

ANNUAL REPORT  
RETENTION LICENCE 8803  
BROWN PLAINS,  
SAVAGE RIVER, TASMANIA

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BY

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SAVAGE RESOURCES LIMITED

Incorporated in Tasmania

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## 1.0 Summary

The project has been downgraded since deposits with better qualities in pigment extenders have turned up in N.S.W., and the potential for a ball clay development at the site is limited by lack of local markets. This report assembles the laboratory studies done earlier on into a single document, with comments on the circumstances which have halted the project. In the field an extensive rehabilitation job has been done on the track system used for the drilling program, and this was the only work program undertaken during the reporting period. No further activity seems likely unless the marketing situation improves.

## 2.0 Introduction

The initial observation of the clay was made by the writer in c. 1983 (see ref 1) in which the presence of organic stained clay was noted. From being only a geological curiosity it became a minor prospect when considered as a possible pottery clay, then a major prospect as a fired clay white pigment extender.

Despite iron and titanium contents that are on the high side, the fired colour is better than would be expected. It transpires that the organic colouration of the raw clay is beneficial since burns out in firing and in the process keeps the iron in the reduced state.

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The pigment application seemed very promising, but there was some doubt if there was enough to support industrial development. 500,000 tonnes was considered the basic minimum, since the yield from the air classifier of the size cut that qualifies as pigment precursor is only some 30% of the dry weight of the clay. The density of the clay has not been measured but does not appear abnormal so can be taken as 1.5.

### 3.0 Drilling program

The drilling program utilized a carefully surveyed and levelled grid for control and dozer cuts for access. These roads have now been backfilled. If further drilling becomes necessary there are now ways to get a rig in directly over the peat.

The samples taken aggregated to nine tonnes weight. The samples were sent on to the Savage Minerals laboratory in Ballarat but have not been examined, at first owing to pressure of work on the process laboratory, and later because the prospect of superior competition developed. The consultants Marafield Ltd. are emphatic on the subject; the Brown Plains clay would be beaten in all factors.

During drilling some ominous indications of excessive iron content turned up, with extensive iron stain in dehumified material basal to the deposit and clots of marcasite in the fresh peat stained clay. These hints are confined to the basal portions.

#### 4.0 Dimensions of the clay body

At first it was thought that the clay would take the form of a persistent flat layer some 2-3m in thickness, truncated by the modern surface and covered by more sand and gravel. The drilling revealed an ancient low relief surface including gravel channels covered by up to 5 metres thickness of clay. The clay spreads further than the gravel but becomes thinner away from the inferred channel centres and feathers out as it laps on to the bedrock. A few bodies of even grained medium sand were encountered which are interpreted as beach/bar deposits. The channel system intersects with the modern surface so that bedrock highs occupy some ground where good thicknesses of clay were hoped for and modern valleys cut out some more of the clay. But it is reasonably certain that the target quantity of clay exists so long as the inferred zone of iron contamination is not larger than it looks.

Maps and sections provide the basis for a volume estimate. Using an arbitrary density estimate of 1.5 there is 700,000 tonnes in the drilled area with perhaps another 100,000-200,000 in the adjacent undrilled area with other evidence for the presence of the clay. The geological groundwork is finished for the present.

#### 5.0 Cainozoic geology of Brown Plains

The most informative exposure is at the bend in the track where descent to the Whyte River gauging station commences. The exposure has been cleaned off during road work with a bulldozer and the original gutter exposures have now reappeared. The diagram Fig 4 shows features to be seen at this site plus channel sample locations.

The sequence here from the base starts with a gravel of subrounded cobbles in pebbly sand matrix grading upwards to pebbly sandy gravel, then a sandy clay bed, of variable colour with patches of vivid iron staining affecting half the exposure, with the rest bleached off white. Another gravel follows grading from pebbly sand at the base to coarse sand at the top. The principal clay layer follows which is split by a thin granite derived sand near the base and a thicker granite-derived sand near the top. The absence of bioturbation of the clay is shown in the preservation of fine lamination and plant fossil material in the clay and is evidence of its lacustrine character. From disconnected higher exposures there is evidence for further clay and granite derived sand beds overlain by a sandy, subrounded quartz gravel of more or less fluvial character. The whole area has a surficial cover of subangular quartz gravel overlain by peat.

The main clay bed to the base of the upper sand split is about 3

metres at this site and in another exposure 300 metres west but the sand/clay boundary is much complicated by load cast and less regular soft sediment deformation in which the sand has sunk into the clay and the clay has squished up into the sand.

Groundwater movement in the sand beds and along joints in the clay produces a local alteration in which the organic colour is lost transforming the clay from a stiff almost brittle clay to a pink, plastic clay. In the lower bed of comparatively sandy clay iron staining is present possibly introduced from the adjacent sand but more probably indicating a higher iron content in the original clay. Some other indications of an iron rich basal zone were seen in the drilling samples including rare segregations of marcasite. The pink layers are cut by the superficial gravel cover so must be older than the present surface.

In the gravels there are some billy quartzite concretions (silcrete cemented) including some fairly extensive surface pavements.

The channel filling gravel at the base is more clearly fluvial than the others which look more like beach deposits. Gold and cassiterite occur in the lower gravel, also monazite, tourmaline, garnet and zircon. The suite is compatible with derivation from the granite terrain across the Whyte River.

Previously it was thought that a distinction between gravels related

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to the pre-basalt drainage system ("Bullocks Head Formation") and those related to post-basalt erosion surfaces ("Brown Plains Formation") could be made simply on the gravel type with ideally all well rounded polymictic cobble gravels belonging to the Bullocks Head and the mostly subangular quartz gravels belonging to the Brown Plains Formation. There is a grey area in the case of the lower gravels described above which had a fabric of intermediate character. These were placed in the younger formation in previous work. But it appears now that both the gravel and the overlying clay properly belong in the Bullocks Head Formation. The heavy mineral suite is more typical of the Bullocks Head in showing a restricted and local source for the gravels from the other side of the Whyte River in contrast to the Brown Plains Formation itself, now restricted locally to the topmost subangular gravel unit, which includes a major amount of chromite, particularly in a heavy mineral suite drawn from serpentinite and granite terrains at least that are outside the present catchment.

The lake appears to have developed from the abrupt damming of a creek system draining from the Meredith Range, over a gently dissected surface with a local relief of some 20m. A likely circumstance was for a basalt flow to have blocked the old drainage for long enough for the lake to fill before later flows covered the area to fix the course of the Whyte River, which approximates to the eastern edge of the basalt covered area. The basalt has since been eroded off and post basalt stepped erosion surfaces have developed

which carry remnants of Brown Plains Formation subangular gravel. The major valleys have been deeply incised but maintain the pattern imposed by the basalt flows

#### 6.0 Conclusions

The first use considered for the clay was as the ball clay element in a pottery feedstock. Bendigo Pottery were at one stage looking for a good white firing ball clay but they require only 5 tonnes a week which is not enough to support a quarry. Also they are used to purchasing a made up pottery base from a retailer including ball clay, china clay, feldspar and sand in appropriate proportions rather than making up their own mixes. The pigment extender option was very promising until the superior clays turned up in N.S.W. but has now closed, and along with it hopes of producing pottery base material as a by product of the pigment production. Both as a pottery clay and as a pigment extender the fired colour is borderline as far as desirable whiteness is concerned. The other uses contemplated as possible by products; casting slips and paper filler/coater were dependent on the pigment extender operation and the quartz content of the pigment extender would probably make it too abrasive, while the pigment process itself is costly enough to give an edge to the competition. In summary, not enough market at present. Perhaps a market may develop for a Tasmanian sourced "white" pottery clay on the scale of ten years or so.

Silica?

## 7.0 References

1. B.G. Penny, C.H.C. Shannon, and L. Vanzino, Report on Field Investigations within EL 4/61, West Coast, Tasmania. Summer field season, 1983-1984, Savage Resources Ltd. unpub. report. (1984).
2. R.W. Annett and C.H.C. Shannon, Annual Report on Field Investigations within EL 4/61, West Coast, Tasmania, Vols 1 and 2, September 1986 to June 1987, Savage Resources Ltd. unpub. report. (1987).
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APPENDIX 1  
CLAY SAMPLE LEDGER

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CLAY SAMPLE LEDGER

SAMPLE NUMBER	LOCATION (grid ref)	DESCRIPTION
GS 1	482917	From road gutter, dark brown clay with macerated plant fossil material, some humic acid material and sand in joints. Series of spot samples over 10m.
GS 2	"	From next 10m of road gutter downhill from GS 1, dark brown clay, minor contamination of sample from sand in joints.
GS 3	"	From next 10m of road gutter downhill from GS 2, light brown clay, more plastic than dark variety and apparently derived from it by a near surface wet weathering process.
GS 4	"	From next 10m of road gutter downhill from GS 3, dark brown clay c.f. (S 2.
GS 5	"	From next 10m of road gutter downhill from GS 4, dark brown clay c.f. GS 2. end of continuous section.
GS 6	482916	Fines component of gravel associated with the clay.
GS 7	479917	From the gravel pit area 300m W. of GS 1-5 suite, 1.5m stratigraphic section of dark brown clay.  The aim is to get a precise sample of the column previously sampled by GS 1-5. Samples GS 8-15 constitute a complete column through the deposit taken with a hand auger in a series of auger holes. The staircase of holes is adjacent to old sample GS 5 in the new exposure.
GS 8	482917	Top of section, 45cm of pink plastic clay, with minor sand 2-3cm at c. 20cm.
GS 9	"	30cm pink plastic clay.
GS 10	"	35cm dark brown stiff clay.
GS 11	"	65cm as above.
GS 12	"	65cm as above.
GS 13	"	30cm as above.
GS 14	"	45cm pink clay with sand at base.
GS 15	"	clayey sand, mostly light grey, minor orange. end of continuous section.

