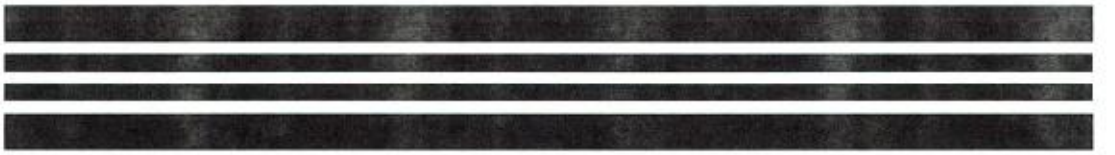

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Preliminary investigation of the arachaeological remains of goldmining at Junction Reefs, Belubula River, NSW : report

PRELIMINARY INVESTIGATION OF THE ARCHAEOLOGICAL REMAINS OF GOLDMINING AT JUNCTION REEFS, BELUBULA RIVER, NSW.

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Report compiled by
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For
Petroleum Securities Australia Limited.

April 1984.

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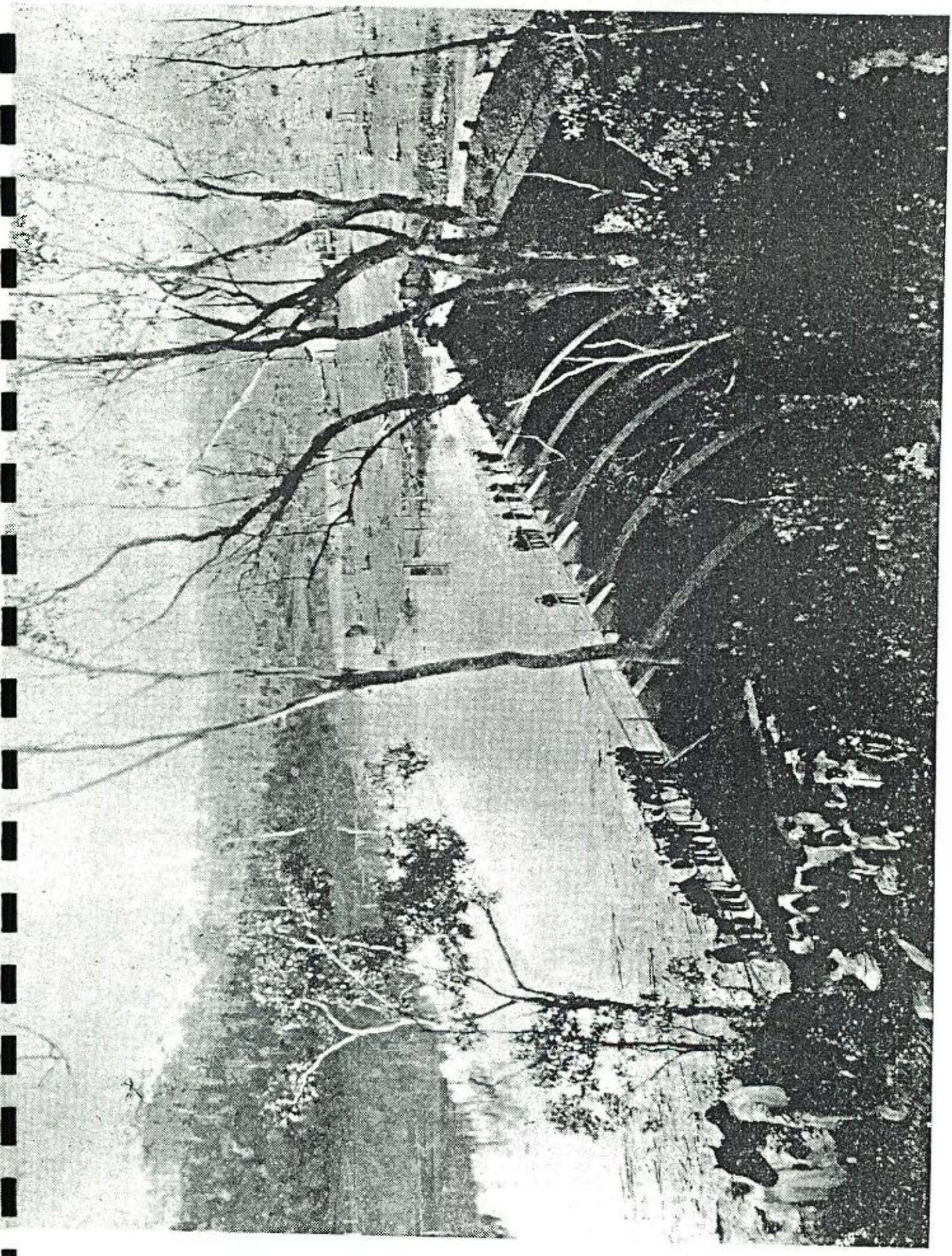


Belubula Dam.

Inventory: item 3. Belubula Dam. This photograph of the dam under construction is taken form O.Schulze, 1897 (Geological and Mining Museum, SI/55-8, Bathurst, no. 1375).

1. Introduction

The gold bearing deposits at Junction Reefs were exploited from 1870 to 1940, with major periods of mining activity in the 1870s and from 1895 to 1939.

The term Junction Reefs refers to the whole area, including three mines, namely the Frenchman's, Cornishmen's, and the Junction. Care should be taken to differentiate between the name of the area and the Junction mine.

The report was prepared following the basic guidelines set out in J.S. Ker, 1982, The Conservation Plan, National Trust of Australia (N.S.W.).

The conclusions and recommendations of this report may be rapidly assessed by reference to sections 9 and 10.

2. Location of site.

The site of Junction Reefs is situated on the Belubula River, near Mandurama and Lyndhurst, in the Parishes of Lyndhurst and Belubula, County of Bathurst, New South Wales. It is 33km .ESE. of Blayney, and 70km from Bathurst. The Belubula River is a tributory of the Lachlan River. (8630, I and IV, Canowindra, 845775).

3. National Trust Register.

The site of Junction Reefs is classified by the National Trust of Australia (N.S.W.) under the following heading:
Blayney Shire Council
Junction Reefs
Belubula Dam on Lyndhurst Goldfield, including main service pipeline and mines area.

The area classified is decribed as follows[1]:

BELABULA DAM ON LYNDHURST GOLDFIELD, INCLUDING MAIN SERVICE PIPELINE AND MINES AREA
The eastern bank of the Belabula River, from the junction with Marangulla Creek to the northern boundary of Lot No 218; along this boundary and corresponding boundaries of adjoining lots to point on northern boundary of Lot 260 which is 100m from the bank of the River; then parallel to River at a distance of 100m from bank of River to western boundary of access road; along this boundary to western bank of River; along this boundary to a point which is 1km above the dam; across River, then back along the eastern bank of River to northern boundary of Dam; then along the projection of line of Dam wall to a point which is 1.5km east of eastern bank of River; then around in a line parallel at 1.5km from bank of the River to western boundary of Marangulla Creek; 1.5km from the River; along this boundary to the Junction with the Belabula River

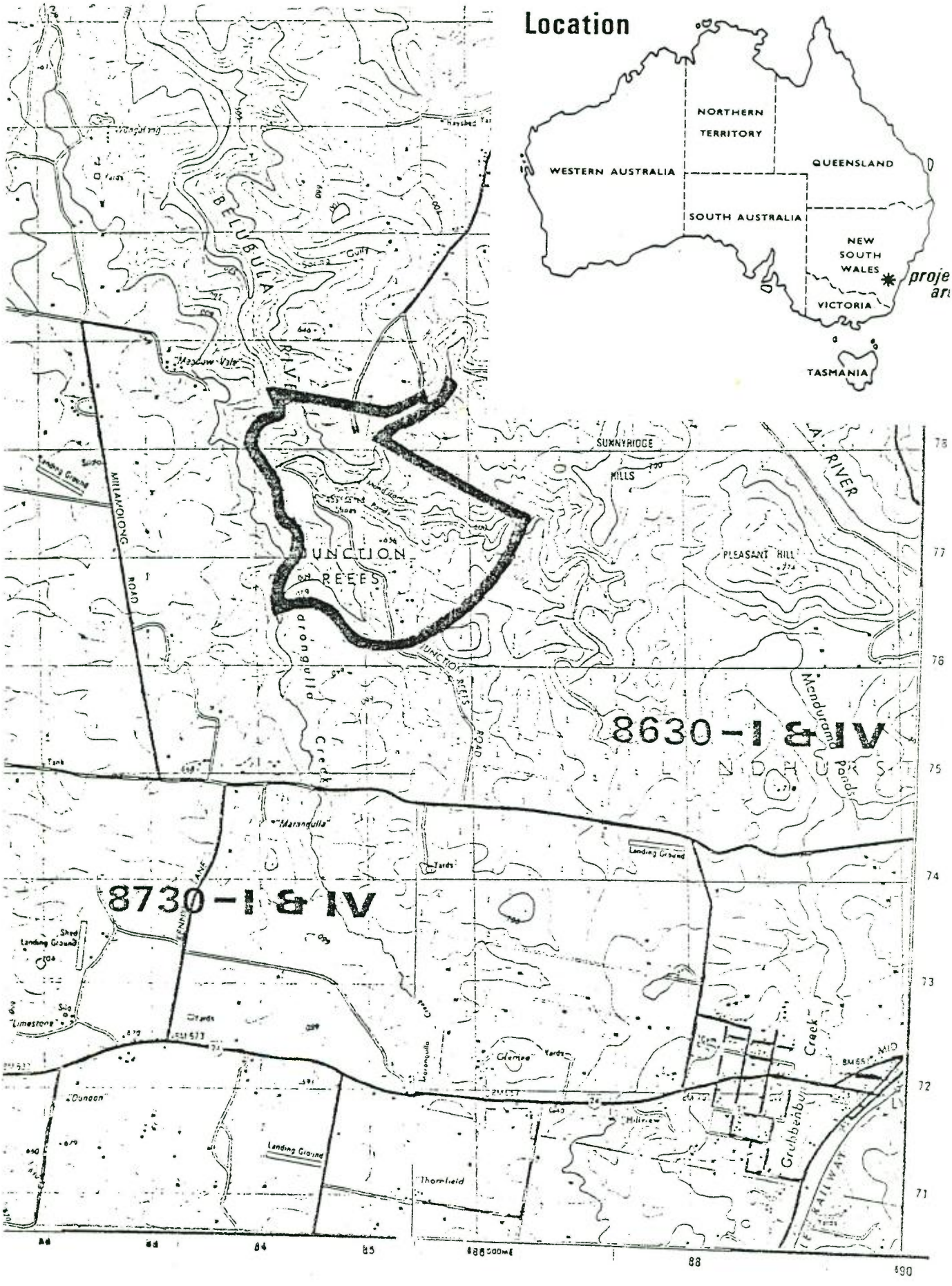


Figure 1. Location of Junction Reefs, Belubula River, N.S.W., indicating area classified by the National Trust. (1:50,000).

4. Purpose of investigation

Petroleum Securities Australia Limited have begun investigations into the feasibility of mining the low grade auriferous ores at Junction Reefs. They approached the Department of Environment and Planning to assess whether approval would be given for mining. The Department requested, under the provision of the Heritage Act, 1977, that Petroleum Securities undertake an investigation of the archaeological remains at Junction Reef. inventory

5. Duration and area of investigation.

In March 1984 Petroleum Securities commissioned E. Higginbotham to undertake a preliminary investigation of Junction Reefs, but to concentrate his study within the area defined in figure 2.

Preliminary documentary research was commenced on 19 March 1984 at the Department of Mineral Resources, N.S.W.

