East End Mine Action Group (Inc)

10 November 2014

Select Committee into Certain Aspects of Queensland Government Administration relating to Commonwealth Government Affairs,
PO Box 6100
Parliament House
Canberra ACT 2600

By email only 10 attachments

Dear Sir/Madam,

Thank you for facilitating the Senate inquiry and presenting the opportunity for participation.

This submission is prepared to comply with the Terms of Reference of the Senate Inquiry into the current Queensland Government.

Terms of Reference

The trigger mechanism rests with the Queensland Government's evasion of their responsibilities under the principles and objectives of the National Strategy for Ecologically Sustainable Development (particularly the Precautionary Principle) established in relation to entering into international conventions on the environment; and under Water Reform and the National Water Initiative. See attachment NWC biennial assessment of NWI 3.12.2010

We allege that recently enacted legislation by the State, and recommendations of 28 October 2014 by the Department of Environment & Heritage Protection (DEHP) on the East End Mine No 5 Project fails to act to ensure the principles and objectives of ESD are adhered to; continues to absolve East End mine from having to repair/prevent their widespread cumulative depletion of the water table into the future; and fails to treat the interconnected aquifer system as a single resource and to require the return of the overused aquifer system to environmentally sustainable levels of extraction through use of the best available science.

Executive Summary

EEMAG Inc alleges that the current government like all its predecessors since the East End Mining leases were granted in 1976 (along with Special Agreement Act mine status in 1977) allows the mine to operate under minimum compliance conditions into the indeterminate future. In 2014 that original structure (contract) agreed between the mine and government remains unchanged under the policy of the present government and DEHP's recommendations. Historically and presently this *intentional* outcome is achieved by:

1. false benchmarking of science which is shaped to fit the political agenda;
2. an *unofficial* policy of non-enforcement of regulatory standards reinforced by legislative means;
3. non-enforcement of big ticket items, i.e. principles and objectives of ESD and Water Reforms, by fixing the mine's EA on non-recognition of extensive off-lease dewatering impacts.

1 False benchmarking of science shaped to fit the political agenda

The current East End Mine No 5 Project EIS application for new mining lease 80156 and amendment of its Environmental Authority that begun in 2009 *under the now Department of Environment & Heritage Protection* presented the opportunity to correct legacy issues embedded within the original approvals or to deal with further adverse impacts that have arisen over the life of the mine.

The difficulty is *original* approvals and further mining impacts identified over the life of the mine, are protected from change or challenge by legislation that provides for amendment of an Environmental Authority, with public objections restricted solely to the amendment – <u>i.e. it is forbidden to object against any inadequacies and inappropriateness of the original EA.</u> However this constraint is not considered to apply to DEHP. This evil law unjustly favours miners, discriminates against stakeholders and the environment and by example - that we will now elaborate upon, has destroyed the accountability of the current DEHP approval process for the East End Mine No 5 project.

2 An unofficial policy of non-enforcement of stated regulatory standards reinforced by legislative means

The current Queensland Government redrafted a number of existing Bills to frame the Mineral & Resources (Common Provisions) Bill 5 June 2014 (that may become law in December 2014,) that amongst other things reduces the scope of objectors and perpetuates [1] provisions that allows for an amendment of an Environmental Authority with public objections restricted solely to the amendment. The government could have rescinded the clause that prohibits public objections against the original component of an EA but chose not to do so, despite having a thorough understanding of its implications.

The consequence is that in the case of the East End Mine, deficiencies within the *existing* EA will be perpetuated indefinitely and the affected community must live with those imposts while continuing to subsidise the operations of the East End Mine through the mine being exempted from properly rectifying adverse impacts.

[1] *Environmental Protection Act 1994,* section 232(4):
'To remove any doubt, it is declared that a submission made under section 160, as applied under subsection (1)—
(a) may be made about an existing provision of the environmental authority only to the extent the provision is proposed to be amended under the amendment application; and
(b) cannot be made about activities carried out under the environmental authority before the deciding of the amendment application.
5 *Environmental Protection Act 1994*, section 189(1).

3 Non-enforcement of big ticket items, I.e. ESD and Water Reforms, by fixing the mine's EA on non-recognition of extensive off-lease dewatering impacts.

The final stages of the current East End Mine No 5 Project was handled by DEHP Brisbane. The question has to be asked why?

EEMAG's informed input as an *Advisory Body* to the EIS was basically ignored by the proponent and DEHP. Department of Environment and Heritage Protection's October 2014 assessment of the East End Mine No 5 EIS (that is available on their website) includes recommendations to the applicant on their Environmental Management Plan and draft EA.

As a participating and well informed party, EEMAG believes it is obvious that DEHP have defaulted on their wider obligations on a great many fronts.

Our comments on DEHP's 28 October 2014 recommendations on the draft EA:

- DEHP does not take into account Serious Environmental Harm due to constant mine dewatering that keeps surface flows and underground aquifers in a chronically depleted state. (Some 25 make good replacement water supplies have been provided to landholders at the company's expense) See attached DNR&W 2011, Map 19 based on DNR&W's interpretation of mine depletion of the East End aquifer to 2008. DNR&W evaluated the area affected by mine pit dewatering at approximately 50 sq km in 2008. Beyond the dotted line, insufficient monitoring points existed to make any definition. Map 19 has no content on claims of additional mine dewatering impacts upon Bracewell.

- The EIS proposes the existing mine will deepen from 45 to 90 metres AHD, and new ML Application 80156 to 90m AHD. The proponents used the discredited Dr Frans Kalf 1997 and 1999 *Darcian Flow* models (that were abandoned when they could not evolve) as a *valid foundation* on which to construct further Darcian Flow hydrology studies and to conclude that the maximum additional drawdown would be 2 metres. The EIS predicts mining will continue at the existing site for a further 55-70 years.

- Meaningful negotiations are unlikely to take place between EEMAG and the mine as DEHP have given the community no supportive grounds. EEMAG is placed in the invidious position of having to contest public objections against the EA *amendment* in the Land Court. EEMAG will incur the burden of financial costs for legal representation, expert witnesses and the inconvenience of time and effort to debunk the findings of a proponent that has spent five years preparing hypothetical hydrologelogical conceptualisations and assumptions about future impacts. On the other hand, the history and known facts of the company's operations under the *original* component of the EA that obviously represents the best possible guide to the future is exempted by legislation from consideration or *correction* of *its* gross inadequacies. EEMAG will strive for the Court's recognition that local limestone aquifers are complex karst aquifer systems and seek support of a grout curtain justified by the Precautionary Principle. However, even if the Court makes favourable recommendations, decisions remain at the Minister's discretion.
- In the East End Mine Supplementary EIS an assessment and costing was provided on the installation of a grout curtain to restrain water from reaching the East End Mine.

The proposition was costed at about $37,000,000 and was not adjudged feasible by the proponents. EEMAG obtained the assistance of Donald A Bruce an international expert who recommended changes to the methodology and the costed it at about $25,000,000.

- DEHP accepted EIS consultants Groundwork Plus's aquifer conceptualisation and accompanying explanation that conduits are mainly clay filled and that the conceptual models, quote, "The bottom layer (Layer3) has a low secondary porosity and comprises limestone with closed fractures." to discount the relevance of karst, particularly at depth. DEHP unjustifiably failed to adequately consider submissions containing hard evidence to the contrary and the opinions of three experienced karst aquifer practitioners, independent of Government and the East End mine, that local aquifers constitute a complex karst aquifer system with *viable* sinkholes and interconnections between surface flow and groundwater, including *viable* conduit activity at depth.
- DEHP failed to include karst as an environmental value, recognise eco system damage, and did not adhere to the Precautionary Principle of Ecologically Sustainable Development.
- All company and Departmental hydrology findings rely upon inappropriate Darcian Flow methodology (i.e. even predictable groundwater flow like in a sand aquifer) and dissenting evidence from EEMAG and our experts is not incorporated in their reports. Local limestone aquifers are demonstrably complex karst with viable sinkholes i.e, surface to underground water connections, sinking streams, springs and a secondary network of randomly occurring conduits with unpredictable flows. When the mine pit intercepts secondary conduits they can dewater the length of the conduit to that level. Karst typically results in much more rapid transmission with the additional potential for catastrophic inflow if a major conduit is intercepted. Currently, the mine operates below sea level. It is recognised in Australia and internationally that Darcian flow methodology is inappropriate to assess groundwater flows in a karst aquifer system with conduit flows.
- EEMAG and our experts on limestone hyrogeology consider the methodology adopted for evaluating local hydrogeology and future drawdown effects is fatally flawed and invalid for the purpose. The EIS is therefore considered to contain NO relevant risk analysis or reliable assessment of the further likely drawdown upon the already severely depleted aquifers.

See copy of conjoint letter and CV's of EEMAG hydrologists Dr Peter James, Dr Brian Finlayson and Dingle Smith sent to the minister of Natural Resources & Water in 2007 expressing concern about the lack of recognition of karst aquifer status and the use of Darcian Flow and water contours as the principal means of evaluating karst limestone aquifers and stating that after a decade the major environmental impacts still need to be resolved rationally and quantitatively. See also Dingle Smith's Groundwater hydrology study conducted for the 2003 Federally funded $100 K Mt Larcom Community Restoration Project Report that documents the importance of recognising karst aquifer behaviour. See also Water injection of sinkholes on Lucke Farm and Inflow to sinkhole attachments. These documents provide physical proof of karst, expert evidence and strong grounds on which to challenge the veracity of DEHP's 2014 recommendations.

- DEHP's recommendations for a draft EA includes raising mine pit discharge volumes from 10 ML/D under recharge conditions to 30ML/D. Despite this additional drawdown and obvious catastrophic dampening effect on recharge, the EIS and the DEHP assessment fails to evoke the Precautionary Principle or to place any additional requirements upon the mine to remediate or provide additional safeguards to return the area of overuse to environmentally sustainable levels of extraction or protect the affected community beyond the unsatisfactory processes already in existence.

EEMAG alleges what has occurred / is occurring has been intentional and that the current government has knowingly acted dishonestly and dispensed political patronage with reckless indifference in regard to the accuracy of the science and traded off the welfare of the community affected by mine pit dewatering (water continues to be discharged as waste) and its detrimental affect upon the essential natural water resource systems on which the health of the environment and biodiversity depends.

EEMAG believes it was incumbent upon DEHP to conduct a proper environmental oversight so as to arrive at a well informed risk assessment on deepening the mine from 45 to 90 M AHD. Presently the risk assessment is the equivalent of playing Russian Roulette with live ammunition in the chamber.

There is a long standing need to repair / prevent ongoing environmental harm to the karst aquifer system via a legitimate environmental assessment and issuing of NEW whole of project Environmental Authority that recognises dewatering impacts that have already occurred.

- Based on DEHP's 2014 recommendations the mine stands to receive ongoing unjustified approvals to deplete the interconnected karst aquifer system without limit while continuing to be exempted from proper compliance with ESD and Water Reforms.

3 Environmental Authority – how falsified approvals were granted

We have already shown how the defective component of an EA is perpetuated indefinitely. Historical evidence is now presented on just how the *original* component of the mine's whole of project EA was fixed in 2001 on the allegedly false and misleading mine consultant's Hydrology Report within the Gladstone Expansion Project EIS of 1996 that evaluated, quote, "pumping from the mine has created a steep drawdown cone extending approximately 500 metres from the pit boundaries" – in contravention of the Special Conditions attached to the leases that required analysis, compiling and distributions of hydrology reports - the report was the first hydrology report made public since the mine commenced operations in 1979 – a period of 16 years! The consultant's Report erroneously claimed there were only negligible off-lease dewatering impacts after 16 years of continuous mine dewatering. (No public objection process was permitted for the mine's 1996 trebled expansion and thus the disputed hydrology report could not be challenged.) See attached file CR Dudgeon Report

However, subsequent hydrology reports in 1997 by Dr Peter James found extensive mine pit zones of influence entrenched in both Bracewell and East End aquifers; in1998 DNR interpreted the water monitoring data and found a 20 sq km mine pit zone of influence at East End in 1991 – 5 years prior to the 1996 EIS and 22 sq kms in 1998. See attachment Figure 9. Mine Consultant Dr Kalf 1999 determined a 33 sq kms mine pit zone of influence at East End while Dr Waterhouse for EPA May 2001 confirmed Kalf's 33 sq kms zone.

See attached Freedom of Information EPA Memorandum of 22/10/2001 that reveals EPA in 2001 chose not to use those hydrology findings of off-lease impacts produced after 1996.

Instead, EPA in 2001 - desperate to provide an EA so that leases that expired in1997 and had continued to operate under the discretion of the various Minister for Mines could have the tenure renewed - after receiving an application for a NEW EA rejected it and then facilitated an *amendment* to the EA as a precursor for lease renewal in 2003 by ruling that the 1996 EIS findings were "still valid." with no significant increase in environmental harm. EPA's 2002 amendment of the EA had no legal pathway and subsequently required retrospective legislation to bring it into legal conformity. (Documents and legislation available on request)

Other than a monitoring program, DEHP's proposed 2014 East End Mine Environmental Authority *still* has NO conditions to minimize / repair off-lease water depletion despite the existence of numerous hydrology studies identifying widespread off-lease mine dewatering impacts OR to consider wider depletion claims upstream at Bracewell, shown as Area B in CRP Fig 3 / DNR Figure 8 attached.

We respectfully request you to read the text of David (Dingle) Smith's Groundwater hydrology study (attached) conducted for the Federally funded 2003 Mt Larcom Community Restoration Project Report that explains the crucial importance of recognising that the limestone aquifer system intercepted by the East End limestone mine is a complex karst aquifer system. Smith (one of Australia's leading limestone hydrologists) also reviews many of the Hydrology reports on the mine's impacts.

EEMAG were not privy to how the DEHP arrived at their determinations but their 28 October 2014 recommendations to the proponent suggests that DEHP have retained their reliance upon the consultant's Report within the 1996 EIS with its effectively no off lease mine dewatering impacts.

Appendages

Within the EIS, DEHP leaves unchallenged numerous false claims by the proponent. As an example, within the Executive Summary on page 9 and elsewhere, quote, "Mine dewatering at the existing mining operation has caused a cone of water table depression ("drawdown") to gradually develop around the East End Mine. In combination with *recent low rainfall amounts,* this drawdown has impacted mostly on bores closest to the mine to varying extents." My italics.

The reference to "recent low rainfall amounts," is a blatant disregard of factual circumstances. Rainfall source Brady gauge approximately 8 km southwest of the mine

In their 2011 Hydrology Study DNR&W quoted local annual average rainfall at 912.72 mm

Rainfall, calendar year		2010	1,962 mm (second highest annual rainfall on record)
		2011	912
		2012	984
		2013	1,567
	To 8/11/14	2014	776

Prior to 2010, local aquifers were severely depleted by a combination of constant pumping and lack of recharge due to ongoing drought. Mine pit water discharges averaged less than 2 ML /day. In March 2011 Cement Australia received DEHP approval to increase mine pit water discharges from 6 ML/d and under recharge conditions 10 ML/d to a maximum of 30 ML/day under controlled conditions.

Mine pit discharges, financial year	2010-2011, 2826 ML or 7.7 ML/day.
	2011-2012, 2,326 ML or 6.4 ML /day.
	2012-2013, 5,471 ML or 15 ML/day.
	2013-2014, 2,820 ML or 7.2 ML/day.

Obviously claims of "recent low rainfall amounts" is entirely without substance and although the erroneous statement was brought to the attention of DEHP they did not correct the record.

For the past nineteen years the East End Mine Action Group (EEMAG) has been in dispute with the East End Mine and every state government over the minimum compliance strategy under which the East End Mine operates.

We have made many submissions to both Federal (see example to NWC attached) and State seeking to have the East End Mine's EA made representative of their environmental impacts. The East End Mine No 5 Project is just another example of a long line of political and officially made decisions disguised by the appearances of a legitimate process while duplicitously providing approvals to the operators of the East End mine via allegedly corrupted science, pseudo consultation and disempowerment of all other stakeholders.

In September 2013, I donated a printed copy of my book Road to Exploitation, subtitled Political Capture by Mining in Queensland to each of the eighty nine State politicians. The book provided evidence backed up by documents to support every allegation and detailed the background circumstances of how the mine operates under political patronage and an unofficial policy of non enforcement of regulatory standards legalised by false benchmarking of the science. I have not received any challenge to the authenticity of the book's contents. Ignorance is no defence before the law, particularly when it can be shown that the powers-that-be have intimate knowledge and are party to such odious circumstances.

In view of the false benchmarking of the science, corrupted nature of project approvals and the lack of commitment to valid regulatory supervision EEMAG believes it is totally inappropriate and foolhardy for the Federal Minister to delegate Commonwealth approval powers to the state.

Yours faithfully,

Research & Communication Officer for
East End Mine Action Group Inc

This submission is authorised by members of EEMAG Inc

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THE UNIVERSITY OF NEW SOUTH WALES
WATER RESEARCH LABORATORY

GROUNDWATER MONITORING AROUND BRACEWELL – EAST END LIMESTONE MINING LEASES

by

C R Dudgeon

Technical Report No. 95/08

August 1995

PREFACE

The work reported herein was carried out and is published under the direction of the Director of the Water Research Laboratory, acting on behalf of the client, Queensland Cement Ltd.

Information published in technical reports is available for general release only by permission of the client and the Director.

SUMMARY

Queensland Cement Ltd (QCL) holds four limestone mining leases near Mt Larcom, approximately 30 km west of Gladstone, Qld. The East End open pit mine in one of the leases has been used to extract limestone for cement making for the past fifteen years.

A monitoring network established to obtain baseline data on water table levels and quality and detect any alterations to the natural groundwater regime due to mining, is described in this report. Typical results are given.

The mining lease conditions nominate the Queensland Irrigation and Water Supply Commission (now absorbed into the Department of Primary Industries [DPI]) as custodians of data and arbitrator in the event of disputes with landholders. The lease conditions specify that owners of groundwater sources which pre-date the granting of the leases are to be provided by QCL with alternative supplies.

DPI plots of water level and conductivity data provided by QCL's consultants for all water sources monitored are available to supplement this report.

The East End mine has produced a steep local drawdown cone limited to a distance of the order of half a kilometre from the pit. Water table levels have fallen significantly in this zone and are controlled mainly by the mine. Outside this zone water table levels are controlled more by the balance between recharge and depletion of the aquifer by natural drainage and mine de-watering.

The simultaneous occurrence of mine expansion and the worst recharge conditions on record because of drought have made it difficult to distinguish between the effects of drought and the effects of mine de-watering. It is the author's opinion that under existing drought conditions, water levels between 0.5 and 1 kilometre from the mine are of the order of 2 metres lower than they would have been in the absence of the mine. Although it is believed the available evidence indicates that water levels in water sources close to the mine are not greatly below levels which would have occurred due to natural gravity drainage of the aquifer, some landholders have experienced water supply problems. QCL has already assisted four landholders who have water sources where the water level has fallen below the bottom of the well/bore or below the pump intake.

In future wet weather conditions the rapid drainage of water into the mine through solution channels in the upper 10 m of the limestone will prevent water levels near the mine

recovering to normal levels. Under these conditions water levels could be 10 m below original natural values a short time after significant recharge from heavy rainfall. However, in such circumstances there will not be a heavy demand for groundwater and the few landholders close to the mine will not be seriously disadvantaged in relation to existing water use for stock and domestic purposes.

A more definite appraisal of the effects of mining in the groundwater regime must await the next major spell of wet weather.

CONTENTS

LIST OF FIGURES

1. INTRODUCTION

This report on the results of monitoring groundwater and stream flow conditions around mining leases held by Queensland Cement Ltd (QCL) in the Bracewell – East End area is intended to provide information to local landholders and other interested parties about the extent of the zone which has been significantly affected by the de-watering of the open cut limestone mine at East End. It is an interim report because a major aquifer recharge event is required before long term changes to the groundwater regime near the mine can be fully assessed. This will not occur until a good summer wet season arrives and ends the drought. A more comprehensive report will be prepared when this happens.

2. BACKGROUND TO WATER MONITORING

When the mining leases were granted to QCL in 1976, a condition was imposed to ensure monitoring of water table levels and groundwater quality and baseflows in creeks which might be affected by mining. QCL commissioned the Water Research Laboratory (WRL) to prepare a proposal for the monitoring program. This proposal was approved by QCL and the Queensland Irrigation and Water Supply Commission (IWS) after some modifications were made and agreed by both parties.

In 1977 a letter addressed to Mr G A Lucke, Chairman of the Mount Larcom and Districts Protest Group, was provided by IWS for distribution to interested landholders to outline the monitoring requirements and request their co-operation in the collection of data. In the letter it was stated that the duties of the Company (ie, QCL) and its consultants were "merely to collect basic data relating to the groundwater supply" and that "Any determinations of the effect of mining operations on groundwater supplies will be made by the Irrigation and Water Supply Commission."

The lease conditions state that QCL must provide an alternative water supply in place of water sources which existed prior to the granting of the leases and which are injuriously affected by mining.

3. COLLECTION AND REPORTING OF DATA

QCL retained WRL to set up the monitoring network and make the required measurements. Since the inception of the monitoring program, data has been collected by WRL (acting through Unisearch Ltd) and reported to the Brisbane and Rockhampton offices of the appropriate Queensland Government department, originally IWS, now the Department of

Primary Industries (DPI). The data is also provided to QCL. The work has been supervised by Dr C R Dudgeon, formerly Director of WRL but now retired from that position and currently a Visiting Professor at WRL and consultant to Unisearch Ltd.

Data from some water sources owned by landholders who objected to the Company's consultant collecting the data have been measured by IWS and subsequently by the Water Resources section of DPI.

