SAICE AWARDS 2006
WINNERS AND PROJECTS

- Technical Excellence Category winner
  a world-class project

- Challenging bridge repairs earn a commendation

- Mondi effluent treatment plant
  a massive project

- Precast concrete toilet wins Community-based Award

- Malawi project characterised by ingenuity and innovation.
ON THE COVER

The SAICE Technical Excellence Award 2006 was won by the Cradle of Humankind project. PDNA, one of the country’s larger multidisciplinary consultancies in the built environment, played a major role in all facets of this fascinating project. They were also involved with the commendation-winning Mondi Secondary Effluent Plant project.

SAICE AWARDS 2006

TECHNICAL EXCELLENCE CATEGORY

Challenging bridge repairs earn a commendation 10
Mondi effluent treatment plant a massive project 12
Multifaceted mine closure and rehabilitation at Rietspruit Mine 14
Formidable design and construction challenges posed by Clifton project 16
Unconventional layout for key interchange 20
Innovative cost-saving solution at Vaalkop 22
Marquard reservoir designed with unique capability of extension 24
Cathodic protection of a historical rail bridge 26
Toyota plant’s vehicle capacity doubled 28
Innovative solutions to construction challenges during interchange upgrade 30
Successful precast concrete solution 32
Getting it smooth 34

PROFILE

‘Average’ takes on a new meaning 2

COMMUNITY-BASED CATEGORY

Innovative new precast concrete toilet wins Community-based Award 36
Community participation key to the success of ARRUP 38
Valuable lessons learnt from Modimola project 40
Water supply projects changing the face of rural KwaZulu-Natal 42

INTERNATIONAL CATEGORY

Malawi project characterised by ingenuity and innovation 44

LOOKING BACK IN SESOTHO 47

HISTORY AND HERITAGE

Past Masters 8: Thomas Charles John Bain 48

SAICE AND PROFESSIONAL NEWS

Technical guideline published 51
Establishment of a new Joint ICE-SAICE Division 52
Diarise this! 52
‘I THINK WHEN YOU BUILD a company – by definition a company is a group of people working collectively with a common vision, building towards a focused goal – and if you don’t start off with that collective attribute you lose the essence,’ are Dempsey’s opening words. Around this assertion the sum and substance of the founder and executive chairperson of PDNA unfolds.

DETERMINED TO SUCCEED
As a youngster growing up in Durban in the 1960s/70s, Dempsey’s driving ambition was to play professional soccer. He professes to have been a very average student at school. ‘I’m not a naturally bright person and I had to work very hard to matriculate with a C pass.’ This divulgence carries considerable weight because it became part of his leadership ethos. ‘At PDNA I tend to not always appoint the so-called brain-boxes. I like being with average people, because for me average people try harder, work harder,
and focus harder.’

Besides being a consummate sportsman, Dempsey also wanted to build structures – roads, bridges, sports stadiums – for communities such as the one he was born into that didn’t have these facilities. So he enrolled for civil engineering studies at the University of Durban-Westville in 1975. ‘It was a disastrous time in South Africa’s history, with political rallies, class boycotts and clashes between students and the police constantly occurring on campus,’ he reflects. Within months all sports activities and tuition were disrupted and for Dempsey the situation became unbearable. ‘I was not particularly politically active or inclined but I realised that what I saw happening around me would eventually drive me to activism, because I don’t do things by halves.’

He resolved, ‘Either I could succumb to my surroundings or develop and use my intellect to fight the apartheid system.’ He dropped out of university in mid-1975 and took on a job as a junior building estimator at Ilco Homes in Queensburgh. ‘My move to Ilco upset my father, who had envisaged engineering education while at the same time putting my skills to good use in the community, the country and the continent.’

In that first year of study Dempsey wrote an impassioned plea to the United Nations for financial help. ‘In my ten-page letter I explained in detail what I’d done with my life this far and what I wanted to achieve. They replied that they primarily supported bursaries to the medical/health-care sector, but that I should contact them again once I had my results. This spurred me on to work even harder and I passed with above average marks. It’s a toss-up how it happened, but out of 600-odd applicants I was awarded a joint Unesco-British Council bursary on condition that I continued to perform well academically. They also recommended that I convert to a degree course straightaway.’

The bursary took him to the Kingston Polytechnic in Surrey for the next four years. ‘Kingston suited me excellently because they offered practical-oriented engineering education while at the same time being academically connected for exams to Imperial College. It was also closer to the bright lights of London,’ he laughs. ‘I had great lecturers, played soccer at first-team level, and mixed with students from all over the world with varying social and political experiences.’

He graduated with a BSc (Hons) degree in civil engineering in 1981 and was offered a permanent position with leading British company WS Atkins for whom he worked in his industrial training year. Simultaneously he spotted an Anglo American advertisement recruiting civil engineers to work in South Africa. ‘I applied, they interviewed me in London, appointed me, and flew me back to South Africa.’

Not long after his return he met Jackie Padayachy, the daughter of old family friends, whom he’d last seen six years earlier. ‘I had forgotten how young girls grow up and here was this beautiful young woman standing in front of me.’ They were married within two years.

**MAKING IT HAPPEN**

At Anglo Dempsey gained valuable experience working on cutting-edge mining projects and venturing into territory black engineers then had seldom breached, such as designing and developing for Simmergo the first solid pumping pipeline in the country. ‘The first time we tested it we blew it to smithereens – thank goodness Anglo had resources – but we fixed the problem and learnt a lot.’

He worked on the use of naturally graded filters for dams at a time when other mines were still using filter cloth to drain slimes dams.

In Lenasia, where he and Jackie were allowed to settle, Dempsey found that as an engineer working for Anglo, his advice on how to fix infrastructure and buildings – houses, business premises, temples or schools – was frequently sought. ‘At the back of my mind there also was the desire to repay Unesco for investing in me by putting my skills to good use in the community, the country and the continent.’

Slowly there assembled around him a group of technically proficient people who did small engineering jobs, advised disadvantaged communities on technical issues and, of special importance to Dempsey, gave guidance to youngsters on technical careers. ‘The driving ambition that I had to succeed I wanted to pass on to children, because education is a passport like no other.’

Then a local businessman asked them to tender for the design and construction of his corporate headquarters. ‘The team would work after hours until late into the night to complete the project on time.’

Other jobs began trickling in and they formed a Section 21-type company, which they called Technical Alliance. Any profits earned after wages and fees had been paid were immediately re-invested to grow the company. But the name Technical Alliance had no clout or capital, and Dempsey, as a role model in the community, was urged to attach his name to the fledgling company. Thus PD Naidoo & Associates were born. Apart from being mother to three-year-old Pritina and one-year-old Mervyn, Jackie administered the office, which was still operating out of a back room of their Lenasia home.

At Anglo, Dempsey had reached the ranks of senior civil engineer and, through part-time studies at Wits, had completed the Postgraduate Diploma in Engineering (GDE) in South Africa and also within

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**Dempsey Naidoo (centre) was a finalist in the Ernst & Young and Rand Merchant Bank World Entrepreneur Awards in 2004, pitching engineering into mainstream business recognition. From left: Phillip Hourquebie, Steven Soad, Pam Golding, Raymond Ackerman, Dempsey Naidoo, Koos Bekker, Glen van Heerden and Michael Pfaff.**
Soon his working days started stretching to 12–14 hours a day because Anglo demanded their pound of flesh and PDNA was growing to such an extent that, in 1990, they moved offices closer to the formal sector – at 29 Kerk Street in downtown Johannesburg. Fortunately he could depend on younger engineers like Ali Naidu, who today is the CEO of the company, to direct the work during daylight hours. The time had also come to officially declare the business to Anglo. ‘I was grateful to them for eventually allowing me to continue running it, when they understood its social significance, and for the moral support some of them gave me. However, the model did not enjoy universal support amongst the directorate.

By 1993, when travelling in and out of the office late at night was becoming increasingly dangerous, PDNA moved to a house in Melville. Two important contracts came their way in this time: the extensions to Johannesburg International Airport and Park Station in the CBD, for which they provided project and site management services. The joint venture design and supervision of the Durban Metro’s Westrich housing project followed, entailing the construction of 2 500 low-income housing sites, a bulk sewer line, bus route and roads. On the strength of this appointment they opened their first branch office in Durban. The winds of change that were blowing through South Africa were catching PDNA full blast, and they were well positioned to take advantage of it. It poignantly illustrated what an immediate difference the change of government made to the progression of black business procurement in the new South Africa.

At Anglo Dempsey’s prospects were also soaring. After spells in the gold and new mining divisions as well as with De Beers, he was offered an executive position on the large Namaqua Sands mineral extraction project at Saldanha, with a future directorship beckoning. At PDNA his young colleagues were pleading with him to join them full-time because they could depend on younger engineers like Ali Naidu, who today is the CEO of PDNA and that’s a wonderful achievement for all of us involved in the company.

Anglo the political climate was slowly changing, and he glimpsed an opportunity to apply for Anglo’s elite management training, to which only a handful of candidates were admitted. ‘I hadn’t abandoned my vision of fighting the system at an intellectual level to prove that given a chance, black kids could go all the way. Some of my ex-bosses might say, that guy was fairly average, but he was in the right place at the right time, and I wouldn’t dispute it,’ he says.

Dempsey’s application was successful. He was exposed to excellent corporate training, including a concentrated ‘internal’ MBA, and would over the next ten years rub shoulders with the ‘blue-blooded’ top echelon of the corporation. ‘As a black person I had broken through a ceiling that few before me had pierced and it felt good to engage on that level.’

BRINGING TOGETHER THE OLD AND THE NEW

Dempsey started positioning PDNA as ‘a company that is not entitled to anything, but give us the chance and we’ll prove to you that we can deliver’, which has remained the ethos of the firm to this day. Greasing of palms is a no-go topic. He still remembers too well the corruption and bribery prevalent in township councils in the 1980s, from which companies like PDNA were precluded. ‘I have delivered both large-scale and modest engineering projects in my life, and you have to apply a different mindset when working on big projects like dams and pipelines than when building houses for impoverished communities. Unfortunately the industry doesn’t always understand this. What I’ve brought into PDNA from day one is to try and make each project uniquely relevant to society. It’s not just about steel and concrete or the size, it’s about the human benefit. Don’t just put your name to the biggest and most dazzling project; put your name to the most relevant infrastructure.’

In positioning ourselves in post-1994 South Africa, we have drawn on our black empowerment status but also realised very early on, probably earlier than most in our sector, that if we didn’t bring existing white skills and black ambitions and talent together we would not be building a company for the future of the country.’ Dempsey’s early ‘affirmative action’ appointment – in fact, now one of PDNA’s four founder directors – was a young ‘boersman’ from Pretoria, who could hardly speak English when he joined the company in 1992. Today some 65 per cent of the 400-strong staff come from the previously disadvantaged sector, but PDNA fully acknowledges the contribution of senior white managers, which has been critical in building a successful technical company.

‘If I could leave a legacy it would be that the PDNA model of integration, of bringing together the old and new South Africa, will be applied across the board in the industry. PDNA employees who left to start out on their own have built companies based on our model and that to me is the greatest compliment. Other sectors are engaging the model to integrate their businesses, especially for start-ups.’

Apart from bringing skill and opportunity together in one firm, the social element is of equal importance to Dempsey. He refers to PDNA as a ‘family’. ‘I enjoy learning about new cultures, so within PDNA I wanted our employees not only to work together but also to socialise together. We haven’t just built an engineering consultancy; we’ve assembled a cultural potpourri of people based on mutual respect and recognition, and that’s a wonderful achievement for all of us involved in the company.

Dempsey Naidoo, the driving force behind PD Naidoo & Associates

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Besides its rich heritage of natural beauty, South Africa is also home to several significant sites that have been accorded World Heritage Site status by the United Nations Educational, Scientific and Cultural Organisation (Unesco). The hominid sites at Swartkrans, Sterkfontein and Kromdraai, collectively known as the Cradle of Humankind, is a site of major significance and was proclaimed a World Heritage Site in 1999.

Maximising the appeal of the site, which had not reached its true potential, led government to make available funding for the development of a visitors’ centre at the Sterkfontein Caves and a second at Mohale’s Gate through the launch of a public-private partnership.

A WORLD-CLASS PROJECT

The world-class project on the two construction sites included building a five-star boutique hotel with 24 rooms, an amphitheatre for 3 000 people, and accommodation for 120 visiting learners for utilisation by schools from throughout the country. Retail development included the construction of a market arena with restaurants and curio shops.

The landmark development on the site is the Tumulus Building. This exhibition venue was constructed to reinforce the entire concept underlining the origins of humankind and allows visitors entrance to the vast man-made underground lake, which is the major attraction at the development. The Tumulus structure is egg-shaped, narrowing towards the top, and is partly sunk into the ground. Half of the structure, to the south, is covered with soil and grassed over with original veldt grasses, helping to conserve the unique feel of the project.

The Tumulus Building, besides containing a conference centre for 500 delegates and a restaurant, features a 150 m long underground museum cave which traces the development of humankind through a series of static and interactive exhibits.

The northern side of the development is in sharp contrast to the south, providing visitors with a high-tech building associated with the 21st century and completing the visual associations between the dawn of humankind and current times.

PDNA’S ROLE

PDNA was involved with the structural, civil, electrical and mechanical engineering aspects of the massive R193 million undertaking, the only engineering company on site to be involved with all facets of the project’s consulting engineering requirements.

Making the project unique was the unusual fact that PDNA, besides having a leading role in the engineering facets of the project, participated at shareholder level. The company, which holds equity in the concession company, is still an equity participant.

The civil aspects of the project included roads, stormwater drainage water supply and pressure boosting the water supply from Rand Water as well as controlling the effluent flowing...
from the site, which is treated in the wetlands.
All parts of the project were coordinated by engineers working full-time for the company. This was a unique accomplishment by what was the youngest and smallest engineering company on site.

THE CHALLENGES
All work was undertaken against a background of intense commercial, budget and technical deadlines. An innovative approach was demanded of the company as it moved through the project from structural engineering to the mechanical engineering requirements.
Complicating the project was the environmental setting – a sensitive environmental area, which placed additional demands on the PDNA team.

MEETING THE REQUIREMENTS
Design and construction took place simultaneously with architects and engineers designing, whilst construction teams were on site building. The logistics of the project – since crowned with international design and engineering awards – were incredible. More than 70 000 m$^2$ of soil was excavated to allow for the construction of the Tumulus Building, cutting in of roads, and ‘sinking’ the amphitheatre below ground level. All soil was retained in a single stockpile and later used for backfilling the southern semi-circle of the Tumulus and covering the museum cave.
The Tumulus Building, primarily because of its shape, presented the most challenges. The egg-shaped building is characterised by huge spans over circular areas. The design also called for slender columns in the interior of the building.
Circular and raked beams were used throughout and were designed specifically to cater for the circular slabs. All the slabs had to be precast and specially detailed to avoid cracks in the finish, which would have detracted from the overall appeal of the building.
Because the building is egg-shaped, weight distribution was of major concern. Account also had to be taken of the weight of the soil placed over the southeastern aspect of the building.

Account had to be taken of the sensitive environment on which the Cradle of Humankind is placed. An artificial wetland was created to manage wastewater, effluent and sewage.
which had a potential ‘sliding height’ of 24 m and the fact that the façade was covered with growing grass. This problem was solved by using geofabric mattresses to give stability to the soil. ‘Nailed’ into the ground, these basket-shaped structures were an essential part in meeting the stringent geotechnical demands of this unique structure.

