Performance, Shroeder *et al*. 1994) is a quasi two dimensional hydraulic model simulating movement of water entering, crossing and leaving a landfill site. This model is available for free from the USEPA. Meteorological data, data relative to the composition of soils as well as the geometric parameters of the site design are entered in the model and a global water balance of the site is obtained. With the help of empirical models, the software can take into account recharge effects, snow melt, runoff, infiltration, evapotranspiration, plant growth, capillary retention, lateral drainage, leachate recirculation, unsaturated vertical drainage and seepage through soils, geomembranes and composite systems. It is therefore possible to simulate the behaviour of systems with various combinations of plant covers, soil covers, tailings, lateral drains and low permeability barriers.

Generally, at the site, the period when the soil is not frozen ranges from mid-May to mid-November. The total precipitation for 1996, 1997 and 1998 as well as the average since 1960 are presented in Tables 1 and 2. Snow was removed from the cover during the construction period of the winter 1995-96, therefore, the water volume from thawing in the spring of 1996 was significantly lower than normal. Excluding the month of July, precipitation for 1996 was always below normal and, therefore it was considered a relatively dry year. Precipitation for 1996 was 32.3 % lower than the average since 1960, as presented in Table 1.

In 1997, precipitation was slightly above average, except for the month of November. Table 1 shows that the precipitation amounts were 7.0 % above the mean observed since 1960.

In 1998, the monitoring period ended in September. Nevertheless, the precipitation was 10.7 % lower than the mean since 1960 for an equivalent period.

The available volume of water for recharge to the fine layer is obtained by subtracting the runoff and evaporation from the total precipitation. The more the fine layer is saturated, the better it will act to reduce the flux of oxygen and prevent the oxidization of the acid-generating tailings. Figures 3 to 6 present the water balance for the period 1996 to 1998.

Since snow was removed from the top of the impoundment during construction, the volume of runoff water was lower than normal in 1996, representing only 32.6 % of the average volume. The HELP analysis shows that runoff is not present until spring, when the top sand layer is already saturated with water. During the rest of the year, the hydraulic conductivity of the top layer of sand is increased sufficiently and the precipitation completely infiltrates. At the same time, the evaporation calculated for 1996 was lower than normal, only 72.5 % of the normal volume. The recharge available at the surface of the impoundment in 1996 was therefore 270.1 mm, 11.3% lower than mean observed since 1960, except for the month of August. The available recharge for this month was distinctly lower than normal, having effectively no recharge. Particular attention will be given to the results for August 1996 to analyze the behaviour of the cover under this extreme condition in the following sections.

In 1997, the available recharge at the cover's surface was 371.1 mm, 21.9% above the 30-year average. This increase results from higher precipitation and evapotranspiration, which was calculated to be 12% lower than normal. Finally, in 1998, the available recharge until the end of September rose to 255.3 mm, 16.2% above the average for an equivalent period.

In conclusion, the available yearly recharge at the top of the cover for 1996 to 1998 represents 43.4%, 37.7% and 35.9%, respectively of the total precipitation (see Figures 3 and 4).

The slopes of the cover showed smaller changes between 1996 and 1998 than those observed for the top of the impoundment, as presented in Table 2. The available recharge for 1996 was 262.74 mm, 86.3% of the average volume since 1960 and 366.97 mm in 1997, 20.5% above the mean. The available recharge until the end of September 1998 was 255.45 mm, 16.4% above the mean for an equivalent period. Here again, the available recharge for the month of August 1996 was especially low estimated at 2.07 mm, 5.3% of the average calculated recharge for the month of August.

The HELP simulation also predicts that the difference of the water balance distribution is rather low between a dry year and a wet year, as shown in Figures 5 and 6. The available recharge is therefore slightly more significant on the top of the impoundment than that the slopes: 2.4% for 1996; 1.4% for 1997; and no difference for the year 1998.

3.0 MONITORING RESULTS

3.1 Instrumentation of the site

The instrumentation program for the LTA site was completed in two phases, each with specific objectives. Phase A, implemented during the summer 1996, was designed to obtain the fundamental conditions in the cover in order to compare the behaviour of the cover with that obtained through simulation during the feasibility phase. During Phase A, 10 stations were installed on top of the site (CS96-1 to CS96-10) and 10 others on the slopes (PS96-1 to PS96-10). Figure 7 shows the locations of these stations.

Figure 2 shows the Phase A set-up of the instruments for each station. Oxygen probes are used to the measure the oxygen consumption under the multi-layer cover. Since the oxygen consumption measurement is actually a flux, the effective coefficient of oxygen diffusion across the cover can be calculated using the methodology proposed by Elberling *et al.* (1994). The TDR probes (Time Domain Reflectometry) measure the *in situ* water content of the material, and Watermark humidity sensors enable the measurement of the capillary suction in the soil. These three parameters will permit the analysis of the cover's efficiency and will establish the relationship between the water content and the *in situ* capillary suction of the material, and the cover's capacity to reduce the oxygen flux.

The type of monitoring station installed in Phase A allows vertical profiling of fundamental conditions but it is fairly disruptive (since stations have to be installed after the construction of the cover) and expensive. Logistical reasons at the time of construction did not permit the installation of the instruments. To install each monitoring station, it was necessary to excavate the cover materials, to install the instruments, and then refill and compact the area around the monitoring instruments.

Although the monitoring instrumentation installed during Phase A enabled the collection of indispensable information concerning the behaviour of the cover, there is still a need to study the spatial distribution of conditions in more detail. Specifically, a better analysis of the behaviour of the whole cover and a more precise identification of the problem areas of the cover potentially requiring additional intervention is required.

A second set of monitoring stations were installed in the 1997 summer. Figure 2 shows the instrumentation set-up for Phase B stations. These stations consist of a TDR probe driven vertically to the fine material layer. This type of station causes minimal cover disruption and permits a wider distribution of stations, and consequently, an understanding of *in situ* conditions. The disadvantage of these stations is that only the volumetric water content is measured and these stations are located at a depth where they can be affected by evaporation. Phase B consisted of 15 stations installed on the west dyke (TA97-1 to TA97-15), nine stations on the north dyke (TA97-16 to TA97-24) as well as six on the east dyke (TA97-25 to TA97-30). The locations are shown on Figure 7.

3.2 Monitoring Results - Phase A

Results obtained from the monitoring stations are presented in Tables 3 to 15. Water retention curves for CS96 and PS96 stations (probes T3 and T5 installed in the MNR tailings) are presented in Figures 8 and 9. The X axis represents the volumetric water content obtained from TDR probes, and the Y axis are the suction potential measured using the Watermark probes (Figure 2).

It should be noted that the important element of the water retention curves obtained in the laboratory is located at the inflection point, in other words where the curve changes slope. This point closely represents the AEV (Air Entry Value) of the material. In addition, the qualifier *apparent* is applied since, by definition, such a curve is obtained from laboratory tests done during drying conditions. In the present case, results of Figures 8 and 9 were obtained in a dynamic environment, essentially composed of transient periods of recharge and drying. The term *apparent water retention curve* applies solely to the *in situ* response of the material to these transient phenomena and represents a qualitative appreciation of other phenomena such as hysterisis.

The analysis of these figures shows that in three-years of observation, few areas seem to present marked drainage, with perhaps the exception of the top of the fine layer of stations CS96-3, CS96-4 (Figure 8) and PS96-1 (Figure 9). Most points are essentially on the left or very near to the apparent AEV, on the saturated side. The average apparent AEV for most of these curves, which corresponds roughly to the inflection point, would be situated in the range of 100 to 200 cm of water, which is in agreement with the AEV observed during the laboratory tests (MEND 2.22.4a 1999). The *apparent water retention curves* show that the fine layer of the cover stayed practically saturated over a period of three years.

Results obtained from the oxygen consumption tests are actually a measure of the oxygen flux. These results permit the calculation of the effective oxygen diffusion coefficient through the cover (Elberling *et al*., 1994). A coefficient of $1*10^{-8}$ m^2/s was identified as an objective during the geochemical modelling analyses to provide minimal oxidation conditions (SENES, 1995 and McMullen *et al*., 1997). The effective oxygen diffusion coefficient results are shown in Figures 10 and 11, with the apparent water retention curves already presented in Figures 8 and 9 as background.

This method allows the comparison of the calculated effective diffusion coefficient and the apparent water retention curve. Thus, in theory, for a low suction (elevated saturation), the diffusion coefficient would be low and would be found in the lower left corner of the diagram. Inversely, for a more elevated suction (consequently a lower saturation), the diffusion coefficient would be higher and would be found in the upper right corner of the diagram.

The predicted results were not observed in Figures 10 and 11, although the results are in the expected order of magnitude of $1*10^{-8}$ m^2/s. The explanation may lie in the calculation method used, which assumes that the material composing the fine layer (Zone 2, Figure 2) does not consume oxygen. These materials are classified as alkaline tailings, with a net ABA (Acid Base

Accounting) of 100 kg/t of neutralization. MNR mine tailings, nevertheless, possess low contents of pyrite and the small amount of acidity produced is largely neutralized by the alkaline elements. These tailings, which were used in the construction of the cover for Zone 2, consume oxygen, which in turn causes the erroneous calculation of the effective oxygen diffusion coefficient in multi-layer cover of the LTA site.

Oxygen consumption measurements were done by URSTM on the borrow pit of fine material used for the cover (MNR site, MEND 2.22.4a 1999). The results are presented in Table 16 and Figure 12. Alkaline MNR mine tailings used for the fine layer in the LTA cover effectively consume, on average, 28 moles/m^2/yr of oxygen, with peaks that can reach 95 moles/m^2/yr.

To put these values in perspective, all oxygen consumption readings completed on the LTA cover are in the same order of magnitude as the background levels measured on the tailings at the MNR site as shown in Figure 12. The observed oxygen flux reduction for covered tailings is significant when compared to oxygen consumption values of the uncovered tailings, which have a mean of 517 moles/m^2/yr (Tibble and Nicholson, 1997). The reduction in oxygen consumption would be about an order of magnitude when the raw values are compared. It is likely that the reduction is even higher, considering the background values from the MNR tailings. A revised value for the different effective oxygen diffusion coefficients will be established when the different parameters are isolated by numerical modelling.

In conclusion, results from the Phase A monitoring stations demonstrates that the cover remained practically saturated over a period of three years and that the reduction of the oxygen consumption would be at least an order of magnitude.

3.3 Monitoring Results - Phase B

The most efficient way to quantify the overall performance of the cover is to quantify the global oxygen flux of the site. Unfortunately, for the reasons mentioned above, the presence of background levels in these measurements make the exercise more difficult.

To evaluate the overall performance of the cover, it is necessary to use a common reference unit. An alternative method consists of evaluating the saturation of the cover and estimating the distribution over the whole site. The saturation is the ratio of the volumetric water content and the porosity. This is a dimensionless value, and is therefore a possible common unit for the assessment between stations. However, it is difficult to determine the porosity since the grain size of the materials *in situ* as well as their compaction is presumably different for all stations. The compaction was estimated at each monitoring station using the highest volumetric water content readings observed, in conjunction with zero suction. This method obtains a conservative estimate that is closer to reality, within the limit of probe precision. The value obtained will be qualified by the terms *estimated degree of saturation* to take into account this approximation.

Monitoring results from Phase B stations provide a better distribution profile for the degree of saturation over the whole site. It is possible to estimate the degree of saturation for the cover from the TDR probe readings (see Figure 2) for the TA97, CS96 and PS96 series. Estimated saturation values for each station are presented in Tables 17 to 28, whereas profiles of saturation present are presented in Figures 13 to 17.

A significant difference in the percent of saturation between the fine layer (blue and green curves), made with fine MNR tailings (Zone 2), and the capillary barrier (red curve), composed of sand (Zone 1) is observed in Figures 13-14. The efficiency of the capillary barrier is well illustrated; the sand layer (red curve) low estimated degree of saturation keeps the subjacent layer (blue and green) moist practically year-round. This observation is especially apparent for stations situated on the slopes of the cover (set PS96, Figure 14).

The goal of the CS96 stations (MNR tailings), installed on the top of the cover, was to verify the series of overall degree of saturation to ensure that the design value of 85 % was largely achieved (MEND 2.22.4a, 1999). The extreme drought period in August 1996 had little effect on the estimated average degree of saturation of the top of the cover. This weak decline is especially attributable to the capillary barrier effect, while the percent of saturation of the capillary layer (red curve) fell below 60 % and, the estimated degree of saturation of the fine layer (MRN tailings - oxygen barrier) was around 80 %. The difference in the estimated saturation degree between 1996 (dry) and 1997-98 (moist) is barely noticeable.

As for the stations on the slopes, the variation in percent saturation is distinctly more significant depending on *in situ* conditions.

The east and southeast slopes represent the least humid sections of the cover (MNR tailings, stations PS96-1 to PS96-3, as well as TA97-25 to TA97-30). This area was thoroughly tested in 1996, in particular during the dry period of August 1996. Estimated saturation values as low as 75 % were obtained for station PS96-1, whereas stations PS96-2 and PS96-3 had values over 80 %. Values for 1997 are somewhat higher, around 80 % saturation. The difference between 1996 (dry) and 1997-98 (wet) is more significant for station PS-96-3 (southeast dyke) than for the stations on the top of the cover.

North dyke stations (MNR tailings, stations PS96-4 to PS96-10, and TA97-21 to TA97-24) and west dyke stations (silt of the borrow pit #1, stations TA97-1 to TA97-10) show, on average, values near the 85% saturation objective; although the degree of saturation varies with recharge conditions. The difference between 1996 (dry) and

1997-98 (wet) is not significant for PS96-4 to PS96-10. When the North dyke (with plateau, 20 m high) and southeast dyke (without plateau, 18 m high) are compared, it is apparent that the presence of the plateau significantly helps the retention of water by offering shorter continuous discharge surfaces.

In all cases, decreases in the estimated degree of saturation in the fine layer are observed in spring 1997 and 1998, and in August 1997. This seems contradictory if one considers only the calculations for the available recharge. These decreases are especially defined for the East and South-east dyke stations, and curiously, for those situated mid-slope such as TA97-2, TA97-5, TA97-14, TA97-8, TA97-27, PS96-2, and PS96-6. The transient effect of the recharge is found to be the cause of these observations. This hypothesis has been confirmed with the help of hydrogeological simulations done with SEEP/W, a finite element program.

During construction of the cover on the slopes, the capillary barrier (Zone 2 – fine material layer) ends in the toe drains of the dykes. These are made of sand. Toe drains are necessary to lower the water table inside the impoundment and to promote the long-term stability of the dykes.

When significant recharge events take place, as in the spring and July 1997, the capillary barrier becomes saturated and is no longer capable of eliminating the infiltration surplus. The increase in the degree of saturation in the capillary barrier is evident for stations CS96-9, PS96-3, PS96-6, PS96-7 and PS96-8. In these cases, the capillary barrier becomes saturated with water, continuous flow conditions are established and the layer loses its capillary barrier properties. When the significant recharge period ends, the discharge from the capillary barrier is so great that a preferential discharge pathway forms, bringing with it the water from the fine layer by gravity and suction (the suction caused by the discharge is greater than those from the capillary properties of the fine material). It is essentially a hydraulic short circuit.

The decrease of the estimated percent saturation in June and August 1997 was observed after a significant recharge period. Figures 18 to 22 illustrate the results of hydrogeological simulations for the southeast, north and west dykes. The size of the area affected during high drainage periods with respect to that observed the following month when the discharge in the capillary barrier was lower are shown. The significant recharge of June and July 1997, followed by the very dry period of August 1997, would have created difficult conditions for water retention in the slopes as shown by the estimated saturation percent results.

Using known information such as the actual locations of the monitoring stations and their associated variations in the degree of saturation and some interpolation, a layout of the site was prepared identifying the areas of interest (e.g. low saturation).

This was accomplished using the program SURFER, while employing the so-called "krigeage" method to interpolate between monitoring stations. According to this method, the further an area is from a station, the less representative it becomes. This is especially true for the results of 1996, when the number of monitoring stations was relatively small. Better results are expected for 1997 and 1998, with 50 stations monitored. The estimated saturation layouts are shown on Figures 23 to 39.

The two dryer zones previously identified, the southeast dyke and a portion of the north dyke, are shown on these figures.

In conclusion, Phase B results confirmed that the cover remained saturated during the three year monitoring period, and this because of the capillary effect generated by the layout of the multi-layer cover. Also, the presence of a plateau in the slope, reducing the continuous discharge surface, significantly increased the water retention.

The results also demonstrated that in significant recharge periods, the capillary barriers can develop continuous flow conditions, particularly in the lower slopes. This causes a decrease in the estimated percent of saturation in the middle of the slopes resulting in a hydraulic short circuit. These monitoring results were used to obtain a spatial distribution of the estimated percent of saturation, to identify areas that are lower in saturation than the remainder of the site.

4.0 HYDRAULIC BARRIER TEST CELL

During Phase A and B of the monitoring program, two specific areas requiring additional intervention, were identified for further study. They are:

- the conditions for the formation of a hydraulic short circuit in the capillary barrier layer, that can potentially dry the fine layer of a multi-layer cover; and
- the degree of saturation found in slopes without a plateau that can sometimes be lower at certain places.

These two points should be incorporated directly in the design of future covers. It could consist of systematically incorporating plateaus in slopes to reduce the water discharge (and runoff and infiltration) and to promote a sufficient permeability in the capillary barriers and toe drains. This will permit water discharge during significant recharge periods and prevent continuous flow conditions.

In cases where the cover is already constructed, such as LTA, another type of structure must be used. The construction of a hydraulic barrier at LTA would improve the performance of the cover by resolving the short circuit and degree of saturation phenomena. A typical hydraulic barrier is shown in Figure 40.

The underlying principle of a hydraulic barrier is to create a saturated zone (in the fine material) that results in a suction value of close to zero. With this, the capillary forces are again in equilibrium in the fine layer and the impact of the humid layer can be found to have an affect on a larger area than the immediate proximity of the monitoring structure. To obtain such a volume of water, it would be necessary to replace a section of the capillary barrier by a more impervious material. This material would also act as a plug to prevent a fast discharge of the moisture in the capillary barrier. This intervention will not be very effective in preventing a hydraulic short circuit, but will attenuate some of the effects. The difficulty lies in spacing these hydraulic barriers so that their effect is complementary up to the top of the dyke.

A test cell was constructed in November 1997 to study the performance of a hydraulic barrier. This cell was constructed by excavating a 20 m-long trench on the southern extremity of the southeast dyke's slope, then building the hydraulic barrier with a silty material (Figures 41 to 44). The slope was instrumented as shown in Figure 45.

Instrument responses were compared to readings obtained from control stations, PS96-1 to PS96-3. This allowed a fast-determination of the design performance. Table 29 gives the results of the readings, whereas Table 30 compares the estimated degree of saturation from the test cell probes to those of the control stations.

In 1998, the hydraulic barrier test cell demonstrated a significant improvement in slope condition, as shown in Figure 46. The estimated saturation improved in absolute values by 20 % on the top of the slope, 10-15 % for the mid-slope and 10 % for the base of the slope, compared to control values. The impact of the hydraulic barrier on the estimated saturation in the southeast dyke's slope, is encouraging and suggests that the design will function efficiently.

5.0 GEOCHEMICAL PERFORMANCE OF THE COVER

Analysis of the performance of the cover can be done by averaging the oxygen consumption test results presented in Table 16. These results are summarized as follows:

TAILINGS OXYGEN CONSUMPTION MEASUREMENTS
(moles $O_2/m^2/yr$)

		Range	Average	Standard Deviation
University of Waterloo, June 1996	Exposed	228-836	517	139
University of Waterloo, June 1996	Covered	<1-10	2.7	3.2
University of Waterloo, October 1996	Covered	<1-29	5.5	7.4
URSTM, July 1997	Covered	<1-95.2	30.9	36.1
URSTM, October 1997	Covered	<1-105	18.8	28.8
URSTM, June 1998	Covered	0-180.8	56.3	58.2
URSTM, August 1998	Covered	40.6-84.0	61.0	17.2
URSTM, October 1998	Covered	0-20.8	5.2	10.4

As mentioned in Section 3.2, there is background values caused by oxygen consumption of MNR mine tailings that make interpretation of the results more difficult. Numerical simulations will be done to take into account this contribution and to more accurately establish the performance of the cover.

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With measurements of oxygen consumption, it is possible to calculate the reduction of the acid production on the site. The two main reactions of acid formation from pyrite are:

$$FeS_2 + {}^{7}/_{2}\, O_{2\,(g)} + H_2O \quad + Fe^{2+} + 2\, SO_4^{2-} + 2\, H^+$$

$$FeS_2 + {}^{15}/_{4}\, O_{2\,(g)} + {}^{7}/_{2}\, H_2O + Fe(OH)_3 + 2\, SO_4^{2-} + 4\, H^+$$

The amount of acid generated for every mole of oxygen consumed would, be between 0.57 and 1.07 moles H^+. According to Table 16, oxygen consumption in the covered stations was reduced two orders of magnitude when compared to the exposed (control) stations. In terms of acid production, the results are:

TAILINGS ACID PRODUCTION
(moles $H^+/m^2/yr$)

		Minimum	Maximum	Reduction
University of Waterloo, June 1996	Exposed	295	553	-
University of Waterloo, June 1996	Covered	1.5	2.7	99.5 %
University of Waterloo, October 1996	Covered	3.1	5.9	98.9 %
URSTM, July 1997	Covered	17.6	33	94.0 %
URSTM, October 1997	Covered	10.4	19.5	96.5 %
URSTM, June 1998	Covered	32.1	60.2	89.1 %
URSTM, August 1998	Covered	34.8	65.3	88.2 %
URSTM, October 1998	Covered	3.0	5.6	99.0 %
	Average	14.6	27.5	95.0 %

The cover, over a three-year period, reduced tailings oxidation by 95 %, on average. Apparently, an effective oxygen diffusion coefficient of $1*10^{-8}$ m^2/s, obtained at 85 % of saturation, is sufficient to inhibit acid production. Based on a three-year study period, the multi-layer cover displayed an effective geochemical performance.

6.0 CONCLUSIONS

Based on the degree of saturation, the multi-layer cover has performed more efficiently than anticipated. After three complete years of hydrogeological studies, it appears that the multi-layer cover performed adequately. The key findings of the study are:

- The capillary barrier concept was successfully demonstrated. The top and the slopes of the cover remained saturated for three years;
- The reduction in oxygen consumption was found to be at least an order of magnitude;
- The presence of plateaus on slopes, significantly increases water retention in the cover by reducing the continuous discharge surface;
- In significant recharge events, the capillary barrier can develop continuous flow conditions, particularly at the base of slopes. This promotes a momentary decrease in the degree of saturation of the cover resulting in a hydraulic short circuit;
- With sufficient monitoring stations, it would be possible to identify local areas that may require additional intervention;
- The concept of the hydraulic barrier used to help water retention was very successful; and
- The reduction in the average tailings oxidation is approximately 95 % for the three-year study.

Some numerical simulations will be carried out to exclude the oxygen consumed by its MRN tailings used for the construction of the cover. The results on the performance of the cover will be more accurate. This data will be published when available.

7.0 DISCUSSION AND RECOMMENDATIONS

The multi-layer cover construction on Les Terrains Aurifères (LTA) site enabled the performance of this technology to be evaluated on a full scale site. The project demonstrated the relevance of using alkaline mine tailings (as proposed by Aubertin *et al.* 1995) as construction material thereby providing significant cost savings. Similar projects should take into consideration the following recommendations.

♦ Theoretical considerations

At least three parameters are essential to provide an economically and geochemically optimal design:

- The maximum oxygen flux value (obtained typically by the numerical modelling or by column tests), that will result in a negligible oxidation or acceptable water quality in the long term;
- Effective oxygen diffusion coefficient (De) values as a function of the saturation for the material considered for construction of the cover (determined by laboratory tests). Knowing the maximum oxygen flux allowed, the required thickness can be calculated using the method presented in Elberling *et al*. 1994;
- Soil water characteristic curves of the various construction materials considered for the cover, are required to design the capillary barrier to promote quasi-permanent saturation of the fine material layer in the cover.

♦ **Conceptual considerations**

The project demonstrated that geotechnical properties of the MNR tailings, used as the fine material in a multi-layer cover, are unique to this site. The MNR tailings possess characteristics that could be found in a relatively common sandy silt. The difficulty lies in evaluating the thickness of the material needed to promote minimal oxidation conditions, and to design a geometry enabling a hydraulic contrast with the sand of the capillary barrier.

Based on observations made during the LTA monitoring program, two additional recommendations should be incorporated into the design phase. They are:

- plateaus be incorporated on the slopes that have a drop in elevation significantly larger than the AEV of the material, and
- the use of more permeable material for the construction of toe drains, or the use of larger drains, to prevent the capillary barriers from becoming saturated during significant recharge events thereby provoking hydraulic shorts-circuits in the cover.

♦ **Geotechnical and Economic Considerations**

Site management is an important element in any construction project. It could affect the overall cost of the project. Specific design requirements (e.g. compaction) need to be adhered to in areas of extreme conditions such as inadequate foundations. Novel techniques need to be developed. In the LTA cover project, winter construction was the most suitable solution. This project demonstrated the efficiency of a 1.6 m thick multi-layer cover. This cover which cost $65 000 /ha, succeeded in reducing the tailings oxidation by an average of at least 95% over a period of three years.

AUTHORS:

Pascal Garand, Golder Associés Ltée
Jean-François Ricard, Golder Associés Ltée

TECHNICAL REVIEWERS

Michel Aubertin, École Polytechnique de Montréal
Jacques McMullen, Barrick Gold Corporation
Pierre Pelletier, Barrick Gold Corporation
Phillipe Poirier, Barrick Gold Corporation
Gilles Tremblay, Natural Resources Canada(CANMET)

SPECIAL THANKS TO:

Jody Vaillancourt, Golder Associés Ltée

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Table 1
Stack surface estimated available recharge
Calculations with HELP

Months	Precipitation Average	1996	1997	1998	Runoff Average	1996	1997	1998	Evaporation Average	1996	1997	1998
	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
mid-November	40.06	0.00	31.75	8.75	3.18	0.00	0.18	0.00	4.88	0.00	4.77	4.61
December	65.16	0.00	102.00	30.50	7.33	0.00	24.80	0.00	5.14	0.00	6.76	7.00
January	58.97	0.00	113.50	59.00	5.53	0.00	0.00	0.55	4.81	0.00	2.16	4.66
February	43.20	0.00	32.00	22.50	12.48	0.00	0.00	123.27	5.24	0.00	4.06	11.54
March	60.98	0.00	39.00	90.50	104.21	0.00	0.00	13.11	13.28	0.00	8.00	17.65
April	61.01	114.50	31.50	33.50	91.36	76.60	238.72	0.00	43.34	26.12	33.12	35.03
May	73.14	44.00	94.50	47.00	7.87	0.00	13.22	0.00	45.88	44.16	61.82	10.00
Spring	402.52	158.50	444.25	291.75	231.97	76.60	276.92	136.93	122.56	70.28	120.69	90.49
June	94.42	87.50	66.00	173.50	0.01	0.00	0.00	0.00	56.45	35.17	25.21	62.76
July	101.38	137.00	151.00	80.50	0.00	0.00	0.00	0.00	60.62	49.52	53.13	59.94
August	97.19	58.00	96.00	81.00	0.00	0.00	0.00	0.00	57.36	52.98	39.44	58.73
September	101.42	85.00	124.50	85.00	0.00	0.00	0.00	0.00	48.30	33.50	58.56	47.58
October	82.49	64.50	93.00		0.00	0.00	0.00		28.88	29.17	33.87	
mid-November	40.06	31.75	8.75		3.18	0.18	0.00		5.77	4.77	4.61	
Annual	919.48	622.25	983.50	711.75	235.17	76.78	276.92	136.93	379.93	275.39	335.50	319.50
% vs prec.					25.6%	12.3%	28.2%	19.2%	41.3%	44.3%	34.1%	44.9%
% vs avg.		67.7%	107.0%	89.3%		32.6%	117.8%	59.0%		72.5%	88.3%	92.5%

Months	Available recharge Average	1996	1997	1998	Cummulative recharge Average	1996	1997	1998
	mm	mm	mm		mm	mm	mm	mm
mid-November	frozen	frozen	frozen	frozen	frozen	frozen	frozen	frozen
December	frozen	frozen	frozen	frozen	frozen	frozen	frozen	frozen
January	frozen	frozen	frozen	frozen	frozen	frozen	frozen	frozen
February	frozen	frozen	frozen	frozen	frozen	frozen	frozen	frozen
March	frozen	frozen	frozen	frozen	frozen	frozen	frozen	frozen
April	frozen	frozen	frozen	frozen	frozen	frozen	frozen	frozen
May	frozen	frozen	frozen	frozen	frozen	frozen	frozen	frozen
Spring	47.99	11.62	46.65	64.34	47.99	11.62	46.65	64.34
June	37.96	52.33	40.79	110.74	85.96	63.95	87.44	175.08
July	40.75	87.48	97.87	20.56	126.71	151.43	185.31	195.64
August	39.83	5.02	56.56	22.27	166.54	156.45	241.87	217.91
September	53.12	51.50	65.94	37.42	219.66	207.95	307.81	255.33
October	53.61	35.33	59.13		273.27	243.28	366.94	
mid-November	31.11	26.81	4.15		304.38	270.09	371.09	
Annual	304.38	270.09	371.09	255.33				
% vs prec.	33.1%	43.4%	37.7%	35.9%	Ratio vs precipitations			
% vs avg.		88.7%	121.9%	116.2%	Ratio vs 30 years average			

Note 1: Estimates based on climatic data from Val d'Or airport (temperature, precipitations) and Normandin (radiations).

Note 2: Precipitations for Nov. 1995 to March 1996 were considered nil, because snow was removed during cover constrcution

Table 2

Dykes outer slopes estimated available recharge

Calculations with HELP

Months	Precipitation				Runoff				Evaporation			
	Average mm	1996 mm	1997 mm	1998 mm	Average mm	1996 mm	1997 mm	1998 mm	Average mm	1996 mm	1997 mm	1998 mm
mid-November	40.06	71.40	31.75	8.75	3.18	0.00	0.18	0.00	4.88	4.07	4.77	4.54
December	65.16	31.00	102.00	30.50	7.33	0.00	24.80	0.00	5.13	4.57	6.76	7.00
January	58.97	41.00	113.50	59.00	5.40	26.58	0.00	0.00	4.80	3.82	2.16	4.66
February	43.20	12.00	32.00	22.50	12.18	0.00	0.00	0.55	5.39	4.97	4.06	11.54
March	60.98	14.50	39.00	90.50	104.73	116.09	0.00	123.27	13.35	14.09	8.00	17.65
April	61.01	114.50	31.50	33.50	89.39	76.13	238.64	13.11	42.98	27.03	35.73	35.03
May	73.14	44.00	94.50	47.00	7.66	0.00	12.69	0.00	44.68	44.26	62.59	9.99
Spring	402.52	328.40	444.25	291.75	229.86	218.80	276.31	136.93	121.22	102.81	124.07	90.41
June	94.42	87.50	66.00	173.50	0.01	0.00	0.00	0.00	57.17	35.59	25.68	62.76
July	101.38	137.00	151.00	80.50	0.00	0.00	0.03	0.00	62.08	50.75	53.39	59.89
August	97.19	58.00	96.00	81.00	0.00	0.00	0.00	0.00	57.89	55.93	39.54	58.73
September	101.42	85.00	124.50	85.00	0.00	0.00	0.00	0.00	49.18	31.79	59.37	47.58
October	82.49	64.50	93.00		0.00	0.00	0.00		28.64	28.81	33.61	
mid-November	40.06	31.75	8.75		3.18	0.18	0.00		5.70	4.77	4.54	
Annual	919.48	792.15	983.50	711.75	233.06	218.98	276.34	136.93	381.89	310.44	340.20	319.37
% vs prec.					25.3%	27.6%	28.1%	19.2%	41.5%	39.2%	34.6%	44.9%
% vs avg.		86.2%	107.0%	89.3%		94.0%	118.6%	59.6%		81.3%	89.1%	91.9%

Months	Available recharge				Cummulative recharge			
	Average mm	1996 mm	1997 mm	1998	Average mm	1996 mm	1997 mm	1998 mm
mid-November	frozen	frozen	frozen	frozen	frozen	frozen	frozen	frozen
December	frozen	frozen	frozen	frozen	frozen	frozen	frozen	frozen
January	frozen	frozen	frozen	frozen	frozen	frozen	frozen	frozen
February	frozen	frozen	frozen	frozen	frozen	frozen	frozen	frozen
March	frozen	frozen	frozen	frozen	frozen	frozen	frozen	frozen
April	frozen	frozen	frozen	frozen	frozen	frozen	frozen	frozen
May	frozen	frozen	frozen	frozen	frozen	frozen	frozen	frozen
Spring	51.43	6.79	43.88	64.41	51.43	6.79	43.88	64.41
June	37.24	51.91	40.32	110.74	88.67	58.71	84.20	175.15
July	39.30	86.25	97.58	20.61	127.97	144.96	181.78	195.76
August	39.30	2.07	56.46	22.27	167.27	147.03	238.24	218.03
September	52.24	53.21	65.13	37.42	219.51	200.24	303.37	255.45
October	53.85	35.69	59.39		273.36	235.93	362.76	
mid-November	31.18	26.81	4.21		304.53	262.74	366.97	
Annual	304.53	262.74	366.97	255.45				
% vs prec.	33.1%	33.2%	37.3%	35.9%	Ratio vs précipitations			
% vs avg.		86.3%	120.5%	116.4%	Ratio vs moyenne 30 ans			

Note 1: Estimates based on climatic data from Val d'Or airport (temperature, precipitations) and Normandin (radiations).

Note 2: Precipitations for Nov. 1995 to March 1996 were considered nil, because snow was removed during cover constrcution

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Table 3

T-1 probe (capillary break) results for CS96 stations
Volumetric water content

Date	CS96-1	CS96-2	CS96-3	CS96-4	CS96-5	CS96-6	CS96-7	CS96-8	CS96-9	CS96-10
14-Jun-96	28.2	32.1	35.3	31.9	49.1	34.4	39.5	34.5	28.7	35.0
2-Jul-96	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a
18-Jul-96	24.8	29.1	29.5	27.8	50.0	33.9	46.1	n-a	27.3	33.8
26-Jul-96	17.2	10.2	26.4	27.3	50.2	33.9	45.9	49.0	35.1	24.0
8-Aug-96	15.4	10.2	21.8	18.6	48.7	32.8	43.1	47.5	34.4	15.4
11-Sep-96	13.6	12.7	16.9	16.7	48.5	31.9	45.1	47.8	12.7	34.8
17-Sep-96	16.0	n-a	19.6	19.1	48.0	32.2	43.7	47.8	n-a	35.0
18-Oct-96	15.8	0.0	18.0	18.0	48.7	33.2	45.7	50.2	13.8	35.8
29-May-97	15.6	n-a	18.0	17.0	47.0	30.6	41.9	48.2	18.8	31.6
9-Jun-97	14.5	n-a	16.0	15.8	46.3	30.5	40.0	47.4	13.5	30.2
5-Jul-97	17.0	n-a	19.9	19.9	46.2	30.8	n-a	47.5	36.6	30.2
15-Jul-97	20.2	n-a	26.5	22.2	46.5	31.0	42.6	51.2	26.0	30.1
4-Aug-97	14.6	n-a	21.3	16.3	45.4	30.1	39.8	46.9	21.0	30.0
17-Oct-97	15.6	n-a	25.1	18.2	46.4	31.5	41.6	53.4	26.4	31.2
22-Oct-97	20.2	n-a	26.5	22.2	46.5	31.0	42.6	51.2	26.0	30.1
4-Nov-97	19.3	n-a	25.5	21.9	47.8	31.8	45.1	53.4	26.7	32.1
11-Nov-97	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a
20-Apr-98	17.8	n-a	19.1	0	46.7	28.8	45.1	50.9	14.8	32.0
28-Apr-98	16.0	n-a	16.3	0	45.7	28.8	41.8	49.2	12.2	31.0
4-May-98	15.0	n-a	15.1	0	44.4	28.0	39.7	48.4	11.2	29.7
19-May-98	13.3	n-a	13.6	0	41.6	26.4	38.9	46.7	9.8	29.0
25-May-98	13.6	n-a	14.0	0	45.0	25.9	39.4	47.7	10.5	28.0
1-Jun-98	15.9	n-a	17.7	0	46.1	28.7	39.8	48.5	12.2	32.1
9-Jun-98	15.8	n-a	16.1	n-a	45.1	28	39.8	47.6	10.5	31.1
19-Jun-98	15.8	n-a	16.4	n-a	43.8	28.2	39.4	47.5	10.6	30.7
26-Jun-98	18.7	n-a	19.7	n-a	45	30.5	39.5	47.5	n-a	n-a
9-Jul-98	15.5	n-a	16	n-a	44.9	30.1	39	47	11.1	30.9
14-Jul-98	15	n-a	15.2	n-a	42.8	29.5	38.8	46.6	10.3	29.9
22-Jul-98	15.6	n-a	16.2	n-a	45	30.3	20	47.5	11.3	30.7
31-Jul-98	16.4	n-a	17.5	n-a	44.3	30.5	37.8	47.7	12.2	30.9
6-Aug-98	14.8	n-a	15.6	n-a	n-a	29.8	38.7	46.4	11.5	30
13-Aug-98	14.5	n-a	14.9	n-a	43.5	29.8	36.4	46.6	11.7	30.8
19-Aug-98	13.9	n-a	14.4	n-a	43.6	29.8	n-a	46.5	10	30
26-Aug-98	15.5	n-a	16.8	n-a	42.8	30	38.6	46.7	n-a	n-a
12-Sep-98	15.1	n-a	15.6	n-a	45.3	31	39.3	47.8	10.6	29.9
30-Sep-98	16.3	n-a	16.9	n-a	46.3	31	39.7	48.7	12	31.1

n-a: not-available

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Table 4

T-3 probe (retention layer lower part) results for CS96 stations
Volumetric water content