The site itself was investigated on 24 and 25 March 1984. The area studied differed from that outlined by Petroleum Securities for the following reasons:

1). Archaeological remains were traced up to and beyond dam so that the technology and full extent of the mining area could be assessed.

2). The piping and water race was traced from the dam to the north west corner of the mining area, so that the workings associated with the dam could be assessed.

3). The area to the east of the Belubula River upstream from its junction with Mandurama Ponds, and the area to the south of Mandurama Ponds were not investigated,

Figure 2. Project area designated by Petroleum Securities, also indicating location of the three main mines, the Frenchman's, Cornishmen's, and the Junction (1:5000).

since no documentary evidence referred to them, and no archaeological remains led into them.

4). The area to the west of the Belubula River and Marangulla Creek, in the Parish of Hampton was not investigated since no documentary evidence referred to it. Although this area was clearly visible from the area of the survey, only a trackway could be seen.

5). Open-cut mines were not investigated in detail due to obvious dangers. No underground investigation was undertaken.

The remainder of the area was investigated in detail.

A number of documentary sources were consulted during this preliminary investigation. However several questions remained unanswered after the site survey, but could not be followed up in detail, due to the various constraints upon the investigation (see bibliography).

This report was completed in April 1984.

6. History of goldmining at Junction Reef[2].

Few records exist for the mining of gold at Junction Reefs prior to the commencement of the Department of Mines Annual Reports in 1875. The area was probably first exploited in 1870[3] by three companies, namely the Junction, Frenchman's, and Cornishmen's (see figure 2). The main source of energy was steam power, but the expense of fuel, unreliability of water, and the low grade of the ores contributed towards the closure of each company by 1876, the Junction and the Frenchman's being sold at a great loss.

Already by 1876 the potential for further economic exploitation was seen:

'Several mining engineers of experience, who have seen these mines, are of opinion they would all pay well if worked by water power by means of turbine wheels, thus saving expense of fuel,Firemen, etc., and at the same time obtain the stone by quarrying, instead of mining, which would effect a still greater saving.'

Junction Reefs, because of the low grade of the ore, was most suitable for large scale exploitation. Only such workings could hope to remain economical for any period of time. Investment was increasingly needed for sophisticated processes and machinery to save the very fine particles of gold, and for the development of an economic source of power.

Junction Reefs represents in microcosm the processes of change taking place throughout the goldfields. There was little opportunity for the individual miner, panning or exploiting alluvial gold. The area quickly became the domain of companies able to invest large sums in equipment. Very soon after the commencement of exploitation in 1870 steampower was abandoned in favour of more economic energy sources, water power to drive turbines, and diesel engines in the twentieth century. Sophisticated processes soon

made their appearance: amalgamation with mercury gave way to proposals for chlorine treatment. The cyanide process made its appearance around the turn of the century, in conjunction with the roasting of the ores. Attempts were also made at smelting with copper ores.

Between 1876 and 1895 little mining activity took place at Junction Reefs. Steam power was abandoned, and attempts were made to use water power. In 1879 and 1880 a 20 foot water wheel was used at Frenchman's by a small party, possibly to be identified as the Sultan Goldmining Company. Also in 1880 another party worked the Cornishmen's using a water-wheel.

It appears that W.H. Binsted and Company, possibly later renamed the Mandurama Goldmining Company, acquired the Junction in 1885. This claim had remained idle since the scrapping of the plant in 1876. In 1887 this company was erecting 'superior gold-saving machinery', powered by a turbine wheel. After substantial trials it was clear that much of the fine gold was still being lost in treatment. Betwen 1889 and 1891 the company was again erecting sophist-icated equipment, possibly involving chlorination, but little appears to have come of this venture.

Until 1895 the unreliability of the water supply still affected goldmining activities in spite of advanced processes, and the use of economical power, the water-wheel, and the turbine.

In September 1895 the Lyndhurst Gold-fields Company Limited, later known as the Lyndhurst Railway and Mines Limited, was formed and registered. This Company amalgamated the mines, namely the Frenchman's, Cornishmen's, Belubula (neighbouring the Cornishmen's), Mandurama (the Mandurama Goldmining Company at the Junction), and the Junction, comprising a total area in excess of 272 acres[4]. Between 1895 and 1897 the Company were involved in the construction of the

large concrete and brick dam across the Belubula River above the waterfalls. Up to 1899 it appears that the water turbine (Pelton Wheel) and equipment constructed by the Mandorama Goldmining Company may still have been employed. However in 1899 the new Company had completed its new crushing and concentrating plant, probably using the chlorination process, but were soon to add an additional Edwards roaster and several cyanide vats in 1901, and a water jacket blast furnace in 1903. From 1900 the cyanide process was adopted in favour of the chloride-process.

The advent of the Lyndhurst Railway and Mines Limited illustrates the fact that only larger companies with extensive capital could hope to exploit the low grade ores economically. The building of the dam for approximately £9000 was a necessary capital investment to ensure the continuous working of the mines in an area subject to irregular rainfall.

However in spite of the capital available to it, the Company failed in an attempt to largely extend the scale of production. In 1904 and 1905 quantities of ore were smelted with copper ores on a successful basis. Attempts to raise the capital necessary to connect the mine with the railway network failed, so that it was impossible to develop the smelting process in conjunction with outside copper mines.

From 1905 onwards various other parties took up leases at the Junction Mine, on the south side of the river. Their precise relationship with the Lyndhurst Railway and Mining Company is obscure, but it is clear that the Company continued mining at both the Cornishmen's and the Junction, processing the ore at the former site[5]. The Junction Mine was variously worked by L. Edgley in 1905-1906 (erected a Huntington Mill in 1906), C.M. Thomas in 1905 (erected a cyanide plant), W.N. Willis in 1906, J.M. Hogan

between 1907 and 1915, when he was bought out by Sheahan Bros., and the latter from 1808 to 1934. Both Hogan and Sheahan were connected to water power in 1911, Hogan also constructed two cyanide vats in that year, while Sheahan had erected a ten head battery in 1910.

In the early 1930s several companies were working in the area. For example, John Grant and Son had a working option on Sheahan's, and were erecting equipment, later remodelled, in conjunction with Mandurama Gold Limited. By 1934 Sulphide Gold (Junction Reefs) Limited was dominant, and was erecting new plant at the Cornishmen's. In 1937 Mount Morgan Company became part-owners of Sulphide Gold, and the additional capital was devoted to extending the cyanide plant. However in April 1939 the plant closed as the ores were not payable. Mandurama Gold rebuilt their plant at the Junction Mine, but the venture did not continue.

The exploitation of the mines at Junction Reefs in the twentieth century illustates the interdependent relationship of the mining groups and companies. Working options were taken up, and mining by tribute occured. Ores were treated on neighbouring leases, and water power may have been leased.

By 1940 the major activity at Junction Reefs had ceased, to be followed by only intermittent minor workings in subsequent years.

7. The location and distribution of mining activity.

Site survey on the 24 and 25 March 1984 revealed the basic layout of the Junction Reefs goldmining area. The site may be divided up into several categories as follows:

1) mines and open-cut working, including adits and shafts
2) plant ruins, sites where ores was processed, and machinery constructed
3) energy sources, including dams, water-races, piping, etc.
4) communication routes, including ore shoots, etc.
5) settlement areas, sites of buildings and other facilities.

The identification, and the sketching of these categories onto plans revealed the layout of the site, and enabled a basic understanding of the workings to be obtained (figure 3).

7.1 Mines and open-cut workings.

Gold bearing ores are distributed on the north side of the Belubula River, between the Cornishmen's and the Frenchman's, and on the south bank of the River at the Junction. (For a more detailed geological description see appendix 1). The main mining activity took place in these three locations. Open-cut workings are first mentioned in the Annual Reports of the Department of Mines in 1912, and in general both the open-cuts at the Junction and the Cornishmen's are dated to the twentieth century. Mining of deeper gold bearing rock was undertaken with shafts and adits, etc., and these may be dated from 1870 onwards. These latter are visible at all three locations.

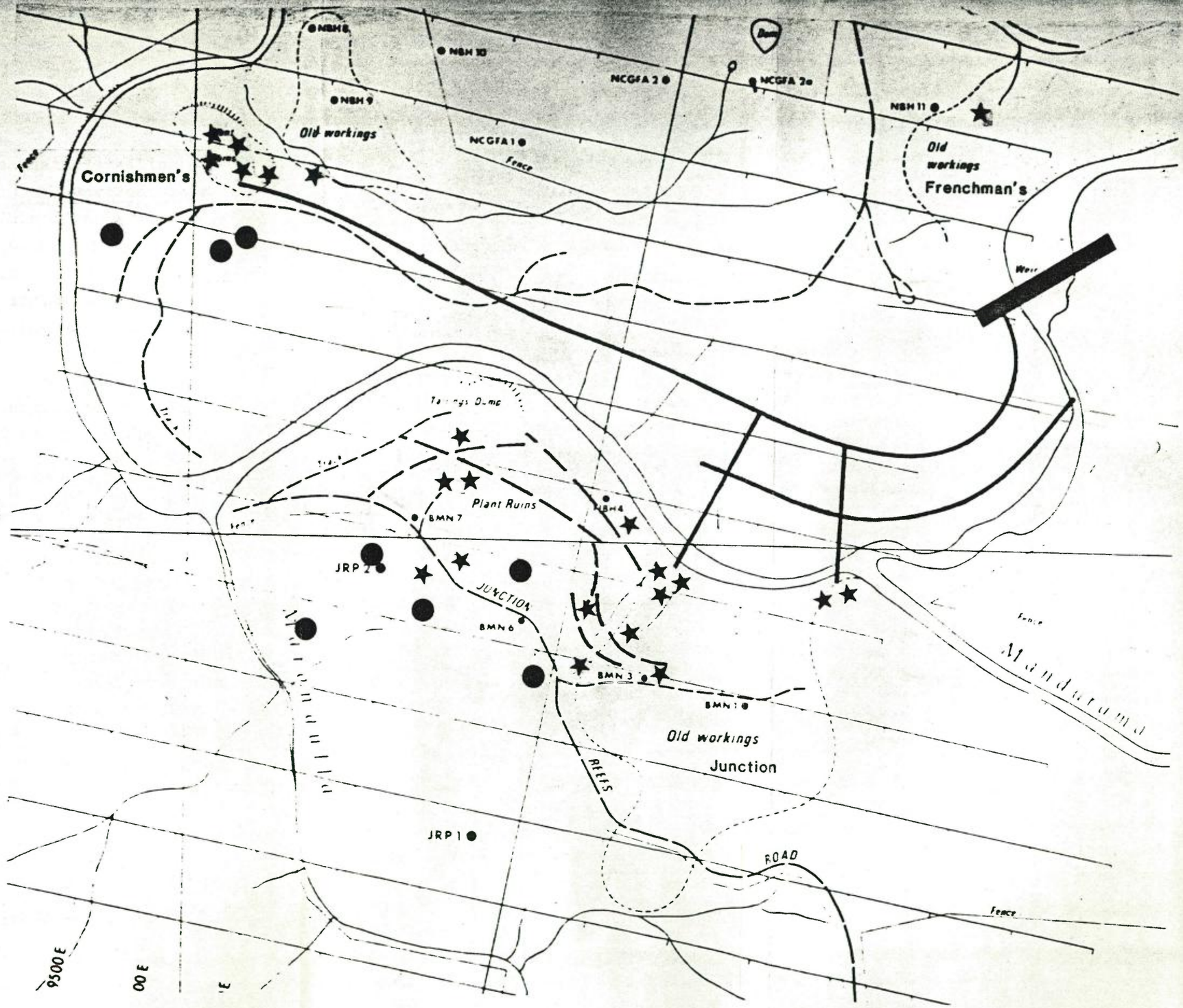


Figure 3. Sketch plan of the mining activity at Junction Reefs, indicating the three main mines (Junction, Frenchman's, Cornishmen's), the Belubula Dam (thick line), water-races and steel piping (medium line), plant ruins (stars), roadways (dashed line), mine workings (dashed outline), and sites of buildings (large dots) (1:5000).