4. MONITORING NETWORK

The lease condition requires monitoring to be carried out in a rectangle extending 11.8 km east – west and 7.3 km north – south surrounding the four limestone leases granted to QCL. The boundaries of the rectangle are set by the lease conditions as lines of longitude 150° 52′ E to 150° 59′ E and latitude 23° 51′ S to 23° 55′ S. Figure 1 shows the rectangle and the leases.

An initial inventory of wells and bores was compiled by interviewing landholders. The locations were marked on the cadastral map covering the area (see Figure 2) and data concerning the construction, equipment and use of each water source were recorded. Table 1 shows the locations of water sources in Figure 2. The inventory was followed by a level survey to determine the elevations above Australian Height Datum (AHD) of reference points below which the water table level could be measured in each well and bore. Bench marks were left to ensure that reference levels could be recovered in case the reference marks were destroyed for any reason.

Nine observation bores were drilled to a depth of 100 metres in the limestone bodies to be mined to give additional water levels. Three of these are in the limestone currently being mined.

Seven measuring weirs with automatic water level recorders have been constructed on Hut Creek (1), Larcom Creek and tributary (3), Machine Creek (2) and Scrubby Creek (1).

Four storage rain gauges were installed in the ground, one in each lease, to allow total rainfall between monitoring visits to be determined. Two pluviometers, one at the mine discharge weir and the other at the Machine Creek weir, were connected to water level recorders to measure rainfall intensities. A weather station was set up near the existing mine to provide temperature and humidity data.

5. PERIODIC MEASUREMENTS

Measurements of water table levels are made four times per year in wells and bores listed in the initial inventory. Water levels have also been measured in some wells and bores outside the monitoring rectangle and in some other bores constructed since the leases were granted when it was considered that these could provide useful information. Water conductivity measurements are made on samples taken from water sources at the time of each visit. At two yearly intervals, water samples are collected and sent to the laboratory to allow full chemical analyses to be carried out.

The water level and conductivity at each weir is also measured four times per year and the recorder chart operation checked. The recorder chart scales used allow one chart to record up to seven months' data.

6. ADDITIONAL MEASUREMENTS

Additional water level measurements have been made in water sources and observation bores near the East End mine after abnormally heavy and prolonged rainfall to allow a better picture of the recharge pattern to be built up.

An extensive set of data on the groundwater regime close to the mine has also been gathered by measuring water levels in boreholes drilled around the mine. Most of these holes were drilled for mining purposes but some have been drilled for the specific purpose of determining the behaviour of the water table close to the mine.

7. REPORTING AND STORING RESULTS

Water level and conductivity results required by the lease condition were originally reported to IWS but now to DPI. Copies of the data are held in Rockhampton, Gladstone and Sydney. DPI hold the data in their computer data base.

Records of water levels in creeks at the measuring weirs are in the form of continuous charts and are held by WRL in Sydney.

8. INTERPRETATION OF RESULTS

8.1 Investigations to Date

As pointed out earlier, interpretation of the monitoring data to resolve any disputes between QCL and landholders is now the responsibility of DPI. However, analysis of the data has been made for QCL by WRL for three reasons.

The first need to analyse both the routine monitoring data and the additional data collected from mine boreholes arose because of the need to predict pump capacities required to de-water the mine and pumping rates to be allowed for in the discharge licence. The study of the drawdown profile near the mine associated with this investigation also allowed the high water levels encountered in blast holes to be explained.

The second use of the data was to provide information for the granting of a licence to discharge water from the mine into the Larcom Creek system.

The third reason for analysing data has been to provide QCL with opinions as to whether mining has had a significant effect on the ability of several water sources near the mine to continue to supply water during periods of low rainfall and aquifer recharge. As a result of these investigations QCL has cleaned out bores and lowered pumps for two landholders (B28, Currell; B41, Geaney), drilled a new bore and provided a windmill for another (B26, Coller) and is providing a water supply for stock for another (W33, McInally) using water pumped from the mine.

To date, all problems attributed to the effects of mining have been resolved without the need for IWS or DPI to carry out interpretation of data and resolve disputes.

More general data analysis work has been carried out as part of an ongoing program of research aimed at understanding the behaviour of the complex aquifer system. In particular, the effects of geological structure, solution channelling and fracturation of the limestone and non-Darcy flow in controlling the water table profile close to the mine have been studied. Some research papers dealing with these aspects are referenced at the end of this report.

8.2 Reports

Since the only requirement of the lease conditions is the collection and provision of water level and quality data, no previous interpretative reports have been prepared for IWS or DPI. However, regular contact has been maintained with IWS and DPI officers in

Rockhampton to discuss groundwater conditions in the Bracewell – East End area, the diversion of surface water around the mine and disposal of water into Larcom Creek.

A brief summary of groundwater and surface water conditions is provided to QCL with results after each monitoring trip and additional reports are provided to the Company when advice is required.

9. OBSERVED EFFECTS OF MINING AT EAST END

9.1 Surface Water

The only significant effect the East End mine has on surface water is on the Larcom Creek system. Water pumped from the mine is discharged from settling ponds into an originally ephemeral tributary of Larcom Creek. Flow and water quality are monitored at two weirs between the mine and Larcom Creek. Downstream from the weirs, water flows into a shallow lagoon before entering the creek. The water discharged from the mine maintains the lagoon full whereas previously it dried out during prolonged periods of dry weather. As a result, the salt content of the water in the lagoon and in Larcom Creek downstream from the point of entry of the overflow from the lagoon varies much less than it did prior to mining.

The higher average water level in the lagoon caused swampy conditions to prevail between the lagoon and the creek for a higher proportion of the time than that which occurred before mine de-watering commenced. At the request of the affected landholder (Schulz), and with the concurrence of Water Resources, QCL constructed a channel from the lagoon to the creek to allow overflow to occur without causing swampy conditions. A submerged rockfill barrier was constructed across the creek upstream from the point of entry of water from the channel to prevent the movement upstream of saltier water from the mine when less salty surface water was flowing in the creek after rainfall. Recently, somebody, presumably the landholder, has blocked the outlet from the lagoon to the channel and caused a large area of swamp to re-form between the lagoon and the creek. The consequent increase in evaporation from the increased water surface area is decreasing the flow into Larcom Creek.

9.2 Groundwater

The bottom of the mine is now at 0 metres AHD (ie, at about mean sea level and 45 metres below original ground level). Since mining commenced, the discharge of water from the mine has varied between about 10 and 40 litres/second (1,850 to 3,400 cubic metres/day), depending on the surrounding water table level which varies with rainfall conditions. In July 1995 the average daily pumping rate was less than 10 litres/second. It is possible that under present conditions some proportion of the flow from the mine is re-cycling between the lagoon, swamp and creek and not being drawn from groundwater storage. This possibility is the subject of a current investigation.

Currently, during what, for groundwater, is probably the worst drought experienced since the area was subdivided into miner's homestead leases, the mine has not had a large effect on water table levels outside the limestone body being mined. This conclusion is based on comparison of the behaviour of the water table in and around this limestone and other limestone bodies in the monitored rectangle.

Two main reasons can be given to explain the relatively restricted zone of influence of the mine. They are linked to the geology of the limestone deposit.

The limestone body being mined is approximately 3 km in length and its average width is about 0.5 km. It is aligned approximately north west – south east, parallel with the regional fold axes. Its long sides are bounded by volcanoclastic rocks. Its ends appear to be formed by north east – south west trending faults which bring the limestone into contact with volcanic or volcanoclastic rocks.

Solution channelling in the upper part of the limestone has resulted in the limestone being much more permeable than the surrounding volcanic and volcanoclastic rocks. Because of this, the primary effect of pumping from the mine has been to draw down the water table in the limestone, leaving the water table in the much less permeable surrounding rock relatively unaffected. The drawdown cone in the limestone is also much steeper than conventional Darcy flow analysis would predict because of the high rate of non-linear head loss as the flow approaches and enters the mine through a limited number of fractures and solution channels in the limestone.

Initially, the drawdown "cone" was elongated along the strike direction because of preferential solution channelling along fractures in this direction. However, as the water table has fallen as a result of de-watering and lack of recharge during the drought, this effect has been reduced and the greater influence of the more isotropic fracture system at depth has caused the drawdown "cone" near the mine to become more symmetrical and even steeper than in the early stage.

Even though the bottom of the mine is now at 0 m AHD and the water table in the pit is maintained at or below this level, in May 1995 the water table approximately 200 m from the pit (Observation bore 02) was at 33.8 m AHD, ie, about 34 m above the bottom of the pit. At that time the water level approximately 1 km north of the mine (Bore B42, Geaney) was at 35.6 m AHD and 1.5 km to the north-east it was at 37.1 m AHD (Bore B28, Currell). At the north western end of the limestone, approximately 2 km from the mine, the water table was at 36.5 m AHD (Observation bore 03 and bore B22, QCL).

The water table profile near the mine is shown in Figure 3. A more detailed picture of the relatively steep drawdown cone for a range of surrounding water table levels and pit depths is given in Figure 4. Only the bottom level of the pit is shown to avoid confusion. Note the relative insensitivity of the water table profile near the mine to mine depth and rainfall/recharge conditions.

Figures 5 to 8 illustrate the development of the drawdown cone between 1978 and 1995.

In the volcanic/volcanoclastic rock complex beyond the limestone the water table has not shown any significant influence of the mine although a slow migration of water towards the mine must be occurring from areas with more elevated water tables. However, this has always been the case prior to development of the mine.

Unfortunately, no records are available of the levels to which the water table dropped during droughts which occurred before mining commenced. However some evidence can be obtained from the levels to which wells have been sunk to obtain water. Without modern excavating and pumping equipment, a well would not have been sunk to a depth much greater than that required to encounter a reasonable "stream" of water. In subsequent droughts, wells would have been deepened until water again flowed into the bottom of the well and some storage was provided. This agrees with recollections of some long-term landholders. The argument cannot be used for bores which could more easily be sunk well below the water table and in which the lack of storage required sufficient depth to be provided to allow for drawdown caused by pumping.

The bottom levels of wells close to the mine (eg, W33, McInally 35.6 m AHD and W53, ex Gent, now mined out, 36.5 m AHD) can be used as a guide to previous drought water table levels around the mine. These suggest that between 1 and 2 km from the mine the water table in limestone is now about 2 m lower than it would have been in the previous worst drought. For instance, in November 1994 the water level in W33 referred to above was at 35.9 m AHD, only 0.3 m above the bottom and for July 1995, when the well was dry, extrapolation of the recession curve gives a water level about 35.0 m AHD, 0.6 m below the bottom. These figures suggest that the water table is about 1 or 2 m below its previous lowest level.

Interpretation of the water table level results is complicated by the possibility of unknown hydraulically conductive connections between separated bands of limestone near the mine. For instance, well W33 (McInally) and bore B28 (Currell) appear to draw water from a band of limestone parallel to and to the north east of the band of limestone being mined. There may, however, be a reasonably efficient hydraulic connection between the two bands via a fault crossing both bands south east of the mine. Alternatively, the fracture permeability of the intervening rock may be similar to that of the limestone when the water table is very low. Although the mechanism is not clear, the mine appears to have caused a reduction of 1 or 2 m in these water sources in the current drought.

Similarly, bore B41 (Geaney) appears to be well connected hydraulically to the limestone being mined and appears to have suffered a fall of the same order.

10. COMPARISON OF WATER TABLE VARIATIONS OVER THE AREA MONITORED

10.1 General Principles

When a major recharge event results from prolonged heavy rainfall, water table levels rise until they reach a maximum when the outflow rate balances the rate of infiltration of rainwater. Since the ground surface and underlying rocks are very variable, recharge in the Bracewell – East End area varies widely from point to point. Water levels in some bores and wells rise rapidly whereas in others the recharge must move laterally from areas of direct vertical recharge to fill the voids in the aquifer and recharge does not become obvious until some time after rainfall commences. These effects are apparent when the water table and rainfall variations are compared for various water sources. Similarly, the initial rate of fall of the water table as the aquifer drains to creeks and lower lying areas varies from point to point.

Natural drainage of the aquifer under the influence of gravity results in recession curves which are characteristic of individual wells or bores. Extraction of water from the aquifer by pumping from this water source or other sources for which the radius of influence of pumping extends beyond this source will steepen the recession curve. A study of recession curves before and after the introduction of any significant new water extraction should reveal a change from the pre-existing condition.

Removal of significant volumes of water from the aquifer in the vicinity of a water source (well, bore or mine) should also show up in significant alteration of the recovery response of the aquifer locally. Unfortunately, rates of rise in many sources are much greater than subsequent recession rates and it is much more difficult to obtain good curves showing rates of rise. Another problem with attempting to analyse the rising limbs of groundwater hydrographs is that significant recharge events are usually made up of a number of superimposed rises resulting from variable rainfall and infiltration over a considerable period of time. However, an important indicator of the effect of significant extraction of water is the failure of the water table to return to its normal maximum level after a major recharge event when the water table in other comparable sources subjected to the same recharge does so. This effect has been demonstrated in wells and bores which are very close to the East End mine.

Typical water table variation graphs for observation holes and water sources in and around limestone being mined and not being mined are given in Figures 9 to 13. Rainfall data is included to allow the effects of recharge to be observed. These plots and others prepared by DPI to supplement this report will allow individual landholders to see how water levels and quality have varied in water sources of interest to them. Note that for the Bracewell – East End area, the average ratio of total soluble salts (TSS) to conductivity has been found to be 0.62,

ie, TSS (mg/ℓ or ppm) $\cong$ 0.62 × conductivity (μs/cm)

11. FUTURE WATER TABLE VARIATIONS

Because of the prolonged drought and low water table levels, the mine is now acting more like a mine in a complex fractured rock aquifer and drawing water from further afield. Because of the low permeability of fractured rocks in comparison with that of shallow limestone with significant solution channelling the rate of migration of water towards the mine is very slow.

The steep drawdown cone within 0.5 km from the mine will be present until mining ceases and the pit fills with water. The water table levels and gradients within this zone will vary with rainfall conditions.

Outside the steep drawdown cone the effect of mining will continue to be less.

In the limestone being mined, rapid drainage to the mine will occur after recharge while the water table is in the superficial zone of solution channelling. When the water table is below the main solution channels and in fractured limestone, drainage will be slow. The situation may be likened to placing a long tank with perforated walls and full of coarse gravel and water into a bed of saturated sand. Pumping water from the tank will result in a rapid fall in the water surface in the gravel and a relatively level water surface. In the surrounding sand, the lower permeability will allow water to seep into the tank through the perforated walls but the fall in the water surface level will be much slower. Capillary action in the small pores of the sand helps resist the flow as it does in the fractured rocks surrounding the limestone.

The level and shape of the water table in the steep drawdown cone close to the mine is controlled mainly by the pumping from the mine. In the area surrounding the limestone being mined the levels and shape of the water table depend on the balance between slow drainage towards the mine and recharge. Some approximate calculations illustrate this balance.

If 10 litres per second were pumped from the mine during drought conditions and the water were drawn uniformly from a 5 km radius, it would take approximately 2.5 years to reduce the water table level by 1 metre if the storage coefficient of the rock is 1%.

A recharge event averaging an accretion of only 10 mm of rainfall to the water table would restore the 1 metre depletion. This demonstrates the importance of recharge in comparison with the effect of mine de-watering under these conditions.

12. REFERENCES

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WATER RESEARCH LABORATORY, UNIVERSITY OF NSW
BRACEWELL - EAST END GROUNDWATER MONITORING

Table 1 MAP REFERENCES TO MEASURING SITES - OCTOBER 1990
(See attached part of Parish of Nolan Map for grid)

BORES

Site	Reference
B6	J6
B7	J6
B9a	H8
B9b(w)	H5
B10	G7
B12	D4
B13	D5
B14	D7
B15	H5
B17	C4
B19	G3
B22	C8
B23	C8
B24	A9
B26	D8
B27	B9
B28	C11
B34(w)	D12
B35	D6
B39	B3
B40	B6
B41	C10
B43	E3
B44	D3
B46	D2
B47	C3
B48(w)	D3
B50	E8
B51	C10
B53	B3
B54	B3
B55(w)	G10
B56	H9
B58	A4
B61	F9
B62	A5
B63	C8
B65	B4
B68	H8
B70	D6
B71	F3
B72	F3
B73 (now B79)	
B74	A9
B75	D12
B76	D6
B77	B11
B78	B8
B79	F3
B80	B3
B81	D6
B82	E6
B83	H6

WELLS

Site	Reference
W2	H3
W3	J6
W4	H6
W5	D4
W7	I5
W8	H4
W12	G2
W13	H1
W14	H1
W15	G2
W16	G2
W17	G3
W18	G3
W19	E2
W20	E2
W23	G1
W25	H4
W26	H3
W27	B5
W28	B6
W29	B5
W30b	B4
W33	D12
W41	E6
W43	C7
W46	D7
W48a	D2
W48b	D2
W49	C1
W50	D11
W51	D10
W54	E10
W55	E10
W56	E10
W57	G10
W58	B3
W60	B3
W63	A5
W64	E8
W65	F9
W66	B3
W67	E5
W68	E5
W69	F5
W76	H4
W77	A5
W78	B11