Normal loading allowances for a conventional building are in the order of 350 kg/m². Because of the unique nature of the Tumulus, these were increased threefold to 1 000 kg/m². No flexibility was allowed for in the structure – a costly but necessary step.

WATER MANAGEMENT SYSTEMS
The design of the water management system, including the treatment of wastewater, sewerage, the management of stormwater and the design of an artificial wetland, took into account that facilities were expected to produce about 100 kℓ of effluent every day. Effluent from the 2 000 m gravity sewer system, operating in combination with a 350 m rising main, discharges the effluent for treatment in the sewer wetland system.

Water from Rand Water is pumped to a 220 kℓ storage reservoir and then fed through a pressure booster pump station and reticulated at a pressure of 500 kPa through a 1,5 km reticulation system.

A specialist consultant determined the process and designed the effluent and sewerage system. Levels, ponds, pipe work and structures were designed exclusively by PDNA.

ELECTRICAL RETICULATION
PDNA was responsible for the total electrical reticulation to the site. This included power distribution, stepping up and down of the power over long distances, and the installation of all power supply points and lighting.

Specific attention was paid to provide a flexible electrical infrastructure and general lighting for the exhibition designers and builders. This involved installing an open channel in a trough in the museum cave at Mohale’s Gate to meet specific lighting levels throughout the internal structure. The exhibitors were also given dedicated distribution boards, power points and data links at fixed distances. Cable ladders were installed to allow exhibitors to neatly wire their lighting, power and data cables.

The size and complexity of the Tumulus concrete structure created a number of practical problems for the PDNA electrical team, who had to contend with many solid concrete finishes which severely limited lighting options. Installing low voltage down-lighters solved the problem.

The mechanical building services for Mohale’s Gate, engineered by PDNA, involved a full complement of HVAC services, wet services, fire risk management facilities and lifts.

Even with these services, the Tumulus Building presented challenges. One of the largest of these was the installation of an air-conditioning plant that would meet the needs required of a 150 m long underground passage and underground cavern.

Air inside the Tumulus was conditioned by a central plant located in an adjacent service yard, capable of dissipating more than 900 kW.

IN CLOSING
The project, the largest of its type yet undertaken by PDNA in its 20-year history, became a symbol of achievement for the company, marking a quantum leap in its activities and portfolio.

The company was not only tested, but passed with flying colours, gaining tremendous recognition within engineering circles for its achievements on the project.
THE C H MITCHELL BRIDGE is a local landmark in the Port Edward area and crosses the Mtmvuna River close to the Wild Coast Sun. The bridge is a double steel arch structure with cross bracing, supporting two systems of cable hangers from which the deck is suspended. The arch springing points are supported on four cast steel bearings, two on each end of the bridge.

The bridge was refurbished in 2000/01 when, among other items, the expansion joint configuration was modified. A computer model was prepared to analyse the effects of the modification to the expansion joint system at the time.

Several weeks before the Christmas holidays of 2002, explosive devices were detonated at the Eastern Cape side of the bridge causing severe damage to the steel arch structure at its two supports. The sabotage attempt was only partially successful, but left the bridge precariously perched on its crippled supports.

The bridge was closed causing major disruption to the local community and tourists with access to the Eastern Cape effectively cut off. A ferry shuttle service provided by the Wild Coast Sun to the community was the only means of access for pedestrians during emergency repairs.

During this time, the computer model mentioned above was of great help in assessing the redistribution of forces caused by the explosions. Emergency contractors worked long hours in consultation with the design engineer for several weeks to temporarily secure the bridge.

The bridge was opened to traffic just in time for the holiday season – to the great relief of all.

PURPOSE
The consultant was commissioned to prepare and implement a scheme to replace the damaged legs of the arch without disrupting traffic. In addition, the bridge was to be strengthened to accommodate heavy loads envisaged for the proposed toll road at the time. This article focuses on the repair of the arch supports.

DESIGN APPROACH
After assessing the damage and the temporary repairs, it was decided that the practical way to repair the bridge without disruption to traffic was to provide temporary supports attached to the arch above the damaged areas and to replace the latter with pre-fabricated members to the exact shape of the original.

The arch had been repaired by makeshift methods resulting in a structural configuration significantly different from the original design. As a result, the distribution of forces in the arch members was different from the original design with several members possibly overstressed. This problem was approached by designing the temporary supports to the same shape in elevation as the original arch in order to generate the same dead load reaction in both magnitude and direction. This would re-instate the original force distribution in the arch.

In addition, the stability of the bridge against wind forces had to be maintained throughout. This required the design of temporary wind bracing while the various members were being replaced.

CONSTRUCTION PROCEDURE
In broad terms, the methods adopted in the design were based on the following procedures:

- Fabrication of temporary supports and permanent arch members in the workshop
- Installation of clamps to the downstream arch above the damaged area for the attachment of the temporary supports. This support had been the most severely damaged
- Construction of two reinforced concrete bases on either side of each arch support bearing
- Installation of the two temporary supports placed symmetrically about the downstream support, attached to the pre-installed clamps on the arch and supported by a total of two bearings each on the two concrete bases
- Jacking of the temporary supports complete with the attached bearings off their seats to allow a gap of 7 mm for grouting with epoxy mortar
- Releasing the jacks after the epoxy mortar had set to allow the temporary legs to take up full support of the bridge

Challenging bridge repairs earn a commendation
Removing the damaged member and refurbishing the cast steel arch bearing
Installing the new permanent member onto the refurbished cast steel bearing and splicing it to the arch
Jacking the temporary supports to release pressure on the temporary bearings and removing the bearing top adaptor plates
Releasing the jack to allow the permanent member to take up the full load of the bridge
Removing the temporary legs and bearings and repeating the whole process for the up-stream arch member

DESIGN ELEMENTS
Five elements had to be designed as follows:

Temporary bases The reinforced concrete temporary bases were founded on rock and made provision for a centrally placed hydraulic jack and two line rocker bearings, one on either side of the jack, to support the temporary supports
Temporary bearings These were designed as standard fixed line rockers with top plate adaptors to provide room for removal of the bearing once the replaced arch supports were supporting the bridge
Temporary legs The temporary legs were designed as frames built up of heavy steel sections. The legs were designed to be constructed in segments for ease of transport and handling and for final assembly on site
Attachment of the temporary legs to the arch These clamps were designed to accept the top ends of the temporary legs and were subject to meticulous analysis because of the high localised forces required to be transferred to the existing structure
Permanent legs The original legs were constructed by a shipbuilder employing riveting methods. The expertise to manufacture large riveted joints is not available locally and it was decided to weld the joints and to use M30 and M36 High Strength Friction Grip bolts at the splices between the new and existing members. The legs were detailed to the exact measurements as per the original design using Grade 300W steel

CONSTRUCTION PROBLEMS
The main construction problems arose from the confined working space. This was exacerbated by the following:

The stringent safety requirements demanding extensive scaffolding to provide safe access to elevated working areas
The maintenance of wind bracing
The close proximity of various structural elements hampering the tightening of bolts
The scaffolding proved to be a time-consuming factor during the rigging of the large structural elements. The elements were lowered from the top of the bridge and moved through the scaffolding, which had to be dismantled and reassembled to provide a path for the rigging operation. This also applied to wind bracing, which could only be modified during periods of light wind.

During each jacking operation, movements were monitored with dial gauges and force-deflection curves were compared with expected results. It was gratifying to observe the flattening off of the curve exactly when the calculated dead load was read off the pressure gauge. The only problem arose when a hydraulic seal started leaking. Once repaired, the system worked perfectly.

CLOSING REMARKS
The project was satisfying to client, consultant and contractor alike in that the brief for replacing the arch springing points of a bridge with a span of 160 m was achieved with minimal disruption of traffic.

REPAIRS TO THE C H MITCHELL BRIDGE OVER THE MTAMVUNA RIVER

Commendation in the category Technical Excellence in 2006
Submitted by Pietermaritzburg Branch

KEY PLAYERS
Client South African National Roads Agency Ltd
Consultant SNA Civil and Development Engineers (Pty) Ltd
Main contractor Erbacon Construction cc
Sub-contractor (steel construction) SHM Engineering (Pty) Ltd
Mondi effluent treatment
a massive project

RICHARDS BAY in KwaZulu-Natal is situated along a stretch of coastline that is home to some of the most sensitive wetland systems in the world. Mondi Business Paper, a world-class producer of paper products, makes extensive use of water and wood-based products in the production of its paper. The control of effluent, recycling and disposal of water used in the paper production process is a matter of concern to Mondi, who are conscious of the environmental responsibilities inherent in its positioning on this coast, near the industrial hub and harbour facilities of Richards Bay.

This, among other reasons, led Mondi in 2005 to commission the building of a secondary effluent treatment plant to ensure the safety of water recycled for use and water that was destined to be returned to the ocean.

In awarding the contract for this immense project, the construction of a tank with a diameter of 123 m, Mondi catapulted the companies involved in the contract into the construction of what would be Africa's largest effluent treatment tank.

A design and construct consortium led by Grinaker-LTA Civil Engineering (GLTA) undertook the project. Semane structural engineers undertook the surrounding infrastructure and technical building, and ARQ undertook the geological investigation and task of designing the secondary tank founding structure. PDNA was commissioned to act as structural engineers on the main tank.

Because of its large diameter and depth, radial movement due to temperature change and elastic shortening is a lot greater than smaller-radius tanks. This large movement meant that the joint at the wall and floor interface were to be designed carefully and in consultation with Aquatan, waterproof-lining suppliers.

THE PROJECT

Despite the massive size of the project, which required the construction of a 123,2 m diameter outer tank and 72 m diameter inner tank with support infrastructure directing flow in and out of the secondary treatment tank, the plant was designed and constructed in only 12 months.

Construction began on 1 September 2004 and was completed on 15 September 2005.

The siting of the plant on a significant thickness of soft and loose estuarine deposits within the Richards Bay industrial area presented many challenges, including the question of how to accommodate an imposed load of 1 200 MN generated by the tank, which was 10 m high, on a sub-grade of approximately 16 m of loose to medium density sands and soft to firm silts and clays. Conventional foundations were precluded, as excessive settlement would have been problematic.

Another complicating factor was calculating permutations of forces that would be present when the tank was in use by Mondi. In some cases the outer tank could be dry and the inner full. At other times, the opposite would be true, creating different ring pressures and more compression.

The floor detail of the tank also had to be carefully considered. The normal construction would have been totally rigid. By using the unique founding system adopted by PDNA costs for this facet of the development were approximately 20% below the industry norm.

Because of the expense required to use piling and foundations to cope with forces of about 250 kN/m, a solution in the form of a partially piled structure was decided on.

THE SOLUTION

In the solution adopted, portions of the structure are pored out on piles that do not extend to bedrock. The rest of the structure 'floats' on the sub-grade.

A pile and pile-cap arrangement supports a 10,5 m high circular post-tensioned retaining inner and outer wall. The core structure comprises a 12 m diameter integral concrete structure, also supported on piles. The pilecapping beam along the circular walls was designed to carry the 10,5 m high walls. Sand with a mortar capping was placed on top of and along the pile cap to form temporary support to the wall during construction.

Bearings were placed at pile positions that transferred vertical loads directly into the ground. Twelve radially guided bearings were placed along the outer circular wall and eight radially guided bearings along the inner circular wall. In total, 60 steel bearings were provided beneath the outer wall and 42 beneath the inner wall.

Wall movement occurs due to tensioning, temperature change, shrinkage and creep. The aeration basin wall (123,2 m diameter) was designed for a water depth of 9,5 m and the secondary clarifier wall (72 m diameter) for a water depth of 4,4 m with a saturated soil depth of 4,0 m below the raised surface bed. The post-tensioning was designed so that with full water pressure, a minimum of 1 MPa compression is retained in the circumferential direction.

Reinforcement was provided to allow for early shrinkage with a maximum crack width of 0,2 mm, additional vertical reinforcement on the outside face was provided to resist tensile stresses due to 'moments' induced during sequential stressing. Also, additional horizontal reinforcement was provided at the top of the wall to withstand tension forces created during initial stressing of the lower parts.

Partial construction joints with continuity of reinforcement to control early shrinkage cracks were provided at not more than 5,8 m c/c. The installation of piles commenced as soon as a suitable working platform was formed. These were installed following the perimeter of the structure in both directions, thus completing the installation of the 107 piles in a short time. Pile trimming, subsurface drainage and leak detection system, underground piping and pile-cap construction was completed thereafter. The installation of bearings and the construction of the tank walls followed the construction of the pile-cap.

The inner and outer walls were constructed in three lifts. The first lift was completed utilising a conventional gang-form system. The second and third lifts were completed through a 'DOKA' bracket arrangement that was supported by the already constructed first lift.

Sleeves with a diameter of 85 mm were cast into the walls.

Cable strands were later installed through the sleeves, which, after tensioning, would provide sufficient circumferential strength to withstand 6200 KN per metre height of load at the tank bottom. Similar magnitudes of resistance were provided for in the 12 m diameter inner tank.

Before the inner and outer tank could be completed, a large volume of fill, 4,0 m deep, which formed the inner-tank raised platform, had to be brought inside. This eliminated the tedious task of having to cart fill material over two 10,5 m high walls.
Other plant and equipment was also brought inside before complete wall closure could take place. Backfilling to the inside face of the inner wall could only commence after this wall was tensioned.

The construction of the launder/overflow channel to the inside face of the inner wall continued as this wall was being built. All ancillary structures such as walkways and dividing walls were constructed simultaneously with the circular walls. Transverse design loading for all dividing walls was fortunately limited to those imposed by wind. There was no resultant transverse load imposed by water, as there would always be water on both sides of the dividing walls.

The cable-tensioning sequence was chosen to limit unbalanced stresses occurring within the walls to a minimum, particularly at buttresses, hence cables were stressed in stages before reaching its full design stress (75% of ultimate).

All cables at the same elevation (set of cables) were stressed simultaneously. The outer wall consisted of 18 sets of cables and the inner tank of 13 sets.

Large (800 mm diameter) and small (150 mm diameter) pipes were required to pass through the post-tensioned walls at certain locations in the tank, because radial movement of the walls was expected to be large, compensators were designed to accommodate this movement at these pipe positions.

The leak detection system restricts ground water seepage into the 100 mm thick no-fines concrete layer, which was prepared to drain only leakages that occurred from the tank, 110 mm slotted PVC geo-pipes drain into manholes positioned on the outside along the circumference of the outer wall. These pipes drain demarcated areas; hence, detection of leakages is made easier.

CLOSING REMARK
A complex project of enormous importance to the participating engineers, the plant demanded high levels of design ingenuity and careful supervision. It continually challenged conventional design theories and construction technology.
RIETSPRUIT MINE IS SITUATED between Ogies and Bethal in Mpumalanga and was developed as an opencast coal mine in the early 1970s. The mining method was mostly open cast and three draglines were utilised for exposing coal.

Rietspruit was the first large opencast coal mine in South Africa to shut down its operations completely towards the end of 2001 – after more than 30 years. During the life of the mine, 1 760 ha of open veld was disturbed. Opencast mining activities took place to a depth of 80 m and approximately 2 112 million tons of material was moved.

Owing to the size of the operation, proper planning for closure and rehabilitation was of utmost importance in order to reduce the huge impact on both humans and the environment. The total mine closure cost amounted to some R302 million, which was to be spent over a period of five years.