7.2 Plant ruins.

Plant ruins, and the remains of ore processing (tailing dams, etc.) are visible in several areas at Junction Reefs, namely at Frenchman's, Cornishmen's, Mining Tenement (M.T.) 1, Mining Tenement (M.T.) 7, the Mining Tenement within Gold Lease (G.L.) 36, on the south bank of the Belubula at its junction with Mandurama Ponds, and also scattered on the hillside to the south and west of M.T.1 and 7. (Figures, 3, 4a, 4b).

There is evidence to suggest that substantial plant remains have been eroded away on the south bank of the Belubula River at M.T. 7 and nearby.

The processes and the date of each site will be discussed in sections 8.1 and 8.4

7.3 Energy sources.

Where steam power, or diesel engines or similar are employed as a power source, the location of these items is identical or incorporated within the plant ruin category. However water power, whether for water-wheels, or turbines (Pelton Wheels) generally leave remains of dams and water races or piping, delivering the energy to the plant. At Junction Reefs there are the substantial and important remains of the dam, still structurally sound[6], and also of the two water races, and piping leading towards the plantruins.

Both the dam, water-races, and piping are described below in section 8.3

7.4 Communication routes.

Several tracks, apart from the main roadway (unsealed) from Mandorama to Burnt Yards, crossing the Belubula River by a now broken causeway, were recorded. They give some

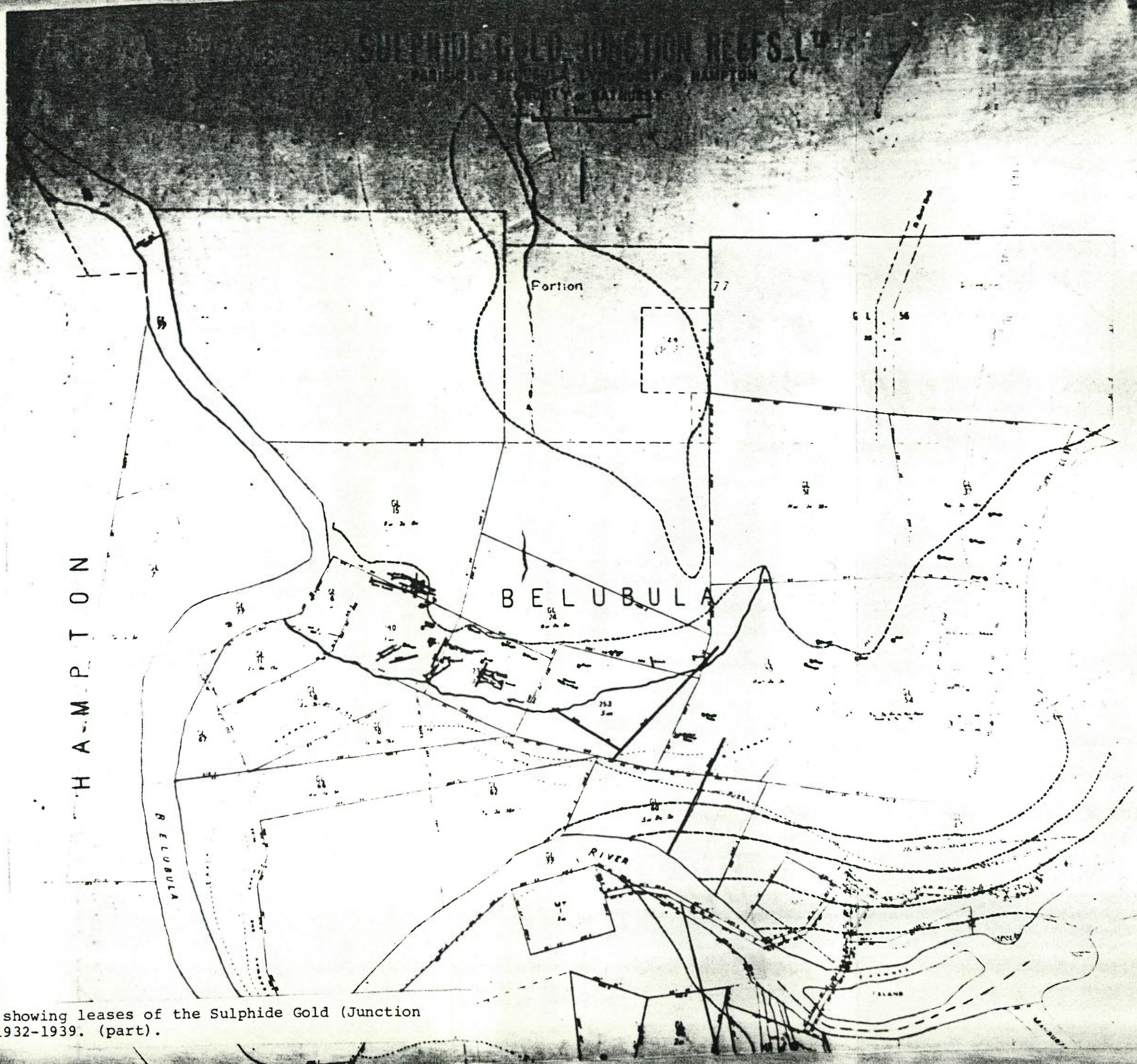


Figure 4a. Plan showing leases of the Sulphide Gold (Junction Reefs) Limtied, 1932-1939. (part).

indication of access and ore-processing, but their usefulness in this context is limited. M.T.1 was however linked to the upper workings at the Junction Mine, as well as to M.T.7. Of greater importance was the survival of an ore shoot leading to M.T.7 from below the open-cut at the Junction Mine. This will be described in section 8.4

7.5 Settlement areas.

Site survey located the remains of several domestic or similar buildings, near both the Junction and the Cornishmen's. These settlement areas undoubtedly housed the employees of the mines, and may have been small independent communities with shops, hotels, etc. In this preliminary survey the relevant documentary research has not been undertaken to obtain more details about these settlements. Most of these remains can be dated to the twentieth century, the period of extensive exploitation by large companies.

A similar settlement area may exist near the Frenchman's, but the site was not closely searched. One plan of the Sulphide Gold (Junction Reefs) Ltd does show an area set aside for residence (figure 4a).

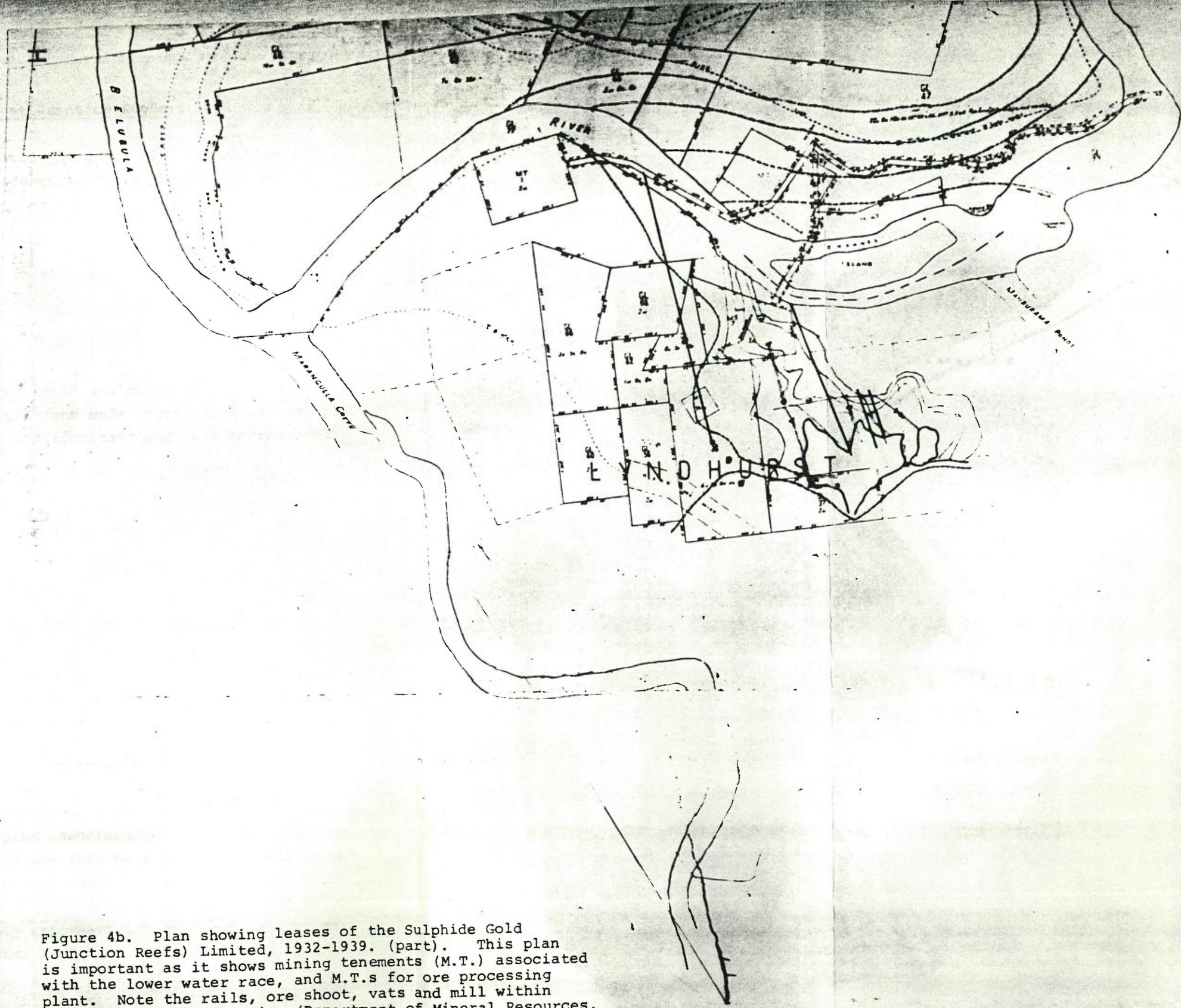


Figure 4b. Plan showing leases of the Sulphide Gold (Junction Reefs) Limited, 1932-1939. (part). This plan is important as it shows mining tenements (M.T.) associated with the lower water race, and M.T.s for ore processing plant. Note the rails, ore shoot, vats and mill within M.T.7 at the Junction Mine (Department of Mineral Resources, N.S.W. Drawing no. 93, frames 1 and 2 (originally P.W.D.)).

8. Goldmining technology at Junction Reefs[7].

The description and dating of goldmining technology and its representation at Junction Reefs may be divided up into several categories as follows:

1. the location and date of mining activities associated with the major companies
2. types of mining
3. energy sources
4. ore processing plant.

Both historical documentation and physical evidence will be discussed, and conclusions made about which aspects of goldmining technology are important and well represented at Junction Reefs.

8.1 The location and date of mining activities associated with the major companies.

The three companies working the gold deposits at Junction Reefs between 1870 and 1876 lent their names to the location of each mine, namely the Frenchman's, Cornishmen's, and the Junction (figures 2, and 3).

After this period the location of mining activities at both the Frenchman's and Cornishmen's remains well defined. However this is not the case with the plant associated with the exploitation of the Junction Mine.

Exploitation of the Frenchman's was never on a large scale. The water wheel and plant associated with the Sultan Goldmining Company in 1879 and 1880 have left no identifiable remains, and may be buried under the silts behind the dam. The shafts, adits, and remains of a roaster/smelter which survive today probably represent intermittent activities from the 1930s onwards.