NOTE: (w) in Bore list indicates source is actually a well
CRD 24/10/90 Q C L

OBSERVATION HOLES

Site	Reference
01	R12
02	D10
03	C9
04	D6
05	C5
06	B3
07	C2
08	G2
09	G3

SPRINGS

Site	Reference
S1	G2
S1	H4

PLUVIOGRAPHS

Site	Reference
PL1	D11
PL2	B7

RAIN GAUGES

Site	Reference
R1	D10
R2	C7
R3	G2
R4	B3

WEATHER STATION

Site	Reference
WT1	D10

WEIRS

Site	Reference
WR1	D11
WR2	B7
WR3	F3
WR4	B1
WR5	A3
WR6	D11
WR7	H13

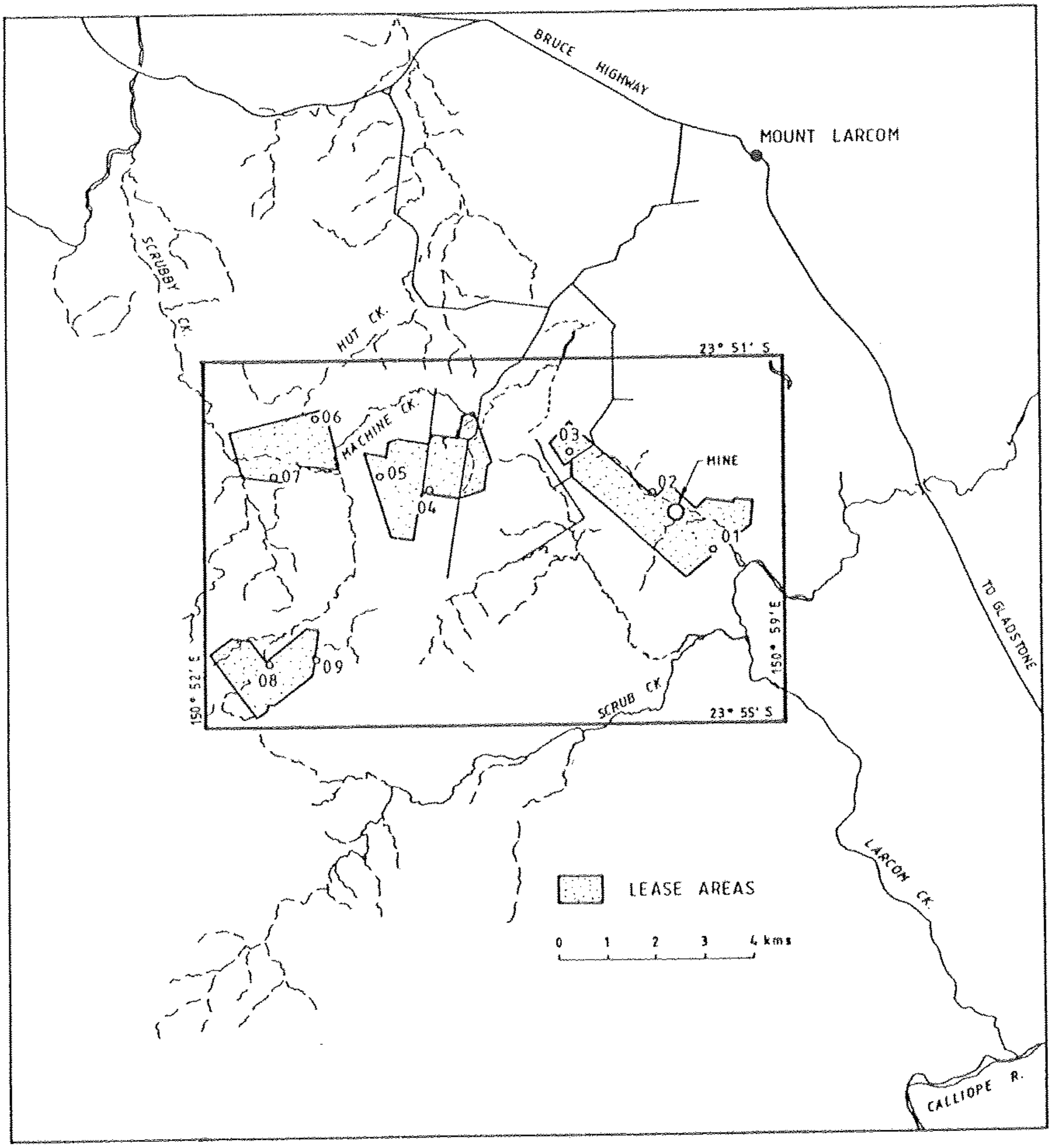


FIG. 1 LOCATION PLAN SHOWING MONITORING RECTANGLE

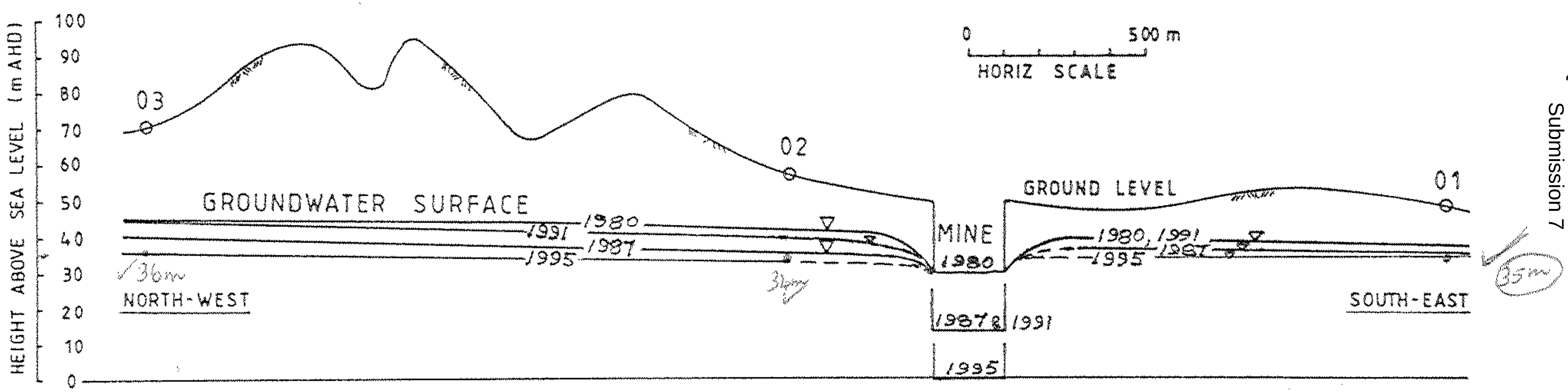


FIG. 3 GROUNDWATER SURFACE PROFILES AT EAST END MINE

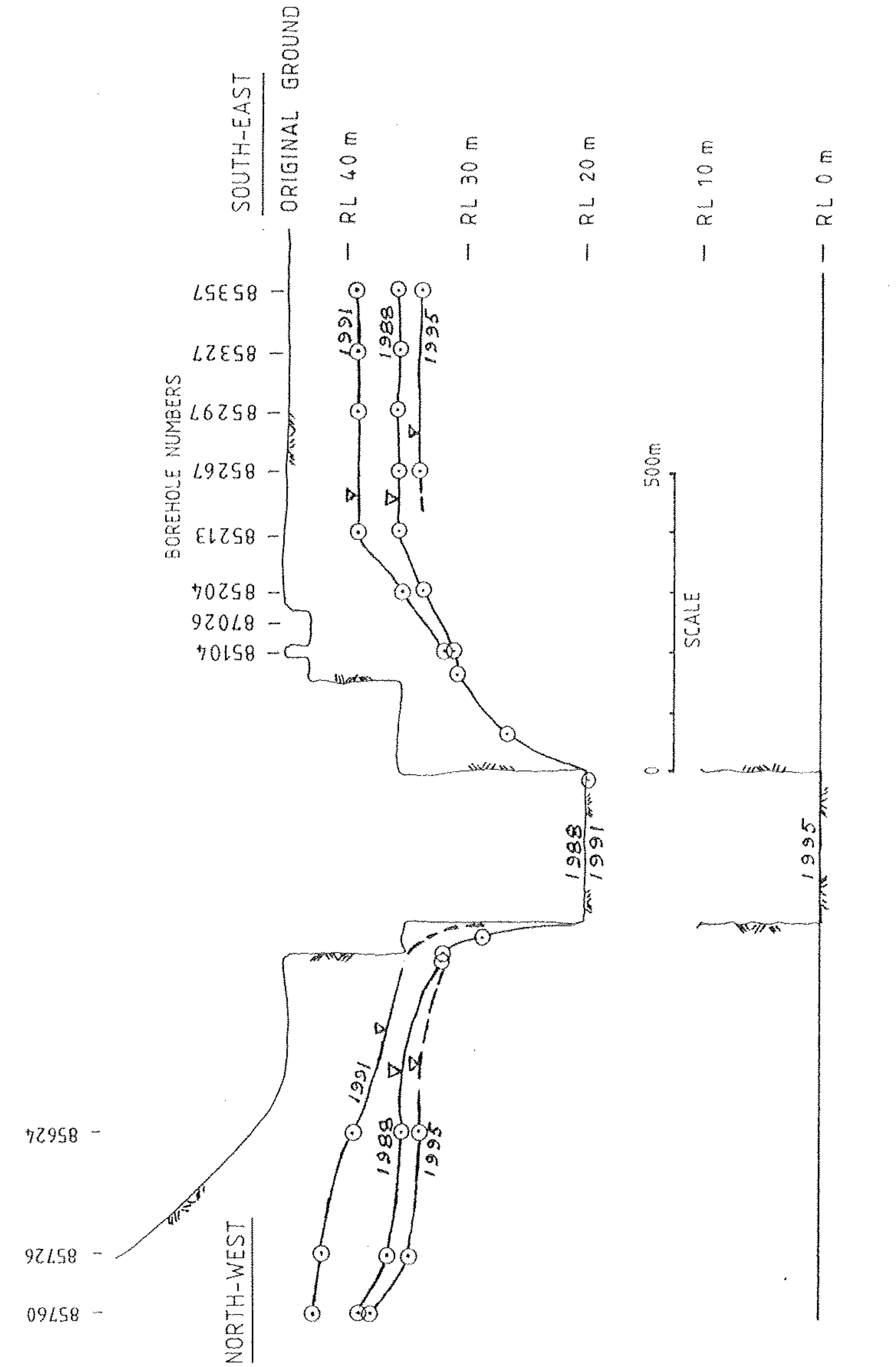


FIG. 4 EAST END MINE - WATER SURFACE PROFILE N.W. - S.E.
AT 7/8/88, 1/4/91 & 27/7/95

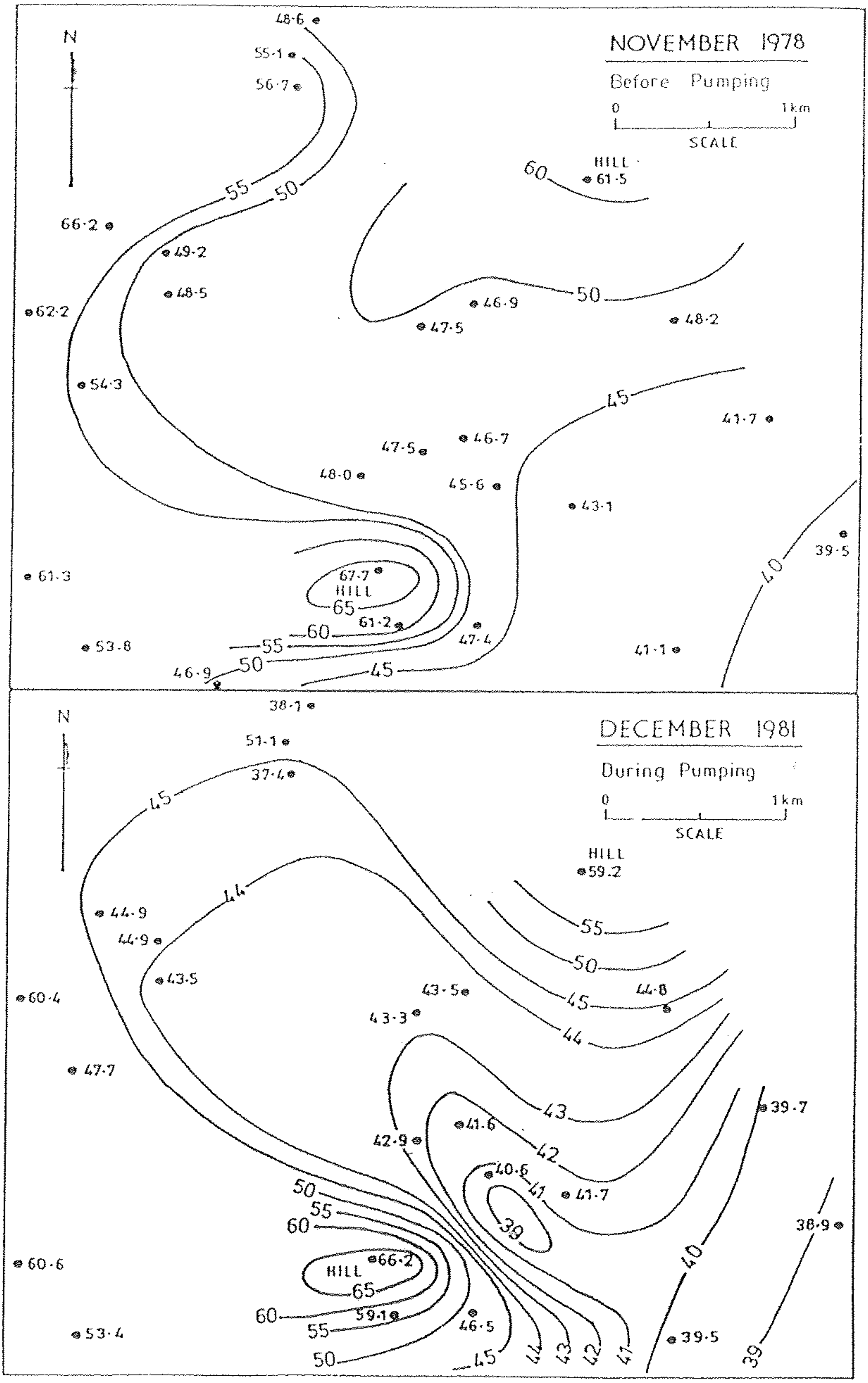
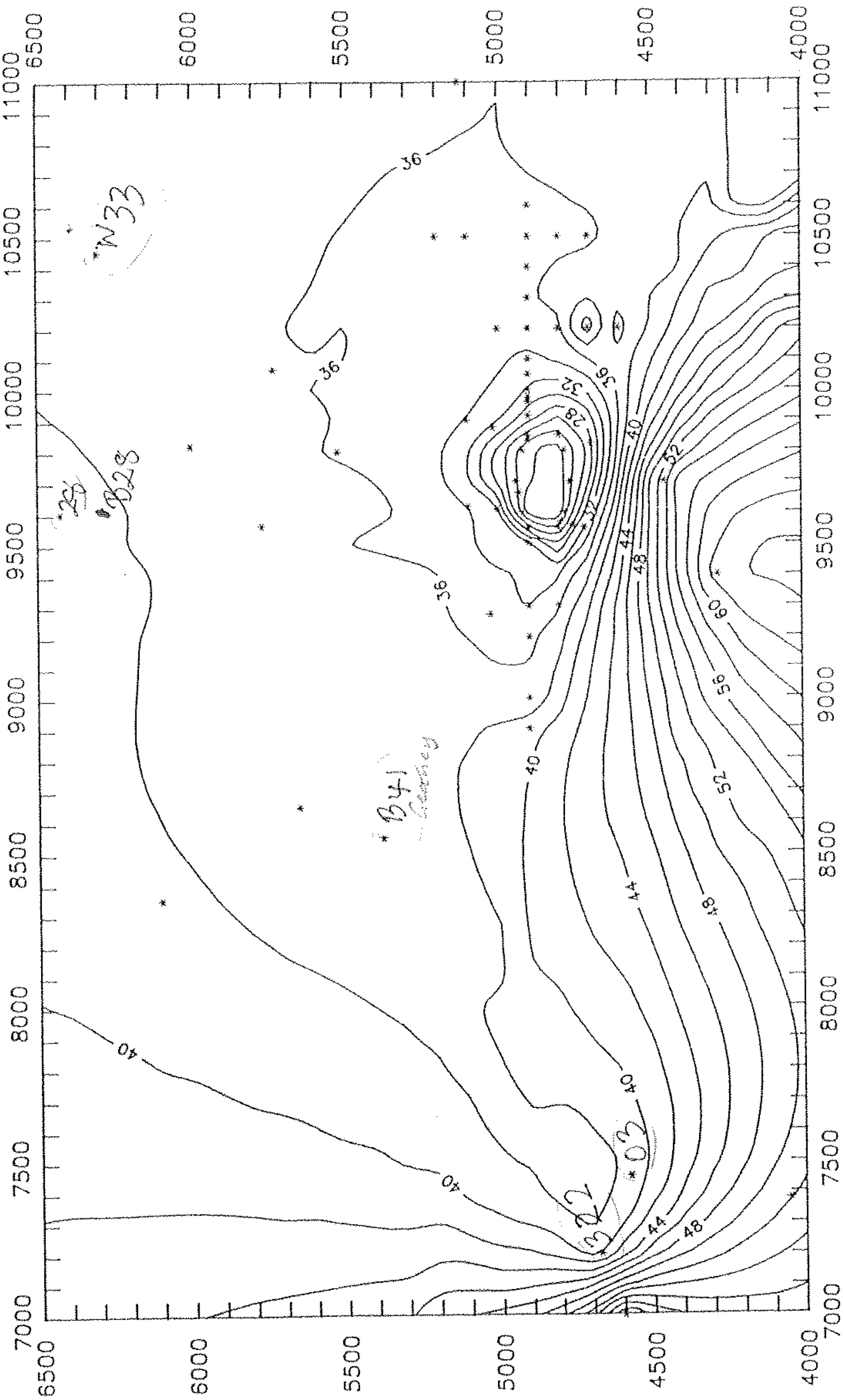