APPROACH
An integrated planning approach dealt with all issues of mine closure and not only the environmental rehabilitation. Planning for closure started in 1998 when a comprehensive closure cost assessment was carried out. Coal-mining operations ended in 2001. A five-year period was earmarked for rehabilitation and closure.

Specialist studies were commissioned to investigate the impacts of different scenarios of surface water and groundwater management on mine closure. Predictive modelling was done which eventually resulted in an inter-mine flow groundwater assessment where typical ‘time to decant’ and water qualities could be predicted.

Extensive use was made of computer software specifically developed by African EPA for the optimisation of rehabilitation designs.

Close contact was maintained during the whole closure planning process with interested and affected parties, which included miners, farmers, adjacent mines and service delivery personnel operating in the mine-owned Reedstream Park village. Local and district municipalities that needed to take over the mine infrastructure and service delivery aspects, previously operated by the mine, were also involved.

SOME OUTSTANDING FEATURES
Dragline rehabilitation – a first
Rehabilitation of opencast mining is normally done with bulldozers, trucks and shovels. With the realisation that the largest component of the mine closure costs involves the huge volumes of material to be moved, the decision was taken to investigate different methods for rehabilitation construction.

Three options were evaluated:
- The conventional method with bulldozers, trucks and shovels
- Using draglines for rehabilitation purposes
- A combination between the conventional and dragline options

To our knowledge the option to use draglines had never been tested or done in the past and no information of past experience was available when we started the investigations. Dragline operation is extremely expensive and is therefore normally only used in the production process to expose coal. A combination of dragline work (bulk movement) and conventional construction equipment proved to be the most cost-effective way in the case of Rietspruit Mine rehabilitation.

SOCIAL PLAN
Rietspruit Mine Services is committed to the sustainability of the Rietspruit community after mine closure. An integrated social plan was developed addressing personnel downscaling, housing and sustainable development of the community. In compliance with labour regulations, collective agreements were reached with the unions and associations with regard to downscaling activities at the mine.

Strategies to replace contractor services with mine employees, alternative employment and placement of affected employees at other Ingwe operations were followed. Retrenchment of mine personnel was linked to the provision of housing and the creation of jobs for the affected employees.

The mine committed itself to transform the town (Reedstream Park) into an independent, economically and socially stable entity after mine closure. It is envisaged to sell mine houses below market value to employees and to donate all income obtained from the sale of the houses to a Section 21 company who would utilise this money for job creation opportunities. A R2 500 education grant was offered to all retrenched employees as part of their severance packages.

MINE CLOSURE PLAN
The mine and the consulting team had to develop a closure plan which could be used as a manage-
ment tool during the decommissioning phase of the mine.

A substantial list of items had to be addressed during the mine closure process. Some of the more important ones are listed here:

- **Residential areas and property subdivisions**
  Properties belonging to the Rietspruit Mine included a complete village with residential houses, recreational facilities, a shopping complex, water purification works, wastewater treatment works, low-cost housing and associated infrastructure. The entire infrastructure needed to be sold off and the services transferred to the local municipal council. Vacant land belonging to Rietspruit Mine needed to be sold off or subdivided and the town needed to be proclaimed

- **Rietspruit Dam**
  When the mine was initially developed a dam was constructed to supply freshwater to the mine and village. Decisions had to be taken on how to transfer the operations and liabilities to new owners. The fate of the recreational club and water rights negotiated with neighbouring farmers all needed to be resolved during the closure process

- **Administration and workshop infrastructure**
  The mine infrastructure consists of various buildings, workshops, wash bays, offices, etc. Part of this infrastructure needed to be demolished while infrastructure that could be used for other purposes needed to be sold off, subdivided and transferred to new owners

- **Plant infrastructure**
  The mine operated a complete coal-washing plant consisting of stacker reclaimer infrastructure, railway lines, silos, water dams, water pipelines, conveyor belts, etc. A decision on the future fate of the plant involved a thorough technical and financial evaluation

- **Slimes dam**
  Rietspruit Mine operated a coal slimes dam as part of its beneficiation operations. The slimes dam needed to be rehabilitated after decommissioning as part of the closure process

- **Underground workings**
  Decommissioning of the underground workings needed to be carefully planned with rehabilitation of the opencast spoils. Once the underground workings were decommissioned, salvaging of equipment from the underground workings needed to take place within a short space of time before closure of the underground workings could be done

- **Opencast infrastructure**
  All fixed assets belonging to the mine needed to be salvaged and sold off or demolished. This included items such as the explosive magazine, ring feed power supply to the draglines, and seed stores

- **Water management structures**
  The mine operated numerous dams and water management infrastructure during its operations. These dams contained either clean or polluted water and needed to be dealt with in a responsible manner. Polluted water cannot be discharged into the environment and careful planning was required to ensure that this water would be dealt with properly during the decommissioning phase

- **Highwall shaping**
  The total length of highwall at the mine amounted to some 8 km. Risk assessments were done on various alternatives to the highwalls in a way that would be cost beneficial as well as acceptable from an environmental and safety point of view

- **Authorities and interested and affected parties**
  Involving stakeholders in the closure process proved to be a valuable investment. During the development of the Rietspruit mine closure plan, authorities and other IAPS were kept up to date with the latest planning. In this way all parties were able to make their contributions during the development of the closure plan.

**CLOSING REMARKS**

The project entailed the closure of the mining operations of Rietspruit Mine and the rehabilitation of the environment back to its natural state. The pioneering use of draglines for rehabilitation, in combination with conventional construction equipment, resulted in significant cost savings.
Formidable design and construction challenges posed by Clifton project

THE EVENTIDE APARTMENT PROJECT in Clifton stands out as an achievement in civil engineering excellence. This valuable site is located in the heavily built-up area between Clifton ‘Moses’ Beach and Victoria Road, Cape Town. The ten-storey RC-framed apartment building was built off a base platform which was cut into the mountain slope with 27 m high laterally supported rock faces to three sides of the site. The excavation was blasted out of the granite bed-rock with due care taken to protect the surrounding environment.

The RC-framed structure required many innovative solutions to satisfy the unusual architecture of this prestigious development

STRUCTURE
Project background and architectural requirements
Kantey and Templer were appointed as civil and structural engineers in support of a large professional team. The client brief was to design the best apartment block in Cape Town to match the prestige of this spectacular site.

Architecture JV Stefan Antoni and Dennis Fabian Berman prepared a design proposal to comply with stringent building line restrictions in order to protect view corridors of neighbouring properties. The envelope of the building was eventually agreed upon after extensive negotiations between the developer, local residents and the City Council.

Pre-construction sales demand for these apartments was strong and the project was given the go-ahead in May 2003. The professional team had been engaged in an ‘at-risk’ capacity to this stage. The project presented us with a host of issues during design and construction of this unique project.

Excavation and lateral support
The excavation to form the building platform for the Eventide apartment block was one of the largest ever undertaken for a residential development on the Atlantic seaboard. In order to meet the requirements of the City of Cape Town that the top floor of the development be no higher than the existing road level, combined with the need to create sufficient apartment space to make the scheme viable, it was proposed to create a vertical excavation face some 27 m high against the boundary line of three sides of the site. One of these boundaries was the kerb line along Victoria Road.

Geologically the site is situated in terrain composed of and underlain by granites of the Cape Granite Suite with a relatively thin cover of transported (colluvial) and/or residual soils. The granite ranges from completely weathered very soft rock locally near the top and more typically as medium weathered to unweathered hard to very hard rock with isolated joints as the depth increased.

The excavation volume totalled approximately 42 000 m³ of which some two thirds was classified as hard rock.

The excavation volume totalled approximately 42 000 m³ of which some two thirds was classified as hard rock. To minimise disturbance of the neighbouring property owners and the risk of damage to adjoining properties, a strict monitoring programme was implemented. Each blast was monitored using recording vibration monitors. The resulting ground vibrations were reviewed and the blast designs modified to ensure compliance with the specifications.

The bulk of the excavated material was removed from site by means of two tower cranes which had to be moved around the site as the excavation depth increased.

Permanent lateral support of the excavation face is achieved by means of eleven rows of ground anchors at 3 m centres both ways. The upper 4 m portion of the excavation face is supported by soil nails and a 150 mm layer of mesh reinforced gunite

Anchor lengths vary from 10 m to 26 m. Groundwater drainage is achieved by means of vertical wick drains attached to the excavation face before gunite application. In areas of groundwater concentration horizontal drains were installed into the excavation face.

An extensive programme of monitoring ground movement was undertaken with accurate survey readings taken every two weeks. No discernable movement of the surrounding buildings was recorded; however, some settlement of the roadway surface over approximately a 40 m length occurred with associated movement of the upper portion of the excavation face.

The excellent cooperation between the principal contractor, WBHO, and the sub-contractors, Franki piles and Ross Demolition and Kantey & Templer, resulted in a well-executed project with the minimum disturbance of the surrounding property owners and neighbours

City Council requirements
The developer obtained permission to occupy ‘subterranean’ space beneath the proposed future Victoria Road widening line. The City insisted that this component of the structure be a separate structural entity functioning as a bridge such that the main building could be demolished without affecting the ‘bridge’ structure.

A 1.5m deep earth fill zone under the sidewalk had to be provided that would carry a myriad of services running along Victoria Road. The bridge structure was built to conform with the City’s requirements in terms of design
to bridge vehicular loading applied to the street level structural deck as well as the use of galvanised reinforcing throughout with a minimum of 50 mm cover. The ‘bridge’ component was separated from the main structure with an expansion joint.

Foundations
The RC-framed structure was designed to bear on pad footings cast onto hard granite. A safe bearing capacity of 2,0 MPa was used and the blast platform was cut to a level of 8,050 above sea level. The lift service basement was excavated to 5,300 above sea level. This level included an area incorporating the two large vehicle lifts, two passenger lifts and the lift motor room area to service all four lifts. The entire area was tanked with RC walls around the basement perimeter. Groundwater permeating the rock fissures surrounding the basement footprint is collected into perimeter subsoil drains which discharge to a well sump. The sump is drained with permanent pumps.

A 700 mm thick fill zone between the rock platform level 8,050 and the soffit of the RC surface bed was taken up by a myriad of services buried in sandy backfill material. The 150 mm thick surface bed was cast on the compacted backfill and the walls of the ground floor apartments are built off the reinforced concrete surface beds. The surface beds were reinforced so as to avoid excessive jointing which would interfere with the design of floor finishes.

RC frame
The RC frame was designed to incorporate the following features:
- RC flat slabs with no transfer beams: 280 mm thick RC flat slabs were used in the apartment area with 340 mm thick slabs over the larger spans of the parking garage
- Column layout to suit the ‘cut-back’ effect of the balconies without excessive cantilever spans
- Balconies designed to carry swimming pools
- Span/depth ratios of the slabs to control de-
flections and thus prevent cracking to expensive floor finishes.

- The ten-storey frame was braced for wind and seismic loading by the use of RC shear walls. Shear walls were located around the substantial lift shaft (two vehicle and two passenger lifts) and around the opposite side of the parking area.

- RC fin walls as an architectural feature were used in a load bearing function on the north side of the ‘cleavage’. This was done to reduce the number of columns required in that area. The RC fin walls stepped back in a terraced fashion.

- The slab at level 8 includes a large double-volume component with heavily loaded columns extending through the void.

- Two fire escape staircases (nine floors) were designed with precast flights to assist the contractor.

- Balcony door thresholds were given a 60 mm weather step and the top of structural slab sloped to full bores located on the outer perimeter area.

- Balconies were designed with an upstand edge beam to support glass balustrade insets. Safety glass balustrades are secured with epoxy grout into formed slots into the top of the RC upstand beams. A shaped ‘eyebrow’ feature was included as an architectural feature around the perimeter of each floor.

- The main lift shaft was cast ahead of the slab decks and bearing pockets were strategically positioned to support the slabs.

In satisfying the above criteria a structural solution was arrived at that was neither symmetrical nor grid-like. A decision was taken to analyse a computer-generated model the entire RC frame to determine the interaction effects of the out of symmetry layout. This exercise required the specialist input of Dr Andrew Lloyd of ZLH Consulting Engineers, who modelled the entire RC structure on STAADPRO software. The analysis ran many different load permutations. The effect of seismic loading on the shear walls and certain column to slab connections resulted in some large stress concentrations. Heavy column and slab reinforcing was required in some areas to counter the seismic effect.

**Stormwater diversion**

An existing stormwater gully draining a large area of the slopes of Lion’s Head traversed the property. In order to accommodate the development this stormwater route had to be diverted to the side of the site. We installed a temporary diversion pipe fixed to the south flank of the excavation for the duration of the construction phase.

The existing stormwater pipe crosses under Victoria Road around the middle of the site, thereafter it is diverted in the newly built services zone to a vertical 400 mm diameter uPVC dropper pipe located at the northeast corner of the site. Stormwater plunges 18 m vertically to an RC stilling well, at which point it discharges to another RC stilling further 6 m below via an inclined 400 mm diameter uPVC pipe. The lower stilling well drains to the sea via a 450 mm diameter RC stormwater pipe. This system is designed to give the City Stormwater Authority access for maintenance purposes.

**Environmental management**

The client employed the services of an environmental officer to monitor the construction phase. The construction phase impacted heavily on neighbours in the area. The excavation and blasting phase was the most severe. Daily rock blasts were kept within prescribed acceptable vibration standards. PPS meters were set up at strategic positions around the site to monitor the shock felt by adjacent properties. All blasts were covered with heavy-duty rubber mats and soil over-burden to prevent ‘fly rock’ damage beyond the site boundaries.

**IN CLOSING**

The Eventide apartment project has presented a number of formidable challenges in a broad civil and structural engineering context. The main features that make this project stand out from other ten-storey apartment buildings are:

- The 27 m deep laterally supported excavations against three sides of the site boundary and in a built-up environment.

- Numerous architectural requirements accommodated in the structural solution.

- Building a separate ‘bridge’ structure to support Victoria Road and associated underground services.

-Stormwater diversion through the site.

This project provided a wide variety of unusual challenges for civil engineers to solve in the urban context. The chosen solutions had to take careful consideration to satisfy the environmental expectations and to assist the architects in achieving their aesthetic goals.
Unconventional layout for key interchange

THE K90/K157/P157-2 INTERCHANGE is located at the northeastern boundary of O R Tambo International Airport (previously Johannesburg International Airport), Africa’s busiest airport, which currently caters for more than 13 million passengers each year and hosts airlines from all five continents.

During the last decade development around the airport has boomed and in the near future one of the Blue IQ-financed projects, the Industrial Development Zone (IDZ), will also be completed. This necessitated an in-depth investigation and re-evaluation of the road network around the airport.

The existing first order road network mainly comprises two freeways, the R21 (P157-2) to Pretoria and the R24 (P119-1) to Johannesburg, as well as various arterials used to access the airport and the Ekurhuleni and Johannesburg metropolitan areas.

Two major second order dual carriageway K-routes to the east of the airport (roads K90 and K157) form part of the road network plan for Gauteng Province, as compiled by the PWV Consortium during the 1970s. Feasibility studies completed since 1999 indicated the need for the development of a free-flow access interchange to the northeast of airport between these two roads and the R21 (P157-2) freeway, to improve access to the airport and the surrounding developing areas.

