UNDERGROUND REPORT

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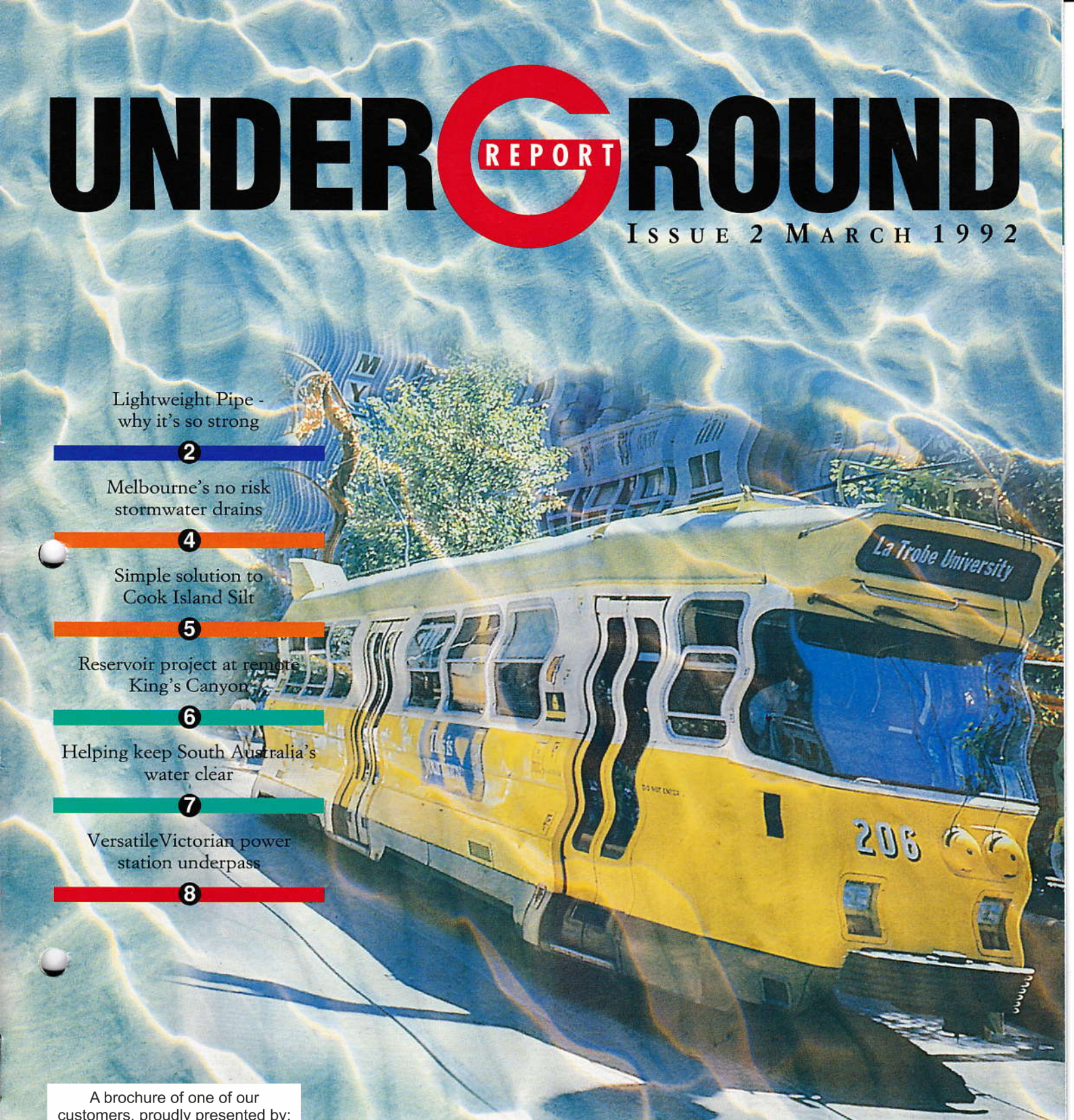

BOLD NEW SOLUTION TO MELBOURNE'S STORMWATER DRAINAGE SAVES TIME, MONEY AND RISK.