CLAY SAMPLE LEDGER

SAMPLE NUMBER	LOCATION (grid ref)	DESCRIPTION
GS 16	482917	2m south from GS 14, blister of yellow clay occupying 20cm of the interval sampled near base of GS 14.
GS 17	"	70cm leached white clay, silty in part from upper portion of clay bed below 1.5 - 2.0m of sand between this sample and GS 15.
GS 18	"	60cm yellow-orange-pink leached clay, lower portion of bed sampled by GS 17. Rests on basal gravel bed of variable thickness, which overlies weathered Timbs Formation.
GS 19	"	c. 30cm, white sandy clay from above 1.2m sand bed overlying GS 8.
		Samples GS 20 to GS 24 comprise a spot sampled column over 2.8m of exposure in an erosion gully in a gravel pit. The material is mostly indurated owing to weathering processes acting adjacent to transported gravel cover. The top is exposed but not the base and it is considered very likely that this is the same clay bed sampled by GS 1-5 and 8-15.
GS 20	480919	top, pink and brown clay, some silty.
GS 21	"	brown indurated clay and stiff clay.
GS 22	"	as above.
GS 23	"	as above.
GS 24	"	bottom of exposure, as above but with minor coarse sand indicating approach to true bottom of bed.
GS 25	480915	50cm hand auger sample, pink clay over orange sandy clay.
		Samples GS 26-28 constitute a continuous section taken with a hand auger, the top is truncated. At 471912 this locality is over 1km from the main sample area. It may represent the bed of samples GS 17-18 free of illuvial contamination.
GS 26	471912	top, 40cm, chocolate brown and some pink clay.
GS 27	"	55cm, pink clay.
GS 28	"	75cm, off white clay silty near base.
GS 29	476918	80cm, indurated, chocolate brown silty clay grading to clayey sand.

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CLAY SAMPLE LEDGER

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SAMPLE NUMBER	LOCATION (grid ref)	DESCRIPTION
<p>Samples GS 30-34 comprise a series of partially overlapping 25kg samples from the main clay exposure. The aim of this sampling was to collect material of a particular colour and/or grain size which would be likely to be reproducible under full scale quarrying conditions.</p>		
GS 30	482917	1.5m, chocolate brown clay.
GS 31	"	1m, as above.
GS 32	"	1.2m, as above.
GS 33	"	1m, as above.
GS 34	"	1.2m, off white clay slightly sandy.
GS 35	471912	Roadside cutting, 1.5m section of chocolate brown clay, 25kg sample.
CR 1	449911	Light brown plastic clay from gravel pit south of road c.f. GS 3.
CR 2	435899	1.5m section of dark brown, well bedded clay. Base not exposed these but 15m away allowing thickness estimate of 2 - 3m. Road cutting exposure.
CR 3	452911	Brown silty clay from grader scrape next to road.

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APPENDIX 2

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MARAFIELD PTY LTD

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THE RESULTS OF A PRELIMINARY INVESTIGATION OF TEN SAMPLES  
OF  
TASMANIAN CLAY SUPPLIED THROUGH "STECK RESOURCES PTY LTD"  
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John A. Hosking

22 February 1987

301 Lydiard St Nth, Ballarat, VIC 3350.

## PREAMBLE

Ten clay samples were supplied by Steck Resources Pty Ltd with instructions for a "quick and cheap appraisal", this we have endeavoured to do within the limitations and dictates of the material itself.

The material is very unusual in that much of it has a very high organic content and it was evident that there was significant sandy contamination, (it is not certain how much of this is inherent, and how much is due to near surface sampling.) Because of this high and variable contamination, it was felt that to achieve some sort of meaningful comparison, the samples should be examined only after some level of standard refining. The aspirations of the client, to satisfy a ceramic market, to some extent dictated the procedure, and it was decided to screen the fully dispersed samples through 150# prior to any physical or chemical examination.

## THE PROCEDURE

Each clay was dispersed at 33% solids using a low speed mixer and a polyacrylate dispersant at an initial dose level of 0.4 %. In most cases this dose was found to be inadequate and undispersed residue was further treated in a high speed mixer with additional dispersant.

The clay slurry was diluted to about 15% solids and screened through a 150# screen. The >150# residue was dried and weighed. The screened slurry was topped up to 6 litres with water and thoroughly mixed before taking a 1 litre aliquot. The 1 litre sample was sedimented at 12 secs per millimeter depth to remove all +10u material and the residue rediluted and sedimented a second time. The <10u fraction of three clays was retained for further examination. The >10u residue was dried and weighed.

The remaining screened slurry was flocculated by adding hydrochloric acid and allowed to settle for 24 hours. After this period, the supernatant liquid was decanted and a sample of clay filtered on a Buckner vacuum funnel.

The filter cake was cut into 100mm strips and dried. After drying the strips were measured to

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ascertain drying shrinkage and weighed prior to firing.

Each clay was fired at 1000 C and 1180 C and the resultant strips measured and weighed to determine loss on ignition and firing shrinkage.

The fired strips were then boiled in water for one hour, cooled, dried, and weighed, to determine absorption.

A subjective assessment of colour was also made.

Five selected samples were also sent for full chemical analysis.

## THE RESULTS

The results of the physical examination of the samples are recorded in Table 1 and the chemical analysis of the five selected samples is recorded in Table 2.

Below are recorded a number of observations made during the process of examination.

### General Comments

The majority of the samples have a very high organic content, this is distributed throughout the size range. Some of the dispersed slurries showed evidence of an oily film on the surface, and in one case the >150# fraction was actually smouldering after drying at 200 C !

Most of the clays are not very strong or plastic, but this is almost certainly a function of the high level of fine sand present, as evidenced by high >10u contents. The finer fractions increased dramatically in strength and plasticity.

As we were dealing with an unknown quantity, some procedures were modified as the investigation proceeded, and, although we have no control, some logical deductions can be made from the varying results. Some of the GS clays

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in particular contained some very tough particles which resisted dispersion and, as we proceeded we tried a number of methods to effect better dispersion. These methods varied from rubbing these particles out manually to redispersing them once or even twice in a high speed macerator. It may be significant that the sample subjected to the most violent dispersion also gave the highest <10u result.

TABLE 1

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SAMPLE NO.	APPEARANCE	DISPERSANT DEMAND	% +150#	% +10u	% -10u	DRYING SHRINKAGE	LOSS ON IGNITION	FIRING 1000 C	SHRINKAGE 1180 C	ABSORPTION		FIRED COLOUR	
										1000 C	1180 C	1000 C	1180 C
GS1	Dark brown with large amount of humus	0.65	31.40	24.10	45.50	6.00	13.46	1.00	11.50	50.90	22.70	White	White
GS2	Dark brown clay with some humus	0.42	11.90	40.40	47.70	6.00	18.95	1.50	6.00	28.60	17.60	White	White
GS2 A	<10u fraction of GS2	-	-	-	100.00	9.00	-	1.00	3.00	31.90	-	White	-
GS3	Light brown clay	0.66	11.10	28.30	60.60	7.00	16.47	1.00	19.00	54.20	23.80	White	Off white
GS4	Dark brown clay with some humus	0.53	22.00	28.80	49.20	6.00	19.40	0.00	15.00	65.40	22.20	White	Pale cream
GS5	As above	0.74	34.20	32.60	33.20	7.00	16.51		8.00	61.50	34.80	White	Pale cream
GS6	Fine silica sand												
GS7	Dark brown clay	0.60	5.60	53.00	41.40	4.00	4.90	1.00	4.00	33.40	22.90	White	Cream
CR1	Off white clay	0.60	0.90	66.30	32.80	7.00	5.71	0.00	10.00	24.00	5.30	Pale cream	Buff
CR2	Dark brown with large amount of humus	0.60	21.80	22.60	45.60	6.50	10.14	0.00	11.50	43.80	15.20	Orange	Orange
CR3	Brown silt	0.60	43.90	26.20	29.90	9.00	6.03	1.00	3.00	24.80	19.90	Off white	Pale cream

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TABLE 2

SAMPLE NO.	DESCRIPTION	SiO2	Al2O3	Fe2O3	CaO	MgO	Na2O	K2O	MnO	TiO2	L.O.I.
GS1	-150# fraction	61.60	19.20	0.84	<.01	0.56	0.05	2.80	0.01	0.75	14.20
GS1A	As above, fired to 1000 C	70.90	2.70	0.96	<.01	0.67	0.06	3.40	0.01	0.90	0.42
GS2	-150# fraction	58.40	16.90	0.98	<.01	0.61	0.12	2.70	0.01	1.10	19.90
GS2A	-10u fraction	55.70	27.10	0.97	<.01	0.67	0.07	3.50	0.01	1.00	10.92
CR1	-150# fraction	64.00	21.10	1.46	<.01	1.00	0.11	4.40	0.01	1.70	6.25

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## DISCUSSION

We will divide this discussion into two sections, firstly dealing with the GS series of samples and then with the CR series. Sample number GS6 is excluded from these comments, being a very fine sand with an almost total absence of clay.