DESIGN

In May 2001 the Gauteng Department of Public Transport, Roads and Works (Gautrans) appointed Vela VKE Consulting Engineers (Pty) Ltd in association (joint venture) with Mokgawa Mtshali and Associates to complete the preliminary design of the K90/K157/P157-2 Interchange as well as the detail design of the first phase, the K157/P157-2 Interchange. The project was fast-tracked through the involvement of Blue IQ, resulting in stringent time constraints on both the design and construction stages.

The number of roads converging in one position required a rather unconventional interchange design, which is further complicated by sub-standard interchange spacings, limited land availability, and height restrictions in the flight paths at the airport. All major turning movements in all directions were accommodated in a free-flow configuration with grade separation structures where required. Design standards were adhered to and the layout was kept as simple as possible to allow clear messages to be relayed to motorists through the use of predominantly overhead road signs. The interchange geometry also ensured that construction could be completed without adversely affecting traffic flow conditions on existing roads, particularly the R21 freeway.

Drainage was another factor requiring much deliberation because of the fairly flat natural topography of the area as well as existing drainage problems on the R21 freeway.

The preliminary design was completed to a stage at which the required road reserves could be proclaimed and expropriated, after which the design team’s focus shifted to the detail design of the first phase, which was completed in September 2002.

CONSTRUCTION

The tender process followed immediately after completion of the detail design and the Grinaker-LTA/Thamane/Yikusasa JV was appointed to construct the first phase, with construction commencing in May 2003.

The construction of the first phase of the interchange included 6 km of ramps, 2 km of dual carriageway and four new bridges with a total of 19 spans and a combined length of more than 580 m. The contract included the rehabilitation (through total reconstruction) and upgrading of 3 km of the existing R21 freeway, including the widening of an existing bridge and rehabilitation of three existing bridges.

Construction of the first phase was completed in June 2005, one month ahead of the initial completion date estimated in February 2002, within the approved budget of just more than R170 million.

Accommodation of traffic

One of the most challenging aspects during the construction stage was accommodating the high traffic volumes on the existing freeway, one of the busiest freeways in South Africa.

During the construction of the bridge spans over the southbound carriageway and the reconstruction of the southbound carriageway, a deviation with two lanes in each direction, divided by central concrete New Jersey-type barriers, was constructed on the northbound carriageway. Thereafter, the traffic was deviated onto the southbound carriageway, again with two lanes in each direction and the central NJ-barriers, to enable the construction of the bridge spans over the northbound carriageway and the reconstruction of the northbound carriageway.

Special features

Owing to the high cost of expropriation of developed land along the R21, two soil nail retaining walls had to be constructed. A median retaining wall also had to be constructed in the R21 median at horizontal curves because of the level difference between the two carriageways and the narrow median as a result of the additional inner lanes.

Because of the presence of an old landfill site, a section on one of the ramps underneath a 10 m high fill had to be compacted using dynamic compaction. One of the bridge piers in the narrow median of the existing K119 dual carriageway road was founded on conventional auger piles. The foundations for the widening of the existing bridge on the R21 over Constantia Avenue were constructed by way of percussion piles because of the poor founding conditions and height limitations under the existing structure.

Materials

As there is a relative shortage of road building materials in urban areas, a section of land of about 20 ha within the interchange complex was identified as a possible source of gravel material. A borrow pit investigation showed that enough suitable gravel material should be available for the construction of the bulk earthworks and gravel pavement layers. To provide more material suitable for the sub-base layers, material obtained through the in-situ recycling of the surfacing and gravel base of the existing R21 and Atlas Road was mixed in with the gravel material obtained from the borrow pit. The proper management of the borrow material ensured that no additional gravel material had to be obtained from other sources.

Owing to the close proximity to the airport and excellent accessibility from both the R21 (semi-direct) and K119 (Great North Road), the borrow pit has been designed to provide adequate drainage and final levels that would make it suitable for later development.

Environmental matters

An environment impact assessment (EIA) was conducted in the design stages to determine the impact of the interchange. This included public participation meetings.

An environmental management plan (EMP) was also compiled to control the impact on the environment. The site was inspected on a monthly basis by an environmental consultant to ensure that the requirements of the EMP were adhered to.
Safety
Site safety and traffic safety officers were appointed to ensure that a high standard of safety was maintained during construction and the requirements of the Occupational Health and Safety (OHS) Act being adhered to. From a safety point of view the construction site was extremely well managed with virtually no construction-related incidents or accidents occurring in the 26-month construction period.

PUBLIC INTEREST
The interchange vastly improves access to the developing areas in the vicinity of the airport. The rehabilitation and upgrading of the R21 freeway resulted in an improved level of service on the section of the freeway between the airport and the Pomona Interchange.

CLOSING REMARKS
The K90/K157/P157-2 Interchange is a unique interchange with an unconventional layout, providing free-flow traffic movements in all directions between two major dual carriageway K-routes and a major freeway, all converging at a single point. It displays ingenuity in design, construction and management necessitated by the unique geographic location, layout of the existing road network, high traffic volumes on the R21 freeway and stringent time and budget constraints.
SOUTH AFRICA is a country where periodic droughts and their consequences are a fact of life. Allied to this is the fact that the country is undergoing rapid urbanisation. The consequences of this are high levels of pollution and contamination of existing scarce supplies which has left many local authorities facing challenges that are typical of cities in a developing country.

Maximising the use of this precious resource and ensuring that potable water is clean and safe places increasing demands on government at local, regional and national levels. Concerned with the technical, economic, environmental and social issues enshrined in the National Water Resource Strategy they continue to rely on the application of dedicated engineering expertise and appropriate technology to achieve their aims of providing water to all.

THE VAALKOP WATER TREATMENT PLANT

Magalies Water is one of the major suppliers of potable water to the people of Gauteng, the North West Province and Limpopo and operates the Vaalkop, Wallmannsthal, Klipdrift, Temba and Cullinan water purification schemes.

Over the years, the waters of the Vaalkop Dam became more and more polluted as increasing agricultural and industrial activity and a growing population resulted in nutrient-rich waters entering the catchment of the dam. This in turn led to an increase of toxins, bacteria, viruses and other substances in the water.

The nutrient-rich water resulted in a substantial algal load, which led to a high level of objectionable tastes and odours in the water. This problem was exacerbated by water received from the Crocodile River through a canal link between the Vaalkop and Roodekopjes dams, which receives raw water from the Hartbeespoort Dam. Hartbeespoort Dam has been well documented for its problematic water quality and the foul odours caused by algal blooms.

ADDITIONAL INSTALLATIONS AT VAALKOP

Pressure on the Vaalkop water treatment plant to meet purified water requirements saw the construction of additional water treatment installations that began to incorporate sophisticated water treatment technology to meet the demands of consumers for clean, odourless drinking water.

In 2000 PDNa was entrusted with the design, tender procedures, contract administration, site supervision and project management of the new 90 million litres a day Phase Five extension of the plant. The project, with a value of R128 million, entailed the use of innovative process design to achieve its objectives.

The company returned to the Vaalkop site in 2003 to prepare a proposal to assist with further upgrading of the original plant and combat problems caused by the deteriorating quality of the raw and recovered water in Plant No 1.

At this stage, because of the deteriorating quality of the water, the plant was unable to cope and had been decommissioned.

REFURBISHMENT OF VAALKOP PLANT NO 1

In February 2003, PDNa, with project partners GFJ (now a merged unit within the PDNa Group), prepared a proposal for Magalies Water to upgrade Plant No 1 at Vaalkop with appropriate technology able to treat the deteriorating quality of the raw and recovered water. PDNa were responsible for the design of the project and also undertook the site supervision.

As costs were a major issue, it was proposed

Combining three water treatment processes in a single plant – a first for South Africa – proved to be an effective solution to ensuring the quality of Vaalkop’s potable water.

Innovative cost-saving solution at Vaalkop
that existing structures should be utilised where possible to reduce expenditure, upgrading the plant on a footprint similar to the original plant.

Cost containment had to be achieved without compromising the engineering solutions required to effectively combat the tastes and odours that were contaminating the water and negatively impacting on product quality.

The projected cost of the refurbishment project when work began was R55 million, a saving of approximately R35 million in additional costs that would have been necessary for the construction of a new 30 Mt/day treatment plant.

Work began in March 2005 and the refurbished plant came on stream in July 2006.

**INNOVATIVE SOLUTION**

The innovative cost-saving solution proposed for the Vaalkop No 1 Plant involved using three different technologies to treat the 20 million litres of raw water from the Vaalkop Dam and 10 million litres of supernatant water from Plants 2 and 3 that pass through the refurbished plant.

The processes suggested were to be used simultaneously for the first time in the country, supplying a much more robust procedure that had ever been formerly used.

Ozone treatment is applied to aid disinfection of the raw water. The ozone required is supplied by an ozone generator installed on site that uses an electrical corona-discharge process that results in oxygen (O₂) being converted into ozone (O₃) and is followed by coagulation and flocculation to assist with the removal of suspended solids.

A dissolved air flotation (DAF) process continues the procedure, being used for further removal of solids and stripping algae from the water. Through this technology, first used in South Africa in 1984, 10–40 micron air bubbles are injected into the feed water stream where algae and lighter particles adhere to the bubbles and float to the surface where they are continuously skimmed off and removed.

Further disinfection with ozone treatment and a pass through a traditional sand filter removes remaining solids and metal hydroxides. Granular activated carbon (GAC) then traps and removes any unpleasant odours and tastes that may have lingered in the water.

Chlorination in the clear water well is followed by water being pumped to No 2 and No 3 plants for ammonia dosing to convert free chlorine to monochloramines.

**BENEFITS**

There are three major benefits for Magalies Water and their consumers:

- The refurbishment of Plant No 1 resulted in the production of an improved quality of potable water being supplied by the utility. This improvement has been achieved through a cost saving over the alternative of constructing a new plant.
- The water is not only be more acceptable from an aesthetic point of view, it is also safer because of ozone’s ability to destroy pathogens and other harmful substances in the water.
- Magalies Water will be well placed in future to better treat raw water that can be expected, because of population and usage pressure, to be of ever-deteriorating quality.

Water is a scarce resource in South Africa. To meet the demand for potable water will require a commitment to optimising available supplies by applying increasingly novel engineering solutions.

Innovative cost-saving solution at Vaalkop

Rapid urbanisation and industrialisation is taking its toll on South Africa’s water resources. High levels of pollution will increasingly place pressure on authorities to harness new technologies to combat deteriorating water quality.

The challenge at Vaalkop was using existing structures and reducing costs without compromising engineering solutions.
SETSOTO MUNICIPALITY in the Eastern Free State identified a need to increase the potable water storage capacity of Marquard and Moemaneng, and Kwezi V3 Engineers were appointed in August 2004 as the design and project management consultants on the project. The project was completed on 1 July 2005.

PURPOSE
While the water demand in Marquard and Moemaneng amounted to 1,36 Mℓ/day, the storage capacity had been only 2,38 Mℓ (enough for 24 hours). With the 3 Mℓ reservoir the storage capacity was raised to 5,38 Mℓ (48 hours).

CHALLENGES
The project presented various challenges. First, Marquard has a generally flat topography which limits the options for the location of reservoirs. Second, the available funding ruled out the possibility of an elevated reservoir(s) with the required capacity (3 Mℓ). The limited funding also had to be used to maximise the reservoir capacity, and third, the funding available required that most of the project funding – R2,9 million of a total of R4 678 577 – had to be spent before 31 March 2005.

DESIGN FEATURES
The project comprised the construction of a 3 Mℓ concrete reservoir and a 2,08 km pipeline from the reservoir to Moemaneng.

The reservoir could be constructed only in its present location because it is the only place near Marquard and Moemaneng with sufficient elevation. Other locations would require long supply pipelines to and from the reservoir.

CONSTRUCTION
The reservoir has a diameter of 29 m and a height of 5,895 m and was designed and built using floating-roof technology. With this technology the floor, wall and pillars are built, after which the roof – which has a total mass of 357 tons – is constructed on the floor around the pillars.

The concrete roof is built to float on the water and is raised above the pillar caps by the water pumped into the reservoir. The roof is then rotated into position and the water level in the reservoir is lowered to rest the roof on the pillars and wall supports.

The steel reinforcing was designed to accommodate a 6 Mℓ reservoir, and 75% of the cost of the additional steel reinforcing was covered by the exclusion of shuttering in the roof construction.

What makes this project unique is that the capacity of the reservoir can be doubled in the future by raising the roof, pumping in water and

**MARQUARD: 3 Mℓ RESERVOIR AND GRAVITY FEED PIPELINE TO MOEMANENG**

Category Technical Excellence 2006
Submitted by Free State Branch

**KEY PLAYERS**

Client Setsoto Municipality
Consulting engineers Kwezi V3 Engineers (Bloemfontein)
Contractor Pro-Care Civils (Welkom)
Project financiers MIG
rotating it so that the openings in the roof correspond with the pillars. The roof is lowered around the pillars by lowering the water level.

The wall and pillars may then be extended and the roof raised to its new position by raising the water level in the reservoir and following the same procedure than before. This implies that the client will not need to demolish the existing roof and construct a new one, which will bring about a great saving.

IN CLOSING
What elevates this project to the class of excellence is the planning involved in making provision for the future expansion of the capacity of the reservoir, as well as the resulting saving.
The composite bridge deck consists of steel railway lines encased in concrete. Mass concrete piers and abutment walls support the bridge deck. Old rails (approximately 30 kg/m) appear to be the only reinforcing in the bridge deck. Seventeen rails, each with an approximate cross-sectional area of 3,85 x 10^3 mm^2, have been used at 177 mm centres. In addition, the 1926 bridge deck has four rolled steel joists in each span used as additional reinforcement, two 254 x 146 mm I-section profiles with an approximate cross-sectional area of 3,99 x 10^3 mm^2 at 305 mm centres positioned below the travelled rail line(s). There is also limited/restricted space available between the rail reinforcement, particularly near the flange sections of reinforcement.

TECHNICAL CONSIDERATIONS
Both bridges experienced advanced deck deterioration, evidenced by large cracks, spalled and delaminated portions of the bottom concrete cover and intense corrosion of the rail reinforcement, as a result of advanced chloride-induced corrosion. It appeared that only the bridge deck is reinforced and required protection (approximately 280 m^2), while the piers and abutments were constructed from mass concrete. Limited diagnostic testing revealed that chloride levels of 2% (by mass of cement) were determined in 2001 at the level of the reinforcing steel.

Various repair options, including desalination, structural strengthening and demolition and reconstruction, were considered but were found to be not feasible.

Cathodic protection was selected as the most suitable repair option to reinstate the rail bridge after considering the technical, environmental, historical and financial implications.

In view of the unusual nature of the strengthening option a complete design was also put to tender for pricing. It was found that the cost of this option would be roughly twice the cost of the cathodic protection option.

One concern related to the cathodic protection system was ongoing monitoring and maintenance requirements, but in view of the nature of the rail maintenance which has an electrification component, the owner did not consider this a problem.

ENVIRONMENTAL CONSIDERATIONS
An environmental scoping process was conducted to identify issues and concerns related to the proposed activities. The main issues were as follows:
■ The bridges are considered to be historically significant structures in view of their age. In addition the remains of an old wooden structure and other historical artefacts were identified in the construction area during the scoping study
■ Several interest groups identified the Silvermine River as a sensitive river/estuarine environment

After due consideration and public participation processes, approval for construction was granted by means of a record of decision from the relevant environmental protection authority.
based on contractually binding regulatory mitigation measures. Key issues were that access to the sensitive areas had to be restricted and that the sensitive river environment had to be protected and suitable care had to be taken not to disturb the watercourse and riverbanks unnecessarily.