In 1879 and 1880 the Annual Reports of the Department of Mines mention the use of a water wheel at the Cornishmen's.

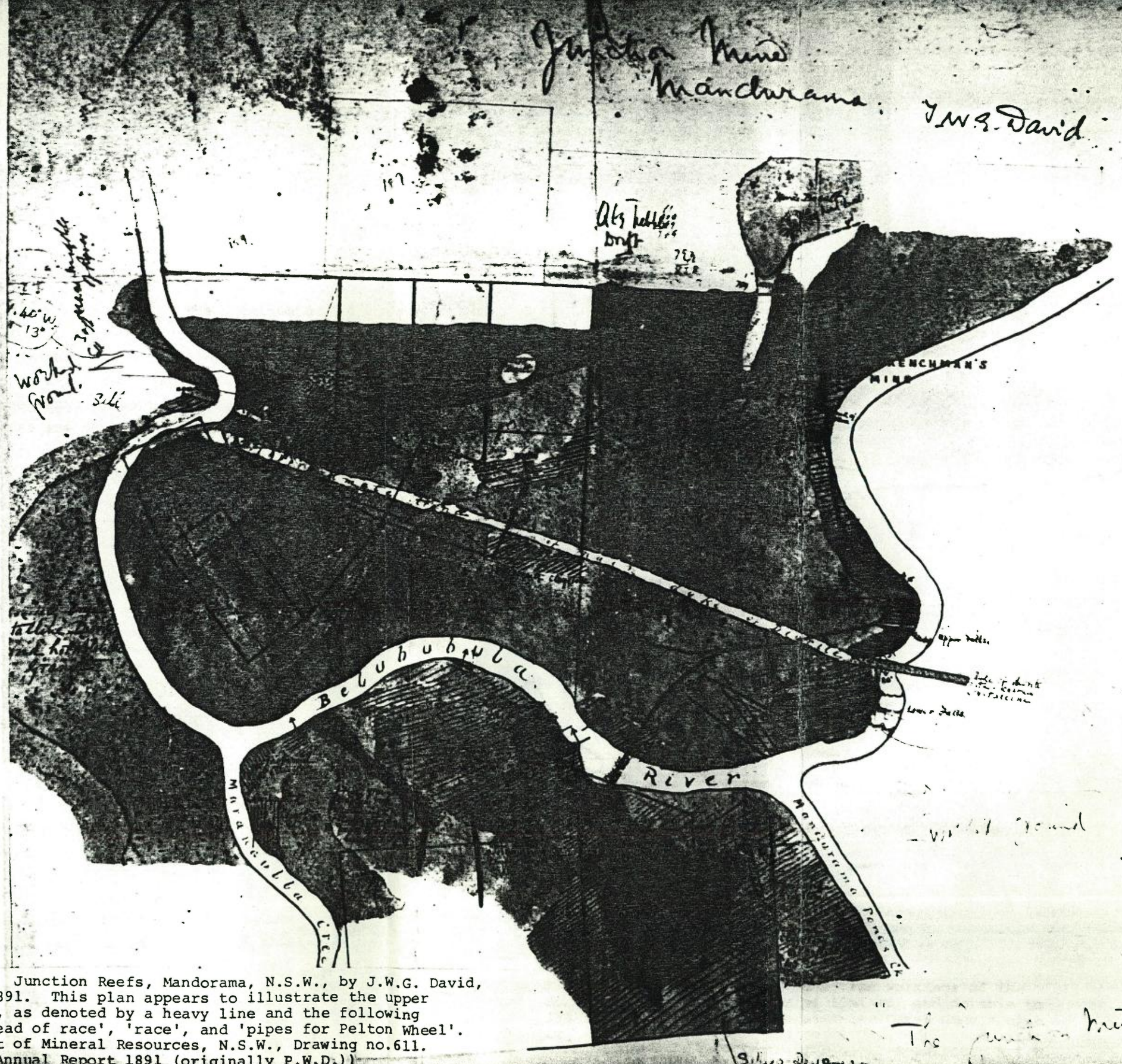


Figure 5. Junction Reefs, Mandorama, N.S.W., by J.W.G. David, probably 1891. This plan appears to illustrate the upper water race, as denoted by a heavy line and the following notes: 'head of race', 'race', and 'pipes for Pelton Wheel'. (Department of Mineral Resources, N.S.W., Drawing no.611. Frame 1. Annual Report 1891 (originally P.W.D.))

Again no trace survives today, except perhaps for the water race and a hint in the documentation for the location of the wheel and machinery. The water race from the dam to the Cornishmen's may pre-date the construction of the dam (see figure 5). The location of the water wheel tunnel on plans of the Cornishmen's (figures 4a, and 6) may indicate the location of this water wheel in the gully.

The location of any attempts to use water power at the Junction Mine in the 1880s is uncertain. The location of Mining Tenements (M.T.) 3,5, and 6, delineating the lower of the two water races from the Belubula River give some indication of the alternatives, either M.T.1 or M.T.7 (figure 4b). In 1882 the Annual Reports locate the workings as follows: 'These [reefs] are situated on the face of a very steep hill, and the crushing plant worked by a turbine water wheel, is on the bank of the river immediately at the foot of the hill'. This reference is ambiguous, but in 1886 Binsted and Co. moved the crushing plant 400 yards towards the falls, so that water-power could be used to drive a turbine. This would appear to indicate that prior to 1886 the crushing plant was located at M.T.1, and after that date at M.T. 7.

The further use of M.T.1 in the nineteenth and twentieth centuries is uncertain. The remains are confined to tailing dams, mullock heaps, and plant ruins (including stumps or wooden posts, and concrete pillars or beds for equipment). Scattered over the neighbouring hillside various concrete bases for equipment are located at two sites, with adjoining communication routes. These two sites appear to be for identical equipment.

The formation in 1895 of the Lyndhurst Gold Fields Co. Ltd. saw the construction of the Belubula Dam by 1897 and of new crushing and processing plant by 1899. Until that year the crushing plant had remained at M.T.7, but this

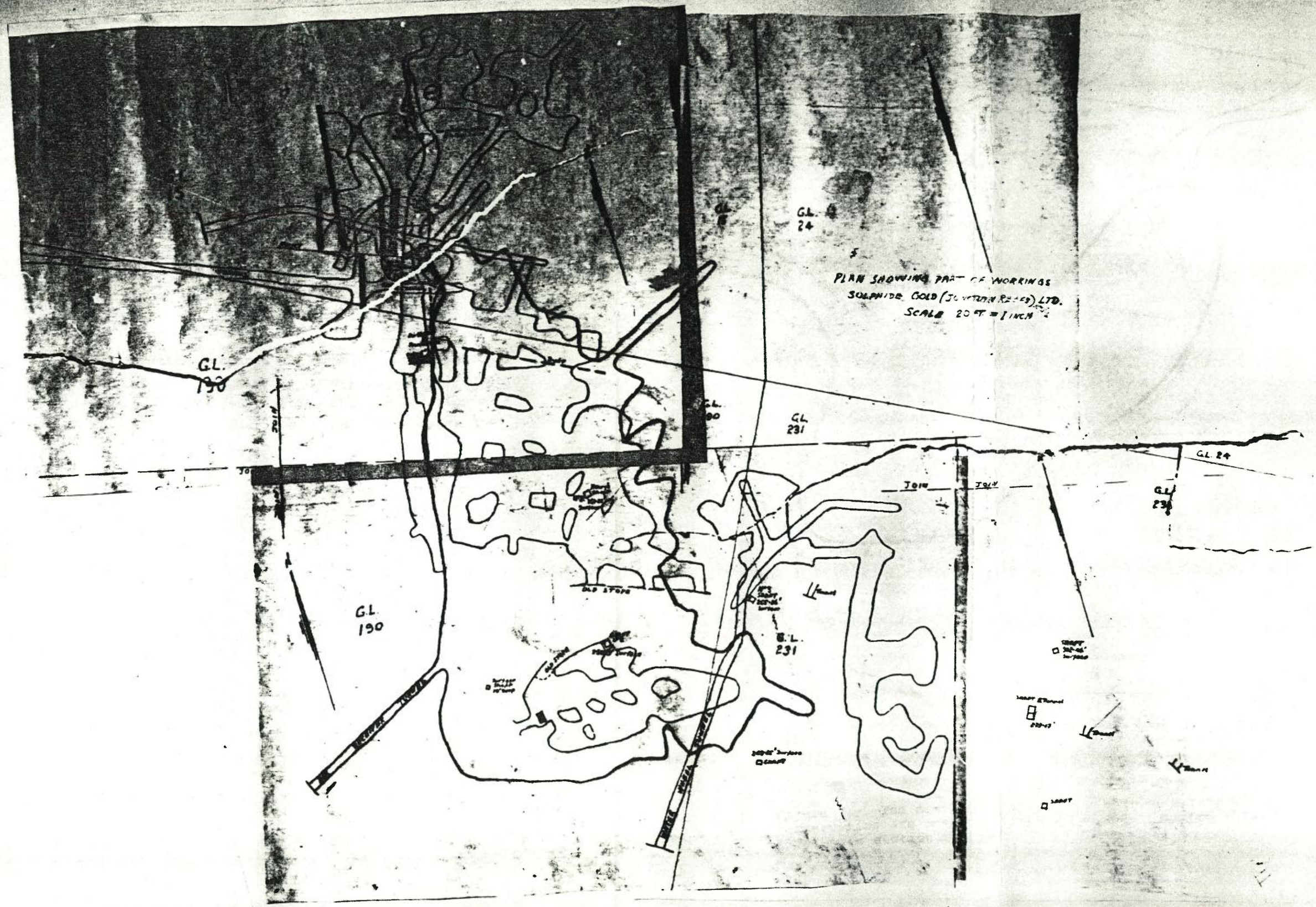


Figure 6. Plan showing part of the workings of the Sulphide Gold (Junction Reefs) Limited, and datable to 1932-1939. The plan illustrates the Cornishmen's mine or Sulphide Mine. Note air receiver tunnel, and water wheel tunnel. (Department of Mineral Resources, N.S.W., Drawing no. 3220, frame 2. Mine Record 765 (formerly P.W.D.)

site was found to be cramped, and additions therefore very expensive. The decision was made to erect the new plant at the Cornishmen's.