Date	CS96-1	CS96-2	CS96-3	CS96-4	CS96-5	CS96-6	CS96-7	CS96-8	CS96-9	CS96-10
14-Jun-96	44.5	51.5	48.3	46.8	46.3	53.6	49.1	57.7	43.9	45.2
2-Jul-96	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a
18-Jul-96	41.9	48.0	46.0	45.5	45.0	52.3	47.2	n-a	41.2	42.0
26-Jul-96	39.5	48.1	46.3	45.2	45.2	52.7	46.5	54.3	42.7	40.0
8-Aug-96	37.6	47.2	45.5	42.4	42.5	49.7	45.3	51.9	39.8	39.1
11-Sep-96	35.4	39.9	40.0	40.2	39.7	51.5	45.8	51.4	39.9	40.4
17-Sep-96	37.5	48.1	44.4	44.3	39.4	50.8	45.4	50.2	n-a	40.8
18-Oct-96	37.7	49.7	43.1	45.6	41.2	53.0	46.8	54.0	41.3	44.0
29-May-97	38.5	46.0	42.6	42.9	40.0	48.9	44.6	53.3	37.7	40.5
9-Jun-97	37.3	44.2	39.4	39.7	39.0	47.4	42.1	51.7	36.7	39.1
5-Jul-97	37.9	42.7	42.4	42.7	38.8	47.9	n-a	51.8	37.3	39.3
15-Jul-97	38.4	43.1	43.5	45.0	39.3	48.1	45.0	57.7	37.7	39.4
4-Aug-97	36.0	40.9	42.3	39.9	38.7	47.2	42.5	51.3	37.5	39.5
17-Oct-97	27.4	45.5	45.5	44.1	39.6	49.0	45.3	57.6	38.5	42.1
22-Oct-97	38.4	43.1	43.5	45.0	39.3	48.1	45.0	57.7	37.7	39.4
4-Nov-97	39.4	47.3	46.9	46.6	43.0	52.1	46.7	57.7	45.2	44.9
11-Nov-97	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a
20-Apr-98	38.9	46.2	45.6	45.2	40.8	n-a	46.9	56.2	37.1	39.9
28-Apr-98	37.7	44.5	42.2	40.1	39.5	n-a	45.3	55.2	36.4	39.2
4-May-98	36.3	39.7	39.4	39.2	38.8	n-a	43.9	53.7	35.4	38.5
19-May-98	34.7	38.9	37.8	37.9	38.4	n-a	39.9	51.4	33.1	37.6
25-May-98	35.4	37.9	38.6	38.8	39.3	n-a	42.3	53.6	33.8	38.7
1-Jun-98	37.9	47.2	43.4	43.2	39.7	n-a	44.7	53.2	35.8	39.7
9-Jun-98	37.1	42.5	39.5	39.9	38.8	n-a	43.1	52.8	34.8	38.8
19-Jun-98	36.8	40.8	39.8	39.6	38.6	n-a	42.4	52.4	34.5	38.4
26-Jun-98	37.8	40.9	42.9	40.6	38.9	n-a	41.8	52.1	n-a	n-a
9-Jul-98	36.5	40.2	39.6	39.5	38.8	n-a	40.8	50.9	35.2	38.8
14-Jul-98	35.6	39.5	38.8	39.1	38.2	n-a	39.8	50.9	34.2	37.9
22-Jul-98	36.7	41	39.8	39.7	38.8	n-a	41.8	52.6	35.3	38.8
31-Jul-98	37.4	41.3	41.3	40.1	38.9	n-a	39.4	52.5	35.6	39
6-Aug-98	35.7	39.3	39.1	39.2	38.3	n-a	41	51.1	35	38.2
13-Aug-98	35.9	41.3	38.7	38.7	38.3	n-a	38.8	51.4	36	39.2
19-Aug-98	35.3	40.2	38.5	38.5	38.4	n-a	39.4	51.7	34.8	38.7
26-Aug-98	36.4	39.7	39.7	39.4	38.2	n-a	39.9	51.2	n-a	n-a
12-Sep-98	36.4	42.2	39.6	39.8	39.2	n-a	42.7	53.3	35.5	n-a
30-Sep-98	37.8	45.1	43.4	42.6	40.3	n-a	44.8	55.3	36.9	40.6

n-a: not-available

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Table 5

T-5 probe (retention layer upper part) results for CS96 stations
Volumetric water content

Date	CS96-1	CS96-2	CS96-3	CS96-4	CS96-5	CS96-6	CS96-7	CS96-8	CS96-9	CS96-10
14-Jun-96	41.1	48.8	45.7	46.1	45.1	47.6	50.3	47.8	39.2	39.4
2-Jul-96	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a
18-Jul-96	39.4	46.9	39.6	45.8	43.1	46.9	48.6	n-a	38.9	38.5
26-Jul-96	38.6	47.3	39.2	44.4	44.0	47.1	47.9	46.8	40.7	38.5
8-Aug-96	37.2	46.4	37.3	38.1	41.2	45.5	45.7	45.3	39.5	37.5
11-Sep-96	36.9	38.5	35.3	36.7	41.9	46.8	45.3	46.5	38.5	41.1
17-Sep-96	37.7	44.0	36.2	39.4	42.7	46.7	45.0	46.2	n-a	41.8
18-Oct-96	38.5	45.5	35.9	39.1	45.4	48.3	46.6	48.1	39.3	45.3
29-May-97	n-a	48.0	35.7	38.0	42.9	45.9	45.6	56.2	37.7	40.3
9-Jun-97	n-a	46.9	34.1	36.3	39.8	42.5	43.6	53.3	36.7	39.2
5-Jul-97	n-a	46.9	36.6	39.5	41.7	45.3	n-a	52.4	37.8	39.5
15-Jul-97	38.5	46.8	38.3	43.1	42.4	45.3	46.6	57.1	38.5	39.5
4-Aug-97	36.6	46.5	36.6	36.8	41.1	43.9	45.2	52.7	38.2	39.7
17-Oct-97	37.7	47.9	38.5	38.3	45.2	46.8	46.7	48.4	40.2	43.5
22-Oct-97	38.5	46.8	38.3	43.1	42.4	45.3	46.6	57.1	38.5	39.5
4-Nov-97	39.2	48.8	39.9	45.0	46.8	48.1	48.4	57.1	39.7	45.5
11-Nov-97	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a
20-Apr-98	n-a	45.0	37.0	35.8	45.4	33.0	46.3	58.7	36.3	41.9
28-Apr-98	n-a	42.1	35.6	34.0	43.9	34.3	45.2	56.9	35.6	40.0
4-May-98	n-a	39.6	34.4	32.8	40.6	33.4	43.8	55.1	34.4	39.3
19-May-98	n-a	38.2	32.1	31.6	39.4	32.7	39.3	50.9	32.1	38.0
25-May-98	n-a	38.9	33.0	32.5	42.0	33.8	40.2	53.3	33.0	38.9
1-Jun-98	n-a	43.2	37.2	37.0	45.0	39.0	45.1	55.1	35.1	41.7
9-Jun-98	n-a	39.6	34.8	34.4	40.3	38.3	41.8	53.2	33.2	39.9
19-Jun-98	36.7	39.5	34.3	34.2	40.4	38.5	41.2	51.6	32.8	39.5
26-Jun-98	n-a	40.8	37.1	36.5	41.7	54	43.2	51	n-a	n-a
9-Jul-98	n-a	39.6	33.8	34.1	41	43.8	40	50.6	33.6	40.4
14-Jul-98	n-a	38.9	33.1	33.4	39.7	41.6	39.6	49.6	32.5	39.3
22-Jul-98	n-a	39.8	34.3	34.3	41.9	45.2	41	51.5	33.7	40.9
31-Jul-98	37.2	40.9	35.3	35.5	42.3	55.1	42.8	51.9	34.3	42.3
6-Aug-98	n-a	38.8	33.4	33.4	39.9	41.4	39.8	50.6	33.5	39.7
13-Aug-98	36.2	39.5	33.1	32.9	40.2	41.3	39.6	50.9	34.6	42
19-Aug-98	35.9	39.1	32.9	32.7	40.9	41.8	39.4	51.3	33.4	40.1
26-Aug-98	n-a	39.4	34.4	n-a	40.5	52.8	39.6	50.7	n-a	n-a
12-Sep-98	n-a	39.7	34.2	34.4	43.7	45.6	40.2	52.9	33.6	42.1
30-Sep-98	n-a	42.4	36.2	35.7	45.5	56.5	42	54.8	35.4	45.4

n-a: not-available

Table 6

W-2 probe (retention layer lower part) results for CS96 stations
Suction potentiel (cbars)

Date	CS96-1	CS96-2	CS96-3	CS96-4	CS96-5	CS96-6	CS96-7	CS96-8	CS96-9	CS96-10
14-Jun-96	2	3	3	2	3	2	3	3	2	2
2-Jul-96	1	2	2	2	2	2	2	2	2	2
18-Jul-96	2	2	2	2	2	1	3	n-a	3	2
26-Jul-96	11	4	3	3	1	1	3	2	n-a	n-a
8-Aug-96	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a
11-Sep-96	10	8	8	10	0	0	7	2	0	0
17-Sep-96	9	6	6	6	0	0	5	2	n-a	0
18-Oct-96	13	10	11	10	1	0	8	1	1	1
29-May-97	16	9	11	11	3	2	9	3	2	1
9-Jun-97	15	10	11	11	2	1	9	2	5	0
5-Jul-97	6	3	4	5	1	1	n-a	1	2	0
15-Jul-97	5	2	0	5	2	1	1	0	2	0
4-Aug-97	12	8	3	8	1	1	5	1	3	0
17-Oct-97	11	7	1	5	1	1	5	2	4	0
22-Oct-97	5	2	0	5	2	1	1	0	2	0
4-Nov-97	6	3	1	4	2	1	3	0	4	1
11-Nov-97	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a
20-Apr-98	13	7	10	7	12	6	5	6	5	2
28-Apr-98	17	11	14	11	2	6	9	6	7	2
4-May-98	16	11	14	12	1	5	10	5	7	1
19-May-98	19	15	16	14	0	6	12	4	11	1
25-May-98	18	14	15	13	0	6	11	3	12	1
1-Jun-98	11	10	9	2	6	2	7	4	6	1
9-Jun-98	14	11	12	7	1	2	9	3	10	1
19-Jun-98	11	8	9	6	1	1	8	2	8	1
26-Jun-98	5	2	2	0	1	0	4	2	n-a	n-a
9-Jul-98	12	6	9	7	0	0	7	2	7	0
14-Jul-98	11	6	8	6	0	0	7	2	6	0
22-Jul-98	11	5	8	6	0	0	6	2	6	0
31-Jul-98	9	5	6	2	0	0	5	2	4	0
6-Aug-98	12	6	8	6	0	0	7	1	4	0
13-Aug-98	13	8	9	9	0	0	7	1	5	0
19-Aug-98	14	9	10	9	0	0	8	1	7	0
26-Aug-98	10	6	6	3	0	0	6	2	n-a	n-a
12-Sep-98	11	7	8	6	0	0	6	2	5	0
30-Sep-98	10	7	7	4	0	0	6	2	5	0

n-a: not-available

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Table 7

W-4 probe (retention layer upper part) results for CS96 stations
Suction potentiel (cbars)

Date	CS96-1	CS96-2	CS96-3	CS96-4	CS96-5	CS96-6	CS96-7	CS96-8	CS96-9	CS96-10
14-Jun-96	2	2	2	2	2	2	1	2	2	2
2-Jul-96	2	2	2	1	1	1	3	2	2	1
18-Jul-96	9	3	7	2	2	1	5	n-a	3	2
26-Jul-96	13	11	10	6	2	1	9	2	n-a	n-a
8-Aug-96	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a
11-Sep-96	13	12	11	11	4	1	11	1	7	0
17-Sep-96	13	12	11	10	1	0	11	1	n-a	0
18-Oct-96	18	17	16	14	1	1	13	1	10	1
29-May-97	20	22	16	14	1	2	16	1	6	1
9-Jun-97	16	21	14	13	4	5	13	1	7	0
5-Jul-97	11	13	9	7	0	1	n-a	2	1	0
15-Jul-97	1	2	1	0	0	1	4	0	1	0
4-Aug-97	16	19	9	11	0	1	11	0	4	0
17-Oct-97	18	19	8	12	0	1	12	2	2	0
22-Oct-97	1	2	1	0	0	1	4	0	1	0
4-Nov-97	10	14	5	4	1	2	9	0	3	0
11-Nov-97	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a
20-Apr-98	20	22	16	15	6	n-a	n-a	5	12	2
28-Apr-98	24	26	20	18	15	n-a	n-a	5	15	2
4-May-98	21	23	18	16	15	n-a	n-a	4	13	1
19-May-98	22	27	20	19	18	n-a	n-a	5	17	1
25-May-98	22	26	19	18	17	n-a	n-a	4	16	1
1-Jun-98	15	21	11	7	2	n-a	n-a	5	11	1
9-Jun-98	20	22	17	14	9	n-a	n-a	4	16	1
19-Jun-98	16	18	14	12	1	n-a	n-a	3	13	0
26-Jun-98	9	11	5	4	0	n-a	n-a	3	n-a	n-a
9-Jul-98	15	16	13	11	1	n-a	n-a	3	11	0
14-Jul-98	15	17	13	11	0	n-a	n-a	3	11	0
22-Jul-98	15	16	12	11	0	n-a	n-a	3	11	0
31-Jul-98	14	15	11	9	0	n-a	n-a	3	9	0
6-Aug-98	16	17	13	11	0	n-a	n-a	3	9	0
13-Aug-98	16	20	14	13	1	n-a	n-a	3	10	0
19-Aug-98	20	22	16	14	4	n-a	n-a	3	13	0
26-Aug-98	13	18	11	9	0	n-a	n-a	3	n-a	n-a
12-Sep-98	15	19	12	10	0	n-a	n-a	2	10	0
30-Sep-98	14	19	11	9	0	n-a	n-a	2	10	0

n-a: not-available

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Table 8

T-1 probe (capillary break) results for PS96 stations
Volumetric water content

Date	PS96-1	PS96-2	PS96-3	PS96-4	PS96-5	PS96-6	PS96-7	PS96-8	PS96-9	PS96-10
14-Jun-96	6.3	3.3	0.0	n-a	n-a	n-a	n-a	n-a	n-a	n-a
2-Jul-96	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a
18-Jul-96	9.4	16.1	0.0	n-a	n-a	n-a	n-a	n-a	n-a	n-a
26-Jul-96	8.7	15.6	0.0	n-a	n-a	n-a	n-a	n-a	n-a	n-a
8-Aug-96	7.8	14.6	0.0	5.7	6.1	15.3	7.5	8.2	6.9	46.1
11-Sep-96	7.8	14.6	0.0	14.1	5.6	6.0	n-a	n-a	n-a	n-a
17-Sep-96	8.3	15.4	9.2	18.0	6.9	6.6	n-a	9.9	9.0	46.9
18-Oct-96	8.7	16.0	10.9	18.8	6.7	6.7	7.2	8.7	8.0	n-a
29-May-97	8.2	15.8	34.9	n-a	n-a	n-a	6.7	8.6	7.4	33.5
9-Jun-97	7.7	15.0	0.0	5.9	5.2	20.8	6.3	7.7	6.8	0.0
5-Jul-97	9.1	16.4	33.9	7.0	7.0	27.9	7.5	10.6	9.7	6.6
15-Jul-97	10.3	16.9	25.4	7.9	7.6	33.0	28.8	36.2	10.6	0.0
4-Aug-97	7.5	14.3	34.5	6.1	5.4	21.0	9.1	7.6	7.1	16.0
17-Oct-97	n-a	16.1	37.6	7.2	6.6	23.7	10.2	8.4	8.0	18.4
22-Oct-97	10.3	16.9	25.4	7.9	7.6	33.0	28.8	36.2	10.6	0.0
4-Nov-97	n-a	17.5	37.9	8.0	7.7	30.1	12.7	11.1	9.7	18.5
11-Nov-97	n-a	17	38.4	n-a	n-a	n-a	n-a	n-a	n-a	n-a
20-Apr-98	n-a	11.7	36.1	7.7	3.8	23.9	8.0	8.7	7.3	17.9
28-Apr-98	n-a	16.0	35.4	7.0	5.7	23.1	9.0	7.9	7.8	16.6
4-May-98	n-a	15.0	24.0	6.7	5.5	22.3	8.8	7.6	7.5	16.6
19-May-98	n-a	13.6	20.5	6.1	5.0	19.1	7.9	7.0	6.8	16.3
25-May-98	n-a	13.7	20.9	6.3	5.0	n-a	n-a	n-a	6.7	15.3
1-Jun-98	n-a	16.1	21.6	7.8	n-a	21.6	n-a	8.2	9.1	18.9
9-Jun-98	n-a	15.2	19.6	6.9	6.3	22.7	9.5	8.4	8.2	17.5
19-Jun-98	n-a	15.2	21	36.2	6.6	25.3	9.8	9.3	8.5	18
26-Jun-98	n-a	16.3	24.5	7.3	n-a	30.6	12.2	41.1	10.3	18.6
9-Jul-98	n-a	14.8	21	6.6	5.7	24.9	9.5	8.1	7.6	16.5
14-Jul-98	n-a	14.2	28.6	6.5	5.9	21.6	8.8	7.7	7.3	16.4
22-Jul-98	n-a	14.8	21.2	6.7	6.1	24.2	9.4	8.5	7.9	17
31-Jul-98	n-a	15.2	20.6	6.9	6.9	26.5	10.1	9.7	9.2	17.6
6-Aug-98	n-a	13.5	20.5	6.4	5.6	21.7	9.1	8.1	7.6	16.2
13-Aug-98	n-a	13	n-a	6.3	5.3	20	8.5	7.5	7.1	15.8
19-Aug-98	n-a	n-a	19.7	n-a	5.3	19.2	8.3	7.4	6.9	16
26-Aug-98	n-a	13.8	20.7	7.1	6.7	20.7	8.6	8.6	8.7	17.8
12-Sep-98	n-a	14.6	20.7	6.8	6.1	21.3	9	8	7.7	17.4
30-Sep-98	n-a	15.7	21.9	7.7	7.4	22.3	9.2	9.4	9	17.9

n-a: not-available

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Table 9

T-3 probe (retention layer lower part) results for PS96 stations
Volumetric water content

Date	PS96-1	PS96-2	PS96-3	PS96-4	PS96-5	PS96-6	PS96-7	PS96-8	PS96-9	PS96-10
14-Jun-96	47.4	28.8	36.5	n-a	n-a	n-a	n-a	n-a	n-a	n-a
2-Jul-96	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a
18-Jul-96	45.0	32.7	37.7	n-a	n-a	n-a	n-a	n-a	n-a	n-a
26-Jul-96	43.2	30.0	37.8	n-a	n-a	n-a	n-a	n-a	n-a	n-a
8-Aug-96	37.9	28.4	36.3	27.3	33.4	27.1	35.9	37.0	35.1	38.5
11-Sep-96	33.6	27.7	36.6	26.6	33.3	28.8	n-a	n-a	n-a	n-a
17-Sep-96	38.0	30.1	38.4	29.7	35.5	36.0	n-a	38.6	37.1	39.0
18-Oct-96	39.3	31.1	39.9	29.5	36.4	34.4	37.2	38.9	37.7	n-a
29-May-97	n-a	31.3	44.6	n-a	n-a	n-a	36.2	39.3	35.3	38.9
9-Jun-97	n-a	29.3	41.3	29.8	31.9	28.6	34.6	37.3	34.2	37.9
5-Jul-97	n-a	33.0	42.1	36.1	34.8	33.5	36.7	40.2	37.1	38.3
15-Jul-97	n-a	35.3	45.0	38.5	35.5	37.3	39.3	43.3	37.9	35.9
4-Aug-97	n-a	28.5	41.2	29.5	33.3	29.9	35.7	36.3	35.9	35.9
17-Oct-97	n-a	31.8	47.2	36.0	35.7	33.2	37.8	39.1	38.0	38.7
22-Oct-97	n-a	35.3	45.0	38.5	35.5	37.3	39.3	43.3	37.9	35.9
4-Nov-97	n-a	38.4	48.6	39.0	38.4	36.9	38.4	44.9	38.5	38.7
11-Nov-97	n-a	33.9	50	n-a	n-a	n-a	n-a	n-a	n-a	n-a
20-Apr-98	n-a	37.5	48.0	37.6	15.0	32.5	34.6	39.5	35.2	39.6
28-Apr-98	n-a	32.5	46.8	33.1	29.1	32.0	36.0	38.3	37.1	39.1
4-May-98	n-a	30.5	45.3	31.6	30.2	30.9	35.4	37.3	36.5	38.6
19-May-98	n-a	27.9	42.0	28.5	28.5	28.0	32.9	34.7	35.0	36.7
25-May-98	n-a	27.5	44.6	28.1	28.6	27.6	n-a	32.6	n-a	36.3
1-Jun-98	n-a	30.7	45.5	37.7	33.9	30.9	35.9	30.0	37.2	38.1
9-Jun-98	n-a	30.3	43.7	35.5	33.0	31.6	36.6	39.0	37.2	48.8
19-Jun-98	n-a	30.5	42.7	36.2	33.0	31.8	36.6	39.2	36.9	37.6
26-Jun-98	n-a	33.6	42.8	37.3	33.3	35.5	37.5	41.3	36.9	37.8
9-Jul-98	n-a	29.4	42.0	32.2	31.9	31.6	36.4	37.9	35.6	37.2
14-Jul-98	n-a	28.6	41.4	31.6	31.6	30.4	35.2	37.2	35.1	37
22-Jul-98	n-a	29.1	42.7	33.6	32.8	31.2	36.2	38.5	37	37.6
31-Jul-98	n-a	30.5	42.6	36.4	34.1	33.5	36.8	39.7	37.6	38.1
6-Aug-98	n-a	28.1	40.8	31.8	32.3	30.6	35.7	38.4	36.6	37.8
13-Aug-98	n-a	26.8	41.1	29.8	31.7	28.9	34.5	36.9	35.7	37.5
19-Aug-98	n-a	n-a	41.7	29.5	31.7	28.6	34.1	36.1	n-a	37.8
26-Aug-98	n-a	28.6	40.9	36.5	33.3	29.9	35.3	38.3	n-a	37.7
12-Sep-98	n-a	29.1	44.2	33.6	33.5	30.2	35.7	38.4	n-a	38.6
30-Sep-98	n-a	31.0	45.6	37.9	35.0	31.5	36.5	40.1	n-a	39.5

n-a: not-available

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Table 10

T-5 probe (retention layer upper part) results for PS96 stations

Volumetric water content

Date	PS96-1	PS96-2	PS96-3	PS96-4	PS96-5	PS96-6	PS96-7	PS96-8	PS96-9	PS96-10
14-Jun-96	37.1	23.0	34.6	n-a	n-a	n-a	n-a	n-a	n-a	n-a
2-Jul-96	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a
18-Jul-96	37.1	28.4	34.5	n-a	n-a	n-a	n-a	n-a	n-a	n-a
26-Jul-96	35.2	27.1	34.7	n-a	n-a	n-a	n-a	n-a	n-a	n-a
8-Aug-96	32.4	25.7	33.1	29.8	33.4	30.3	29.1	33.9	30.0	46.2
11-Sep-96	31.1	25.5	34.0	28.6	32.1	31.5	n-a	n-a	n-a	n-a
17-Sep-96	33.7	27.3	35.7	36.9	35.8	34.8	n-a	35.8	33.1	47.6
18-Oct-96	35.1	27.9	37.3	35.6	36.6	34.6	28.6	36.5	32.8	n-a
29-May-97	34.5	n-a	39.7	n-a	n-a	n-a	27.7	36.6	33.6	48.0
9-Jun-97	32.3	n-a	38.8	31.4	37.1	29.1	25.9	35.4	30.7	46.8
5-Jul-97	36.5	n-a	39.2	34.9	38.3	33.5	29.0	37.1	34.7	48.0
15-Jul-97	38.2	n-a	39.3	38.6	38.6	37.0	28.7	38.5	36.2	48.2
4-Aug-97	31.9	n-a	39.1	33.2	36.6	29.6	28.0	35.6	31.5	47.9
17-Oct-97	46.3	n-a	43.5	36.9	39.2	34.1	29.2	37.5	34.0	50.0
22-Oct-97	38.2	n-a	39.3	38.6	38.6	37.0	28.7	38.5	36.2	48.2
4-Nov-97	38.9	n-a	44.6	39.1	39.9	37.5	33.0	38.5	35.8	50.0
11-Nov-97	38.0	n-a	45.5	n-a	n-a	n-a	n-a	n-a	n-a	n-a
20-Apr-98	35.9	n-a	45.1	37.7	24.1	19.1	17.4	37.3	18.5	50.8
28-Apr-98	33.8	n-a	43.7	35.7	37.1	34.7	28.3	36.4	32.8	49.4
4-May-98	32.1	n-a	39.9	34.5	35.2	30.8	27.2	35.6	31.6	48.9
19-May-98	29.1	n-a	39.1	32.2	31.4	26.7	25.6	34.1	28.6	47.4
25-May-98	28.9	n-a	39.4	32.7	31.3	27.5	n-a	34.0	28.4	48.1
1-Jun-98	33.0	n-a	41.1	37.9	37.1	30.9	28.7	36.1	33.0	49.6
9-Jun-98	32.6	n-a	39.3	36.0	36.4	30.6	27.8	36.5	32.1	48.4
19-Jun-98	32.8	n-a	39.0	35.9	36.2	30.8	27.8	36.7	32.0	48.3
26-Jun-98	36.3	n-a	39.3	37.0	36.3	37.0	30.6	37.5	34.0	48.2
9-Jul-98	33.2	n-a	38.9	34.1	34.7	31.8	27.4	35.7	30.8	47.5
14-Jul-98	32.3	n-a	38.6	33.7	34.5	30.2	26.7	35.5	29.9	47.2
22-Jul-98	33.6	n-a	39.2	34.9	35.5	31.1	27.5	36.3	31.5	47.9
31-Jul-98	37.7	n-a	39.1	36.0	36.1	35.3	28.3	37.1	32.8	48.2
6-Aug-98	32.2	n-a	38.5	n-a	34.3	n-a	26.9	36.0	30.8	47.7
13-Aug-98	30.1	n-a	38.6	33.2	33.1	28.8	26.1	35.4	29.3	47.7
19-Aug-98	29.8	n-a	38.9	33.1	33.1	28.3	26.1	35.4	29.0	48.1
26-Aug-98	33.0	n-a	38.7	35.8	35.9	29.9	27.5	36.2	31.9	47.5
12-Sep-98	33.0	n-a	39.5	35.3	35.9	30.2	27.0	36.5	31.1	48.8
30-Sep-98	35.0	n-a	41.9	37.1	37.3	31.9	28.0	37.7	33.1	49.2

n-a: not-available

Table 11

W-2 probe (retention layer lower part) results for CS96 stations
Suction potentiel (cbars)

Date	PS96-1	PS96-2	PS96-3	PS96-4	PS96-5	PS96-6	PS96-7	PS96-8	PS96-9	PS96-10
14-Jun-96	3	4	3	n-a	n-a	n-a	n-a	n-a	n-a	n-a
2-Jul-96	6	4	1	n-a	n-a	n-a	n-a	n-a	n-a	n-a
18-Jul-96	6	7	6	n-a	n-a	n-a	n-a	n-a	n-a	n-a
26-Jul-96	4	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a
8-Aug-96	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a
11-Sep-96	9	7	2	3	12	12	15	10	11	2
17-Sep-96	3	2	0	0	3	7	n-a	0	1	0
18-Oct-96	5	4	0	0	6	12	15	3	4	n-a
29-May-97	6	7	2	n-a	n-a	n-a	19	4	4	1
9-Jun-97	8	8	1	3	15	15	20	10	9	0
5-Jul-97	1	2	0	0	1	4	8	2	1	0
15-Jul-97	0	1	0	0	1	0	0	0	0	0
4-Aug-97	7	7	0	4	13	12	16	10	10	1
17-Oct-97	4	4	0	1	7	7	13	2	3	0
22-Oct-97	0	1	0	0	1	0	0	0	0	0
4-Nov-97	2	2	1	1	2	3	6	1	2	1
11-Nov-97	4	4	1	n-a	n-a	n-a	n-a	n-a	n-a	n-a
20-Apr-98	6	4	1	3	140	19	30	4	22	2
28-Apr-98	10	7	1	5	19	20	23	10	13	3
4-May-98	11	8	0	6	18	18	23	12	14	2
19-May-98	18	14	0	10	27	23	27	18	21	8
25-May-98	19	15	0	11	27	23	25	17	21	10
1-Jun-98	11	7	0	2	2	14	19	6	4	2
9-Jun-98	9	8	0	3	9	14	18	3	4	2
19-Jun-98	6	6	0	1	6	11	15	2	4	1
26-Jun-98	2	2	0	1	1	1	6	1	2	0
9-Jul-98	6	6	0	1	12	8	15	3	6	0
14-Jul-98	7	7	0	2	10	10	16	6	8	0
22-Jul-98	6	7	0	1	9	9	14	2	4	0
31-Jul-98	4	5	0	1	3	7	12	1	2	0
6-Aug-98	7	8	0	1	12	11	15	3	6	0
13-Aug-98	10	11	0	4	17	14	17	9	12	1
19-Aug-98	12	13	0	5	18	15	18	11	14	2
26-Aug-98	5	8	0	1	2	12	13	2	2	0
12-Sep-98	7	7	0	1	8	12	14	4	6	0
30-Sep-98	4	5	0	1	3	11	13	1	2	0

n-a: not-available

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Table 12

W-4 probe (retention layer upper part) results for PS96 stations
Suction potentiel (cbars)

Date	PS96-1	PS96-2	PS96-3	PS96-4	PS96-5	PS96-6	PS96-7	PS96-8	PS96-9	PS96-10
14-Jun-96	7	9	5	n-a	n-a	n-a	n-a	n-a	n-a	n-a
2-Jul-96	9	8	5	n-a	n-a	n-a	n-a	n-a	n-a	n-a
18-Jul-96	6	7	5	n-a	n-a	n-a	n-a	n-a	n-a	n-a
26-Jul-96	9	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a
8-Aug-96	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a
11-Sep-96	13	12	8	5	13	14	15	13	15	5
17-Sep-96	8	7	5	2	5	8	n-a	6	5	2
18-Oct-96	10	6	6	5	8	15	18	9	10	n-a
29-May-97	12	13	4	n-a	n-a	n-a	21	14	11	2
9-Jun-97	12	n-a	4	7	16	19	21	15	13	0
5-Jul-97	5	n-a	3	0	4	5	9	3	3	0
15-Jul-97	2	n-a	0	0	2	2	0	1	1	0
4-Aug-97	12	n-a	2	8	15	17	18	15	15	4
17-Oct-97	9	11	3	5	9	14	17	12	10	1
22-Oct-97	2	n-a	0	0	2	2	0	1	1	0
4-Nov-97	5	7	3	3	4	8	9	5	5	1
11-Nov-97	10	12	4	n-a	n-a	n-a	n-a	n-a	n-a	n-a
20-Apr-98	12	11	n-a	6	4	8	77	17	3	3
28-Apr-98	17	16	n-a	10	17	23	27	22	14	3
4-May-98	16	13	n-a	10	18	23	24	21	15	2
19-May-98	22	16	n-a	14	26	29	28	26	22	9
25-May-98	23	16	n-a	14	27	30	27	25	21	10
1-Jun-98	15	12	n-a	3	3	17	17	14	8	3
9-Jun-98	16	12	n-a	5	11	19	21	17	11	2
19-Jun-98	12	10	n-a	4	8	15	18	13	9	1
26-Jun-98	6	6	n-a	1	2	5	8	4	3	1
9-Jul-98	11	11	n-a	6	13	15	18	15	11	0
14-Jul-98	11	11	n-a	6	11	15	19	15	12	1
22-Jul-98	11	11	n-a	5	10	15	17	13	10	0
31-Jul-98	8	10	n-a	2	5	11	16	11	8	0
6-Aug-98	12	13	n-a	6	13	16	19	14	11	0
13-Aug-98	15	15	n-a	9	18	20	21	18	15	3
19-Aug-98	16	16	n-a	10	19	23	23	20	18	5
26-Aug-98	11	13	n-a	2	3	17	16	11	8	1
12-Sep-98	11	11	n-a	5	9	17	18	14	11	2
30-Sep-98	10	10	0	3	4	15	16	10	8	1

n-a: not-available

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Table 13

TDR probe results for TA97 (West dyke) stations

Volumetric water content

Date	TA-97-1	TA-97-2	TA-97-3	TA-97-4	TA-97-5	TA-97-6	TA-97-7	TA-97-8	TA-97-9	TA-97-10	TA-97-11	TA-97-12	TA-97-13	TA-97-14	TA-97-15
16-Jul-97	41.9	31.0	35.3	38.2	23.4	33.0	31.3	29.0	5.9	38.4	37.4	37.6	34.7	22.3	26.5
4-Aug-97	39.2	29.6	32.8	37.5	21.3	33.3	27.8	26.5	6.6	37.7	36.0	37.3	33.0	19.9	26.2
4-Sep-97	38.4	24.5	33.9	42.0	30.6	33.6	28.6	27.6	7.5	38.9	37.1	38.0	33.2	23.5	26.5
17-Oct-97	45.5	32.0	35.6	39.5	25.4	35.0	30.0	28.4	8.3	39.9	38.6	40.1	34.5	25.1	27.4
4-Nov-97	47.0	34.4	36.8	40.1	28.4	35.6	30.7	30.2	9.1	40.9	39.8	42.1	36.8	27.5	28.9
20-Apr-98	47.7	n-a	n-a	42.8	23.2	n-a	30.0	n-a	n-a	n-a	n-a	n-a	36.2	n-a	n-a
28-Apr-98	46.8	30.3	14.0	38.4	n-a	23.4	28.6	n-a	6.4	39.2	36.4	37.6	34.3	25.8	24.3
4-May-98	43.0	29.5	32.2	37.5	19.2	20.1	27.6	22.5	6.0	38.2	34.2	36.0	32.6	25.4	23.1
19-May-98	37.1	28.3	31.0	35.6	16.9	29.5	26.3	20.5	5.4	35.1	26.0	34.4	30.1	22.5	21.1
25-May-98	35.8	28.4	31.8	36.9	17.1	30.4	26.6	20.7	5.8	35.9	25.6	35.1	30.5	22.4	21.5
1-Jun-98	45.7	30.9	33.8	38.6	21	31.4	29.6	n-a	8	37.9	36.9	37.6	34.1	25.5	25.0
9-Jun-98	42.4	28.9	32.4	37.6	20.5	30.3	28.4	n-a	7.2	37.0	34.8	36.0	32.6	25.2	24.7
19-Jun-98	40.6	29	32.2	37.4	20.6	30.3	28.4	n-a	7.3	36.8	34	36.0	32.7	25.1	24.3
26-Jun-98	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a
9-Jul-98	38.2	28.9	32.4	36.6	20.5	31.1	26.9	n-a	5.9	36.4	29.7	34.8	31.7	25.0	24.2
14-Jul-98	37.0	28.2	31.5	35.4	19.5	30.2	27.3	n-a	6.9	35.9	29.7	34.3	31.1	23.0	23.9
22-Jul-98	38.2	29	32.6	32.6	20.5	31.2	27.4	n-a	6.7	36.8	30.4	35.1	31.9	24.5	24.7
31-Jul-98	40.6	29.7	33.5	37.6	21.8	31.4	28.3	n-a	7.2	37	33.7	35.9	32.8	25.4	25.4
6-Aug-98	35.1	28.6	31.8	35.6	20.1	30.6	26.4	n-a	5	35.6	n-a	34.2	30.6	24.2	23.4
13-Aug-98	31.7	28.9	32.1	36.5	19.3	31.5	26.5	n-a	5.2	36.1	21.8	34.9	30.6	23.4	23.7
19-Aug-98	n-a	n-a	31.5	35.4	18.1	30.7	26.4	n-a	5.7	35.7	20.4	34.4	29.8	22.6	23.3
26-Aug-98	n-a	n-a	n-a	36.2	20.4	30.7	28.3	n-a	7.3	36.5	33.2	35.2	31.2	24	24.7
12-Sep-98	38.9	n-a	32.9	37.2	20	31.6	28.2	n-a	8	36.9	29.4	35.3	32.7	24.4	24.3
30-Sep-98	46.3	31.5	35.4	39.5	22.3	32.8	29.7	n-a	8.5	38.6	36.8	37.4	34.7	25.6	25.6

n-a: not-available

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Table 14

TDR probe results for TA97 (North, East and South East dykes) stations
Volumetric water content

Date	TA-97-16 North	TA-97-17 North	TA-97-18 North	TA-97-19 North	TA-97-20 North	TA-97-21 North	TA-97-22 North	TA-97-23 North	TA-97-24 PS96-4	TA-97-25 East	TA-97-26 East	TA-97-27 East	TA-97-28 South-east	TA-97-29 South-east	TA-97-30 South-east
16-Jul-97	27.9	35.3	35.6	31.9	26.7	28.0	28.0	29.0	26.7	34.6	34.2	20.6	27.6	7.2	20.9
4-Aug-97	26.4	35.0	31.3	31.8	25.9	27.5	25.9	26.1	24.7	27.1	34.0	21.2	26.0	6.6	22.0
4-Sep-97	27.2	36.1	33.7	32.7	26.6	28.4	n-d	28.3	26.0	29.7	35.4	19.6	26.5	6.8	22.5
17-Oct-97	28.8	38.3	36.3	34.8	27.9	30.2	n-d	24.8	28.0	33.1	37.3	21.4	28.0	7.0	25.7
4-Nov-97	31.4	39.5	38.4	35.6	31.1	35.1	30.6	30.3	31.4	36.2	39.0	27.0	30.5	6.9	27.0
20-Apr-98	34.2	37.5	38.7	31.1	33.1	30.6	24.6	26.9	33.2	35.2	38.8	21.3	36.3	14.0	24.1
28-Apr-98	29.1	35.7	35.2	29.9	28.1	29.5	23.2	22.7	28.4	31.4	34.7	18.7	30.2	13.5	22.3
4-May-98	27.8	34.0	32.7	29.7	26.3	28.8	21.6	20.7	26.0	29.0	32.6	17.0	26.9	13.3	21.1
19-May-98	25.6	32.3	28.9	28.7	23.2	27.7	19.0	20.5	21.2	26.6	30.0	19.5	24.5	12.1	19.4
25-May-98	n-d	31.9	28.5	29.1	n-d	27.7	n-d	n-d	21.0	26.8	31.1	22.1	24.5	12.6	19.9
1-Jun-98	28.9	n-d	36.0	n-d	28.7	33.1	24.7	26.4	28.2	33.3	35.2	n-d	27.8	9.8	23.8
9-Jun-98	28.0	34.9	35.0	30.7	26.6	29.3	23.8	23.7	27.0	32.1	32.7	22.1	27.0	13.6	21.6
19-Jun-98	28.0	34.9	34.4	30.5	26.5	29.3	24	25.1	26.4	31.3	32.2	22.2	27.2	13.9	22.1
26-Jun-98	29.9	36.6	37.0	31.7	29.3	31.5	25.1	25.8	29.5	32.2	34.2	26.2	29.5	14.5	25.5
9-Jul-98	27.3	34.0	32.0	29.8	25.7	28.6	22.6	19.3	25.0	28.3	29.9	19.1	27.5	13.2	21.2
14-Jul-98	26.8	33.2	31.2	29.5	26.2	28.4	22.3	22.1	25.5	28.4	31.0	20.8	27.5	13.0	22.4
22-Jul-98	27.3	34.4	32.7	30.1	26	28.8	23.2	22.9	26.1	29.1	31.8	20.2	28.1	13.5	22
31-Jul-98	28.4	35.4	34.7	30.9	27.4	29.8	24.3	25.3	28.2	31.4	32.4	n-d	28.7	14.2	23.6
6-Aug-98	26.9	33.7	31.4	29.7	n-d	27.9	22.3	21.1	24.7	27.6	31.7	23	27.1	13.1	20.7
13-Aug-98	26.1	33	29.3	29.6	n-d	28.2	21.3	18.8	23.2	26.2	32.2	25.5	26.4	12.7	19.8
19-Aug-98	25.9	33.2	28.9	29.8	23.7	28.3	21.3	23.3	22.8	25.8	n-d	25.2	26.1	12.6	20.5
26-Aug-98	27	34.5	32.5	30.4	n-d	29.9	23.1	25.3	26.4	31.5	33.8	24.4	27.3	13.7	23.4
12-Sep-98	26.9	34.5	32.4	30.5	26.6	29.4	23.8	24.8	25.7	29.5	35.0	22.8	28	13.8	23.8
30-Sep-98	28	36.5	35.5	31.7	27.7	31.6	25	n-d	27.7	34.8	36.0	26.5	29.3	14.9	25.1

n-a: not-available

Table 15

Tensiometers probes results for Ten97 stations (cbars)

