Australian Tailings Consultants

Down to Earth

MPA Williams and Associates

Newsletter of Australian Tailings Consultants and MPA Williams and Associates June 2004

MANAGING ACID SULFATE SOILS

AASS, ASS, and PASS are the acronyms for actual acid sulfate soil, acid sulfate soil and potential acid sulfate soil. They have become a regular part of our language in our Melbourne and Perth offices over the last few years as we investigate and provide recommendations to our clients who have such materials on their sites.

Without going into the complex chemical reactions that occur, potential acid sulfate soils (PASS) contain metal sulfides (mainly FeS_2) that generate sulfuric acid runoff when they are exposed to the atmosphere. Incident rainfall or runoff water can subsequently mobilise the acid. The acid runoff can have an undesirable affect on aquatic life (fish kills), on agriculture and on engineering structures.

The accompanying photograph shows a test pit from a site investigation in a coastal area of Victoria. Actual acid sulfate soil (AASS) overlying PASS was immediately suspected during the excavation because of the rich iron red colour of the clay in open fissures in the zone above the grey clay.

Test pit from a site investigation.

Both AASS and PASS were subsequently verified by laboratory testing. It was found that the water table in the formerly swampy area had been lowered to the level of the red/grey clay interface. Permanent saturation is a defence against acid runoff.

Similar oxidation and discolouration occurs in acid sulfate rock. The effect of acid sulfate rock has long been recognised in the mining industry and is known in that context as acid rock drainage (ARD). On site, a quick check of the pH of any surface water can often verify the presence of acid sulfate rock and acidic sulfate runoff. Water with a pH value less than 4 is an indicator of the problem.

In some early coastal developments in NSW and Queensland the management of ASS was not handled well and as a result news of even the possible presence of ASS on a potential development site has local conservationists up in arms. In an article in the Sunday Age (19/10/03) related to a coastal development near Inverloch in Victoria, a local conservationist is quoted as saying:

> ***"These are acid sulphate soils; once you disturb those soils you can cause huge environmental damage, because when the soil is mixed with air and water, the resulting sulfuric acid kills everything in its path."***

Whilst the potential for environmental damage is the issue at stake, with proper management, there need not be any acid runoff that ***"...kills everything in its path!!"***

Management of acid sulfate soil and rock essentially involves prevention of ongoing oxidation of the materials or treatment with acid neutralising agents such as lime. The latter can be quite expensive; therefore we concentrate on management solutions which mechanically prevent the ongoing oxidation of the materials. If oxidation is prevented, no acid can be generated and the concerns of conservationists, the EPA and the community can generally be satisfied.

It is nearly twelve months since our last issue of Down to Earth and several people have asked us ***"why have we dropped off the mailing list?"***

Our original goal was to produce a newsletter every six months, however, pressure of work, rather than lack of suitable news has seen the interval between newsletters grow. We will be taking steps to redress this in the future!

The last twelve months has seen continuing growth for Australian Tailings Consultants and MPA Williams and Associates with several appointments in our Melbourne and Perth offices. Our Frankston Project Office has wound down with completion of the design phase for the Sungun Copper Project; however, this is only a lull before ATC takes on its largest project ever – the upgrade of the tailings and water management systems at the Sar Chesmeh Copper Mine in Iran. There will be more about this in our next issue.

This issue presents a feature on in-pit tailings storage and discusses an innovative approach to rehabilitation. Other articles discuss the Tailings Beach Slope Research Project initiated by ATC, provide an update of construction activities underway at the Miduk Copper Project in Iran and closer to home the topical issue of acid-sulfate soils and coastal development is discussed.

We hope that you enjoy this issue of Down to Earth. Feel free to contact us if you would like further information on any of the featured articles, or if you have a more general enquiry.

Paul Williams

IN THIS ISSUE

We feature three articles from Australian Tailings Consultants and one from MPA Williams and Associates:

- **In-Pit Tailings Storage**
- **Tailings Beach Slope Research Project**
- **Miduk Copper Project in Iran**

In-Pit Tailings Storage – Overview

By its very nature mining involves excavation, and open pit methods are often employed. The ultimate fate of open pits is an issue – should they be backfilled or should they be left open?
At some operations the mining sequence is such that backfilling of pits with tailings becomes possible. This is often the case at sites with numerous but isolated orebodies and where separate pits must be excavated. At other sites, such as the now decommissioned Nabarlek Uranium Mine in Queensland, the entire pit may be excavated and the ore stockpiled before processing commences. The pit is then immediately available. The issue for pits backfilled with tailings is in turn, how should they be de-commissioned? Should they be just left, should a water cover be maintained or should they be covered?