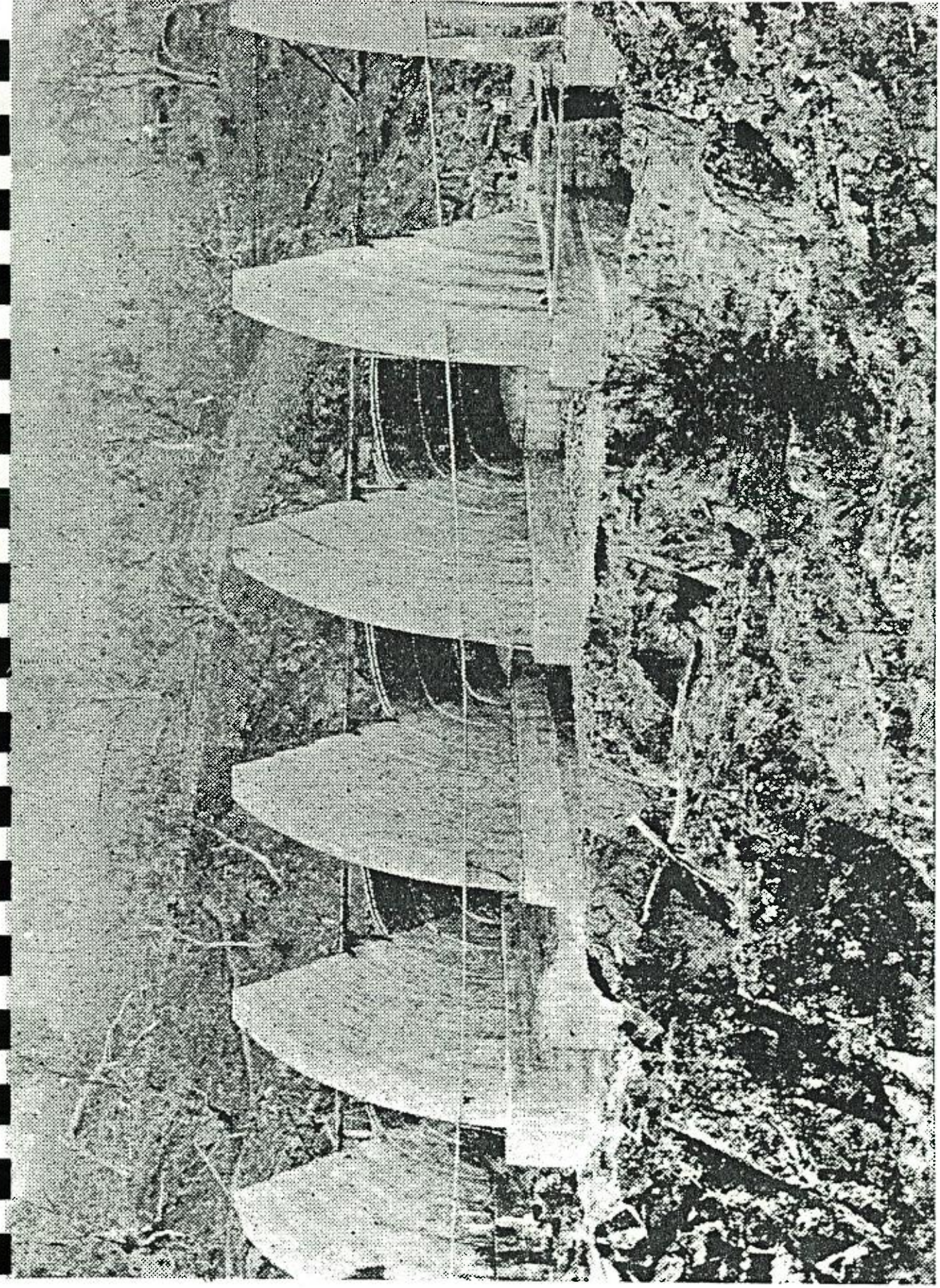
The Cornishmen's, also known as the Belubula, remained the centre for ore processing for the Lyndhurst Railway and Mines Company, and was connected to the Belubula Dam with water pipes. This mine was also the location of the treatment plant for the Sulphide Gold (Junction Reefs) Company, and thus was almost continuously occupied from 1895 to 1939 as the centre for ore processing at Junction Reefs.

The date for the continued use of M.T.7 and neighbouring plant at the Junction Mine is uncertain. M.T.7 appears to have been first used in 1886, but the location of the remaining plant in the area certainly post-dates the construction of the dam in 1897. Huntington Mills are first mentioned in 1905, although they may not have survived in their original location. The present remains in the area of M.T.7, at the junction of the Belubula River with Mandurame Ponds, and in M.L.36 (figure 4b) are most likely to date from 1905 to 1939.

8.2 Types of mining.

The techniques of mining for gold at Junction Reefs have already been briefly described in section 7.1.

Little physical evidence survives of ore extraction machinery, although there are several references from documentary sources. The Lyndhurst Railway and Mine Company were using at least 3 Rand rock drills, and a Blake pump, in addition to air compressors and receivers, at both the Junction and Cornishmen's Mine[8]. In 1937 the Sulphide Gold (Junction Reefs) Company were using jack-hammers and poppers in the mines, and a steam shovel in the open-cut at the Junction. At the Cornishmen's or Sulphide Mine the same company was using an Ingersol Rand



Belubula Dam during Construction.

Downstream View.

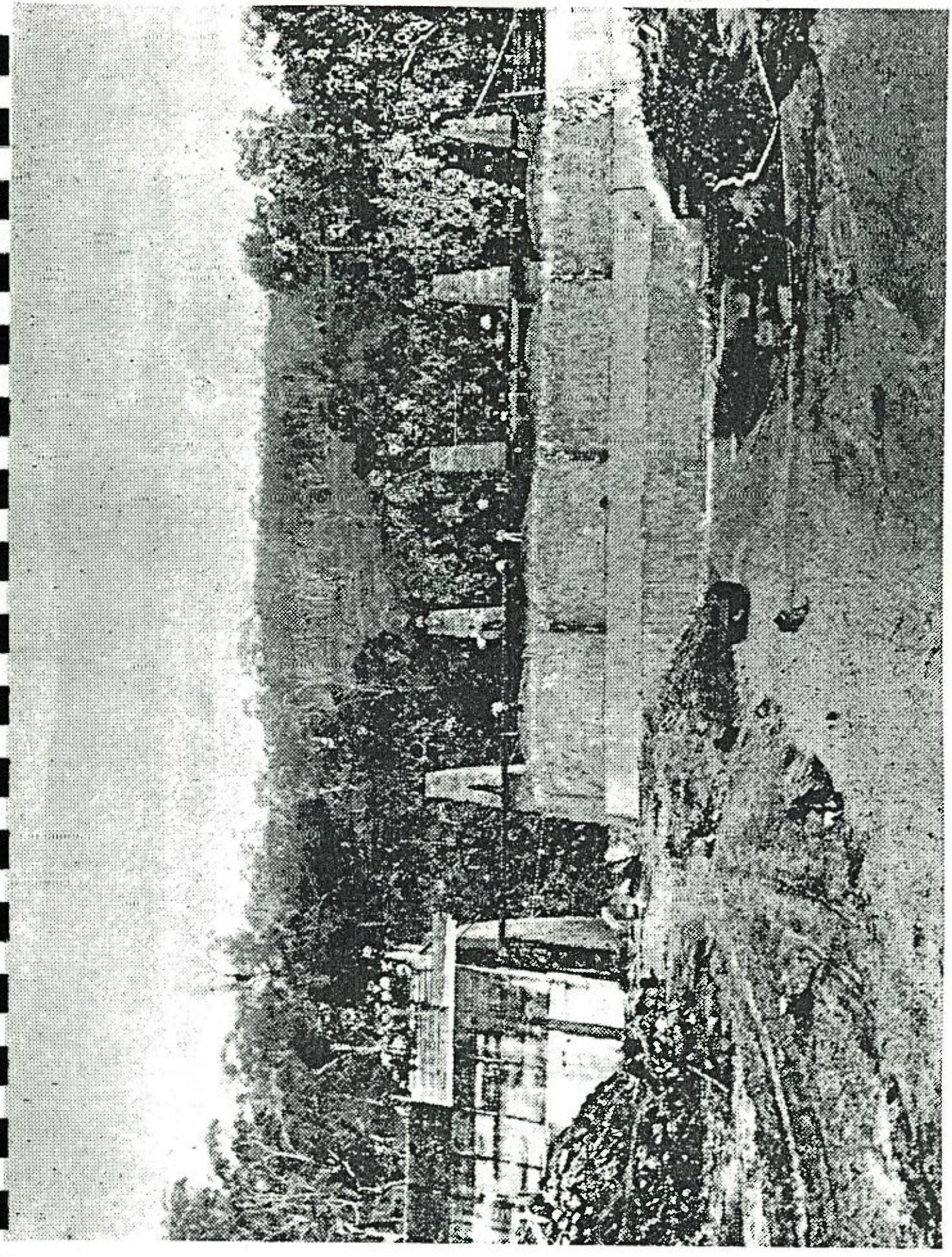
Inventory: item 3. Belubula Dam. This photograph of the dam under construction is taken from O.Schulze, 1897 (Geological and Mining Museum, SI (55-8, Bathurst, no. 1376).

air compressor and five rock drills (see figure 6 for the air receiver tunnel). The type of ore extraction equipment, and the mining techniques at Junction Reefs were widespread and in general use. The ore extraction equipment has not survived, and all that remains are the shafts, adits and open-cuts.

8.3 Energy sources.

A variety of energy sources were employed at Junction Reefs. Their development in the nineteenth and twentieth centuries mirrors similar processes on other gold fields. Of special importance to the Junction Reefs goldfield was the construction of a brick and concrete arched dam in 1895, which was claimed to be the first of its type in Australia[9]. The dam is associated with extensive piping which allowed water under high pressure to drive water turbines (Pelton Wheels) at three locations, one at the Cornishmen's, and two at the Junction Mine. At least one of these turbines (Pelton Wheels) survives at the Junction, driving a small electrical generator (British Thompson Houston, Derby, England). Another turbine may survive at the Junction but is at present obscured by vegetation.

The construction of the dam may be best described in the words of O.Schulze, engineer and designer[10]:



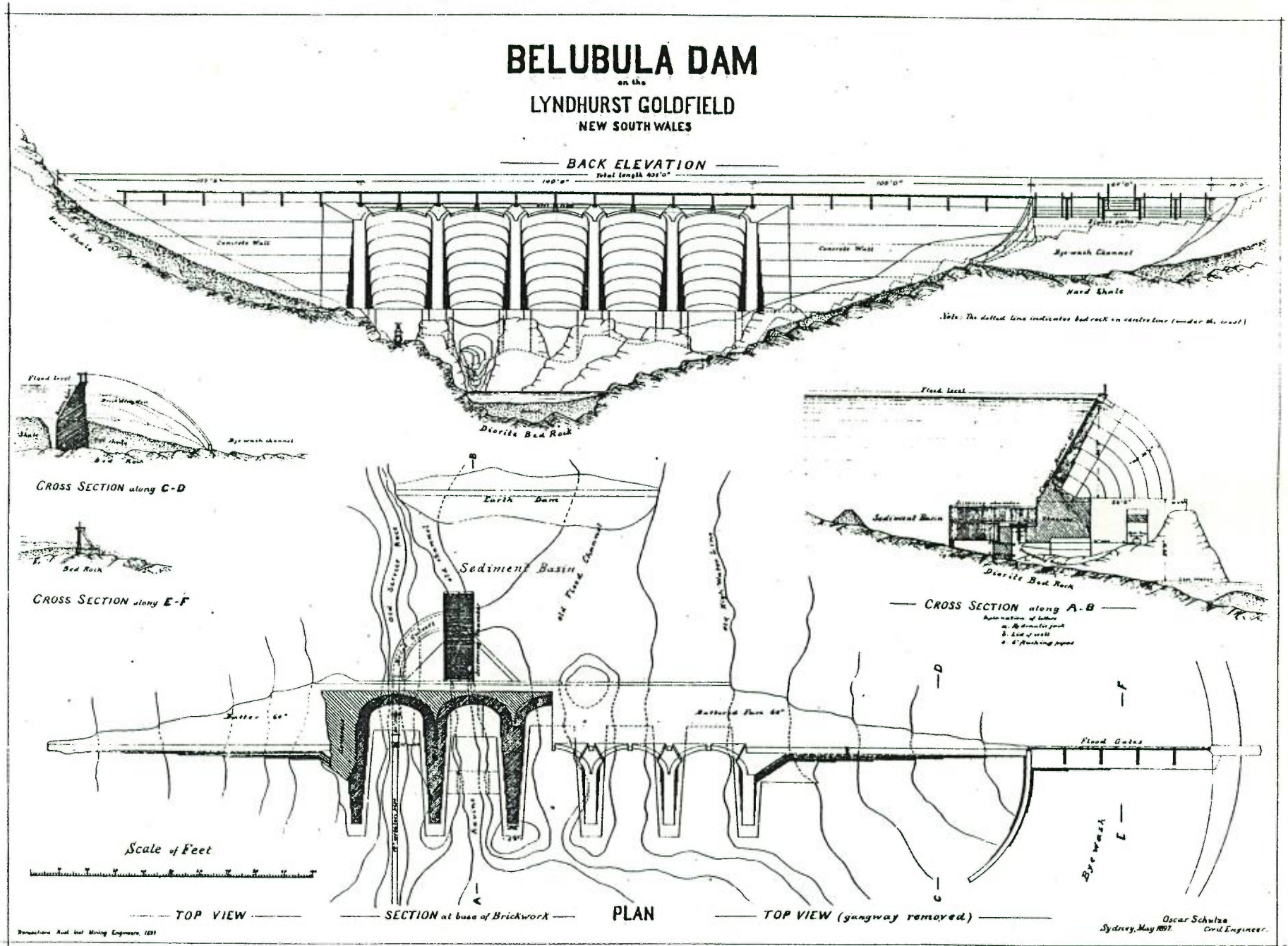
Upstream View.