### The GS clays

The GS clays are all very high in organic content, which explains a number of very high losses on ignition. This is not a disadvantage for ceramic use as it will burn away totally on firing. However the very high level of +150# is a drawback as it will require very large screen areas to be installed by the customer if the intention is to supply crude clay to the factory. The 150# problem is exacerbated by the problems with dispersion as, although it is believed that much of the material reporting as 150# is in fact undispersed clay, the level of power input required to disperse this would again be beyond the practical limits for a commercial producer.

Having made the above reservations, the remaining properties are, for the most part, ideal for a producer of white tableware. Fired colour is good to

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excellent, and such factors as shrinkage, and absorption all within an acceptable range.

As much of the sampling was at surface the 150# problem may have been exaggerated both by concentration and contamination and the sample described as a stratigraphic section, GS7, having the lowest 150# level of all, seems to confirm this.

In general we would expect levels of 5% greater than 150# to be acceptable to the market and some more intensive sampling will be required to determine if this is achievable.

As far as producing a processed clay is concerned, these clays have a number of possibilities. From our assessment to date, for example, most of the GS samples could be refined to yield a material competitive with a number of existing commercial clays. This comment being based solely on the fired colour and general range of other properties. At what level they could compete depends to a great extent on the chemistry.

Reference to Table 2, indicates that, chemically, these clays are typical ball clays with relatively high iron and titania contents. This is likely to limit their ceramic use to such applications as domestic whiteware. They would not be suitable, for example for the export porcelain market. Other significant features are high potash which will contribute to vitrification and save some felspar cost to the user, and high magnesium, this may signify the presence of plastic montmorillonite, or may

Simply be residual steatite on the like  
from the serpentines mentioned by  
your geologist.

### The CR clays

The CR clays are not encouraging, having poor fired colour and, apart from CR1, being heavily contaminated with grit.

Sample CR1 was exceptionally low in grit and had the whitest unfired appearance of all the samples. It was the only CR sample sent for chemistry. Neither the fired properties nor the chemistry fulfilled the initial promise. The clay was very high in free silica, with high iron and titania, the fired colour was not good. The only positive characteristic was the degree of self vitrification due to the high alkalis. If this material were next door to a tile plant it might have a future, but in its present location it can be eliminated along with the rest of the CR samples seen to date.

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APPENDIX 3

MARAFIELD PTY LTD

AN EVALUATION OF TASMANIAN  
CLAY SAMPLES FOR PIGMENT  
PRODUCTION AND THE RESULTS  
OF PROCESS DEVELOPMENT STUDIES

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Marafield

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## PREAMBLE

Some preliminary studies indicated that clays discovered by Savage Resources had qualities which could make them suitable for the production of calcined clay pigments for the paint, plastics, rubber and paper industries.

Further work was commissioned to confirm this using larger, representative samples from the "GS" range of clays. During the course of this work, some parameters would be established for the required process route.

This document, in two main sections, describes the process route established to date, and the "products" resulting from these processes.

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## PROCESS DEVELOPMENT

The starting point for the process development study was data available to us on some American practices in this area. The Tasmanian clay had a number of features which suggested that it might behave in a similar way to the American equivalents.

In general, the requirements of the process were:-

1) To fully disperse the clay to result in a 10% to 20% solids slurry. In earlier work, dispersion was found to be a problem.

2) To then cut the clay at a suitable particle size to reduce the free silica to an acceptable level and to remove all coarse particles, which would interfere with the intended end use.

3) To dewater and dry the refined product.

4) To mill the dried clay to a fine powder.

5) To dehydroxylate the clay using a controlled heat process. (This would also burn out the dark organic

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staining.)

6) To again finely mill the calcined powder.

7) To air classify the powder to remove any oversize aggregates.

## 1) DISPERSION

In view of the difficulty in dispersing these clays during earlier studies, it was decided to increase the solids level to 50% and use ammonia to raise the pH to 9 to 10. A polyacrylate dispersant "Carybon" was also used at a dose rate of 0.5%

The dispersion was carried out in a 0.37 KW, high speed blunger so as to have a power input of 25 KWHrs per tonne.

Under these conditions dispersion was relatively easy and a very fluid slurry was produced. This slurry was diluted to about 12.5% solids before further processing. (Subsequent mixes were made at even higher solids, up to 70% and these higher levels are recommended.)

## 2) REFINING

In previous work initial cuts were made at 100 microns and the effect of cutting at 10 microns was

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examined. The silica level was significantly reduced at the finer cut, but was still considered too high for pigment production. For the current study it was decided to lower the cut point again to 5 microns, and this was achieved using a "Mozley" 25mm cyclone fed by a 37mm centrifical pump.

The system worked well, but would be better in practice if a staged system were used. This would improve recovery which we estimated to be 30% using our system and 35% using a staged system.

The fine product was collected in large plastic drums and the underflow, a combination of extremely fine silica, clay, and organics was also collected and is being held pending any decision to examine or dump them.

### 3) DEWATERING

The fine product slurry was acidified to pH 5.0 to coagulate the clay to assist settling. However the aggregates formed were too small to promote effective dewatering and would have certainly caused problems in later filter pressing.

The use of a long chain anionic flocculant (Alfloc 627) at dose rates of 400 ppm was extremely effective, forming large flocs which settled rapidly, and enabled slurry densities of 25% to be achieved.

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## 3a) FILTER PRESSING

This is very much a trial and error process, as it is impossible to predict the ultimate bulk density of the filter cake or its moisture content. The samples were taken in numerical order, the first trial, on sample GS 30 resulting in an underfilled press which had to be topped up with GS 31. Further pressings gave no trouble and produced a firm, handleable cake. None of the common problems such as excessive pressing time, sticky cakes and filtrate losses, occurred during the trials.

## 3b) DRYING

After a number of trials, involving drying, extruding, and milling in various sequences, it was decided that the material was most easily handled in the following way:-

- a) Dry the filter cake, either whole or in large pieces.
- b) Crush the dry cake to minus 5mm. (We actually used a modified industrial mincer for this process.)

## 4) MILLING

In practice either a Hosakawa or Bauer pulveriser

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would be used for this purpose, but these types of machine are not available at a small enough scale for this exercise. We simulated the effect by using two passes through a disc pulveriser, which, we feel, does not achieve the same degree of fineness.

### 5J CALCINING

The production calcining technique is very complex and concentrates on ensuring no hot spots, which produce abrasive particles, and also introduces a mixing action as the clay cascades though the kiln. At this stage we can only static calcine and cannot introduce the degree of thermal shock inherent in the high temperature gradients used in practice. (See accompanying graphs.)

Calcination trials were carried out under heavy and light oxidation and mild reducing conditions at peak temperatures ranging from 950 C to 1080 C. As a basis for comparison, all the samples were fired at 1030 C and reflectivities measured.

### 6J RE-MILLING

Again two passes though a disc pulveriser were used and fineness checked. Due to a number of reasons the material was too coarse and a purpose designed air classifier was built to separate the product.

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## 71 CLASSIFICATION

This process was introduced to remove particles in excess of 20 microns and produced a consistent fine product which could be used for reflectivity measurement. It consists of elutriating the powder in an air stream and collecting the fines in a filter bag.

## THE RESULTS

The aims of this phase of the project were:-

1) To establish whether the Tasmanian clays were suitable for the production of calcined products.

2) To identify any differences between the samples supplied.

3) To carry out preliminary work on establishing a production route.

4) To produce some pigment samples for testing by the paint industry.

5) To recommend a definitive route for the development of a viable project.

The results will be discussed in two sections, the first relating to the clay potential and the second to the actual process. Both carry recommendations for the next phase.