Newmont's Tanami Operation, Assault [right] and Battery [lower] Pits being backfilled with tailings. Bastille Pit [left] used for stormwater runoff.

Issues

There are a number of issues which must be addressed when worked out pits are proposed for tailings storage. These include, but are not limited to:

- Consolidation of the tailings
- Water recovery
- Seepage
- Monitoring, during and after tailings deposition
- Rehabilitation

Consolidation

The aspect ratio of pits, combined with modern processing plant throughputs, almost invariably results in a rapid rate of rise of the tailings leading to an underconsolidated deposit.
Such deposits undergo significant post-depositional settlements.

Bullakitchie Pit at Newmont's "The Granites" Gold Mine during filling. The wet surface is typical of in-pit tailings deposition and is an indication of underconsolidated tailings and considerable future surface settlement.

The application of a surcharge due to the placement of a soil or rock cover induces further settlement. In order to plan for the life-of-mine tailings storage and rehabilitation, the magnitude and rate of settlement, during and after deposition must be understood. Such predictions require sophisticated tailings testing methods and computer modelling programs of the type developed by ATC.

Water Recovery

Responsible use of water in the mining industry is becoming of paramount concern. Water must be recovered from the pit and the decant pond area minimised to reduce evaporation. Often the main haul road out of the pit can be used in the water recovery plan. Tailings discharge can be managed such that it pushes the decant pond to the haul road and pumpsets can gradually retreat up the road.

Seepage

The environmental effects of seepage must be considered. Seepage is possible from two sources, the tailings and the decant pond. The amount of seepage possible from the tailings is governed by the relative permeability of the tailings and the pit walls.

The permeability of the tailings in the pit will vary from place to place and time to time.

In general the permeability reduces with depth and time due to consolidation. Consolidation flow is mostly upwards and the potential for seepage from this source is limited. The tailings have a "caking" effect and for this reason underdrainage is not effective.

Good water recovery practice will minimise seepage from the decant pond.

Monitoring

Monitoring of the tailings surface should be carried out to confirm the results of the consolidation modelling and to predict any departures from the expected rate of rise, and thus life, of the storage. Bores should be established to monitor seepage to groundwater. The bores should be sensibly place to ensure that spurious results are not recorded due to the bores being within a zone of local stress relaxation or blast affected rock.

Rehabilitation

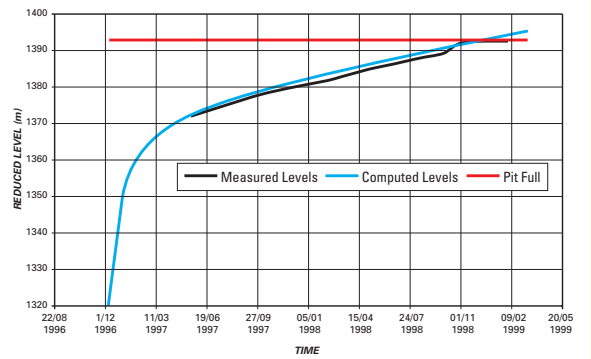
The issues to be addressed with respect to rehabilitation relate to the required final landform. For example, can the pit be left open, does it require a permanent water cover, or must it be covered with earth or rockfill such that a self-shedding landform is created? The geochemistry of the tailings may determine the appropriate method. Creation of a self shedding cover requires knowledge of the strength of the tailings in order to design a safe and economical cover system.

In-Pit Tailings Storage – A Case Study

The Granites Gold Mine

This mine, operated by Newmont Australia Ltd., has a number of worked out pits which are being progressively filled with tailings.

The first pit to be filled was Bullakitchie Pit and the accompanying figure below shows how consolidation modelling accurately predicted the filling rate over the period December 1996 to January 1999.



Results of Computer Modelling on Tailings Discharge into Bullakitchie Pit at The Granites Gold Mine operated by Newmont.

[Above] Bullakitchie Pit. Creating self-shedding profile by central discharge of thickened tailings.

[Inset] Construction of the engineered perimeter bund.

[Right] The tailings surface shortly before rehabilitation. Slow placement of tailings and contemporaneous desiccation has produced a trafficable surface.

Seepage was found to be minimal and transient. The traditional landowner, the Central Lands Council, requires that the pits be rehabilitated to a self-shedding land form.