Date	Ten 97-1 PS96-1	Ten 97-2 PS96-4	Ten 97-3 PS96-7	Ten 97-4 TA-97-13	Ten 97-5 TA-97-5
16-Jul-97	5.0	9.0	7.0	8.0	7.0
4-Aug-97	n-a	n-a	n-a	n-a	n-a
4-Sep-97	8.0	18.0	15.0	7.0	15.0
17-Oct-97	4.0	16.0	16.0	6.0	9.0
4-Nov-97	n-a	n-a	4.0	2.0	0.0
11-Nov-97					
20-Apr-98	0	0	0	0	n-a
28-Apr-98	0	0	0	4	n-a
4-May-98	0	n-a	n-a	n-a	n-a
19-May-98	n-a	n-a	n-a	n-a	n-a
25-May-98	0	4	0	2	n-a
1-Jun-98	0	0	0	3	n-a
9-Jun-98	0	0	0	4	n-a
19-Jun-98	0	0	0	5	n-a
26-Jun-98	0	0	n-a	n-a	n-a
9-Jul-98	0	0	0	4	n-a
14-Jul-98	0	0	0	4	n-a
22-Jul-98	0	0	0	4	n-a
31-Jul-98	0	0	0	2	n-a
6-Aug-98	0	0	0	6	n-a
13-Aug-98	0	0	0	2	n-a
19-Aug-98	0	0	0	3	n-a
26-Aug-98	0	0	0	4	n-a
12-Sep-98	0	0	0	n-a	n-a

n-a: not-available

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Table 16

Oxygen consumption results

Transect	Stations	Un. Waterloo (June-96) Flux moles $O_2/m^2/yr$	Un. Waterloo (June-96) Coeff. diff m^2/s	Un. Waterloo (Oct.-96) Flux moles $O_2/m^2/yr$	Un. Waterloo (Oct.-96) Coeff. diff m^2/s	URSTM (July-97) Flux moles $O_2/m^2/yr$	URSTM (July-97) Coeff. diff m^2/s	URSTM (Oct.-97) Flux moles $O_2/m^2/yr$	URSTM (Oct.-97) Coeff. diff m^2/s	URSTM (June 98) Flux moles $O_2/m^2/yr$	URSTM (June 98) Coeff. diff m^2/s	URSTM (aug-98) Flux moles $O_2/m^2/yr$	URSTM (aug-98) Coeff. diff m^2/s	URSTM (Oct.-98) Flux moles $O_2/m^2/yr$	URSTM (Oct.-98) Coeff. diff m^2/s
BRK2-ABCD	CS96-1	6.20	1.75E-08	4.90	1.38E-08	18.70	5.27E-08							20.78	5.86E-08
BRK2-E		3.30	9.30E-09	0.00	1.00E-09	13.30	3.75E-08								
BRK2-F		0.00	1.00E-09	3.90	1.10E-08										
BRK2-GHIJ	CS96-2	6.20	1.75E-08	11.90	3.35E-08			45.80	1.29E-07						
BRK2-K		0.00	1.00E-09	29.60	8.34E-08			7.40	2.09E-08						
BRK2-L		0.00	1.00E-09					27.30	7.69E-08						
								0.00	1.00E-09						
								0.00	1.00E-09						
BRK2-MN	CS96-3	5.10	1.44E-08	20.50	5.78E-08										
BRK2-OP	CS96-9	0.90	2.54E-09	1.70	4.79E-09										
BRK3-AB	CS96-4	0.00	1.00E-09	5.10	1.44E-08										
BRK3-CD	CS96-5	6.20	1.75E-08	3.00	8.46E-09	0.00	1.00E-09								
BRK3-EF	CS96-6	1.90	5.36E-09	4.00	1.13E-08	86.10	2.43E-07								
BRK3-GH	CS96-10	10.10	2.85E-08	0.00	1.00E-09										
BRK4-AB	CS96-7	0.90	2.54E-09	0.00	1.00E-09	0.00	1.00E-09								
BRK4-CD	CS96-8	7.30	2.06E-08	0.00	1.00E-09	5.10	1.44E-08								
BRK5-A	PS96-1	0.30	8.46E-10	8.00	2.25E-08	59.00	1.66E-07	0.00	1.00E-09	64.25	1.81E-07	48.00	1.35E-07	0.00	1.00E-09
BRK5-B		0.00	1.00E-09	2.10	5.92E-09										
BRK5-C	PS96-2	2.00	5.64E-09	9.60	2.71E-08	95.20	2.68E-07	9.10	2.56E-08	95.70	2.70E-07	65.10	1.83E-07	0.00	1.00E-09
BRK5-D		0.00	1.00E-09	1.80	5.07E-09			0.00	1.00E-09						
BRK5-E	PS96-3	0.00	1.00E-09					0.00	1.00E-09			40.55	1.14E-07	0.00	1.00E-09
	PS-96-4							105.10	2.96E-07						
	PS-96-5							0.00	1.00E-09	43.95	1.24E-07	84.00	2.37E-07		
	PS-96-6							86.30	2.43E-07	50.10	1.41E-07	67.55	1.90E-07		
BRK6-A				4.20	1.18E-08										
BRK6-B	PS96-7			0.00	1.00E-09	4.90	1.38E-08	0.00	1.00E-09	71.90	2.03E-07				
								0.00	1.00E-09						
BRK6-C	PS96-8			1.30	3.66E-09	26.20	7.38E-08	0.00	1.00E-09	180.80	5.10E-07				
								23.40	6.60E-08						
BRK6-D	PS96-9			4.20	1.18E-08										
	TA-97-10							37.70	1.06E-07						
	TA-97-11							0.00	1.00E-09						
	TA-97-12							11.00	3.10E-08						
	TA-97-7							37.00	1.04E-07	0.00	1.00E-09				
	TA-97-8							7.20	2.03E-08	0.00	1.00E-09				
	TA-97-9							15.30	4.31E-08	0.00	1.00E-09				
	Average	**2.65**	7.85E-09	**5.51**	1.58E-08	**30.85**	8.72E-08	**18.75**	5.33E-08	**56.30**	1.59E-07	**61.04**	1.72E-07	**5.19**	1.54E-08
	Std. Deviation	**3.19**	8.68E-09	**7.39**	2.07E-08	**36.06**	1.01E-07	**28.85**	8.10E-08	**58.16**	1.64E-07	**17.15**	4.83E-08	**10.39**	2.88E-08

LTA non-covered

Avg	**517**	**moles $O_2/m^2/an$**
Std. Dev.	**139**	**moles $O_2/m^2/an$**
range	**228 à 836**	**moles $O_2/m^2/an$**

MNR tailings Flux moles $O_2/m^2/an$	MNR tailings Coeff. diff[1] m^2/s	MNR tailings Flux moles $O_2/m^2/an$	MNR tailings Coeff. diff[1] m^2/s
27.00	7.61E-08	11.2	3.16E-08
95.50	2.69E-07	45.1	1.27E-07
0.00	1.00E-09	4.1	1.16E-08
24.70	6.96E-08	15.9	4.48E-08

[1]: stationnary coeffient of diffusion

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Table 17

Estimated saturation of the capillary break (T1) for CS96 stations

Date	CS96-1	CS96-2	CS96-3	CS96-4	CS96-5	CS96-6	CS96-7	CS96-8	CS96-9	CS96-10
14-Jun-96	92.8	105.6	116.1	104.9	97.8	101.5	85.7	64.6	78.4	97.8
2-Jul-96	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a
18-Jul-96	81.6	95.7	97.0	91.4	99.6	100.0	100.0	n-a	74.6	94.4
26-Jul-96	56.6	33.6	86.8	89.8	100.0	100.0	99.6	91.8	95.9	67.0
8-Aug-96	50.7	33.6	71.7	61.2	97.0	96.8	93.5	89.0	94.0	43.0
11-Sep-96	44.7	41.8	55.6	54.9	96.6	94.1	97.8	89.5	34.7	97.2
17-Sep-96	52.6	n-a	64.5	62.8	95.6	95.0	94.8	89.5	n-a	97.8
18-Oct-96	52.0	0.0	59.2	59.2	97.0	97.9	99.1	94.0	37.7	100.0
29-May-97	51.3	n-a	59.2	55.9	93.6	90.3	90.9	90.3	51.4	88.3
9-Jun-97	47.7	n-a	52.6	52.0	92.2	90.0	86.8	88.8	36.9	84.4
5-Jul-97	55.9	n-a	65.5	65.5	92.0	90.9	n-a	89.0	100.0	84.4
15-Jul-97	66.4	n-a	87.2	73.0	92.6	91.4	92.4	95.9	71.0	84.1
4-Aug-97	48.0	n-a	70.1	53.6	90.4	88.8	86.3	87.8	57.4	83.8
17-Oct-97	51.3	n-a	82.6	59.9	92.4	92.9	90.2	100.0	72.1	87.2
22-Oct-97	66.4	n-a	87.2	73.0	92.6	91.4	92.4	95.9	71.0	84.1
4-Nov-97	63.5	n-a	83.9	72.0	95.2	93.8	97.8	100.0	73.0	89.7
11-Nov-97	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a
20-Apr-98	58.6	n-a	62.8	0.0	93.0	85.0	97.8	95.3	40.4	89.4
28-Apr-98	52.6	n-a	53.6	0.0	91.0	85.0	90.7	92.1	33.3	86.6
4-May-98	49.3	n-a	49.7	0.0	88.4	82.6	86.1	90.6	30.6	83.0
19-May-98	43.8	n-a	44.7	0.0	82.9	77.9	84.4	87.5	26.8	81.0
25-May-98	44.7	n-a	46.1	0.0	89.6	76.4	85.5	89.3	28.7	78.2
1-Jun-98	52.3	n-a	58.2	0.0	91.8	84.7	86.3	90.8	33.3	89.7
9-Jun-98	52.0	n-a	53.0	n-a	89.8	82.6	86.3	89.1	28.7	86.9
19-Jun-98	52.0	n-a	53.9	n-a	87.3	83.2	85.5	89.0	29.0	85.8
26-Jun-98	61.5	n-a	64.8	n-a	89.6	90.0	85.7	89.0	n-a	n-a
9-Jul-98	51.0	n-a	52.6	n-a	89.4	88.8	84.6	88.0	30.3	86.3
14-Jul-98	49.3	n-a	50.0	n-a	85.3	87.0	84.2	87.3	28.1	83.5
22-Jul-98	51.3	n-a	53.3	n-a	89.6	89.4	43.4	89.0	30.9	85.8
31-Jul-98	53.9	n-a	57.6	n-a	88.2	90.0	82.0	89.3	33.3	86.3
6-Aug-98	48.7	n-a	51.3	n-a	n-a	87.9	83.9	86.9	31.4	83.8
13-Aug-98	47.7	n-a	49.0	n-a	86.7	87.9	79.0	87.3	32.0	86.0
19-Aug-98	45.7	n-a	47.4	n-a	86.9	87.9	n-a	87.1	27.3	83.8
26-Aug-98	51.0	n-a	55.3	n-a	85.3	88.5	n-a	87.5	n-a	n-a
12-Sep-98	49.7	n-a	51.3	n-a	90.2	91.4	n-a	89.5	29.0	83.5
30-Sep-98	53.6	n-a	55.6	n-a	92.2	91.4	n-a	91.2	32.8	86.9
n-a: not-available										
Average	54.4	51.7	63.2	49.0	91.6	89.8	88.0	89.7	47.5	85.3
	10.1	40.7	16.7	34.4	4.2	5.8	10.4	5.7	23.5	9.9

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Table 18

Estimated saturation of the retention layer lower part (T3) for CS96 stations

Date	CS96-1	CS96-2	CS96-3	CS96-4	CS96-5	CS96-6	CS96-7	CS96-8	CS96-9	CS96-10
14-Jun-96	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	97.1	100.0
2-Jul-96	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a
18-Jul-96	100.0	96.6	98.1	97.6	99.6	98.7	100.0	n-a	91.2	93.5
26-Jul-96	94.3	96.8	98.7	97.0	100.0	99.4	98.5	94.1	94.5	89.1
8-Aug-96	89.7	95.0	97.0	91.0	94.0	93.8	96.0	89.9	88.1	87.1
11-Sep-96	84.5	80.3	85.3	86.3	87.8	97.2	97.0	89.1	88.3	90.0
17-Sep-96	89.5	96.8	94.7	95.1	87.2	95.8	96.2	87.0	n-a	90.9
18-Oct-96	90.0	100.0	91.9	97.9	91.2	100.0	99.2	93.6	91.4	98.0
29-May-97	91.9	92.6	90.8	92.1	88.5	92.3	94.5	92.4	83.4	90.2
9-Jun-97	89.0	88.9	84.0	85.2	86.3	89.4	89.2	89.6	81.2	87.1
5-Jul-97	90.5	85.9	90.4	91.6	85.8	90.4	n-a	89.8	82.5	87.5
15-Jul-97	91.6	86.7	92.8	96.6	86.9	90.8	95.3	100.0	83.4	87.8
4-Aug-97	85.9	82.3	90.2	85.6	85.6	89.1	90.0	88.9	83.0	88.0
17-Oct-97	65.4	91.5	97.0	94.6	87.6	92.5	96.0	99.8	85.2	93.8
22-Oct-97	91.6	86.7	92.8	96.6	86.9	90.8	95.3	100.0	83.4	87.8
4-Nov-97	94.0	95.2	100.0	100.0	95.1	98.3	98.9	100.0	100.0	100.0
11-Nov-97	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a
20-Apr-98	92.8	93.0	97.2	97.0	90.3	n-a	99.4	97.4	82.1	88.9
28-Apr-98	90.0	89.5	90.0	86.1	87.4	n-a	96.0	95.7	80.5	87.3
4-May-98	86.6	79.9	84.0	84.1	85.8	n-a	93.0	93.1	78.3	85.7
19-May-98	82.8	78.3	80.6	81.3	85.0	n-a	84.5	89.1	73.2	83.7
25-May-98	84.5	76.3	82.3	83.3	86.9	n-a	89.6	92.9	74.8	86.2
1-Jun-98	90.5	95.0	92.5	92.7	87.8	n-a	94.7	92.2	79.2	88.4
9-Jun-98	88.5	85.5	84.2	85.6	85.8	n-a	91.3	91.5	77.0	86.4
19-Jun-98	87.8	82.1	84.9	85.0	85.4	n-a	89.8	90.8	76.3	85.5
26-Jun-98	90.2	82.3	91.5	87.1	86.1	n-a	88.6	90.3	n-a	n-a
9-Jul-98	87.1	80.9	84.4	84.8	85.8	n-a	86.4	88.2	77.9	86.4
14-Jul-98	85.0	79.5	82.7	83.9	84.5	n-a	84.3	88.2	75.7	84.4
22-Jul-98	87.6	82.5	84.9	85.2	85.8	n-a	88.6	91.2	78.1	86.4
31-Jul-98	89.3	83.1	88.1	86.1	86.1	n-a	83.5	91.0	78.8	86.9
6-Aug-98	85.2	79.1	83.4	84.1	84.7	n-a	86.9	88.6	77.4	85.1
13-Aug-98	85.7	83.1	82.5	83.0	84.7	n-a	82.2	89.1	79.6	87.3
19-Aug-98	84.2	80.9	82.1	82.6	85.0	n-a	83.5	89.6	77.0	86.2
26-Aug-98	86.9	79.9	84.6	84.5	84.5	n-a	84.5	88.7	n-a	n-a
12-Sep-98	86.9	84.9	84.4	85.4	86.7	n-a	90.5	92.4	78.5	n-a
30-Sep-98	90.2	90.7	92.5	91.4	89.2	n-a	94.9	95.8	81.6	90.4
n-a: not-available										
Average	88.5	87.1	89.4	89.4	88.2	94.6	92.1	92.4	82.5	88.9
	5.7	6.9	6.0	5.8	4.4	4.1	5.5	4.0	6.6	4.2

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Tableau 19

Estimated saturation of the retention layer upper part (T5) for CS96 stations

Date	CS96-1	CS96-2	CS96-3	CS96-4	CS96-5	CS96-6	CS96-7	CS96-8	CS96-9	CS96-10
14-Jun-96	100.0	100.0	100.0	100.0	96.4	84.2	100.0	81.4	96.3	86.6
2-Jul-96	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a
18-Jul-96	100.0	96.1	99.2	100.0	92.1	83.0	100.0	n-a	95.6	84.6
26-Jul-96	98.0	96.9	98.2	96.9	94.0	83.4	98.6	79.7	100.0	84.6
8-Aug-96	94.4	95.1	93.5	83.2	88.0	80.5	94.0	77.2	97.1	82.4
11-Sep-96	93.7	78.9	88.5	80.1	89.5	82.8	93.2	79.2	94.6	90.3
17-Sep-96	95.7	90.2	90.7	86.0	91.2	82.7	92.6	78.7	n-a	91.9
18-Oct-96	97.7	93.2	90.0	85.4	97.0	85.5	95.9	81.9	96.6	99.6
29-May-97	n-a	98.4	89.5	83.0	91.7	81.2	93.8	95.7	92.6	88.6
9-Jun-97	n-a	96.1	85.5	79.3	85.0	75.2	89.7	90.8	90.2	86.2
5-Jul-97	n-a	96.1	91.7	86.2	89.1	80.2	n-a	89.3	92.9	86.8
15-Jul-97	97.7	95.9	96.0	94.1	90.6	80.2	95.9	97.3	94.6	86.8
4-Aug-97	92.9	95.3	91.7	80.3	87.8	77.7	93.0	89.8	93.9	87.3
17-Oct-97	95.7	98.2	96.5	83.6	96.6	82.8	96.1	82.5	98.8	95.6
22-Oct-97	97.7	95.9	96.0	94.1	90.6	80.2	95.9	97.3	94.6	86.8
4-Nov-97	99.5	100.0	100.0	98.3	100.0	85.1	99.6	97.3	97.5	100.0
11-Nov-97	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a
20-Apr-98	n-a	92.2	92.7	78.2	97.0	58.4	95.3	100.0	89.2	92.1
28-Apr-98	n-a	86.3	89.2	74.2	93.8	60.7	93.0	96.9	87.5	87.9
4-May-98	n-a	81.1	86.2	71.6	86.8	59.1	90.1	93.9	84.5	86.4
19-May-98	n-a	78.3	80.5	69.0	84.2	57.9	80.9	86.7	78.9	83.5
25-May-98	n-a	79.7	82.7	71.0	89.7	59.8	82.7	90.8	81.1	85.5
1-Jun-98	n-a	88.5	93.2	80.8	96.2	69.0	92.8	93.9	86.2	91.6
9-Jun-98	n-a	81.1	87.2	75.1	86.1	67.8	86.0	90.6	81.6	87.7
19-Jun-98	93.1	80.9	86.0	74.7	86.3	68.1	84.8	87.9	80.6	86.8
26-Jun-98	n-a	83.6	93.0	79.7	89.1	95.6	88.9	86.9	n-a	n-a
9-Jul-98	n-a	81.1	84.7	74.5	87.6	77.5	82.3	86.2	82.6	88.8
14-Jul-98	n-a	79.7	83.0	72.9	84.8	73.6	81.5	84.5	79.9	86.4
22-Jul-98	n-a	81.6	86.0	74.9	89.5	80.0	84.4	87.7	82.8	89.9
31-Jul-98	94.4	83.8	88.5	77.5	90.4	97.5	88.1	88.4	84.3	93.0
6-Aug-98	n-a	79.5	83.7	72.9	85.3	73.3	81.9	86.2	82.3	87.3
13-Aug-98	91.9	80.9	83.0	71.8	85.9	73.1	81.5	86.7	85.0	92.3
19-Aug-98	91.1	80.1	82.5	71.4	87.4	74.0	81.1	87.4	82.1	88.1
26-Aug-98	n-a	80.7	86.2	n-a	86.5	93.5	81.5	86.4	n-a	n-a
12-Sep-98	n-a	81.4	85.7	75.1	93.4	80.7	82.7	90.1	82.6	92.5
30-Sep-98	n-a	86.9	90.7	77.9	97.2	100.0	86.4	93.4	87.0	99.8
n-a: not-available										
Average	95.8	88.1	89.8	81.0	90.5	77.8	89.8	88.6	88.8	89.3
	2.9	7.6	5.5	9.0	4.3	10.8	6.4	6.0	6.6	4.5

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Table 20

Suction potential (cm of water) (retention layer lower part-W2) for CS96 stations

Date	CS96-1	CS96-2	CS96-3	CS96-4	CS96-5	CS96-6	CS96-7	CS96-8	CS96-9	CS96-10
14-Jun-96	20.4	30.6	30.6	20.4	30.6	20.4	30.6	30.6	20.4	20.4
2-Jul-96	10.2	20.4	20.4	20.4	20.4	20.4	20.4	20.4	20.4	20.4
18-Jul-96	20.4	20.4	20.4	20.4	20.4	10.2	30.6	n-a	30.6	20.4
26-Jul-96	112.2	40.8	30.6	30.6	10.2	10.2	30.6	20.4	n-a	n-a
8-Aug-96	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a
11-Sep-96	102	81.6	81.6	102	1	1	71.4	20.4	1	1
17-Sep-96	91.8	61.2	61.2	61.2	1	1	51	20.4	n-a	1
18-Oct-96	132.6	102	112.2	102	10.2	1	81.6	10.2	10.2	10.2
29-May-97	163.2	91.8	112.2	112.2	30.6	20.4	91.8	30.6	20.4	10.2
9-Jun-97	153	102	112.2	112.2	20.4	10.2	91.8	20.4	51	1
5-Jul-97	61.2	30.6	40.8	51	10.2	10.2	n-a	10.2	20.4	1
15-Jul-97	51	20.4	1	51	20.4	10.2	10.2	1	20.4	1
4-Aug-97	122.4	81.6	30.6	81.6	10.2	10.2	51	10.2	30.6	1
17-Oct-97	112.2	71.4	10.2	51	10.2	10.2	51	20.4	40.8	1
22-Oct-97	51	20.4	1	51	20.4	10.2	10.2	1	20.4	1
4-Nov-97	61.2	30.6	10.2	40.8	20.4	10.2	30.6	1	40.8	10.2
11-Nov-97	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a
20-Apr-98	132.6	71.4	102	71.4	122.4	61.2	51	61.2	51	20.4
28-Apr-98	173.4	112.2	142.8	112.2	20.4	61.2	91.8	61.2	71.4	20.4
4-May-98	163.2	112.2	142.8	122.4	10.2	51	102	51	71.4	10.2
19-May-98	193.8	153	163.2	142.8	1	61.2	122.4	40.8	112.2	10.2
25-May-98	183.6	142.8	153	132.6	1	61.2	112.2	30.6	122.4	10.2
1-Jun-98	112.2	102	91.8	20.4	61.2	20.4	71.4	40.8	61.2	10.2
9-Jun-98	142.8	112.2	122.4	71.4	10.2	20.4	91.8	30.6	102	10.2
19-Jun-98	112.2	81.6	91.8	61.2	10.2	10.2	81.6	20.4	81.6	10.2
26-Jun-98	51	20.4	20.4	1	10.2	1	40.8	20.4	n-a	n-a
9-Jul-98	122.4	61.2	91.8	71.4	1	1	71.4	20.4	71.4	1
14-Jul-98	112.2	61.2	81.6	61.2	1	1	71.4	20.4	61.2	1
22-Jul-98	112.2	51	81.6	61.2	1	1	61.2	20.4	61.2	1
31-Jul-98	91.8	51	61.2	20.4	1	1	51	20.4	40.8	1
6-Aug-98	122.4	61.2	81.6	61.2	1	1	71.4	10.2	40.8	1
13-Aug-98	132.6	81.6	91.8	91.8	1	1	71.4	10.2	51	1
19-Aug-98	142.8	91.8	102	91.8	1	1	81.6	10.2	71.4	1
26-Aug-98	102	61.2	61.2	30.6	1	1	61.2	20.4	n-a	n-a
12-Sep-98	112.2	71.4	81.6	61.2	1	1	61.2	20.4	51	1
30-Sep-98	102	71.4	71.4	40.8	1	1	61.2	20.4	51	1

n-a: not-available

Average	108.3	69.9	73.9	65.7	14.5	15.1	63.1	22.7	50.0	6.8
	46.1	35.3	45.5	36.4	22.9	19.8	28.0	14.9	29.6	7.3

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Table 21

Suction potential (cm of water) (retention layer upper part-W4) for CS96 stations

Date	CS96-1	CS96-2	CS96-3	CS96-4	CS96-5	CS96-6	CS96-7	CS96-8	CS96-9	CS96-10
14-Jun-96	20.4	20.4	20.4	20.4	20.4	20.4	10.2	20.4	20.4	20.4
2-Jul-96	20.4	20.4	20.4	10.2	10.2	10.2	30.6	20.4	20.4	10.2
18-Jul-96	91.8	30.6	71.4	20.4	20.4	10.2	51	n-a	30.6	20.4
26-Jul-96	132.6	112.2	102	61.2	20.4	10.2	91.8	20.4	n-a	n-a
8-Aug-96	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a
11-Sep-96	132.6	122.4	112.2	112.2	40.8	10.2	112.2	10.2	71.4	1
17-Sep-96	132.6	122.4	112.2	102	10.2	1	112.2	10.2	n-a	1
18-Oct-96	183.6	173.4	163.2	142.8	10.2	10.2	132.6	10.2	102	10.2
29-May-97	204	224.4	163.2	142.8	10.2	20.4	163.2	10.2	61.2	10.2
9-Jun-97	163.2	214.2	142.8	132.6	40.8	51	132.6	10.2	71.4	1
5-Jul-97	112.2	132.6	91.8	71.4	1	10.2	n-a	20.4	10.2	1
15-Jul-97	10.2	20.4	10.2	1	1	10.2	40.8	1	10.2	1
4-Aug-97	163.2	193.8	91.8	112.2	1	10.2	112.2	1	40.8	1
17-Oct-97	183.6	193.8	81.6	122.4	1	10.2	122.4	20.4	20.4	1
22-Oct-97	10.2	20.4	10.2	1	1	10.2	40.8	1	10.2	1
4-Nov-97	102	142.8	51	40.8	10.2	20.4	91.8	1	30.6	1
11-Nov-97	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a
20-Apr-98	204	224.4	163.2	153	61.2	n-a	n-a	51	122.4	20.4
28-Apr-98	244.8	265.2	204	183.6	153	n-a	n-a	51	153	20.4
4-May-98	214.2	234.6	183.6	163.2	153	n-a	n-a	40.8	132.6	10.2
19-May-98	224.4	275.4	204	193.8	183.6	n-a	n-a	51	173.4	10.2
25-May-98	224.4	265.2	193.8	183.6	173.4	n-a	n-a	40.8	163.2	10.2
1-Jun-98	153	214.2	112.2	71.4	20.4	n-a	n-a	51	112.2	10.2
9-Jun-98	204	224.4	173.4	142.8	91.8	n-a	n-a	40.8	163.2	10.2
19-Jun-98	163.2	183.6	142.8	122.4	10.2	n-a	n-a	30.6	132.6	1
26-Jun-98	91.8	112.2	51	40.8	1	n-a	n-a	30.6	n-a	n-a
9-Jul-98	153	163.2	132.6	112.2	10.2	n-a	n-a	30.6	112.2	1
14-Jul-98	153	173.4	132.6	112.2	1	n-a	n-a	30.6	112.2	1
22-Jul-98	153	163.2	122.4	112.2	1	n-a	n-a	30.6	112.2	1
31-Jul-98	142.8	153	112.2	91.8	1	n-a	n-a	30.6	91.8	1
6-Aug-98	163.2	173.4	132.6	112.2	1	n-a	n-a	30.6	91.8	1
13-Aug-98	163.2	204	142.8	132.6	10.2	n-a	n-a	30.6	102	1
19-Aug-98	204	224.4	163.2	142.8	40.8	n-a	n-a	30.6	132.6	1
26-Aug-98	132.6	183.6	112.2	91.8	1	n-a	n-a	30.6	n-a	n-a
12-Sep-98	153	193.8	122.4	102	1	n-a	n-a	20.4	102	1
30-Sep-98	142.8	193.8	112.2	91.8	1	n-a	n-a	20.4	102	1
n-a: not-available										
Average	145.5	163.8	116.4	101.5	32.8	14.3	88.9	25.2	87.0	5.9
	61.0	72.7	53.7	52.7	53.3	11.3	46.2	15.1	50.9	6.9

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Table 22

Estimated saturation of the capillary break (T1) for PS96 stations

Date	PS96-1	PS96-2	PS96-3	PS96-4	PS96-5	PS96-6	PS96-7	PS96-8	PS96-9	PS96-10
14-Jun-96	20.7	10.9	0.0	n-a	n-a	n-a	n-a	n-a	n-a	n-a
2-Jul-96	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a
18-Jul-96	30.9	53.0	0.0	n-a	n-a	n-a	n-a	n-a	n-a	n-a
26-Jul-96	28.6	51.3	0.0	n-a	n-a	n-a	n-a	n-a	n-a	n-a
8-Aug-96	25.7	48.0	0.0	15.7	20.1	46.4	24.7	20.0	22.7	98.3
11-Sep-96	25.7	48.0	0.0	39.0	18.4	18.2	n-a	n-a	n-a	n-a
17-Sep-96	27.3	50.7	24.0	49.7	22.7	20.0	n-a	24.1	29.6	100.0
18-Oct-96	28.6	52.6	28.4	51.9	22.0	20.3	23.7	21.2	26.3	n-a
29-May-97	27.0	52.0	90.9	n-a	n-a	n-a	22.0	20.9	24.3	71.4
9-Jun-97	25.3	49.3	0.0	16.3	17.1	63.0	20.7	18.7	22.4	0.0
5-Jul-97	29.9	53.9	88.3	19.3	23.0	84.5	24.7	25.8	31.9	14.1
15-Jul-97	33.9	55.6	66.1	21.8	25.0	100.0	94.7	88.1	34.9	0.0
4-Aug-97	24.7	47.0	89.8	16.9	17.8	63.6	29.9	18.5	23.4	34.1
17-Oct-97	n-a	53.0	97.9	19.9	21.7	71.8	33.6	20.4	26.3	39.2
22-Oct-97	33.9	55.6	66.1	21.8	25.0	100.0	94.7	88.1	34.9	0.0
4-Nov-97	n-a	57.6	98.7	22.1	25.3	91.2	41.8	27.0	31.9	39.4
11-Nov-97	n-a	55.9	100.0	n-a	n-a	n-a	n-a	n-a	n-a	n-a
20-Apr-98	n-a	38.5	94.0	21.3	12.5	72.4	26.3	21.2	24.0	38.2
28-Apr-98	n-a	52.6	92.2	19.3	18.8	70.0	29.6	19.2	25.7	35.4
4-May-98	n-a	49.3	62.5	18.5	18.1	67.6	28.9	18.5	24.7	35.4
19-May-98	n-a	44.7	53.4	16.9	16.4	57.9	26.0	17.0	22.4	34.8
25-May-98	n-a	45.1	54.4	17.4	16.4	n-a	n-a	n-a	22.0	32.6
1-Jun-98	n-a	53.0	56.3	21.5	n-a	65.5	n-a	20.0	29.9	40.3
9-Jun-98	n-a	50.0	51.0	19.1	20.7	68.8	31.3	20.4	27.0	37.3
19-Jun-98	n-a	50.0	54.7	100.0	21.7	76.7	32.2	22.6	28.0	38.4
26-Jun-98	n-a	53.6	63.8	20.2	n-a	92.7	40.1	100.0	33.9	39.7
9-Jul-98	n-a	48.7	54.7	18.2	18.8	75.5	31.3	19.7	25.0	35.2
14-Jul-98	n-a	46.7	74.5	18.0	19.4	65.5	28.9	18.7	24.0	35.0
22-Jul-98	n-a	48.7	55.2	18.5	20.1	73.3	30.9	20.7	26.0	36.2
31-Jul-98	n-a	50.0	53.6	19.1	22.7	80.3	33.2	23.6	30.3	37.5
6-Aug-98	n-a	44.4	53.4	17.7	18.4	65.8	29.9	19.7	25.0	34.5
13-Aug-98	n-a	42.8	n-a	17.4	17.4	60.6	28.0	18.2	23.4	33.7
19-Aug-98	n-a	n-a	51.3	n-a	17.4	58.2	27.3	18.0	22.7	34.1
26-Aug-98	n-a	45.4	53.9	19.6	22.0	62.7	28.3	20.9	28.6	38.0
12-Sep-98	n-a	48.0	53.9	18.8	20.1	64.5	29.6	19.5	25.3	37.1
30-Sep-98	n-a	51.6	57.0	21.3	24.3	67.6	30.3	22.9	29.6	38.2
Average	27.9	48.8	54.1	24.7	20.1	66.4	34.2	28.1	26.9	37.5
	3.7	7.9	31.6	17.0	3.1	20.4	18.1	22.3	3.9	22.1

n-a: not-available

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Table 23

Estimated saturation of the retention layer lower part (T3) for PS96 stations

Date	PS96-1	PS96-2	PS96-3	PS96-4	PS96-5	PS96-6	PS96-7	PS96-8	PS96-9	PS96-10
14-Jun-96	100.0	75.0	73.0	n-a	n-a	n-a	n-a	n-a	n-a	n-a
2-Jul-96	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a
18-Jul-96	100.0	85.2	75.4	n-a	n-a	n-a	n-a	n-a	n-a	n-a
26-Jul-96	96.0	78.1	75.6	n-a	n-a	n-a	n-a	n-a	n-a	n-a
8-Aug-96	84.2	74.0	72.6	70.0	87.0	72.7	91.3	82.4	91.2	78.9
11-Sep-96	74.7	72.1	73.2	68.2	86.7	77.2	n-a	n-a	n-a	n-a
17-Sep-96	84.4	78.4	76.8	76.2	92.4	96.5	n-a	86.0	96.4	79.9
18-Oct-96	87.3	81.0	79.8	75.6	94.8	92.2	94.7	86.6	97.9	n-a
29-May-97	n-a	81.5	89.2	n-a	n-a	n-a	92.1	87.5	91.7	79.7
9-Jun-97	n-a	76.3	82.6	76.4	83.1	76.7	88.0	83.1	88.8	77.7
5-Jul-97	n-a	85.9	84.2	92.6	90.6	89.8	93.4	89.5	96.4	78.5
15-Jul-97	n-a	91.9	90.0	98.7	92.4	100.0	100.0	96.4	98.4	73.6
4-Aug-97	n-a	74.2	82.4	75.6	86.7	80.2	90.8	80.8	93.2	73.6
17-Oct-97	n-a	82.8	94.4	92.3	93.0	89.0	96.2	87.1	98.7	79.3
22-Oct-97	n-a	91.9	90.0	98.7	92.4	100.0	100.0	96.4	98.4	73.6
4-Nov-97	n-a	100.0	97.2	100.0	100.0	98.9	97.7	100.0	100.0	79.3
11-Nov-97	n-a	88.3	100.0	n-a	n-a	n-a	n-a	n-a	n-a	n-a
20-Apr-98	n-a	97.7	96.0	96.4	39.1	87.1	88.0	88.0	91.4	81.1
28-Apr-98	n-a	84.6	93.6	84.9	75.8	85.8	91.6	85.3	96.4	80.1
4-May-98	n-a	79.4	90.6	81.0	78.6	82.8	90.1	83.1	94.8	79.1
19-May-98	n-a	72.7	84.0	73.1	74.2	75.1	83.7	77.3	90.9	75.2
25-May-98	n-a	71.6	89.2	72.1	74.5	74.0	n-a	72.6	n-a	74.4
1-Jun-98	n-a	79.9	91.0	96.7	88.3	82.8	91.3	66.8	96.6	78.1
9-Jun-98	n-a	78.9	87.4	91.0	85.9	84.7	93.1	86.9	96.6	100.0
19-Jun-98	n-a	79.4	85.4	92.8	85.9	85.3	93.1	87.3	95.8	77.0
26-Jun-98	n-a	87.5	85.6	95.6	86.7	95.2	95.4	92.0	95.8	77.5
9-Jul-98	n-a	76.6	84.0	82.6	83.1	84.7	92.6	84.4	92.5	76.2
14-Jul-98	n-a	74.5	82.8	81.0	82.3	81.5	89.6	82.9	91.2	75.8
22-Jul-98	n-a	75.8	85.4	86.2	85.4	83.6	92.1	85.7	96.1	77.0
31-Jul-98	n-a	79.4	85.2	93.3	88.8	89.8	93.6	88.4	97.7	78.1
6-Aug-98	n-a	73.2	81.6	81.5	84.1	82.0	90.8	85.5	95.1	77.5
13-Aug-98	n-a	69.8	82.2	76.4	82.6	77.5	87.8	82.2	92.7	76.8
19-Aug-98	n-a	n-a	83.4	75.6	82.6	76.7	86.8	80.4	n-a	77.5
26-Aug-98	n-a	74.5	81.8	93.6	86.7	80.2	89.8	85.3	n-a	77.3
12-Sep-98	n-a	75.8	88.4	86.2	87.2	81.0	90.8	85.5	n-a	79.1
30-Sep-98	n-a	80.7	91.2	97.2	91.1	84.5	92.9	89.3	n-a	80.9
Average	89.5	80.3	85.3	85.4	84.7	84.9	92.1	85.5	95.0	78.4
	9.5	7.3	6.9	9.9	10.4	7.7	3.7	6.5	3.0	4.7

n-a: not-available

March 1999

Table 24

Estimated saturation of the retention layer upper part (T5) for PS96 stations

Date	PS96-1	PS96-2	PS96-3	PS96-4	PS96-5	PS96-6	PS96-7	PS96-8	PS96-9	PS96-10
14-Jun-96	80.1	81.0	76.0	n-a	n-a	n-a	n-a	n-a	n-a	n-a
2-Jul-96	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a
18-Jul-96	80.1	100.0	75.8	n-a	n-a	n-a	n-a	n-a	n-a	n-a
26-Jul-96	76.0	95.4	76.3	n-a	n-a	n-a	n-a	n-a	n-a	n-a
8-Aug-96	70.0	90.5	72.7	76.2	83.7	80.8	88.2	88.1	82.9	90.9
11-Sep-96	67.2	89.8	74.7	73.1	80.5	84.0	n-a	n-a	n-a	n-a
17-Sep-96	72.8	96.1	78.5	94.4	89.7	92.8	n-a	93.0	91.4	93.7
18-Oct-96	75.8	98.2	82.0	91.0	91.7	92.3	86.7	94.8	90.6	n-a
29-May-97	74.5	n-a	87.3	n-a	n-a	n-a	83.9	95.1	92.8	94.5
9-Jun-97	69.8	n-a	85.3	80.3	93.0	77.6	78.5	91.9	84.8	92.1
5-Jul-97	78.8	n-a	86.2	89.3	96.0	89.3	87.9	96.4	95.9	94.5
15-Jul-97	82.5	n-a	86.4	98.7	96.7	98.7	87.0	100.0	100.0	94.9
4-Aug-97	68.9	n-a	85.9	84.9	91.7	78.9	84.8	92.5	87.0	94.3
17-Oct-97	100.0	n-a	95.6	94.4	98.2	90.9	88.5	97.4	93.9	98.4
22-Oct-97	82.5	n-a	86.4	98.7	96.7	98.7	87.0	100.0	100.0	94.9
4-Nov-97	84.0	n-a	98.0	100.0	100.0	100.0	100.0	100.0	98.9	98.4
11-Nov-97	82.1	n-a	100.0	n-a	n-a	n-a	n-a	n-a	n-a	n-a
20-Apr-98	77.5	n-a	99.1	96.4	60.4	50.9	52.7	96.9	51.1	100.0
28-Apr-98	73.0	n-a	96.0	91.3	93.0	92.5	85.8	94.5	90.6	97.2
4-May-98	69.3	n-a	87.7	88.2	88.2	82.1	82.4	92.5	87.3	96.3
19-May-98	62.9	n-a	85.9	82.4	78.7	71.2	77.6	88.6	79.0	93.3
25-May-98	62.4	n-a	86.6	83.6	78.4	73.3	n-a	88.3	78.5	94.7
1-Jun-98	71.3	n-a	90.3	96.9	93.0	82.4	87.0	93.8	91.2	97.6
9-Jun-98	70.4	n-a	86.4	92.1	91.2	81.6	84.2	94.8	88.7	95.3
19-Jun-98	70.8	n-a	85.7	91.8	90.7	82.1	84.2	95.3	88.4	95.1
26-Jun-98	78.4	n-a	86.4	94.6	91.0	98.7	92.7	97.4	93.9	94.9
9-Jul-98	71.7	n-a	85.5	87.2	87.0	84.8	83.0	92.7	85.1	93.5
14-Jul-98	69.8	n-a	84.8	86.2	86.5	80.5	80.9	92.2	82.6	92.9
22-Jul-98	72.6	n-a	86.2	89.3	89.0	82.9	83.3	94.3	87.0	94.3
31-Jul-98	81.4	n-a	85.9	92.1	90.5	94.1	85.8	96.4	90.6	94.9
6-Aug-98	69.5	n-a	84.6	n-a	86.0	n-a	81.5	93.5	85.1	93.9
13-Aug-98	65.0	n-a	84.8	84.9	83.0	76.8	79.1	91.9	80.9	93.9
19-Aug-98	64.4	n-a	85.5	84.7	83.0	75.5	79.1	91.9	80.1	94.7
26-Aug-98	71.3	n-a	85.1	91.6	90.0	79.7	83.3	94.0	88.1	93.5
12-Sep-98	71.3	n-a	86.8	90.3	90.0	80.5	81.8	94.8	85.9	96.1
30-Sep-98	75.6	n-a	92.1	94.9	93.5	85.1	84.8	97.9	91.4	96.9
Average	74.1	93.0	86.1	89.6	88.7	84.1	83.6	94.4	87.5	95.0
	7.3	6.5	6.5	6.6	7.7	10.2	7.6	3.2	9.0	2.0

n-a: not-available

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Table 25

Suction potential (cm of water) (retention layer lower part-W2) for PS96 stations