## THE CLAYS

The samples received fell into two visual categories, samples GS 30 to 33 were very dark in colour with a strong peaty odour, samples 34 and 35 were of a pale buff colour with less organic odour. Where, for various reasons, any samples were combined, only those of the same visual type were used.

None of the samples presented any particular problems and their behaviour was extremely uniform despite their superficial differences. Trials on recoveries yielded very similar figures and we expect a level of 30% recovery prior to calcining to be normal with a further loss on ignition resulting in an overall product recovery of 25%.

We think that the refining residue would be capable of retreatment to produce a good ceramic raw material, but this would be the subject of a separate study.

The clays are extremely susceptible to slight variations in calcination conditions, and we do not believe that these have yet been optimised. However under identical conditions the various samples yielded the following reflectivities:-

SAMPLE	BRIGHTNESS	YELLOWNESS
GS 30	N/a	N/a
GS 30/31	77.6	8.7
GS 31	75.1	10.2
GS 32/33	75.3	7.5
GS 34	81.3	6.9
GS 35	77.5	8.9
GS 34*	81.7	8.3
ACCL Accfine	80.7	7.8

Note: GS34\* was fired at a lower temperature at high speed

The Accfine sample is for comparison.

The work to date indicates that the colour of clays is of little use in predicting final brightness, but we are also aware that colour responds to calcination conditions and the optimum may not be the same for all types.

Chemistry appears to be the most significant factor in determining final calcined colour with iron and titania being the most important. With the process envisaged here, we feel that iron is the overriding contributor to fired yellowness and some systems for reducing it should be examined. The included table gives full chemistry.

## Marafield

The chemistry indicates some quite large variances between samples, with iron levels from less than 1% to more than 2% and titania varying from 0.8% to over 2%. In general the chemistry is very similar to earlier samples, and the alumina levels (especially after calcining) are very stable. On the basis of the work to date, it can be stated that feed for pigment production should be selected on the basis of low titania and iron levels.

## THE PROCESS

The pilot plant studies have aimed at reproducing the system used in America for the production of clay based pigments. However, from the cost point of view, it was too early in the project to consider using any purpose designed equipment and the simulation has been carried out using available plant together with some fabricated modifications. ALL OF THE DIFFERENCES IN THE PROCESS ARE LIKELY TO CONTRIBUTE TO A WORSE RESULT THAN WOULD BE ACHIEVED IN PRACTICE.

The dispersion technique used was effective, but we would like to achieve a higher work input to ensure that all the available fine fraction is recoverable. For pilot purposes this would involve modifying the existing mixer to handle smaller volumes of material at higher solids. In a production unit we would aim for a work input of about 40 KWHrs per tonne.

The refining technique used to date is crude and somewhat inefficient. In practice the process would require a second stage comprising 10mm cyclones and a scavenger stage to reduce losses to tailings. This can be simulated, but the sample size available did not allow a more

040

Marafield

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sophisticated approach. In view of the high level of relatively coarse organic trash, we would also introduce a number of screening stages into the circuit.

The dewatering and drying processes used also differed from the American practice, in that the clay was pressed in the flocculated state rather than being directly spray dried. Our experience with small scale spray driers has not been happy and simulating this phase is a problem. It is possible that by employing a drum drier (which would have to be fabricated) that a direct dried, dispersed clay could be produced.

Milling was not a major problem but could probably be improved by using a small attritor mill (this could also be use for the final milling of the calcined product.)

Calcining is very difficult to simulate as the American process uses a Herreschoff kiln which contains a series of trays mounted on a vertical shaft and the clay cascades through a temperature gradient in about 35 minutes, it is then flash cooled. (See earlier graphs). To come close to this process would involve us in fabricating a small scale unit using high grade stainless steel and insulating fibre blanket.

Secondary milling presents no problem.

Air classification can be relatively easily

041

Marafield

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simulated, we already have a serviceable unit which we will be making more flexible.

The accompanying flow diagram shows our best opinion as to a final process for full scale production.

012

Marafield

PAGE 15

## THE PIGMENTS

The table of reflectivities indicates one of the most important properties of a mineral based pigment. In general the results to date have shown that brightnesses as good and better than existing clay extenders can be achieved, but these are still 4% lower than imported calcined clay pigments. The high yellowness figures are encouraging, as it is frequently possible to modify such pigments to increase brightness. Factors contributing to improved brightness are, finer particle size, better controlled calcining, and chemical iron reduction.

In other respects the pigments produced to date are too coarse, (a function of process rather than feed), and as a result of higher bulk density than is normal. However the density of 0.3 tonnes per metre lies between that of a clay, 0.4 tonnes per metre, and a pigment, 0.23 tonnes per metre.

Although we would be happy for a small sample to be examined by a paint manufacturer for comment, we believe that pigments of far better quality are produceable from selected feed.

C-13

Marafield

PAGE 16

## PROPOSED PROGRAMME

A number of areas ranging from reserves to market now need to be examined.

Firstly some reserve needs to be established and we believe that this can be done on the basis of iron and titania. A number of auger drill holes will be required with chemistry on each 1 metre increment. The aim should be to establish a minimum of 500,000 tonnes of low iron/titania clay. The areas most promising at present are those comprising samples GS 2 (first series) and GS 34 , GS 32 and 33 also look interesting.

Secondly the market now needs closer examination. A study should be carried out of market size, paint, rubber and paper, for pigments and of the investment casting and insulator industry as potentially markets for oversize material.

Thirdly some further small scale work should be carried out using existing material , to optimise the calcination temperature and investigate chemical reduction of iron which could effectively bring unsuitable material into reserve. It might also be useful at this point to examine the residues with a view to producing further saleable products. We would particularly like to investigate their use in white casting slips.

Marafield

PAGE 17

After the completion of this work consideration should be given to the production of one tonne of pigment from the identified reserve for market sampling both here and overseas.

Only after the completion of these phases should detailed plant design commence.

0  
1  
2

CHEMISTRY OF SAMPLES

REFINED

SAMPLE NO	SiO2	Al2O3	Fe2O3	CaO	MgO	Na2O	K2O	MnO	TiO2	L.O.I.
GS31	45.10	21.50	1.00	0.03	0.79	0.19	3.40	0.01	1.20	26.80
GS34	52.60	27.50	0.98	0.03	0.76	0.18	3.60	0.01	0.77	13.50
GS35	49.90	28.20	2.05	0.03	1.06	0.19	3.70	0.01	2.10	12.80
GS30/31	46.60	23.80	1.04	0.04	0.82	0.18	3.60	0.01	1.20	22.70
GS32/33	46.00	21.60	0.98	0.04	0.74	0.18	3.30	0.01	1.00	26.20
GS32/33 (bleached)	45.50	22.10	0.90	0.05	0.67	0.19	2.90	0.01	0.90	26.80

CALCINED

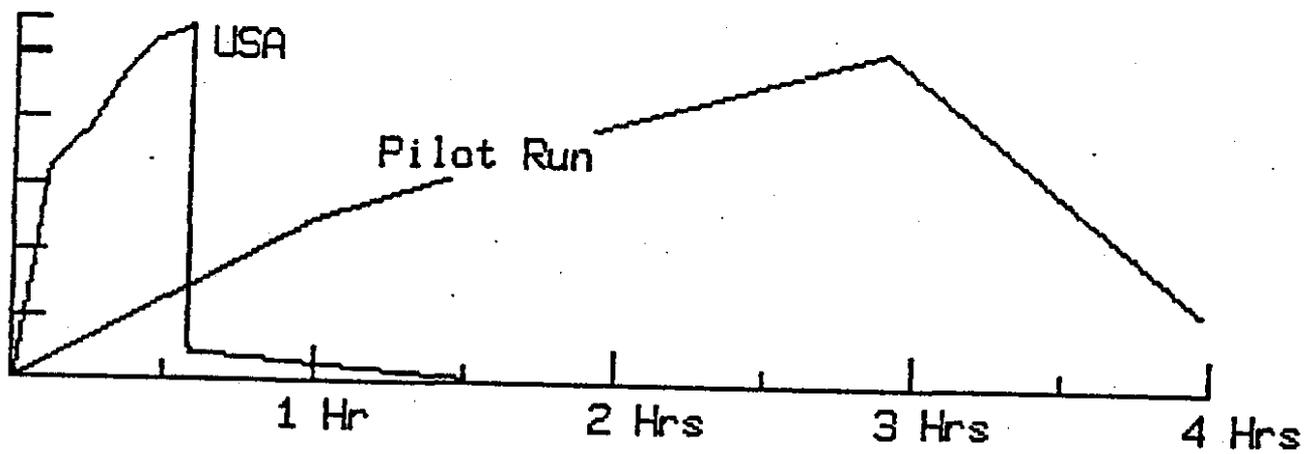
GS31	61.61	29.37	1.37	0.04	1.08	0.26	4.64	0.01	1.64	
GS34	60.81	31.79	1.13	0.03	0.88	0.21	4.16	0.01	0.89	
GS35	57.22	32.34	2.35	0.03	1.22	0.22	4.24	0.01	2.41	
GS30/31	60.28	30.79	1.35	0.05	1.06	0.23	4.66	0.01	1.55	
GS32/33	62.33	29.27	1.33	0.05	1.00	0.24	4.47	0.01	1.36	
GS32/33 (bleached)	62.16	<del>32.87</del>	1.23	0.07	0.92	0.26	3.96	0.01	1.23	