Inventory: item 3. Belubula Dam. General view, completed, and full of water. (O.Schulze, 1897: Geological and Mining Museum, SI/55-8, Bathurst, no. 1377).

This dam has been built across the Belubula River, about half a mile above the old battery of the Junction Mine, now belonging to the Lyndhurst Company. Several waterfalls occur between the battery and dam, aggregating 150 feet in height. The dam is built in a narrow gorge, through which the river falls another 25 feet, and above which the valley widens out, the river flowing almost level through same for a considerable distance. The intention of the Company is the construction of a reservoir which will store up enough water to supply continuous working power to the battery during the driest seasons, which could be accomplished by building a dam 45 feet in height above the level of the old water-race. The particular site was chosen on account of the apparent good rock formation visible right across the gorge, and the foundation was laid into and across this bed-rock of solid diorite. Several perpendicular rock elevations running parallel with the water were made use of as foundations for buttresses, built to strengthen the main wall, which thereby could be reduced in thickness. The foundations of the main wall and buttresses are carried up in concrete masonry to 12 feet above the water-race, or 10 feet above the outlet pipe, the front wall at this level being about 180 feet long and 14 feet wide, increasing in thickness downwards. The buttresses are six in number, 28 feet apart from centre to centre, each 40 feet long, 12 feet wide on top where they abut the inner wall, and narrowing to 6 feet wide at the outer end, thickening downwards, but carried up to the same level as the concrete formation of the main wall. The height of the foundation varies in accordance with the rugged nature of the bottom (bed-rock) from 1 to 30 feet. On the top of these foundations the buttresses are built up on brick masonry tapering from 8 to 4 feet thick, these are united by brick arches of eliptical shape, which decrease in thickness upwards from 4 to 2 feet, and are built at an inclination of 1 in 2, the spandrils between these arches are faced up flush, with concrete, thus on the water side forming a uniform face 36 feet high, with a batter of 1 in 2. On both sides of the central portion of the dam the ground rises and the wall is continued about 100 feet up and into the hill sides to firm rock faces, and concrete masonry with the same batter continued on the water side, but vertical at the back, the width on top being 2 feet. The whole length of the dam measures thus 340 feet, and shows a straight uniformly battered cemented face on the water side while the back is ribbed and shows five chambers under the overhanging arches between the huge buttresses. A bye-wash is constructed in the extension of the dam on the east side 65 feet wide, divided into five sluice openings with a wing wall built on the rock to lead the water clear of the dam. Allowance is also made for occasional extreme flood waters to run over the dam between the buttresses. The race which was left open during construction being arched over will serve permanently as an emergency outlet for which purpose a projection was built out from the main wall with a 5 feet well in it through which the reservoir can be emptied into the gorge. This well is usually closed by a wooden lid 12 inches in thickness, which can be raised by means of a hydraulic ram of 50 tons power, worked by a pump placed at the back of the wall. The service outlet is carried through the main wall by 24-inch cast-iron pipes the entrance of which being formed by a tapering and rising brick culvert, the vertical opening of which together with that of the emergency outlet and of two 6-inch flushing pipes are enclosed by a wooden grating built in the shape of a steep roof and surrounded by a sediment pit. The dam contains in its construction about 6,000 yards of concrete and 500,000 bricks, together with which 5,000 casks of Henmoor cement were used.

The water in the river will be backed up for a length of 1¼ mile and about 500,000,000 of gallons of water will be impounded, which with the fall of 225 feet made available by a conduit of 18-inch welded steel pipes will supply 200 h.p. for a term of three months, even if the river should stop running, which seldom, if ever, happens.

Water from the dam was used from 1897 onwards to drive equipment at both the Cornishmen's and the Junction. The dam had silted up by 1937, but it is not clear whether it was still able to function at a reduced capacity.



Inventory: item 3. Belubula Dam. Plan, elevation, and sections. O.Schulze, 1897. (Geological and Mining Museum, SI/55-8, Bathurst, no. 1378).

It follows that the importance of the dam also reflects upon the remaining network of piping, and equipment that it powered. The survival of at least one turbine (Pelton Wheel), coupled to an electrical generator is unusal in a situation where machinery was frequently dispersed or scrapped after use.

The following is a note on the construction and history of the Pelton Wheel[11].

> A new type of turbine, whose invention was due to sheer chance, was the Pelton wheel. During the gold rush in California in the 1860s, the most common method of washing for gold was to flush the sand and gravel away with a jet of water under very high pressure. The water was usually led in pipes or hoses to the site from reservoirs higher up the river. About 1870, when the gold ran out, this piped water was often used to drive water-wheels. A mining engineer, Lester A. Pelton (1829–1908), who worked in these parts, had built a water-wheel with curved blades. One day, the water jet happened to strike the outer edges of the blades, and the speed of the wheel increased so much that it flew into pieces.
>
> This intrigued Pelton. After long consideration, he realized that the power of the jet was best exploited when its direction was completely reversed by the blade. He changed the blade design to incorporate two buckets, whose edges were joined to form the middle of the blade. This split the jet of water in two, and the shape of the buckets caused both jets to reverse direction. One or more nozzles could be used to supply water to the wheel, which became known as the Pelton wheel or the jet-splitting double-bucket turbine. This type of turbine is especially suitable for large heads of water with a moderate or low rate of flow. Manufacture of the Pelton wheel began on an industrial scale in the 1880s.

The remains of other forms of motive power have left no substantial remains at Junction Reefs. The concrete beds for equipment at the Junction testify to the use of various types of motors, and similar remains are present at the Cornishmen's. The presence of part of a large boiler at the latter mine is most likely dated to the early twentieth century when steam power was used for driving a winch[12].

Inventory: items 27 and 28. Pelton Wheel and generator, 1974. (Geological and Mining Museum, SI/55-8, Bathurst no. 626).

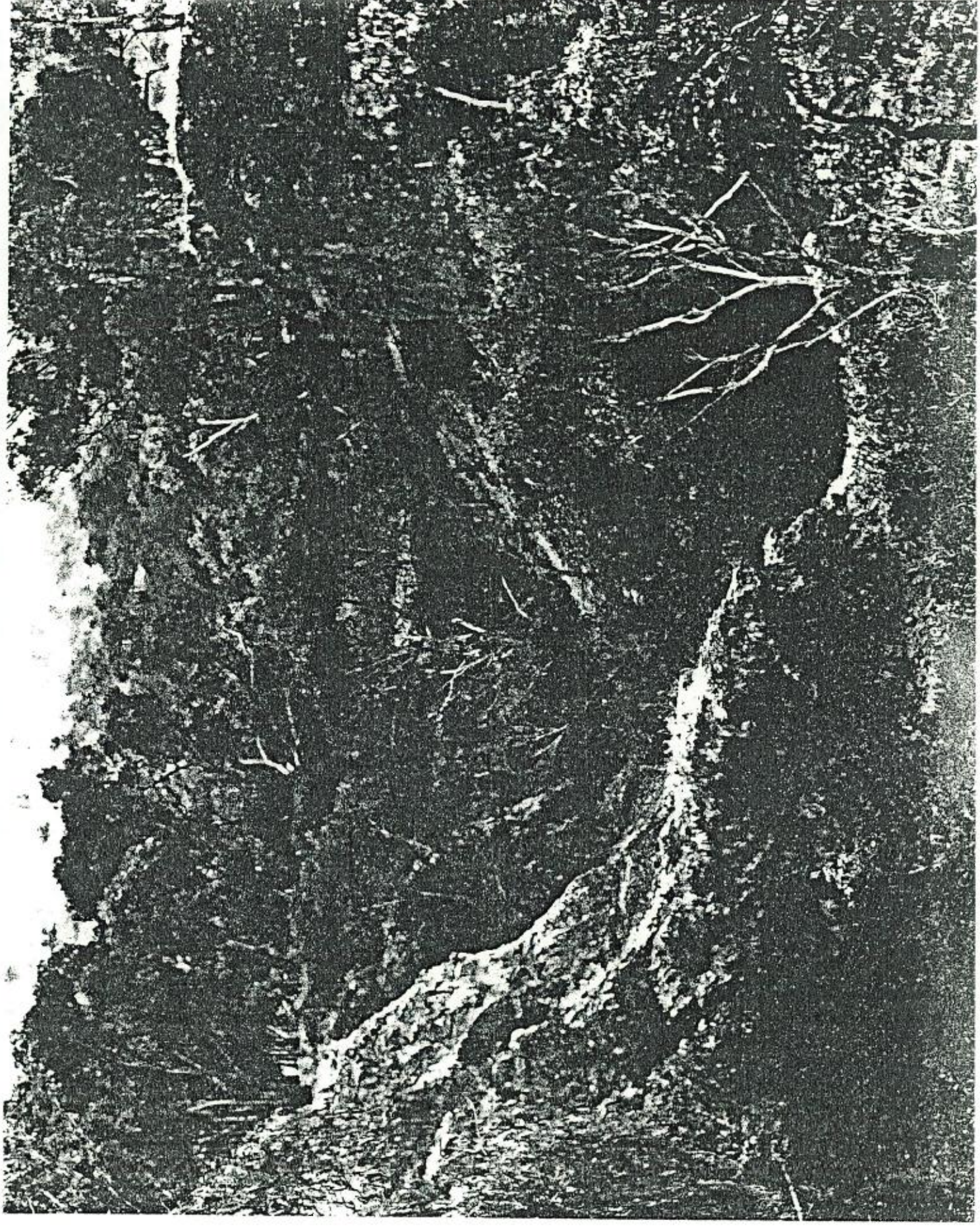
8.4 Ore processing plant.

Before describing the variety of ore processes used at Junction Reefs, a brief note follows on the means by which ore was transported from the mines or open cuts to the plant. Little evidence survives apart from the roadways terraced into the hillside at both the Junction and the Cornishmen's. At the latter the remains of a trestle bridge from the adit to the plant lie scattered in a gully. At the Junction a small tramway survives at the entrance to one adit, but its course has been destroyed by recent prospecting activity. From documentary evidence (figure 4b) the tramway led to an ore shoot, which conveyed the ore directly to a Huntington Mill. The shoot, constructed of steel piping (originally used for water-power), and the Huntington mill survive intact.

Various ore-processing techniques were used at Junction Reefs in the nineteenth centruy. The ores were crushed in stamper batteries, and amalgamated with mercury. Difficulties were soon apparent, and much of the fine gold was lost in treatment. Several attempts were made to remedy this problem, which was vital especially when low grade ores were being treated. There is some suggestion that chlorination was employed towards the turn of the century.