Date	PS96-1	PS96-2	PS96-3	PS96-4	PS96-5	PS96-6	PS96-7	PS96-8	PS96-9	PS96-10
14-Jun-96	30.6	40.8	30.6	n-a	n-a	n-a	n-a	n-a	n-a	n-a
2-Jul-96	61.2	40.8	10.2	n-a	n-a	n-a	n-a	n-a	n-a	n-a
18-Jul-96	61.2	71.4	61.2	n-a	n-a	n-a	n-a	n-a	n-a	n-a
26-Jul-96	40.8	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a
8-Aug-96	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a
11-Sep-96	91.8	71.4	20.4	30.6	122.4	122.4	153	102	112.2	20.4
17-Sep-96	30.6	20.4	1	1	30.6	71.4	n-a	1	10.2	1
18-Oct-96	51	40.8	1	1	61.2	122.4	153	30.6	40.8	n-a
29-May-97	61.2	71.4	20.4	n-a	n-a	n-a	193.8	40.8	40.8	10.2
9-Jun-97	81.6	81.6	10.2	30.6	153	153	204	102	91.8	1
5-Jul-97	10.2	20.4	1	1	10.2	40.8	81.6	20.4	10.2	1
15-Jul-97	1	10.2	1	1	10.2	1	1	1	1	1
4-Aug-97	71.4	71.4	1	40.8	132.6	122.4	163.2	102	102	10.2
17-Oct-97	40.8	40.8	1	10.2	71.4	71.4	132.6	20.4	30.6	1
22-Oct-97	1	10.2	1	1	10.2	1	1	1	1	1
4-Nov-97	20.4	20.4	10.2	10.2	20.4	30.6	61.2	10.2	20.4	10.2
11-Nov-97	40.8	40.8	10.2	n-a	n-a	n-a	n-a	n-a	n-a	n-a
20-Apr-98	61.2	40.8	10.2	30.6	1428	193.8	306	40.8	224.4	20.4
28-Apr-98	102	71.4	10.2	51	193.8	204	234.6	102	132.6	30.6
4-May-98	112.2	81.6	1	61.2	183.6	183.6	234.6	122.4	142.8	20.4
19-May-98	183.6	142.8	1	102	275.4	234.6	275.4	183.6	214.2	81.6
25-May-98	193.8	153	1	112.2	275.4	234.6	255	173.4	214.2	102
1-Jun-98	112.2	71.4	1	20.4	20.4	142.8	193.8	61.2	40.8	20.4
9-Jun-98	91.8	81.6	1	30.6	91.8	142.8	183.6	30.6	40.8	20.4
19-Jun-98	61.2	61.2	1	10.2	61.2	112.2	153	20.4	40.8	10.2
26-Jun-98	20.4	20.4	1	10.2	10.2	10.2	61.2	10.2	20.4	1
9-Jul-98	61.2	61.2	1	10.2	122.4	81.6	153	30.6	61.2	1
14-Jul-98	71.4	71.4	1	20.4	102	102	163.2	61.2	81.6	1
22-Jul-98	61.2	71.4	1	10.2	91.8	91.8	142.8	20.4	40.8	1
31-Jul-98	40.8	51	1	10.2	30.6	71.4	122.4	10.2	20.4	1
6-Aug-98	71.4	81.6	1	10.2	122.4	112.2	153	30.6	61.2	1
13-Aug-98	102	112.2	1	40.8	173.4	142.8	173.4	91.8	122.4	10.2
19-Aug-98	122.4	132.6	1	51	183.6	153	183.6	112.2	142.8	20.4
26-Aug-98	51	81.6	1	10.2	20.4	122.4	132.6	20.4	20.4	1
12-Sep-98	71.4	71.4	1	10.2	81.6	122.4	142.8	40.8	61.2	1
30-Sep-98	40.8	51	1	10.2	30.6	112.2	132.6	10.2	20.4	1

n-a: not-available

Average	66.5	63.6	6.4	25.5	142.1	114.0	156.6	53.5	72.1	13.9
	43.4	34.9	12.0	28.1	258.9	62.7	70.9	50.6	64.8	23.5

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Table 26

Suction potential (cm of water) (retention layer upper part-W4) for PS96 stations

Date	PS96-1	PS96-2	PS96-3	PS96-4	PS96-5	PS96-6	PS96-7	PS96-8	PS96-9	PS96-10
14-Jun-96	71.4	91.8	51	n-a	n-a	n-a	n-a	n-a	n-a	n-a
2-Jul-96	91.8	81.6	51	n-a	n-a	n-a	n-a	n-a	n-a	n-a
18-Jul-96	61.2	71.4	51	n-a	n-a	n-a	n-a	n-a	n-a	n-a
26-Jul-96	91.8	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a
8-Aug-96	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a
11-Sep-96	132.6	122.4	81.6	51	132.6	142.8	153	132.6	153	51
17-Sep-96	81.6	71.4	51	20.4	51	81.6	n-a	61.2	51	20.4
18-Oct-96	102	61.2	61.2	51	81.6	153	183.6	91.8	102	n-a
29-May-97	122.4	132.6	40.8	n-a	n-a	n-a	214.2	142.8	112.2	20.4
9-Jun-97	122.4	n-a	40.8	71.4	163.2	193.8	214.2	153	132.6	1
5-Jul-97	51	n-a	30.6	1	40.8	51	91.8	30.6	30.6	1
15-Jul-97	20.4	n-a	1	1	20.4	20.4	1	10.2	10.2	1
4-Aug-97	122.4	n-a	20.4	81.6	153	173.4	183.6	153	153	40.8
17-Oct-97	91.8	112.2	30.6	51	91.8	142.8	173.4	122.4	102	10.2
22-Oct-97	20.4	n-a	1	1	20.4	20.4	1	10.2	10.2	1
4-Nov-97	51	71.4	30.6	30.6	40.8	81.6	91.8	51	51	10.2
11-Nov-97	102	122.4	40.8	n-a	n-a	n-a	n-a	n-a	n-a	n-a
20-Apr-98	122.4	112.2	n-a	61.2	40.8	81.6	785.4	173.4	30.6	30.6
28-Apr-98	173.4	163.2	n-a	102	173.4	234.6	275.4	224.4	142.8	30.6
4-May-98	163.2	132.6	n-a	102	183.6	234.6	244.8	214.2	153	20.4
19-May-98	224.4	163.2	n-a	142.8	265.2	295.8	285.6	265.2	224.4	91.8
25-May-98	234.6	163.2	n-a	142.8	275.4	306	275.4	255	214.2	102
1-Jun-98	153	122.4	n-a	30.6	30.6	173.4	173.4	142.8	81.6	30.6
9-Jun-98	163.2	122.4	n-a	51	112.2	193.8	214.2	173.4	112.2	20.4
19-Jun-98	122.4	102	n-a	40.8	81.6	153	183.6	132.6	91.8	10.2
26-Jun-98	61.2	61.2	n-a	10.2	20.4	51	81.6	40.8	30.6	10.2
9-Jul-98	112.2	112.2	n-a	61.2	132.6	153	183.6	153	112.2	1
14-Jul-98	112.2	112.2	n-a	61.2	112.2	153	193.8	153	122.4	10.2
22-Jul-98	112.2	112.2	n-a	51	102	153	173.4	132.6	102	1
31-Jul-98	81.6	102	n-a	20.4	51	112.2	163.2	112.2	81.6	1
6-Aug-98	122.4	132.6	n-a	61.2	132.6	163.2	193.8	142.8	112.2	1
13-Aug-98	153	153	n-a	91.8	183.6	204	214.2	183.6	153	30.6
19-Aug-98	163.2	163.2	n-a	102	193.8	234.6	234.6	204	183.6	51
26-Aug-98	112.2	132.6	n-a	20.4	30.6	173.4	163.2	112.2	81.6	10.2
12-Sep-98	112.2	112.2	n-a	51	91.8	173.4	183.6	142.8	112.2	20.4
30-Sep-98	102	102	n-a	30.6	40.8	153	163.2	102	81.6	10.2
Average	112.5	114.3	38.9	55.0	105.2	153.7	196.3	134.0	104.4	22.1
	47.9	30.4	21.3	38.2	71.7	71.9	132.5	65.6	54.8	25.4

n-a: not-available

Table 27

Estimated saturation for TA97 stations (West dyke)

Date	TA-97-1	TA-97-2	TA-97-3	TA-97-4	TA-97-5	TA-97-6	TA-97-7	TA-97-8	TA-97-9	TA-97-10	TA-97-11	TA-97-12	TA-97-13	TA-97-14	TA-97-15
16-Jul-97	87.84	90.12	95.92	89.25	76.47	92.70	100.00	96.03	64.84	93.89	93.97	89.31	94.29	81.09	91.70
4-Aug-97	82.18	86.05	89.13	87.62	69.61	93.54	88.82	87.75	72.53	92.18	90.45	88.60	89.67	72.36	90.66
4-Sep-97	80.50	71.22	92.12	98.13	100.00	94.38	91.37	91.39	82.42	95.11	93.22	90.26	90.22	85.45	91.70
17-Oct-97	95.39	93.02	96.74	92.29	83.01	98.31	95.85	94.04	91.21	97.56	96.98	95.25	93.75	91.27	94.81
4-Nov-97	98.53	100.00	100.00	93.69	92.81	100.00	98.08	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
20-Apr-98	100.00	n-a	n-a	100.00	75.82	n-a	95.85	n-a	n-a	n-a	n-a	n-a	98.37	n-a	n-a
28-Apr-98	98.11	88.08	38.04	89.72	n-a	65.73	91.37	n-a	70.33	95.84	91.46	89.31	93.21	93.82	84.08
4-May-98	90.15	85.76	87.50	87.62	62.75	56.46	88.18	74.50	65.93	93.40	85.93	85.51	88.59	92.36	79.93
19-May-98	77.78	82.27	84.24	83.18	55.23	82.87	84.03	67.88	59.34	85.82	65.33	81.71	81.79	81.82	73.01
25-May-98	75.05	82.56	86.41	86.21	55.88	85.39	84.98	68.54	63.74	87.78	64.32	83.37	82.88	81.45	74.39
1-Jun-98	95.81	89.83	91.85	90.19	68.63	88.20	94.57	n-a	87.91	92.67	92.71	89.31	92.66	92.73	86.51
9-Jun-98	88.89	84.01	88.04	87.85	66.99	85.11	90.73	n-a	79.12	90.46	87.44	85.51	88.59	91.64	85.47
19-Jun-98	85.12	84.30	87.50	87.38	67.32	85.11	90.73	n-a	80.22	89.98	85.43	85.51	88.86	91.27	84.08
26-Jun-98	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a	n-a
9-Jul-98	80.08	84.01	88.04	85.51	66.99	87.36	85.94	n-a	64.84	89.00	74.62	82.66	86.14	90.91	83.74
14-Jul-98	77.57	81.98	85.60	82.71	63.73	84.83	87.22	n-a	75.82	87.78	74.62	81.47	84.51	83.64	82.70
22-Jul-98	80.08	84.30	88.59	76.17	66.99	87.64	87.54	n-a	73.63	89.98	76.38	83.37	86.68	89.09	85.47
31-Jul-98	85.12	86.34	91.03	87.85	71.24	88.20	90.42	n-a	79.12	90.46	84.67	85.27	89.13	92.36	87.89
6-Aug-98	73.58	83.14	86.41	83.18	65.69	85.96	84.35	n-a	54.95	87.04	n-a	81.24	83.15	88.00	80.97
13-Aug-98	66.46	84.01	87.23	85.28	63.07	88.48	84.66	n-a	57.14	88.26	54.77	82.90	83.15	85.09	82.01
19-Aug-98	n-a	n-a	85.60	82.71	59.15	86.24	84.35	n-a	62.64	87.29	51.26	81.71	80.98	82.18	80.62
26-Aug-98	n-a	n-a	n-a	84.58	66.67	86.24	90.42	n-a	80.22	89.24	83.42	83.61	84.78	87.27	85.47
12-Sep-98	81.55	n-a	89.40	86.92	65.36	88.76	90.10	n-a	87.91	90.22	73.87	83.85	88.86	88.73	84.08
30-Sep-98	97.06	n-a	96.20	92.29	72.88	92.13	94.89	n-a	93.41	94.38	92.46	88.84	94.29	93.09	88.58
n-a: not-available															
Average	85.6	85.6	87.4	87.8	69.8	86.5	90.2	85.0	74.9	91.3	81.6	86.3	88.9	88.0	85.4
	9.4	5.8	12.1	5.2	10.8	9.5	4.6	12.8	12.5	3.7	13.7	4.7	5.2	6.0	6.2

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<u>Table 28</u>

Estimated saturation for TA97 stations (North, East and South East dykes)

Date	TA-97-16	TA-97-17	TA-97-18	TA-97-19	TA-97-20	TA-97-21	TA-97-22	TA-97-23	TA-97-24	TA-97-25	TA-97-26	TA-97-27	TA-97-28	TA-97-29	TA-97-30
16-Jul-97	81.58	89.37	91.99	89.61	80.66	79.77	91.50	95.71	80.42	95.58	87.69	76.30	76.03	48.32	77.41
4-Aug-97	77.19	88.61	80.88	89.33	78.25	78.35	84.64	86.14	74.40	74.86	87.18	78.52	71.63	44.30	81.48
4-Sep-97	79.53	91.39	87.08	91.85	80.36	80.91	n-d	93.40	78.31	82.04	90.77	72.59	73.00	45.64	83.33
17-Oct-97	84.21	96.96	93.80	97.75	84.29	86.04	n-d	81.85	84.34	91.44	95.64	79.26	77.13	46.98	95.19
4-Nov-97	91.81	100.00	99.22	100.00	93.96	100.00	100.00	100.00	94.58	100.00	100.00	100.00	84.02	46.31	100.00
20-Apr-98	100.00	94.94	100.00	87.36	100.00	87.18	80.39	88.78	100.00	97.24	99.49	78.89	100.00	93.96	89.26
28-Apr-98	85.09	90.38	90.96	83.99	84.89	84.05	75.82	74.92	85.54	86.74	88.97	69.26	83.20	90.60	82.59
4-May-98	81.29	86.08	84.50	83.43	79.46	82.05	70.59	68.32	78.31	80.11	83.59	62.96	74.10	89.26	78.15
19-May-98	74.85	81.77	74.68	80.62	70.09	78.92	62.09	67.66	63.86	73.48	76.92	72.22	67.49	81.21	71.85
25-May-98	n-d	80.76	73.64	81.74	n-d	78.92	n-d	n-d	63.25	74.03	79.74	81.85	67.49	84.56	73.70
1-Jun-98	84.50	n-d	93.02	n-d	86.71	94.30	80.72	87.13	84.94	91.99	90.26	n-d	76.58	65.77	88.15
9-Jun-98	81.87	88.35	90.44	86.24	80.36	83.48	77.78	78.22	81.33	88.67	83.85	81.85	74.38	91.28	80.00
19-Jun-98	81.87	88.35	88.89	85.67	80.06	83.48	78.43	82.84	79.52	86.46	82.56	82.22	74.93	93.29	81.85
26-Jun-98	87.43	92.66	95.61	89.04	88.52	89.74	82.03	85.15	88.86	88.95	87.69	97.04	81.27	97.32	94.44
9-Jul-98	79.82	86.08	82.69	83.71	77.64	81.48	73.86	63.70	75.30	78.18	76.67	70.74	75.76	88.59	78.52
14-Jul-98	78.36	84.05	80.62	82.87	79.15	80.91	72.88	72.94	76.81	78.45	79.49	77.04	75.76	87.25	82.96
22-Jul-98	79.82	87.09	84.50	84.55	78.55	82.05	75.82	75.58	78.61	80.39	81.54	74.81	77.41	90.60	81.48
31-Jul-98	83.04	89.62	89.66	86.80	82.78	84.90	79.41	83.50	84.94	86.74	83.08	n-d	79.06	95.30	87.41
6-Aug-98	78.65	85.32	81.14	83.43	n-d	79.49	72.88	69.64	74.40	76.24	81.28	85.19	74.66	87.92	76.67
13-Aug-98	76.32	83.54	75.71	83.15	n-d	80.34	69.61	62.05	69.88	72.38	82.56	94.44	72.73	85.23	73.33
19-Aug-98	75.73	84.05	74.68	83.71	71.60	80.63	69.61	76.90	68.67	71.27	n-d	93.33	71.90	84.56	75.93
26-Aug-98	78.95	87.34	83.98	85.39	n-d	85.19	75.49	83.50	79.52	87.02	86.67	90.37	75.21	91.95	86.67
12-Sep-98	78.65	87.34	83.72	85.67	80.36	83.76	77.78	81.85	77.41	81.49	89.74	84.44	77.13	92.62	88.15
30-Sep-98	81.87	92.41	91.73	89.04	83.69	90.03	81.70	n-d	83.43	96.13	92.31	98.15	80.72	100.00	92.96
n-a: not-available															
Average	81.8	88.5	86.4	86.7	82.1	84.0	77.8	80.0	79.4	84.2	86.4	81.9	76.7	80.1	83.4
	5.6	4.7	7.6	4.8	6.8	5.2	8.0	10.1	8.5	8.5	6.4	10.1	6.4	18.9	7.4

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Table 29

Probes results for the hydraulic break test cell

Date units max.	Ten 97-6 (cbars)	Ten 97-7 (cbars)	Ten 97-8 (cbars)	PS97-1 (VWC) 35.0	PS97-2 (VWC) 45.0	PS97-3 (VWC) 39.9	PS97-4 (VWC) 41.2	PS97-5 (VWC) 45.1	PS97-6 (VWC) 44.7	PS97-7 (VWC) 48.7
11-Nov-97	10	0	4	33.5	38.0	39.1	37.4	45.1	44.7	47.5
20-Apr-98	59	1	12.5	33.7	45.0	n-a	n-a	44.2	38.1	n-a
28-Apr-98	59	8	12	32.0	39.4	39.9	41.2	40.9	30.2	48.7
4-May-98	60	14	14	30.5	38.2	38.3	39.4	39.1	28.9	47.1
19-May-98	n-a	n-a	n-a	28.2	35.4	36.5	37.4	38.0	28.4	46.1
25-May-98	63	18	14	28.4	36.1	36.8	37.4	37.3	29.0	45.8
1-Jun-98	63	10	11	32.8	38.6	39.3	39.1	39.3	36.0	48.0
9-Jun-98	63	13	14	32.0	37.4	37.9	38.1	39.0	30.4	47.3
19-Jun-98	64	14	14	32.0	37.1	37.6	37.9	38.5	31.0	46.7
26-Jun-98	62	10	12	35.0	38.1	38.8	38.6	38.3	32.5	46.7
9-Jul-98	63	13	13	31.4	37.1	37.8	37.9	37.9	28.9	46.5
14-Jul-98	63	13	11	30.8	36.9	37.5	37.7	37.7	28.6	46.3
22-Jul-98	64	12	10	31.3	37.4	37.9	38.2	38.2	29.2	46.9
31-Jul-98	64	12	11	31.7	37.1	38.2	38.3	36.9	30.3	46.8
6-Aug-98	66	15	11	30.1	36.3	37.0	37.3	37.6	28.7	46.1
13-Aug-98	66	15	13	28.9	36.2	35.9	37.0	37.2	n-a	45.2
19-Aug-98	66	14	10	29.0	36.3	36.9	37.0	36.9	28.8	45.8
26-Aug-98	66	14	10	30.9	37.1	37.4	37.1	38.2	31.1	46.3
12-Sep-98	66	12	9	31.8	37.5	37.9	37.8	38.9	29.5	47.4
30-Sep-98	n-a	n-a	n-a	32.9	38.6	38.7	38.1	39.8	33.4	48.4

n-a: not-available

VWC: Volumetric water content

March 1999

Table 30

Hydraulic break test cell results comparison

Suction potential (cbars)

Date	Ten 97-6		Ten 97-7		Ten 97-8	
Control		PS96-1		PS96-2		PS96-3
		W2-W4		W2-W4		W2-W4
11-Nov-97	10	7	0	8	4	2.5
20-Apr-98	59	9	1	7.5	12.5	1
28-Apr-98	59	13.5	8	11.5	12	1
4-May-98	60	13.5	14	10.5	14	0
19-May-98	n-a	20	n-a	15	n-a	0
25-May-98	63	21	18	15.5	14	0
1-Jun-98	63	13	10	9.5	11	0
9-Jun-98	63	12.5	13	10	14	0
19-Jun-98	64	9	14	8	14	0
26-Jun-98	62	4	10	4	12	0
9-Jul-98	63	8.5	13	8.5	13	0
14-Jul-98	63	9	13	9	11	0
22-Jul-98	64	8.5	12	9	10	0
31-Jul-98	64	6	12	7.5	11	0
6-Aug-98	66	9.5	15	10.5	11	0
13-Aug-98	66	12.5	15	13	13	0
19-Aug-98	66	14	14	14.5	10	0
26-Aug-98	66	8	14	10.5	10	0
12-Sep-98	66	9	12	9	9	0
30-Sep-98	n-a	7	n-a	7.5	n-a	0

Estimated saturation

Date	PS97-1		PS97-2	PS97-3	PS97-4		PS97-5	PS97-6	PS97-7	
Control		PS96-1				PS96-2				PS96-3
max.	35.0	45.7	45.0	39.9	41.2	33.4	45.1	44.7	48.7	47.8
11-Nov-97	95.7	82.1	84.4	98.0	90.8	88.3	100.0	100.0	97.5	100.0
20-Apr-98	96.3	77.5	100.0	n-a	n-a	97.7	98.0	85.2	n-a	97.6
28-Apr-98	91.4	73.0	87.6	100.0	100.0	84.6	90.7	67.6	100.0	94.8
4-May-98	87.1	69.3	84.9	96.0	95.6	79.4	86.7	64.7	96.7	89.1
19-May-98	80.6	62.9	78.7	91.5	90.8	72.7	84.3	63.5	94.7	85.0
25-May-98	81.1	62.4	80.2	92.2	90.8	71.6	82.7	64.9	94.0	87.9
1-Jun-98	93.7	71.3	85.8	98.5	94.9	79.9	87.1	80.5	98.6	90.7
9-Jun-98	91.4	70.4	83.1	95.0	92.5	78.9	86.5	68.0	97.1	86.9
19-Jun-98	91.4	70.8	82.4	94.2	92.0	79.4	85.4	69.4	95.9	85.6
26-Jun-98	100.0	78.4	84.7	97.2	93.7	87.5	84.9	72.7	95.9	86.0
9-Jul-98	89.7	71.7	82.4	94.7	92.0	76.6	84.0	64.7	95.5	84.7
14-Jul-98	88.0	69.8	82.0	94.0	91.5	74.5	83.6	64.0	95.1	83.8
22-Jul-98	89.4	72.6	83.1	95.0	92.7	75.8	84.7	65.3	96.3	85.8
31-Jul-98	90.6	81.4	82.4	95.7	93.0	79.4	81.8	67.8	96.1	85.6
6-Aug-98	86.0	69.5	80.7	92.7	90.5	73.2	83.4	64.2	94.7	83.1
13-Aug-98	82.6	65.0	80.4	90.0	89.8	69.8	82.5	n-a	92.8	83.5
19-Aug-98	82.9	64.4	80.7	92.5	89.8	n-a	81.8	64.4	94.0	84.4
26-Aug-98	88.3	71.3	82.4	93.7	90.0	74.5	84.7	69.6	95.1	83.4
12-Sep-98	90.9	71.3	83.3	95.0	91.7	75.8	86.3	66.0	97.3	87.6
30-Sep-98	94.0	75.6	85.8	97.0	92.5	80.7	88.2	74.7	99.4	91.6
Average	89.6	71.5	83.8	94.9	92.3	79.0	86.4	70.4	96.1	87.9
	5.2	5.5	4.4	2.5	2.5	6.8	4.9	9.3	1.9	4.8

n-a: not-available

Date:	99-01-07	Échelle:	-
Dessiné par:	S.R./J.-F.R.	Projeté par:	J.F.R.
Vérifié par:	J.F.R.	Approuvé par:	P.G.
No. de dessin:		No. de projet:	971-7301

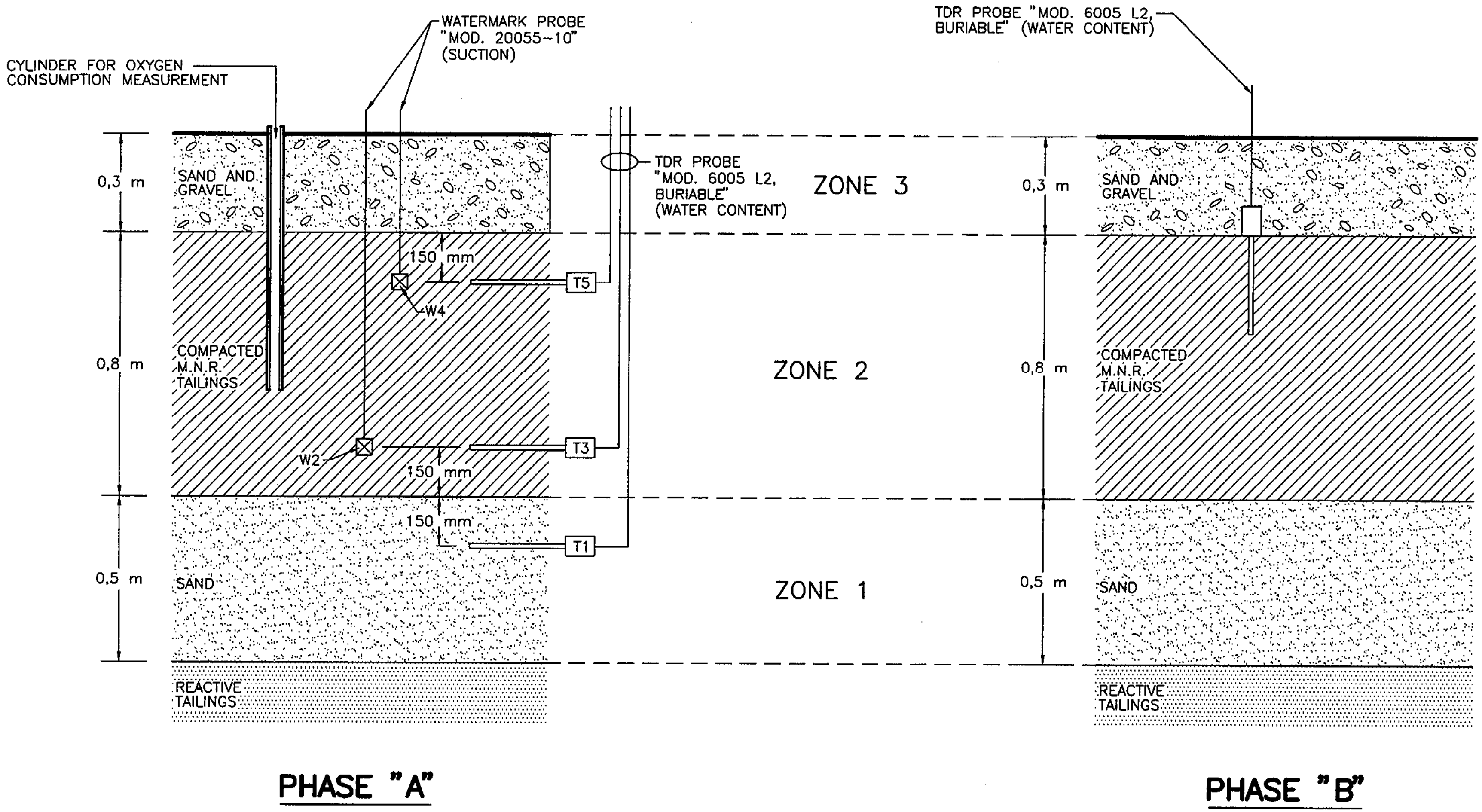
CANMET

Field performance of the LTA composite dry cover

Golder Associés
63, Place Frontenac, Pointe-Claire, Qué.
H9R 4Z7
Tél.: (514) 630-0990 Fax: (514) 630-1178

Site plan view

FIGURE 1



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Checked by:	J.-F.R.	Approved by:	P.G.
Drawing no.:	9730102D	Project no.:	971-7301

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FIELD PERFORMANCE OF THE LTA COMPOSITE DRY COVER

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MONITORING STATIONS LAYOUT

FIGURE 2

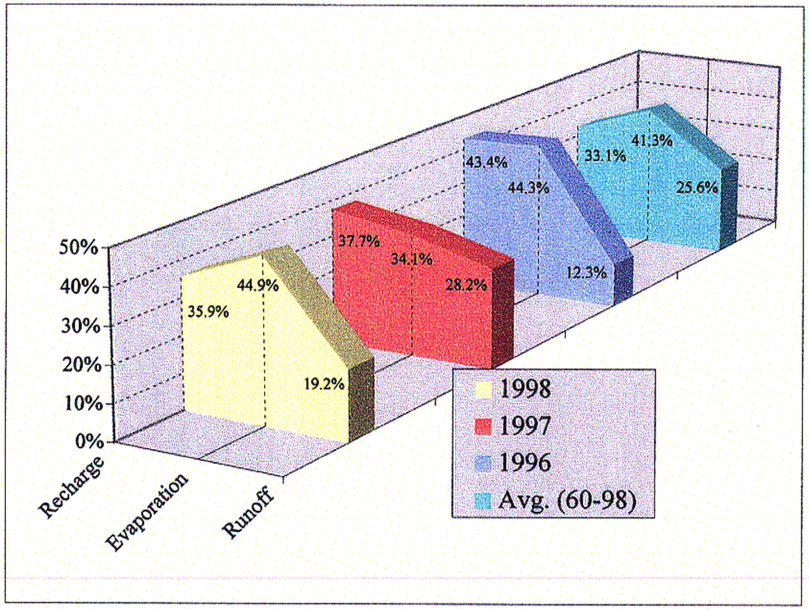


Figure 3 : Stack surface water balance (vs precipitation)

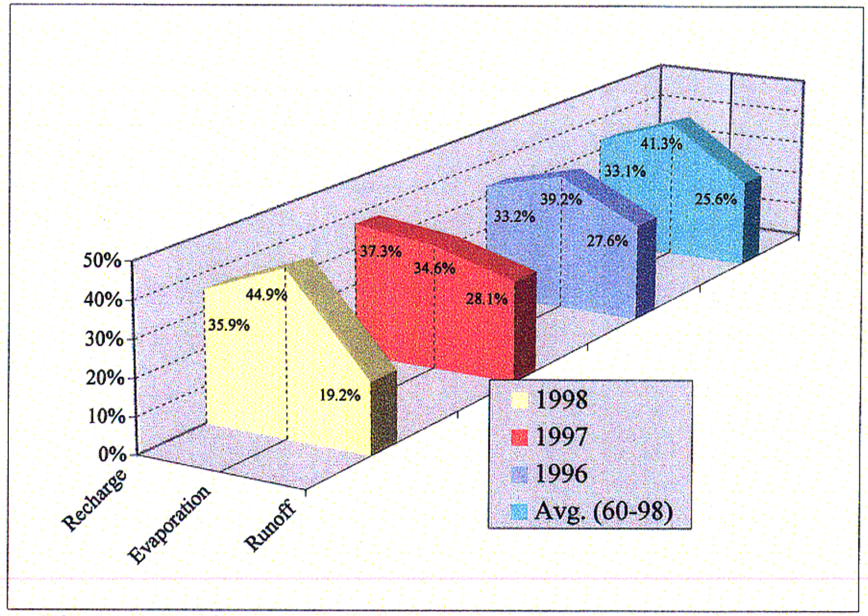


Figure 4 : Dykes outer slopes water balance (vs precipitation)

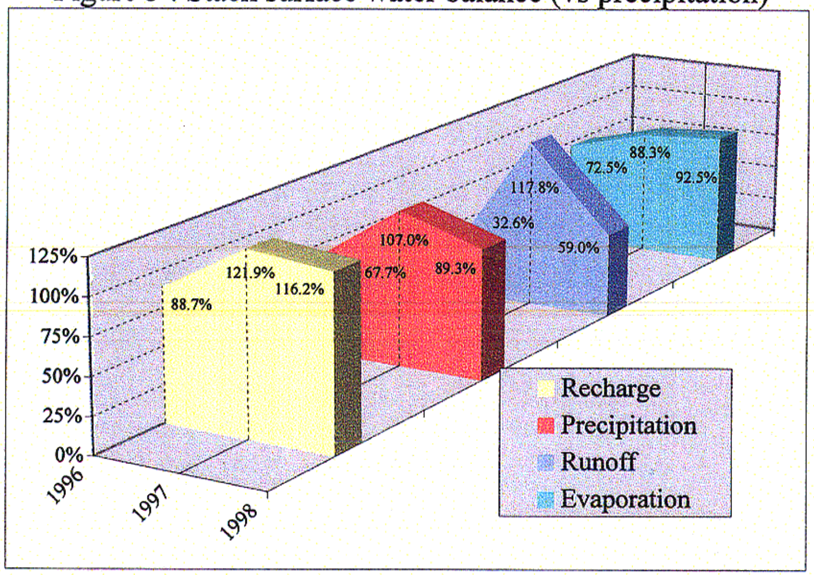


Figure 5 : Stack surface water balance (vs 60-98 avg.)

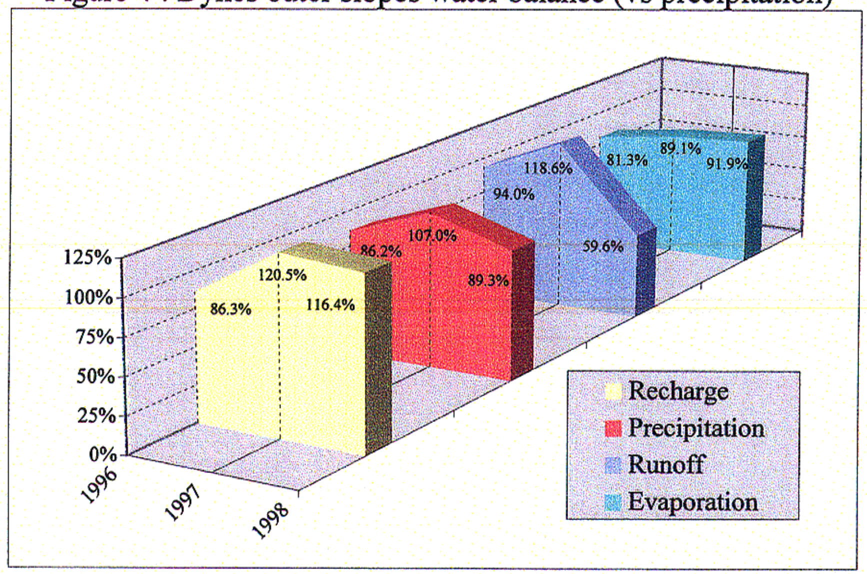
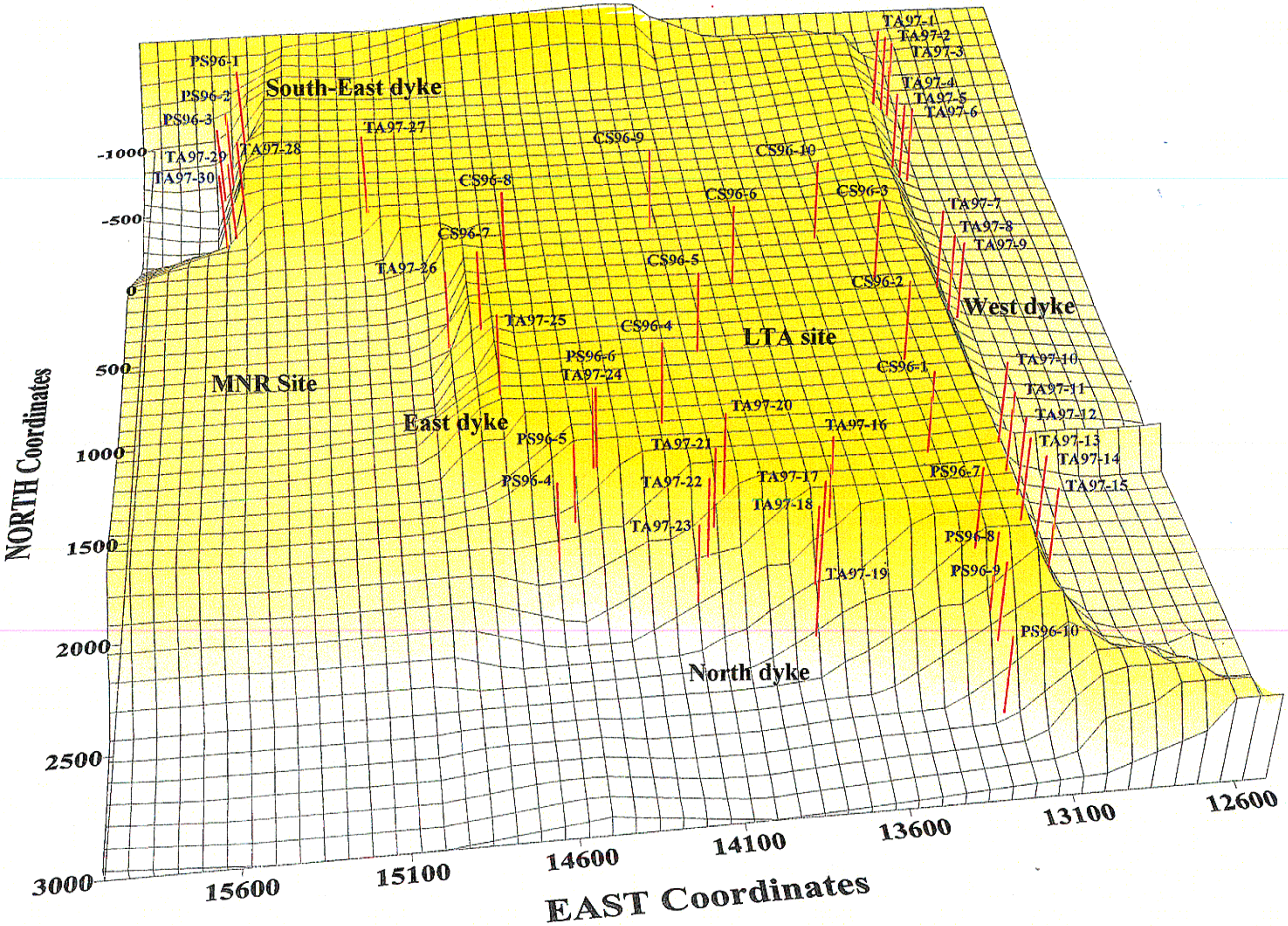


Figure 6 : Dykes outer slopes water balance (vs 60-98 avg.)