Lightweight pipe -

Light weight flexible plastic pipe has seemingly little inherent strength or stiffness. Yet it often performs better than heavy rigid pipes when installed under identical conditions. The following article explains how this occurs.

The engineering profession has long recognised the benefits of flexibility when applied in the design of structures and machines. Suspension bridges, tall buildings, towers, ships and aircraft are all designed to deflect without suffering structural distress.

Flexible pipe is also designed to deflect under external loading, and in fact derives its load carrying capacity from its flexibility.

This works in two ways:

1. Loads on the pipe are largely vertical. These cause the vertical pipe diameter to attempt to decrease, with a

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consequent increase in horizontal diameter. The horizontal diameter increase is opposed by the side support soil.

2. As the top of the pipe deflects, and passive soil support develops at the sides of the pipe, the whole mechanism tends to form an 'arch' in the soil over the pipe. The arch relieves the pipe of a proportion of its load. In strong soils, this arching effect can be very significant, and research has shown that often very little of the imposed load is transferred to the pipe. The concept of arching explains why sub-terrain passages remain open.

Arching can occur in all soils that have an angle of internal friction greater than zero, which includes all granular soils and most fine grained soils in the drained state. Arching comes about by the grain to grain contact of the soil particles. It is a form of shear resistance, and is as stable and permanent as other forms of shear resistance. For example footings founded on sand are supported by the sands shear resistance.

The effective strength of the pipe/soil system developed by a flexible pipeline can be remarkably high.

The pipe/soil system concept does not apply to rigid pipes as they cannot deflect without cracking. Thus the embedment cannot provide them with any support.

Rigid pipe is stiffer than the soil in which it is embedded. Thus when the soil above the pipe is loaded, it tends to consolidate down- ward, thereby transferring loads to the stiffer pipe. Loads on a rigid pipe often actually increase with time. Flexible pipe is less stiff than its surrounding embedment, and thus when vertical loads are applied, the pipe deflects, transferring the load to the surrounding embedment. The resulting soil arching effect can carry almost all the imposed load.

Experience demonstrates that deflection of buried flexible pipe will continue for a period of time after completion of pipe installation, before final equilibrium is reached.

Thus by measuring the deflection in the pipes shortly after laying, it is possible to accurately check that the embedment and compaction effort is sufficient to provide an adequately strong soil/pipe system. This is a major advantage flexible pipes have over rigid pipes. With rigid pipes it is not possible to immediately check whether the pipe embedment provides it with adequate protection, and any deficiencies may not become apparent until well after the project's completion.

For HDPE profile wall pipe (i.e. Black Brute) the ASTM Standard requires a 60 % deflection test without any form of structural degradation. However, to ensure joint integrity and full pipe hydraulic performance it is common practice to limit the long term deflection to 7.5% at 50 years. This obviously allows a significant safety margin for additional deflection due to unforeseen circumstances.

Whilst the reduction in cross-sectional area caused by deflection affects the pipes flow capacity, the reduction is minimal until acceptably, high deflection is reached. Any reduction of flow capacity caused by deflection in plastic pipes is usually more than offset by its smoother bore and reduction in the number of joints when compared with rigid pipe systems.

Research, confirmed by actual field measurements, has shown that pipes made of HDPE (such as Black Brute) undergo at least 80% of the 50 year predicted deflection in the first year.

Further, over 75% of the first year's deflection occurs within approximately 21 days.

For the Melbourne and Metropolitan Board of Works (Melbourne Water) in 1988, Black Brute was not only a new product for stormwater drainage, but one which differed substantially from products they had traditionally used.

Since 1988 however, the Board's experience, together with the experience of Water Authorities throughout Victoria, has demonstrated how the advantages of Black Brute can be used to reduce the cost, and improve the efficiency of drainage projects.

Nowhere has this been more graphically demonstrated than in the major upgrading which took place in early 1989 at Punt Road and Swan St, one of Melbourne's busiest intersections. Running diagonally across the intersection are two Black Brute pipelines, with diameters of 2100mm and 1500mm, installed to replace existing brick barrel drains. In addition a new 1200mm Black Brute drain has been installed running under Punt Road for a distance of approximately 40 metres.