FIG. 5 Groundwater Surface Contours – 1978, 1981



Groundwater Surface Contours — September 1988

FIG. 6

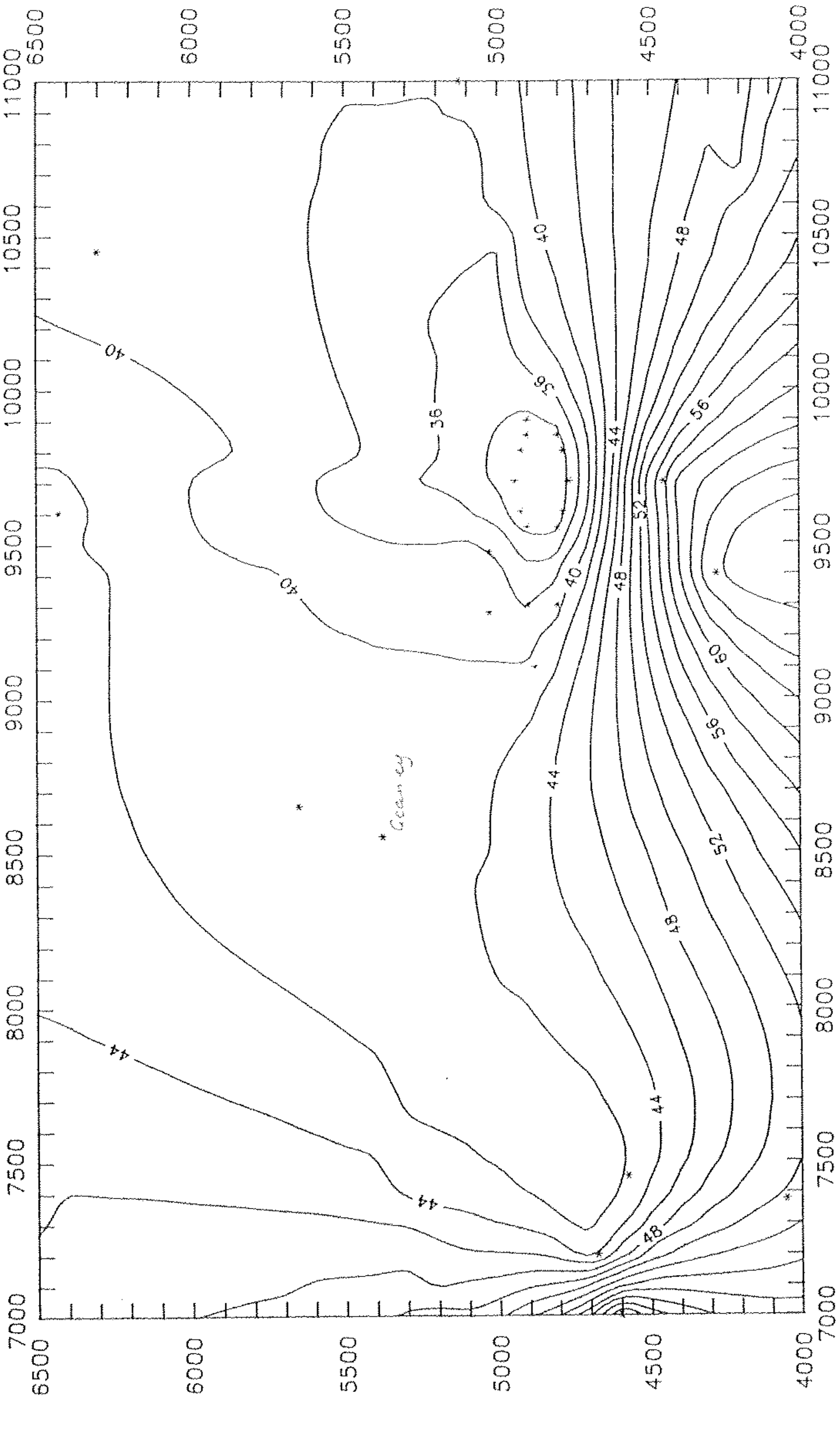


FIG. 7 Groundwater Surface Contours — December 1983

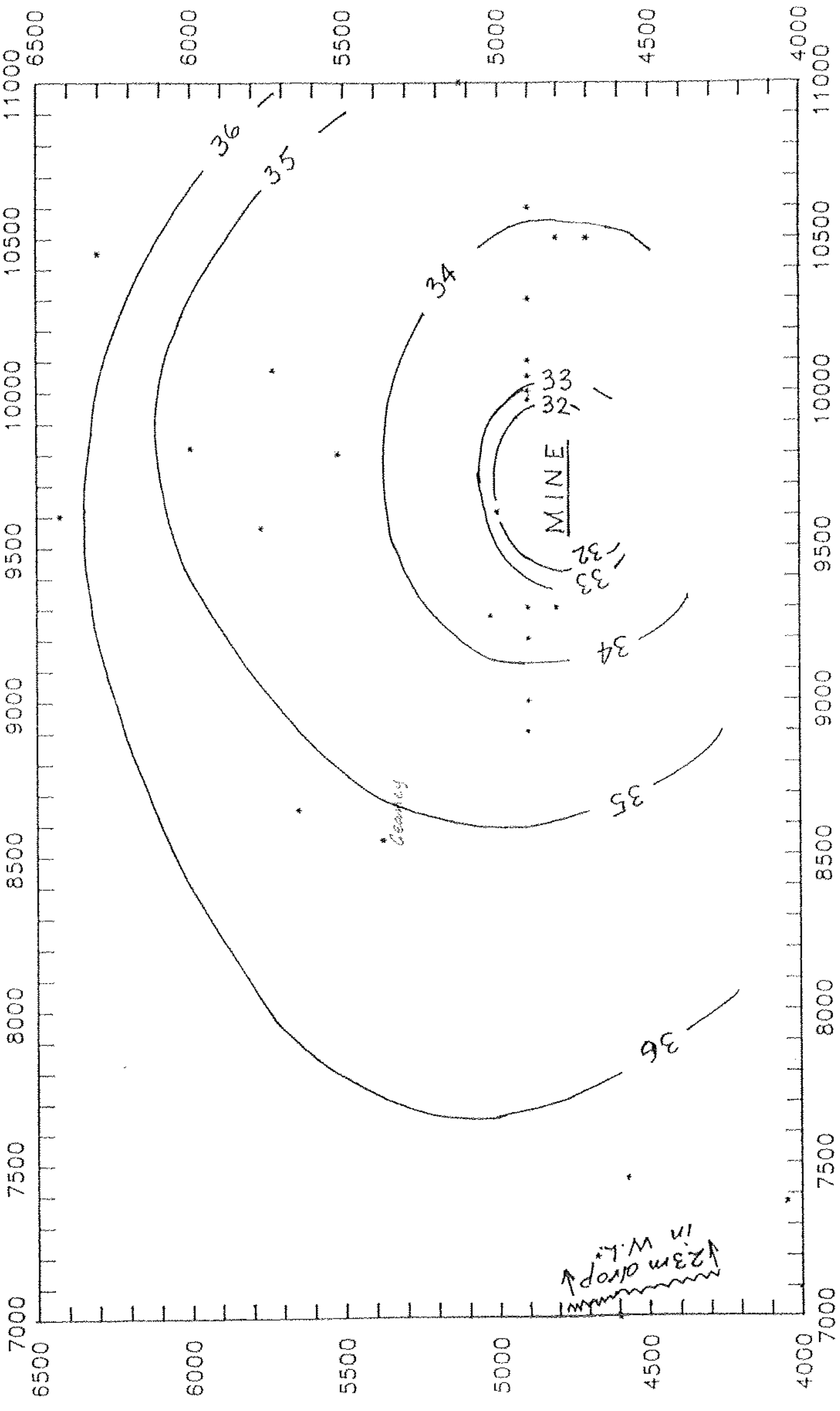


FIG. 8 Groundwater Surface Contours — July 1995

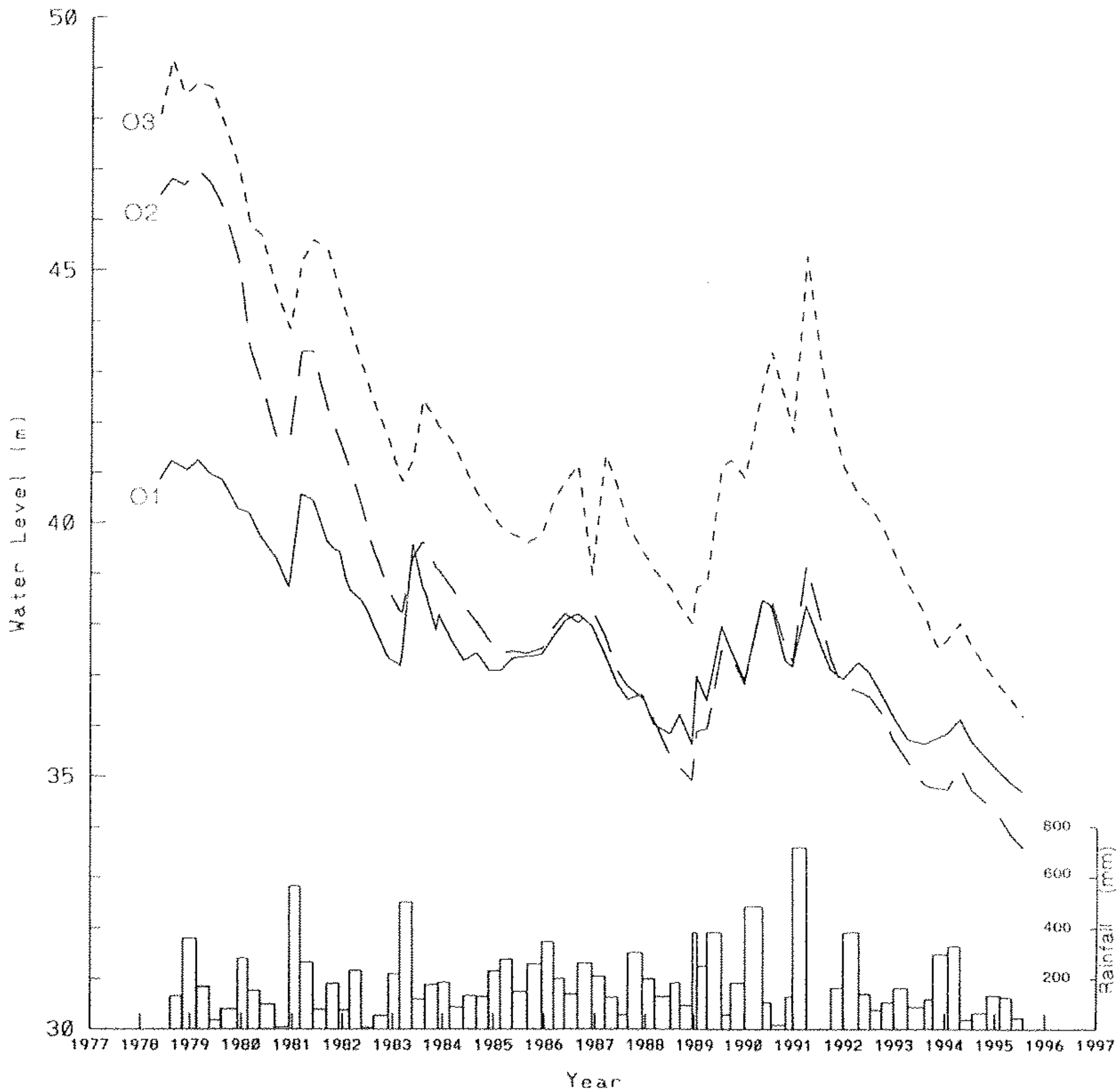


Fig. 9 Water Table Levels – Observation holes in limestone being mined

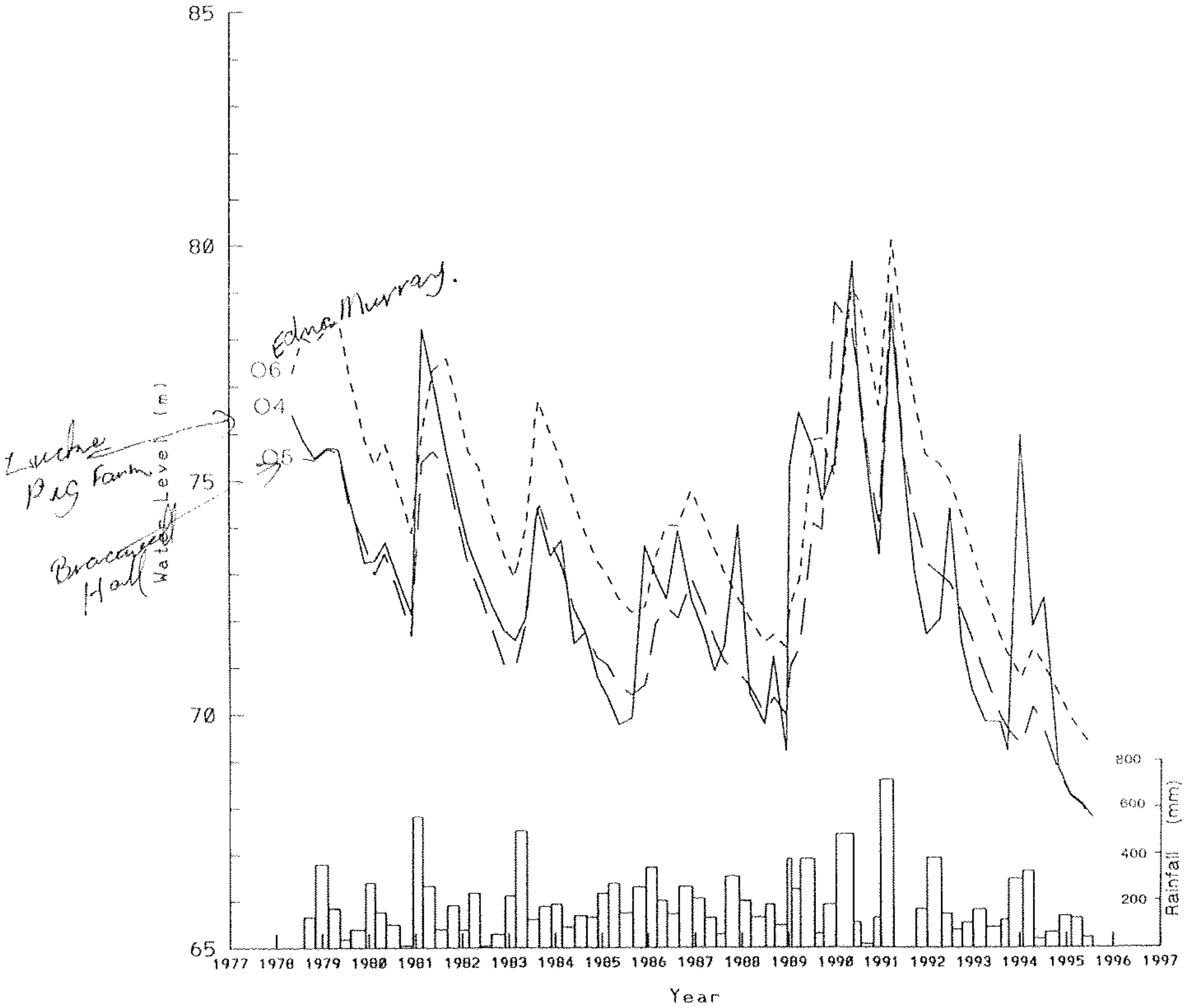


Fig. 10 Water Table Levels – Observation holes in limestone remote from mine

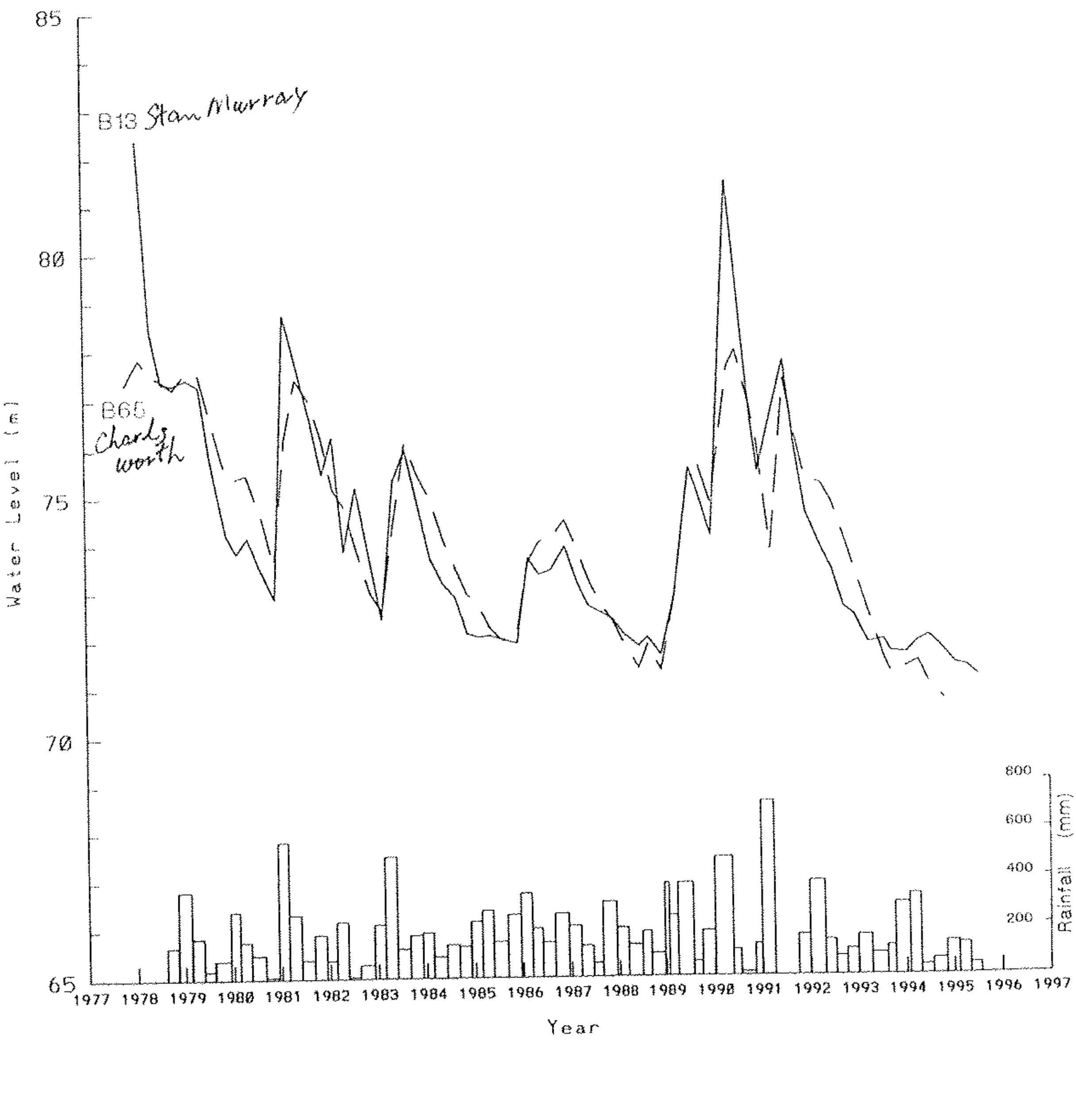


Fig. 13 Water Table Levels – Water sources near boundaries of limestone not being mined

Water injection of sinkholes on Lucke Farm

Introduction

DNR& M's negative assessment of Lucke Farm by Senior Hydrologist Jeff Lloyd, contained the following observation. Quote, "Another obvious karst feature of the area is sinkholes. The sinkholes apparent are generally the surface expression of a vertical shaft. On inspection it is found that most of the sinkholes are terminated by earth floors at fairly shallow depths, usually less than 3 m below the surface."

This assertion that the sinkholes are basically blind and a range of other equally inaccurate observations became the catalyst for a decision to record and systematically inject water into the sinkholes on Lucke Farm to prove their surface to aquifer connection. There are five sinkholes on Lucke Farm and one on Lake Road near Bore 04 about 10 m from the Lucke property boundary that have been pumped. Before proceeding with the outcome of the farm trial it may be beneficial to examine the nature of a karst aquifer, of sinkholes and their role from a hydrogeological and administrative perspective.

Karst aquifer status

Re DNR& M Investigation of Water Supply C Lucke & Sons, Bracewell via Mt Larcom by Senior Hydrologist Jeff Lloyd. Quote, "The results of weathering in limestone, solution and leaching, is known as karst. According to VT Springfield and Others, karst may be divided into two groups (1) surficial features that do not extend far below the surface: and (2) karst features that extend well below the surface and affect the circulation of the water below. It is my belief that the karst features at East End and Bracewell generally fit into type (1) karst."

Rebuttal

See Attachment A for the relevant extracts from a submission presented by C.H.C. Shannon on behalf of the University of Queensland Speleological Society to the 1975 Gladstone Warden's Court in relation to an application by Darra Explorations for extensive mining leases within the Mt Larcom district. Quote, "It is felt it is the duty of the University of Queensland Speleological Society to present information for the sake of conservation of the public interest, particularly on the subjects on which the Society is expert; limestone caves, karst landforms, the limestone 'scrubs', and bats."

The Society's submission is clearly predicated on the basis that Mt Larcom limestone deposits fit within category karst type 2 deposits.

Internationally experienced hydrologists Dr Peter James, Dingle Smith and Professors Ray Volker and Brian Finlayson have all visited and declared the local aquifer system with its caves, karst landform, sinking streams, springs, sinkholes and conduits to be karst aquifer type 2.

Hydrogeologically

Viable sinkholes are a feature of karst aquifer type 2 and where they survive intact they channel overland flow and serve as an example of surface and underground interconnectivity. Unfortunately, their role and value to the ecological system has not always been fully understood or appreciated. Farmers commonly use sinkholes as waste dump sites and during the intense agricultural phase of the 1950's and 1960's many sinkholes became either temporarily or permanently smothered by erosion from the cultivation. Where surface to underground connections are significant and velocity within the conduits or caverns sufficiently turbulent to keep silt suspended or to prevent blocking of pathways such sinkholes survive. Not all sinkholes are located within the gullies or watercourses. Many are found on the banks, on hills or in low lying areas. Apart from their role in facilitating direct infiltration of recharge they presumably also serve as the lungs of the system – allowing easy ingress of water through displacement of air from cracks, crevices and chambers etc. During the sudden but limited limestone recharge arising out of the major rainfall event of February 2003, pressurised air was detected being emitted from bores 96-19; W35 and B104.

Administratively

The incidence of sinkholes and their proven interconnectivity between the surface and underground is important in the context of the Calliope River Resource Plan currently under consideration. As a signatory to the COaG Agreement on the National Water Initiative (NWI) the Queensland Government and their agent DNR&M are bound by the objectives of the NWI that requires interconnected surface and underground aquifer systems to be dealt with as a single resource. Currently the Queensland Government is intent upon dealing only with surface and overland flow and proceeding in such a manner as to ignore the over allocation within the Larcom Creek sub-catchment where widespread and chronic mine induced depletion of the limestone aquifer is permanently entrenched. This conscious administrative decision of the Queensland Government ignores environmental and social equity considerations while failing to comply with the principles of the water reform processes.

Methodology used in farm trials.

Firstly the number and location of the sinkholes were identified. To fit in with the farm program, it was decided that pumping from bore 11196 would take place on Sunday nights. Taps and other connections were turned off and the pumped volume read from the meter. The pump at bore 11196 has a capacity of slightly in excess of 10,000 l/h but as some of the sinkholes were up to 700 m away, this output fluctuated accordingly.

Trial results

Sinkhole A.

On the 29 May 2005, 80,000 litres were pumped over a 12 hour period. Although the sinkhole was only small, no pooled water was evident at the conclusion of the trial. The sinkhole was therefore not pumped to capacity.

Sinkhole B

On 5 June 2005, 130,000 litres were pumped at the site of an old dump over a 12 hour period. The depression around the sinkhole became pooled and it took 20 hours in total for the presumably impaired sinkhole to absorb the 133,000 litres. Sinkhole pumped to capacity.

Sinkhole C

On 12 June 2005, a small sinkhole within about 60 m of Bore 11196 was pumped at the rate of 121,000 l over 12 hours. There was no pooling and the sinkhole was therefore not pumped to capacity. A few minutes before pumping ceased, a small quantity of highly soluble animal feed grade red dye was injected. Within an hour, a dilute discolouration of the water tanks was evident. A 50mm sample was taken but the colour was only visible when magnified by looking into the 3 m depth of water in the open tank. As a check against self-deception the tank was again inspected the following morning but no evidence of dye was then apparent. When Bore 11196 was drilled water was struck at 53 m so obviously the sinkhole has a deep connection.

Sinkhole D

A small sinkhole (near the old dump) that had been silted up for some years was dug out in advance and on 19 June 2005, pumped until the depression around the sinkhole filled and the water was then turned off. The sinkhole absorbed 80,000 L over a 16 hour period. Pumped to capacity.

Sinkhole E

Large sinkhole, pumped 120,000 litres over 14 hours. No pooling. Not pumped to capacity.

Sinkhole F

Sinkhole on Lake Road next to Observation bore 04. Situated within10 metres of the Lucke boundary. Not re-pumped as part of this exercise. See photograph of sinkhole being injected with dye during the EEMAG Dye Trial of May 2002 when 120,000 litres were artificially injected without pooling and on a separate occasion, see photograph of the volume of overland flow being absorbed by the sinkhole. Dye recorded at the mine on the 39th day in both the initial and back-up sample.

Summary

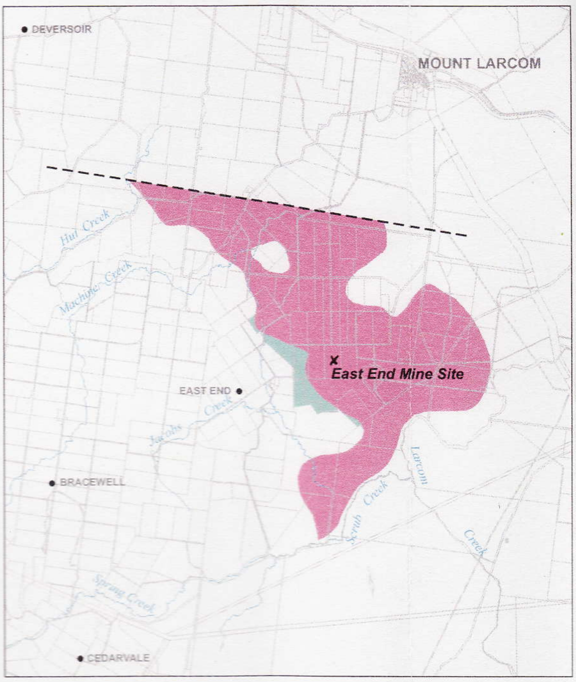
Of the six sinkholes tested, all demonstrated a capacity to absorb significant quantities of water. Sinkholes A, C and E appeared to have a much greater absorption capacity than at the rate pumped. With regard to F it was estimated during the major recharge event of 5, 6 and 7 February 2003 that the sinkhole absorbed 50,000 l/h over an uninterrupted 50 hour recharge period. When the lake filled to about 80 % of its capacity (estimated at about 25 megalitres) F was not overtopped by the lake. See photograph of the stakes inserted in the ground. The gap between each stake represents the daily rate of decline due to absorption by submerged sinkholes.

Following the February 2003 recharge event, and filling of the Bracewell Lake, the Groundwater monitoring round of 4 March 2003 detected a 5m rise at B105 at Armstrong's the closest bore in limestone below Weir 2. Regular monitoring of B105 commenced in1997 and previous recharges or runs in Machine Creek in the absence of the recovery of the Bracewell Lake barely registered a blimp on the hydrograph of B105.

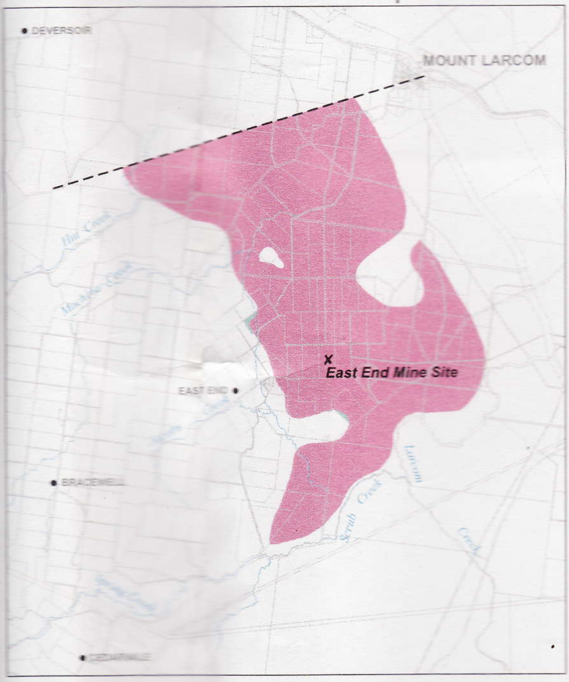
Many other sinkholes that are considered capable of ingesting large volumes of water are located proximate to the north-west and south of Lucke Farm and at other locations throughout the district. Data on the incidence and locations of sinkholes has not been exhaustively logged and with a more thorough survey many more would be expected to be located. However, it is hoped that the results of the present trial will gain sufficient credence to win local sinkholes proper recognition of their type 2 karst status.