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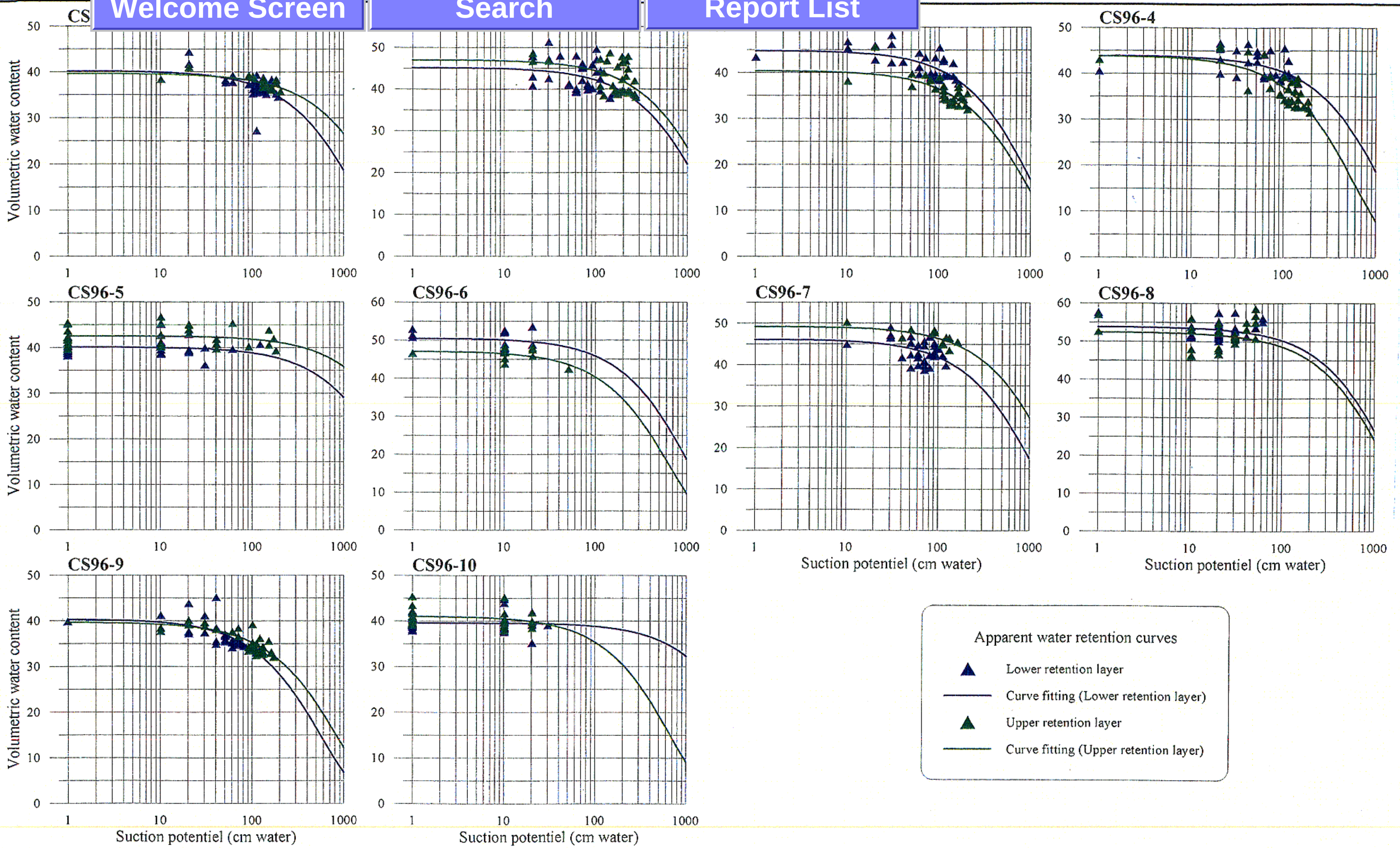
Monitoring stations location	FIGURE 7
Field performance of the LTA composite dry cover	



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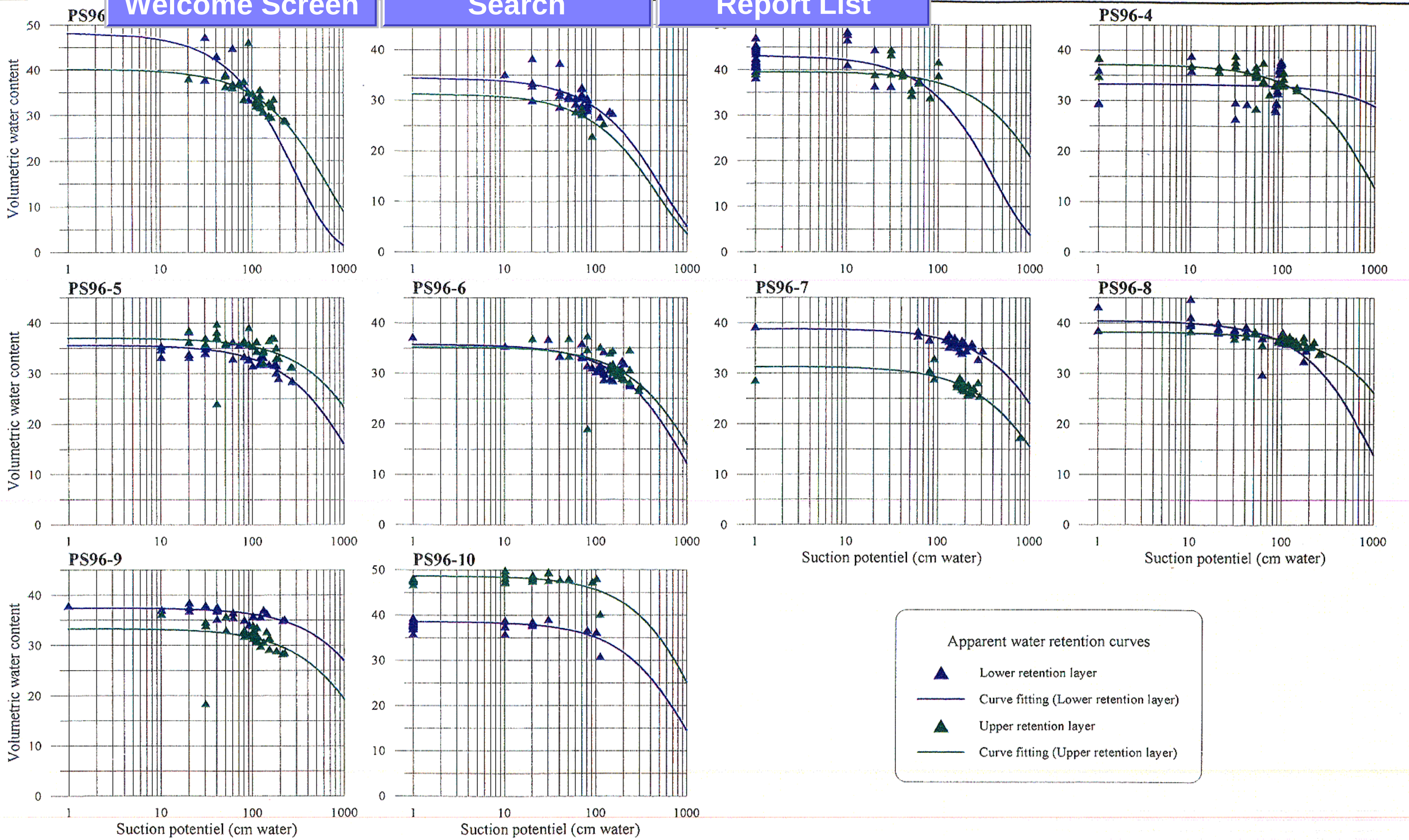
No. de dessin:		No. de projet:	971-7301

CANMET

Apparent water retention curves
Phase A stations (CS96 Stack surface)

FIGURE 8

Field performance of the LTA composite dry cover



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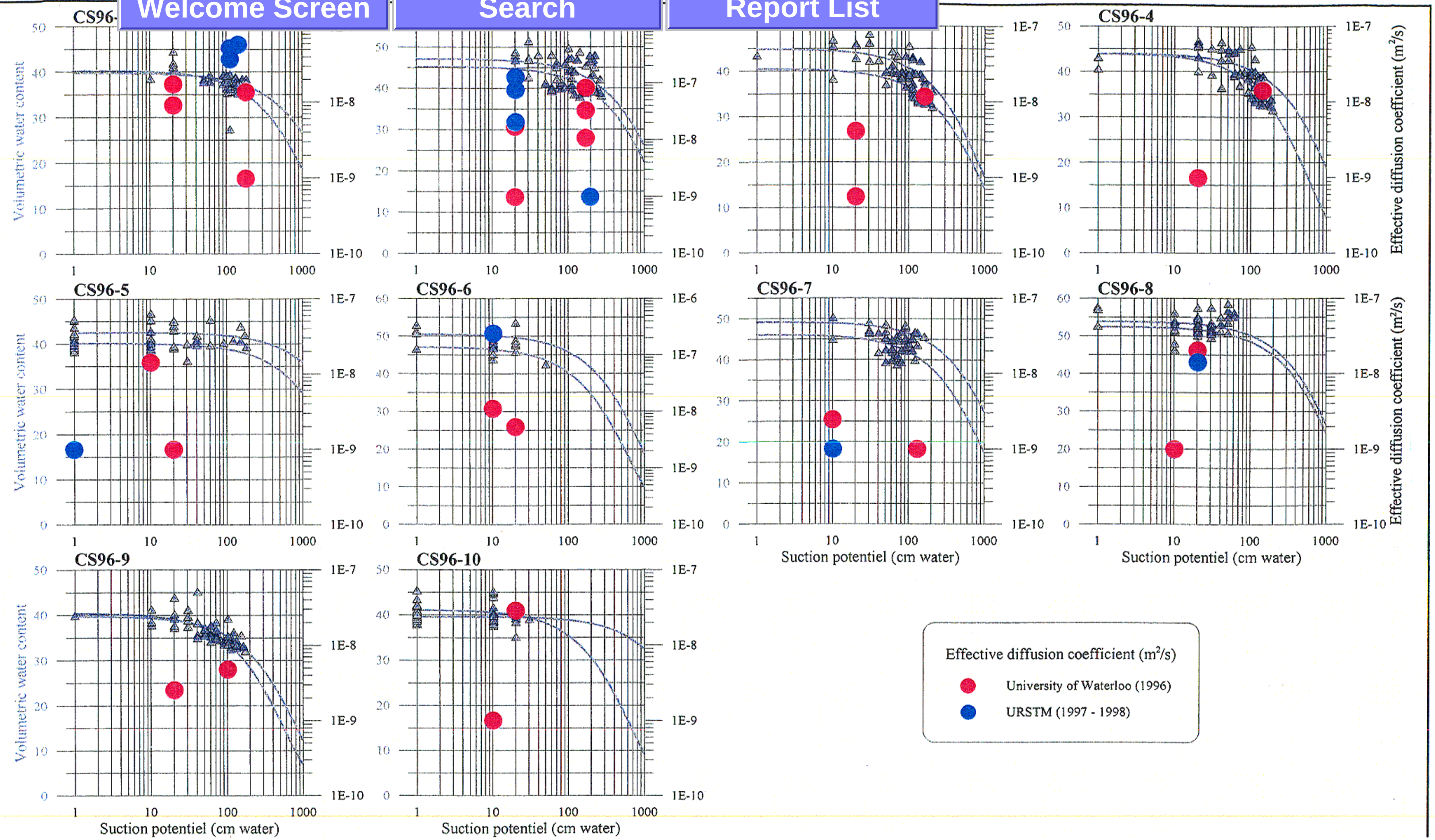
Apparent water retention curves
Phase A stations (PS96 Dyke outer slopes)

FIGURE 9

Field performance of the LTA composite dry cover



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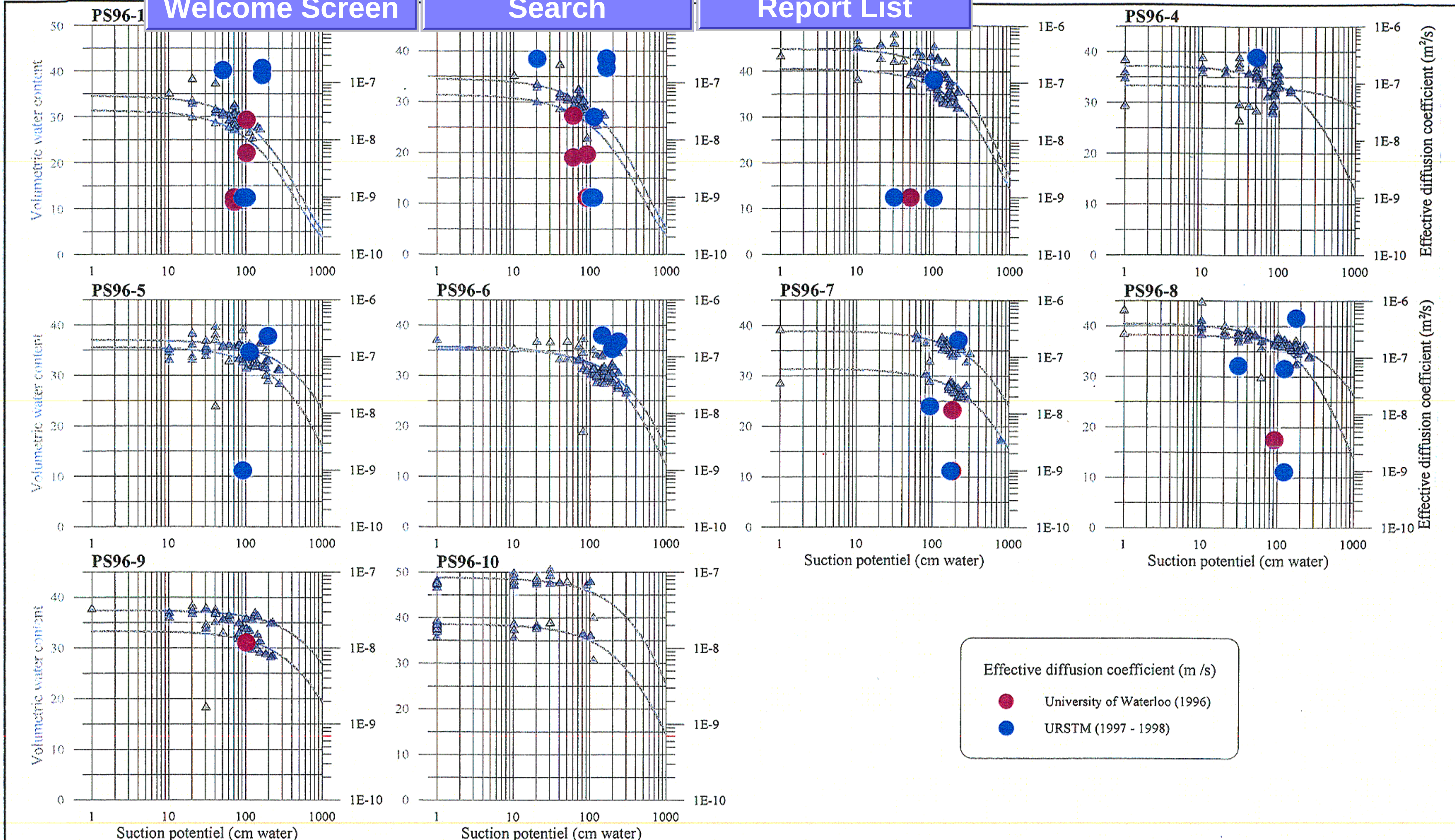
CANMET

Effective diffusion coefficient calculation
Phase A stations (CS96 Stack surface)

FIGURE 10

Field performance of the LTA composite dry cover



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Date:	99-01-07	Échelle:	-
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Effective diffusion coefficient calculation
Phase A stations (PS96 Dykes outer slopes)

FIGURE 11

Field performance of the LTA composite dry cover

March 1999

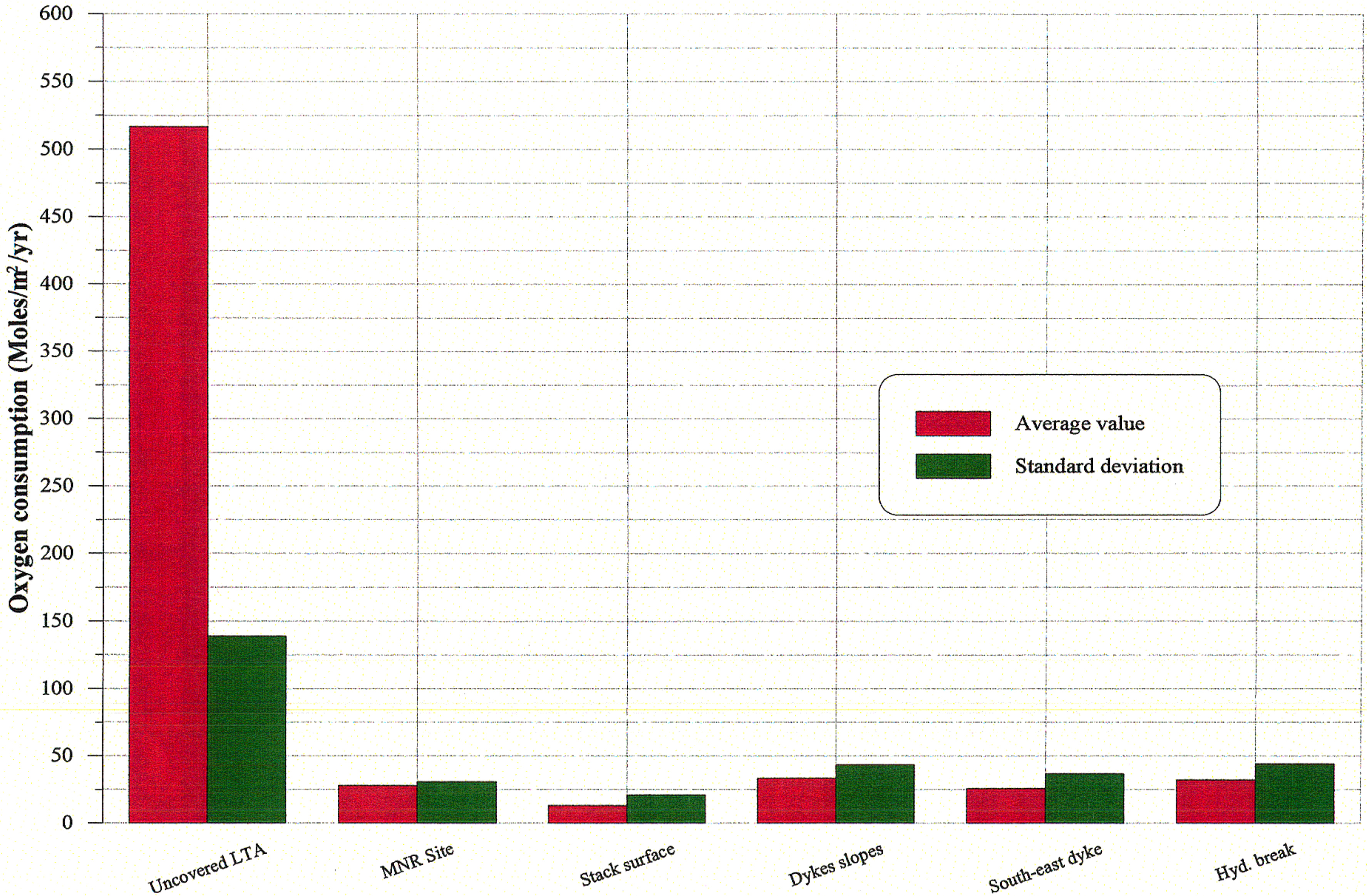
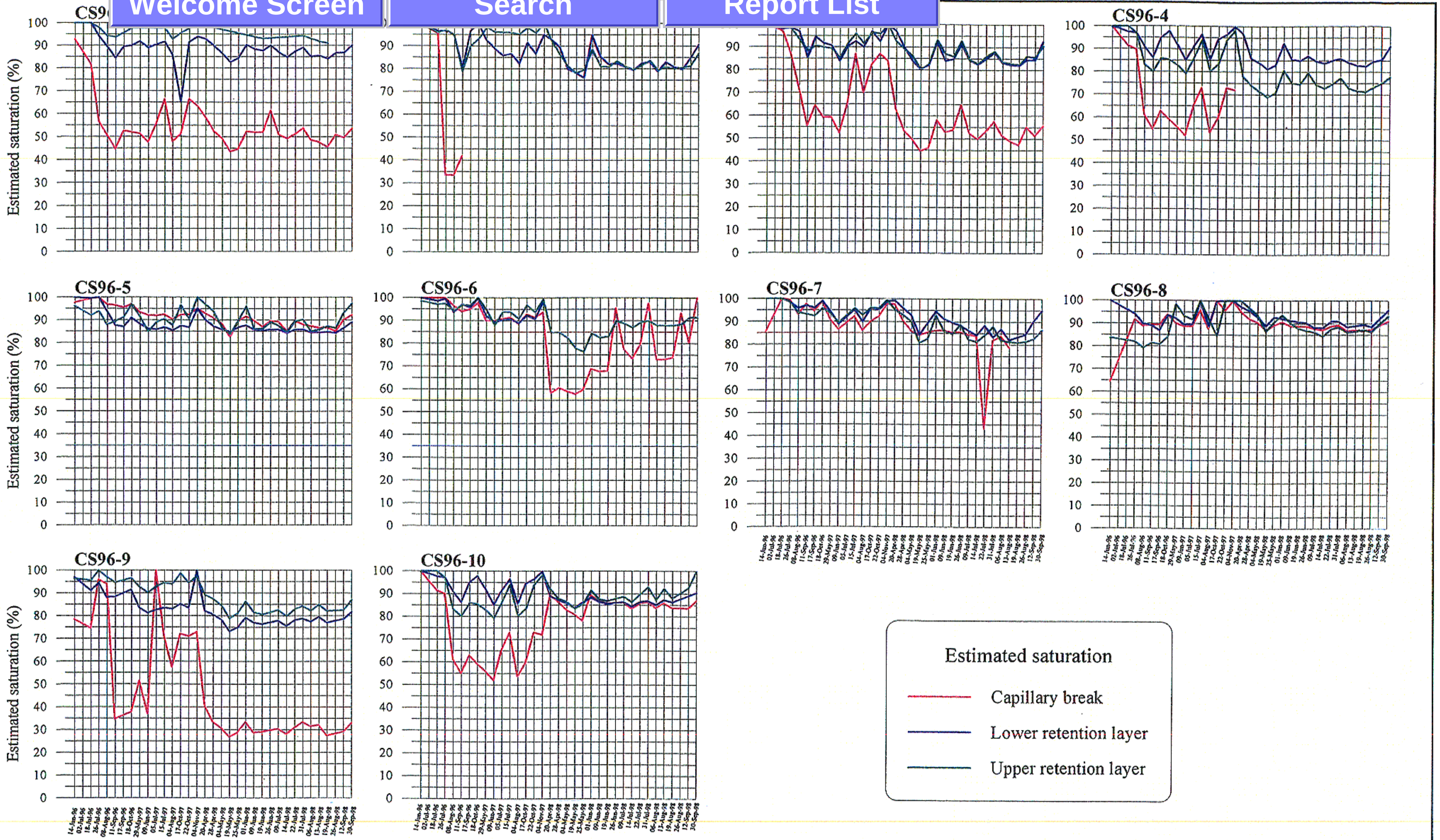


Figure 12: Oxygen consumption measurements results



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No. de dessin:		No. de projet:	971-7301

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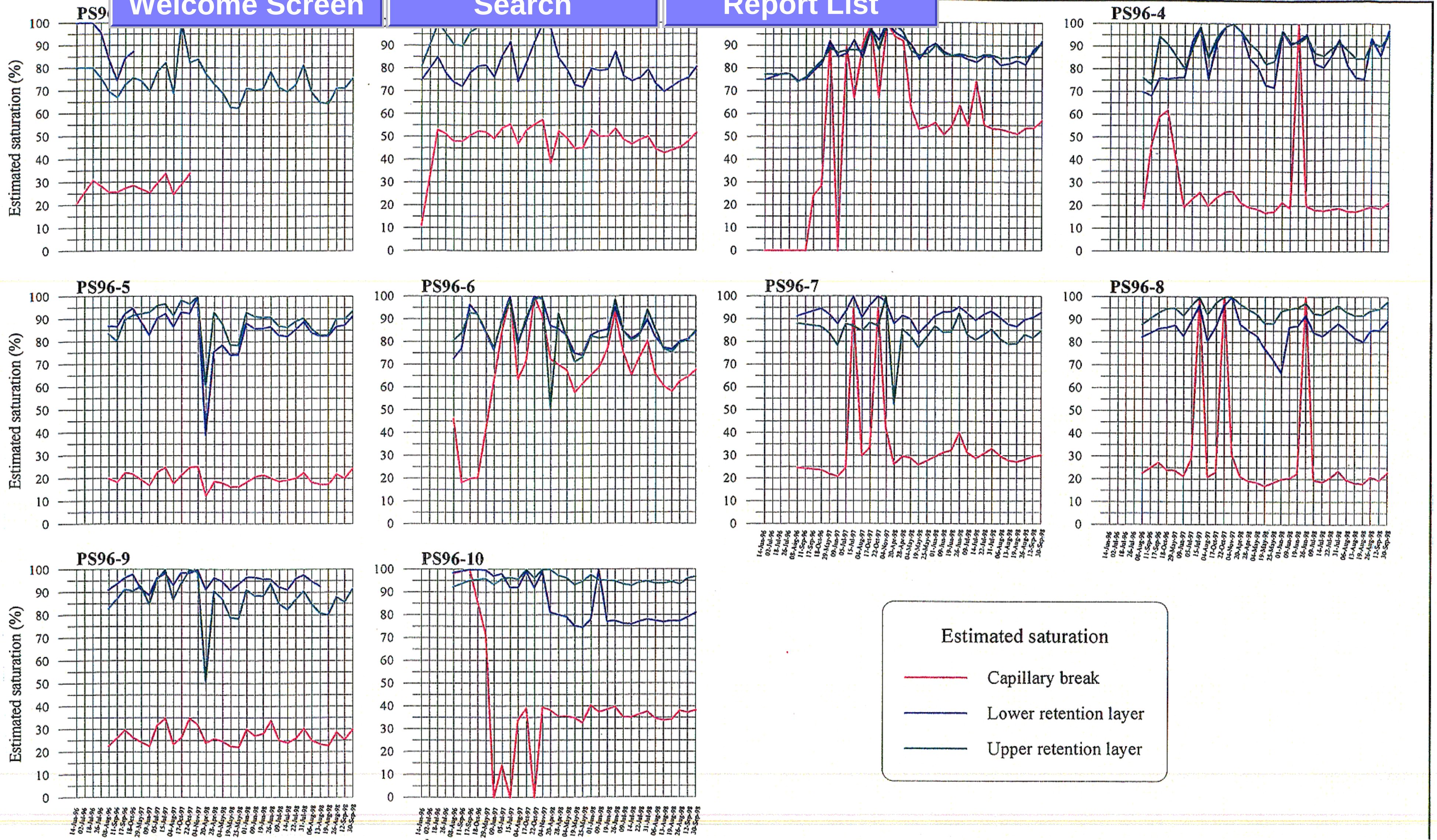
Estimated saturation
Phase A stations (CS96 Stack surface)

FIGURE 13

Field performance of the LTA composite dry cover



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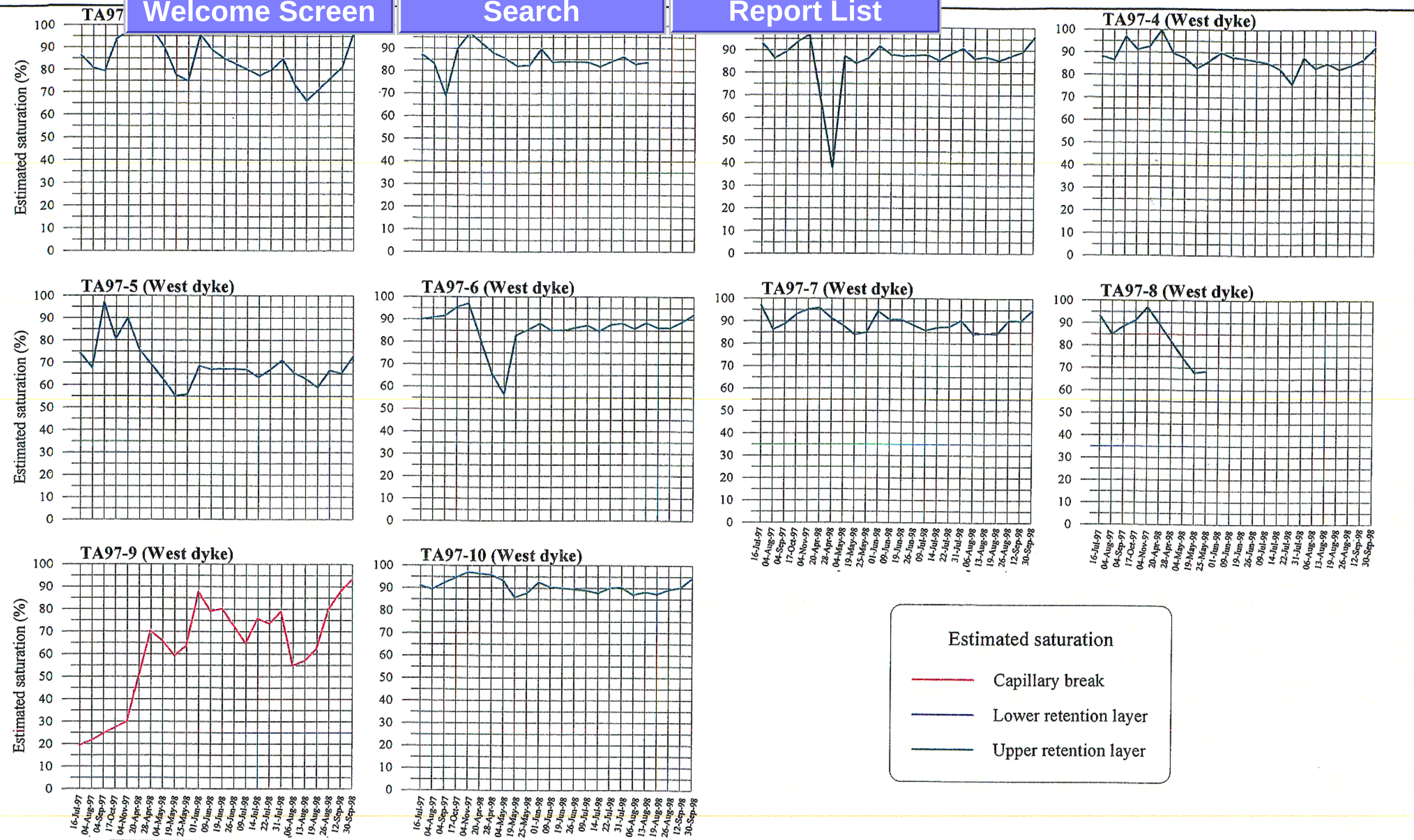
Vérifié par:	J.F.R.	Approuvé par:	P.G.
No. de dessin:		No. de projet:	971-7301

CANMET

Estimated saturation Phase A stations (PS96 North and South-east dykes slopes)

FIGURE 14

Field performance of the LTA composite dry cover



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Date:	99-01-07	Échelle:	-
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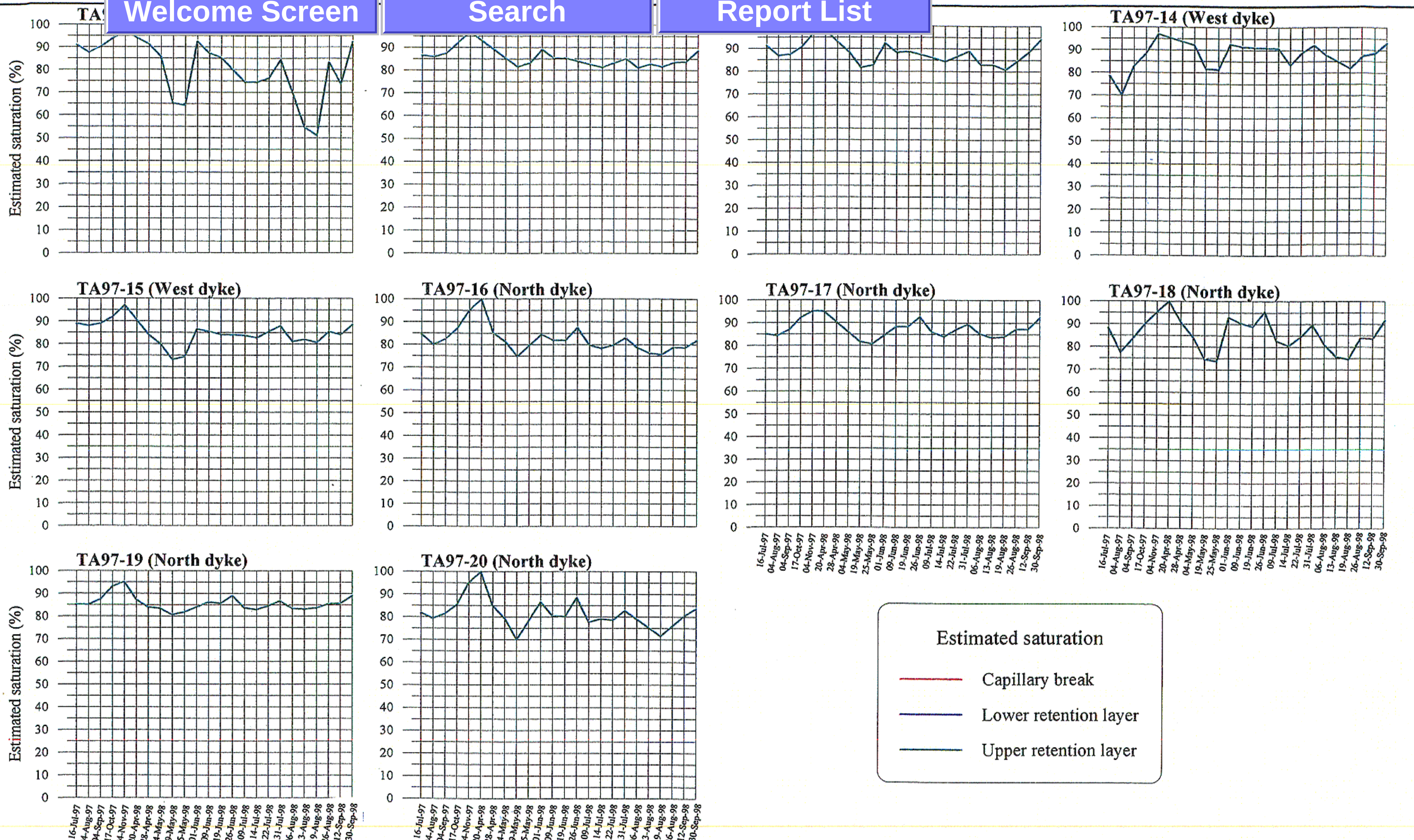
No. de dessin:		No. de projet:	971-7301

CANMET

Estimated saturation Phase B stations (TA97-1 to TA97-10 West dykes slopes)

FIGURE 15

Field performance of the LTA composite dry cover



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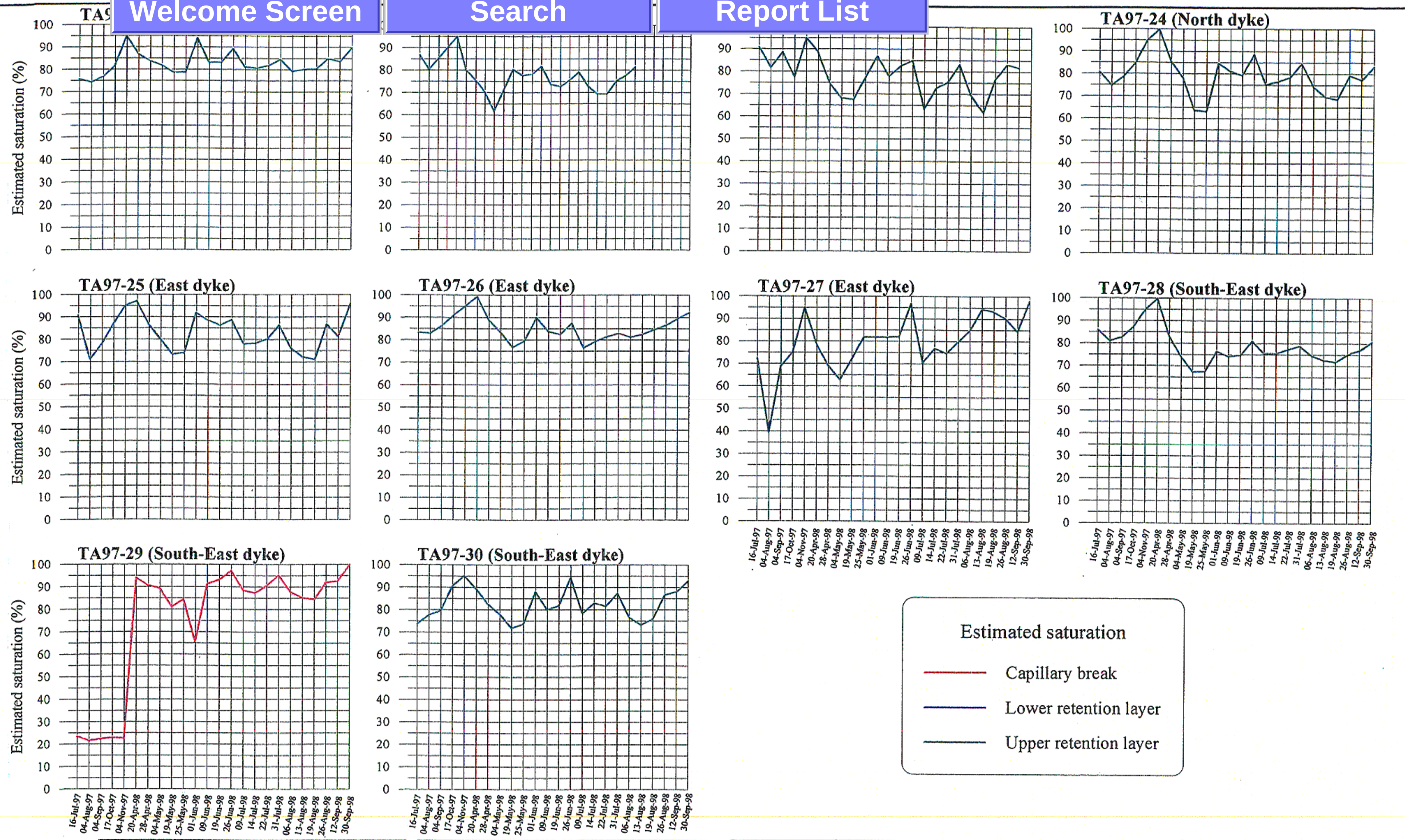
CANMET

Estimated saturation Phase B stations
(TA97-11 to TA97-20 West and North dykes)