**OVERVIEW OF CATHODIC PROTECTION**

Tenders were called for the design, supply of materials, technical supervision during the installation phase and the commissioning of the cathodic protection system. Noteworthy requirements of the contract document were the assurance that the cathodic protection system could achieve the full protection to the embedded rail reinforcing and a minimum 25-year service/operating life.

The design made use of titanium ribbon mesh anode located 40 mm above the bottom flange of the rail reinforcement. Eighteen runs of anode were installed midway between the rail reinforcement for each span. The anodes were secured during installation using plastic clips.

The cathodic protection system was designed in four sub-zones with each bridge having a design current of 3 A per bridge (for two sub-zones per bridge). This design current density is within the maximum current density of the anode to ensure a minimum operational life of 25 years. The operation current is at present set at 1.5 A per bridge – under these conditions the anode life will be at least double.

Monitoring of the system takes place via reference electrodes, mild steel coupons and structure/sense connections embedded within the concrete overlay at various locations in the structure while the system settings and outputs are controlled by the transformer-rectifier. The cathodic protection system will attempt to achieve a significant potential shift (to more negative than ~800 mV vs Ag/AgCl) or polarisation, to attain theoretical immunity, that is, cessation of corrosion.

**TENDER AND CONSTRUCTION**

In view of the specialised nature of the installation the construction was facilitated by way of a two-phase process.

The impressed current-protection system was designed and the embedded materials supplied under a contract for the design, supply, commissioning, and monitoring of a cathodic protection system.

The various components of the cathodic protection system were installed under a separate contract using specialist repair contractors. This contract made provision for the demolition and reinstatement of the soffit (bottom cover to reinforcement) using a sprayed concrete overlay to encapsulate the cathodic protection system. The associated structural-grade sprayed concrete overlay had strict performance requirements to ensure appropriate functioning of the cathodic protection system. The sprayed concrete overlay was applied in two layers: the primary repair, about 50 mm thick, which encapsulated all the embedded CP components and cabling, and the finishing layer, some 25 mm thick, which received a trowelled, wood-floated surface finish.

In a similar fashion to refractory-type sprayed concrete applications, steel twigs were welded to the underside of the rail reinforcement at 600 mm centres to provide a physical key to the sprayed concrete overlay. Particular specifications were formulated for the sprayed concrete overlay at design stage, and included in the contract documentation, to effectively control the presaturation of the concrete substrate and curing of the overlay using a microjet spray system.

**CONCLUSIONS**

Technically sophisticated repair methods such as cathodic protection can provide appropriate solutions for structures in severe marine exposure environments particularly for historically significant structures in environmentally sensitive locations. The unique reinforcement configuration, comprising old rail track sections, complicated and reduced the available repair options for this bridge. An impressed current cathodic protection was selected as the most suitable repair option after due consideration of the technical, environmental, historical and financial factors. Despite the technical complexity of the project, the installation phase was completed within the approved budget.
Toyota plant’s vehicle capacity doubled

TOYOTA’S NEW PAINT PLANT 3 in Prospecton, Durban, will increase the annual vehicle capacity of the plant from 100 000 to 230 000 units. The project was executed by a BKs (Pty) Ltd and Grinaker-LTA team on a fast-track basis, under very strict space, time and budget conditions, and with the surrounding production plant in full operation.

PROJECT DESIGN AND EXECUTION
BKs was awarded the Paint Plant 3 project in mid-2004 after the completion of cost, time, and quality benchmark studies on construction materials and methodologies available in South Africa.

PILING
Pile driving commenced two weeks before Christmas in 2004. The 350 x 350 mm pre-cast piles (10 m to 13 m in length) were manufactured on site; driven into the ground and coupled to form piles of lengths 30 m to 44 m. Within two months, the 1 350 piles were all installed. At the time, it was the largest pre-cast pile contract ever in Durban.

Selected piles were tested throughout the pile installation period thereby continuously calibrating and adjusting the hot and cold set requirements for installation, but without compromising the load carrying capacity and settlement requirements, hence a reduction in installation time and project saving of approximately R5 million.

UNDERGROUND TUNNELS, GROUND FLOOR AND PROCESS PITS
The production process required six underground tunnels for air extraction from the spray booths. The 2 m to 5 m tunnels had a fixed height of 3 m internal. Air with VOC content is extracted at a velocity of 10 m/s and the tunnels feed directly into the air-extraction stack.

The ground floor consists of 300 mm, 400 mm (over tunnels), and 500 mm thick reinforced concrete slabs on piles, forming a piled raft covering a total plan area 20 358 m².

The production process also called for inspection booth conveyor pits of depth 1,5 m covering approximately 20% of the total floor area and vehicle body lift recesses with a depth of 300 mm.

SLIP-FORM CONSTRUCTION
The original design for outer wall construction of the east (220 m long) and west walls (234 m long) was intended to be individual reinforced concrete columns at 6 m centre-to-centre spacing combined with ‘tilt-up’ concrete wall panels. Owing to insufficient wall panel casting area on site and restricted access and working room for installation of the wall panels, as well as time constraints, Grinaker-LTA proposed the use of the slip-form method of construction to be executed by Karrena Africa, a division within the Grinaker-LTA Civil Engineering business unit. This entailed casting the building columns (1200 mm
x 600 mm in section) on the main building grid at 18 m centre-to-centre spacing, where-after the wall (200 mm thick) and two intermediate columns at 6 mm centres were slip-formed as a monolithic unit. This method is more expensive, but much more time efficient, with the sliding crew completing an 18 m x 19,5 m wall panel on average within five days.

The decision to use slip-forming for the construction of a significant part of the overall concrete structure was one of the most decisive elements in the success of the project.

**INTERNAL BUILDING COLUMNS AND PLANT MEZZANINE FLOOR**

The internal pile caps and concrete columns were constructed to its full length up to a height of 16 m agfl. Reinforcement and sleeves for the post tensioning cables passing through the columns for the plant mezzanine floor construction were cast with the columns at the required level. This methodology was followed in order to allow construction of the air-house floor and roof structure supporting onto the columns to continue without delay. While the air-house floor/roof construction progressed, the plant mezzanine floor and ground floor below followed under-cover and with construction activities taking place on all three working levels at the same time.

**AIR-HOUSE FLOOR AND ROOF STRUCTURE**

The air-house (117 m x 51 m) houses plant equipment. The air-house floor is constructed of steelwork lattice trusses spanning east–west at 12 m, 18 m, and 21 m spans and north–south at 9 m spans in general. The trusses are spaced at 6 m centres north–south with column supports on the eastern and western walls at north–south 6 m centres. The internal columns were spaced north–south at 18 m centres, hence lattice support trusses with spans of 18 m to support two intermediate trusses per bay were constructed.

**GENERAL ROOF STRUCTURE**

The general roof structure covers the remaining plan area of the building which is not occupied by the air-house. This roof consists of steelwork trusses spaced at 6 m centres and also supports onto the internal columns.

**STRUCTURAL STEEL CHIMNEYS**

Part of the building contract included the supply and installation of 28 structural steel chimneys varying in diameter from 300 mm to 2 000 mm and lengths from 4,5 m to 13,0 m. The chimneys extend from the level of the bottom flange of the roof trusses to a height of 2 500 mm above the roof sheeting line.

**RTO PLATFORM**

This structure consists of an external floor for support of the RTO plant. The structure was constructed over an access road and it was quite a challenge to execute this task such that it did not cause any prolonged period of closure of the road.

**LINKS**

The Body Shop link is the incoming link for vehicle bodies to the plant. The Assembly Hall link is the outgoing link for vehicles from the plant to the assembly process. The link consists of structural steel framing with steel-beam grillages forming three levels of operation and vehicle body transfer between the two production processes.

**OFFICE BLOCK**

The southern Paint Plant 3 office is of a steel-concrete composite floor construction, brick walls and a steelwork frame with aluminium roof cladding and shop-front façade. The office floor spans 12 m across an access road, which could not be closed and construction had to take place above/over this road.

**OTHER SPECIAL REQUIREMENTS**

Any/all building materials were required to be guaranteed as silicon free, therefore all contractors were required to test their materials. Because dust is a main cause of quality problems for the painting process, special measures were taken to effectively seal the entire building at all joints.

**CLOSING REMARK**

BKs and Grinaker-LTA worked well together on this demanding but rewarding project and the many challenges simply boosted the creative spirit of everyone involved.

The decision to use slip-forming for a significant part of the structure was one of the most decisive elements in the success of the project.
ACCESS TO Mobeni and Jacobs industrial zones in Durban is provided via the Quality Street Interchange and the M4 Albert Luthuli Highway. The interchange experienced severe capacity problems which necessitated a cost-effective, functional and aesthetically pleasing solution. This comprised the widening of the Quality Street bridge over the M4, road pavement rehabilitation and widening, extensive retaining walls in restricted areas, and aesthetically pleasing feature lighting, whilst preserving access to surrounding industry and minimising the impact on the adjacent Jacobs Hostel complex.

The project is a catalyst initiative for renewal of the Southern Industrial Basin by providing a functional and cost-effective solution to relieve the traffic congestion experienced on the Quality Street interchange and to serve as a visually pleasing feature on Albert Luthuli Highway, the southern gateway into Durban.

THE PROJECT

The widening of Quality Street and the ramps at the interchange was dictated by the findings of the traffic investigation, and to some extent the physical constraints of the existing structural components. The choice of which side of the bridge to widen, the northern or southern side, was mainly dictated by the fact that the westerly direction required three lanes, which could fit comfortably onto the existing bridge, while the additional two lanes for the easterly direction traffic, required a new structure on the northern side of the existing bridge.

The interchange is subject to heavy haulage vehicle usage with associated tight turning manoeuvres. This necessitated an up-front traffic capacity analysis to ensure optimum lane and turning lane facilities, careful consideration of the required heavy vehicle turning patterns in this restricted environment, and an appropriate road pavement design incorporating a deformation resistant road surface which would be compatible with heavy vehicle turning movements. A cement resin-impregnated asphalt was selected to meet this requirement.

The interchange ramps themselves required to be regraded as a result of the Quality Street Bridge widening, while the need for additional lanes on the ramps was provided as dictated by the capacity improvement recommendations.

The interchange upgrade included substantial structural works including the Quality Street Bridge over the Southern Freeway, the Landsdowne Road Underpass and the retaining walls supporting the interchange ramps. Each structure was affected by the proposed interchange upgrade. In addition, new retaining walls were also required.

CHALLENGES AND INNOVATIONS

The accommodation of traffic and the geometric constraints associated with this ‘narrow’ diamond interchange, together with Landsdowne Road running directly underneath the ramp intersections, posed substantial construction challenges.

Inadequate vertical clearance for traffic on the M4 necessitated the construction of the new cast in-situ widened deck of the Quality Street Bridge at a higher level and jacking it down after staging was removed. The bridge deck was constructed 860 mm higher than the final seating level and required seven precision interlinked jacks to lower the deck evenly over the entire area of the bridge. The jacking was done in 50 mm increments at an approximate rate of 2 mm per minute.

Traffic accommodation measures included the closure of a shoulder and one lane of each carriageway of the M4, Albert Luthuli Highway, to permit construction of piles, abutments, pier and deck staging. This proved to be least disruptive and ensured ease of construction and minimum traffic disruption.

Owing to the ground conditions predicted from the borehole logs, it was necessary to use

Innovative solutions to construction challenges during

- Elevated Quality Street bridge deck showing temporary supports and jacking equipment at start of jacking down process
- Completed Quality Street Interchange upgrade
- Elevated piling platforms allowing accommodation of traffic on adjacent ramp
- Retaining wall in progress to preserve the hostel complex
- Soil nail lateral support in progress on Quality Street
- Elevated Quality Street bridge deck showing temporary supports and jacking equipment at start of jacking down process
- Completed Quality Street Interchange upgrade

Innovative solutions to construction challenges during
precast driven piles to support new abutments and piers. During installation, vibrations in the vicinity and the existing bridges and buildings were monitored to ensure compliance with acceptable vibration levels. No damage to surrounding buildings was recorded.

Environmental management of available materials was a significant feature of the project in that milled asphalt from the adjacent M4 rehabilitation project, which would normally be discarded, was used extensively as backfill to the reinforced earth retaining walls, thus negating the need to import any fill material.

**PROJECT STATUS**
The project was successfully completed in March 2006 within the 18-month contract period and at a cost of R27,5 million, which was 0,25% below the allocated budget, providing a functional and aesthetically pleasing end product.

**CONCLUSION**
The Quality Street Interchange upgrade has significantly improved the operational efficiency of the interchange. Peak hour congestion and the inadequate turning paths for heavy vehicles have been fully resolved, while introducing additional public transport and pedestrian facilities and thus providing a functional and aesthetically pleasing end product.
Successful precast concrete solution

The scope of the Mondi PM31 UWF conversion project was the demolition of the old paper machine at Mondi Merebank and the construction of a new paper machine, some 180 m long, 12 m wide and 20 m high, within the same physical space. The existing machine hall's outer walls and roof were to remain.

The project was a multidisciplinary shutdown project requiring civil, structural, machine mechanical, piping, electrical and automation contractors to work around the clock. This is believed to be the largest rebuild of a paper machine in the Southern Hemisphere.

The main constraint dictating the design, construction methods and timing of the project was the minimising of disruption to the production of paper. The shutdown time of the paper machine had to be kept as short as possible and the other four paper machines within the mill had to continue with normal operations. Thus work not affecting the production process was executed during the pre-shut phase with the main focus of minimising the amount of work to be carried out during the shut.

The loads produced by the new paper machine are enormous, with huge dynamic factors. In addition, the machine is highly sensitive and the supporting structure was required to be designed to extremely tight vibration tolerances. This required a vibration analysis of the entire support structure. No software capable of modeling and executing this task was available locally and the analysis was performed in London by Arup.

Originally all concrete elements were designed to be conventionally constructed in situ. After a combined project meeting with the paper machine supplier, the project team were requested to investigate the use of precast elements. This had never been attempted before on a paper machine rebuild in South Africa.

This late decision to opt for precast elements meant that a major portion of construction work that was scheduled to happen during the shutdown had to be designed, drawn and constructed pre-shut, within a period of 14 weeks. The main problem was how to connect the precast elements together and to the existing structures and still transfer the enormous moments and forces between elements. The sizes and shapes of the elements could not be changed.
from what had already been agreed with the machine supplier, because the machine had already been manufactured.

Approximately 50 reinforced concrete elements ranging between 6 and 23 tons each were precast in a yard and fitted together on site like a giant jigsaw puzzle. A full-scale model of one of the precast beams was constructed in the precast yard to ensure that all aspects of the design and installation could in fact be carried out.

The design of the structural steelwork on the roof also presented its own challenge. The enclosed heated plenum above the machine house and the poor state of much of the existing steelwork meant design solutions often had to be adapted as work on site progressed.

CONSTRUCTION TECHNIQUES AND SPECIAL MEASURES

Working space and access was severely restricted, both within the mill and in the laydown area. Efficient use of plant was not always possible and labour-intensive methods were often adopted. Very limited use was made of mobile cranes while the tower crane was only useful for the roof work and for lifting limited loads through a hole made in the roof. Dumpers were only permitted to be used on the ground floor, thus the movement of material and equipment was often done by hand.

