Mine surveyors and geotechnical engineers are just two examples of decision makers who need solutions with the flexibility and performance to function in a wide variety of monitoring applications. For slope monitoring, 3D Laser Mapping’s SiteMonitor4D is described as “a state-of-the-art monitoring system using advanced laser scanning technology with powerful, easy to use software.” The automated slope monitoring system was developed in partnership with geotechnical engineers and mining surveyors, and is a portable self-contained system that can be moved into areas of limited access. It is used for monitoring large open pits, small satellite pits and volume measurement. The solution includes a laser scanner, software and IT infrastructure amongst other bespoke elements, giving the user the ability to exploit the potential of laser scanning for measuring change.

Depending on the model of laser scanner being used, the solution can measure a 140 mm grid over a highwall every 30 minutes at 1,000 m range and has a range of up to 6,000 m. With a better than 10 mm accuracy for its georeferenced data, SiteMonitor4D is a safe and accurate well-established monitoring solution. Critical decisions can be made with confidence in real time, helping to prevent or mitigate any risk of slope failure. The analysis module creates a streamlined workflow for geotechnical and structural engineers using a variety of tools to inspect data, such as 2D and 3D visualisations as well as displacement and volume graphs.

“SiteMonitor4D gives us the opportunity to capture large scale data with little human interface”, commented Frans Benade of Anglo American Platinum. “This gives us time to focus on the detailed information in a dynamic, fast moving, production environment.”

SiteMonitor4D works by defining a grid of points, called nodes, completely covering the area of interest. The nodes do not need a target so there is no requirement for prisms - the theoretical locations are defined only in the coordinate system of the scanner. Targets are used for range and atmospheric correction. When an area is measured, the scanner returns to each of the nodes and takes a range measurement. For large open pit mining operations, a range of up to 6 km is more important than speed of acquisition. For smaller, open pit mines and engineering works, a measurement rate of 122,000 points per second and accuracy up to 4 mm will be preferably over long-range performance.

“3D Laser Mapping are no strangers to providing specialist solutions to the mining industry; the company has been providing both SiteMonitor4D and the central, multisensory management system SiteMonitorGE for some time. There’s more in the SiteMonitor solutions pipeline”, according to Dr Graham Hunter, Executive Chairman of 3D Laser Mapping.

“Due to the ongoing expansion and successes the business has achieved in the past twelve months, including a number of major product launches, we are expanding the senior management in mining and monitoring area of activity, and appointed Colin Thomson as Technical Director for Mining and Monitoring in September 2014. Colin is well known in the African market as a knowledgeable professional in the field of geotechnical monitoring systems.”

RIEG L has added a new terrestrial laser scanner to its portfolio. The VZ-2000 is RIEGL’s fastest terrestrial laser scanner to date. It comes with a 1 MHz pulse repetition rate and up to 400,000 effective measurements per second, providing a range performance of more than 2,000 m. “The VZ-2000 is a great surveying tool...”
RIEGL has added a new terrestrial laser scanner to its portfolio. The VZ-2000 is RIEGL's fastest terrestrial laser scanner to date for both static and mobile mapping applications with the addition of the VMZ hybrid mobile mapping System" says RIEGL. “For surveying in open pit mines the combination of high performance static surveying with mobile data acquisition will help to improve workflows, safety and efficiency whilst lowering mobilisation costs resulting in a higher return on investment.”

The RIEGL VZ-2000 is a lightweight, long range, high resolution, high speed and wide field of view 3D Laser Scanner especially suited for topography and mining with measurement ranges of more than 2000 m at eye safe Laser Class 1. “RIEGL’s state-of-the-art laser technology offers multiple target detection for each single laser shot, providing better results even in dusty environmental conditions, and enables, up to a certain degree, the penetration of obstructive vegetation, which often covers large disused areas in open pit mining.”