July 199[illegible]

December 1999



September 2006



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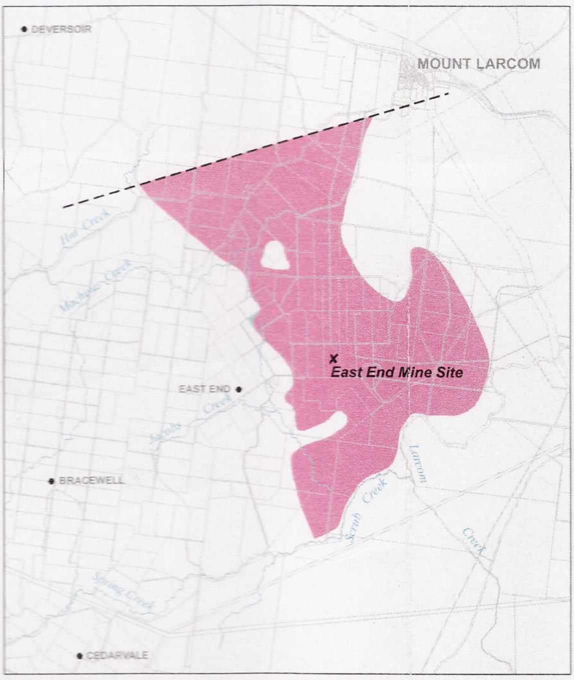
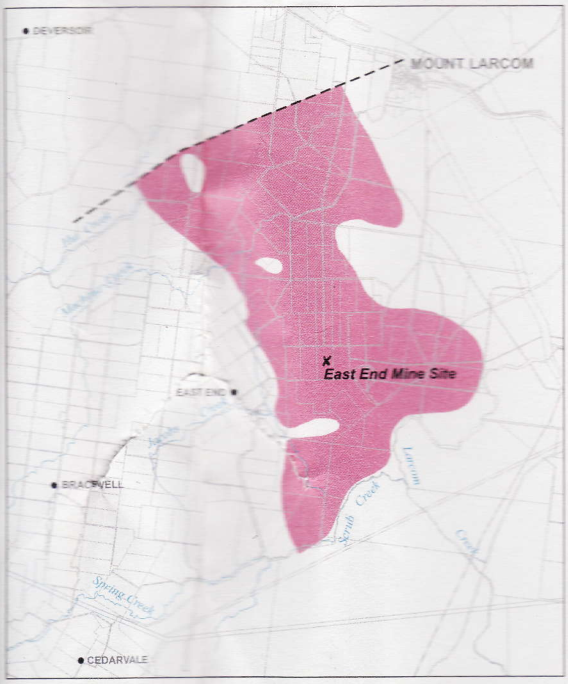
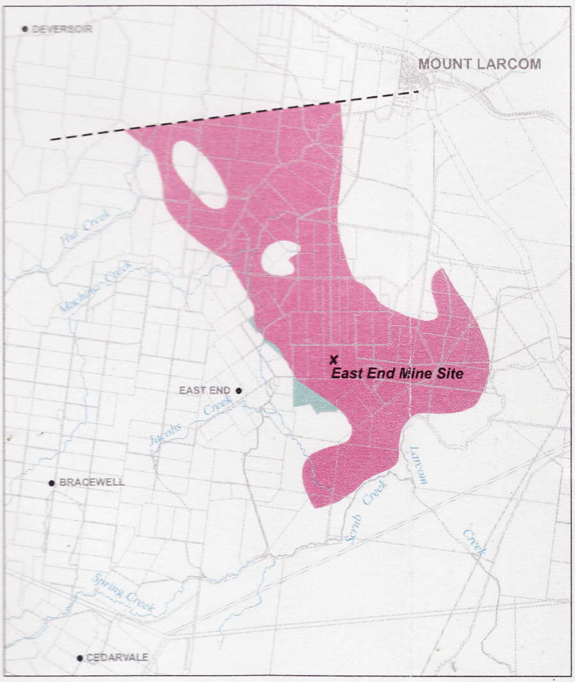


December 2007



March 2008



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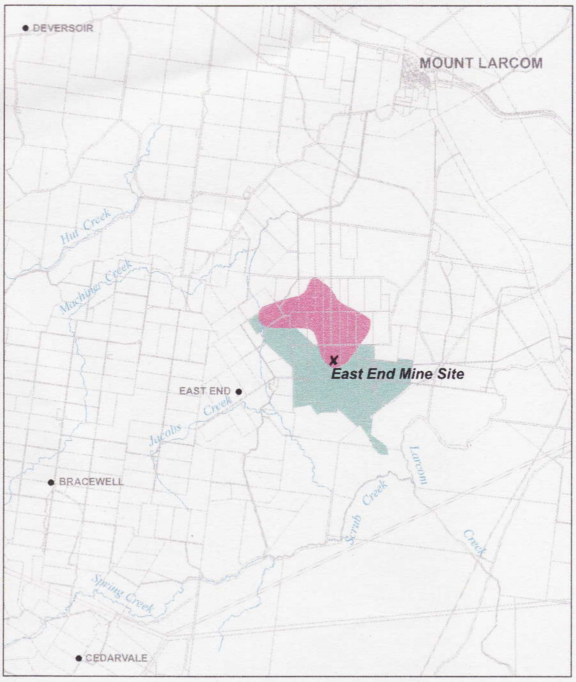

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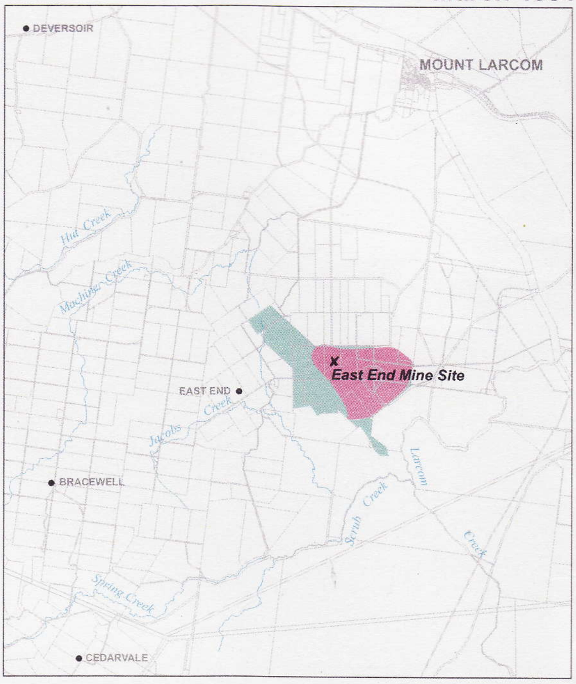

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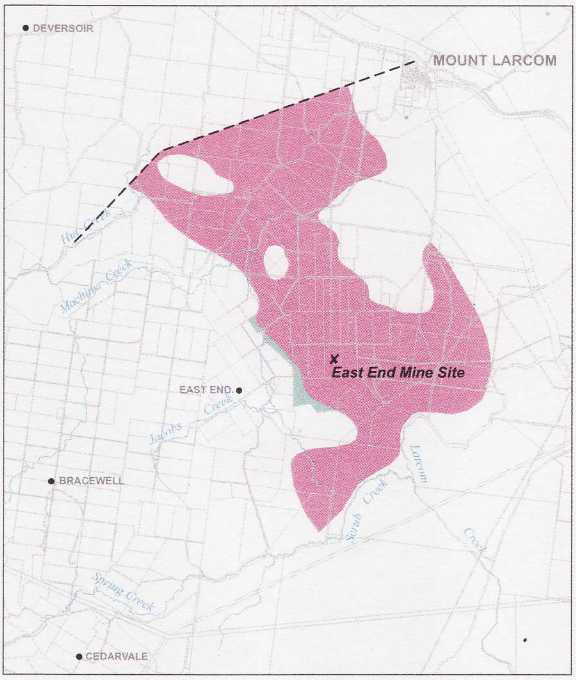

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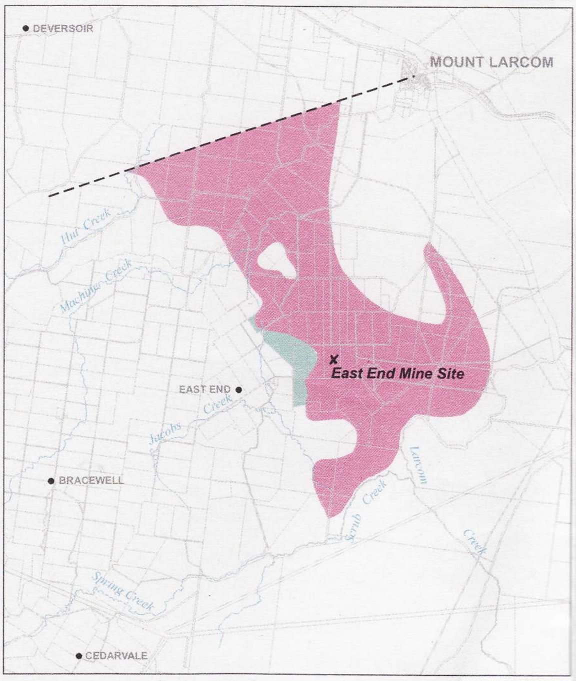
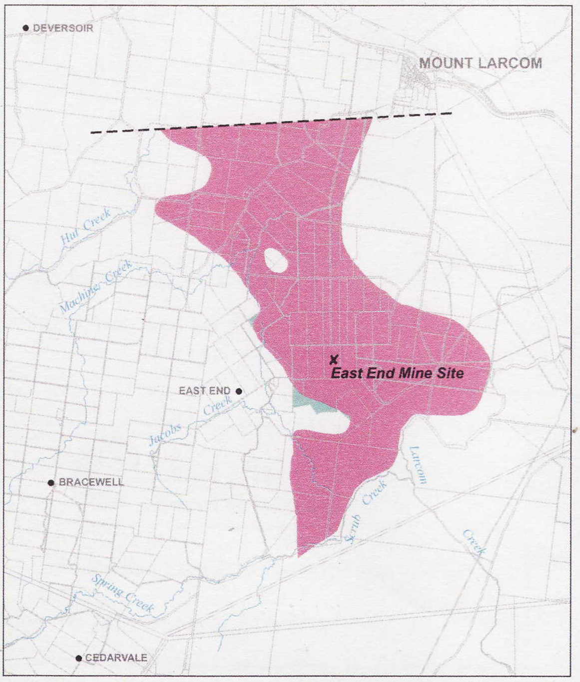
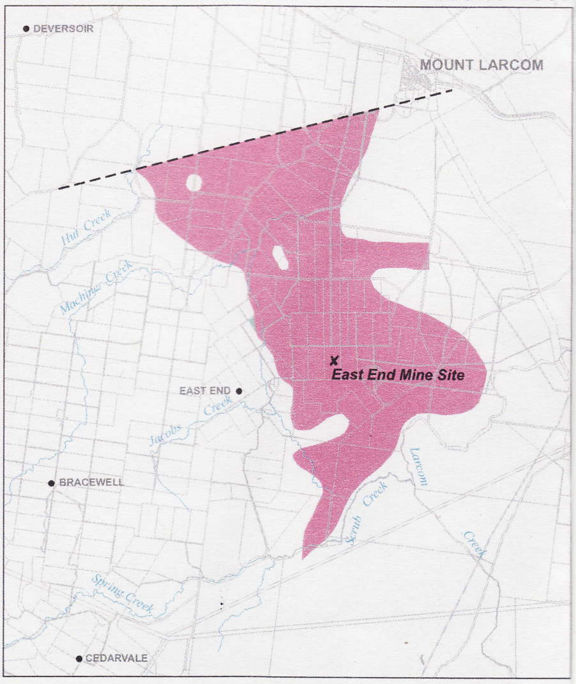


March 2007



June 2007



Bracewell Lake - distance between stakes
Represents daily absorption rate

Volume of overland flow being
Absorbed by Sinkhole F

David I Smith, Brian L Finlayson, Peter M James
Consulting to EEMAG

c/ EEMAG
Bracewell
Via Mt Larcom
Q 4695
21 September 2007

The Hon. Craig Wallace MP
Minister for Natural Resources and Water
Level 13, Mineral House
41 George Street, Q 4000

Dear Sir,

East End Mine, Groundwater Issues

Having just completed a two day meeting with representatives of the DNR&W, discussing the above, we write to you to express a deep concern for the outcome.

The meeting of 13/14 September was held allegedly to achieve a consensus on the groundwater issues. However, assurances that the DNR&W was to act as an unbiased arbiter in this matter were negated by a lack of consideration given to dissenting evidence. Serious scientific discussion was frequently brushed aside when well-reasoned arguments ran counter to the department's established view.

Based on more than a century of cumulative experience with geohydrology and karst aquifers, the undersigned have severe reservations about the department's conceptual plan and also its reliance on a groundwater contouring methodology that contains some basic interpretative flaws. Moreover, the department's adherence to analysis at a regional scale, based on Darcian principles, simply ignores conflicting evidence at a local scale.

Major environmental impacts on groundwater and surface streams have been apparent for a long time in the East End and Bracewell areas. The DNR&W unduly emphasizes the current drought as the only explanation for the impacts, at least for the latter area. This simplistic view again runs contrary to the weight of evidence.

Other investigative work done by the DNR&W up to this point has also been very limited in scope, considering the excellence of the monitoring program that has been established here. The bulk of the data obtained since 1977 have never been subject to rigorous analysis by the department. Neither has the department attempted to incorporate into the conceptualization of aquifer behaviour much of the detailed knowledge and the climatological data held by local landholders regarding, for instance, comparisons between the effects of the 1960s drought and that of the 1990s.

We understand that the content of the forthcoming departmental report lies entirely within the control of the DNR&W. We therefore express our concern that this report will not provide adequate balanced judgments nor logical conclusions and we wish to make it clear that our presence at the meeting in Mt Larcom on 13/14 September should not be taken as an endorsement of that report.

In summary, we would like to bring to your attention that, after more than a decade, the major environmental impacts still need to be resolved rationally and quantitatively and we would welcome your personal opinion in this respect.

Please find attached, for your information, brief notes on the qualifications and experience of the undersigned.

Signed

………………………………………………….

………………………………………………….

………………………………………………….

COPY: Director General, DNR M&W

Minister for the Environment

David Ingle SMITH, Snr Fellow (Ret), Centre for Resource & Environmental Studies, ANU; Formerly Reader, Univ. of Bristol

BSc (Hons, Kings Coll. 1956), Geography
BSc (Hons, Kings Coll. 1957) Geology
MSc (McGill Univ. 1959) Geography/Geomorphology

After taking up an appointment as Lecturer, later Reader, at the University of Bristol, D.I. Smith became involved in research in geomorphology and hydrology, with special reference to limestone regions in both the U.K. and the West Indies. Worked in conjunction with Government and United Nations Agencies; developed various techniques for tracing underground flows in limestone and supervised PhD students in this area. Appointed Senior Fellow in the Centre for Resource and Environmental Studies at the Australian National University, in 1976, and carried out research in water resource problems in Australia, South Africa, Malaysia and China. Worked with a wide range of Commonwealth Departments and water agencies in all States and Territories.

<u>Publications</u>
In excess of 200. Some relevant publications are:

Smith D.I. (1971). The concepts of water flow and water tables in limestone. *Trans Cave Res. Group, Gt Brit.*, 13(2):95-99
Smith D.I. et al (1973). Experiments in tracing underground waters in limestone. *Jnl Hydrology* 19:323-349
Smith D.I. & Atkinson T.C. (1974). Rapid underground flow in fissures in chalk: S. Hampshire. *Qtly Jnl Engin. Geol., 7*(2):197-205
Smith D.I. et al (1976). The hydrology of limestone terrains. *The Science of Speology*, Chapt.6. Academic Press.
Smith D.I. & Atkinson T.C. (1977). Underground flow in cavernous limestones… Malham area. *Field Studies*, 4:597-616
Smith D.I. (1993). The nature of karst aquifers and their susceptibility to pollution. *Catena*, 25:41-58
Another 4 papers of dye tracing, not here listed.

Published "*Water in Australia; resources and management"* (Oxford Univ. Press, 1998), the first comprehensive account of the nation's water resources and management.

Brian Leslie FINLAYSON, **Associate Professor, School of Social & Environmental Enquiry & Co-director, Centre for Envir. Appl. Hydrol., Univ. of Melbourne**

B.A. (Hons. Univ of Qld, 1970) Geography
PhD (Univ. of Bristol 1976) Geomorphology
Roy. Soc. Victoria Research Medal, 2003
Edie Smith Award for contributions to Aus. Speleological Research

Over thirty years experience in university teaching at Bristol, Oxford, James Cook and Melbourne, and held visiting academic positions at Univ. of Amsterdam, Aus. Defence Force Academy, Taiwan Forestry Research Bureau, Chinese Academy of Science, Rhodes University and Central Qld University. Supervised more than thirty Doctorate and fifteen Masters research students. Undertaken individual and multi-disciplinary research in the areas of global hydrology, sediment transport, catchment management, environmental flows etc., and provided specialist expertise in geomorphology, environmental hydrology and karst geomorphology. Undertaken consulting with a wide variety of government agencies, commissions and consultants, both throughout Australia and abroad.

Publications
Some relevant publications.

McMahon T.A. & Finlayson B.L. (2003) Droughts and anti-droughts: the low flow hydrology of Australian rivers. *Freshwater Biology,* 48:1147-1160.
McMahon T.A. el al, & Finlayson B.L. (2002). Estimating discharge at an ungauged site. *Aus. Jnl of Water Resource,.* 5:113-117.
Ladson T.A. & Finlayson B.L. (2002). Rhetoric and reality in the allocation of water to the Environment: case study, Goulburn River. *River Res. & Applications, 18:555-568.*
Davis J, Finlayson B.L., & Hart (2001). Barriers to science informing community-based land and water management. *Aus. Jnl Environ. Management*, 8:99-104

Contributed chapters to two books and joint author/editor of three books, including:
Finlayson, Brian & Hamilton-Smith, Elery (Ed) (2003). *Beneath the Surface: A Natural History of Australian Caves*. UNSW Press, Syd.

Peter Michael JAMES, Consulting Engineering Geologist/Geotechnical Engineer

BSc (Qld, 1959), Geology & Maths
MSc (Eng) & **DIC** (Imperial College, 1965), Geotechnical Engineering
PhD (Imperial College, 1970). “Time Effects and Progressive Failure in Clay Slopes”

After two years seismic exploration for oil, transferred to geotechnical engineering in the UK, in 1961. Postgraduate study/research was followed by a period (1970-74) as senior lecturer in Dept. of Civil Engin., Univ. of Qld. Subsequently worked as an independent consultant in more than fifteen countries, for a range of clients including major consultants, government bodies (including P.R. China, New Zealand, PNG, Malaysia), the ADB and World Bank. Member of a Panel of Experts on dam projects in China, Indonesia and Malaysia. Experience with investigations and projects in limestone/karst includes: Sri Lanka (Kotmale Hydro & Canyon Hydro); P.R.China (Lubuge Hydro); Turkey, (Yedigoze Dam); Queensland, (Bjelke Peterson Dam); air photo interpretation of karst terrain along proposed highway over the Cantabrian Mts, Spain; reservoirs in evaporate terrains in Laos and Greece. Various specific investigations in the area of geohydrology.

<u>Publications</u>
In excess of fifty. Some relevant publications.

Some insitu permeability tests in sands. *Qtly Jnl Engin. Geol.* #2, 1970
A geohydrological study of sand mining impacts: Manifold Hills. *Case Histories in Engin. Geol.,* Vol.3, GSA 1997
Engineering problems associated with unusual weathering processes in limestone. Engin. Geol. Case Histories, Vol 2, GSA, 1992
Comments on the diagnosis of karst features in dam engineering. Aus. Geomechnics #6, 1983

EAST END MINE ACTION GROUP INC (EEMAG)
EAST END
MT LARCOM QLD 4695

SUBMISSION TO
2011 BIENNIAL ASSESSMENT OF NWI

3 December 2010

Dear Sir/Madam,

Thank you for accepting our late Submission. The members of EEMAG wish to congratulate the National Water Commission for calling (May 2010) for mining to be incorporated into water access and planning frameworks compliant with the National Water Initiative.

From EEMAG's 15 year experience in struggling to obtain fairness and administrative justice for landholders affected by dewatering the East End limestone mine; we have identified at least five (5) loopholes that can facilitate mines to be exempt from NWI. All loopholes would have to be closed if the NWC's call for mining to comply with NWI is to come to proper fruition.

EEMAG's situation is that proper compliance with NWI by mining/gas etc projects is essential to properly protect the environmental health of aquifer systems and to properly protect access to water supplies for farming enterprises by requiring mining etc to return overused systems to environmentally sustainable levels of extraction.

Our ongoing experience is that "Special make good Conditions" attached to East End mining leases are not adequately worded nor effectively regulated so as to properly protect water supplies for affected landholders. From time of determination of a landholder's entitlement to commissioning an equivalent alternative water supply commonly takes about 3 years with worst case being 13 years wait for a "like for like" irrigation supply. Dispute over the accuracy of hydrology assessments and /or landholders' entitlements has been ongoing since 1995. There is no appeals process on the merit of Government decisions irrespective of how indefensible they may be able to be shown to be. There is no dispute resolution process of any description.

In 1996/97 replacement bores drilled by the East End mine were around 45 to 50 metres deep. Now (13 years later) replacement bores are commonly drilled 80 – 100 metres plus. Water from deeper bores is more costly and servicing the pump is more problematic and expensive. Bore interception of silt contaminated conduits at depth (more examples of karst) has also proven very problematic. Drying out of sub-soil moisture occurs in concert with loss of ground water levels and loss of perennial stream flow.

We consider that action to repair/avoid cumulative depletion of the water table due to mining – i.e. returning an overused aquifer to environmentally sustainable levels of extraction under NWI – is essential to the long term survival of viable farming in Australia.

EEMAG members respectfully and strongly entreat the National Water Commission to recommend to COAG actions to be formulated and implemented TO CLOSE ALL LOOPHOLES so that mining /gas production etc will be regulated to properly comply with NWI objectives using the best available science. This is the ONLY way the situation will change. Loopholes identified by EEMAG are listed below:

1. We understand that when a mine/gas well project is accorded "significant project status" or has the benefit of a "minimum compliance strategy" (in Queensland) that these override other legislation and that the Company negotiates directly with Government to establish more favourable parameters under which the project is regulated. Under the Mineral Resources Act in Queensland water is treated as waste. This must be amended so that the Mineral Resources Act and Gas (Production and Safety) Act (and others) recognise water as a resource in the same way as the Water Act 2000, and unequivocally require that it must be managed in an environmentally sustainable way.