General resource levelling used on most projects was not permitted, and every available physical space where work was required had to be worked on simultaneously.

The most effective combination of demolition methods involving wirecutting, coring, slab sawing, pneumatic and machine breaking were used to achieve or better scheduled dates and durations. Headroom and working space restrictions required various modifications to demolition equipment, whilst the two 50 tonne overhead cranes transported equipment and concrete blocks along the machine hall to its next position.

The shut commenced on 25 May 2005 and all major civil works were completed by 12 July 2005.

MEETING THE OBJECTIVES

Detailed planning was essential on a project of this nature. Detailed method statements were prepared for all the demolition work and for the critical construction activities. Owing to the resources required for this project no single company could execute the work and hence a joint venture was formed between Grinaker-LTA, Group Five, Ross Civils and Stefanutti & Bressan.

A particular challenge of the project was to integrate all site staff members, almost 100 at peak, from each of the four different companies and to get them to work as a team within such a short space of time.

Work continued 24/7 during the entire shut.

IN CLOSING

The magnitude, complexity and accuracy of work required to be done in such a confined space within a nine-week shut period make this project quite unique.

Below: Dowels into existing pile caps for new shear walls
Above left: Demolition almost complete and precast beams being installed
Above right: Constructing new drive plinth while mechanical demolition is still in progress
EDWIN SWALES VC DRIVE
REHABILITATION AND WIDENING

Category Technical Excellence 2006
Submitted by Durban Branch

KEY PLAYERS
Client eThekwini Municipality
Professional team Jeffares & Green (Pty) Ltd / Iliso Consulting JV
Main contractors Group Five KZN / Pandev JV

Left: Edwin Swales VC Drive in Durban is a major arterial linking the port to the national routes north, south and west of the city. The purpose of this contract was to widen both carriageways of Edwin Swales Drive between Titren Road and the N2 and to overlay the existing concrete pavement with a continuously reinforced concrete pavement with tie bars across adjacent lanes. This, combined with the restricted working space, precluded the use of a continuous paving machine, resulting in the use of labour-intensive methods.

Above: The overlay design consisted of a 135 mm thick continuously reinforced concrete pavement placed on an asphalt separation layer of variable thickness (minimum 20 mm).

Bottom left: A total area of 97 898 m² of continuously reinforced concrete pavement – which equates to a total length of 27.97 lane kilometers – was constructed during the 27-month contract period.

Bottom right: The final riding quality achieved surpasses that of any other hand-placed concrete road and is in fact likely to surpass even the best riding quality produced by mechanical pavers in South Africa and, by all accounts, in most other countries.
The R32.5 million Ugu District Municipality Rural Household Sanitation Project – Programmes 4, 5 and 6 was implemented between March 2004 and March 2006.

The purpose of this project, in keeping with the National Sanitation Policy, was to provide a socially acceptable basic level of sanitation to rural communities within the Ugu District Municipality which was economically feasible, sustainable, environmentally friendly and which assists in improving the current and long-term health status of the community with the provision of ventilated improved pit (VIP) toilets, linked to health and hygiene education programmes for the beneficiaries.

In addition, implementation solutions targeting maximum utilisation of local labour and materials were aimed at creating employment opportunities and providing skills development during construction.

The main objective of the project was to create a 'sanitation need' within the beneficiary communities so that rural households would ensure the use of an acceptable VIP toilet, rather than the bush and/or 'long drops'.

Long-term sustainability was promoted by ensuring the training and use of local labour in the construction of the VIP toilets so that skills would be retained within the community for the construction of new toilets and for the removal and re-erection of toilets when pits filled up.

Toilet superstructures have been designed to be removed and reinstalled in segments, over new pits, when the need arises.

The project was implemented between March 2004 and March 2006. In total 10 418 household units benefiting some 70 000 people were built, providing more than 2 400 jobs.

An integrated approach with active involvement of all stakeholders was adopted. Social consultants were responsible for identification and notification of beneficiaries, based on liaison with local amakhosi, isinduna and councillors. They were also responsible for awareness creation, training and capacity-building on safe sanitation practices, health and hygiene and waterborne diseases and training on operation and maintenance procedures for VIP toilets.

Following an announcement by Department of Water Affairs and Forestry that steel toilets were no longer to be offered as an option for VIP toilet installations, an innovative new precast concrete toilet superstructure was developed.

The new structure utilised precast concrete culvert like 'c-sections' for the walls that are durable, maintenance free and sturdy, but at the same time modular. This allowed for transportation of components over difficult terrain, utilising of local people during construction with associated skills development, and from an operational perspective easy removal and re-assembly of the superstructure over a new pit when the pits are eventually full.

Sensitive and holistic handling of environmental issues by way of geotechnical and hydrological investigations by specialist consultants preceded construction.

Pits for VIP toilets were sited by the project team comprising the engineer’s staff, the social consultant and the environmental health officer in consultation with the homeowner. Thereafter the pit was dug by the beneficiary and inspected by the engineer’s representative in accordance with dimensions specified.

If necessary, pits were lined if necessary with a ferrocement lining. Local people were...

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**SAICE AWARDS 2006 – COMMUNITY-BASED**

**Innovative new precast concrete toilet wins Community-based Award**

The Ugu District Municipality Rural Household Sanitation Project – Programmes 4, 5 and 6, winner of the SAICE National Award for Community-based Projects in 2006, was submitted by the Durban Branch.

**KEY PLAYERS**

**Client**
Ugu District Municipality, Water and Sanitation Department

**Consulting engineers**
Stemele Bosch Africa (Pty) Ltd (Multidisciplinary Consulting Services)

**Numerous contractors, suppliers and ISO consultants**

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**UGU DISTRICT MUNICIPALITY RURAL HOUSEHOLD SANITATION PROJECT – PROGRAMMES 4, 5 AND 6**

Winner of the SAICE National Award for Community-based Projects in 2006

Submitted by Durban Branch

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**S A I C E  A W A R D S  2 0 0 6  –  C O M M U N I T Y - B A S E D**
again trained to line pits. Pit linings include apertures for seepage of water and a ‘ring beam’ at ground level.

Precast concrete slabs and wall sections were stored at central depots, and then transported through often steep and difficult terrain to individual household sites using local labour.

The area over the pit was levelled and the cover slab positioned to receive the superstructure comprising four culvert-like precast concrete ‘c-sections’. The galvanised steel roof sheet, PVC vent pipe with flyscreen fitted to the cover slab and a wooden door and frame completed the toilet, which was then handed over to the beneficiary.

Ugu’s targeted procurement policy was adopted in respect of all procurement. Local emerging businesses were engaged and eight suppliers, nineteen construction managers and seven ISD consultants were appointed for implementation of the programmes.

The total project value amounted to R32 568 220 and it was funded through the MIG programme.

Approximately 70 000 people from the community are clearly the beneficiaries of this project which has maximised local inputs as well as addressing job and skills creation and ultimately improving the quality of life. In order to achieve this, the project was broken down into smaller components which required a higher level of competence in terms of the overall project management and co-ordination to ensure completing projects on time and within budget.

The quality of the project, both from a technical and project management consideration, was controlled throughout by the application of Stermele Bosch Africa’s ISO 9001/2000 certified quality management system.

The project has been successful in delivering a long-term sanitation solution to many rural families within Ugu District Municipality but, more importantly, it has provided people with dignity.
IN 2001, THE THEN KZN MINISTER of Transport and present KZN Premier, Mr S’bu Ndebele, announced the launch of the African Renaissance Roads Upgrading Programme (ARRUP), a bold roads upgrading infrastructural investment initiative aimed at fast-tracking rural development in KwaZulu-Natal.

ARRUP is aimed at the upgrading and blacktopping of approximately 509 km of the nine most heavily trafficked and strategically important transport corridors in KwaZulu-Natal at a cost of approximately R3,12 billion. This huge investment in these major corridors intends to unlock a massive but undeveloped potential to create new jobs and business opportunities, and to diversify the region’s economy.

ENGINEERING DESIGN APPROACH
Innovation in design
Detailed planning is a vital part of the ARRUP methodology. The ARRUP steering committee comprises a carefully selected, multi-skilled team of individuals who are tasked with ensuring that the department’s vision of ARRUP is put into practice in innovative ways that maximises employment and empowerment opportunities with a focus on women and youth and prioritises programme objectives and targets. This entails ensuring that labour-intensive techniques are adopted in designs based on the guidelines set by the Expanded Public Works Programme and unbundling contracts.

Planning on each ARRUP project is structured around project liaison committees (PLCs) which are formed on each ARRUP project. Planning around appropriate design of the road takes place in conjunction with practical planning around community needs. Local knowledge from community members is incorporated into the planning of the road particularly around issues such as safety, speed curbing as well as the identification of culturally relevant and historically significant sites.

Linking water to integrated development
As investment in ARRUP projects increases, so too does the ability of the programme to unlock the economic potential of rural communities and their natural resources. The KZN Department of Transport (DOT) is committed to maximising socio-economic development.
in the arrUP corridors by using a holistic, integrated and innovative approach to the planning, design and provision of blacktop roads by integrating water, agriculture, road commerce, industry and other developmental infrastructure.

**PROJECT IMPLEMENTATION**

**Community participation**

The philosophy that a road should be engineered and constructed in a way which directly benefits the people who live within its proximity is at the core of arrUP. Active community participation in the planning and implementation of each project is vital, and this is successfully achieved through the workings of the PLCs.

These participatory forums represent all relevant stakeholders, including amakhosi (traditional leaders), local government, provincial government departments, local business, environmental and tourist authorities, public transport and other community interest groups. While the DOT suggests various relevant sectors or stakeholders for consideration, representation on each PLC is decided on by the beneficiary community during the communication strategy meeting, which is the first meeting of each project.

**Training and mentoring**

ARRUP creates opportunities for emerging contractors to participate in higher-order road construction. This is ensured by teaming emerging contractors with established contractors in joint ventures, thus presenting huge opportunities for skills development and growth to Vukuzakhe contractors. (A KZN Department of Transport initiative, Vukuzakhe is a staged advancement, emerging contractor development programme.)

**SOCIO-ECONOMIC DEVELOPMENT**

**Development initiatives**

One of the fundamental principles of arrUP is to ensure that the local community benefits from the road construction. As part of their arrUP contract commitment to the DOT, contractors make use of specialised plant and skilled operators on site to improve community facilities where possible.

In the same vein, consultants utilise the presence of engineering professionals on site to promote engineering as a career choice amongst local school pupils and to inspire interest in the study of mathematics and science. This is achieved through school presentations, the donation of study aids and equipment, by excursions of learner groups on structured site visits, or through the individual mentoring of selected learners who have demonstrated the potential to enter the profession.

**Corridor developments**

Part of the arrUP planning strategy is to identify opportunities along the road where input from other departments can be actioned to create an integrated response to the needs of communities living along the road. An overall spatial survey is carried out to identify potential developmental opportunities within the corridor of the road. The departmental team then acts to leverage partnerships that will realise these opportunities. These strategies have already yielded good results, for example, along the arrUP roads P235 and P68, the Hlabisa and Ugu municipalities and the local communities are involved in integrating water needs for road construction with the agricultural and business needs of the community.

**IN CLOSING**

ARRUP has thus far created 10 142 new jobs, with more than 65% of the total construction expenditure directed toward broad-based black economic empowerment through the creation of Vukuzakhe opportunities (against a set target of 67%). With its focus on social development, it looks set to create a model for road-building practice that can be effectively applied to all developing countries, but its far-reaching implications and immediate benefits in terms of employment creation and poverty eradication are already being implemented and felt in KwaZulu-Natal.
IN THE VILLAGE OF MODIMOLA, near Mafikeng, an impoverished community faces a brighter future thanks to a project which marked the official launch of the Expanded Public Works Programme (EPWP) in North West Province and which addressed job creation, poverty alleviation and food security.

The EPWP is one of the South African government’s short- to medium-term programmes covering all spheres of government and state-owned enterprises. Through this programme, significant numbers of the unemployed are drawn into productive, gainful employment where they acquire skills, thereby increasing their capacity to earn an income once they leave the programme. Employment opportunities are created in government-funded infrastructure projects, environmental and cultural programmes, as well as social programmes.

The EPWP is an important programme in a context where, in September 2003, 4.6 million people were unemployed, in terms of the strict definition, and 8.3 million, in terms of the broad definition, and where a very high proportion of the unemployed have never worked.

In July 2003, the Economic Development and Infrastructure Cluster’s Executive Committee in North West Province approved a project to create labour-intensive employment in road construction and maintenance and small-scale irrigation farming for impoverished communities in the province. Two months later Africon was appointed to develop a public works programme to address these objectives, based on the firm’s experience in developing and implementing a similar project in Malawi.

The area which was identified for the project is located along the Mafikeng–Vryburg road and includes the villages of Makgabane and Modimola and surrounds, encompassing some 200 households comprising 1 100 beneficiaries.

Following the finalisation of the business plan in March 2004 and a successful three-month test phase, the project was rolled out and completed in July 2006.

**PROGRAMME OBJECTIVES**

The primary objective of the Modimola EPWP was to contribute towards the overall objective of the national EPWP by increasing job creation and food security, thereby reducing poverty in North West Province.

In addition, the programme focused on the development of small, medium and micro-enterprises (SMMEs), as well as the construction and repair of various road and agricultural infrastructure in the targeted areas.

**ROADS**

- Routine maintenance of a 70 km section of the Mafikeng–Vryburg road
- Route patrols on the road between Mafikeng and Taung, over some 230 km
- Construction of 10.5 km of access and internal roads, two stormwater drainage structures and 21 concrete drifts in Modimola and Madiba-Makgabane
- The building of two bridge structures

**AGRICULTURE**

- The establishment of an agricultural project where small emerging farmers from the Modimola village cultivate cash crops for own consumption and commercial purposes under irrigation next to the Molopo River
- The labour-intensive construction of infrastructure required for the agricultural project

**TRAINING**

Supporting the two technical components, there was a strong, standardised training component.

**PROGRAMME MANAGEMENT**

Africon was responsible for the development of the programme concept and the business plan. As such, the firm undertook the overall management of the programme, in consultation with the provincial Department of Public Works. In this regard, Africon made extensive use of its proprietary site management system to ensure that a high standard of work was attained.

Other role-players involved during implementation included the national and provincial departments of Agriculture, Conservation and Environment, the provincial department of Transport, Roads and Community Safety, the provincial department of Water Affairs, and the Central District Municipality.

**PROGRAMME COMPONENTS**

This R25 million project was designed so that the technical components, namely roads and agriculture, supported by a comprehensive training component, would together achieve the socio-economic targets.
All training was undertaken in cooperation with the Construction or Agricultural SETAs and the Department of Labour.

PROGRAMME ACHIEVEMENTS
The programme achieved the following to the benefit of the targeted communities:
- Some 200 households, comprising 1 100 people, benefited directly from the project
- R5,73 million was generated from construction and maintenance activities
- R1 million will be generated annually from small-scale agriculture
- Some 50 permanent jobs and 480 temporary jobs were created
- Sixteen people successfully completed the NQF Level 2 construction learnership programme
- Thirty people, including 21 women, successfully completed the NQF Level learnership programme in farming and they are all farming on their own 0,53 ha plot
- A co-operative has been registered for the farmers to manage the farming enterprise

CONCLUSION
Valuable lessons learnt from the Modimola EPWP will be incorporated in other, similar projects.
UTHUNGULU DISTRICT MUNICIPALITY has five local municipalities under its area of jurisdiction, namely Mthonjaneni (KZ285), Ntambanana (KZ283), uMlalazi (KZ284), Nkandla (KZ286) and Mbonambi (KZ281), covering some 7 418 km² of predominantly deep rural tribal authorities in Zululand, previously having extremely poor infrastructure levels. Further, the District Municipality has the third highest population in the province, serving some 762 791 people.