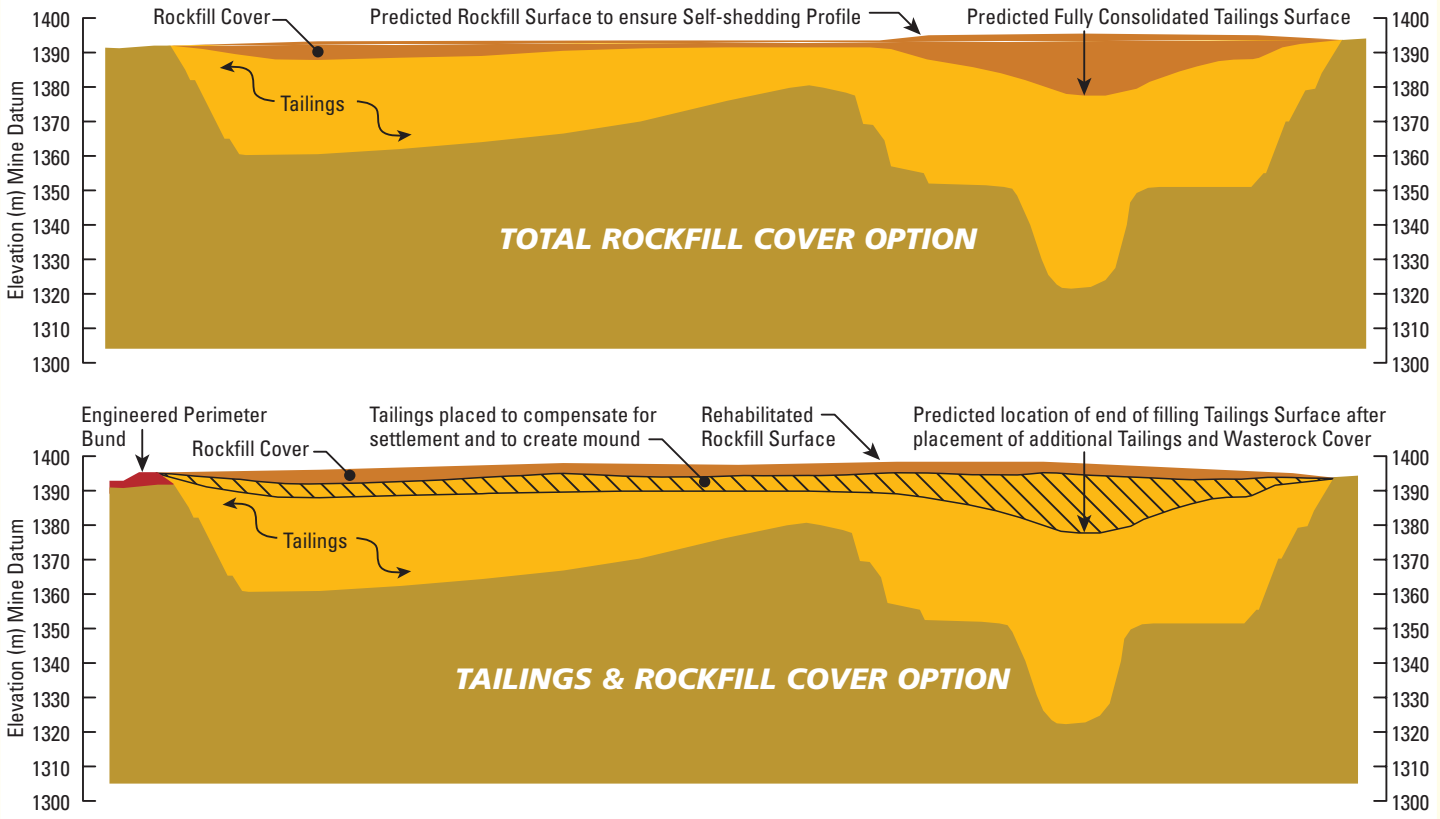
Studies were undertaken to assess the volume of waste rock required to form a suitable cover that allowed for future settlement. This was of the order of 250,000m^3.

To reduce costs an innovative technique was developed to minimise the amount of waste rock required by periodically topping up the pit with tailings to create the self shedding surface. Tailings were placed at a slow rate over the period 2000 to 2002. Placement of tailings compensated for the ongoing settlement and led to the formation of a strong trafficable crust.