2. Groundwater levels and interconnectivity that sustains surface flows and related eco-systems MUST be declared an Environmental Value under the Environmental Protection Act for regulating mines in combination with the Mineral Resources Act and the Petroleum and Gas (Production and Safety) Act etc. When regulating mining etc in Queensland, the Department of Environment and Resource Management (DERM) does NOT accord groundwater levels environmental value status and thus does not accord loss of groundwater levels due to mine dewatering as an environmental impact. DERM's position is NOT consistent with NWI objectives to return overallocated or overused systems to environmentally sustainable levels of extraction.

3.. The process for approving Environmental Authorities must ensure that the Environmental Authority IS framed on a frank and fearless assessment of cumulative dewatering impacts using the best available science, so that a mine cannot be exempted from NWI objectives via a Environmental Authority framed on an outdated, false and misleading Report which is grossly unrepresentative of the mine's impacts. To achieve this outcome the basis on which the Original EA is framed must remain appealable by public objections so that an unrepresentative EA can be effectively challenged and the mine brought into compliance with proper recognition of its impacts. **(Section 251 (4) of Queensland's EPAct 1994 is being used to amend existing Environmental Authorities and to restrict public objections to just the amendment. Section 251(4) ensures that an original, but grossly inadequate Environmental Authority (for example the East End mine at Mt Larcom) can remain the basis for regulating the mine with the original inadequate EA protected from effective challenge. This strategy also allows mine pit discharge licenses to be increased to permit increased discharges on the false benchmark that impacts have not migrated off-lease. Section 251(4) would need to be rescinded if mining/gas is indeed to comply with NWI objectives.)**

4. Environmental Impact Statements commonly require development of an Environmental Management Plan (EMP). However Queensland's EP Act 1994 allows EMP's to be devolved into the Environmental Management Overview Strategy (EMOS). From our understanding this is not really the purpose of the EMOS that is supposedly a document for auditing and guiding assessments of applications for an Environmental Authority. The purpose of an EMP is to list beneficial and detrimental impacts, environmental values, identify adverse impacts, to undertake minimisation strategies, alleviation or mitigation measures so that the mine operates on an environmentally sustainable basis. In the case of the East End Mine, absorption of the EMP into the EMOS neuters and glosses over the EMP criteria.

5. An independent and affordable merits review/appeals process should be established to allow disputes over data and technical assessments and disputes over matters of equity to be explored effectively at the State level, so that landholders' water supplies CANNOT be traded-off to mine dewatering by way of false science, so that technical assessments for mine dewatering impacts are required to be full, frank and fearless and so that inaccurate assessments of cumulative dewatering impacts etc can be effectively challenged etc. There is NO process to effectively challenge technical reports used by Queensland Agencies irrespective of how indefensible the technical report may be. Landholders (a relatively weak-voiced minority) are defenceless against the greater bargaining power of mining/gas etc companies and in their negotiated dealings with Government.

There is copious evidence that science used by DERM to regulate the East End mine is falsely benchmarked, and shaped to fit the State's commitment to a "minimum compliance strategy" for the East End mine. This flows into science used for Calliope River Water Resources Plan. EEMAG supplied this evidence in our 2005, 2007 and 2009 submissions.

We understand that the Commonwealth has merits appeals process for Immigration and Taxation, and that people convicted of heinous crimes have the right of appeal. It is essential for farmers needing to maintain access to essential natural water resources that are the lifeblood of farming to be accorded right of appeal on the merit of administrative decisions. Indeed it is evident that the lack of any independent merits appeal process (by default) encourages the use of inaccurate science so that mining etc can minimise/avoid their responsibilities to the environment and to affected persons.

The above issues have been raised with the Queensland Government in various ways, including EEMAG's Submission on Strategic Cropping Land in March 2010.

EEMAG members again respectfully and strongly entreat the National Water Commission to recommend to COAG actions to be formulated and implemented to close ALL loopholes so that mining /gas production etc will be regulated to properly comply with NWI objectives using the best available science. This is the ONLY way the situation will change.

Yours sincerely,

Heather Lucke
Secretary

ATT D

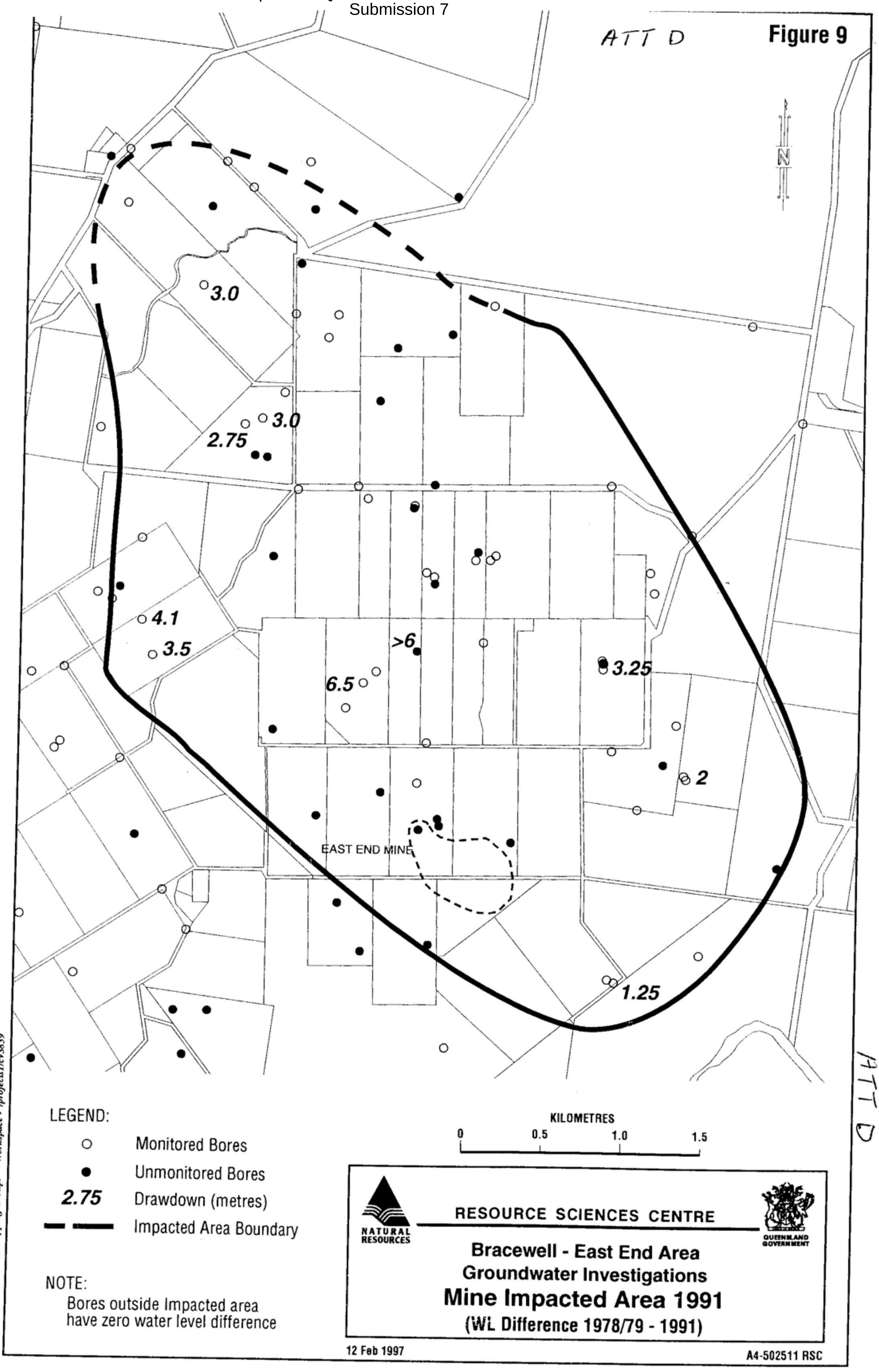


Figure 9
N
3.0
3.0
2.75
4.1
3.5
>6
6.5
3.25
2
EAST END MINE
1.25
LEGEND:
Monitored Bores
Unmonitored Bores
2.75 Drawdown (metres)
Impacted Area Boundary
NOTE:
Bores outside Impacted area have zero water level difference
KILOMETRES
0
0.5
1.0
1.5
NATURAL RESOURCES
RESOURCE SCIENCES CENTRE
QUEENSLAND GOVERNMENT
Bracewell - East End Area
Groundwater Investigations
Mine Impacted Area 1991
(WL Difference 1978/79 - 1991)
12 Feb 1997
A4-502511 RSC
Produced at the Resource Sciences Centre of the Department of Natural Resources by the Spatial Information and Mapping Group. Workspace - /projects1/cv3839

ATT D

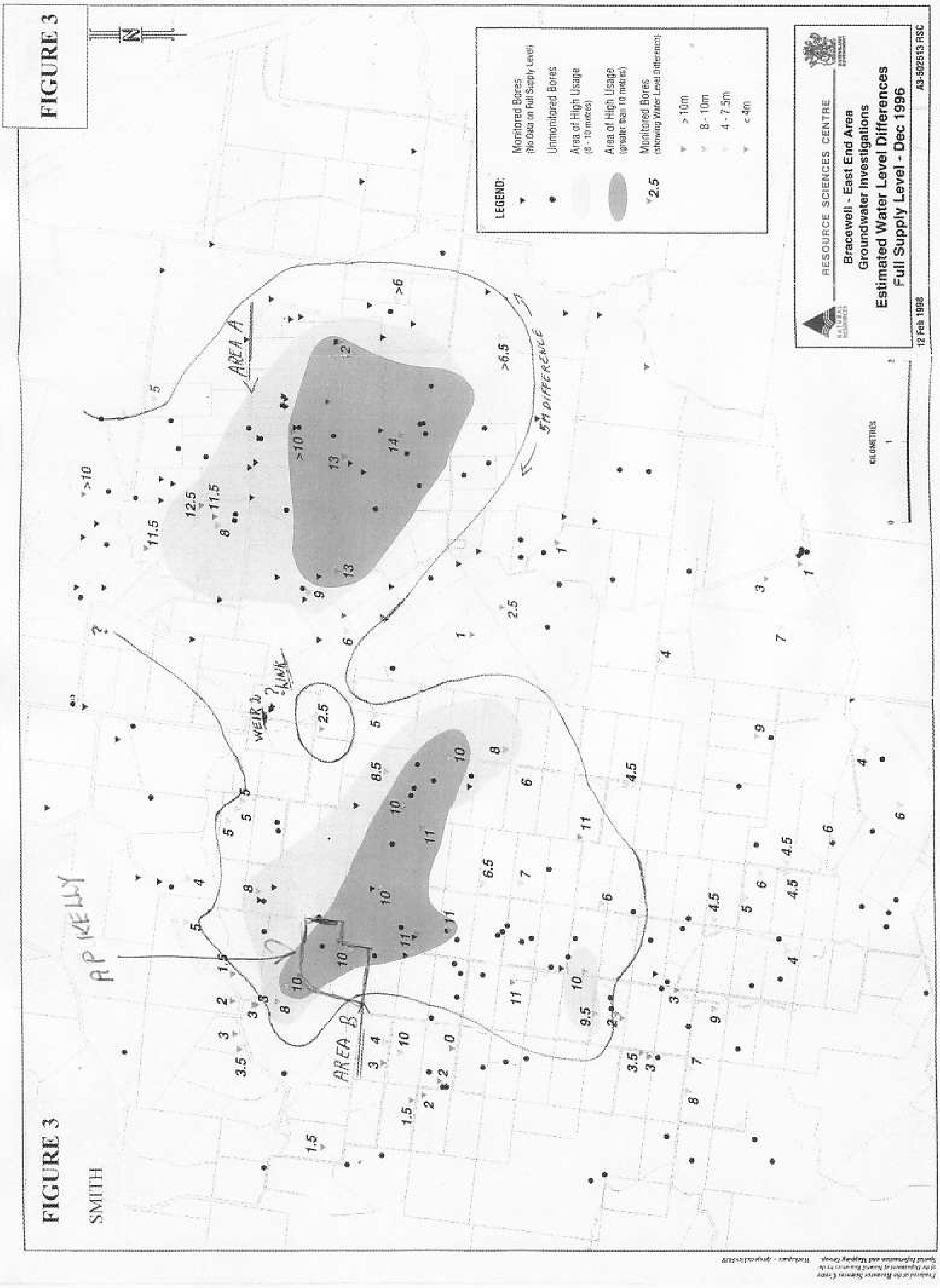


FIGURE 3
FIGURE 3
SMITH
N
LEGEND:
Monitored Bores (No Data on Full Supply Level)
Unmonitored Bores
Area of High Usage (8 - 10 metres)
Area of High Usage (greater than 10 metres)
Monitored Bores (showing Water Level Difference)
2.5
> 10m
8 - 10m
4 - 7.5m
< 4m
RESOURCE SCIENCES CENTRE
Bracewell - East End Area
Groundwater Investigations
Estimated Water Level Differences
Full Supply Level - Dec 1996
12 Feb 1998
A3-502513 RSC
KILOMETRES
AREA A
AREA B
5M DIFFERENCE
A P KELLY
WEIR ? LINK

Price estimates indicate that such water may be delivered for approximately $1 per kilolitre, which is about double the current price for domestic water in Gladstone.

Neighbouring Miriam Vale Shire has estimated that a desalination plant producing one megalitre for day would produce water at between $1.27 and $1.39 per kilolitre. Currently that Shire provides water to Agnes Waters at approximately 75c per kilolitre.

2.2 GROUNDWATER RESOURCES

2.2.1 INTRODUCTION

The question as to whether pumping from the Queensland Cement Ltd quarry has led to depletion of groundwater limestone aquifers in the Bracewell area of Mt Larcom has become lengthy and contentious.

This account reviews much of the now voluminous literature on this matter and concludes that there is a large body of evidence to support the view of deleterious effects on the groundwater of the East End, Bracewell and Cedar Vale areas.

Attention is drawn to the shortcomings in the Golder & Associates Reports prepared for the Environmental Protection Agency of the Queensland Government and especially to the lack of recognition that limestone aquifers have both slow and fast flow components. The former is amenable to the standard methods used for computer modelling of groundwater and the latter is not.

The account is organised into six Sections. These are:

1. Introduction
2. Limestone Hydrology
3. Water Use and Budgeting
4. Drought
5. Modelling
6. The Future

A bibliography to a selection of the major reports related to groundwater in the region is given. References to limestone hydrology and the like from the wider literature are not included.

The impression of the writer is that the local residents, many of whom are members of the East End Mine Action Group (EEMAG) fall into the category of Aussie battlers wrestling with a large industrial concern and government agencies all of whom have available large financial and human resources. It is akin to the situation presented in the Australian film – *The Castle*. The hope of this review is that more attention will be given to the shortcomings that are apparent in the publications and reports from QCL and the various government bodies involved.

2.2.2 LIMESTONE HYDROLOGY

2.2.2.1 General Background

The East End Mine and the surrounding area are dominantly composed of limestones. A feature of limestone terrain is that much of the water flow is subterranean with connections between surface streams and groundwater. In such areas water supply is dominated, and often dependent upon, the use of groundwater usually obtained from bores. This is the case for the farming community in the Mt Larcom region, which for many years relied upon bore water for pasture irrigation and for other rural activities. Groundwater of this kind can be regarded as a form of natural storage, akin to storage in dams in non-limestone regions. Indeed, it has the advantage over dam storage because losses due to evaporation in the summer months are negligible. As with surface storage it is necessary to manage the resource in a sustainable manner so that the groundwater is not `mined', ie, the reserves over-exploited so that the storage is depleted or becomes unusable.

All limestone areas are dominated by underground water flow but the presence of fissures of all kinds, enlarged by natural solution of the limestone over long periods of geological time, results in patterns of underground water movement that differ from those in other rock types. The solution action of water in some forms of limestone can lead to the development of 'karstic' features. The term 'karst' comes from a region in northern Yugoslavia where these distinctive features were first described over a century ago. These features include a paucity of surface flow, streams that flow intermittently and which have enlarged fissures present in the stream beds, the presence of sink holes down which flood water flow and, at the extreme, the formation of caves. Caves are evidence of conduit flow in earlier phases of the development of karst features, under present conditions these conduits are often left 'high and dry'. However, conduit flow continues but at depth with the conduits now full of water. It is stressed that conduit flow can occur in solutionally enlarged fissure of very much smaller dimensions than `caves' which are generally defined as sufficiently large to allow entry by humans!

The limestone terrain in the Mt Larcom area, and especially in the disputed Bracewell area, exhibits such karstic features in the surface terrain. These include stream flow sinking into fissures in limestone stream beds, the presence of sink holes that are only activated in times of flood rains and evidence of (now dry) caves that indicate flow in major fissures in earlier times, ie. before deeper conduits were solutionally enlarged.

2.2.2.2 Implications for groundwater

The development of karstic features indicates that the form and patterns of sub-surface flow are complex. Some water flows rapidly, especially after heavy rain, along solutionally enlarged fissures that can regarded as similar to flow in pipes. Other water moves very slowly essentially as intergranular flow. The latter style of groundwater movement is regarded as the normal type of groundwater flow in non-limestone aquifer, such as sandstones.

A simple example of conduit flow is that in limestone areas, and the Bracewell area is no exception, boreholes for water sunk a few metres part can result in very different yields, some of no value as a source of water while others can have high water yields.

The difference in flow rates between the conduits and the slower inter-granular movement can vary by factors of thousands. In large conduits water flow is often measured in kilometres per day, intergranular flow at less than millimetres per day.

Often the pattern of underground water movement in karst areas does not match that of surface water catchments. It is difficult to define the underground catchments but frequently they differ quite markedly from those defined by surface streams.

A further feature of underground flow in karst limestones is that the conduit flows, which can carry a large proportion of the groundwater flow, can occur at considerable depths. In many places throughout the world, large freshwater springs emerge on the sea floor often at some distance from the coast and at depths well below sea level. The problem is that it is difficult to locate such underground flow lines. A well-known UK example is the very large fresh water springs that were encountered in the construction of the railway tunnel beneath the Severn Estuary. These are some 40m below sea level. Initially they flooded the tunnel and very large amounts of water have been pumped daily from the tunnel over a period exceeding a hundred years. Similar occurrences are known in Australia. For example, the very large submarine freshwater springs off the coast in southeastern Australia that are fed from limestones in the Mt Gambier region. Recently it has been suggested that similar submarine limestone springs exist off parts of the Queensland coast.

It is widely recognised in groundwater studies that underground flow in limestones, especially those having karstic features, is very different to that found in non-limestone aquifers. This has major implications for all forms of groundwater modelling which basically rely on what is termed Darcian flow. Such models normally assume that groundwater movement is isotropic over relatively large areas. While these assumptions remain as the basis for groundwater modelling and development they are of limited value in limestone aquifers, especially those with karst features.

A letter from the Minster (to DI Smith dated 25 Nov. 2002) states '…modelling is being done or a regional scale and is not meant to be utilised at a small scale'. This adds weight to the contention stressed through this report that possible conduit flow, such as postulated in the vicinity of Weir 2 or elsewhere would not be apparent from the Kalf modelling undertaken for QCL.

2.2.2.3 The Mt Larcom Area

The basic bedrock geology has been described in many of the reports and is illustrated in the Golder Associates report of April 2002. Their key map (Figure 3, marked as checked by John Waterhouse) however contains a major drafting error in that the key to the two major geological units is reversed.

The latest accounts classify the bedrock geology into the Erebus Beds and the Mt Alma Formation. Golder Associates describe the Erebus Beds as 'limestone continuous' and the latter as 'limestone discontinuous'. The mine is located in the Erebus Beds and provides by far the best exposures in the region with most of the quarry faces composed of massive limestones. The occurrence of the limestone is the reason for the mine.

Dr. James (1997) reports on an inspection of the mine: '…that karst activity, in the form of open channels and pipes, can be observed to quite deep levels within the open pit; within 5-10m of the base of the pit and well above the pristine water table' (p.3)

The disputed Bracewell area is mainly located in the Mt Alma Formation (ie. the 'limestone discontinuous' unit) of Golder Associates.

It is necessary to stress that in situ rock outcrops within the area are limited and that this restricts detailed mapping of the underlying geology. Maps by Golder Associates show major areas of outcrop many of which are located on low ridges. If indirect methods of geological mapping are used, it is clear that, in the Bracewell area, there are large areas of terra rosa soils. Such soils are uniquely found developed on limestone rock.

The division into Erebus Beds and the Mt Alma Formation is a key element in the dispute. Golder Associates stress that there is poor continuity of groundwater flow between the rocks that form these two formations. The critical disputed link is in the vicinity of Weir 2.

For Golder Associates at Weir 2 there is a ‘rock barrier’ composed of low permeability rocks of volcanic origin, ie with very different flow characteristics to the limestones. This, they argue, isolates the limestone aquifer upstream of Weir 2 from that downstream of the weir and thereby any effects of mine de-watering cannot be transmitted to upstream locations.

Other consultants, namely Dr. James (1997) and Prof. Volker (1998), take a differing stance and argue that there is (or could be) a groundwater link in the vicinity of Weir 2 that permits the effects of the mine de-watering to impact on the Bracewell aquifer.

It is possible to approach the problem in several ways, the major of which are:

- a detailed consideration of the geology and water movement in the area immediately adjacent to Weir 2;
- comparisons of changes in groundwater water level upstream of Weir 2 with other localities in the area that are agreed by all to be unaffected by mine-de-watering.
- water tracing in the vicinity of Weir 2 to clarify the possible fast flow connections from the disputed Bracewell area to the mine.