In the twentieth century the cyanide process became dominant. The Cornishmen's has substantial remains of this process associated with the activities of the Lyndhurst Railway and Mines Company, and the Sulphide Gold (Junction Reefs) Company. Cyanide vats also remain at M.T. 7 at the Junction, while M.T.1 has a terraced layout and tailings dams, similar to the Cornishmen's.

The most common procedure in use in the twentieth century (by the Lyndhurst Railway and Mines Company) was as follows:



Inventory: item 31. Open-cut mine, Junction Mine, 1974.
(Geological and Mining Museum, SI/55-8, Bathurst no.623)

(wet) crushing of the ores in a battery, followed by amalgamation, or by roasting in an Edward's furnace and then cyanidation. In 1904-1905 the Lyndhurst Company made an attempt to smelt the gold ores with copper ores, and although this was successful the company could not raise the necessary finance to develop this process. Also in 1905 the first Huntington Mills were introduced at the Junction Mine: two are recorded in use c.1905[13]. The Huntington Mill replaced the stamper battery, and progressively in the twentieth century more sophisticated crushing equipment was used. A description of the power plant and mill at the Cornishmen's or Sulphide Mine will suffice to illustrate the developments by 1937:

> A new power plant and treatment mill has been erected at this mine. These units were placed in commission early in November of last year.
>
> *The Power Plant.*—A 400-h.p. 4-cycle 8-cylinder Crossley Diesel engine of the solid injection type was installed. This engine operates an A.C. dynamo which generates current at 415 volts. Motors have been installed throughout the mill. A 104-h.p. two-cylinder Ruston Hornsby Diesel engine, also of the solid injection type, is employed to operate an Ingersol Rand air compressor of 300 cubic feet of free air per minute capacity. The air is required to operate five rock drills in breaking ore supplies.
>
> *The Mill.*—The mill is working three shifts per day and is designed for the treatment of 100 tons of crude ore per twenty four hours. The ore is delivered from the mine to a 20-inch by 10-inch jaw breaker, and is broken to approximately 3 inches. It is then transferred by means of a belt conveyor to a No. 3 Jacques crusher and reduced to 1½ inches. The crushed ore then passes to a set of rolls 32 inches by 18 inches, and is reduced to ¼ inch in size. A tube mill 5 feet by 9 feet is in closed circuit with two classifiers and a set of corduroy strakes. The strakes recover from 40 to 50 per cent. of the gold. The concentrate is amalgamated in a barrel, the residues from which are shipped to smelter. The overflow from the classifiers is delivered to a 30-feet Dorr thickener for dewatering. The underflow is passed, by means of a Dorr pump, to a disc filter, which removes 95 per cent. of the grinding solution. The solids are then repulped in a Vortex mixer, where cyanide and lime are added preparatory to precipitation, the Merrill Crowe process being used. The plant is not yet working to full capacity. The ore being treated is a mixture of sulphides and oxidised material, the latter obtained from an open cut in Sheehan's workings. Because of the lack of uniformity in ore supplies, mill technique has not yet reached standardisation, recoveries are low and consumption of cyanide and lime is somewhat irregular. The crudes average 5.5 dwts. of gold per ton and an 80 per cent. recovery is hoped for.

Since it was usual that machinery was dispersed or scrapped when it was no longer used, the survival of such plant is important. Furthermore this process acted against

Inventory: item 32. Tramway at adit entrance, 1974.
(Geological and Mining Museum, SI/55-8, Bathurst, no. 629).

the continued existence of machinery associated with superceded technology: there is a tendency for only the most recent plant to survive.

The following is a brief list of some of the surviving, and identifiable machinery:

At the Cornishmen's claim:

site of water wheel ?
site of stamper battery
cyanide plant, including vats, and some machinery
Dorr thickener
remains of smelting furnace.

At M.T.7, Junction Mine:

an almost complete Huntington Mill
ore shoot
other equipment covered by thick vegetation
steel piping associated with Pelton Wheel
Cyanide vats.

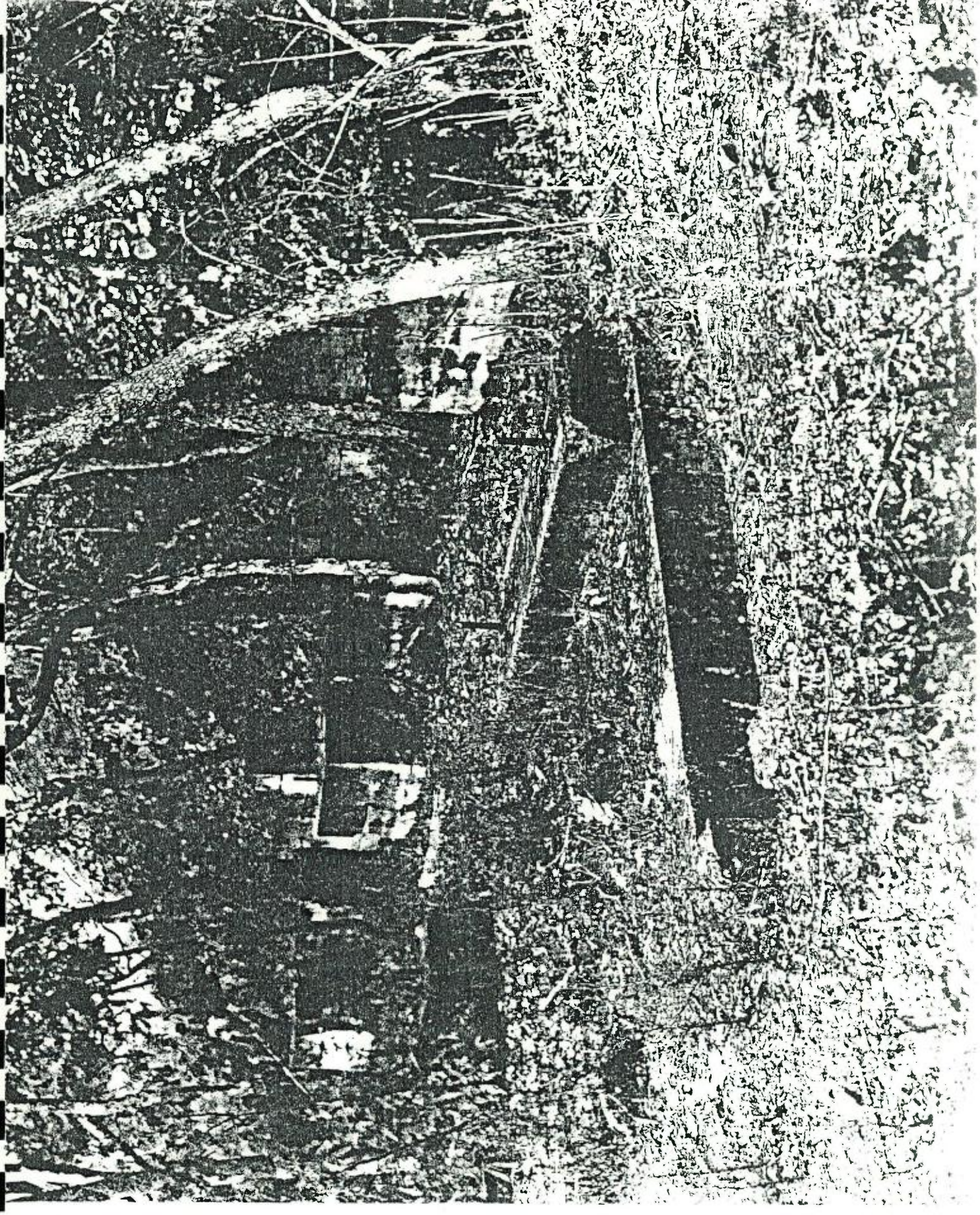
This site is subject to erosion, and part of the plant may have been lost.

At the junction of the Belubula River and the Mandorama Ponds:

Pelton Wheel in situ.
British Thompson Houston generator in situ.
concrete machine beds
steel piping for water power in situ.

At the Mining Tenement (M.T.) with Gold Lease (G.L.) 36 (figure 4b):

base of a Huntington Mill.



Inventory: item 33. Machine beds, 1974. (Geological and Mining Museum, SI/55-8, Bathurst, no.611).

9. Statement of significance.

This section is based upon the archaeological and historical evidence discussed in sections 6 to 8, and indicates the importance or significance of Junction Reefs or parts of the whole site, in terms of archaeological, historical, or technological context.

The whole site of Junction Reefs is significant because:

- it illustrates the development, common to many gold fields, of larger companies and groups with sufficient capital to mine low grade or inaccessible auriferous ores.

- it illustrates the development, common to other gold fields, of more sophisticated gold saving processes and treatment.

- it illustrates the development, common to other gold fields, of more economic sources of power, from steam, through water-wheel, water-turbine (Pelton Wheel), to diesel and electric motors.

- the layout of the whole area is well preserved including the mines and open-cut workings, plant ruins, energy sources, communication routes, and settlement areas.

The Belubula Dam, and associated water races, steel piping and machinery are significant because:

- the dam was the first of its kind constructed in Australia.

- the dam represents a large capital investment, and is a massive structure, unusual in terms of the gold extraction industry.

- the dam and its associated machinery represent an early attempt to generate electricity by water power (hydro-electric power).

- the dam survives in good condition.

- the steel piping, Pelton Wheel, and electrical generator survive in situ.

- the piping and water-races indicate the plant that was associated with the dam, and powered by high water pressure.

The plant at the junction of the Belubula River and Mandorama Ponds is significant because:

- the steel piping, Pelton Wheel, electrical generator, and machine beds survive in situ.

- the machinery represents an early attempt to generate electricity by water power (hydro-electric power).

Mining Tenement (M.T.) 7, at the Junction Mine is significant because:

- substantial remains survive of ore processing machinery, dating back to c. 1905.

- the machinery is associated with steel piping delivering water power from the Belubula Dam.

- a Huntington Mill, brought in c.1905, survives almost complete and in situ, with attached gearing and associated equipment.

- Other machinery survives but is obscured by vegetation. The machinery may include a Pelton Wheel, powered by high pressure water delivered in steel pipes from the Belubula Dam.

. the ore shoot survives constructed of steel piping, which delivered the ore from the mine to the plant.

The Mining Tenement within Gold Lease 36 (figure 4b) is significant because:

. it contains the base of a Huntington Mill, although probably not in situ.

The Frenchmen's Mine is significant because:

. a small smelter or roaster with a flue constructed of steel piping survives almost complete, illustrating individual skill or bushcraft in the improvisation of materials.

The Cornishmen's Mine is significant because:

. substantial remains of machinery associated with the cyanide process survive.

. the plant ruins are associated with the water race and steel piping which brought water power from the Belubula Dam.

. remains of a smelter survive.

. the site of the large stamper battery survives.

. the remains of a Dorr thickener, used in the cyanide process, are well preserved.

10. Recommendations.

On the basis of the statement of significance various conclusions or recommendations can be made.

These recommendations refer only to the area of the site survey, as designated by Petroleum Securities in figure 2.

The statement of significance was compiled only in terms of archaeological, historical and technological significance, and makes no comment on the scenic beauty of the area or its suitability for public recreation.

It is suggested that some of the archaeological remains of mining activity at Junctions Reefs are not important or significant enough to warrant their conservation in preference to further mineral extraction. Such remains might include open-cuts and adits, communication routes, sites of buildings, and some plant ruins.

It is suggested that approval could be given for future mineral extraction provided that the more important remains are not disturbed, and that measures are taken to reduce the opportunities for vandalism or souvenir hunters at those sites where substantial remains of machinery survive.

The most important remains of mining activity at Junction Reefs include the following:

- the plant ruins, including ore shoot with M.T.7.
- Pelton Wheel and electric generator at the junction of the Belubula River and Mandurama Ponds.
- the plant ruins and tailing dams at the Cornishmen's Mine (Lyndhurst Railway and Mines Limited, Sulphide Gold Limited).

