Abstract
The Department of Transport and Main Roads is a member of the Origin Alliance, which is upgrading the Ipswich Motorway between Dinmore and Goodna. During the preliminary project design stage, it was discovered that some sections of the motorway was to be constructed over abandoned coal mines. These mines were worked from the mid 1800’s right up until 1987. The size, extent and stability of the abandoned mine operations were largely unknown. Given the critical nature of the motorway and the required 100 year design life, it was necessary to undertake an extensive investigation into the stability of the mines and undertake a risk assessment. This paper details how the old mine workings were filled with cement paste to eliminate any potential future risks to the motorway.

Introduction
An alliance was selected as the contract type for the $1.95 billion upgrade of 8km of the Ipswich Motorway between Dinmore and Goodna. The Origin Alliance was formed in June 2008 to deliver the project. The alliance members were Department of Transport and Main Roads (TMR), Abigroup Contractors Pty Ltd, Seymour Whyte Constructions Pty Limited, Fulton Hogan Pty Ltd, Parsons Brinckerhoff Australia Pty Limited and SMEC Australia Pty Ltd. The motorway forms a vital link in the transport freight route between Sydney, Melbourne and Brisbane it also supports the economy of South East Queensland by providing connections to the Port of Brisbane and major freight terminals within the Brisbane hub consisting of Rocklea, Archerfield and Acacia Ridge.

This particular section of the Ipswich Motorway (Dinmore to Goodna) is an extremely constrained corridor with the Queensland Rail Corridor (QR) flanking the motorway to the north and residential and commercial properties on the southern side of the motorway (Figure 1). Accordingly, to complete the upgrade works, complex staging arrangements were required to accommodate traffic and minimise impacts on property.

During the course of the initial geotechnical investigation it was found that the motorway traversed over a number of abandoned coal mines. This paper focuses on these investigations, the long term safety risks and the subsequent mine filling operations that occurred to mitigate any risks to the safety of motorway operations.

1 Bill Holz is part of the Keller Minefill Joint Venture
Figure 1. Ipswich Motorway during construction

History of coal mining in the Ipswich area

Historical records indicate that coal was first discovered in this area on the banks of the Bremer and Brisbane Rivers in 1828. It is unknown when actual mining activities commenced, however it is generally believed mining began in the early months of 1843 to fuel the Sovereign, a two-masted schooner-rigged wooden paddle-steamer. The site of the first mine at Redbank was on the river bank near Morris’s Woollen Mills and in 1856 the small rural community of Goodna was recognised. With the digging of foundations and sinking of wells, the geology of the area was better understood and a coal seam was identified a short distance to the west of the boundary of Goodna and 100m south of the road to Ipswich.

A Collieries Bill introduced into New South Wales\(^2\) Parliament in 1854 required that all pits, levels, shafts, tunnels and borings made for the extraction of coal should be recorded. There is no evidence, however to show that this legislation was ever enforced in the Moreton Bay colony. Consequently, detailed plans of early mining activities are scant or non existent.

Prior to 1952 there was no obligation on freehold owners to notify the government of activities or provide drawings. Of those records that the Queensland Department of Mines kept, many were destroyed in Brisbane’s 1974 flood. Of the drawings that were salvaged, many were undated and/or incomplete or were not the latest version. Most of the coal has been extracted using “bord and pillar” techniques where the coal is removed from a room and pillars remained to support the overburden. Later mining operations used the “longwall” system of extraction where the roof is collapsed behind the mined area.

\(^2\) Queensland was not an independent colony or state at this time. Queen Victoria gave her approval and signed Letters Patent on 6 June 1859 to establish the new British self governing colony of Queensland. Queensland became a state on 1 January 1901.
Over the years, subsidence events have been recorded in and around the immediate vicinity of the Ipswich Motorway. More recently subsidence has been noted in the Collingwood Park area, although the failure mechanism is considered different to the mines located in the immediate vicinity of the motorway. A sinkhole has since been detected in the area immediately adjacent to the motorway corridor and was subsequently filled. The mine filling operations at Goodna have also been extended laterally to also include filling under the QR rail corridor. Figure 3 shows the consequences of a large area mine collapse while Figure 4 shows a sinkhole which is the result of a localised mine roof collapse.