2.2.2.4 Weir 2.

When it became clear that the area immediately adjacent to Weir 2 was of critical concern QCL undertook a seismic survey prior to drilling additional bore holes, subsequently used for pump tests.

Following this work EEMAG, undertook excavations in the same area in order to gain a better understanding of the local situation, these were supervised by Dr. James.

There had been dispute over the interpretation of the findings. The excavations show that there is relatively rapid flow especially in a calcrete layer. ‘Calcrete‘, as with limestone, is a calcium carbonate deposit susceptible to solution and which can exhibit the same flow characteristics as limestone bedrock. Accounts of these excavations, together with detailed borehole and weir discharge observations, are presented in a report by EEMAG and by Dr James, see James (1998).

It is pertinent to note the comments of Prof. Volker (1998) on these investigations.

> ‘James reported on the results of the excavation near Weir 2 … he claims that laterally extensive layer of relatively high hydraulic conductivity occurs across the flat lands of the valley constriction near Weir 2. This is dismissed by DNR [Feb 1998]. It would appear that there was confusion in the part of DNR about the validity of the calculation of hydraulic conductivity from the pit test inflow and the implications for downstream flow’.

It’s also pertinent to note that solutionally-enlarged limestone fissures are well-exposed in the stream bed several hundred metres upstream of Weir 2, these would accommodate quite large stream flows. Downstream of Weir 2 there is on occasion recharge into Machine Creek. This could also be interpreted as indicating a hydrological connection in the limestone across the ‘barrier’.

Volker (2000) gives an excellent summary of the situation at Weir 2 and its significance for the area under dispute. This is reproduced below.

> 'If there is a relatively high permeability layer though the valley near Weir 2 and if it is was confined under pre-mining conditions, then a lowering of the water level at the downstream due to mining will increase the flow through it from Bracewell to the East End aquifers. The magnitude of the consequent influences on Bracewell groundwater levels would depend on a number of factors, most of which are open to considerable uncertainty. Kalf claims that the modelling results show no measurable influence of pit drawn down in the Bracewell aquifer. Of course that conclusion is directly dependent on the assumptions made in the development of the model and on the calibration process.'

Volker comments in an earlier review of the problem '…that the results from the pits excavated at Weir 2 early in 1998 seem to have been treated in a rather cavalier fashion in DNR (1998) without obvious justification'. He points out '…that information obtained from an excavated pit should not be under-estimated since it samples a greater area in plan than does a bore'

The 'interim conclusion' to Volker's study of Aug. 1998 is:

> 'On the basis of the available evidence, it cannot be concluded that there is no effect of mine dewatering on the Bracewell aquifer, for the following reasons.
> 1. Some connectivity between the aquifers in the vicinity of Weir 2 appears likely as indicated by the permeable material exposed by the excavation in early 1998.
> 2. In such a complicated aquifer system there is a distinct possibility of channels of relatively more permeable material linking the aquifers and acting as confined flow conduits.
>
> The evidence on amounts and timing of drawdown in the Bracewell aquifer, in spite of the prolonged drought, are consistent with the possibility of mine de-watering effects reaching the Bracewell [area]'

His summary (1998) concludes:

> 'The evidence on amounts and timing of drawdown in the Bracewell aquifer, in spite of the prolonged drought, are consistent with the possibility of mine dewatering effects reaching the Bracewell'.

To these earlier accounts can be added the findings of the analysis of rainfall and surface runoff at Weir 2. This is discussed below, see Section 4.2 and based on a consultant report by Spate (2002). The basic finding is that the runoff events in response to similar rainfalls have shown major decreases since the 1980s. This indicates that progressively more flow is carried by groundwater connections below the area of the Weir 2. Such declining water levels progressively lessen the stream surface flow. Put another way in pre-mine conditions water discharged from the area as both surface and groundwater flows. The major and progressively increased reductions in surface flow are because virtually all of the discharge from the Bracewell catchment is now carried by groundwater connections that link the groundwater flows above and below Weir 2. This supports the view that there is no effective barrier and that there is a continuity of flow.

2.2.2.5 Regional falls in groundwater levels

The report by Dr James (1997) analyses the borehole monitoring records to compare changes in groundwater level. This map is reproduced here as **Figure 1.** The comparisons are between the map of 1979 groundwater levels (accepted by all parties and included in earlier reports) and the observations from monitored boreholes for the period 1995-96. (See Figure 3.)

Such comparisons would be widely regarded by hydrogeologists as the accepted way to interpret patterns of change due to the mine de-watering. As far as I can see, this approach of a map of change in groundwater levels over the whole region has not been attempted in the reports by Golder and Associates although similar methods are reported DNR (1998).

Golder Associates, (April, 2002, Table 2) acknowledge the use of

> '…hydrogeological interpretations, based on '…groundwater contours, interpreted geology and applying experienced-based judgements to accepted hydrogeological principles. ' as 'an application of well-established principles'.

These re-echo the comments of Golder Associates of May, 2001 (p.9). A simplistic approach is to contour the data without regard to topography and geology '…it is acknowledged that this approach might give the appropriate interpretation in the event (believed not to be correct) that East End Aquifer is directly connected with other limestone bodies through all ridges'.

The method used by Dr. James (1997) does not contour the 1995/6 water level data but shows where major falls in level have occurred. These are reproduced here as F**igure 1.** *The boreholes marked in green are those where there was little or no drop in level; those in red represent boreholes at which a major drop in level has been recorded.*

Key points to note are that the areas of little change (in green) are around the periphery of the disputed area and indicates that the effects of drought were relatively minor. To quote James '…the effects of the drought had been nullified by the past seasons'. James also adds a note to say the same pattern applied if 1997 observations were used.

The areas of major decline (in red) are those associated with the area of the mine (these approximate to the area of depletion depicted in the modelling results by Kalf) and the Bracewell area. Golder Associates do not accept the latter as having been effected by the mine de-watering. The Golder Associates map (Figure 11, April 2002) only shows depleted areas adjacent to the mine, these cease a short distance downstream from Weir 2.

It is also worthy of note that the groundwater levels in the Bracewell areas exhibit a 'flat' water level. Such a pattern is indicative of the fast underground flow rates commonly encountered in karstic limestones.

James also provides a number of cross sections that show the changes in water level from 1979 to 1995/96. One of these, Section 1 in James, is reproduced here as a part of **Figure 2.**

Section 1 on Figure 2 shows that from the vicinity of the mine and across the Bracewell area the decline in water levels is considerable, approximating to 5-7 metres.

Sections across other parts of the area, see **Section 2 on Figure 2**, show very little change in water level, this is especially the case for bore holes either located on volcanic rock or more distant from the mine.

Section 3, also shown as part of Figure 2, runs the length of Machine Creek and passes close to the contentious Weir 2.

The various accounts also consider minor changes in underground water catchment divides but such detail is not given here. The substance of the argument is best illustrated in the maps and cross sections.

James (1998) conclusion is:

> '… that in the Bracewell Lease No.1 aquifer [in this account referred as the 'disputed' area or 'the Bracewell area'] depletion of the order of 5-7m is on record. This is now proposed as an indirect result of mine pumping, with seepage losses occurring probably through the topographical restriction near the Machine Creek bridge [close to Weir 2]'.

The areal analysis of the borehole records undertaken by James accords with normal practice in analysing water level changes. It is assisted by the availability of a large number of borehole records. This is important as local anomalies can occur in the pattern due to perched water tables and the possible effect of nearby pumped boreholes. There is however, very little doubt regarding the overall pattern which is fully consistent with depletion by mine de-watering. The pattern also shows that for those areas agreed as not effected by mine de-watering (Bracewell apart) that changes in water level have been minor.

The DNR report (1998) has maps, see especially Figure 8 reproduced here as **Figure 3,** that also show changes in level. These show differences between full supply level (generally taken as 1978/79) and those observed in December 1998. The overall pattern is similar to that presented by James and described above. That is there are two areas of major drawdown, one close to the mine and the other in the Bracewell area. Both the mine and Bracewell areas are labelled as 'areas of high usage'. This is a rather strange term to use, the implications that the Bracewell area is a result of pumping for irrigation although elsewhere this current review (Section .3.2) shows that this has declined by two thirds in volume terms over the last twenty years. 'Substantial reductions' are now accepted by Golder Associates, see Addendum May 2001.

The DNR report (p.24) dismisses the effect of mine de-watering as responsible for the Bracewell depletion. The reasoning is:

'If the argument is that the area of highest water level decline are largely caused by the mine then these areas ought be continuous and the amount of decline should decrease with distance from the mine. This is not the case, therefore factors other the mine must be responsible for this pattern'.

This again concerns the links in the area of Weir 2. As the critical link is narrow, see the descriptions in the Weir 2 studies undertaken by EEMAG and James, it would not show up in the map produced by the DNR. The spacing of boreholes is much too coarse. Despite this even on the DNR map there is a 'trough' that gives some credence to a link between the two areas of major draw down. This is indicated by the addition of a 5m contour for deletion on **Figure 3.** It is possible that the links underlying Weir 2 could be a relatively narrow limestone bedrock conduit that would not be apparent on maps of this kind.

Monitoring since the James report has continued and it is recommended that this study of the decline or otherwise of the boreholes is again plotted in map form as a major guide to the argument regarding the extent of mine de-watering.

James (1998) also comments on the extrapolation of the records into the future. He considers likely that in the Bracewell area levels will decline still further perhaps to an overall depletion of 17m.

EEMAG however, in privately conducted research over the last five years identifies losses at around 10 m in the Lower Bracewell limestone aquifer. In consideration of new record lows, EEMAG suggests that conduit flow from Bracewell to East End appears to ease (or cease) at around 66 AHD and the Lower Bracewell limestone aquifer is not worsening or declining further below about 59.5 m AHD. EEMAG warns this finding cannot be regarded as a permanent feature as further conduit intersection at the East End mine could change that.

EEMAG also makes a distinction between the Lower Bracewell limestone aquifer and “a substantial alluvium aquifer around and above Weir 2 associated with Machine Creek.” In contrast with the Lower Bracewell limestone aquifer, EEMAG’s data indicates periodic segregation between the limestone and alluvium with the alluvium falling to new record lows with each successive dry.

2.2.2.6 Flood of early 2003

The 30-day period, 3 Feb. to 2 March 2003, was one of exceptionally heavy rainfall in the Mt Larcom area. During this period 584mm were recorded at the Lucke gauge in Bracewell, 650mm at the Brady gauge at Cedar Value, 625mm at the Peters’ gauge in Hut Creek and 520 at Padget’s at East End. These totals are close to the annual rainfall received for several years during the 1990s and represent a major recharge event.

The automatic rainfall collection for the QCL mine site for the 30 day period was recorded at 920mm, very much higher than for the other gauges in the area. It has since been agreed the automatic measuring system malfunctioned.

Such an event undoubtedly represents one of the major recharge events in the area for some years. It is therefore instructive to consider the results to date of such a high rainfall event.

The rains resulted in surface flooding and the formation of the Bracewell Lake. This is a temporary natural storage that forms a shallow lake after major rainfall events. On this occasion it is estimated to have achieved about 80% capacity. When full surface storage is estimated to be about 30 megalitres.

A feature of the Bracewell Lake is that it discharges down well-defined sink holes. This is clear evidence of the presence in the Bracewell area of well-defined subterranean conduit flow.

The rate of draining of the Bracewell Lake via the sink holes in 2003 was shorter than was observed for similar events over the last 30 years or more.

It would be expected that such a major recharge event would have resulted in rises in the boreholes throughout the area including those in the local limestone aquifer. Detailed records of the borehole levels associated with this event have been undertaken by EEMAG and are still continuing. These records are available to interested parties.

The official March 2003 quarterly data indicates that several limestone boreholes at East End and a couple in Bracewell actually declined in level. Certainly at this period, use for irrigation or other abstraction purposes would be effectively zero.

The most significant feature from these records is that the increases in borehole levels in the local limestones up-gradient from Weir 2 represent less than a 50% recovery. For the first time in more than a decade infiltration from limestone to Machine Creek between Webbs' and the bridge at Bracewell Road is causing a persistent flow at the bridge. This stream flow has been measured at about half of the 18mm flow currently discharging over Weir 2. On the other hand, the once perennial Tea Tree limestone springs, located close to Weir 2, have not discharged in response to the heavy rains of early 2003. These springs were perennial up to1984, they then became sporadic although re-generated during a prolonged aquifer recovery period in 1989-1991. They have not flowed since about late1992 or early 1993.

All the indications are that much of the potential recharge has discharged via subterranean conduits fed by the sink holes. Further, that such discharge was at levels well below the elevation of Weir 2. This accords with the views expressed by Volker and James (Section 2.5 above) that the dewatering associated with the mine extends into the Bracewell area.

Ideally, confirmation of this deep and rapid flow from the Bracewell limestones to the severely depleted East End aquifer and the mine may be able to be obtained by analysing the records of water discharged into the mine. However, the arrangements for assessing the mine discharge were incapable of measuring such high flows. This further highlights the shortcomings of the mine pump records, further discussed in Section 3.2.

2.2.3 WATER USE AND WATER BUDGETTING

2.2.3.1 Pump- out

An unusual and commendable aspect of the assessment of the potential impact of the mine on local groundwater was the installation of a monitoring network. The main components of this are observations of water levels in boreholes and the installation and monitoring of several stream gauges. The records from some of the boreholes and for Weir 2 are available although it is pertinent to note that the latter were not converted to flow readings until the 1990s. Although many of the early weir records are acknowledged to be of a poor quality they do permit analysis of changes of run off over the life of the mine.

The most significant data required to assess the de-watering effects of the mine is undoubtedly the measurement of the mine pump-out. It is unclear if this was an initial requirement of the monitoring network.

Pumping from the mine commenced in late 1979 and a letter from the Minister for Lands, Forestry and Water Resources (dated 13 May 1980) states that `the installation of a meter to record de-watering of the mine is being considered'.

The measurement of de-watering would best be undertaken by a meter on the pipe that links the quarry sump to the settling ponds. This has only very recently been installed. The method used from 1980 is to measure the flow at Weir 6 which is at the outlet from the settling ponds. While this gives an indication of the pump out, the quantities recorded at the Weir 6 will have been reduced by evaporation from the settling ponds.

The problem is that the discharge data for Weir 6 are not available until November 1983, over four years after the mine pumping commenced. Further the records for Weir 6 prior to 1996 only contain very short runs of data. For the period early Dec. 1987 until I October 1990 the only records are for a 10-week period in late 1989. There are no records from July 1994 until February 1996.

For the first 17 years of operation (to 1996) of the mine pump out data is only available in a discontinuous way for 7½ years.

The lack of any consistent run of data for the mine pump out until February 1996 means that any systematic analysis of the effects of the mine on the local water budget is impossible, for instance, comparable analysis of changes in run-off undertaken for Weir 2 and reported to EEMAG.

The Golder Associate report (April 2002) spends many pages discussing water use in the region of the mine but limits its comments on the mine pump out to:

> '…QCL mine pumping data has not been collated into a single data set. However, inspection of the data in various reports shows that the current dry season pumping rate of about 1,700 kl/day is a reasonable estimate. It is accepted that higher rates were pumped in earlier times of mine development causing the draw down in the East End aquifer' (Golder 2002, p.36).

It is interesting to note that a year earlier the Golder Associates report of May 2001 (p.18) commented:

> 'Mine abstraction (surface water plus groundwater) are monitored but the data have not been interpreted to provide a clear interpretation showing the amount of groundwater pumped. A mine water balance approach would be useful to provide a transparent process by which a justified estimate of the amount of groundwater pumped by the mine could be provided to the stakeholders'

That such a statement could be made by the EPA consultants and then not acted upon in the 'consolidated review' of April 2002 requires some kind of explanation.

The only comment that I can find to early pump-out volumes from the mine is contained in a letter from the Minister (N.Hewitt), dated 1980, that gives a figure of 60 litres/sec. (5184 kl/day) for the early period of pumping.

The Golder Associates report concludes (April 2002, p.36) by commenting:

> 'If EEMAG does not have and still requires this information [pump out data] then either QCL or the appropriate Queensland government department are the appropriate sources'

In response to requests from me for further information, QCL directed me to Kershaw and Co. and a phone conversation with David Kershaw (June 2002) indicated that if the early data were ever collected they are now lost.

This must have been known by Golder Associates and the lack of any analysis of mine pump data, the critical component of any attempt to obtain a water balance for the area surrounding the mine, suggests that they do not have the data either.

The Department of Natural Resources (DNR 1998, p.38) comments that 'discharge data are available at the mine site so that there is some knowledge of the aquifer discharge at the mine, even though there are gaps in the records'.

As the records available only appear to start in a systematic way from 1996, the above statement is hardly a sound account of the mine use data.

That such comments can be made twenty years after mine pumping had commenced requires some explanation by QCL. This confirms the view of this account that for a groundwater model not to take into account the mine pump out volumes is a major omission and does not represent best practice. The lack of useable mine pump out data prior to 1996 is very serious omission. Why this was not corrected much earlier also remains a mystery.

The lack of a useable run of mine pump data indicates a major flaw in the administration of the monitoring program and also renders any attempt to obtain a water balance presented in the various reports by Golder Associates to be so incomplete as to be of no practical value.

Even to a non-technical reader of the voluminous reports on the mine it is apparent that the amount pumped out of the quarry is the single most significant feature to be addressed in discussing the impact of the mine of local surface and groundwater.

2.2.3.2 Irrigation use

A major reason for the decline in water levels in the disputed Bracewell area, both groundwater and for surface streams, stressed in all Golder Associate Reports is the use by irrigators. These were accompanied by comments that there was a lack of data on such use. This is not surprising as it is not a requirement in Queensland for records to be of extraction in unlicensed irrigation areas. One would have expected QCL or EPA to undertake the appropriate studies to gather information on irrigation use. This is especially the case because irrigation is a major plank in their argument for the decline in water levels in the Bracewell area.

The local community view was that, for a variety of reasons, irrigation use had declined substantially since the mine commenced operations in the late 1970s. Among the reasons is that groundwater and surface water discharges had declined since the mine commenced pumping. In order to quantify this perception, Peter Brady (of EEMAG) undertook a survey of local irrigators about the year 2000.

Brady reported the number of irrigators using groundwater bores in 1980, close to the time that pumping from the mine commenced, as 20½ (the '½'s indicate minor use). The corresponding number for 2002, from the survey, was 6½. The survey also provided estimates of the decreases in the area irrigated and in the volumes pumped for irrigation.

Both the estimates for area irrigated and volumes pumped for irrigation in the year 2000 were approximately one-third of the pre-mine figures.

Brady also points out errors in the irrigation rate used in earlier water budgeting studies by Kalf.

This matter was addressed by Golder Associates in their addendum of May 2001 which briefly reviews Brady's initial data and comments:

> 'it is certainly accepted that there has been a <u>substantial reduction</u> [in irrigation use] <u>over the last 20 years'</u> [writer's underlining] (p.9, addendum May 2001).

The discussion of Brady's data does not mention that the irrigation volumes and area in 2000 was a third of that in 1980. It is also clear that no attempt has been made to incorporate the revised, and much reduced irrigation, information into the groundwater modelling. Brady's data were again updated in December 2001 in the EEMAG publication *Hydrology, Hydrogeology and Trilogy* (2001) a copy of which was made available to Golder Associates.

It is disappointing to see the response of Golder Associates to this survey undertaken by Brady. Golder Associates (p. 18, April, 2002) ignores the Brady's survey of irrigation use and again comments that;

> '…the lack of such information [irrigation use] has limited the effectiveness of model calibration in several areas and makes more difficult the task of separating out mine impacts from those attributable to drought'

Having agreed that 'there is a substantial reduction in irrigation use' in the May 2001 Addendum report this is discounted in the report of April 2002 which goes on to discuss the importance of plant transpiration from vegetation along Scrub Creek. Presumably this information had previously been incorporated into water balance studies and the model? If not, it is further evidence of the very shoddy approach to providing an acceptable water balance model. It appears that having received information regarding irrigation use that this has been casually discarded.

It is worthy of comment that QCL has spent vast sums in gathering groundwater information but has made no effort whatsoever to survey past irrigation use. Once this was gathered by EEMAG (by Brady) it is then largely ignored. It is notable that the Golder Associate reports to the EPA devote only minimal space and effort to aspects that involve economic, social or environmental aspects.

It is surely time that the modelling undertaken for QCL was adjusted to take account of 'these substantial reductions' in irrigation.

As a related point, water was formerly also abstracted from surface streams, especially for occasional irrigation for pasture at times of drought. As shown in the discussion of the analysis of stream flows for Machine Creek at Weir 2 what were formerly near perennial streams are now dry for most of the year and unavailable for this form of irrigation certainly at times of low rainfall when they would have previously been used. The changes to surface stream flow are discussed elsewhere in this review, see Section 4.2

2.2.3.3 Water budgeting – Summary

The water balance studies by QCL and Golder & Associates fall far short of what could be considered as best practise.

- They have failed at any stage to analyse the mine pump out data;
- The absence of the systematically collected mine pump out data prior to early 1996 displays either a major disregard for the key element in the monitoring program or extremely poor administration in that the records have been 'lost'.
- Although agreeing (in May 2001 but not in April 2002) that irrigation use has declined substantially they have failed to use this in modelling studies.

The lack of the mine pump-out data prohibits any sensible analysis of changes in rainfall runoff relationships of the kind undertaken for Weir 2.