Thanks to the light weight (less than 10 kg) and the integrated water and dirt resistant Human-Machine Interface (HMI), equipped with large buttons, allows for stand-alone operation without computer, and ensures a single person can easily operate the scanner in the field, even whilst wearing gloves. With an internal storage capacity of up to 64 Gb and the optional add-on rechargeable battery, “the VZ-2000 provides straightforward, fast and efficient data acquisition.”

The VZ-2000 boasts an Integrated GNSS receiver, inclination sensors, a laser plummet, and a compass providing additional information that enables easy on-site registration of the scan positions. For combined photogrammetric applications, the scanner can be equipped with an external high-resolution and fully calibrated digital camera.

The new RIEGL VMZ Hybrid Mobile Laser Mapping System for 3D Static and Kinematic Data Acquisition, also offers the possibility to use this new high-accuracy, high-speed long range laser scanner for mobile applications. Thus, the RIEGL VZ scanners (also applicable for the VZ-400 and the VZ-1000) are supported by a fully integrated IMU/GNSS unit. Designed to provide easy coupling and de-coupling of the scanner from this IMU/GNSS unit the VMZ enables quick switching from mobile to terrestrial applications and vice versa without the loss of system calibration. A frame based roof-mount – compatible with standard roof bars – is used to mount the scanner to the vehicle where it can be used in either vertical or horizontal positions. As with the standard VZ scanners, the combination of high-resolution laser scan data with image data can be achieved thanks to a calibrated and GPS synchronised Nikon DSLR camera, or a panoramic camera system such as a Point Grey Ladybug A single laptop running RIAACQUIRE, RIEGL’s software package for kinematic laser scan data acquisition, is necessary for system operation.

For data acquisition, different scanning modes are provided. 2D line scan mode of the VZ-Scanner at a user-definable horizontal position of the scanning head optimises the scanning workflow for different applications. 3D mode of the scanner with continuous rotation of the scanning head (Radar mode) enables highly efficient mobile data acquisition. Full 360° static scanning – whilst the vehicle is standing still – is used for the acquisition of highly accurate control scans. The highest absolute accuracy is based on 3D fine-scanned reflectors.

Reutech Mining has announced that it recently commissioned the world’s first MSR120 Radar Module (RM) in North America. The MSR120 RM forms part of the Short Range product family of the Movement and Surveying Radar (MSR) range of products, and provides the user with all of the Real Aperture Radar (RAR) functionality of its Long Range siblings, but at a fraction of the cost.

When asked to comment on the benefits of the MSR120 RM, Alex Pienaar, Regional Marketing and Sales Manager said, “We believe in providing our clients with cost effective solutions without compromising on what we offer in terms of features and functionality. By offering the Radar Module as a standalone option, we are able to cut once-off sales costs as well as recurring service costs.”

The MSR120 RM can be mounted on a variety of non-level platforms including a standard light delivery vehicle or trailer. This is the ideal solution for the client who – as part of their monitoring program – requires a radar solution as a fixed permanent installation with the added option of extensive and unlimited mobility. In addition to this, the MSR120 offers significantly faster scan speeds than what is the current MODERN OPEN PITS
norm in all mining applications, higher 3D spatial resolutions and a much greater coverage area even at very short distances. Product highlights include the following:

- Full operational scan from 30 to 1,200 m
- Faster scan speed
- Higher 3D spatial resolution
- Non-DTM dependence allows for greater on-site flexibility
- Greater coverage area – especially at shorter distances.
- Superior operational availability
- Reduced service intervals
- Minimal number of moving parts.

**Hexagon unites technologies**

Productive mining companies know technology drives their future. Faced with rising energy costs, scarcer high grade ores, declining commodity prices, and tighter profit margins, mines must quickly adapt to survive. Enter **Hexagon Mining**, arguably the first company to unite the world’s leading software innovators and create an unprecedented spread of technologies within the mining vertical.