The accompanying long sections, below, show the original and ultimate options. Tailings were discharged at a slow rate from a series of standpipes and an engineered bund was created at low points to minimise the risk of stormwater escaping from the site during storm events.

The use of tailings reduced the amount of waste rock used by about 150,000m^3. The cost saving due to using tailings compared to using waste rock was of the order of $300,000. Future pits will be rehabilitated using similar principles.

Bullakitchie Pit Long Sections After Rehabilitation*



*NOTE: VERTICAL SCALE EXAGGERATED

Research Grant for Tailings Beach Slope Study

[Right] The beach slope test flume at Peak Gold Mine. The Peak CTD tailings stack is in the background.

Australian Tailings Consultants are proud to announce that an Australian Research Council grant for a three year study into thickened tailings beach slopes has been awarded to RMIT University as manager and ATC and Anglogold Ashanti as Partner Investigators and sponsors.

Through their work on stacked tailings schemes – central thickened discharge (CTD) and/or down-valley discharge of thickened tailings – over the past twenty years, ATC have recognised the need for better methods of beach slope prediction, a fundamental parameter in the design of such schemes. At the moment only approximate empirical methods are employed. A basic theoretical underpinning of the tailings slurry behaviour that governs stack formation is lacking.

Having developed a proposal for the scope of a research project into the topic, ATC obtained the support of the Rheology and Materials Processing Centre at RMIT University and of Anglogold Ashanti as co-sponsors.

Anglogold Ashanti operate a CTD tailings disposal stack at their Sunrise Dam gold mine in Western Australia.

The research team at the Rheology and Materials Processing Centre will consist of Professor Sati Bhattacharya, Andrew Chryss (Research Associate), and PhD student Tim Fitton. Paul Williams of ATC will provide co-supervision of the PhD student, will assist in planning the research and will oversee the on-site field experimentation.

Anglogold Ashanti's Tom Gibbons will bring expertise on operational aspects and the Sunrise Dam site will be available for field work.

A preliminary project on the topic has been running for the past six months. Behnam Pirouz is a PhD student at KNT University in Tehran. He is employed by Sungun Copper. Sungun is one of three large tailings disposal design projects that ATC are currently undertaking for the National Iranian Copper Industries Company (NICICO) in Iran. Behnam has been in Australia for twelve months on leave of absence working with ATC and undertaking beach slope research.

The field component of this has been supported by Peak Gold Mines in Cobar, NSW, recently acquired by Wheaton River Minerals Ltd from Rio Tinto. The CTD stack at Peak has been running since 1991.

Research work on site to date has included flow-through flume testing with offtake from the tailings delivery line. This has enabled high flow rates of continuously fresh tailings to be used, an important distinction from what is normally available in a laboratory setting.

Early results are encouraging and we hold high hopes for an exciting three years.

Iranian civil engineer Benham Pirouz who is on exchange to ATC from the National Iranian Copper Industries Company.

Testing in progress.

Electronic flow and density measuring equipment was supplied by Delft Hydraulics from the Netherlands.

MIDUK UPDATE

The Miduk Copper Project in Iran was featured in our Newsletters of June 2001 and April 2003. The tailings management system includes the construction of two dams and four Deep Cone® paste thickeners.

Construction is now well underway and Australian Tailings Consultants is providing technical assistance during construction of Stage One of the 90m high rockfill tailings retaining dam and the 43m high asphaltic concrete core water retaining dam.

Stage One of the tailings retaining dam is over 50% complete with more than 1,000,000 cubic metres of rockfill having been placed to date. At the water retaining dam the outlet pipe and plinth are complete and foundation grouting is in progress.

The local contractor SCICCo, the Sar Chesmeh Investment Copper Company, has engaged Norwegian contractor, Kolo Veidekke, to construct the asphaltic concrete core.

Kolo-Veidekke's modified paver is due on site in July and the screening and crushing plant has been established.

Commissioning of the plant is due in late 2004 or early 2005.

Grouting in progress at the water retaining dam.

Grouting in progress at the water retaining dam. The outlet pipe (trapezoidal concrete structure) for return water is functioning as the stream diversion.

[Right] Decant structure under construction.

Deep Cone® Thickeners engineered by GL and V.

ATC geotechnical engineer Janusz Kwiatkowski (white helmet) enjoys a traditional meal during grouting operations at the water retaining dam.

[Left to Right] Mr Saffari, Mr Mojtaba, Mr Kwakili, Mr Rezvani and Mr Kwiatkowski.