Traditionally, replacing the brick drains would have been carried out using reinforced concrete pipes, however the advantages of Black Brute were particularly relevant to the projects requirements. Despite the Board's initial hesitation in using a 'new' product in such a demanding application, their 'punt' on using Black Brute, can after

nearly three years, be regarded as having paid off.

In a paper presented at the 1990 Municipal Works Officers Conference some of the reasons given by Vic Roads for the choice of Black Brute ahead of reinforced concrete pipes were -

1. The superior flow characteristics of Black Brute enabled a smaller diameter pipe to be chosen. This allowed more cover to the pipeline and construction savings through narrower trench widths and less road pavement reinstatement.

2. Lighter weight of the pipes meant much smaller construction plant was required. Even the 2100mm diameter pipes were light enough to be moved by a back hoe.

3. The longer lengths (6 metres) meant faster installation.

4. Availability of pre-fabricated fittings in HDPE.

Installation work was carried out by both the MMBW and Vic Roads and included the removal and reinstatement of tram lines.

The pipes were bedded and backfilled to the pipe crown using 14mm aggregate compacted by forking, rodding and vibrating plate to 80% Density index. The trench base and sides were lined with geotextile fabric to prevent migration of fines and ensure support around the pipe was maintained. Backfill from the top of the pipe to road pavement level, in places a depth of less then 600mm, was with crushed rock road base.

Estimates of the cost savings made possil Black Brute are substantial. Savings were pipe because a smaller size was used.

There was also a saving of around 50% on plant hire and labour, and a 20% saving in time and material.

Measurements of the internal diameters of all pipes have been taken, both horizontally and vertically at various stages since completion. Maximum design deflection after this period is 5%, however measurements taken indicate that deflection of only approximately 1.5% have occurred. As expected, most of this deflection occurred within the first 130 days. In particular readings taken indicate that deflection over the past twelve months has been negligible. The major authorities involved are thus confident that this Black Brute pipeline will continue to perform well within its design limits.

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Lynch's Bridge

Black Brute's light weight and flexibility mean it is often used when a pipeline must be laid in weak or unstable soil conditions.

The construction of Lynch's Bridge, as part of the Maribynong Drive Widening Project also meant laying twin 900mm nominal diameter stormwater pipelines, each some 380 meters long, under what will eventually become the carriageway. The area where the stormwater pipelines are to be laid is also the main entrance to Flemington Race Course.

Test boreholes taken by Vic. Roads showed that the in-situ ground conditions comprised Coote Island Silt to a depth of at least 30 metres. Coote Island Silt is extremely weak and soft, and with the area occasionally submerged by tidal water, the project presented obvious challenges.

Black Brute was chosen ahead of cement lined mild steel for the stormwater pipes because of its light weight and its ability to better accommodate the expected ground settlement. The inherent corrosion resistance of Black Brute was also a substantial advantage. Reinforced concrete was not considered.

To compensate for the weak in-situ soil an imported rock foundation was first laid. Crushed rock bedding and backfill compacted to 95% Standard Density was used around the pipeline. The bedding was surrounded by geotextile fabric. Twin 900mm pipelines were chosen (instead of one larger pipeline) to minimise the amount of imported fill required.

After completion of the roadway it is anticipated that over the years, a total ground settlement of some 600mm could occur. The soil movement is expected to be fairly uniform over the length of the pipeline, and maximum design deflection of 7.5% has been allowed.

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POLYTEMP TAKES THE HEAT AT KINGS CANYON

Kings Canyon, with its sheer 300 metre high walls, is one of the Northern Territories most awesome sights. From the plateau - like summit to the lush oasis of palm trees, rock pools and shady crevices at the base of the canyon, visitors can't fail to be impressed by the spectacular colours and features.

Until now, it has largely been bypassed by travellers because of its remoteness, some 310 kilometres from Alice Springs, and the lack of available facilities.

Now that has all changed as just seven kilometres from Kings Canyon is the recently opened Kings Canyon Frontier Lodge.

With motel units, back packers accommodation, a caravan park, camping grounds and 250 seat restaurant, Frontier Lodge will allow more visitors to experience the stark beauty of this unique region. Several shops and a service station complete what amounts to a small village.