Launched this year by global information technology giant, Hexagon AB, Hexagon Mining is unique among the industry’s software players. The group states: “Hexagon Mining is the only company to solve surface and underground challenges by integrating design, planning, and operations technologies for safer, more productive mines. Combining the innovative technologies of Devex Mining, Leica Geosystems Mining, MineSight and SAFEmine, Hexagon Mining seamlessly links mine planning, design, fleet and production management, optimisation, fatigue monitoring, and collision avoidance software for a comprehensive flow of data across all operations.”

“We strongly believe the industry needs a supplier with a 360-degree vision, connecting the best products, capabilities and solutions,” says Hexagon Mining President, Guilherme Bastos. “No other vendor has ever assembled such a large spread of technologies within the mining vertical. Hexagon Mining wants to reshape traditional ways of thinking about the industry, and offer a smarter way to mine.”

While that may start with Hexagon Mining’s existing products, the company told **IM** that exciting new technology is also in the pipeline. The fleet management and optimisation expertise offered by Leica Geosystems Mining, for instance, presents immediate relief for mines facing tough times with rising capital expenditure and operating costs. Hexagon Mining believes fleet management represents a huge opportunity to minimise energy consumption, reduce carbon footprints, and save money.

MineSight’s activity-based planning product, Atlas, lets the mine planner define an operational plan down to the lowest level of detail needed. Leica’s fleet management solution optimises the real-time scheduling and dispatch of mobile mining equipment. With a fleet management solution in place,
The company will focus on tracking grade and software, together with MineSight's Axis product, "Drawing upon visualisation and automation help our customers make the most of their data," says Bastos. "We are dollars in these details," says Bastos. "Web/mobile dashboards will display safety information, production equipment statistics, and more. "There product KPIs, critical work stoppage events, can plan and schedule around real information planning and operational programs, customers information and feeding it back into MineSight's equipment breakdowns. By analysing such breaks, crew stand-down times, lunches, critical equipment needs. By adjusting and making the most of their assets, a company can lower its operating costs."

Hexagon Mining says it will focus on business intelligence and business analytics, (BI/BA) identifying lost time that's non-productive: breaks, crew stand-down times, lunches, equipment breakdowns. By analysing such information and feeding it back into MineSight's planning and operational programs, customers can plan and schedule around real information coming from their mine.

Hexagon Mining also plans to build a standard BI/BA product across all the products it supports. Web/mobile dashboards will display safety information, product KPIs, critical work stoppage events, production equipment statistics, and more. "There are dollars in these details," says Bastos. "We help our customers make the most of their data."

The drill and blast cycle is also integral to Hexagon Mining's vision, says the group. "Drawing upon visualisation and automation software, together with MineSight's Axis product, the company will focus on tracking grade and rock fragmentation. This part of the mining cycle is too important to get wrong," says Bastos. "Poor fragmentation has major upstream costs for crusher energy, refining ... the whole mining process. Get the crushing and grinding right the first time and you really save energy costs and decrease the hit on the local energy grid. So we're looking to close that loop via Leica's drill fleet management machine guidance, and MineSight's drill and blast modules. This is all about breaking down silos and creating a seamless platform through which data flows smoothly."

Essential to that integration and pervading all Hexagon Mining solutions is safety. "SAFEmine has set a global benchmark for solutions that prevent mining accidents. More than 18,000 mining vehicles in 45 mines worldwide are equipped with SAFEmine's Collision Avoidance Systems (CAS)." Now the Switzerland-based company has launched FatigueMonitor, which is integrated with CAS.

"CAS protects vehicle operators from collisions in the constrained mining environment," says Bastos. "SAFEmine's data shows that a lot of mining accidents happen due to fatigue. Fatigue Monitor smartly fuses CAS data with PerClos and body clock inputs that can detect early signs of fatigue and prevent this type of accident."