634046

015

### Comparison of American and Pilot Run Temperature Profiles

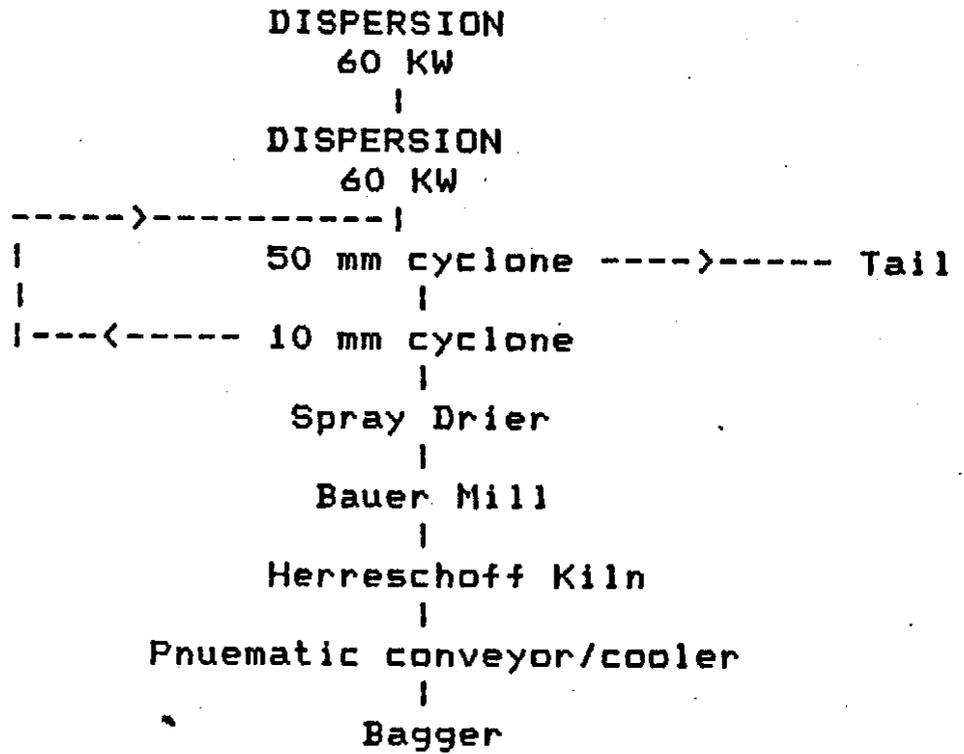
Degrees centigrade  
1100  
500  
0

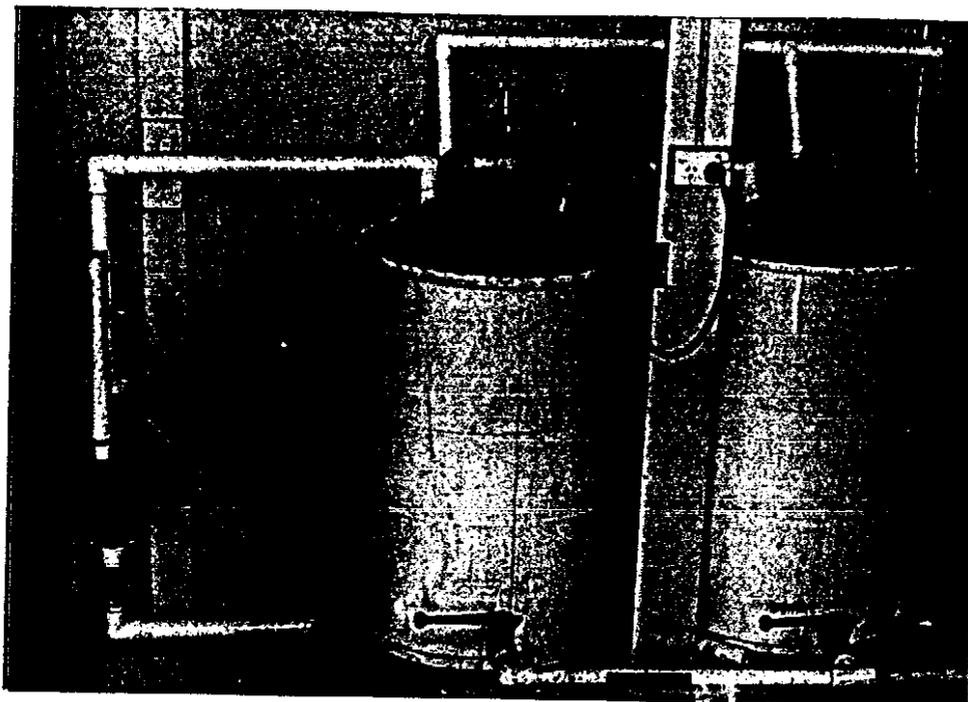


634047

047

SCHEMATIC FLOW SHEET

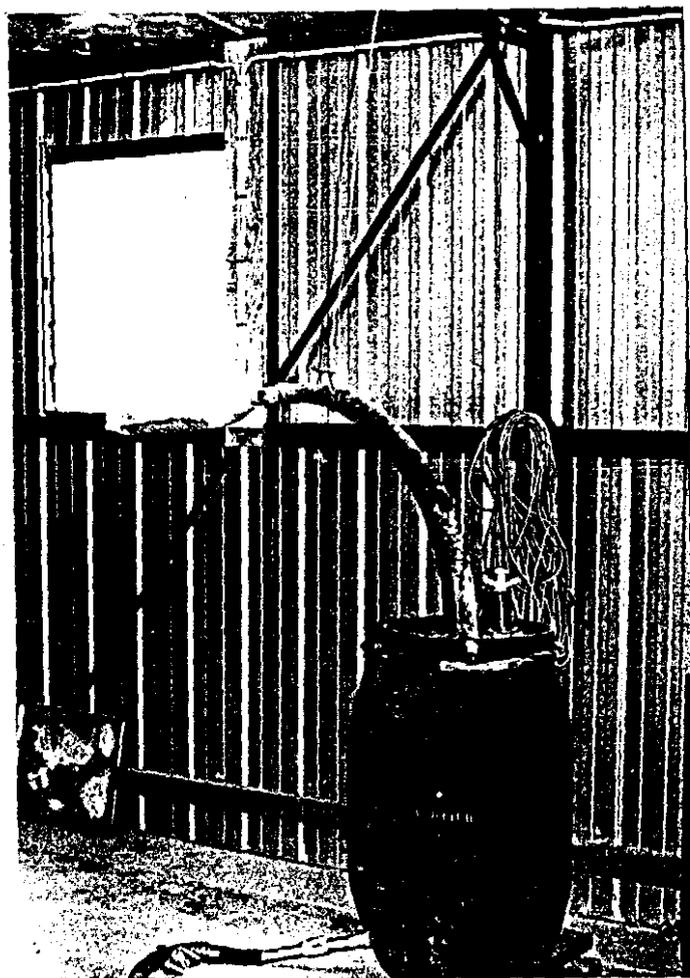
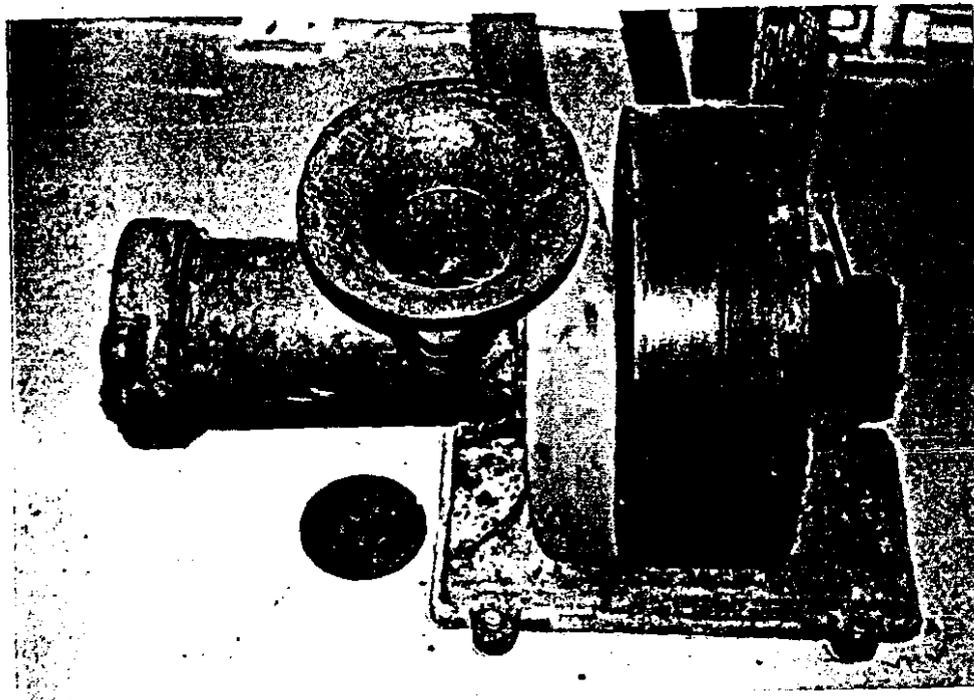