![Figure 3. Mine collapse under roadway in Europe](image)

![Figure 4. Sinkhole under roadway – Pennsylvania USA](image)

**Local geology and mines**
Several geological faults were identified along the corridor by the Queensland Geological Survey. The bedrock geology, except in the west and east, comprises sedimentary rocks including conglomerate, sandstone, shale and coal of a number of formations at different locations including, in increasing age, the Raceview Formation, the Aberdare Conglomerate and the Blackstone and Tivoli. Tertiary claystone and sandstone of the Redbank Plains Formation, which comprises the rocks under the western end of the motorway site, overlies the productive Tivoli Formation sedimentary rocks there.

Desk top studies during the preliminary design stage revealed that there were potentially three mines that could affect the service life and operational safety of the Ipswich Motorway namely:

- Goodna Mine (water filled)
- New Redbank Mine (methane filled)
- Westfalen No 3 Mine (methane filled)

The Goodna Mine workings are at an average depth of 30m below the existing ground level and are flooded with contaminated water. The New Redbank and Westfalen No 3 mines were working mines as recently as 1987. Although both these mines were essentially dry in the areas of interest, they contained high levels of methane gas. The New Redbank Mine was found to have multiple levels of works at depths of approximately 90m. Mine workings at Westfalen No 3 were marginally shallower but the voids averaged 7m in height.

While the alignment of the motorway was adjusted within the confines of the constrained corridor, it was not possible to avoid the mine workings altogether. As it was decided that mine filling could not be avoided to some extent, a sub-alliance team was formed — the Origin Keller Sub Alliance. This was comprised and the Origin Alliance team plus specialist mine filling contractors — Piling Contractors Pty Ltd and Keller Ground Engineering Pty Ltd.

Given the specialised nature of the mines in so far as understanding mine stability and the associated techniques used to stabilise them, a specialist mining engineer was appointed to assist the design team. In addition, an expert panel consisting of mine experts from Australian and overseas was formed to provide proactive guidance, review, understanding of risk issues and verification on mine subsidence issues.
In particular the expert panel was asked to review and confirm the design approach to key issues such as:

- The risks of mine subsidence
- Investigate methods and plans
- Methodology for the analysis of mine stability
- Review the design approach
- Consider the mitigation measures for the works
- Undertake verification
- Review the geotechnical investigation plan

**Goodna Mine**

Of the three mines under consideration, the Goodna Mine workings were identified as posing the greatest credible risk in terms of potential subsidence (sinkhole formation) during the design life of the motorway. The best information on the mine geometry (layout) available at the time was based almost entirely on anecdotal observations. Observations indicated that a ‘bord and pillar geometry’ that comprised 6-7m wide rooms separated by 3m rectilinear support pillars. No mine plans were available for this mine and as such, the overall extent of the workings directly under the motorway had to be determined by surface drilling. The finished level overburden depth ranged from approximately 20m to 35m in the vicinity of the motorway.

The initial boundaries of the mine were established under a program of percussion drilling. A total of 100 boreholes (percussion drilled and cored) were drilled to investigate the presence of mine voids and to confirm the boundaries of the workings. Various techniques for investigating the mine workings were evaluated for suitability in defining the depth and actual extent of the mine workings. Given the project program and the complex staging required for this project, delay costs were determined as being the main driver for this project and consequently investigative cost became secondary. What was essential to understand was — the location the mine voids, connectivity of the voids and their size. Additionally it was also necessary to understand the impacts of a failure occurring outside the corridor and how it could be contained accordingly. Apart from cored holes, the other methods trialled to understand the extent of the workings were:

- Seismic surveys — this could not provide the level of detail required
- Down the hole sonar — this proved to be useful
- Down the hole laser — down the hole laser in the Goodna mine was later discounted as the mine voids were fully flooded
- Down the hole video — underwater filming was of some value although limited by water clarity in certain areas

A complicating factor in understanding the mine layout was that the Goodna Mine was flooded. In the early stages of the investigation a simple fish finder “echo sounder” along with a digital compass was used to map voids. While rudimentary, this process proved to be extremely useful, providing an initial understanding of the voids which were then allowed the voids location to be plotted and also assisted with optimizing the drilling investigations. This apparatus was lowered into the void using 1.25m carbon fibre rods screwed together. Plots were then generated in Excel using manually recorded distance and bearing measurements. This process proved to be very labour intensive and was later replaced by a more complex purpose designed sonar device. Without a clear understanding of the mine layout, filling of the mines would prove to be very difficult and would not result in any certainty that the voids were completely filled or that the fill would not simply run out of the corridor area. On previous mine filling operations it was not uncommon for the grout to be detected up to 80m away from the point of injection.
The MASW (Multi-channel Analysis of Surface Waves) geophysical method was also tested at Goodna mine to identify voids along a line of boreholes. This method proved unsuitable in this situation in identifying the location of voids.