In addition to the CAS and fatigue monitoring solutions, SAFEmine's versatile safety package includes SafetyCentre and ShovelAssist. SafetyCentre is made for haul trucks, displaying all relevant safety information via cameras and radar, and other sensors, such as tire pressure. ShovelAssist is a solution to avoid damaging light vehicles and clean-up equipment around shovels. Bastos concludes: "At Hexagon, we are not just imagining bridging the gap between short term planning and operations, or connecting fleet operations with mine planning, or making analytics and business intelligence holistic and universal; we are making these solutions a reality. Integration and automation across the entire mining chain is the goal. We have all the necessary ingredients to achieve that goal." Hexagon Mining will exploit existing GIS and CAD technology within the greater Hexagon family. Technologies such as Smart H2O from Hexagon Solutions offer the potential to monitor tailings dams and water dams in critical areas. The new unified company is headquartered in Tucson, Arizona, with more than 30 offices across five continents:

- Belo Horizonte, Brazil-based Devex Mining delivers leading solutions for fleet and production optimisation, process automation, machine maintenance, business intelligence and analytics, and autonomous control.
- Co-headquartered in Brisbane, Australia and Tucson, Arizona, Leica Geosystems Mining delivers leading solutions for fleet and production optimization, high-precision machine guidance, machine maintenance, business intelligence and analytics, and autonomous control.
- Tucson, Arizona-based MineSight is a comprehensive modelling and mine planning platform, offering integrated solutions for exploration, modelling, design, scheduling and operation.
- Baar, Switzerland-based SAFEmine is the leader in collision avoidance and fatigue monitoring systems, delivering extensible solutions that save lives.

**Slope stabilisation progress**

Safety, cost efficiency and sustainability - these properties are described as what have made the TECCO® Slope Stabilisation System from Geobrugg "one-of-a-kind and successful all over the world". Now with three levels of mesh strengths, Geobrugg has expanded the field of application of the TECCO SYSTEM® many times over. It can now be applied to nearly any slope, regardless of whether it is solid rock, soil, or anything in between. Additionally, two new spike plate sizes further expand the range of application and allow optimisation of anchor spacing. The revised RUOLUM® dimensioning software makes it possible to quickly and accurately plan safety measures.

Geobrugg states: "For years, TECCO has been making a name for itself all over the world as a highly efficient system for stabilising slopes. So far the possibilities have been great - but now Geobrugg expanded the TECCO Slope Stabilisation System. Starting in 2014, additional TECCO meshes made of 2 mm and 4 mm diameter high-tensile steel wire are being added to the well-known 3 mm mesh. This full complement of meshes can now be used to optimally secure nearly any slope, and the designer will be able to find the right solution for any geological conditions with this versatile system. The additions to the new TECCO SYSTEM® are not limited to just the expanded mesh options. The newly developed P66 spike
plate increases the load transfer of all meshes, and enables lower total project costs and faster installation times. The interaction of the TECCO meshes with this spike plate allows larger anchor spacing of up to 3.5 m, and reduces surface deformations. This means TECCO is now not only setting new standards in versatility, but also in efficiency."

The key to the success of the TECCO SYSTEM according to the company lies in the large-scale field experiments performed by the Geobrugg Group in the last two years. To perform realistic tests of the calculated results, an experiment was conducted together with the Bern University of Applied Sciences in Burgdorf. A test box (10 x 12 x 1.2 m) filled with gravel was covered with high-strength TECCO mesh. The mesh was anchored in the box with spike plates and nails with a spacing up to 3.5 m x 3.5 m. Tests with a gradual raising of the box showed that the mesh can successfully hold back 230 t of material up to a slope angle of 85° with only a small amount of deformation. The decisive performance factors are the local load transfer from the mesh to the nail, and the punching strength of the mesh on the upper edge of the spike plate.

The full scale testing provided detailed, scientific proof of the key to the success of TECCO mesh – the high tensile wire. All three TECCO meshes are made with high tensile steel wire with a strength of at least 1,770N/mm². This is important as the full scale testing showed that success or failure of the stabilisation system is completely dependent upon the ability of the mesh to transfer loads from the slope to the nails. The only way to achieve this efficiently and safely is to use mesh with high-tensile wire. Plus the unique diamond shape of TECCO enables this critical load transfer from the mesh to the spike plates.