Mr. Abbar, site manager for SCICCo in front of the Crushing and screening plant. The plinth on the right abutment of the water retaining dam is visible in the background.

[Below] Stage One of the tailings retaining dam under construction. Rock quarries are on the right.

Our Staff in Profile

Heather Wardlaw moved from her Canberra birth place in 1980 to study Civil Engineering at the University of Melbourne.

Her aim of becoming a Geotechnical Engineer was achieved when she graduated with a Bachelor of Engineering in 1984. In 1985 she started work with what is now VicRoads and eventually went on to complete a Master of Engineering Science at Monash University in 1992. While completing her MEng Sc Heather worked as a full time tutor at Monash and then as a Geotechnical Engineer for Gutteridge Haskins and Davey.

Heather has been involved in a variety of projects since joining MPAW/ATC in 1995. Her work has included preparing option studies, investigation, design and construction supervision, primarily in the tailings field.

Heather and her husband, Peter, have four year old twin girls, Natasha and Michelle whom she finds just as challenging as Geotechnical Engineering. Following the major change in her life that occurred four years ago, Heather finds her spare time as busy as work.

Her outside interests now include teaching Sunday school, sewing children's costumes, trips to the zoo and especially watching pantomimes. Heather also relishes her new hobby – lead lighting.

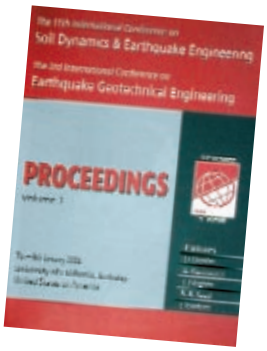
Australian Tailings Consultants and MPA Williams and Associates offer a wide range of services in the geotechnical and mining industry and specialise in the following areas:

- Site Investigation
- Foundations and Ground Improvement
- Hydrogeological Studies
- Water Resources Infrastructure
- Hydrology and Hydraulic Structures
- Landfill and Waste Disposal
- Tailings Disposal
- Pavement Design
- Geotechnical Construction
- Grouting
- Retaining walls and Slope Stabilisation
- Civil Engineering
- Project Management
- Statutory Approvals
- Laboratory Testing

Staff News

- **Stuart Masterson** is WA representative on the National Committee of the Australian Geomechanics Society.
- **Peter Reid** is secretary of the Victorian Branch of the Australian Geomechanics Society.
- ATC/MPAW welcomes **Darren Pemberton** [left} and **Hamish Ross** [right] to the Melbourne Office. Darren is a recent civil engineering graduate from RMIT and Hamish has a Bachelor of Technology in Manufacturing from the University of Tasmania.

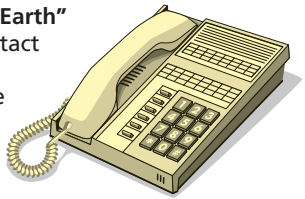
- **Genevieve New** attended a Geotechnical Modelling Workshop based on the GeoSlope products SEEP/W, SLOPE/W and SIGMA/W in June 2003. The workshop was held at Monash University.
- **Philip Soden** attended a Contract Management course run by Engineering Education Australia in July 2003.
- **Keith Seddon** attended the Third International Conference on Earthquake Geotechnical Engineering at the University of California, Berkley in January 2004.
- In March 2004 **Stuart Masterson, John Leavy** and **Helen Tait** attended the Engineering Geology of Perth Seminar run by the Perth Chapter of the Australian Geomechanics Society.



- **Paul Williams** and **Keith Seddon** prepared a paper entitled "*Delivering the Benefits 2, Case History of Century Zinc and Sunrise Dam Gold Mine*" for the Paste 2004 conference held in Cape Town, South Africa in April 2004. **Paul Williams** and **Stuart Masterson** attended the conference.
- **Justin Bullen** attended NATA's course **"An Introduction to the Laboratory Accreditation Requirements"** in April 2004. Justin plans to gain NATA signatory status in September 2004.
- **Helen Tait** attended two workshops on Acid Sulfate Soils, one in April 2004 run by the Queensland Acid Sulfate Soils Investigation Team and the other in May 2004 at the Swan Catchment Centre run by the WA DEP.

More Information

If you would like more copies of this newsletter, more information about **MPA Williams and Associates** or **Australian Tailings Consultants** or further information about an item mentioned in **"Down to Earth"** please contact either our Melbourne or Perth office.



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