TOP: HIGH SPEED MIXER

BOTTOM: PUMP & CYCLONE

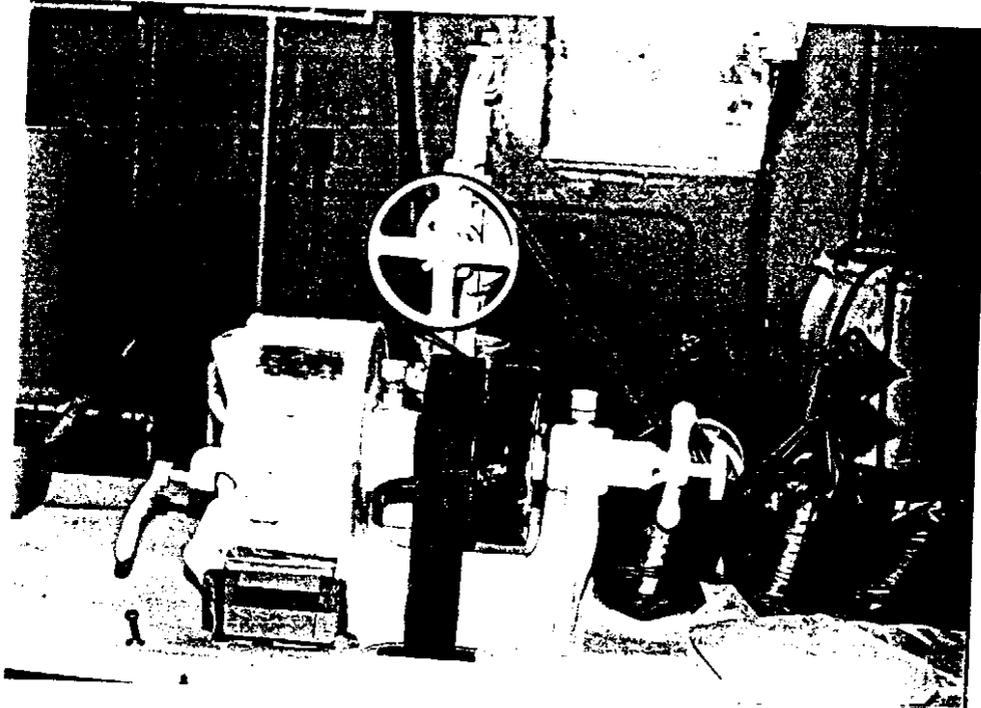
049



TOP: PRIMARY CRUSHER

BOTTOM: AIR CLASSIFIER

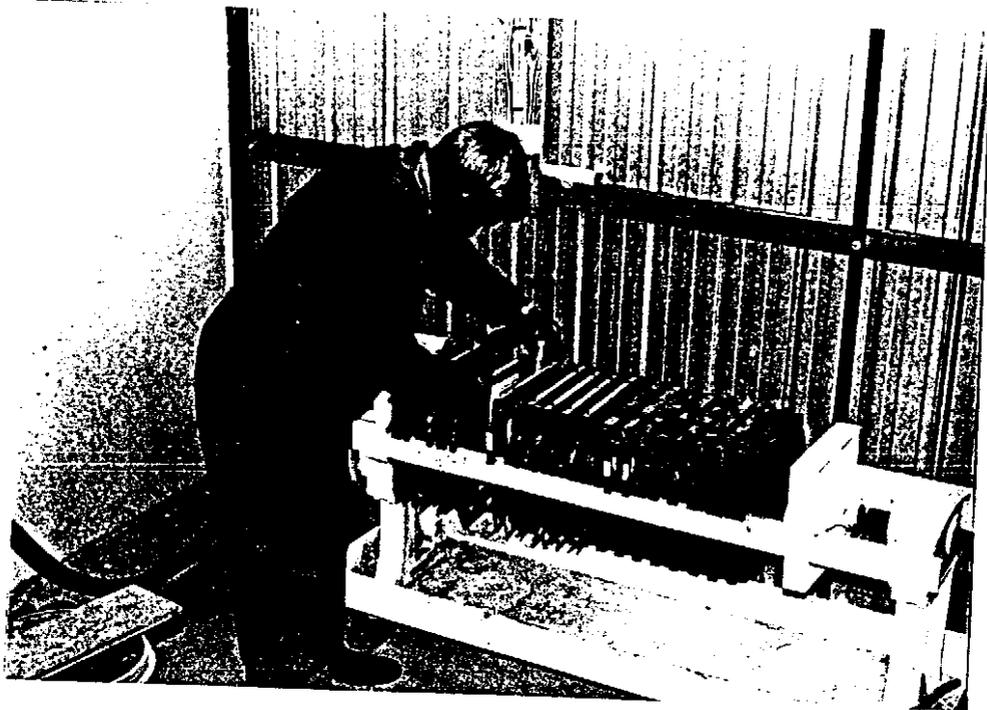
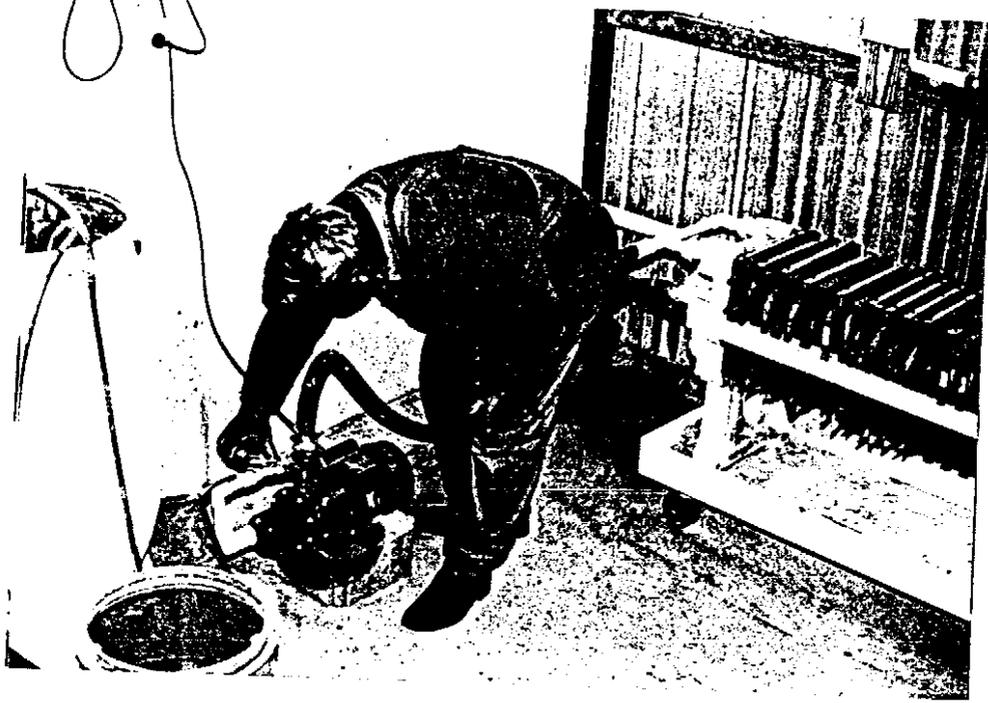
070