"Thanks to the sleek profile of mesh and the lustreless zinc-aluminum coating, the TECCO mesh blends into the landscape. After vegetation has grown through, it is nearly invisible. The vegetation process can be accelerated with the TECMAT® grass seed mat. TECMAT stabilises the topsoil layer, and prevents seeds from washing away." The TECCO SYSTEM is completed with the expanded RUOLUM online dimensioning software, which Geobrugg makes available to planners free of charge at http://applications.geobrugg.com/application.htm. This makes designing the mesh and nailing of the stabilisation system extremely easy. The software helps the designer select the optimal combination of mesh, plate, and anchor spacing by performing a detailed analysis of the interaction between the system components and the slope. Geobrugg also offers RUOLUM application workshops to teach the proper use of the system. "The planners learn how to use the software purposefully, efficiently and reliably."

Open pit network agreement

3D-P, the provider of technology products for the mining industry, recently announced the addition of Rajant’s Kinetic Mesh product line to the company’s list of wireless technologies and expertise. The company stated: “3D-P has long been an industry leader in designing and deploying wireless networks for the open pit mining vertical, with over 80 mine-wide deployments around the world. The agreement with Rajant Corporation names 3D-P as a Kinetic Mesh solution partner for the mining industry, allowing 3D-P to apply their extensive knowledge of outdoor wireless mesh networking to the deployment of Rajant technology globally.”

Rajant for its part “recognises that 3D-P meets the following requirements of their Kinetic Mesh Solution Partner Program”:

- Core wireless design and network expertise, tailored to the mining industry. In addition to demonstrating expertise in Rajant technology the partner must also offer expertise in the design, implementation, and ongoing value added services for all of the supporting technology used in the LAN, back-haul, and distribution network layers that support a successful wireless deployment.

- Application expertise in a wide variety of third party mining applications, including their associated communication protocols and networking requirements.
Integration expertise in a wide variety of third party mining specific hardware platforms and software applications, including their respective interfaces. The partner must demonstrate a working knowledge of the hardware and software tools required to successfully integrate these platforms and applications onto a Rajant wireless network, providing easy access to the stakeholder’s data.

“Merging 3D-P’s proven outdoor wireless design philosophies with the high throughput, low latency, and roaming capabilities of the Rajant Kinetic Mesh product line is truly exciting, providing a major capability shift in wireless networking for mining,” stated Ron White, VP of Technology and CTO at 3D-P. “3D-P is our first Kinetic Mesh solution partner and the timing could not be more perfect. With the current market acceleration we are witnessing in the mining industry and in vehicle-to-vehicle communications, we look forward to having 3D-P’s support and expertise in bringing these opportunities to fruition,” stated Paul Hellhake, CTO at Rajant.

Removing a river rock at Kali Kabur
Managing large open pit mines also involves unique challenges beyond the norm. Geoff Gibson works as General Foreman for PT Redpath Indonesia for the Alimak Department and High Scaling Special Projects. He has been personally involved with developing the high scaling team and completing a variety of complex high scaling projects over his six years with the company.

Well known to IM readers, the Grasberg mine is located in the Indonesian Province of Papua, approximately 100 km from the south coast. PT Redpath Indonesia began as a small contractor to the mine in 1982 and has grown to become the primary underground development mining contractor on site. Redpath’s scope of work has since expanded to include the High Scaling Crew; a small group of men with the task of working on any project outside of the underground development scope requiring the use of technical rope skills, hand held and mechanical mining techniques. Over the years, the High Scaling Crew has worked on projects such as rock fall protection barriers, landslide remediation, installing break through protection barriers and soil nailing.