Investigations using deep (70m) boreholes did not encounter multi-level workings. The investigations revealed that in general the void levels were highly irregular and hydraulic connectivity tests indicated generally good connectivity. The specialised sonar equipment was then used to determine the mine extents. An advantage of the Sonar is that the water does not have to clear for it to be effective.

This method provided evidence of the interconnectivity of the bords within the mine and essentially proved that the bords were not laid out in any consistent pattern (Figure 5). The varying nature of the bord and pillar widths and layout meant that in this mine it was necessary to maintain a tight 4m grid pattern to ensure all voids were intersected with paste injection holes.

Figure 5. Typical sonar scan
One of the difficulties faced was the highly irregular mine works, in due part to the age of the workings and mining by at least three different operators. For example, the height of voids in a series of boreholes ranged from 0.9m to 3.5m and the rock mass in the vicinity of the voids (within 5m) showed signs of relaxation of rock mass which is indicative of a potential collapse. Recent investigations adjacent to the corridor found a large sinkhole (subsequently filled) in addition to local reports of sinkholes along the length of the corridor.

Pillar Stability Assessment — Although the pillar geometry was poorly defined at the Goodna Mine, a stability assessment was undertaken to determine the potential for instability and a sudden collapse. Pillar stability of a mine is dependant upon other factors such as the deterioration of pillars over time, actual material strength and roof rock conditions. The pillar stability was estimated using the University of New South Wales (1,2,3) pillar design approach. The method is empirically based on statistical analysis of a database of stable and unstable case histories in Australia and South Africa. In the absence of exact science, empirical methods provide a practical tool to develop engineering designs. The methods are frequently updated as more case histories are available following further project development. The University of New South Wales method calculates the factor of safety against failure by dividing the pillar load carrying capacity by the actual pillar loads. It should be noted that a factor of safety (FOS) of 1.5 generated in this approach corresponds to a probability of failure slightly less than one in a 1,000. The standard understanding of this concept in the civil engineering industry is that an acceptable long term FOS of 1.5 generally corresponds to a probability of failure of one in a million, which is not the case in this situation. Therefore, to avoid confusion, the term FOS (in the pillar failure context) was redefined as the Pillar Stability Index (PSI). The coal pillar load is estimated using the tributary loading method where the pillar load is estimated based on the overburden pressure and the extraction ratio, namely:

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\text{Pillar load} = \text{width of pillar} \times \text{unit weight} \times \text{overburden depth} \times \text{width of roof supported by pillar}
\]

This method does not take account of possible arching of the rock/soil overburden pressure when calculating the exact pillar loads. The arching of overburden soil/rock behaviour is generally developed when the collapse of working is initiated. For example, when the roof of the intersection of roadways fail, the migration of void to the surface could be hindered by both bulking of broken roof rock and arching behaviour of surrounding rock. However, given the variability in pillar geometry and relatively shallow overburden (average 28m) depth, the method provides a conservative estimate of pillar loads prior to roof failure. The tributary method is widely accepted and used by practitioners around the world for designing coal pillars for underground mines. The coal pillar strength is estimated using the linear relationship (4) and subsequently updated (1,2,3,7) after a detailed statistical analysis of coal pillars (stable and unstable) in Australia and South Africa.

A number of assumptions were made for the calculation of PSI for the coal pillars against failure. Based on the calculations for the Goodna Mine, there existed the potential for pillar instability. In addition, analysis indicated that the collapse of a single unstable pillar could initiate a pillar domino type failure due to progressively increasing loads by failure of neighbouring pillars hence leading to a large scale subsidence event. Accordingly, it was concluded that the Goodna mine be considered unstable given the underground conditions foreseeable over the 100 year design life of the motorway.