VERTICAL & HORIZONTAL  
DISC PULVERISERS

051

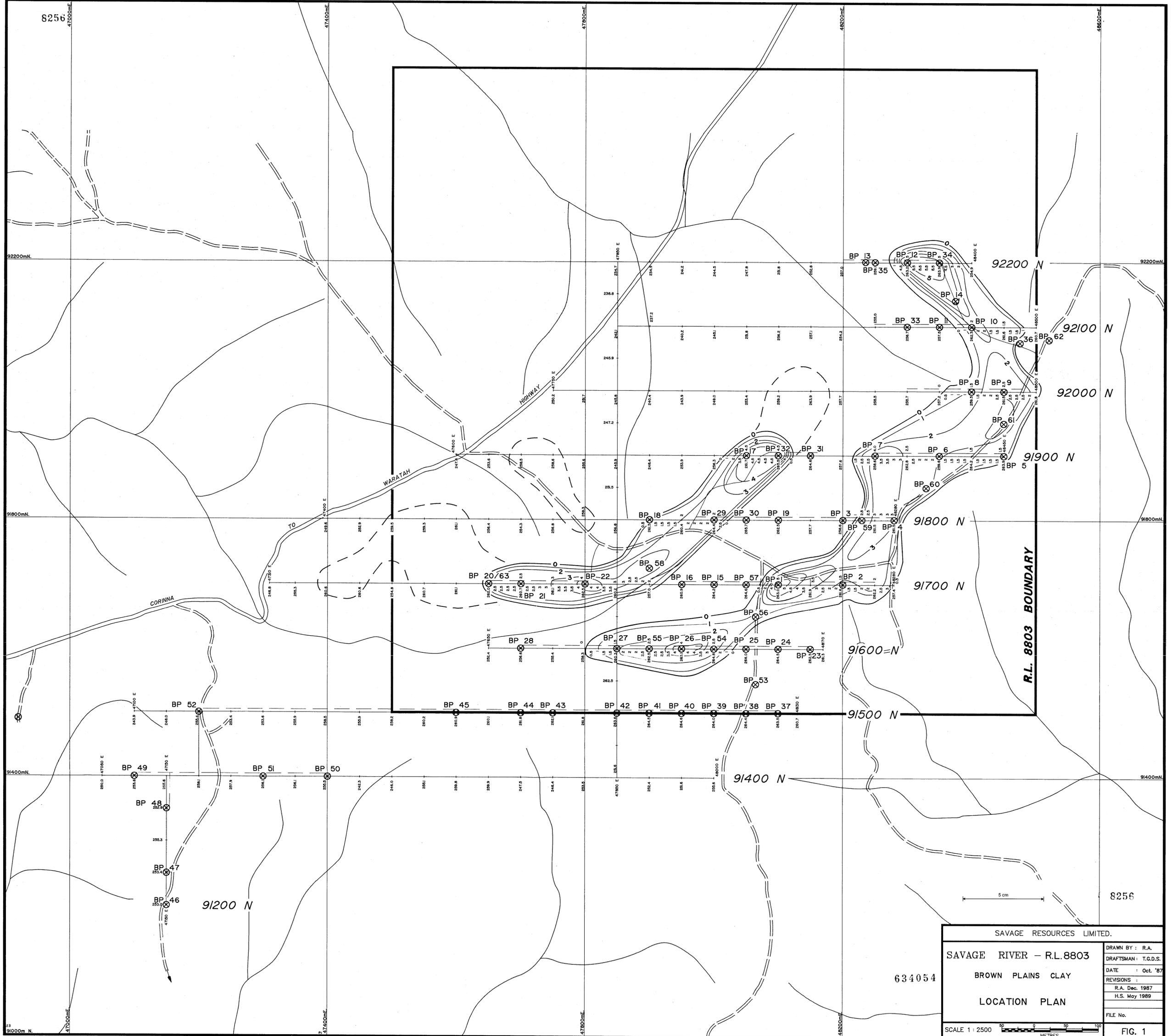
634052



12 INCH FILTER PRESS



IN THE LABORATORY

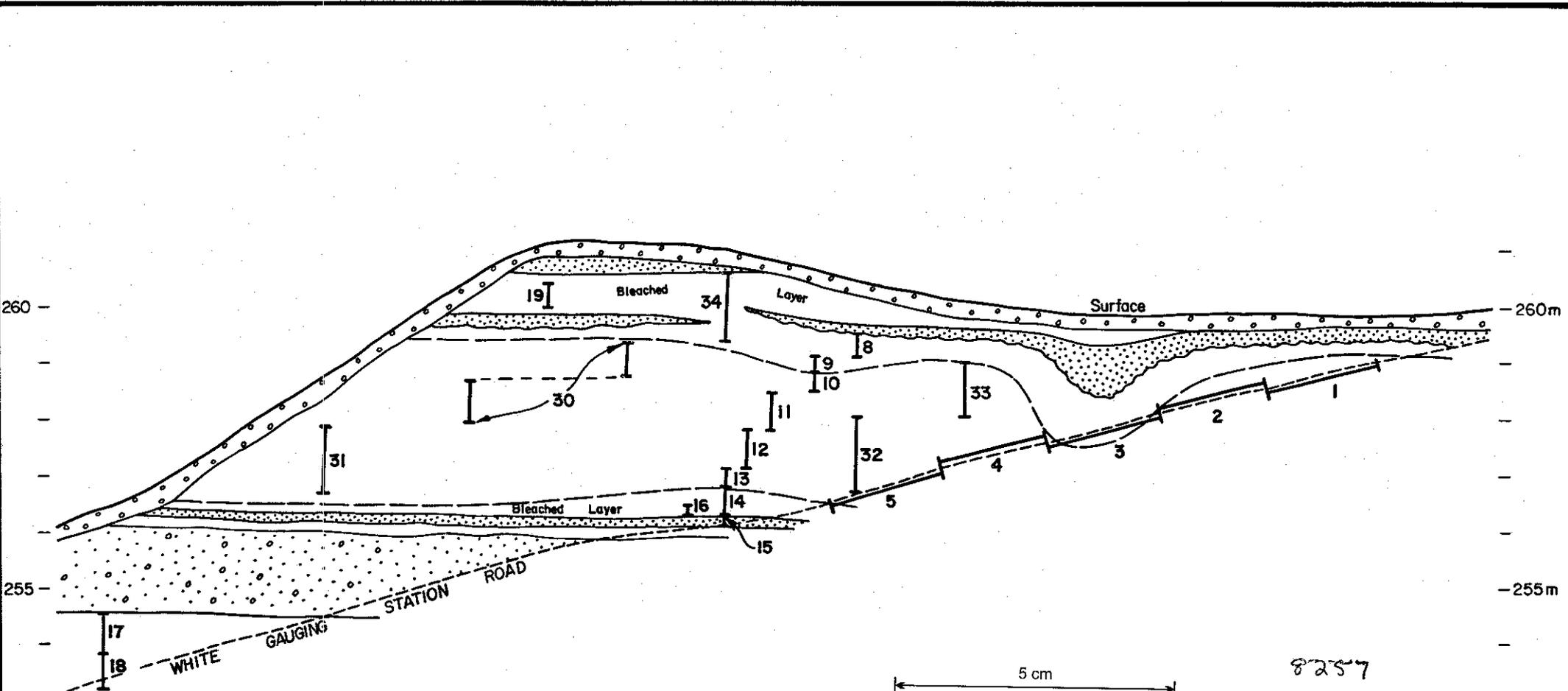


R.L. 8803 BOUNDARY

5 cm

SAVAGE RESOURCES LIMITED.	
SAVAGE RIVER - R.L. 8803	
BROWN PLAINS CLAY	
LOCATION PLAN	
634054	DRAWN BY: R.A.
	DRAFTSMAN: T.G.D.S.
	DATE: Oct. '87
	REVISIONS:
	R.A. Dec. 1987
	H.S. May 1989
	FILE No.
SCALE 1:2500	FIG. 1

8257



**LEGEND**

- Clay
- Sand
- Gravel
- Shist

SCALE:  $\frac{V}{H} = \frac{1}{5}$

10m

5 cm

8257

634055

<b>SAVAGE RESOURCES LIMITED</b>	
<b>SAVAGE RIVER - R.L.8803</b>	DRAWN BY : H.S.
<b>BROWN PLAINS CLAY</b>	DRAFTSMAN: T.G.D.S.
<b>CLAY EXPOSURE</b>	DATE : July '87
<b>SAMPLE LOCATIONS</b>	REVISIONS :
	H.S. May 1989
	FILE NO.
"SCALE AS SHOWN"	<b>FIG. 2</b>

8258

47100m E.

47300m E.

47400m E.

47500m E.

BP 49

BP 51

BP 50

260m

240m

220m

200m

5 cm

8258

634056

89-2964

LEGEND

Clay

Sand

Gravel

Sands & gravels

Chloritic schist and sandstone

BROWN PLAINS FORMATION

TIMBS FORMATION

SAVAGE RESOURCES LIMITED

SAVAGE RIVER - R.L.8803

BROWN PLAINS CLAY

PROFILE LINE 91400m N.

SCALE 1:500 METRES

FIG. 3

DRAWN BY: R.A.

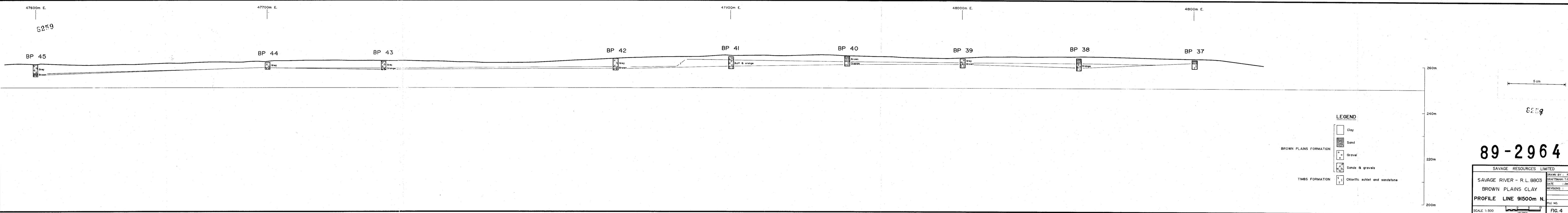
DRAFTSMAN: T.G.D.S.