PT Freeport Indonesia tasked the Redpath High Scaling Crew, to remove part of the Kali Kabur river rock (approximately 40 m long, 25 m high, 16 m deep located at 2,380 ft above sea level) in order to allow the river to flow in a straight line, preventing it from cutting into the river’s bank and to protect the landscape. Locating suitable places to construct buildings is difficult around the mine property due to the mountainous environment. Waste rock from the underground mine development is continually used to build up surrounding areas to allow building construction projects to expand and to safeguard roadways. The Kali Kabur river rock acts as a diversion to the flow of the river, which when the water level rises enough, washes out the deposited material over a steep bank and puts the nearby roadway in danger of collapsing into the water.

There were a number of different methods proposed to remove the rock. Among them, benching from the top down, and also driving a raise through the rock and blasting it from the inside out. Due to concerns Freeport expressed with fly rock, and the presence of a very flat face at a good angle for drilling, the team decided to long hole drill the rock. The High Scaling Crew opted to use a drill rig they themselves designed and is commonly used on vertical projects at the mine. The rock was to be drilled along its entire length at a 1.5 m x 1.5 m pattern using a 45 mm drill bit. The rock was drilled from left to right with the first three rows drilled close together and on gradual changing angles all the while keeping an eye on the left edge to compensate for the amount of ground that needed to be broken. Additionally, the fact that the base of the custom drill is 2 m wide, its size would not accommodate moving the drill close enough to the edge of the rock to drill straight holes.

A tugger (air winch) was installed beside the roadway, which was used to raise and lower the drill rig on the opposite side of the river. An anchor cable was installed along the top of the rock, running the length of the flat face with a pulley block attached to run the tugger cable through. The drill rig was transported to the rock using a helicopter and a long line (a 30 m sling attached to the bottom of the helicopter). The High Scaling Crew, hanging on the face of the rock using static ropes, received and unhooked the drill from the long line. Two cables were installed from the roadway to the Kali Kabur river rock; one cable was used to suspend the bull hose and water line, providing air and water for the drill, while another cable was used as a zip line to ferry equipment directly to the other side.

Immediately, access to the rock proved to be the biggest challenge. A small three-cable bridge was installed from one side of the river to the other, with one cable for walking on, and two cables on either side for handrails, essentially forming a “V” shape. By day, this was an efficient way to cross the river, however, overnight when the Indonesian tropical rain fall was high and the water level rose, the boulders into which the small “V” footbridge were attached, would shift and stretch the cables. The cables would become submerged, causing them to become too slack to walk on to cross the river. On one occasion, the boulder on the near side of the river actually disappeared overnight taking the cables with it.

While the crew continued working and crossing the ever repaired “V” footbridge, a decision was made to install a proper cableed suspension bridge spanning the 65 m from one side of the river to the other. The bridge was constructed with minimal interruption to the work already in progress on the rock. Two large concrete forms were placed in a hole dug by an excavator, followed by rebar formwork for D-plates and handrail beams installed inside the form and finally, concrete was poured. The anchor on the other side of the river was a large freestanding boulder with a gently sloping surface. D-plates and two more posts for handrails were installed in the same configuration as in the concrete block on the opposite side of the river. Five 0.75 in cables were then pulled across to the other side of the river using ropes, pulled up by hand and anchored to the D-plates on the freestanding boulder. On the roadside, the cables were tensioned using come-alongs and chain blocks. Three cables made up the base of the bridge while two extra cables ran through the pipes on the beams rising approximately 1.5 m creating a handrail.

It was after this stage of construction the project was interrupted due to a large fall of ground in the underground at Big Gossan mine in May of 2013. The crew was relocated to assist with the rescue and recovery of those involved. Following the accident, Redpath’s High Scaling Crew was put to work underground, installing rehab throughout all areas of the underground mines. It would be five months before the crew returned to continue working on the Kali Kabur river rock.

The first task was to complete the construction of the suspension bridge as the “V” footbridge had again disappeared. Lengths of four inch channel with two by four inch timber inside the channel were bolted down to the two outside cables using Crosby clamps. Two by four inch timbers were then laid perpendicular to the four inch channels and nailed down. This method of creating a walkway was used for the full length of the bridge, along with using nylon rope to lash the handrail to the support cables below. A safety cable and gate were also installed on the bridge to prevent access and allow the workers to tie-off while traveling along the bridge.