Risk Assessment — Two possible failure mechanisms were considered for the Goodna mine. The first possible failure issubsidence that results from a pillar collapse that causes sudden trough subsidence over the area of pillars that collapse. A second possible failure process involves roof failure and the consequent migration of the void up through the overburden to the surface. This type of sinkhole failure can occur above single mine roadways or intersections where as pillar collapse subsidence requires an area of standing pillars to become destabilised.
Due to the shallow depth of cover (20 to 35m after development), it is expected that both sink hole formation and subsidence events could occur at the Goodna mine. At the time it was assumed that a large scale subsidence event has a more likelihood event than sink hole formation. A systemic pillar failure at the Goodna mine would result in a trough with an estimated magnitude of 1m within the area of mining and the formation of a step at the edges. The sinkhole recently located in the transport corridor at Goodna was approximately 5m wide and 1.5m deep, which would pose a significant safety risk to motorists.

An analysis of the pillar stability indicated that the possibility of sudden instability could not be ruled out based on the information available at the time. Accordingly, in terms of the stability and risk assessment, remedial works were determined as being necessary based on the following:

- The geometry is not well understood and a potentially highly irregular geometry makes it difficult to assess stability with any confidence
- A subsidence event could result in a 1m depression of the road surface
- The shallow depth of cover increases the probability of sinkhole formation
- Safety risk to motorists using the highway at the time of the collapse
- Environmental risks due to the escape of approximately 60 ML of contaminated mine water
- The risk of secondary failures of infrastructure associated with the motorway, such as retaining walls, noise walls, drainage elements and so on
- The cost of remediation and disruption to a major arterial route
- The potential for legal risk of construction activities being seen as the root cause of any collapse that might occur during or after construction.

Notwithstanding the uncertainty of the mine geometry, the pillar stability calculations clearly demonstrated that the pillars would be unstable for a geometric configuration of 2m wide, 2m high pillars and 8m wide roadways. The subsurface information available from the previous six months of investigations (more than 100 boreholes drilled) did not provide any confirmation of the mine geometry with the needed degree of confidence. It was believed at the time that by having closely spaced boreholes an improved level of understanding of the mine geometry would be achieved. Further investigations were limited however as direct surface drilling was not possible while accommodating the motorway traffic (100,000 vpd) and the staging needed for the adjacent road works on the project.

In consideration of public safety, the 100 year design life required, the unknown conditions outside of the corridor and the extent of the identified workings, a “do nothing option” was not considered an appropriate outcome. Accordingly, the Origin Alliance and the panel of experts made the determination that mitigation measures were required to deal with the risk of a potential mine failure either by filling the mines or bridging them.

**Remedial options** — A number of remedial measures were considered to mitigate the risk of a potential mine collapse, namely:

- Re-alignment was investigated, however this was not possible as the Goodna Mine footprint was known to extend outside the area of the corridor.
- Excavating the mine void and refilling was deemed to be not viable. Reasons were the cost of excavating and retaining up to 25m deep temporary cuts against live traffic with associated traffic disruption.
- Designing various large bridging structures so that the motorway could withstand considerable ground displacements was considered. Given the expected extent and magnitude of deformations, this option was considered to be cost-prohibitive.
Partial filling of mine voids was considered. While this would reduce the amount of fill required, consideration of the stiffness of the coal relative to the fill material suggested that the overall level of subsidence may be reduced by partial filling, however the potential for instability may not be significantly changed. This option would not protect the motorway from failures that could initiate from outside the road corridor. In addition, considerable further investigations in terms of time would be required to determine the mine geometry and pillar conditions. Given the project program, the additional time was not available.

Complete filling of the voids with grout, paste or rock fill would effectively eliminate the risk of collapse and subsequent manifestation of ground deformations at the surface. This option reduced the risk to motorway infrastructure to negligible levels. It was believed that this option would allow for optimisation of void filling.

After consideration of all the available options, the decision was to completely fill all the voids within the motorway corridor. Further information on the Goodna Mine and Westfalen No. 3 Mine can be found in the reports listed in the references (5,6).

Filling operations
Restoring or improving mine stability in essence requires filling of the voids with fill material that will remove the space or void for the overburden material to move into. The material strength is usually not a hugely critical factor, however it was believed in this case that in order to reduce the risk of failure further that some material resistance (back pressure) should be designed in. As large quantities of material are required for filling, low grade material (waste products – with a low intrinsic value) was sort. There is considerable flexibility in the material properties that could be used to fill the voids and as well as the construction methods. Usually the optimum design is governed by timing and availability considerations rather than by the material properties of the fill itself.