A most important criterion in the design of Frontier Lodge is that it should have a minimum impact on the surrounding environment. Thus the design, finish and paintwork has resulted in buildings that merge with the topography. For example water from the sewerage treatment plant is used to irrigate a plantation growing firewood for use in campfires, ensuring all native vegetation remains untouched. Protective fencing of sensitive areas also protects the existing ecology.

Water from the reservoir is pumped around the complex in a continuously circulating hot water system. By the time the water has been pumped to the various buildings and returned to the reservoir it has travelled a distance of some three kilometres.

One of the more innovative energy saving initiatives is the resort's hot water supply system, which makes use of waste heat from the generators in the power house.

Water heated by the diesel engines in the power house passes through three shell and tube heat exchangers. The energy extruded by the heat exchangers heats water in a reservoir adjacent to the power house. The original water from the heat exchanges then passes through radiators with thermostatically controlled fans, before re-entering the engines. However so much heat is transferred to energy that to date the fans have not activated.

Naturally it is essential that the water retains as much as possible of its heat throughout its three kilometre journey.

Between the various buildings which go to make up Frontier Lodge, the hot water is conveyed in Hardie Iplex Polytemp elevated temperature polyethylene pipes. The pipes chosen were Class 9 in sizes of 110mm, 90mm and 63mm. They are laid in trenches, and to retain the heat of the water, encased in polyurethane foam and wrapped in a plastic membrane.

The system can be regarded as being a complete success. In initial trials, the hot water was recorded as leaving the power house at 55°C, and returning to the reservoir at a temperature of 54°C, a loss of just 1°C in three kilometres. Now the lodge is in full scale operation, a water temperature of 60°C is commonly used.

S.A.'s pipeline keeps the water clear

A five-year levy on sewerage rates in South Australia is providing considerable resources for environmental enhancement projects.

According to South Australian Water Resources Minister Ms Susan Lenehan, "The top priority is to improve the waters off our shores, and to protect the River Murray by making sure that wastewaters flowing into both are halted or are as 'clear' as possible".

Thus, funds raised from the levy are being used to accelerate efforts to give increased protection to the inland water resources of the state, particularly those used for public water supplies, as well as the coastal marine environment.

As part of one of these projects, some 37 kilometres of Hardie Iplex Blue Brute pipe is being installed as a sewage sludge pipeline. The pipeline will run from Glenelg through Port Adelaide to Bolivar and will remove the need for the sludge to be pumped offshore. Rubber ring jointed Class 12 PVC pipes with a nominal diameter of 200mm are being used. The plastic pipe advantages of abrasion resistance, and capacity to be unaffected by the potentially aggressive sewage were obvious reasons for the choice of PVC.

Instead of being pumped out to sea, the sludge will be dried at Bolivar using solar evaporation. Much of the sludge will be processed into organic fertiliser or soil conditioner, and it is estimated that some 12,000 tones of sludge will be processed each year. The overall benefit will be an improvement in the marine environment and in particular a reduction in the die -off of seagrasses.

Total cost of the sewage sludge pipeline is estimated to be some $13 million.

SECV'S Black Brute Underpass

For the State Electricity Commission of Victoria, the necessity of providing a pedestrian underpass under the main haulage road to Loy Yang power station was a late addition to the project. What was therefore required was some form of structure which was quick and easy to install, and which did not add substantially to the overall project cost.

Black Brute provided the rather unusual answer to these requirements. The State Electricity Commission of Victoria have considerable experience with Black Brute. It has been used in numerous SECV projects throughout Victoria, and its advantages have been proven in a wide range of applications.

For the underpass at Loy Yang, Black Brute pipes with a diameter of 3 metres were chosen.

For this project, Black Brute provided the added advantages that the various fittings needed in a long underpass e.g. lighting, could be easily and safely installed.

Branches with a diameter of approximately 450mm were provided on some of the pipes, which were eventually fitted out as skylights.

For the SECV it was a most cost effective solution. Cover to the underpass is minimal - some 600mm, and the road above carries very heavy loads. The support system provided by Black Brute, which transfers most of this load to the surrounding embedment, has once again provided its effectiveness.