The long hole drilling commenced first using a $36 drill but this proved to be very heavy and difficult to manoeuvre on the face. Subsequently the drill was changed out for a Boart Longyear Secan Jackleg, the drill that the rig was designed to work with. This turned out to be the best option and was able to drill long holes up to 16m long until breakthrough. With a 9 m x 9 m pattern, probe holes were drilled to breakthrough.
acting as a guide for the driller for the depths of the subsequent holes. The drilling operation typically consisted of 1 driller, an off-sider and tugger operator/nipper. The drill steels were changed out using pipe wrenches by the off-sider, while the driller would operate the feed and rotation. The extension steels and tools were slung on the side of the face close by to the drill to allow easy access by the off-sider. The tugger operator lowered or raised the drill at the end of every hole/row.

To reduce tripping hazards and to save time, a man-riding zip line was installed from the end of the bridge on the far side of the river connecting directly to the Kali Kabur river rock. This zip line was also used to ferry equipment that was carried by hand over the bridge to the river rock.

Maintenance, repairs and modifications were carried out during the entire job. The design of the drill rig made it easy to change out a drill if there was an issue. The drill would be unbolted hauled up to the zip line and sent back across the river where it was changed out with a spare drill. The face was a very consistent angle which meant almost all of the holes were drilled on the same angle, slightly lower than horizontal to allow the cuttings to exit the hole. The typical use for the drill's rig design allowed the slide way where the drill is mounted to change the angle, however, due to the consistent angle of the natural face of the rock, this feature was not necessary so the adjusting bar was welded to prevent it from moving at all. This weld actually helped reduce the amount of vibration travelling through the drill rig allowing more power to be transferred to the steel and reduced the wear and tear on other parts of the rig.

Gibson told IM: “With a limited amount of physical space and the proximity of the road, vehicular traffic was always an issue with a constant stream of haul trucks, excavators and other equipment passing the work area. Once the suspension bridge was constructed, it restricted haul trucks from tipping waste rock required to prevent the road embankment from undercutting when almost daily heavy rainfall would cause the river to swell and rage wildly. As expected, the area along the road under the bridge began to undercut compromising bridge safety. With the use of a spotter, trucks would have to back up quite close to the bridge and tip over the edge, angling the rock material towards the bottom of the bridge. No damage was caused to the bridge throughout this delicate task. Due to the wild nature of the river, it was not uncommon for large sections of poly pipe, which fed water to the drill, sometimes up to 100 m in length, to disappear overnight. ”

A variety of methods for blasting were discussed and trialled on the Kali Kabur rock. The first method for blasting included the use of emulsion, but this proved unsuccessful. After reviewing a video of the blast, the emulsion could be seen ejecting from the hole at the time of the blast. With the results from the trail blast, the High Scaling Crew turned to stick powder and loaded the holes using multiple detonators along the length of the hole. To tamp the stick powder, long lengths of electrical conduit were joined together. This proved to be a much more successful method of blasting. The blast plan was designed by Orica and loaded by the High Scaling Crew because of their trained expertise using ropes for working at heights. The rock was removed with several blasts with no reports of any damage from fly rock. Following a blast, an excavator would clean the material from the site and push it into the river, where it would be carried down stream by the force of the moving water. A final bench was taken along the riverside, drilling down into the submerged rock to further help correct the flow of water.

Gibson concludes: “The Kali Kabur river rock project was completed successfully in May 2014 with no accidents or incidents. Redpath's High Scaling Crew is proud of their 8 years of providing safe, incident free work; working diligently and adapting to their potentially high risk environments. Enough of the large Kali Kabur rock was removed to route the river flow in the desired direction, allowing PT Freeport Indonesia to continue expanding areas for future construction along this section of river.” IM