2.2.4 DROUGHT

2.2.4.1 Introduction

The decline in groundwater levels in the disputed Bracewell area since about 1991 is attributed by Golder Associates to the cumulative effects of persistent drought and non-sustainable irrigation use. We have demonstrated above, acknowledged by Golder Associates, that the irrigation use has substantially declined (likely in terms of volume by two-thirds) since 1980.

This is no doubt however, that the whole of the region has been subject to several severe droughts in the period since the mine commenced pumping out groundwater although there was a recovery period in Bracewell in 1989-91. Irrigation apart, the other plank in the Golder Associates accounts is that the changes to groundwater flow in the Bracewell area result from drought conditions.

Before considering the case for groundwater it is necessary to comment on changes to surface stream flow upstream of Weir 2. It is acknowledged that throughout the area there are linkages between surface stream flow and groundwater, this is commonly the case in areas of limestone terrain.

2.2.4.2 Surface stream flow

The Golder and Associate reports are dominantly concerned with hydrogeological aspects of the problem, ie groundwater. The comments regarding changes to surface flow are given less weight.

For example, Golder Associates (May 2001 An Addendum) present little discussion on the reductions over time to stream flow. The main section to consider these is on pages 6/7. This reports the views of long term residents on changes in stream flow in the Bracewell area.

In earlier times the major streams in the Bracewell area, including Machine Creek, were virtually perennial and even in the driest periods associated with severe drought, pools remained which gave shelter to fish and were also used as a local source for irrigation water for pasture. It is likely that these were replenished from groundwater. The same applies to small perennial springs in the area that have now ceased to flow. Details of these are given in various reviews produced by EEMAG, see EEMAG (2002).

Not only have the streams lost much flow but it is likely that the reduced flow has caused major changes to the fresh water aquatic biota. For example, in places the stream banks contain many freshwater mollusc shells, these are no longer found in a living state due to the major changes in stream flow. The streams are now also devoid of fish. Nowhere in any Golder Associates reports is any comment made on such changes to the aquatic environment and biota.

The decreases in stream flow noted above first become apparent to the local residents in the late 1980s.

2.2.4.3 An analysis of stream flow at Weir 2

In order to more fully describe the problem of the reduction in flow at Weir 2, on Machine Creek, the Centre of Resource and Environmental Studies at the Australian National University undertook an analysis of the rainfall and Weir 2 runoff records for the period November 1978 to February 1997.

This used the daily rainfall from the Lucke gauge and the Weir 2 discharge data supplied by QCL. The latter are known to be of poor quality (see comments in DNR 1998).

A simple plot of the rainfall and runoff observations for the whole period is given in **Figure 4.** Simple inspection of **Figure 4** confirms the local perception that flows have declined dramatically over the runoff record.

Using a series of sophisticated techniques (fully described in the full CRES Report, see Spate, 2002) the rainfall and runoff at Weir 2 was compared for various flow events associated with periods of relatively heavy rainfall. The total record was divided into three parts. The periods are late 1978 to early 1985, from 1985 to 1990 and post-1990. The earliest of these is for the period when the effects of mine pump out are thought to be minimal, the second period is when (in the opinion of local residents) the effects became apparent in the Bracewell area and the final period into the 1990's.

Figure 5 analyses the rainfall and stream flow for the three periods to show the stream flow response to equivalent rainfall events. It is clear that the flow over time at Weir 2 for similar rainfall events is progressively and massively decreased. This provides an analytical basis that confirms the perception of the local community. Figure 6 provides an easily assimilated visual interpretation.

However the Golder & Associates maintain that decrease in stream flow is due to prolonged periods of drought. The correspondence in time with the effects of mine pumping (albeit at an unknown rate until about 1996) is regarded by them as coincidental. The contrary view is that the mine pumping has lowered water levels in the Bracewell area and this lowering has caused much of the previous surface flow to take underground flow paths.

The fact that earlier severe droughts did not cause the streams to lose all of their flow is dismissed as 'the current situation is more extreme and some groundwater levels appear to have dropped below the thresholds at which surface flows are sustained.' This is likely true but the question is why have they dropped to such thresholds in response to post-1990 drought conditions when they did not in response to rainfall deficits associated with earlier severe droughts?

The Golder Associates Report of May 2001 An Addendum (p. 7-8) lists some answers to this problem. Leaving aside mine de-watering, they list:

- (a) 'clearance of forest and scrub vegetation since the pre-war years, resulting in more rapid runoff (and less vegetation to intercept light rain, which can have prevented recharge under some conditions then).
- (b) loss of soil structure in grazed areas reducing infiltration and causing more rapid runoff
- (c) the local effects of irrigation'

The first of these explanations (a) is completely at variance with the views held by the majority of surface water hydrologists in Australia and elsewhere. The accepted view is that clearing of trees and shrubs enhances groundwater recharge.

Effects on more rapid runoff of surface water are of secondary importance. To illustrate this is a simple way, the clearing of forest and scrub vegetation is regarded as the major reason for the spread of dryland salinity. Trees and shrubs have deeper roots than grass or pasture and therefore, higher rates of plant transpiration. Once such forests or shrubs are cleared the soil water rises – carrying with it salt to the surface or near surface. To give another example from a limestone area in South Australia, the widespread planting of conifers as a replacement for grasslands has <u>decreased</u> recharge to soil and groundwater. Thus the clearing of forests and shrubs causes more water to pass through the soils to recharge groundwater. Golder Associates, for some reason consider the opposite to be the case!

The comment, point (a) in brackets, regarding changes due to interception are clearly wrong. There is less interception when trees and shrubs are cleared and therefore, more rain falls directly onto the soils and ground vegetation to increase infiltration and thereby groundwater recharge.

Loss of soil structure can cause more runoff especially under heavy rainfall conditions. Thus for heavy rainfall some of the flow into the creeks, including Machine Creek, will be from direct surface runoff. However, the analysis of the discharge at Weir 2 shows the opposite to be the case, ie. for comparable rainfall events there is decreasing runoff with time.

As regards point (c), this is addressed in Section 3.2 of this report. This clearly shows that irrigation has markedly declined over the last twenty years and this is accepted as the case in Golder Associates (May 2001).

These comments from Golder and Associates on surface water hydrology and the effects on recharge are clearly wrong as any text book on hydrology in Australia will confirm.

On this basis, it begins to look more likely that the reason for the Bracewell decline in groundwater levels since about 1991 is due to mine de-watering.

2.2.5 MODELLING

The report *Groundwater flow modelling – a summary* (undated but thought to be September 1999) by Kalf and Associates updates earlier accounts of the groundwater model used in the Mt Larcom region.

This report states (on p.13):

> 'The previous model has also indicated that on a regional basis the fractured rock mass behaves as an equivalent porous medium. The same assumption is used in the new model'.

This limitation is a problem encountered with all comparable models. Models of this kind are routinely used but have major limitations when applied to karstic limestone aquifers. For such aquifers it cannot be assumed that that 'the fractured rock mass behaves as equivalent porous medium'. Kalf (p.10) acknowledges that the limestone in the area is karstic although adds the caveat that 'the limestone is not strongly karstic'. What this means is unclear.

To a degree the problem is apparent in the widely different flow characteristics encountered in boreholes only a few metres apart. More significantly, conduit flow in isolated limestone solution 'pipes' of unknown size and location are not conducive to such modelling. It is accepted in the karst literature that conduit flow is often 'turbulent' in contrast to other rock types where underground flow is 'laminar'. Turbulent flow is not conducive to the methods and assumptions that underpin groundwater models.

Although there are a large number of observation boreholes in the region covered by the model, there are insufficient to recognise conduit flow of the kind described here. This is especially the case when the problem relates to possible underground links that occur in a very small area such as in the vicinity of Weir 2.

Earlier in this account attention was drawn to examples where considerable volumes of underground flow are known at considerable depths and only become apparent because they discharge fresh water at depths well below sea level. There is no easy way to establish the existence of such deep conduit flow. It is quite possible that such flows occur well below the floor of the East End Mine. Thus even if water budgeting studies had been undertaken, and it appears they have not, they could still be inadequate if they relied entirely upon pump out data.

Others have drawn attention to other possible shortcomings with the model and how it has been employed.

The DNR *Position paper – East End Mine and Environs* (1998) in general accepts the model output but also describes a number of limitations. These include:

- Comments on recharge assumptions (p.27) 'This is a standard approach in many models and is quite appropriate in many situations and as a first pass estimate of recharge.' Then on p.29, '…A significant problem with the current model is the method of estimating recharge, there is a need to account for antecedent conditions'

- 'Seed values for aquifer parameters were not plentiful for this model. This particularly applies to values of storativity. Limited values of hydraulic conductivity are available for pumping tests' (p.27).

- 'Although a model is very capable of producing estimates of system response over large areas with many complex interactions it is not a tool to predict the future (p.30)'.

Prof. Volker (2000) provides more critical comment on the Kalf modelling. These include '..it is not clear there has been a meaningful attempt to ensure there are no anomalies between results generated by the model and information such as is available from local residents' (p.2).

Prof. Volker also draws attention to assumptions regarding the values used for recharge. These comments include '…the basic message is that effects of drought on water levels are subject to a great deal of uncertainty and it would be prudent to include consideration of all relevant information' (p,1).

Dr. James (1997) also provides comments on the Kalf modelling. These confirm the comments above that 'the model performs well when conditions are reasonably isotropic, as in sands or in artesian basin conditions' (p.9). He also questions that the model '…simulated changes in the nature of the limestone by varying horizontal permeabilities in different areas. This is no doubt a valid approach in modelling although no justification of the physical base for this is offered'.

However the major limitation is that the model does not appear to have included data on mine pump-out or recognised the major decreases in irrigation use since 1980. Indeed, it does not appear to have seriously addressed any such form of post-mine water budgeting, a lack that has been consistently made by all reviewers such as the Golder Associates reports.

2.2.6 THE FUTURE

2.2.6.1 Introduction

Depletion of groundwater and reductions in surface flows in the disputed Bracewell area due to the effects of the mine are not accepted by QCL or the regulatory agencies. It is the contention of this report however, that there have been major falls in the groundwater levels and in surface water flows, especially for Machine Creek in the Bracewell area, that are dominantly due to the mine.

These changes have already had deleterious economic and social effects on the landholders and adverse effects on the biota of the surface streams. Given the dispute over many of the basic facts it is difficult to provide an account of possible future effects. The only estimates of likely future falls in the groundwater level in the disputed area is given by Dr James (1997) and more recently by EEMAG.

James suggests (on p.10) that the depletion in the most affected Bracewell area could amount to 17 metres in the next 10 years. In the period prior to 1997 he considers the drop attributable to mine de-watering to have been in the range of 5-7 metres. In addition the area of depletion would become much more extensive. Such extrapolation is problematic and could be modified if the linkage between the Bracewell and East End zones of depletion changes due to further falls in level. There will also be perturbations in the level that reflect short-term changes either due to drought or to periods of heavy rainfall causing temporary rises in groundwater levels. However, the overall decline in the water table experienced in the Bracewell area will continue.

The voluminous accounts of the possible effects of mine de-watering contain little mention of the effect on surface stream flow. It is apparent that there have been progressive and continuing declines in flow in Machine Creek. This has changed from effectively a perennial stream to one that only has surface flow following periods of relatively heavy rain. This reduction in flow has been accompanied by major changes in the aquatic biota. It would be useful to obtain the opinion of the DNR as to whether, if such flows reductions are due to mine activity, they contravene any existing environmental legislation. The discussion to date has focussed exclusively on the economic and social effects of mine de-watering with little mention of environmental effects.

The future of the Bracewell area can be considered under three headings. These are:

- effects on the landholders and environment;
- the legal implications;
- remedial measures.

2.2.6.2 Effects on landholders and the environment

The thrust of this account is that groundwater levels and surface water flows in the Bracewell area have already been adversely affected by the mine de-watering. This has depleted the yield that can be obtained from boreholes and from pumping in times of drought from the previously perennial streams. These effects have been a major factor in causing the reduction in the pumping for irrigation predominantly for irrigating pasture. This has resulted in declining land values for the properties.

These changes are continuing and the groundwater levels and surface stream flows will continue to be adversely affected. Such changes will continue into the future and the area affected will continue to increase. This has and will continue to adversely effect the livelihoods of those resident in the area.

2.2.6.3 Legal implications.

It has been accepted from the granting of the initial lease that '…QCL undertakes to provide an equivalent replacement of water supply where a landholder is injuriously affected by mining'. For example, see the Environmental Management Overview Strategy (EMOS) dated July 1996.

The problem is the divergence of opinion on whether the Bracewell area has been adversely affected by mine de-watering.

It is noted that the discussion on 'injuriously affected' is always within the context of groundwater, as outlined above the effects on surface stream flows are not specifically addressed. It is the contention in this review that the effects on surface streams also cause economic and social hardship as well as detrimental environmental effects, eg. to aquatic biota.

2.2.6.4 Remediation

Four remediation techniques are available to make good the effects of mine de-watering. These are:

- cartage of water;
- the construction or deepening of boreholes;
- artificial recharge of aquifers;
- Grouting of limestone aquifers.

<u>Cartage of water</u> can only be effective when the quantities of water are small, ie for domestic supply, watering stock or for the most minor industrial uses. It is not viable as a replacement for lost supply for irrigation purposes.

Construction or deepening of boreholes is the preferred QCL remedy. There is doubt as to whether this would be a successful long-term remediation measure in the depleted Bracewell area. As Dr. James comments (1997, p.10), there is evidence that '…karst activity appears to diminish with depth' and '…bores will have a lower probability of encountering good supplies'. If borehole remediation was proposed in the Bracewell area it would need to be preceded by extensive additional hydrogeological investigations.

Artificial recharge is a technique that brings in water from outside the depleted area to recharge the aquifers. In the Bracewell area this could be from the mine pump out, by diverting surface streams not affected by mine activity or from reservoirs in the region. It is important that the quality of the recharge water is not inferior to the supply which it is replacing.

Such waters are recharged into the aquifer either from unlined recharge ponds (these need not be large in surface area) or by borehole injection.

Recharge techniques are well understood although not widely used in Australia. There are however, problems in applying this technique to areas of karst limestone. There is always the possibility that the recharged water can flow away from the area in fast flow conduits. There are instances where water from mine de-watering is pumped into a nearby stream or down injection bores only to re-appear in a short time back in the mine!

Nevertheless artificial recharge remains a possible remediation measure, but with the acceptance that there is a lesser chance of success in a limestone aquifer than in other commonly occurring rock types.

Grouting is essentially undertaken by pumping cement into injection boreholes so as to block the fissures and conduits usually, but not exclusively, in limestone bedrock. Typically it is used to `waterproof' major dams that have experienced leakage by flow under or around a dam sited on limestones. Dr. James (1997) gives an outline of how grouting could perhaps be used to form a barrier in the vicinity of Weir 2. Grouting of limestone aquifers is an expensive measure and there are many examples where it has not been a fully satisfactory solution to seal aquifer links.

2.2.6.5 QCL Experience

QCL has used water cartage, and borehole deepening and construction in areas close to the East End Mine where there is no dispute as to effects of mine de-watering. It also planned and partly implemented an artificial recharge scheme in the same area. This was to employ borehole injection techniques and it is understood that this was abandoned in part due to the concerns of the potential users as to the quality of the recharge waters, mainly related to increased salinity values.

2.2.6.6 Summary

It is the contention of this review that, commencing in the late 1980s, the disputed Bracewell area has experienced serious depletion of groundwater and surface supplies. The timing corresponds to the introduction of mine pumping. Further expansion of the mine will undoubtedly exacerbate these effects with further and progressive depletion in areas affected to date and the extension of the effects to contiguous landowners.

Such depletion has had major adverse impacts on the livelihoods of those resident in the area especially upon any form of agricultural activity that is dependant on local water supply, notably the raising of cattle. For many the depletion of water has changed the form of agriculture and contributed to the perception of a 'blighted community'. Not only has the way of life changed but the effects on water supply, vital to agriculture, have caused declines in the value of property. Even if QCL accepted that mine de-watering was responsible for such rural decline it is unlikely that remediation of the water depletion would return the community its pre-1990 way of life.

In the Terms of Reference negotiated for the Golder Report it was agreed the precautionary principle would apply. There is little evidence that the EPA or DNR&M have adhered, or required Golder Associates' findings to comply with Ecological Sustainable Development or the guiding principle of their Code of Practice, namely " ... where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation." This especially applies to the changes in surface and groundwater resources that have occurred in the Bracewell area since the commencement of mining operations over twenty years ago.

List of Figures

1

Memorandum

Queensland Government
Environmental Protection Agency
Incorporating the
Queensland Parks and Wildlife Servic

Enquiries
Telephone
Your reference
Our reference

22 October 2001

To: Jon Womersley, Regional Service Director

From: Neil Hoy, Senior Environmental Officer

Subject: Status of Environmental Authorities at East End

Purpose:
This purpose of this memorandum is to explain the status of two EA applications at East End and one EPA initiated amendment and to seek your advice on the timeframe to progress options.

Background:
Prior to 2001 the East End Mine had seven mining leases (ML 3629, 3630, 3631,3632, 3659, 7629 & 80002) with an accepted EMOS dated 1996 and a provisional licence that was current until 1 March 2001.

On 1 January 2001 each ML and the Provisional Licence was deemed to have Transitional Authorities under the Environmental Protection Act.

The various applications / amendments associated with this project are discussed below.

1. FIRST APPLICATION:

On 14 March 2001 an application was lodged for a (new) EA for six of the MLs (3629, 3630, 3631, 3632, 3659, 7629) plus EP Licence 180001 and this was allocated a new EA Number M5765 in MADS. On 20 March 2001 the applicant was advised that the application should have been lodged as an amendment not an application for a new EA. The Coordinated Assessment Committee considered the application on 21 March 2001 and minutes are as follows:

Level 3 decision - East End Mine Assessing Officer - Ian Wilson

1. *Application received (14/3/01) for new Non-Std EA due to expiry of Transitional Authority.*
2. *EIS conducted in 1996 when cement plant upgraded. Information still valid.*
3. *Public outrage: Concerns re hydrology*
4. *EMAG established as community consultation body with Government and community representation (This probably should have been the Community Liaison Group (CLG) N Hoy)*

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Facsimile 07 4936 0508
Website www.env.qld.gov.au

5. *Crown Law recently advised that this project does not come under a special agreement act, and is therefore subject to the new legislation. Public should be happier due to their ability to be more involved.*
6. *Mining Leases expired in 1996. Applications for renewal cannot be finalised until compensation with local sorted out. (May now be addressed by L&RT) Rents, royalties etc paid and company continues to comply with conditions.*
7. *Transitional EA (previously a provisional licence) expired on 1/3/01 Darra claim that their application for amendment was not lodged prior to 1/3/01 because EPA (Rockhampton) did not advise them of their responsibility to do so.*
8. *Application requests a fee waiver.*

Proposed Action
- *EPA initiate an amendment to the TA for the mine (with assoc. EMOS). (Callide project was handled in this way by agreement between the holder and the Rockhampton office).*

Decision
- *ALD for EA application is non-standard, however, liaise with proponent to have application withdrawn (prior to EIS decision being required).*
- *Issue 'Notice of proposed action to amend'.*
- *Hold EIS decision until response from company.*

Action:
- *This approach to expired transitionals to be documented and signed off by the Director, Operations.*

Action:
- *When process agreed apply to other non-amended provisional projects.*

Since the CAC consideration, the applicant has written asking to withdraw the original application on 4 April 2001. This has not been entered on MADS so M5765 still appears in the database and although we never formally agreed to the withdrawal, this EA should probably be listed as withdrawn.

Summary Application One: The original invalid application has been effectively withdrawn.

2. EPA INITIATED AMENDMENT (M2017):

The EPA initiated amendment of T2017 ie M2017 was sent to Darra Exploration on 9 April 2001. It only relates to ML3631 and the conditions that were on the former provisional licence 180001. This refers to the accepted EMOS (taken to be the 1996 version NOT the August 2000 incomplete verion).

Summary EPA initiated amendment: This EA was a *proposed action* from the consideration of the first application above and has replaced the Provisional Licence 180001, refers to the accepted EMOS and requires a new EMOS by 1 April 2002. It covers the high level ERAs on the minesite.

3. ML80002 TA AMENDMENT:

On 26 June [July?] 2001 CSU received an application to amend the TA for ML80002 because the company wanted to increase the area of disturbance on this ML which is held for waste rock disposal.
CAC on 10 August 2001 decided that the application for a non-standard did not involve a significant increase in environmental harm (and that meant there was no need to consider whether an EIS was required). The TA for this ML ie T3984 was to be issued as M3984 and the file material was sent to the Rockhampton office of EPA. The appropriate tasks were allocated to Neil Hoy on MADS and are still shown as outstanding tasks.

All it needs is an EA referring to the existing EMOS and the proposal for a new EMOS to be submitted by [date] and this EA is to become part of the mining project subject to a project authority after the new EMOS is submitted.

Summary ML80002: This file is in this office and we can now issue the EA. We need to decide c how to tie it into the other EAs on site and the timelines - we have 01April 2002 for M2017 above.

4. BALANCE OF TRANSITIONAL AUTHORITIES:

At this time, in addition to M2017, the remaining six transitional authorities for the MLs listed above and ML80002 (which was omitted from the original application) were still in force and may attract annual fees upon their anniversaries under current Regulation.

The tentative milestone of 01 April 2002 for the revision of the accepted EMOS into the EPA forma and the negotiation of full EA conditions for the whole project would appear achievable.

CONCLUSION:

There are thus no unfinished applications for East End sitting with CSU as the original invalid application has effectively been withdrawn and another whole-of-project amendment application is expected to be accompanied by an EMOS revised to EPA template by 1 April 2002.

Advice has to be sought on the options to bring the remaining TA together into one EA before the anniversary of the individual TAs if fees are payable before April 2002.

Neil Hoy
Senior Environmental Officer
22 Oct 2001