FIGURE 16

Field performance of the LTA composite dry cover



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Date: 99-01-07	Échelle: -
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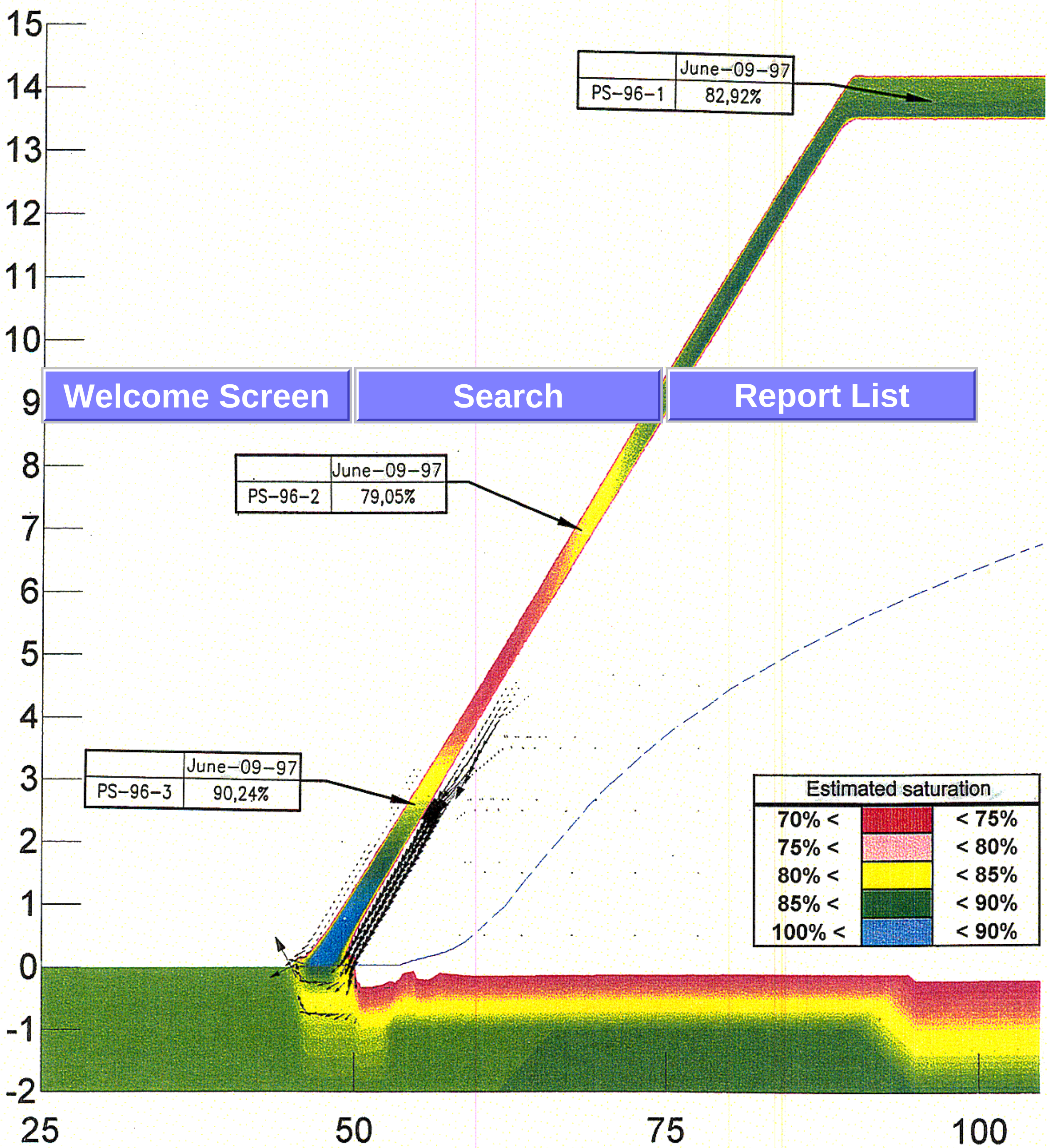
Vérifié par: J.F.R.	Approuvé par: P.G.
No. de dessin:	No. de projet: 971-7301

CANMET

Estimated saturation Phase B stations
(TA97-21 to TA97-30 North and East dykes)

FIGURE 17

Field performance of the LTA composite dry cover



Welcome Screen | Search | Report List

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Checked by: J.-F.R.	Approved by: P.G.		
Drawing no.: 9730118B	Project no.: 971-7301		

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FIELD PERFORMANCE OF THE LTA COMPOSITE COVER

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H9R 4Z7
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SOUTH DYKE MODEL CALIBRATION
(JUNE 1997)

FIGURE 18

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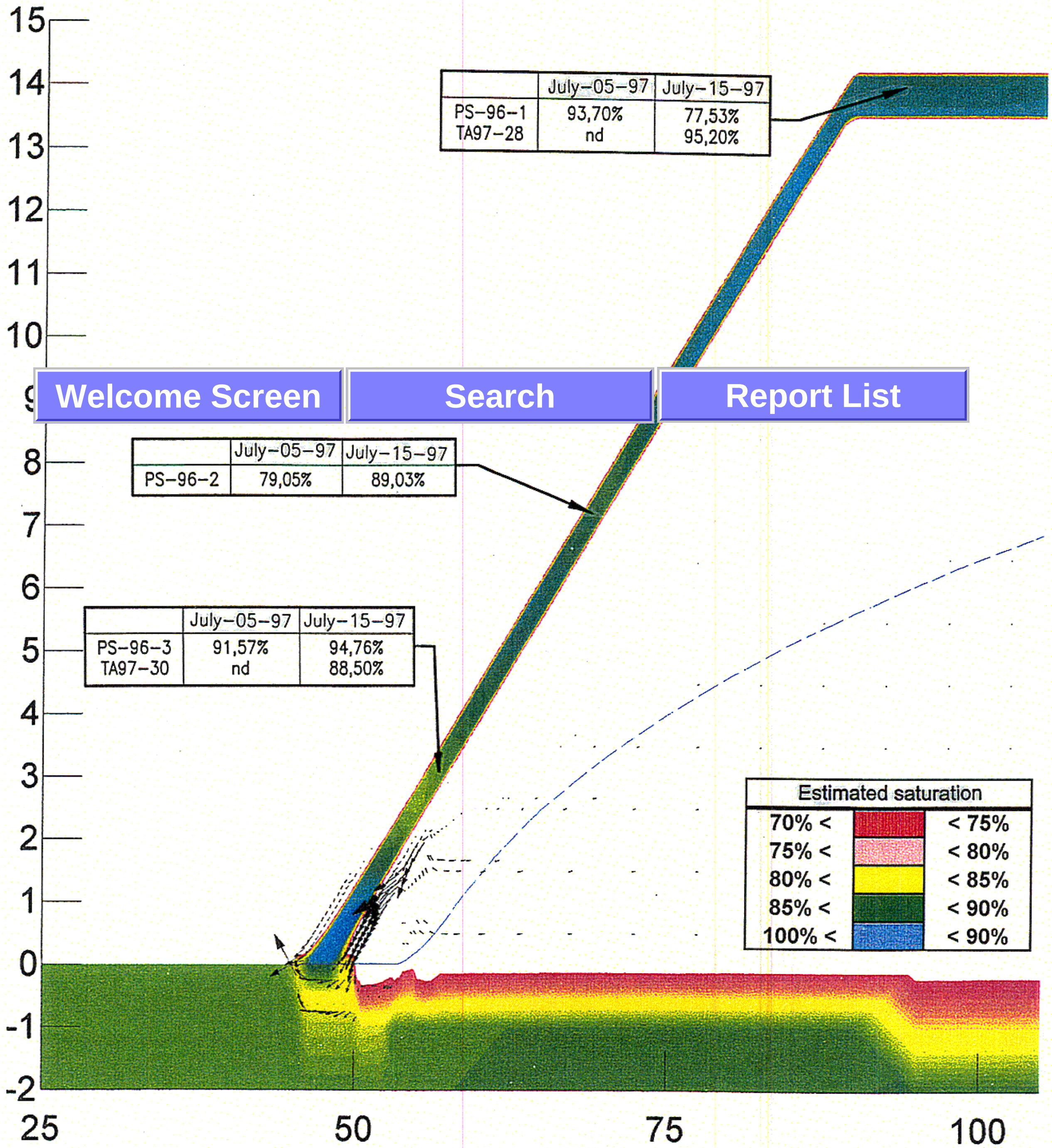

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Checked by:	*J.-F.R.*	Approved by:	*P.G.*
Drawing no.:	*9730119B*	Project no.:	*971-7301*

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FIELD PERFORMANCE OF THE LTA COMPOSITE COVER

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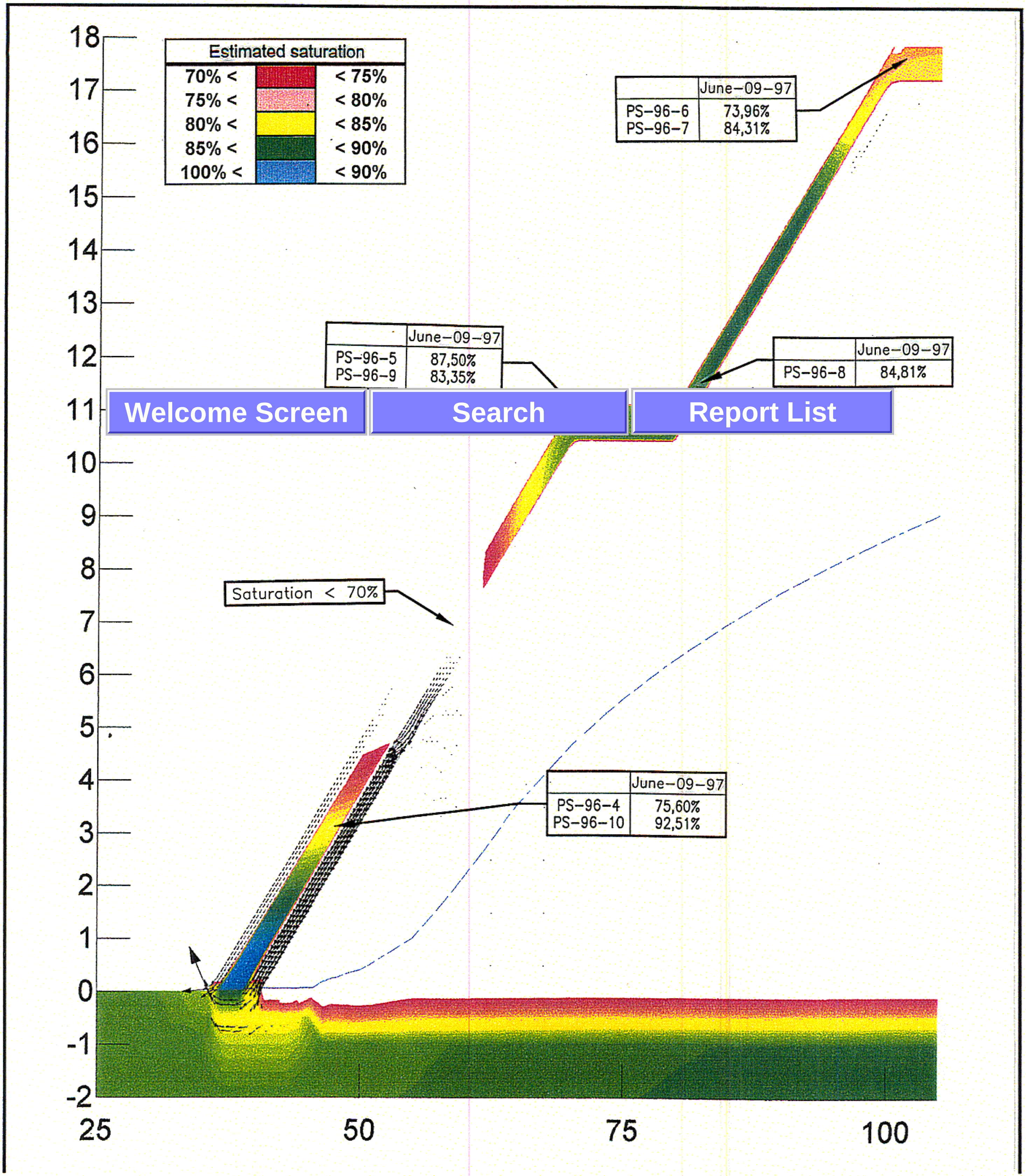
Tel.: (514) 630-0990 Fax: (514) 630-1178

SOUTH DYKE MODEL CALIBRATION
(JULY 1997)

FIGURE 19



Welcome Screen | Search | Report List

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Checked by:	J.−F.R.	Approved by:	P.G.
Drawing no.:	9730120B	Project no.:	971−7301

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FIELD PERFORMANCE OF THE LTA COMPOSITE DRY COVER

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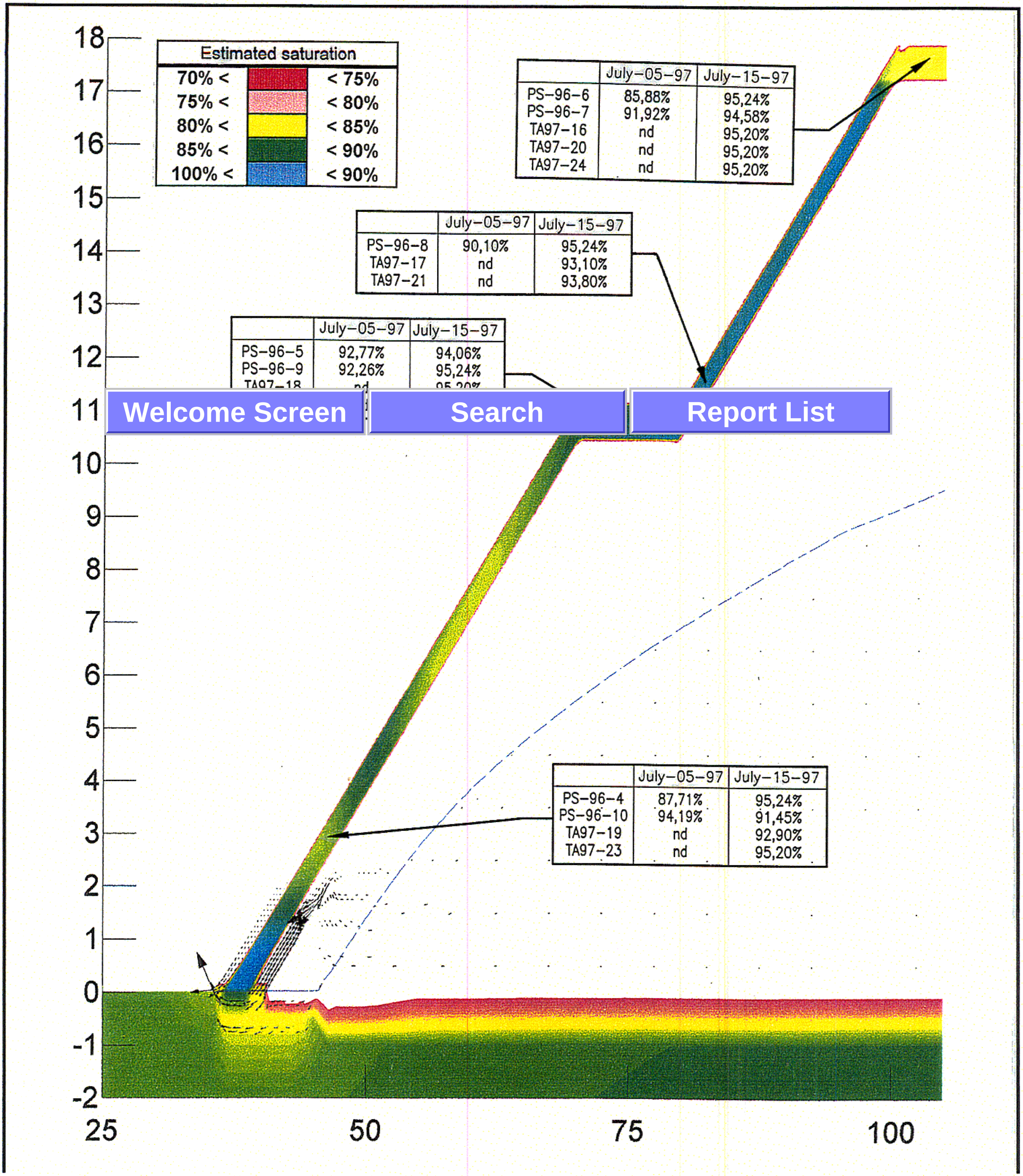
NORTH DYKE MODEL CALIBRATION
(JUNE 1997)

FIGURE 20

Welcome Screen | Search | Report List



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Checked by:	J.–F.R.	Approved by:	P.G.
Drawing no.:	9730121B	Project no.:	971–7301

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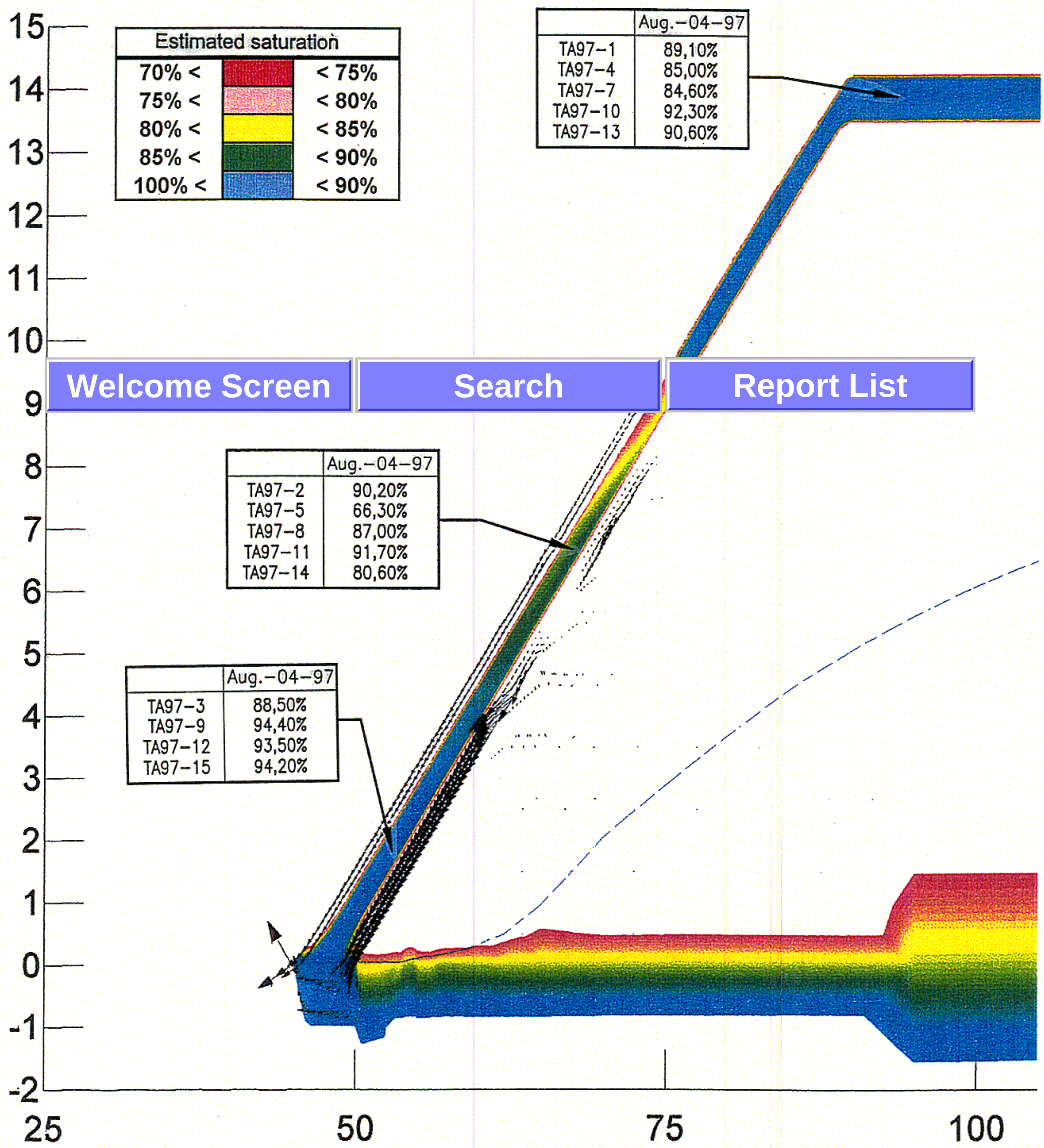
NORTH DYKE MODEL CALIBRATION
(JULY 1997)

FIGURE 21



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Checked by:	J.–F.R.	Approved by:	P.G.
Drawing no.:	9730122B	Project no.:	971–7301

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FIELD PERFORMANCE OF THE LTA COMPOSITE DRY COVER

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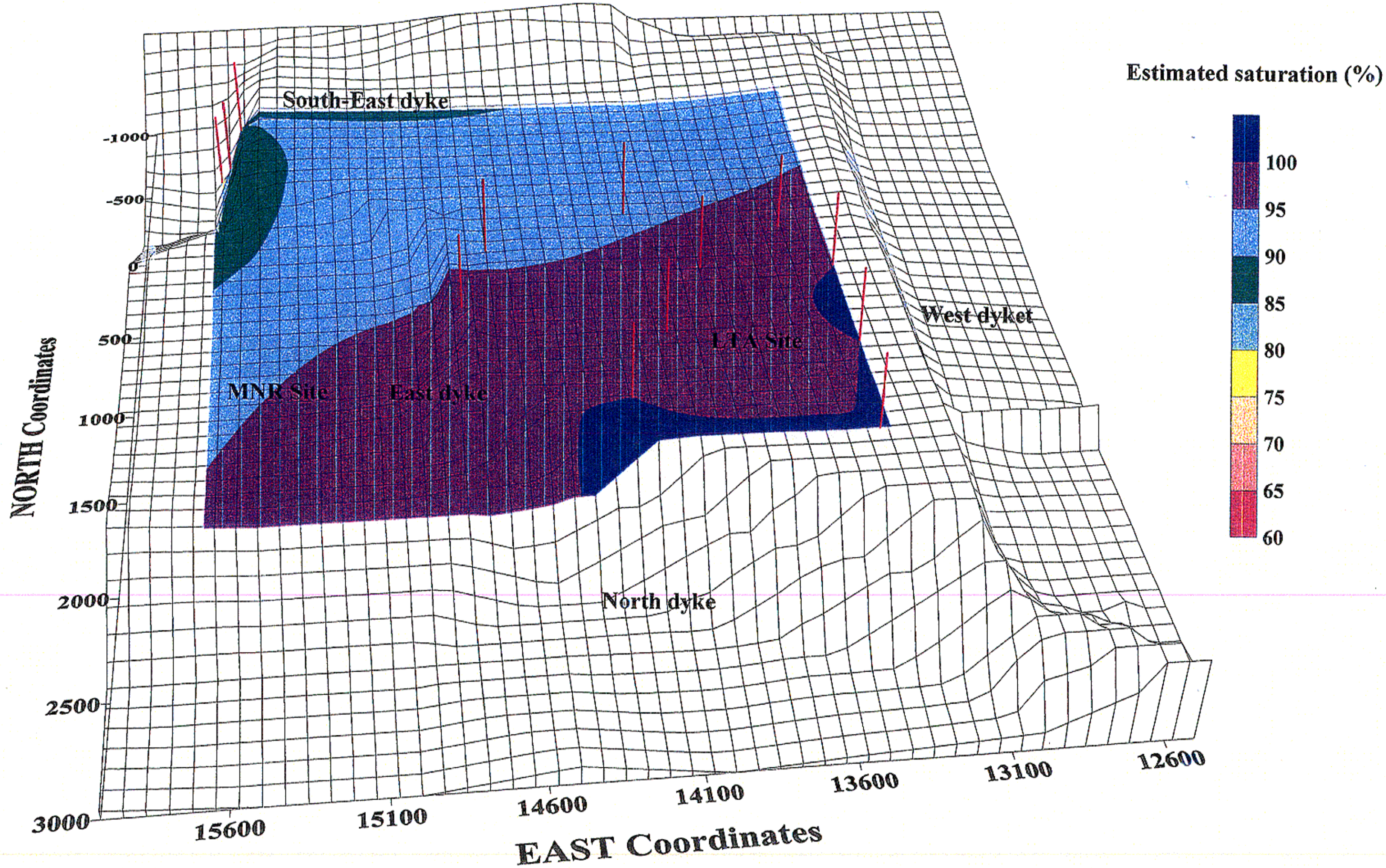
WEST DYKE MODEL CALIBRATION
(AUGUST 1997)

FIGURE 22



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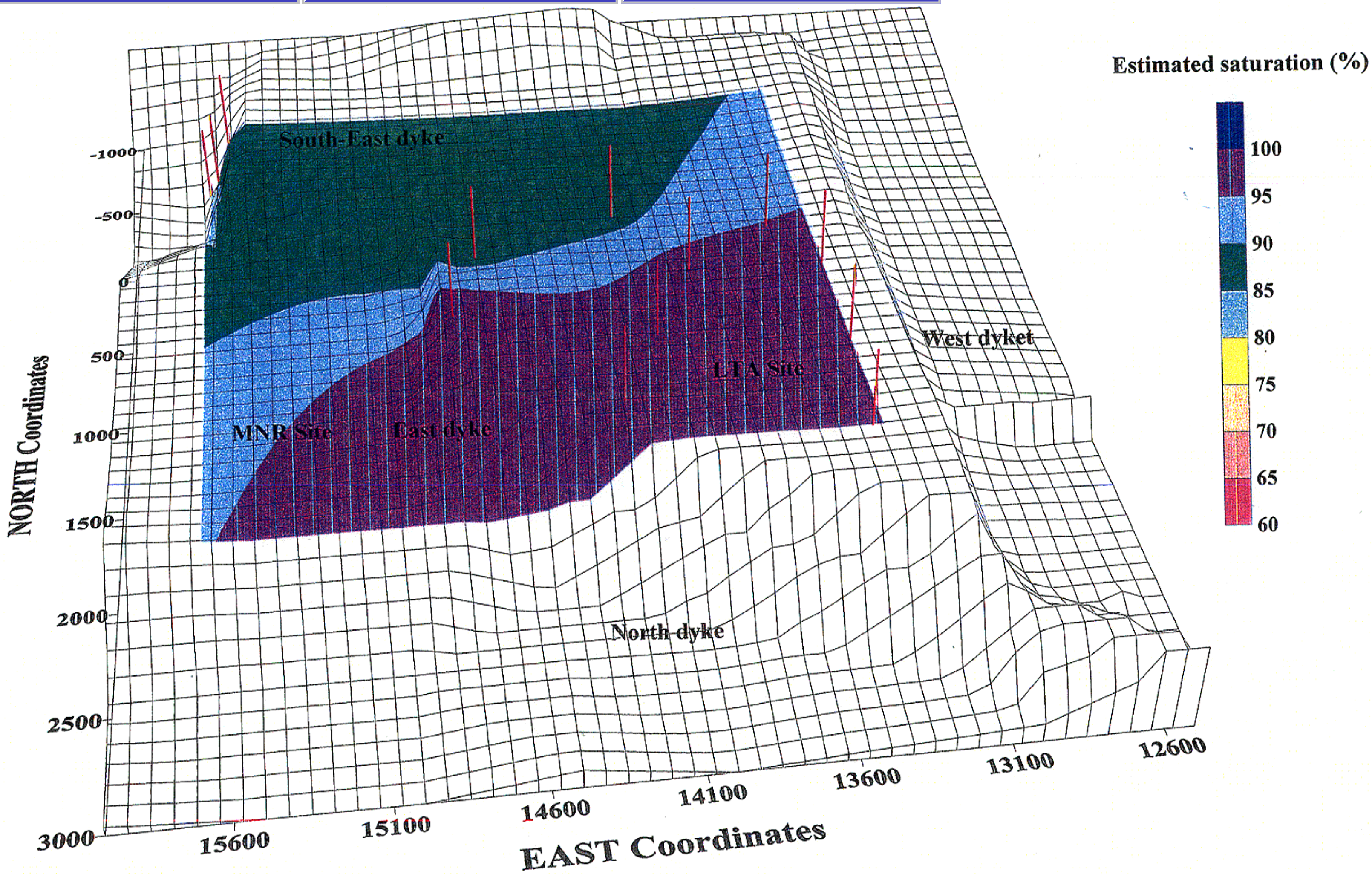

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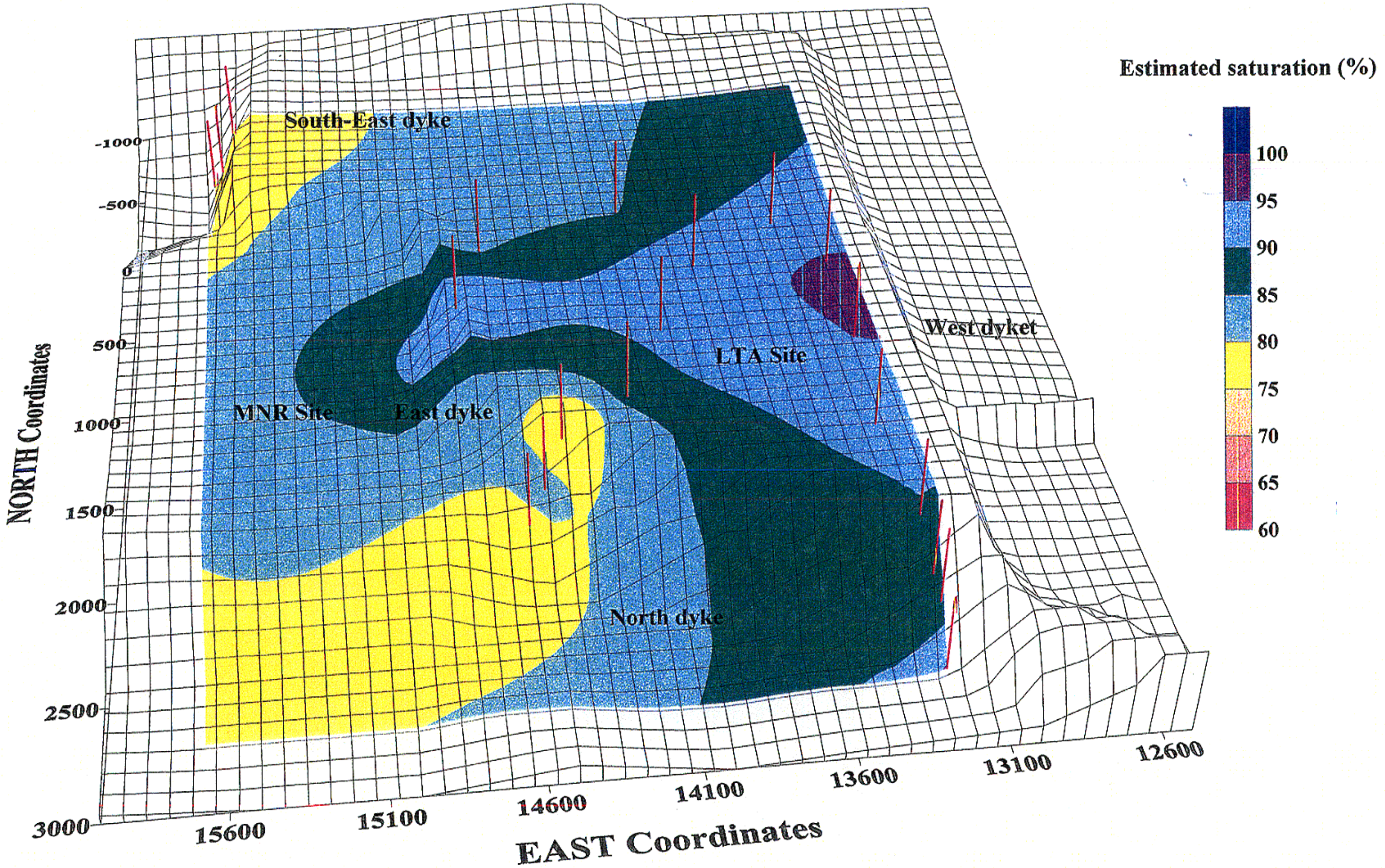
Vérifié par:	J.F.R.	Approuvé par:	P.G.
No. de dessin:		No. de projet:	971-7301

CANMET

Estimated saturation spatial layout
July 1996

FIGURE 24

Field performance of the LTA composite dry cover



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H9R 4Z7
Tél.: (514) 630-0990 Fax: (514) 630-1178

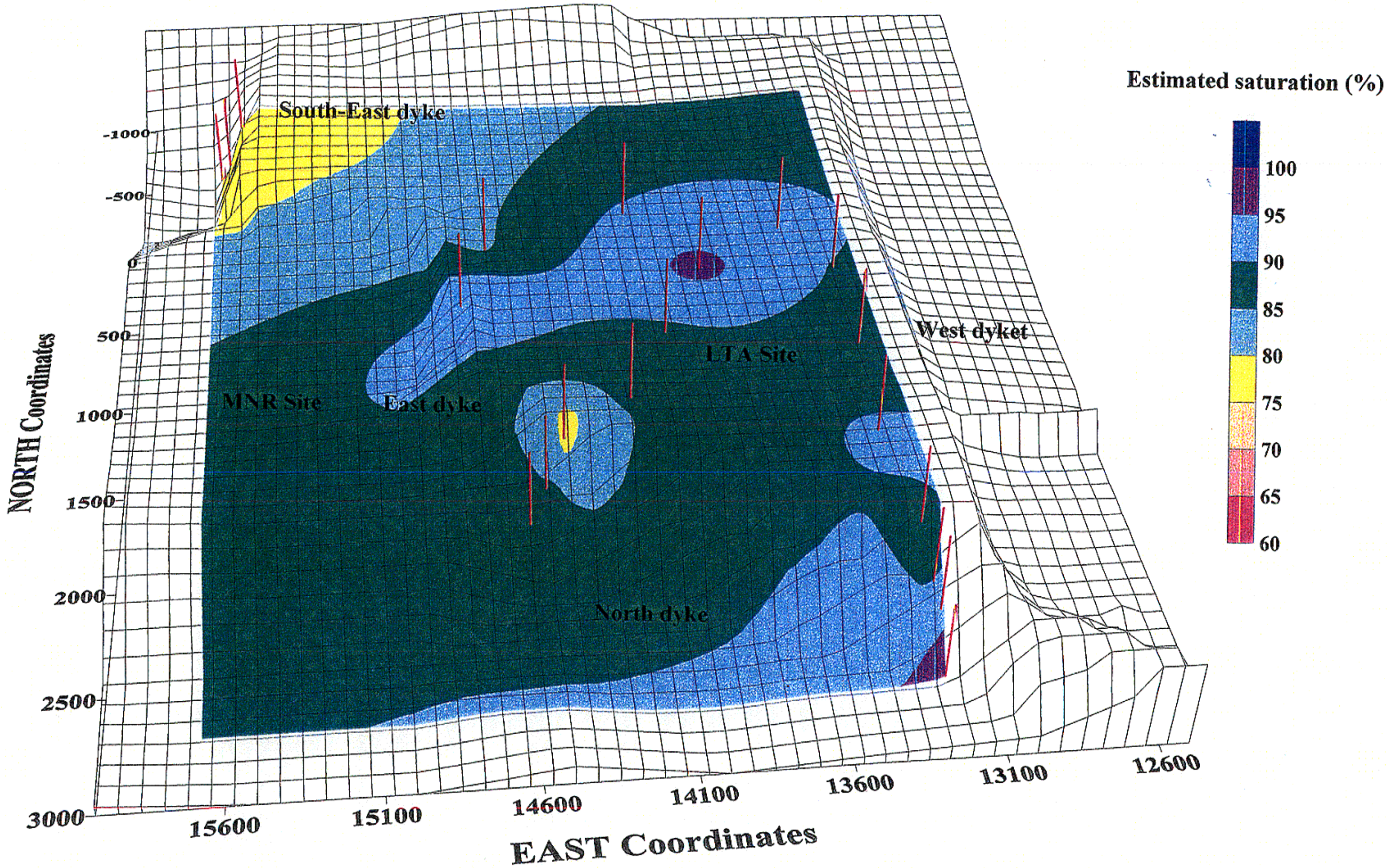
Date:	99-01-07	Échelle:	-
Dessiné par:	S.R./J.-F.R.	Projeté par:	J.F.R.
Vérifié par:	J.F.R.	Approuvé par:	P.G.
No. de dessin:		No. de projet:	971-7301

CANMET

Estimated saturation spatial layout
August 1996

FIGURE 25

Field performance of the LTA composite dry cover



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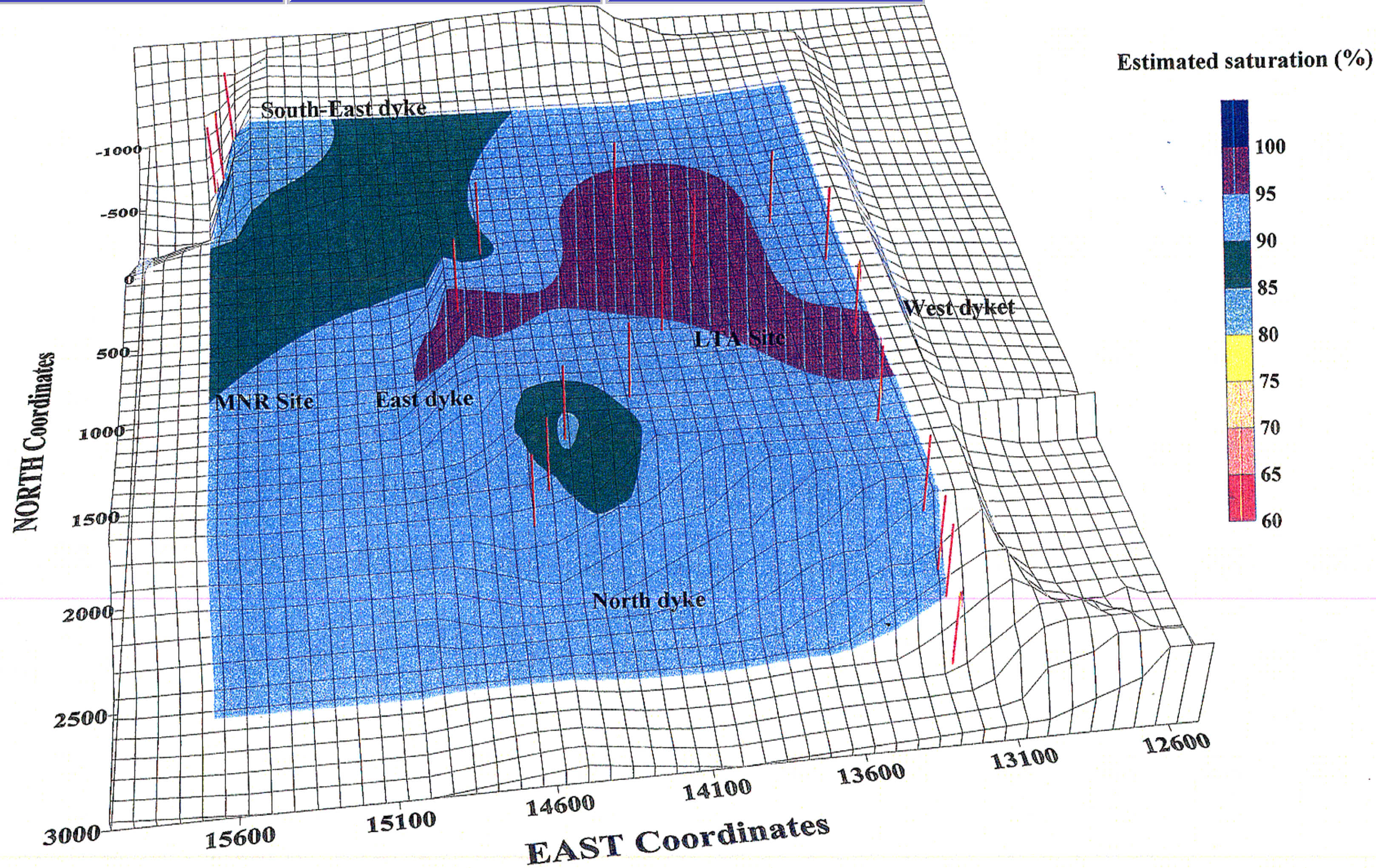
Date:	99-01-07	Échelle:	-
Dessiné par:	S.R./J.-F.R.	Projeté par:	J.F.R.
Vérifié par:	J.F.R.	Approuvé par:	P.G.
No. de dessin:		No. de projet:	971-7301