The material characteristics were as follows:

- Adequate strength to stop propagation of failure from outside the corridor into the motorway corridor
- Adequate strength to support rock mass deformation of pillars to resist rock mass failure
- Adequate strength to support roof rock in the event of localised residual voids being left in place after filling
- Adequate to resist lateral pressures from the fill material up-dip during construction
- The fill strength needed to be designed considering the above criteria which were determined to be a minimum of 1MPa unconfined compressive strength and 100MPa elastic modulus.

Fill material — The paste was a mixture of crusher dust, waste pond ash from the Swanbank Power Station, cement and water. The paste was manufactured in a specially constructed waste water and paste mixing plant (Figure 6) and delivered to the borehole collar by a fleet of concrete agitator trucks. Experiments were done in the preparatory stages of the project to design the most economical paste mix that was able to meet specified strength and workability requirements. These experiments were supported by laboratory testing.

The plant treats the contaminated waste water extracted from the mine using double reverse osmosis. 80% of the waste water was recovered to Class A quality and used onsite in mix manufacture and dust suppression. 20% of the ROC³ contaminated water was used in paste mix production.

3 ROC is Reactive Organic Compounds
Drill and fill methodology — As the mine workings often extended outside the motorway corridor, only that area of the mine beneath the motorway was required to be filled. This introduced the need to construct a barrier on the “down dip” side of the fill zone to form an impenetrable boundary for subsequent “up dip” filling. To achieve this boundary or barrier wall, a series of holes of nominal 150mm diameter were bored to the known depths of the mine. This barrier wall was drilled with a series of holes spaced at 2m centres in a “zig zag” pattern for the full plan length of the estimated mine location and for some distance beyond to ensure the barrier wall drill holes intersected all voids.

During construction, filling works had to be managed to ensure traffic flows under live traffic on existing roads were maintained. Traffic switches were planned as far as possible so that traffic was switched to locations where mine filling works were completed. In some situations, injection holes were drilled at a rake under the live motorway to allow a continuous mine fill operation.

To create a barrier wall on the “down dip” side of the fill, a “mound” of low strength, low slump paste was pumped into the void at a controlled pressure, spreading across the ceiling of the void and effectively providing a ceiling to floor plug (Figure 7). Through overlapping injection points a complete barrier wall was created after which the bulk filling of the mine could occur.

Due to the erratic nature of the bord and pillar layout in some of the workings, a series of holes were drilled in a 4m grid pattern “up dip” of the barrier and for the full length of the mine. These “up dip” holes were then injected with a high slump paste working from the barrier wall in the “up dip” direction (Figure 8). These holes and paste injection were continued for the full width of the future motorway footprint plus a limited distance beyond.
Figure 7. Initial construction of the barrier wall and water extraction

Figure 8. Bulk filling with high slump paste
Water extraction and paste injection volumes
— There was a concern that if the water table was artificially raised or lowered this could result in environmental damage and/or impact on the stability of the mine. This was overcome by ensuring that the water volume extracted was equal to the volume of paste injected into the mine. To achieve this, accurate volume meters were fitted to the paste pumps and accurate water meters were fitted to the borehole water extraction pumps with both injection and extraction pumps operating simultaneously. The connectivity then needed to be confirmed to ensure that water was being extracted from a bord hydraulically connected to the paste injection hole. This connectivity was confirmed by the placement of a hydrostatic meter in a borehole adjacent to the injection point and another adjacent to the borehole pump point. By monitoring these meters in real time, paste injection volume and water abstraction volume could be controlled to ensure that the volumes matched and the water table level remained within defined allowable limits.

Figure 9. Water flowmeters

Figure 10. Hydrostatic water pressure gauges
**Camera observations** — During the filling process, a borehole camera was used to view the construction of the barrier wall from adjacent bore holes to give confidence that the process of creating the “mound” that eventually becomes the barrier wall, was meeting design expectations. The full wall building process was able to be viewed with the wall meeting roof contact requirements necessary to block the void. Further observations of the bulk infilling operations were made to ensure that the paste contacted the roof adding to the confidence of the adopted filling process.