DATE: Jan. '87

REVISIONS:

FILE NO.

FILE NO.



**LEGEND**

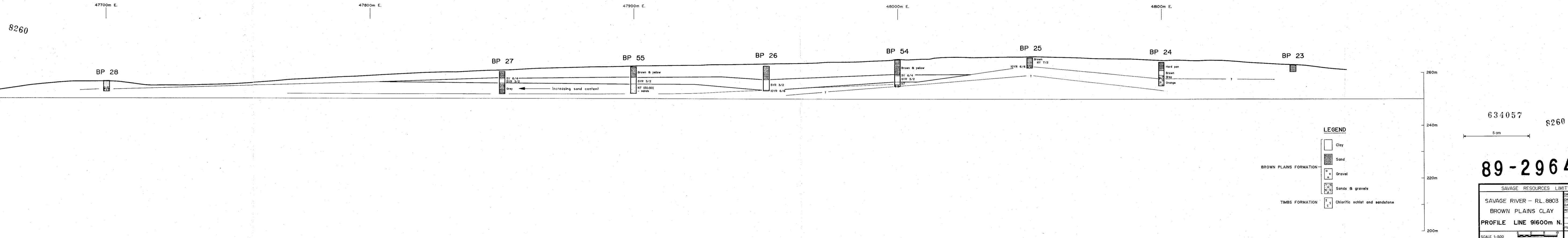
- Clay
- Sand
- Gravel
- Sands & gravels
- TIMBS FORMATION  
Chloritic schist and sandstone

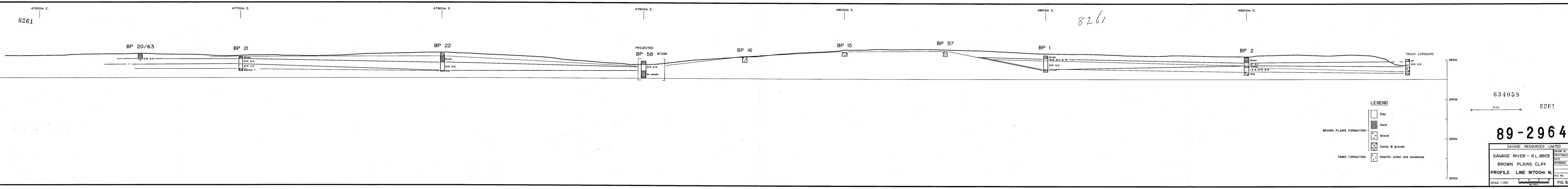
BROWN PLAINS FORMATION

TIMBS FORMATION

**89-2964**

SAVAGE RESOURCES LIMITED	
DRAWN BY : R.A.	DRAFTSMAN: T.G.D.S.
DATE : Jan '87	REVISIONS :
SAVAGE RIVER - R.L. 8803	
BROWN PLAINS CLAY	
PROFILE LINE 91500m N.	
SCALE 1:500	METRES
FIG. 4	





8261

634058

8261

89-2964

**LEGEND**

- Clay
- Sand
- Gravel
- Sands & gravels
- Chloritic schist and sandstone

BROWN PLAINS FORMATION

TIMBS FORMATION

SAVAGE RESOURCES LIMITED	
SAVAGE RIVER - R.L.8803	DRAWN BY: R.A.
BROWN PLAINS CLAY	DRAFTSMAN: T.G.D.S.
PROFILE LINE 91700m N.	DATE: Jan. 87
SCALE 1:500	REVISIONS:
	FILE NO.
METRES	FIG. 6

8262

47800m E.

47900m E.

48000m E.

48100m E.

48200m E.

BP 18

BP 29

BP 30

BP 19

BP 3

BP 59

BP 4

Brown  
5YR 3/2

Brown  
5YR 3/2  
10YR 6/2

S S

Grey  
10YR 6/4

Grey  
Brown  
Grey  
Orange  
Grey

10YR 6/2  
5YR 3/2  
10YR 6/6  
Orange

Brown 10YR 6/2  
5YR 3/2  
10YR 6/6  
Orange-brown

Facies change ?

Possible bedrock

260m

240m

220m

200m

5 cm

LEGEND

Clay

Sand

Gravel

Sands & gravels

Chloritic schist and sandstone

BROWN PLAINS FORMATION

TIMBS FORMATION

8262

634059

89-2964

SAVAGE RESOURCES LIMITED

SAVAGE RIVER - R.L.8803

BROWN PLAINS CLAY

PROFILE LINE 91800m N.

SCALE 1:500

0 5 10 METRES

DRAWN BY : R.A.

DRAFTSMAN: T.G.D.S.

DATE : Jan. '87

REVISIONS :

FILE NO.

FIG. 7

8263

48000m E.

48100m E.

48200m E.

48300m E.

48400m E.

BP 17

BP 32

BP 31

BP 7

BP 6

BP 5

10YR 6/6  
5Y 6/1  
6YR 3/2

Hard pan  
Brown  
6YR 3/2  
10YR 6/2

6YR 3/2  
10YR 8/6

6YR 3/4

Surface gravels  
Grey  
Brown  
6YR 3/2  
10YR 6/6  
Orange clays/gravels

LEGEND

Clay

Sand

Gravel

Sands & gravels

Chloritic schist and sandstone

BROWN PLAINS FORMATION

TIMBS FORMATION

260m  
240m  
220m  
200m

634060

5 cm

8263

89-2964

SAVAGE RESOURCES LIMITED

SAVAGE RIVER - R.L. 8803

BROWN PLAINS CLAY

PROFILE LINE 91900m N.

SCALE 1:500

DRAWN BY : R.A.  
DRAFTSMAN: T.G.D.S.  
DATE : Jan. '87  
REVISIONS :  
FILE NO.

FIG. 8

8264

48300m E.

48400m E.

48500m E.

BP 8

BP 9

■	Brown
■	5YR 3/2
■	10YR 6/2
■	Grey

■	Brown
■	5YR 3/2
■	10YR 6/2
■	Grey

260m

240m

220m

200m

634061

5 cm

8264

89-2964

LEGEND

□ Clay

■ Sand

○ Gravel

○ Sands & gravels

BROWN PLAINS FORMATION

TIMBS FORMATION

Chloritic schist and sandstone

SAVAGE RESOURCES LIMITED	
SAVAGE RIVER - R.L. 8803	DRAWN BY: R.A.
BROWN PLAINS CLAY	DRAFTSMAN: T.G.D.S.
PROFILE LINE 92000m N.	DATE: Jan. '87
SCALE 1:500	REVISIONS:
5 0 5 10 METRES	FILE NO.
	FIG. 9

8265

48200m E.

48300m E.

48400m E.

48500m E.

BP 33

BP II

BP 10

PROJECTED  
BP 36 92075N

Brown  
5YR 3/4  
5YR 3/4

10YR 6/2

5YR 3/2

260m

240m

220m

200m

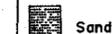
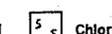
634062

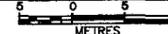
5 cm

8265

89-2964

LEGEND

-  Clay
  -  Sand
  -  Gravel
  -  Sands & gravels
  -  Chloritic schist and sandstone
- BROWN PLAINS FORMATION
- TIMBS FORMATION

SAVAGE RESOURCES LIMITED	
SAVAGE RIVER - R.L.8803	DRAWN BY: R.A.
BROWN PLAINS CLAY	DRAFTSMAN: T.G.D.S.
PROFILE LINE 92100m N.	DATE: Jan.'87
SCALE 1:500	REVISIONS:
	FILE NO.
	FIG. 10

8266

48100m E.

48200m E.

48300m E.

48400m E.

BP 13

BP 35

BP 12

BP 34

Brown

Sandy

5Y 7/2

Sand content increasing

Brown

Brown

10YR 5/4

5YR 3/2

5Y 7/2

Grey

LEGEND

Clay

Sand

Gravel

Sands & gravels

Chloritic schist and sandstone

BROWN PLAINS FORMATION

TIMBS FORMATION

260m  
240m  
220m  
200m

634063

5 cm

8266

89-2964

SAVAGE RESOURCES LIMITED	
SAVAGE RIVER - R.L.8803	DRAWN BY: R.A.
BROWN PLAINS CLAY	DRAFTSMAN: T.G.D.S.
PROFILE LINE 92200m N.	DATE: Jan.'87
SCALE 1:500	REVISIONS:
5 0 5 10 METRES	FILE NO.
	FIG. 11