This comprehensive uThungulu District Municipality project comprises a number of smaller to relatively larger water supply contracts in the rural region of Zululand in KwaZulu-Natal. BKs (Pty) Ltd has been involved in these ongoing projects since 1996 and has subsequently been making a significant contribution to the socio-economic upliftment of several thousand people in the region.

No two contract scopes are exactly the same, but each involves the upgrading of existing systems or construction of new bulk and reticulation pipelines, installation of communal standpipes, reservoirs, water treatment plants and other supplementary products and services; all according to RDP standards.

During the past nine years, BKs has executed some 54 projects, each with a unique extent, value and community requirement, but the following prime objectives remain constant:

- Providing the community with an adequate, safe, reliable and sustainable water service to RDP standards
- Creating a financially feasible project
- Creating local job opportunities
- Building capacity and empowering the local community to take charge of their own affairs through sound and accountable institutional structures
- Establishing and promoting good, accountable governance along national guidelines
- Building awareness of the environment and the value of water as a scarce resource
- Increasing the consumer base to improve affordability and cost recovery, where applicable

In 2000 uThungulu District Municipality awarded BKs (Pty) Ltd with a certificate of achievement for outstanding implementation of projects carried out in the region. To date some 54 individual projects have been undertaken in these rural areas.

SYSTEM DESIGN
Minimum RDP standards are the norm for the design of each system. The following general criteria were used in each of the design processes:

- Water demand
- Maximum water demand
- Design period
- Population growth rate
- Number of people per household
- Summer demand
- System losses
- Storage reservoir capacity

The design period for the main pipelines is 20 years. Standpipes are at an average distance of 200 m from each home with a minimum flow rate of 10 ℓ/min per tap. The robust standpipes have a concrete apron with allowance for drainage of spillage water. Pipelines are mostly HDPE (diameters of 75 mm and less).

SYSTEM OPERATION AND MAINTENANCE
Initially, a water committee was appointed for each scheme and they were trained to be responsible for the operation and maintenance of the system, in addition to the collection of revenue for the water usage. However, legislation has subsequently changed and uThungulu District Municipality has taken on the responsibility of both water service authority (WSA) and water service provider (WSP).

TYPICAL INDIVIDUAL PROJECTS
Four typical examples of the individual contracts in the uThungulu rural water supply projects are:

- Mpungose Phase 2 water project
- Mpungose Phase 1C bulk water supply project
- Mbizo water supply project

These projects are changing the face of rural KwaZulu-Natal.
to the north and the uMlalazi River to the south; an area of 42 km². The scope of work entailed the extension of existing bulk supply infrastructure and the installation of new reticulation lines into the relevant wards.

- **Mpungose Phase 2 water supply project** The Mpungose project served approximately 950 people and is situated 5 km from Eshowe. At least 20 standpipes were installed in an area of 4 km². The labour-intensive method of construction of this R340 000 water supply contract involved members of the local community and provided a number of jobs.

- **Mpungose Phase 1C bulk water supply project** The project is also situated in the Mpungose tribal area some 5 km north of Eshowe.

- **Mnaize and Eziquwaqweni water supply project** This project comprised the installation of the reticulation system in the Mnaize and Eziquwaqweni wards of the Mpungose tribal authority, 10 km northwest of Eshowe. A 150 kℓ reservoir was constructed in the area during the previous construction phase and this project supplied the necessary distribution scheme. Some minor extensions to an existing scheme in the nearby area were also included in the project.

**COMMUNITY PARTICIPATION**
Community approval, support and participation are imperative for the success of each contract and the uThungulu District Municipality water supply project as a whole. Each community has a different requirement and respond in a different manner to the project. For example, the rural communities residing closer to the larger commercial centres, such as Empangeni, Eshowe and Melmoth, are found to be more aware of the government’s goal to provide a water supply to areas previously without, so as to uplift their standard of living, both economically and socially. In the more remote areas, a certain amount of information dissemination is necessary to educate the communities on the afore-mentioned benefits, before any work can commence on a particular project. In both cases, however, it is absolutely vital to have the community ‘buy into’ the proposed projects.

**TRAINING AND JOB CREATION**
Scores of people have been trained during the last nine years. The training is in three main categories, namely technical, administrative and social.

BK’s and the client both place a high priority on training and capacity-building. For each individual project, a local water committee is established and trained. While some committee members may have had previous training on certain managerial aspects such as conflict resolution, they receive detail training on institutional awareness, financial management and the operation and maintenance of a water scheme.

**CONSTRUCTION METHODOLOGY**
In line with tender requirements, small and BEE sub-contractors and skilled and unskilled local labour are invited to participate in the contracts. BK’s designs provide for as many opportunities as possible for each of these previously disadvantaged companies and individuals.

**ENVIRONMENTAL CONSIDERATIONS**
In general, the pipelines that are installed run parallel to existing roads and tracks, with minimal disturbance of the vegetation (pipes are deviated around trees). Further, extreme care is taken to reduce erosion along the trenches by compacting the backfill well and making allowance for settlement. Officials from the Department of Agriculture and Environmental Affairs are invited to site meetings during the construction phase and periodically inspect the works on an ad hoc basis.

**CONCLUDING REMARKS**
It has been found that for each of the projects to be successful it was initially necessary to undertake a certain amount of facilitation with and training of leading community representatives. Not only did the communities benefit economically in the short term, but some labourers subsequently found permanent employment positions with the main contractors appointed to supervise the works.
MaLaWi is a COUNTRY characterised by widespread poverty, with more than half its ten million-strong population living below the poverty line. Improving the standard of living in the country, especially in rural areas, is therefore of significant concern to the Malawi government.

The Poverty Reduction Strategy Paper (MPRSP) identified improved access in rural areas and improved management of natural resources as essential prerequisites for the attainment of this goal.

In 1998, vulnerable areas that would potentially derive the greatest benefit from a targeted public works programme were identified. Five districts in the Central Region of Malawi, namely Lilongwe West, Dowa West, Mchinji, Ntchisi and Kasungu, inhabited by some 1.8 million people, were selected for the initial phase of the Government of Malawi/European Union Public Works Programme (GoM/EU PWP).

Subsequently, partly due to savings achieved by the Project Management Unit (PMU), more districts were included. Eventually, the programme encompassed all the districts of the Central Region with a rural population of some 2.67 million people.

Funding of €16.5 million was obtained from the 8th European Development Fund and the European Multi-Annual Food Security Programme made available a further €6.5 million at the end of 2002.

OBJECTIVES
The overall purpose of the GoM/EU PWP was to contribute towards the Malawi government’s objectives of reducing widespread poverty and increasing food security.

The programme targeted overall socio-economic improvement through the achievement of the following objectives:
- Improved access to rural areas
- Development of sustainable fuel wood and timber supplies
- Improved dry season gardening
- Implementation of projects and activities that would ensure longer-term food security

PROGRAMME MANAGEMENT
An independent Programme Management Unit (PMU) comprising local consultants, local contract personnel and local staff members seconded by the departments of Forestry and Irrigation and the National Roads Authority (NRA) was established to implement the GoM/EU PWP. Led by a predominantly South African team of specialists, the unit was responsible for the management, administration and technical and financial control of the programme as a whole.
Overall guidance on implementation was provided by a programme steering committee comprising representatives from various government departments, as well as the funding agency.

**APPROACH**

Crucial to the success of the GoM/EU PWP was its multi-tier approach, with each component simultaneously addressing both immediate and long-term poverty alleviation, as well as immediate and long-term food security.

**COMPONENTS**

The programme was designed to employ the technical components of roads, forestry and irrigation to achieve its socio-economic targets. The activities were, in turn, designed to maximise the portion of funding paid to the communities by utilising labour-based and appropriate technology methods.

**Roads**

This component centred mainly on the rehabilitation of low-trafficked rural feeder roads, drainage improvement works and the replacement of existing timber bridge decks with concrete decks through labour-intensive construction methods. The work was done by local entry-level contractors through an open, competitive tender system. Training was provided on tendering and technical aspects. The investment in road rehabilitation was protected by community-based maintenance activities, involving villages adjacent to the road. Some 312 road maintenance clubs were formed and allocated the responsibility of routine maintenance of a particular section of road. Payment was based on a performance specification.

**Forestry**

The significant problems of deforestation and deteriorating soil fertility were addressed by providing communities with the technical training and material resources to establish plantations, manage existing forest areas and interplant agricultural land with tree species that would improve soil fertility, in order to ensure sustainable fuel wood supplies and increased food production.

A demand-driven approach was employed, which entailed the forming of some 2 443 village forestry clubs. Each club constructed a nursery and was involved in the whole forestry process, from the cultivation of seedlings to forestry management. This innovative approach ensured community participation and sustainability.

**Irrigation**

The aim of the irrigation component was to eliminate food shortages, improve nutrition and create opportunities for generating income. Support was given to farmers who had sufficient dimba land (low-lying fertile ground) and access to a perennial water source and were interested in investing in dimba crop production. Small-scale irrigation schemes were established using treadle pumps and stream diversions. Individual farmers were grouped into some 733 village irrigation clubs for ease of training, delivery of inputs and loan recovery.

**‘Cash for Assets’ projects**

In support of the Malawi government’s policy of decentralisation, a number of ‘Cash for Assets’ projects were implemented through district level government, the district assemblies. The emphasis was on low-technology,
fast-mobilisation projects with a potentially large impact on job creation and food security.

ACHIEVEMENTS
Overall, the GoM/EU PWP programme achieved tangible results with both immediate and long-term benefits for the targeted rural (and urban) communities, namely:

- Improved access to markets, services and major road networks
- Sustainable supplies of fuel wood and timber needed for development
- Better use of dry season gardens
- Increased average household incomes for participating communities
- Increased capacity in the district level government

The results of the programme components are as follows:

- **Road rehabilitation** Rehabilitated 2,481 km of roads which created temporary employment for 32,877 people (42% female); more than 614,000 direct and indirect beneficiaries
- **Road maintenance** Permanent employment for 2,458 people (362 female) maintaining 2,670 km of roads
- **Forestry** About 85,000 participants involved in planting and forestry management (54% female) raised and planted 35.7 million trees
- **Irrigation** Involvement of 6,714 farmers irrigating 730 ha; more than 200,000 indirect beneficiaries; the potential to produce more than 16,000 tonnes of maize
- **‘Cash for Assets’ projects** More than 1.4 million person days of employment created; 28,067 direct beneficiaries (or 168,400 indirect beneficiaries); more than US$0.6 million paid as wages and eight district assemblies trained and capacitated

SUSTAINABILITY
The structured approach of the programme ensured social, economic and environmental sustainability by means of the following:

- The government’s commitment to implementing policies related to funding, the maintenance of roads and reforested and irrigated lands
- The use of appropriate technology in all components, such as labour-based road rehabilitation and simple forestry and irrigation technologies
- Training on all aspects on all components
- A concerted effort to protect the environment and contribute to its enhancement
- The focus on activities traditionally performed by women to reduce gender imbalances
- Ensuring community participation and sustainability of the various projects and ongoing maintenance after completion of the programme
- Empowering communities to generate their own income and produce their own food

CONCLUDING REMARKS
The programme has in all respects far exceeded its planned targets. Poverty alleviation and increased food security are being achieved, in the short term, by cash injections through the implementation of labour-based works and, in the long term, through road maintenance, forestry and irrigation activities. In addition, the programme is now well embedded within the local structures. It is being driven by the targeted community and a good working relationship continues to exist among all stakeholders.
Like most kids, the only field I ever wanted to see myself in was being a doctor. Civil engineering was never any part of my vocabulary, my very first introduction to civil engineering was in Grade 10.

I was born and raised in Thaba ‘Nchu. I first stayed in town but schooled in the location, where I did my first grade at Eureskuld Primary School. By then, I already had in my mind that I definitely want to be a doctor. I had a very good reason why. My parents always travelled a lot to visit my great-grandparents, my grandparents and many other relatives who were sick and needed a doctor. I thought if I would become a doctor, I would be able to help many other families and save their lives. I didn’t realise there were many other means of helping people other than being a doctor.

Although I was exposed to many engineering aspects as I was growing up, it never occurred to me that on a certain project, there was people like planners, architects, contractors, surveyors, etc. In Grade 10, the only reason I took mathematics and science was because I knew they were the required subjects for being a doctor. A few months later, on a career orientation programme, I was introduced to civil engineering. It was time for me to do some serious introspection. I realised there was more ways than one to give something back to the community. I had the right subjects and I was fascinated. Growing up I was always technical, trying to figure out how certain things work.

In Grade 11 I read a short story ‘n Man kom tuis’ from ‘Kinders van die aarde’. A construction worker working far from home got a lift from a stranger to home and along their conversation the construction worker told the driver: ‘It is not nice seeing my family once a month or even more, but it is wonderful to say that that road going through the mountain could not be used until I set my equipment up and opened it, and it will be there for years and years.’ My mind was made up ...

Qalong

‘Thupa e kojwa e sale metsi, empana mohale o tshaho lerweleng’

KE KENE KERETJIE DILEMO tse pedi, dilemeng tsaka ts'a bohlano le tshela le. Honna ke ne ke bona lela e lebaka seb otswadi baka ba nhutomeng hong sana se lela lela hong ho bale hore ha hore lela sa ha sebetsa ntle le tshisitso yaka. Dilemo tsaka tsa sekolo di qadile sekelong se tlase sa Eureskuld, Thaba ‘Nchu, moo ke hlathetseng teng kaba ka holela teng, profensing ya forestata. Ke badile mophato wa A, B, 1 le 2. Ditshuto ele tsa leleme la Sefatsha, ho ne hole boima ka hore lapeng re ne re bua Sesotho.


Ho keneng haka mophatong wa bororo ke ne ke dula motsaneng wa ‘Moroka Location’, lekeshene le tsebahalang haholo ka Morolong. Morolong ke ne ke dula sebakeng se haufi ka le ’kwari’ (quarry) eseng e sebediswita empa e sa hlokomelwa ka thaba ho lohciswisa (rehabilitated). Hoba Enjenere hohang ene ele ntho e seng teng mohipontse wa, le ho ho bana sebaka se tshwanang le kwari ho ne ho sa bolele letho honna. Ditshuto tsaka tsa sekolo se hodimo di qadile sekelong sa Leratong, Botshabelo, moo ke qadileng mophato waka wa bosupa mme ka qetela ka wa leshome. Ka mokgwa o makatsang, Botshabelo le teng ke ne ke nte ke dula pela kwari empa ena yona ene entse e sebetsa. Ke hopola ka nako e kgolo le e nyane ke utlwa phala e Ila (siren) e be sebhakanyana ka morao hoba le modumo o moholo wa ho thunya. Ke ne ke sa tsebe la phala le llang pele ho modumo oo o tshabeang empa qetellong, ke ne ke se ke tseba hore hang phala ella, le nna ke tlameho ho thswata tsebe sekgowa.