CANMET

Estimated saturation spatial layout
September 1996

FIGURE 26

Field performance of the LTA composite dry cover



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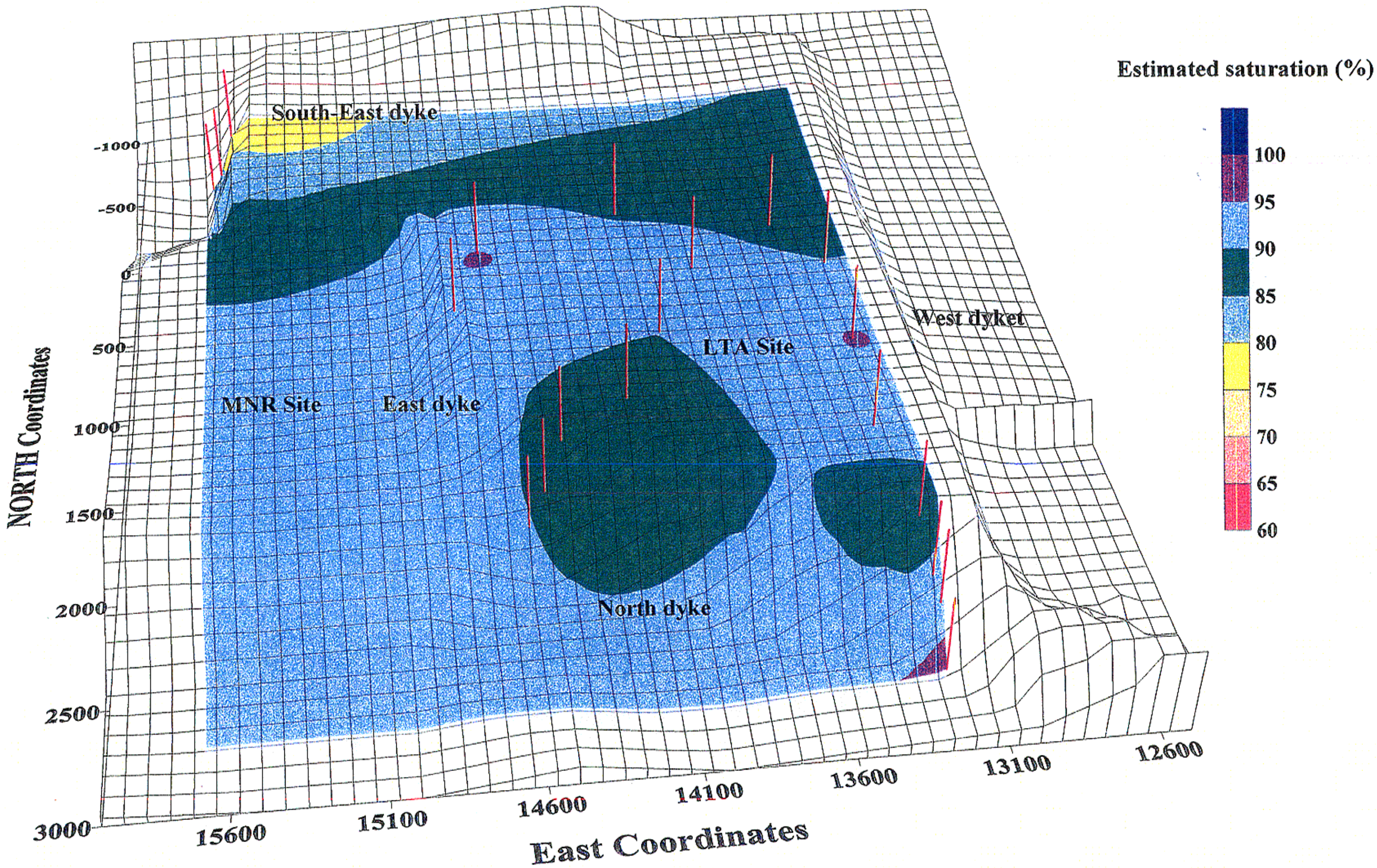
Date:	99-01-07	Échelle:	-
Dessiné par:	S.R./J.-F.R.	Projeté par:	J.F.R.
Vérifié par:	J.F.R.	Approuvé par:	P.G.
No. de dessin:		No. de projet:	971-7301

CANMET

Estimated saturation spatial layout
October 1996

FIGURE 27

Field performance of the LTA composite dry cover



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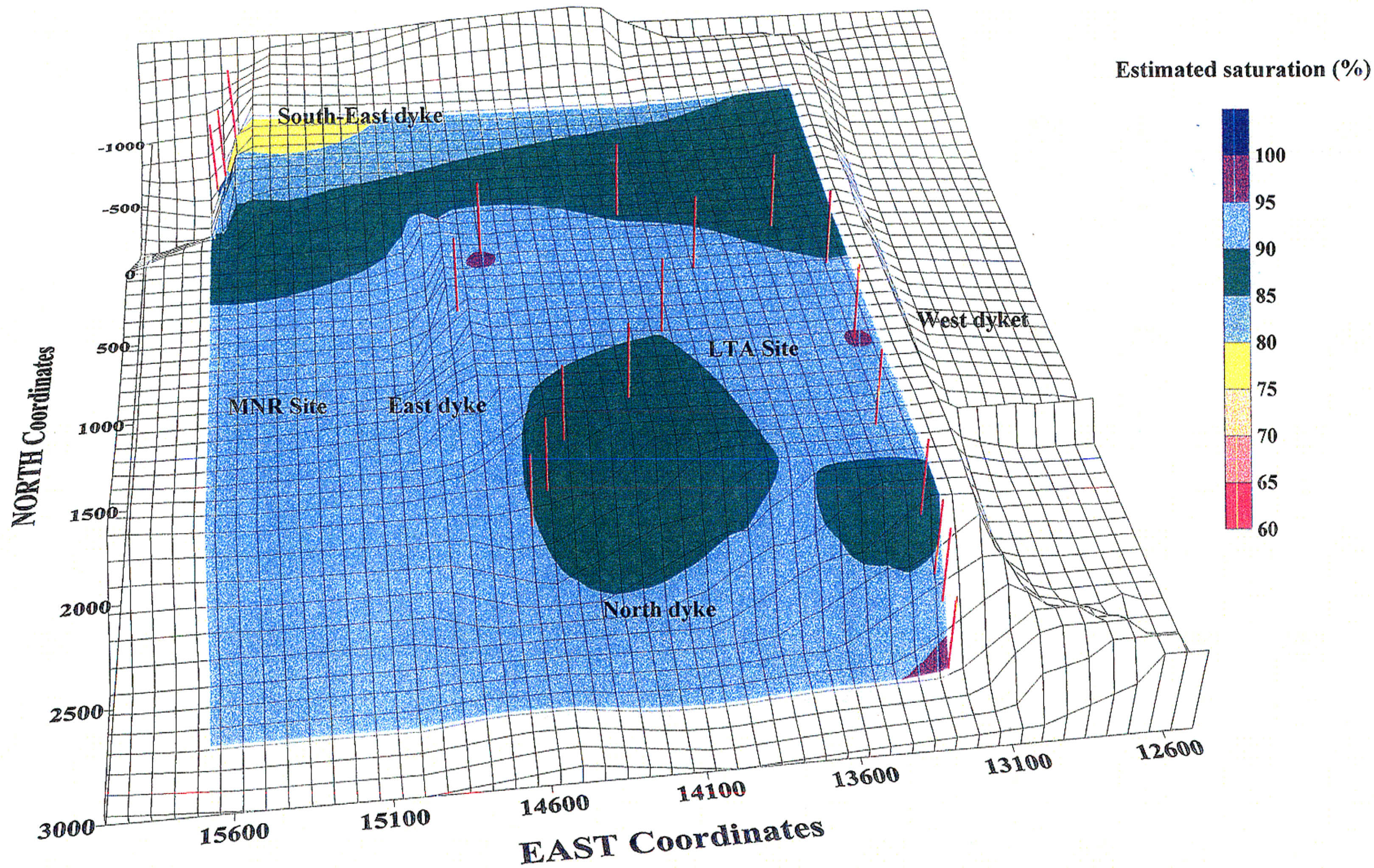
Date:	99-01-07	Échelle:	-
Dessiné par:	S.R./J.-F.R.	Projeté par:	J.F.R.
Vérifié par:	J.F.R.	Approuvé par:	P.G.
No. de dessin:		No. de projet:	971-7301

CANMET

Estimated saturation spatial layout
November 1996

FIGURE 28

Field performance of the LTA composite dry cover



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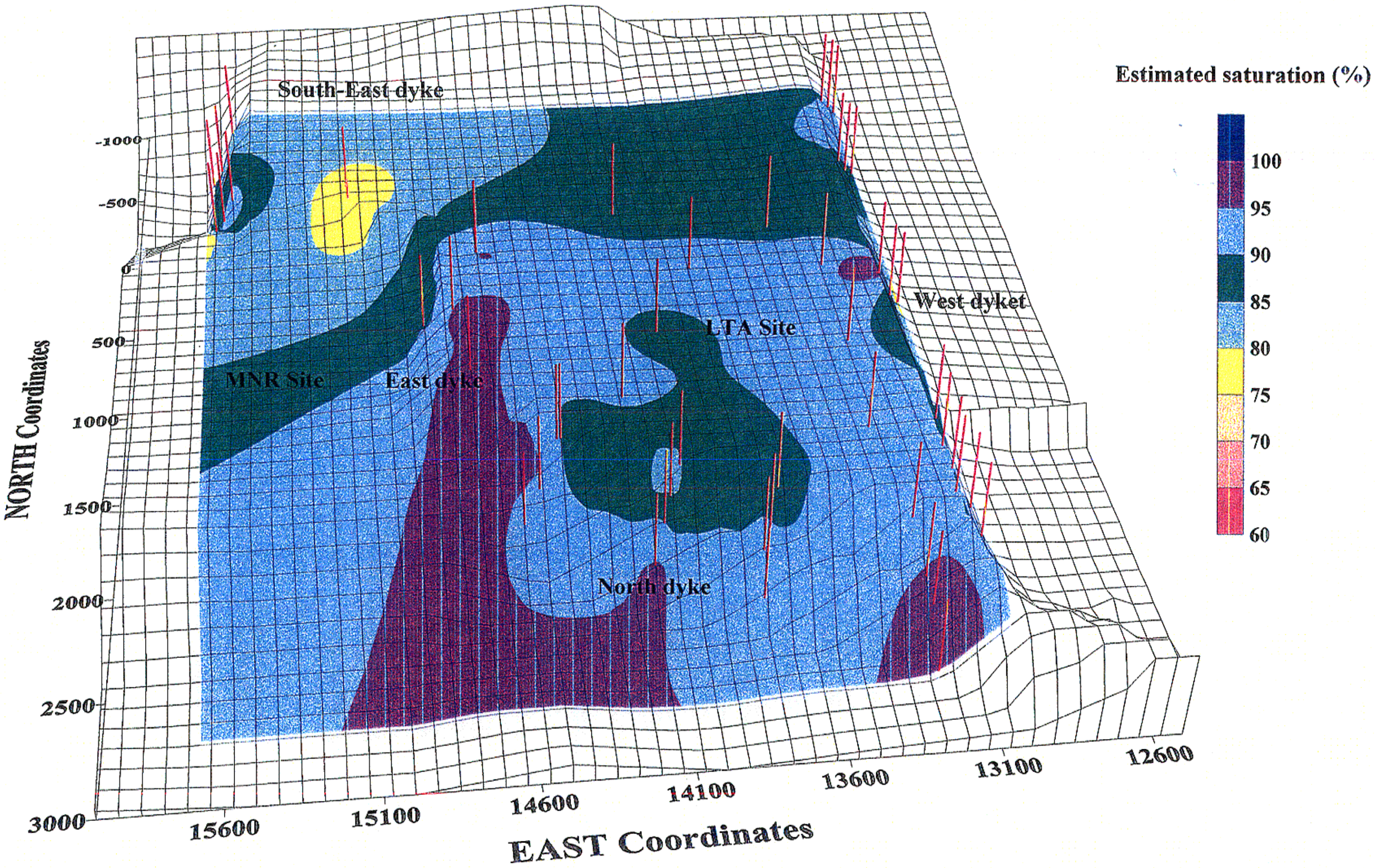
Date:	99-01-07	Échelle:	-
Dessiné par:	S.R./J.-F.R.	Projeté par:	J.F.R.
Vérifié par:	J.F.R.	Approuvé par:	P.G.
No. de dessin:		No. de projet:	971-7301

CANMET

Estimated saturation spatial layout
June 1997

FIGURE 29

Field performance of the LTA composite dry cover



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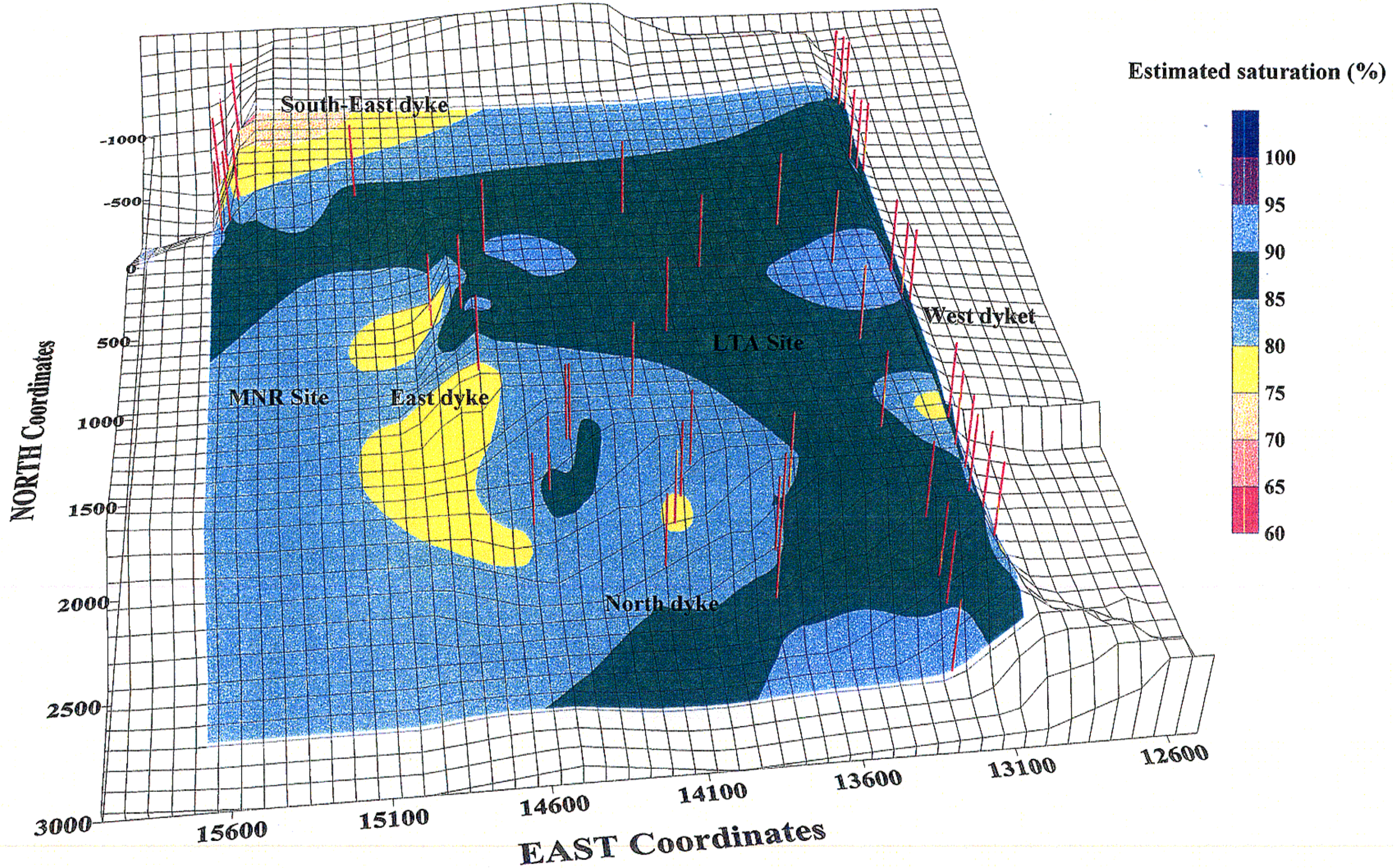
Date:	99-01-07	Échelle:	-
Dessiné par:	S.R./J.-F.R.	Projeté par:	J.F.R.
Vérifié par:	J.F.R.	Approuvé par:	P.G.
No. de dessin:		No. de projet:	971-7301

CANMET

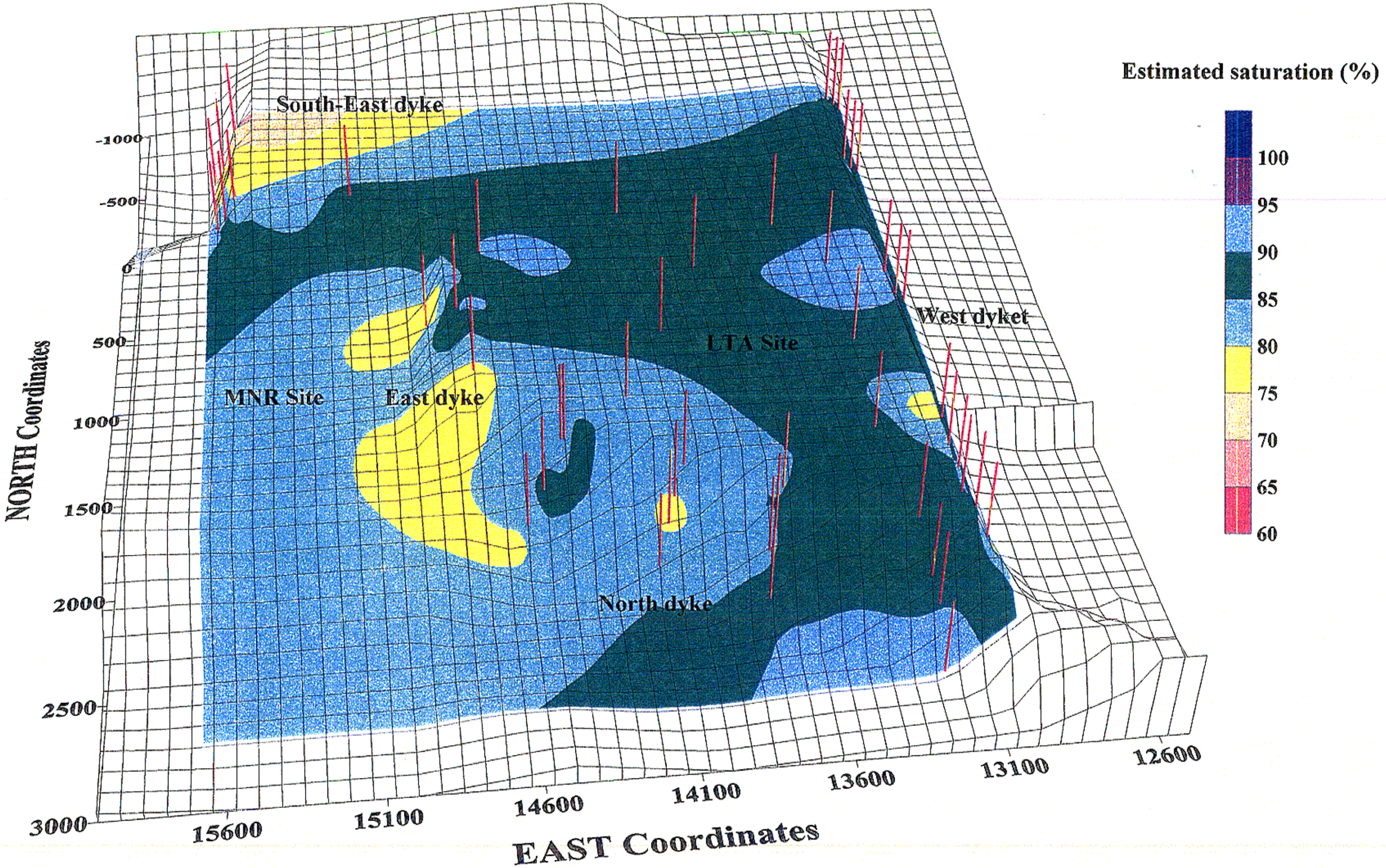
Estimated saturation spatial layout
July 1997

FIGURE 30

Field performance of the LTA composite dry cover



Golder Associés 63, Place Frontenac, Pointe-Claire, Qué. H9R 4Z7 Tél.: (514) 630-0990 Fax: (514) 630-1178	Date: 99-01-07; Échelle: -; Dessiné par: S.R./J.-F.R.; Projeté par: J.F.R.; Vérifié par: J.F.R.; Approuvé par: P.G.; No. de dessin: ; No. de projet: 971-7301	CANMET	Estimated saturation spatial layout August1997; FIGURE 31; *Field performance of the LTA composite dry cover*



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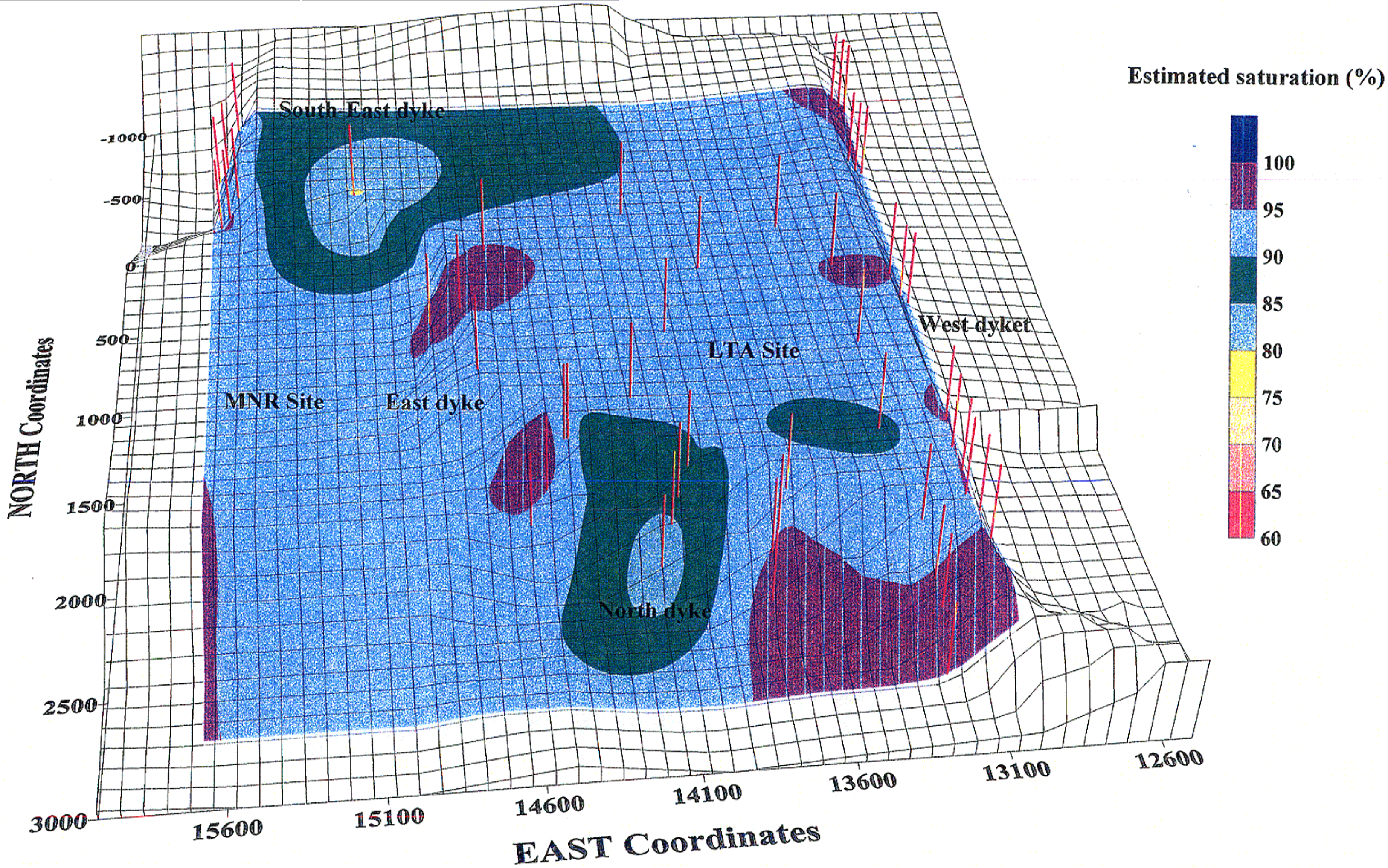
Date:	99-01-07	Échelle:	-
Dessiné par:	S.R./J.-F.R.	Projeté par:	J.F.R.
Vérifié par:	J.F.R.	Approuvé par:	P.G.
No. de dessin:		No. de projet:	971-7301

CANMET

Estimated saturation spatial layout
August1997

FIGURE 31

Field performance of the LTA composite dry cover



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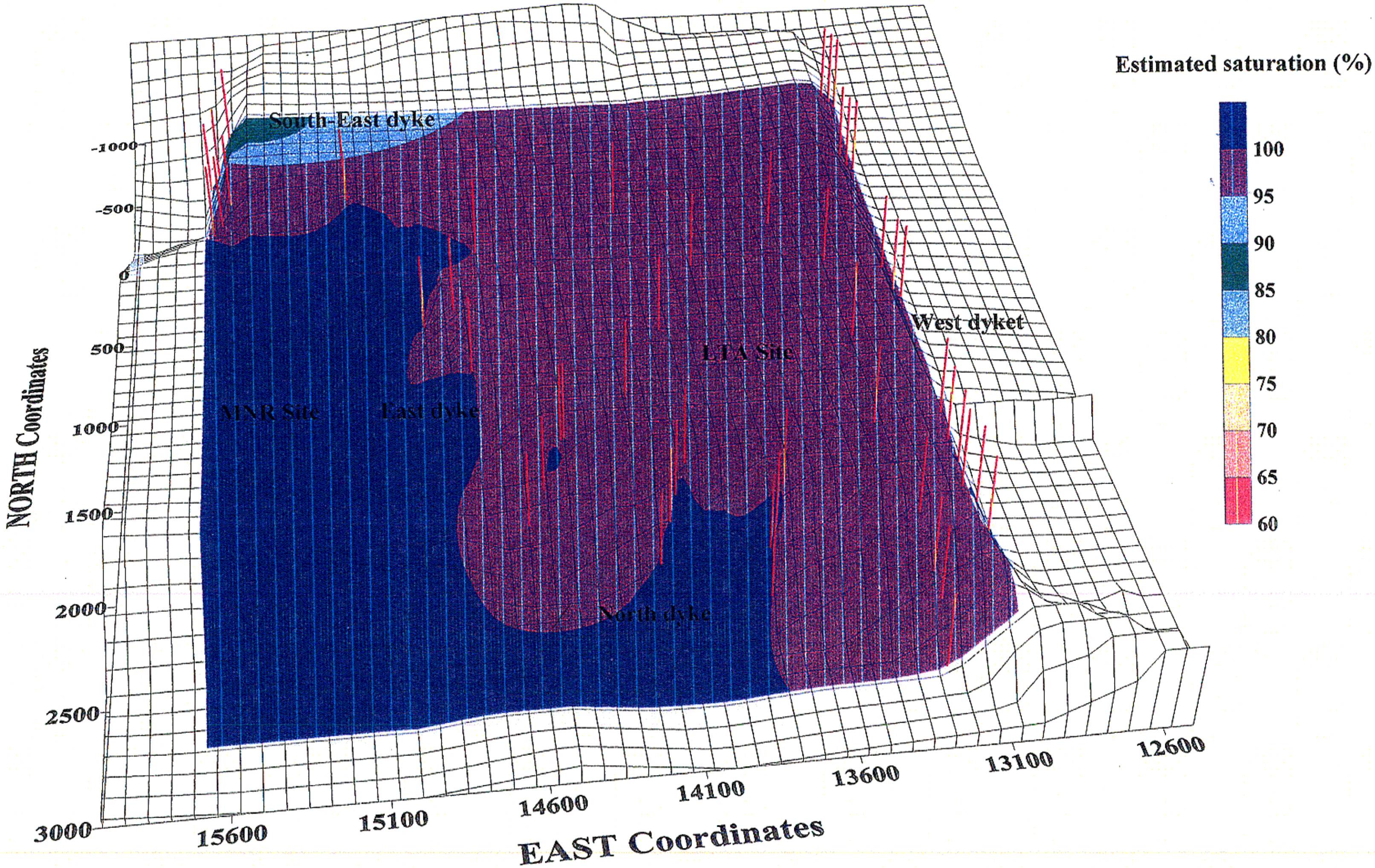
Date:	99-01-07	Échelle:	-
Dessiné par:	S.R./J.-F.R.	Projeté par:	J.F.R.
Vérifié par:	J.F.R.	Approuvé par:	P.G.
No. de dessin:		No. de projet:	971-7301

CANMET

Estimated saturation spatial layout
October 1997

FIGURE 32

Field performance of the LTA composite dry cover



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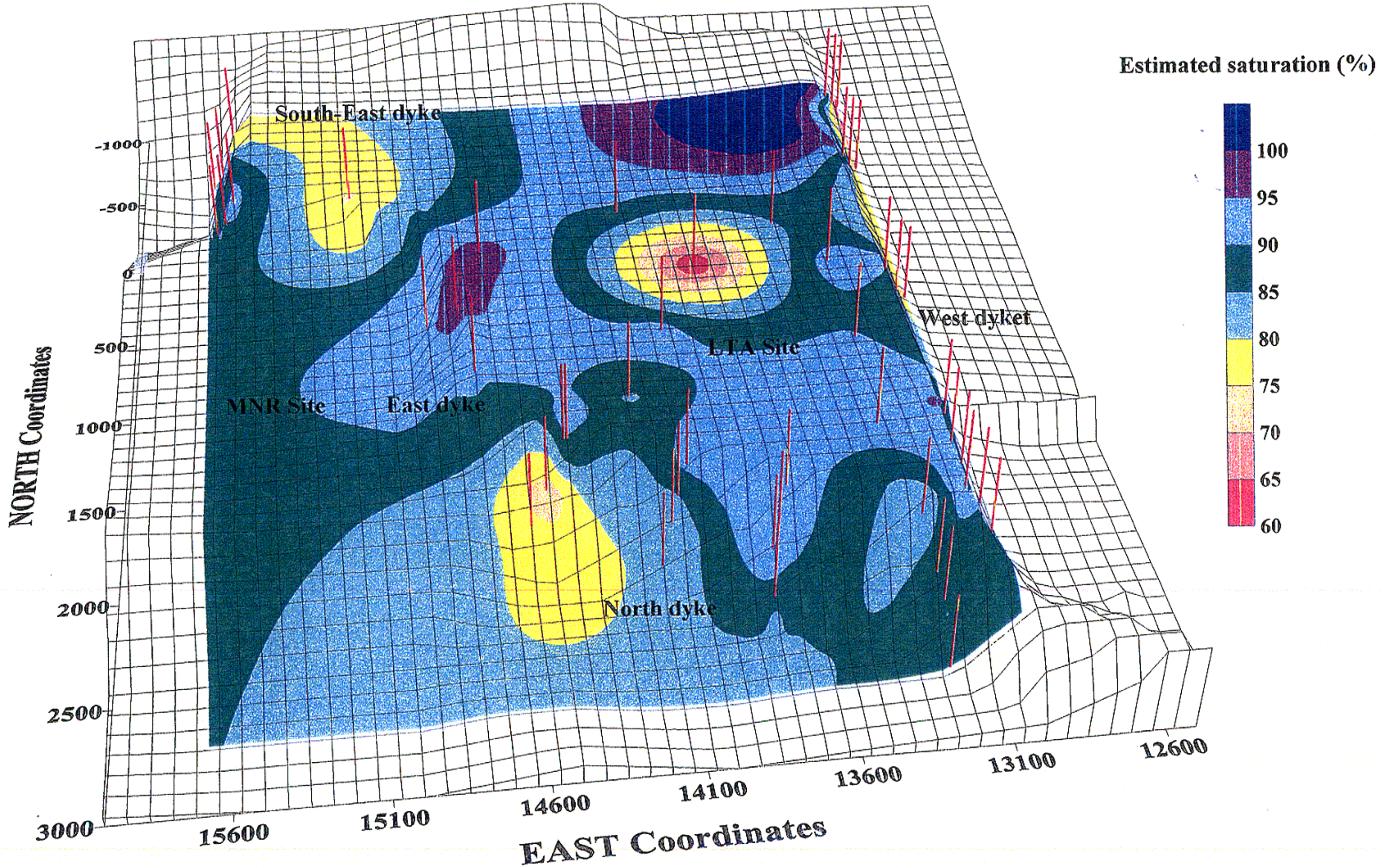
Date: 99-01-07	Échelle: -
Dessiné par: S.R./J.-F.R.	Projeté par: J.F.R.
Vérifié par: J.F.R.	Approuvé par: P.G.
No. de dessin:	No. de projet: 971-7301

CANMET

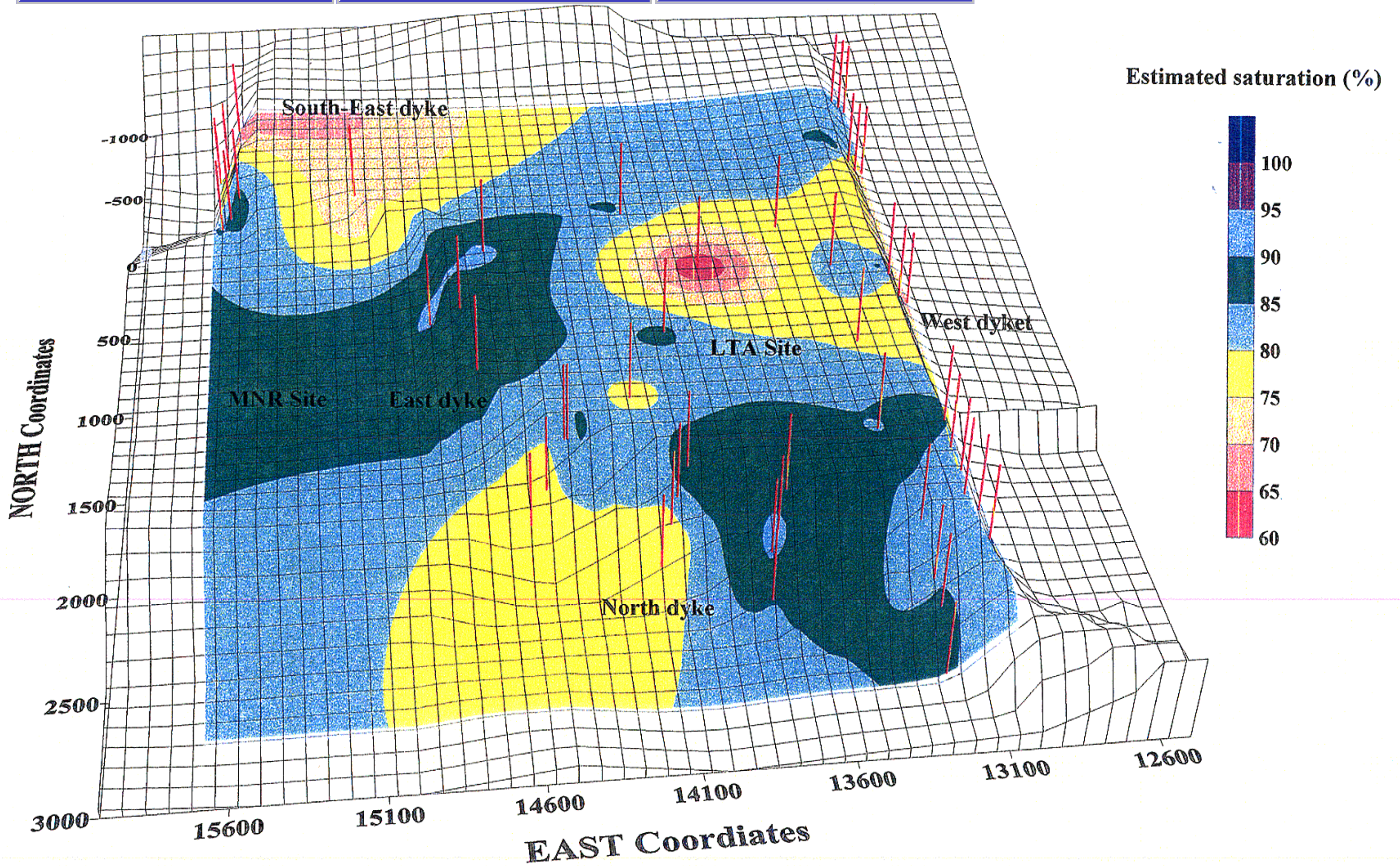
Estimated saturation spatial layout
November 1997

FIGURE 33

Field performance of the LTA composite dry cover



Golder Associés 63, Place Frontenac, Pointe-Claire, Qué. H9R 4Z7 Tél.: (514) 630-0990 Fax: (514) 630-1178	Date: 99-01-07 Dessiné par: S.R./J.-F.R. Vérifié par: J.F.R. No. de dessin:	Échelle: - Projeté par: J.F.R. Approuvé par: P.G. No. de projet: 971-7301	CANMET	Estimated saturation spatial layout April 1998 *Field performance of the LTA composite dry cover*	FIGURE 34



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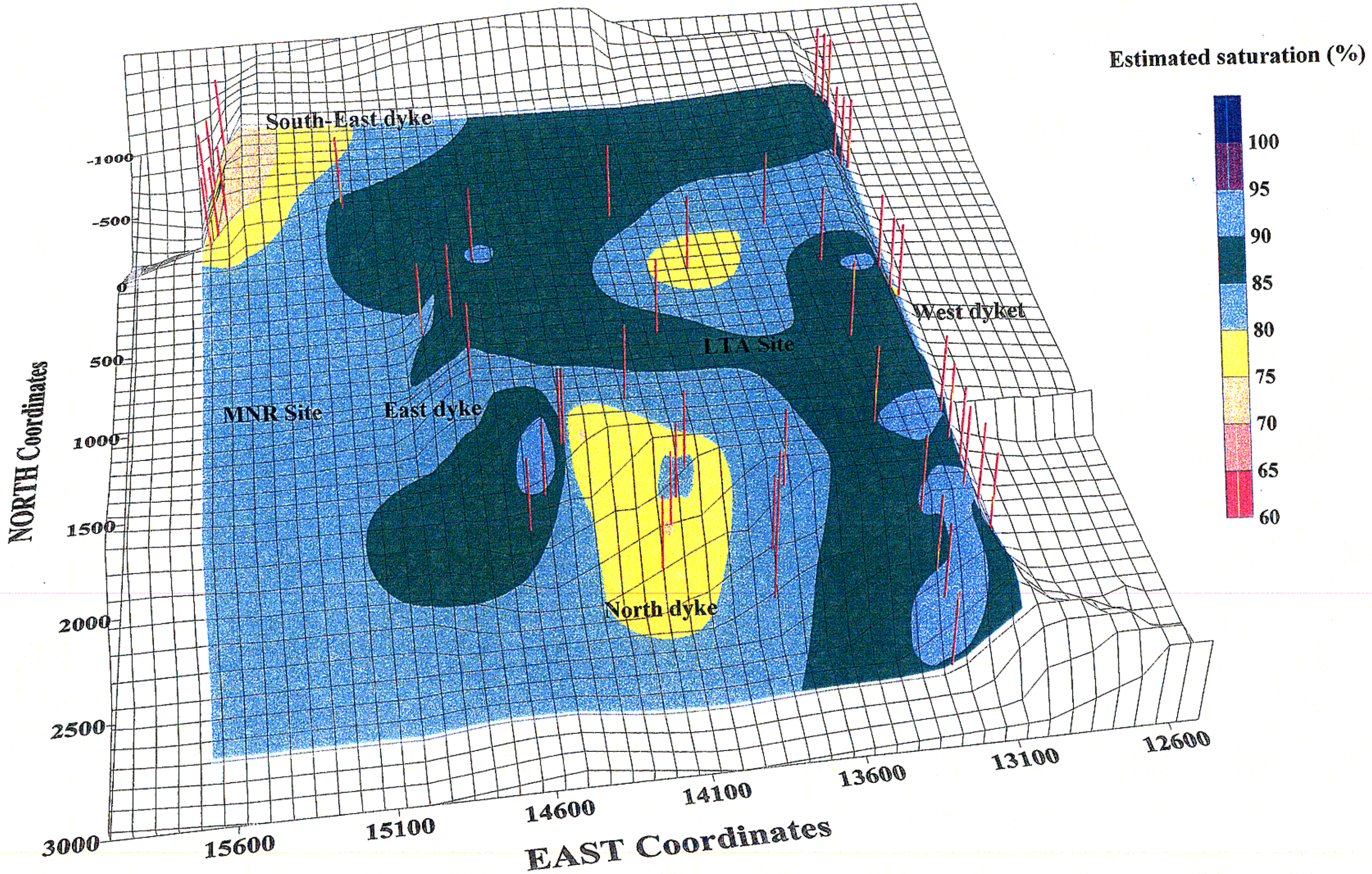
Date:	99-01-07	Échelle:	-
Dessiné par:	S.R./J.-F.R.	Projeté par:	J.F.R.
Vérifié par:	J.F.R.	Approuvé par:	P.G.
No. de dessin:		No. de projet:	971-7301