![Sequential pour of the barrier wall through a tremie](image1)

*Figure 11. Sequential pour of the barrier wall through a tremie*

![Bulk filling paste adjacent to the barrier wall](image2)

*Figure 12. Bulk filling paste adjacent to the barrier wall*
**Fill verification by coring** — In order to confirm that the mines have been adequately filled to a level that met the specification, a programme of coring through a filled zone was implemented. As part of the coring process a core from 2m above the filled zone to 2m below the filled zone was extracted. Core samples were then viewed to ensure the degree of roof contact was within specification and sections of the paste portion of the core were crushed to prove that design strength had been achieved in situ. These cores verified that the filling operations were a success.

![Roof contact core](image13.png)

**Figure 13. Roof contact core**

![Floor contact core](image14.png)

**Figure 14. Floor contact core**
Figure 15. Initial borehole layout for New Redbank Mine

Figure 16. Mine map reduced boreholes by 60%
**Borehole optimisation**

Figure 15 below shows an initial borehole layout for the New Redbank mine. A boundary barrier wall was constructed with the initial intention of drilling a tight 4m grid of drill holes “up dip” of the barrier wall. In this particular mine some old maps were available outlining the bord and pillar locations. Whilst parts of this mine were not entirely in accordance with the maps there were areas, as indicated below, where the mine map could be orientated and identified reasonably accurately.

By orientating the map in conjunction with downhole cameras and inclinometers, confidence could be achieved in proving the mine void locations without the need to drill the full extent of the designed drill hole pattern (Figure 16). This culminated in the elimination of some 60% of the 90m deep holes in the drill pattern leading to substantial savings to the project.

**Westfalen No 3 Mine**

Mine filling activities at the Westfalen No 3 mine were different in a number of respects from filling operations at the Goodna Mine in particular. Westfalen Mine is a relatively modern mine, having closed to mining activity in 1987. Within the fill zone of this mine there are two grade separated layers of mining operations, each nominally 7m high and up to 8m wide with the mine atmosphere consisted substantially of flammable methane gas.

Due to instability concerns of a small portion of the total mine in the vicinity of the fill operation, it was considered that the risk of release of a large quantity of methane gas, should a collapse occur, was sufficiently high to warrant the extraction of the methane from the mine prior to filling. A decision was taken to remove the methane from within a section of the mine. This mine is partially filled with water at its lower extent. This water forms a natural barrier between the “high tide” level within the mine and the “up dip” closed end of the mine where the mine filling was to occur.

The plan was to replace the methane with nitrogen. In the vicinity of the methane extraction flare site, air flow studies were carried to model local atmospheric conditions. These studies were completed by SIMTARS, a Queensland government body that provides mine safety advice, testing and research facilities. Guidelines were devised for the nitrogen injection and venting the displaced methane for disposal by combustion. Risk assessments were prepared on the flaring process, with particular attention to the management of the relationship between oxygen and methane levels to ensure that mixture levels were maintained outside the explosive range.

To achieve this nitrogen “inertisation” of the mine atmosphere, two holes were drilled at the lower extent of the mine (at the “high tide” level) and two holes at the upper extent. A nitrogen generator was located at the surface and nitrogen was pumped down some 102m at the lower end of the mine just “up dip” of the “high tide” level (the drowned lower portion of the mine). The two holes drilled at the upper extent of the mine were directed to an enclosed methane flare where the methane was then flared to the atmosphere. Methane levels were slowly reduced over an eight week period with final low concentration methane remnants released directly to atmosphere.

Mine depths in the fill zone range between 65m and 80m across the fill zone. Collapsing upper level alluvial soils meant that boreholes needed to be cased through the upper 20m to 30m. In portions of the fill zone where a double layer of mine void was present, full depth drill casings were required to enable the return to surface of drill cuttings and to later provide a conduit for paste injection (via the outer drill casing).

**Conclusion**

The mine filling operations were considered a success due to the cooperation and professionalism of all those participating in the project. The negative environmental and safety impacts of the works were successfully addressed through careful handling and treating of extracted mine water and the controlled flaring of methane gases where appropriate. In addition, the mine fill material, largely composed of low grade waste ash from the nearby power station ash ponds, was able to be used in substantial quantities reducing otherwise unused stockpiles of the ash.
The end result were fully stabilised mine workings beneath the motorway corridor ensuring the safety of motorists for the next 100 years and beyond.

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