HA OLE BAKENG SE LOKILENG, KA Nako E LOKILENG, O TLA ATLEHA!

Mophatong wa borobedi, ditshuto tsaka se ka seholong ebole Mathematics le Science, fela ka lebaka la hore ke ne ke tseba e le tsona tse ka seholoeng bakeng sa hoba ngaka ya sekgowa. Dikgwedi tse mnwalwa mophatong wa borobedi ka fumana tshemimo ka Enjenereng.

Ka tseba:
■ Bohlokwa ba sebaka se tshwanang le gware
■ Lebaka la makololo nemang a theosa a nyolosa nako e kgolo le e nyane
■ Lebaka la phala e llang pele ho modumo o tshabeang
■ Koloi e hasang metsi fatshe nakong ya mosebetsi (dust control)

Ke ile kaba ka ellewhe hore hona le batho ba ikarebella sebakeng sa hotshelela le sena, ka bona le ka moo se amang lebatho babang ba mafapha a fapafapane, ba rutehlang le ba sa rutehlang ka ho tshwana bana le bohona ba ho Isa Manyane a tsebe la sepama, e ka sebetsang tulong ena kapa ba sebetsang sebakeng se leng sona lebaka la tulo ena Mohlala e ka tsetsha e njhja, mohao o motjha kapa letamo jwalo jwalo.

Ona ke ona mokgwa o motle wa ho thusa sejwalo ka ho lana ka mosebetsi ho dima ho le jwalo ho eba le tswelopele mosebetsi.

Ditshuto tsaka ke di tsewilelise sekelong se phahameng sa Central University of Technology, Free State. Ke qadile ho sebetsa Bovicon kele dilemo tse 21 ka 2006. Bovicon e sebetsa haholo ka ho atlehisa bo rakontraka ba banyane mme mosebetsi wa rona haholo ka le matsoho (labour intensive), mme le ngaka le mora koloi e hasang metsi fatshe.

‘Mohale o tshaho lerweleng’

Civil Engineering | February 2007 47
A dedicated and extremely conscientious man, Thomas had but one month’s leave in his 46 years in the Public Works Department. Like a good padmaker’s wife, Johanna followed him happily wheresoever his work took him. They had a long and happy marriage, being devoted to one another and to their thirteen children.
Although Thomas was essentially a quiet and gentle man, but he was at the same time able, as his works attest, to control large construction crews in remote areas and, when more senior, to guide and control work on a number of sites, often hundreds of kilometres apart. He was responsible for twenty-six major passes. Two of the better known, which still have gravel surfaces and are largely as Thomas built them, are Swartberg Pass and Prince Albert’s Pass.

The Lady Grey Bridge over the Berg River in Paarl.

In 1873 he was lent to the Railway Department for eighteen months as District Engineer in charge of the construction of the rail extension through Nuwekloof, near Tulbagh. During this time he also surveyed three other proposed railway routes. He then returned to the Road Office of the Department of Public Works until 1888, when he was appointed Irrigation and Geological Surveyor of the Colony. As a result railways, geological investigations, dams and other water supply works may be added to his list of engineering accomplishments.

On the geological side, Thomas investigated and reported on various mineral resources in the Colony, such as the Knysna, Prince Albert, Barkly West and Namaqualand gold fields, and the coal fields of the Eastern Province and the Free State. He was from time to time engaged in making collections of reptilian remains from the locustrine beds of the Karoo for the British and Cape museums, collected other fossils and artefacts, and made copies of prehistoric rock art. Thomas also discovered new botanical species – and played a variety of musical instruments.

The family followed Thomas where his work took him, and this entailed moving every few years. So they had nothing which could be called a settled residence until they bought Woodside, standing in 90 acres of ground in Rondebosch, a suburb of Cape Town, for £1 300 in the 1880s. Thomas died there on his 63rd birthday, after a full and energetic life.

It can be said that Andrew and Thomas Bain, in conjunction with Major Charles Michell, initiated the great age of road-building in the Cape. Thomas Bain in particular made a contribution to road engineering in South Africa which must rank among the greatest made by any engineer. Plaques have been erected in his honour at five different places around the Cape, and his gravestone is housed in the Cultural History Museum in Cape Town.

The story of his attainments continues to serve as an inspiration for today’s road engineers.

Graham Ross

The photographs are from Graham’s best-selling book The romance of Cape mountain passes and are reproduced with permission – Ed
IN AN INITIATIVE AIMED AT promoting discontinuation of the use of coal tar products in road construction, the Southern African Bitumen Association (Sabita) has recently published a technical guideline on the use of bitumen-based primes and stone precoating fluids.

Published as Manual 26, *Interim guidelines for primes and stone precoating fluids*, the document aims to assist road authorities in the selection of proven alternatives to carcinogenic and environmentally unfriendly coal tar products. It focuses on priming granular bases and precoating surfacing stone and is intended to serve as an interim guideline until such time as documents such as the outdated TRH1: Prime coats and bituminous curing membranes (1986) are updated.

‘Worker health and safety, and conservation of the environment, are now internationally accepted as priority objectives in the roads industry, and the continued use of coal tar products flies in the face of global best practice,’ according to Sabita’s executive director, Trevor Distin.

He noted that despite Sabita’s wide-ranging awareness campaign, and the lead taken by, among others, the South African National Roads Agency Limited (SANRAL), and the Gauteng Department of Public Transport, Roads and Works, none of South Africa’s 248 municipalities nor any of the six metropolitan councils had yet undertaken to prohibit the use of coal tar products in their road infrastructure projects.

‘This is a problem demanding immediate and urgent attention,’ he said. ‘It is inconceivable to an association like Sabita that so many engineers continue to allow environmentally harmful and unhealthy products to be specified in their road construction tenders when there is widespread substitution of this product with alternatives that are not harmful to workers or the environment,’ Distin said. ‘We believe the engineering profession in South Africa has a moral obligation to align itself to global best practice in this respect.’

The recognition that worker health, safe working practices and environmental conservation (HSE) have become an obligation and not a choice remains pivotal to the pursuit of global best practice in South Africa’s bituminous products industry, he added. Driven by Sabita and its Centre for Occupational Safety, Health and Environmental Conservation (COSHEC), this commitment to HSE is underpinned by an ongoing campaign of technology development, risk assessment procedures and safe working practices designed to instil a culture in which profitability is not pursued at the expense of employee wellness or the fragility of the environment.

‘This approach dictates that the prosperity of involved companies and organisations be placed at all times side by side with the needs of the people and the planet – a direction that is key to Sabita’s communications programmes with its members.

‘HSE is a key strategic cluster in the current business plan of the association, and operations in this arena are funded by dedicated allocations received from the primary producers of bitumen – the oil companies,’ Distin said. ‘While industrial health and safety is a result of both the nature of the products used and appropriate working procedures, preservation of the environment is centred on the development and responsible use of environmentally friendly products.’

He pointed out that until recent times coal tar was used for priming granular bases and precoating surfacing aggregates during road construction. However, the proven carcinogenic properties of coal tar products had resulted in their almost universal banning and replacement with bitumen-based alternatives.

‘Bitumen is obtained from the distillation of crude petroleum oil imported to meet the country’s liquid fuel energy demands. At ambient temperatures bitumen is non-toxic, non-volatile and resistant to water and weathering,’ Distin said. ‘Coal tar, however, is a condensation by-product obtained from the gasification of coal. The carcinogenic hazards inherent in the use of coal tar products arise from the high concentrations of polycyclic aromatic hydrocarbons (PAHs) in both low and high temperature coal tar products. Identified as either acute or chronic, these hazards have been widely acknowledged since 1985.’

Coal tar products also pose serious environmental hazards, both in their usage and in the disposal of wastes. Their leachability is far greater than that of bitumen due to the presence of water soluble phenols in coal tar, posing a higher threat to surface and ground water supplies, and to microbiological systems. This threat is heightened by the fact that coal tars contain compounds of substantially lower molecular weight than bitumen, including phenols and other aromatic compounds, many of which are liquid at ambient temperatures.

Another recently launched Sabita initiative is a bitumen safety course, which kicked off in June 2006 when 25 employees of member companies took part in the BitSafe Train-the-trainers courses held in Stellenbosch, Johannesburg and Durban. These trainers will now head up comprehensive training courses at their own companies to entrenched awareness of the hazards and risks associated with the handling of bituminous binders.

The modular format of the course facilitates training while limiting impact on production, and the intention is that all employees involved with the handling of bitumen throughout the supply chain should complete all 13 modules within a two-year period. Trainees will be assessed at the conclusion of each module, and will receive a joint Sabita/Asphalt Academy certificate on completion of the course.

The course and its associated awareness-building function is supported with the design and publication of a series of safety posters which are now being issued free of charge to Sabita members. Covering those operations most frequently used in the handling of bitumen such as loading, offloading, sampling and spraying, the posters are designed to be displayed in areas most frequently encountered by workers engaged in the relevant activities by encouraging workers to protect them themselves against injury by wearing personal protective equipment.

Distin said the publication of Manual 26 and the implementation of the BitSafe course were just two of several HSE initiatives being conducted under the umbrella of COSHEC, which was focusing its strategic activities on three primary clusters:

- Advancing the level of awareness of norms and standards through dissemination of global best practice to members; members’ acceptance of and participation in an incident reporting framework; and Sabita incentives for safe and sustainable work practices
- The development and introduction of guide lines covering hazardous situations associated with the handling of liquid bituminous products; and worker protection at plants, work sites and laboratories during all construction operations
- To limit employee exposure to injury or ill health arising from the handling of bituminous products through the development of appropriate guidelines; and the dissemination of best practice knowledge through publications, courses and appropriate media

‘Aside from the above, COSHEC has spelled out several future initiatives aimed at ensuring compliance with global HSE standards within our industry,’ Distin said. ‘These include obtaining a commitment at chief executive level within member companies for the implementation of plans consistent with best practice; promoting a culture of self-regulation; developing comprehensive and generally accepted codes of practice for the handling of bituminous products from source to point of application; and implementing best practice in laboratory procedures involving bitumen solvents and cleaning materials.’
Establishment of a new Joint ICE-SAICE Division

THE INSTITUTION OF Civil Engineers (ICE) and the South African Institution of Civil Engineering (SAICE) first signed an agreement of co-operation in October 1992. Over time the agreement has been reaffirmed and expanded to include the establishment of a joint committee to co-ordinate services to members between the two institutions.

Ongoing discussions have taken place since the last ICE presidential visit in November 2004 on how best the two institutions could work together, given that the majority of ICE members who reside in South Africa are members of both institutions. The end result of these discussions is the establishment of a ICE-SAICE Joint Division along the lines of the very successful Joint Structural Division which was established between SAICE and the Institution of Structural Engineers (IstructE) in 1993.

This division, which will operate along the lines of the other SAICE divisions, will:

- Perform learned society activities that are of mutual interest to both ICE and SAICE with particular emphasis on matters that are of international concern
- Perform the normal ICE country representative services in South Africa
- Arrange ICE presidential visits, Brunel international lectures and the like
- Promote and communicate publications, programmes, best practice and initiatives of ICE and SAICE
- Provide developing country inputs into ICE initiatives and projects and
- Promote the justifiable interests of its members

In terms of the agreement all ICE members who reside in South Africa are automatically members of the joint division. All SAICE members who are not ICE members are invited to join this division. Only the chair of the division is required to be a corporate member of both institutions.

ICE membership entitles members to receive the New Civil Engineer International, a monthly magazine which provides informative articles on a wide range of topics that are of interest to all types of civil engineers, including innovative features of major projects in various parts of the world, brief reports on collapses, failures and disasters wherever they may occur, and feature articles dealing with the issues of the day. This magazine provides valuable insights into global civil engineering practices. ICE members also receive My-ICE e-newsletter which updates members on a number of topics as well as a number of other services (see www.ice.org.uk).

Depending upon qualifications and experience, members can become chartered engineers (similar to professional engineer) or incorporated engineers (similar to professional engineering technologist); qualifications which are recognised in many parts of the world.

SAICE members who are under the age of 45 who elect to become ICE members will pay a concession subscription of £50 for up to five years. Members over 45 will pay the normal non-EU subscription.

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<th>Event and CPD validation number</th>
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<th>Contact details</th>
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<tr>
<td>12–13 February 2007</td>
<td>Business Finances for Built Environment Professionals</td>
<td>Wolf Weidemann</td>
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<td>14–15 February 2007</td>
<td>International Concrete Conference and Exhibition ICCX CT 2007</td>
<td>Joost Walrayen, Mark Alexander, Hugh Fraser, Frank Dehn</td>
<td><a href="mailto:ICCRRR@eng.uct.ac.za">ICCRRR@eng.uct.ac.za</a></td>
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<td>19–23 February</td>
<td>The Application of the Finite Element Method</td>
<td>Roland Prukl</td>
<td><a href="mailto:dhermanus@saice.org.za">dhermanus@saice.org.za</a></td>
</tr>
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<td>21–22 February 2007</td>
<td>Technical Report Writing</td>
<td>SAICE House, Midrand</td>
<td><a href="mailto:dhermanus@saice.org.za">dhermanus@saice.org.za</a></td>
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<td>27–28 February 2007</td>
<td>Handling Projects in a Consulting Engineer’s Practice</td>
<td>Wolf Weidemann</td>
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<td>27–28 February 2007</td>
<td>Soil Stabilization</td>
<td>G Selby Bloemfontein</td>
<td><a href="mailto:sarfuse1@acenet.co.za">sarfuse1@acenet.co.za</a></td>
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<td>28 February – Cape Town</td>
<td>Structural Steel Design to SANS 10162:1-2005</td>
<td>Greg Parrott</td>
<td><a href="mailto:Cdp.sharon@saice.org.za">Cdp.sharon@saice.org.za</a></td>
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<td>6–8 March 2007</td>
<td>e-Transport conference (a project of ITS South Africa)</td>
<td>CSIR International Convention Centre</td>
<td><a href="mailto:info@sasits.com">info@sasits.com</a></td>
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<td></td>
<td>Theme: Sustainable Public Transport for Soccer World Cup 2010</td>
<td></td>
<td><a href="http://www.sasits.com">www.sasits.com</a> &amp; <a href="http://www.e-transport.org">www.e-transport.org</a></td>
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<td>12–14 March 2007</td>
<td>Environmental Management for Roads</td>
<td>S Ballot Pietermaritzburg</td>
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<tr>
<td>26–28 March 2007</td>
<td>Contract Documentation</td>
<td>T Ashford</td>
<td><a href="mailto:sarfuse1@acenet.co.za">sarfuse1@acenet.co.za</a></td>
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<td>14–18 May 2007</td>
<td>CIB World Building Congress: Construction for Development</td>
<td>Cape Town International Convention Centre</td>
<td><a href="mailto:cdejeager@saice.org.za">cdejeager@saice.org.za</a></td>
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<td>23–24 May 2007</td>
<td>Technical Report Writing</td>
<td>SAICE House, Midrand</td>
<td><a href="mailto:dhermanus@saice.org.za">dhermanus@saice.org.za</a></td>
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<td>17 &amp; 18 September 2007 – China</td>
<td>5th International Conference on Current and Future trends in Bridge Design, Construction and Maintenance</td>
<td>ICE</td>
<td>Dayle Long <a href="mailto:Dayle.long@ice.org.uk">Dayle.long@ice.org.uk</a></td>
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