CANMET

Estimated saturation spatial layout
May 1998

FIGURE 35

Field performance of the LTA composite dry cover



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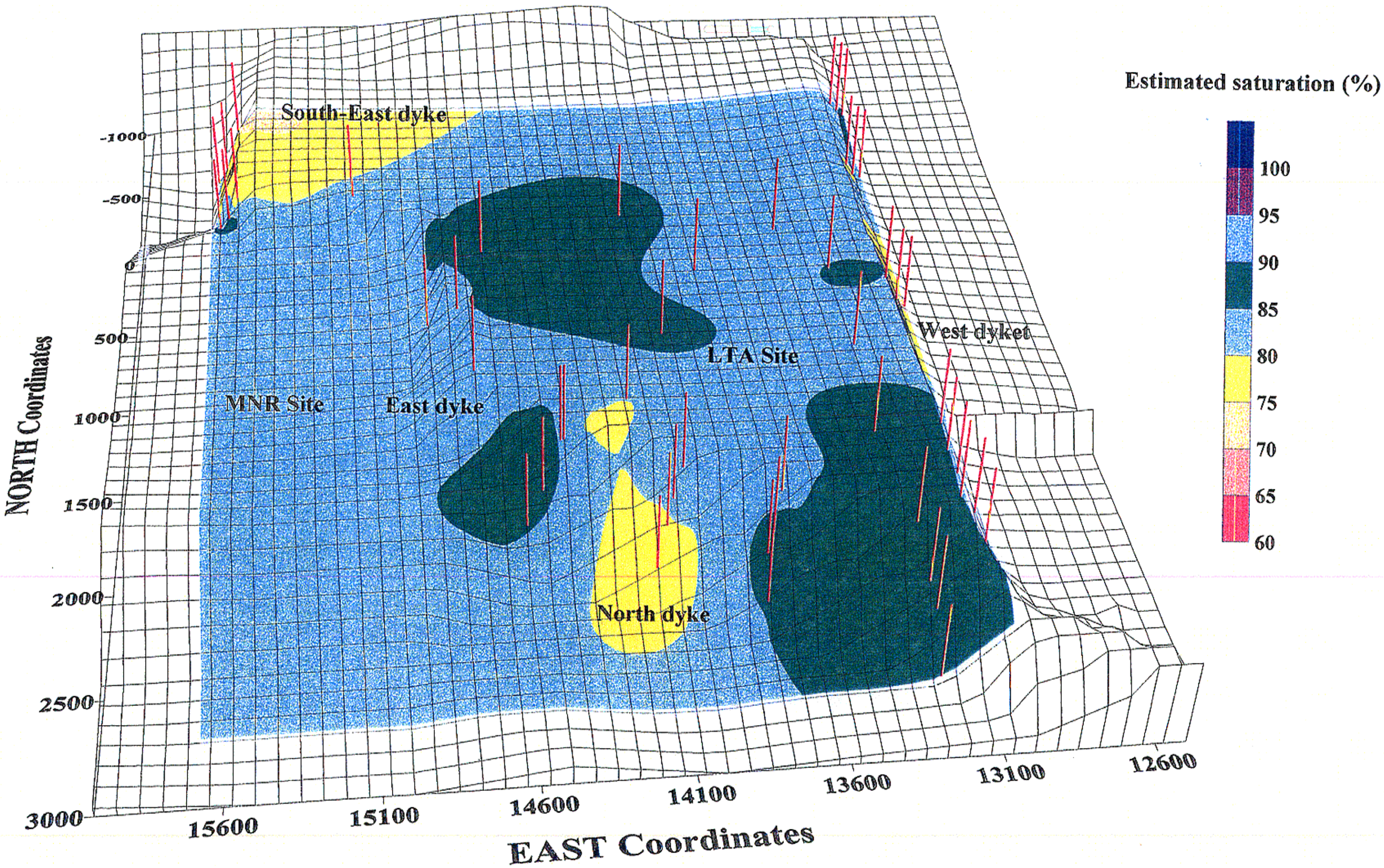
Date:	99-01-07	Échelle:	-
Dessiné par:	S.R./J.-F.R.	Projeté par:	J.F.R.
Vérifié par:	J.F.R.	Approuvé par:	P.G.
No. de dessin:		No. de projet:	971-7301

CANMET

Estimated saturation spatial layout
June 1998

FIGURE 36

Field performance of the LTA composite dry cover



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Date:	99-01-07	Échelle:	-
Dessiné par:	S.R./J.-F.R.	Projeté par:	J.F.R.
Vérifié par:	J.F.R.	Approuvé par:	P.G.
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CANMET

Estimated saturation spatial layout
July 1998

FIGURE 37

Field performance of the LTA composite dry cover

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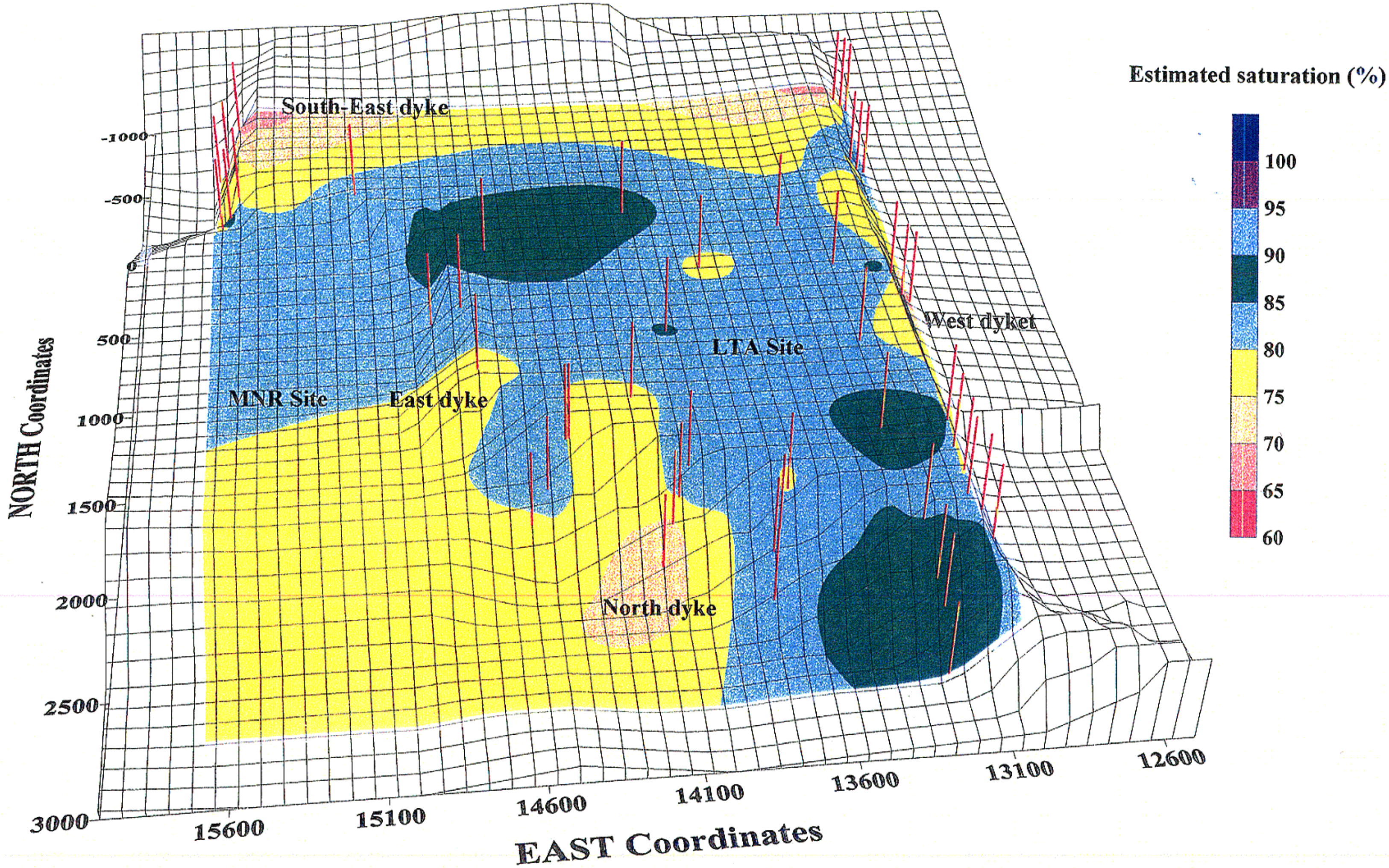

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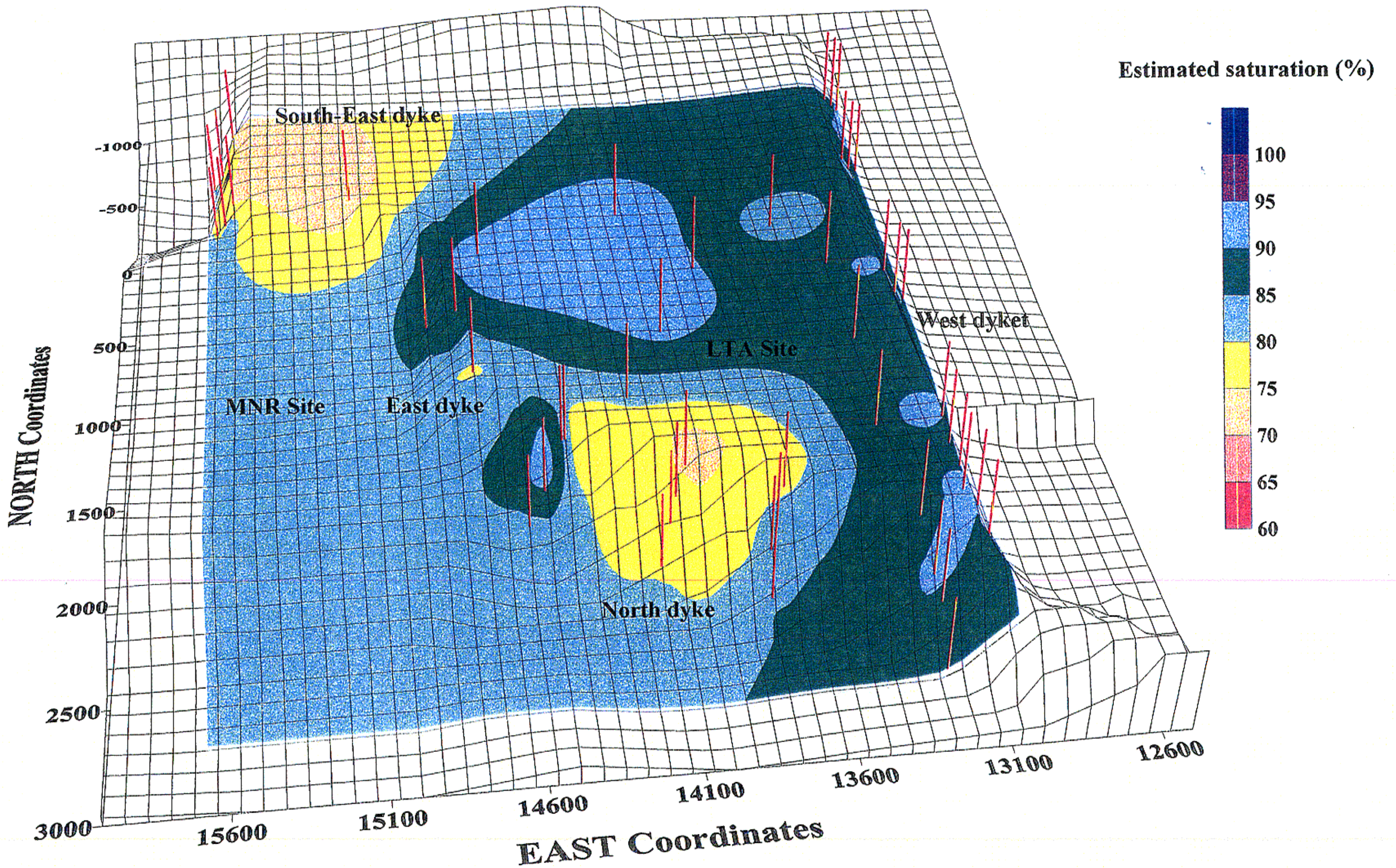
Date:	99-01-07	Échelle:	-
Dessiné par:	S.R./J.-F.R.	Projeté par:	J.F.R.
Vérifié par:	J.F.R.	Approuvé par:	P.G.
No. de dessin:		No. de projet:	971-7301

CANMET

Estimated saturation spatial layout
August 1998

FIGURE 38

Field performance of the LTA composite dry cover



Golder Associés 63, Place Frontenac, Pointe-Claire, Qué. H9R 4Z7 Tél.: (514) 630-0990 Fax: (514) 630-1178	Date: 99-01-07	Échelle: -	CANMET	Estimated saturation spatial layout September 1998 — FIGURE 39
	Dessiné par: S.R./J.-F.R.	Projeté par: J.F.R.		
	Vérifié par: J.F.R.	Approuvé par: P.G.		
	No. de dessin:	No. de projet: 971-7301		*Field performance of the LTA composite dry cover*

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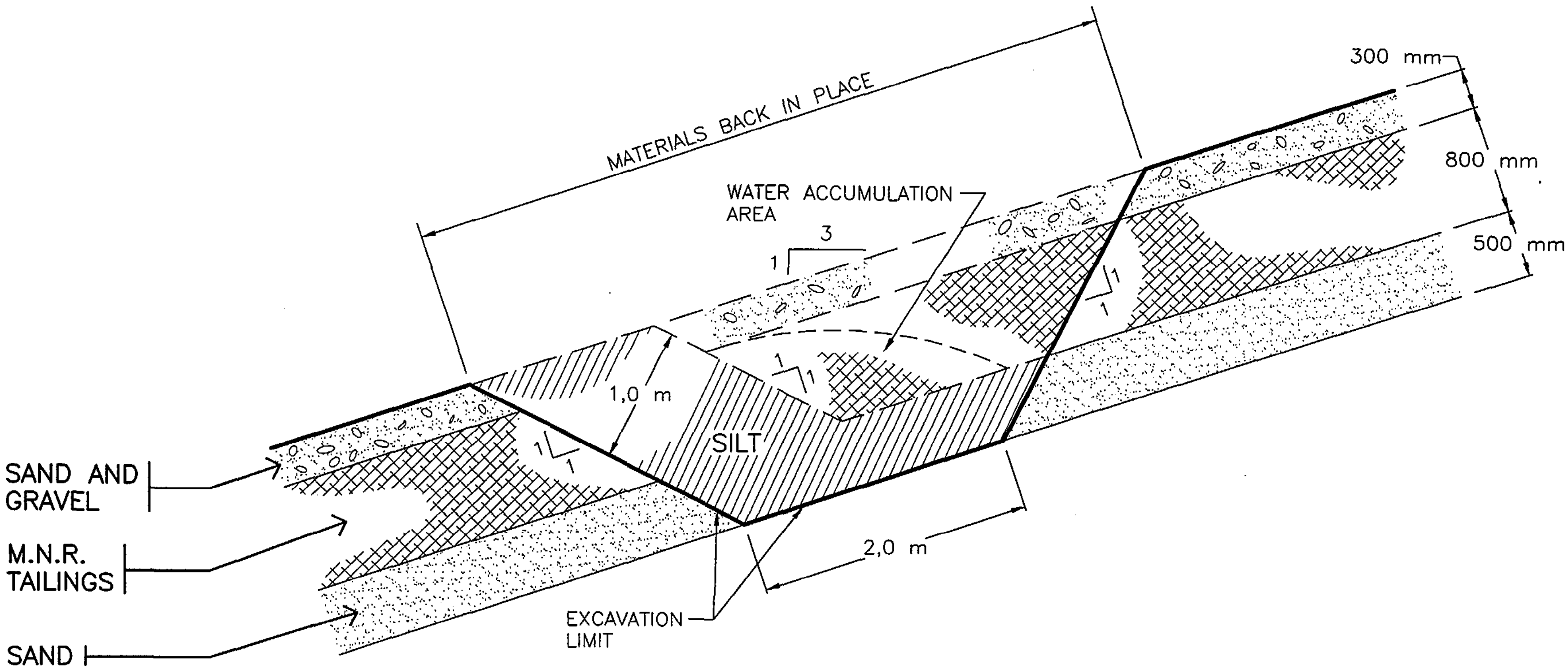

Date:	99–03–12	Scale:	1:50
Drawn by:	M.T.	Planned by:	J.–F.R.
Checked by:	J.–F.R.	Approved by:	P.G.
Drawing no.:	9730140D	Project no.:	971–7301

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FIELD PERFORMANCE OF THE LTA COMPOSITE DRY COVER

Golder Associés
63, Place Frontenac, Pointe–Claire, Qué.
H9R 4Z7
Tel.: (514) 630–0990 Fax: (514) 630–1178

CONSTRUCTION OF A HYDRAULIC BREAK

FIGURE 40

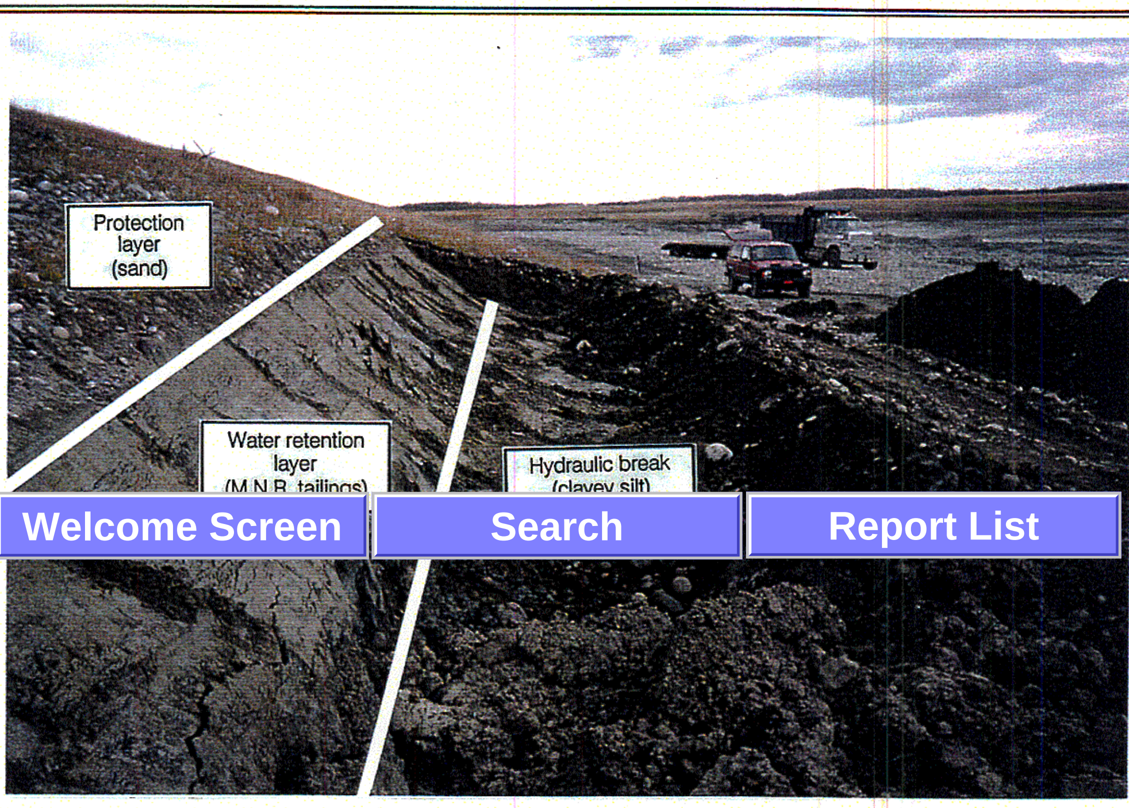

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Figure 41: Test cell excavation.

Figure 42: Hydraulic break construction.

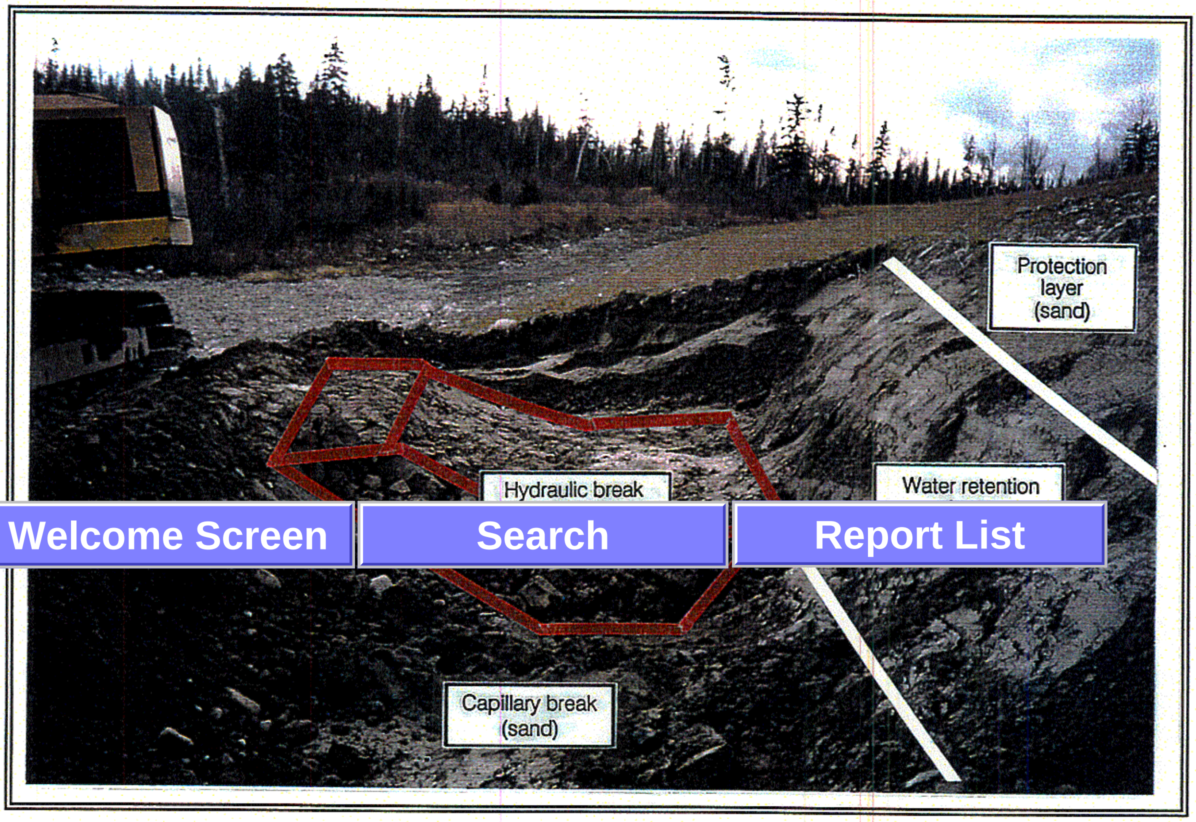


Figure 43: View of hydraulic break.

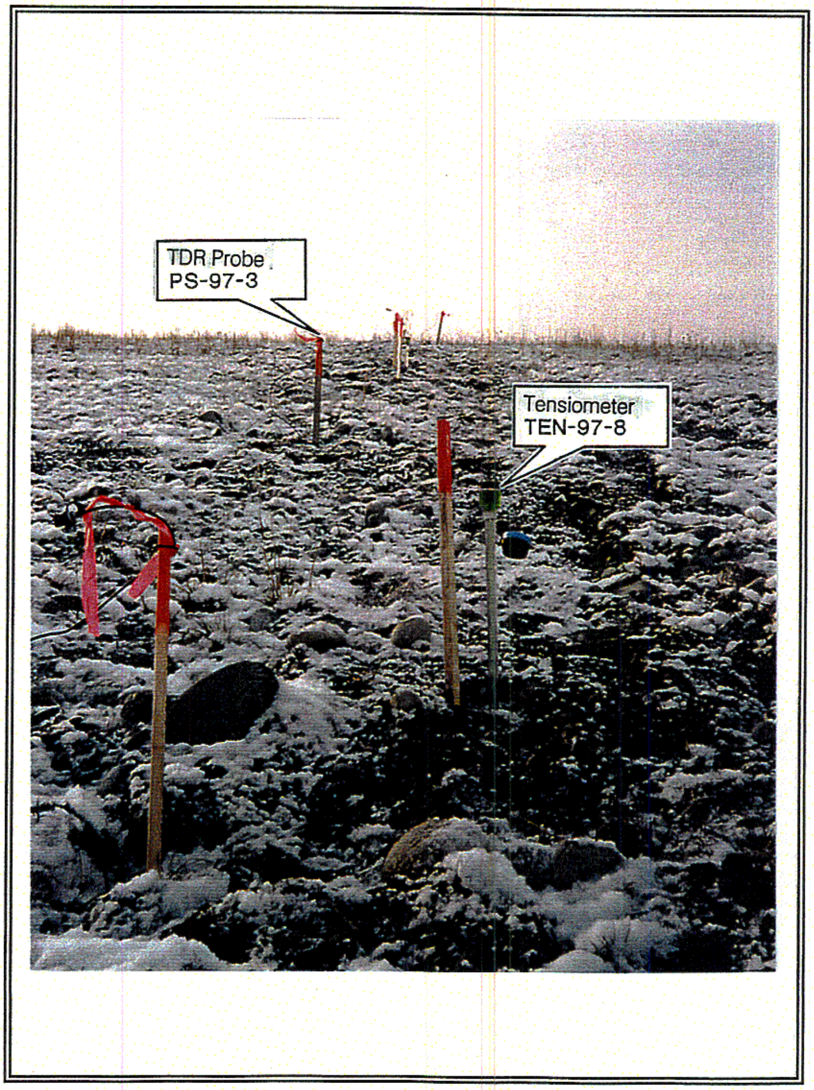
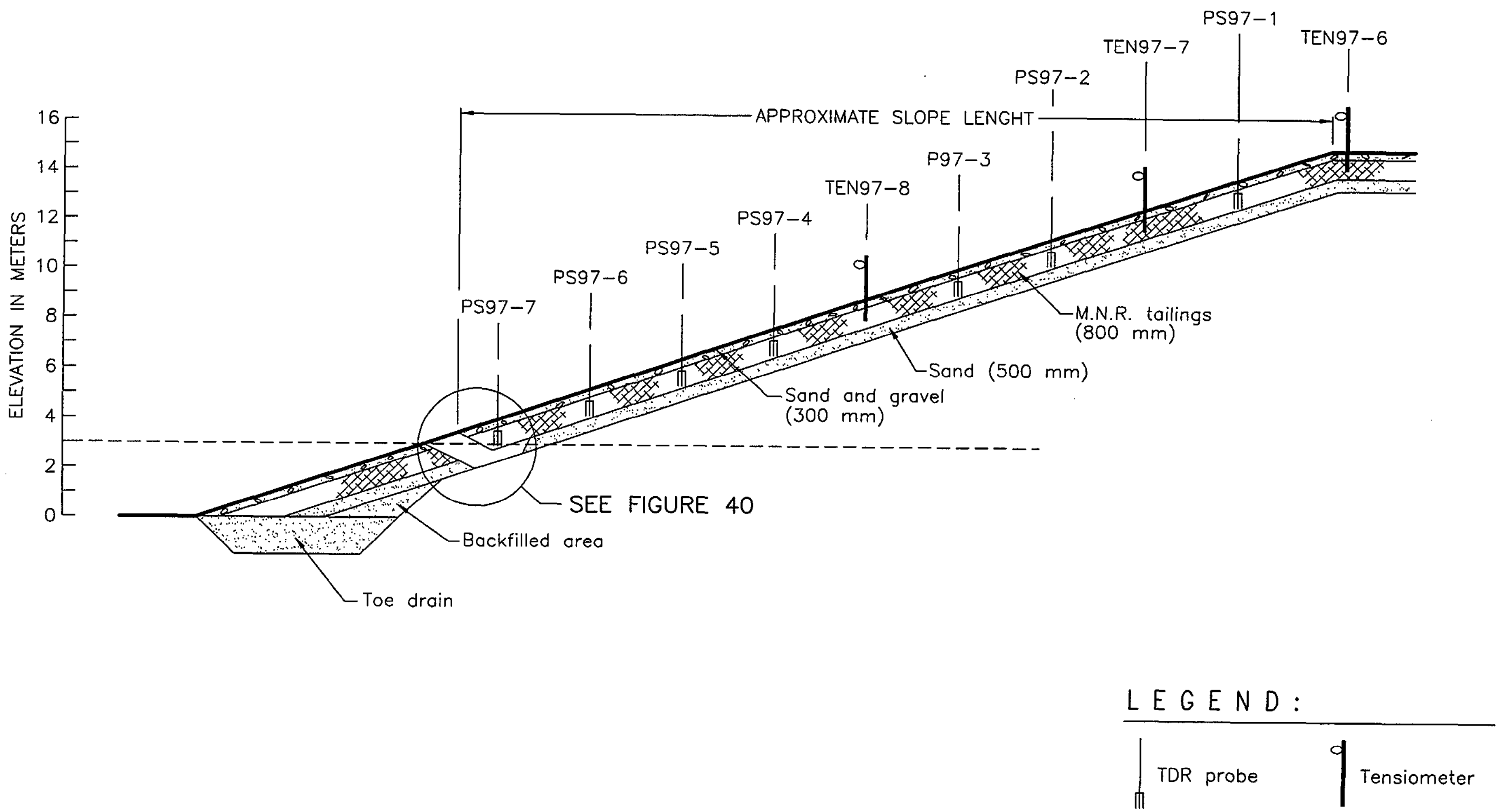


Figure 44: Instrumentation of test cell.



Date:	99–03–12	Scale:	1:250
Drawn by:	M.T.	Planned by:	J.–F.R.
Checked by:	J.–F.R.	Approved by:	P.G.
Drawing no.:	9730145D	Project no.:	971–7301

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FIELD PERFORMANCE OF THE LTA COMPOSITE DRY COVER

Golder Associés 63, Place Frontenac, Pointe–Claire, Qué. H9R 4Z7 Tel.: (514) 630–0990 Fax: (514) 630–1178	INSTRUMENTATION OF HYDRAULIC BREAK TEST CELL	FIGURE 45

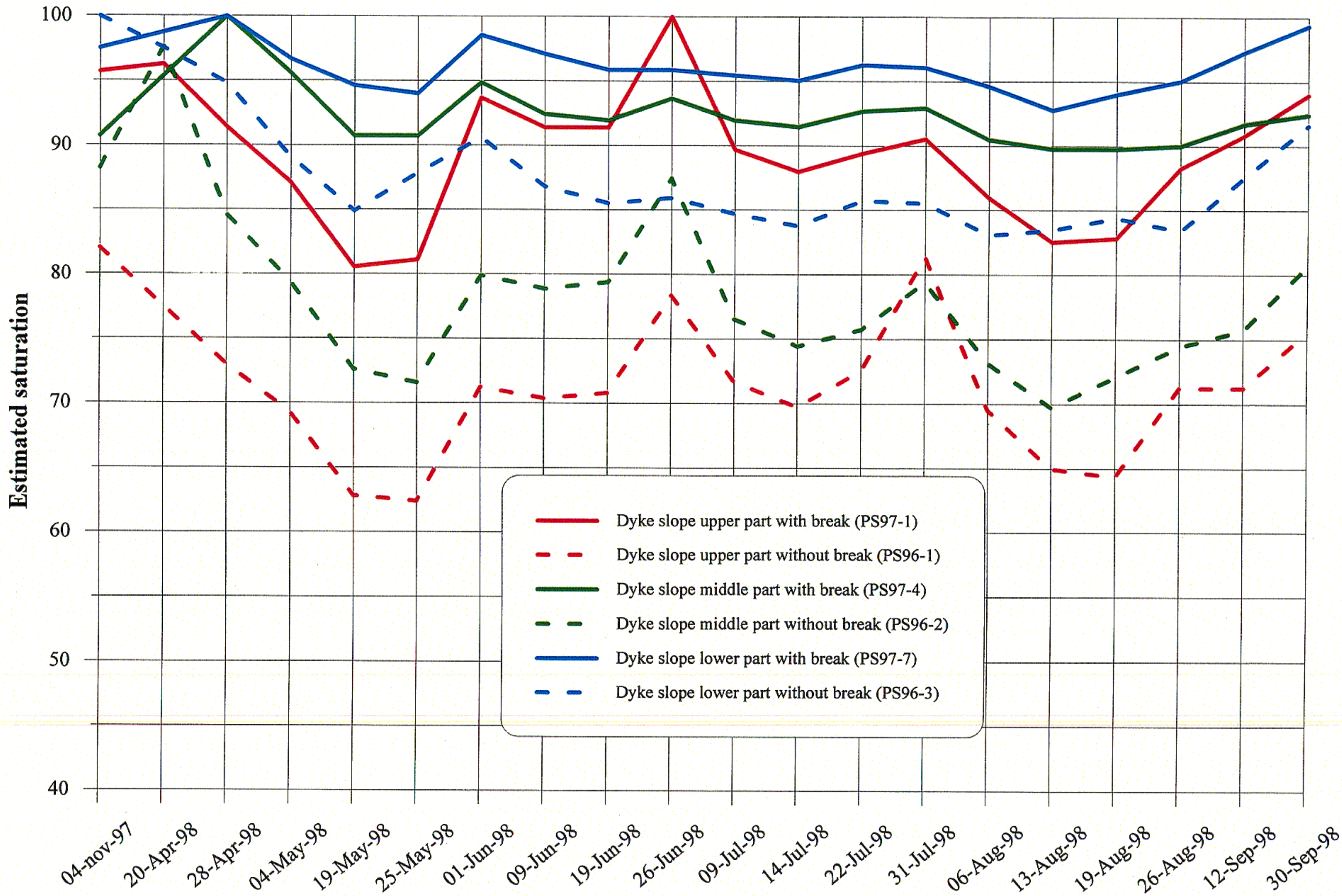
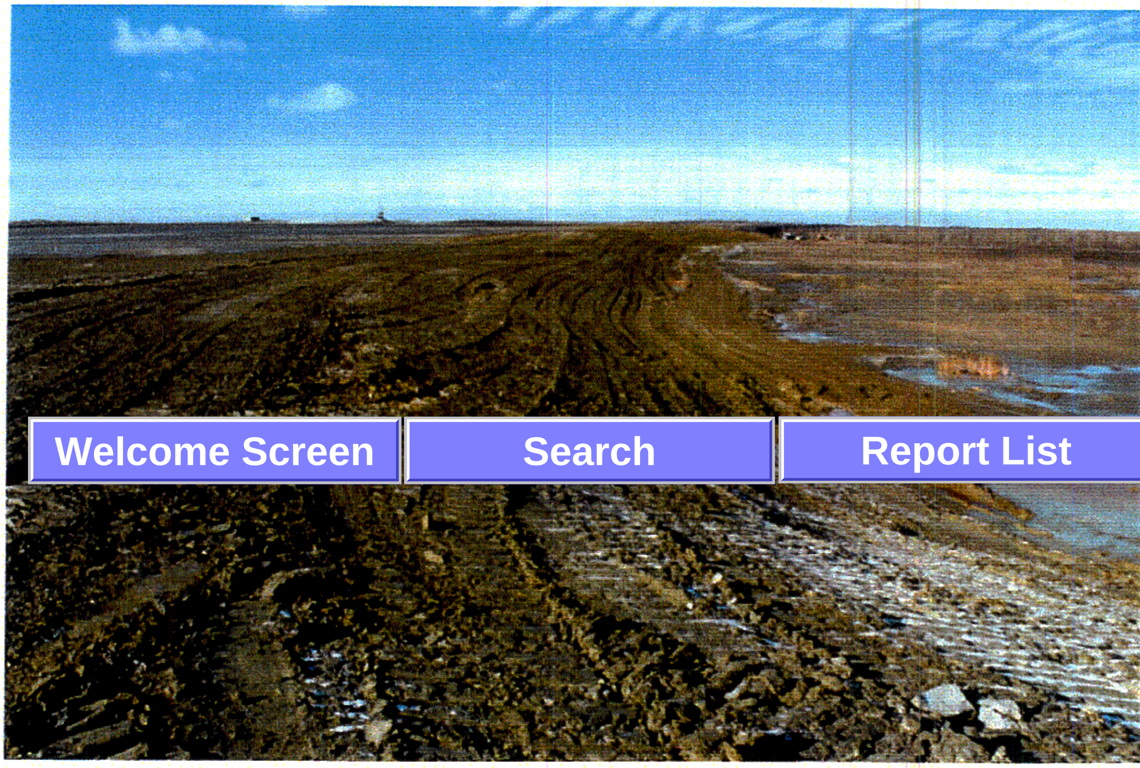


Figure 46: Estimated saturation for the hydraulic break test cell



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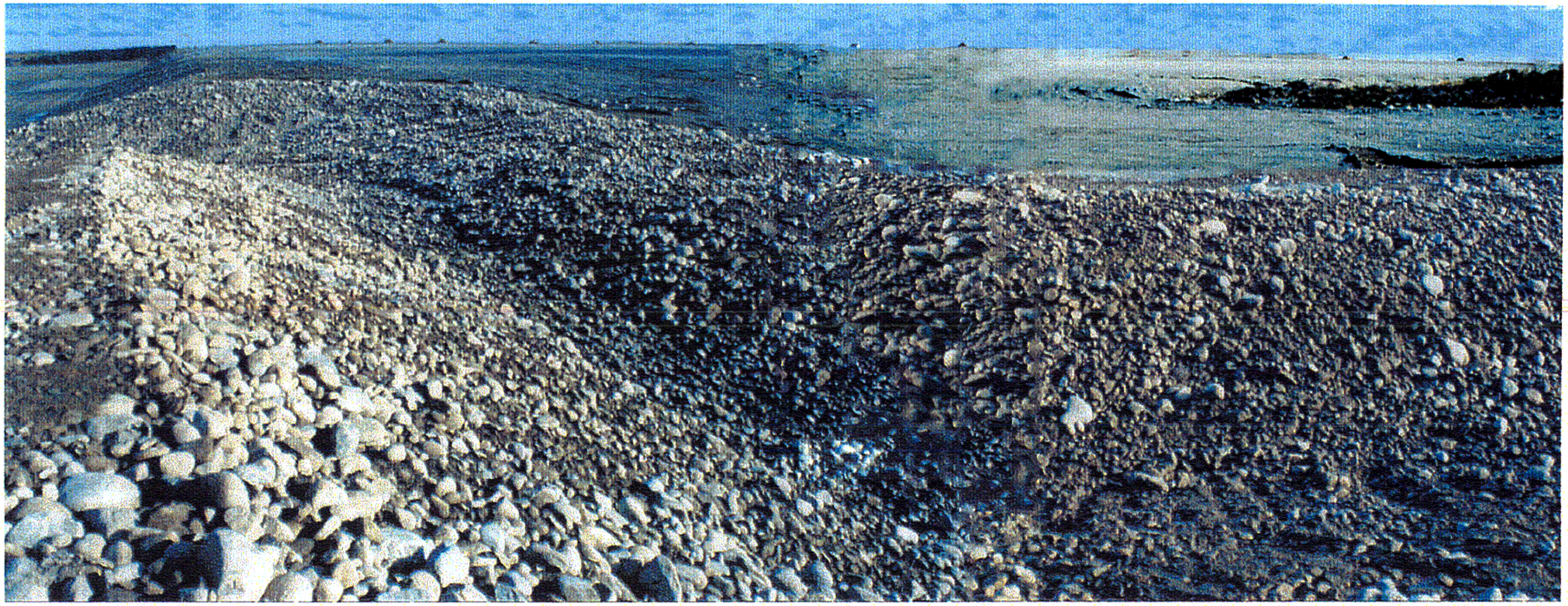
Photograph 1: South-East dyke before construction (fall 1995)

Photograph 2: South-East dyke after construction (fall 1998)

Photograph 3: West dyke before construction (fall 1995)

Photograph 4: West dyke after construction (summer 1996)

Photograph 5: Stack surface before constrution (fall 1995)



Photograph 6: Stack surface after construction (fall 1996)

Photograph 7: North dyke after construction (fall 1996)