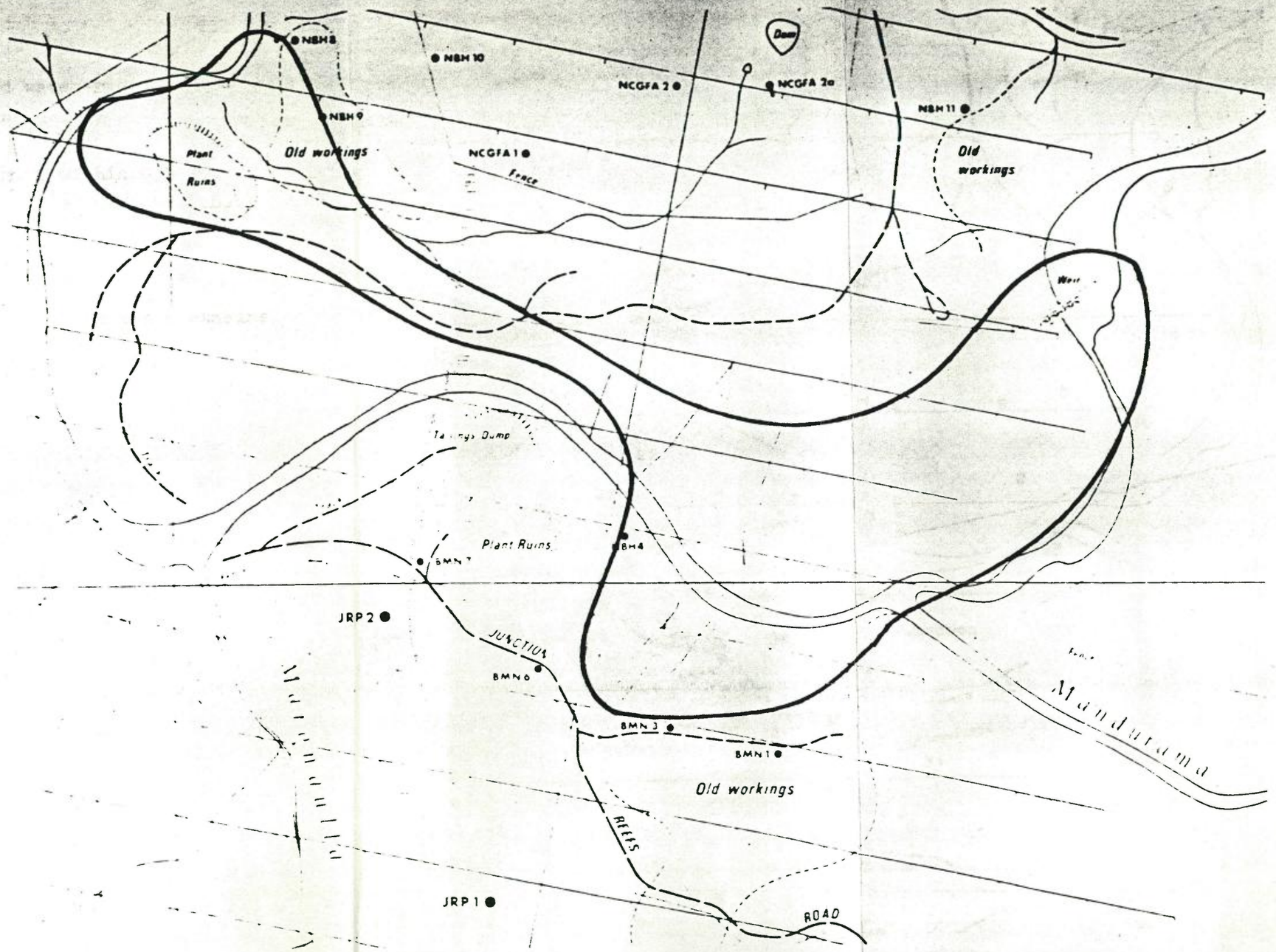


Figure 7. The most improtant mining remains worthy of conservation are contained within the area outlined (heavy line) (see section 10).

. the Belubula Dam, and associated water-races, steel piping, and other equipment.

. base of Huntington Mill on the M.T. within G.L.36 (figure 4b). In this instance it is suggested that the removal of this item for safe keeing could allow future mineral extraction on this M.T.

Figure 7 outlines the area which includes the above remains.

Acknowledgements.

The author would like to acknowledge the assistance of Ned Overton (Petroleum Securities), Dr Dale Thompson, Peggy Mashman, A. Bashford (Department of Mineral Resources, N.S.W.), Helen Temple, and Chris Betteridge (Department of Environment and Planning, N.S.W.)

Notes.

1. The National Trust of Australia (NSW). 1982. Register, p211.

2. Unless otherwise stated all the references in this section are derived from the Annual Reports of the Department of Mines, NSW.

3. Parish of Lyndhurst, County of Bathurst. Parish map indicates that the area was reserved for mining purposes on 15 June 1870.

4. Carpenter, C.W. 1897. The Mines of New South Wales, 44f.

5. Apart from Annual Reports see Mining Records 79, and 80, Department of Mineral Resources, N.S.W.

6. Crisp, C. 1979.

7. Refer to note 2.

8. Mine Record 79, Department of Mineral Resources, N.S.W.

9. Schulze,O. 1897, p.168.

10. Mines, Department of N.S.W. 1897. Annual Report, 81f.

11. Strandh, S. 1979. A History of the Machine. New York, p.106f.

12. Mine Record, No. 79, Department of Mineral Resources, N.S.W.

13. Mine Record, No. 80, Department of Mineral Resources, N.S.W.

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Crisp. C. 1979. Report on Junction Reefs dam. Consulting Engineers.

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Maps.

Central Mapping Authority of NSW. Blayney 8730-I and IV, Canowindra, 8630 - I and IV, both 1:50,000, topographic.

Parish maps: Belubula, and Lyndhurst, County of Bathurst.

Photographs.

Geological and Mining Museum, Sydney. Collection of photographs.

Appendix 1. Geological description of the auriferous deposits at Junction Reefs, N.S.W.

The auriferous ore deposits at Junction Reefs are found in a series of near horizontal beds on either side of the Belubula River. Sulphide and oxide ores were extracted in the nineteenth and early twentieth century.

Various sources may be consulted for a detailed geological description of the gold bearing deposits at Junction Reefs. Examples are given below.

Mineral Resources, Department of N.S.W. Mine Records, 79, 80.

Paterson, I.B.L., and Bowman, H.N. 1977. 15-17.

Wilson, G.I. 1970. 420-422.

JUNCTION REEF (LYNDHURST) GOLDFIELD
production table
(No figures available for years not quoted)

Year	Ore Raised (tons)	Gold (oz)	value (£)	Year	Ore raised (tons)	Gold (oz)	Value (£)
1886	260	86	----	1917	2557	72[illegible]	2887
1903	5825	----	----		2000	715	2324
1904	4125	1902	7403	1918	2000	5[illegible]	1827
1905	367	221	914		2986	873	3324
	1907	717	2451	1919	1187	466	1820
	1373	246	930		960	290	950
1906	4293	1620	5102	1920	1200	300	1200
	---	---	1000	1921	700	20[illegible]	320
	3440	---	---		2272	1027	4570
1907	3684	1450	4212	1922	1228	461	1667
	390	185	700		---	180	630
1908	---	1020	3007	1923	1341	385	1463
	210	38	132		214	75	203
1909	---	1085	3434	1924	1100	690	2417
	2904	1062	3334		294	132	456
1910	1515	668	2511	1925	850	527	1741
	1960	774	2344		705	403	1410
1911	4840	1107	4068	1926	200	340	1100
	1000	171	552		148	62	175
	874	437	1312	1927	160	70	245
1912	3071	---	---	1929	400	--	677
	1100	494	1627	1930	80	26	---
	937	453	1140		141	147	---
1913	8961	1694	4864	1931	1030	288	---
	200	333	2500	1932	400	150	---
	500	201	630		306	310	---
1914	2464	1071	2620	1933	170	69	---
	1260	700	2450		90	25	---
	1000	200	700	1934	146	--	---
1915	3213	1291	4268	1935	6601	1679	---
	3000	900	3158	1936	1803	269	---
	200	60	---	1937	23274	2118	18526
1916	4410	713	2803	1938	7701	1015	---
	2320	773	2331				

Table 1. Production of gold from Junction Reefs, N.S.W., 1886-1938.

Appendix 2. Inventory of main archaeological relics at Junction Reefs, Belubula River, N.S.W.

This inventory contains a list of the main archaeological relics identified during two days of preliminary site survey at Junction Reefs. Where necessary some additional comments are attached to the list.

Those items marked with an asterisk (*) have a photograph within this report.

The inventory is arranged in the following order:

Frenchman's
Belubula Dam
Water-races, and steel piping
Cornishmen's
Junction: M.T.1
M.T.7
Junction of Belubula River and Mandurama Ponds
M.T. within G.L.36
Mines and open-cut
Other relics.

The inventory numbers sites in sequential order, the location of each item appearing in figure 8. Where possible each item was sketched onto plan with references to a pegged grid at 50 metre intervals, which was previously laid out over part of the area.

Frenchman's

1.* Several adits.
2.* Smelter or roaster?, possibly post 1940.

Belubula Dam

3.* Belubula Dam, 1897.

Water-races and steel piping

4.* Upper water-race, probably associated with a water-wheel at the Cornishmen's in 1979-1880. The line of the water-race is approximately followed by steel piping and water power provided by the dam after 1897.

5.* Upper water race. The divergence of the steel piping from the course of the water-race indicates that they were separate items, and not comtemporary.

6.* Junction of steel water pipe at the upper water race with branch piping to supply Junction M.T.7.

7.* Steel piping to M.T.7, at the Junction mine.

8.* Junction of steel water pipe at the upper water race with branch piping supplying equipment at the junction of the Belubula River and Mandurama Ponds.

9.* Steel piping to equipment at the junction of the Belubula River, and Mandurama Ponds.

10. Lower water race, on Mining Tenements 3,5, and 6. This water race pre-dates the dam, and supplied Mining Tenements (M.T.) 1 and 7 at the Junction Mine. Probably constructed c.1880. (see figure 4 for location of M.T.s).

Cornishmen's.

11.* Several adits.

12. Location of water-wheel, 1879-1880.

13. Location of stamper battery.

14.* Part of boiler.

15.* Cyanide plant: cyanide vats.

16.* cyanide plant: Dorr thickener.

17. Tailing dams.

18. Smelter, or roaster ruins.

19. Causeway across Belublua River.

20. House sites.

Junction. M.T.1

21.* Plant ruins.

22.* Tailing dams.

Junction: M.T.7

23.* Ore shoot.

24.* Huntington mill.

25.* Cyanide vat, partly eroded away by river.

26. Other machinery at M.T. 7 obscured by vegetation.

Junction: junction of Belubula River and Mandorama Ponds.

27.* Pelton Wheel.

28.* Electrical generator, manufactured by British Thompson Houston, Derby, England.

Junction: M.T. within GL.36.

29.* Base of Huntington mill.

Junction: mines and open-cut

30. Several adits

31.* Open-cut

32.* tramway at adit entrance.

Junction: other relics

33.* Machine beds.

34. Machine beds. Both 34 and 35 housed similar machinery.

35.* Machine beds.

36.* Plant ruin.

37.* Loading stage? Both 36 and 37 may be associated, and may have served to transport ore from the mine to the plant.

38.* Workshop.

39. Site of building.

40. Site of building.

41. Site of building.

42. Site of building.

43. Site of building.

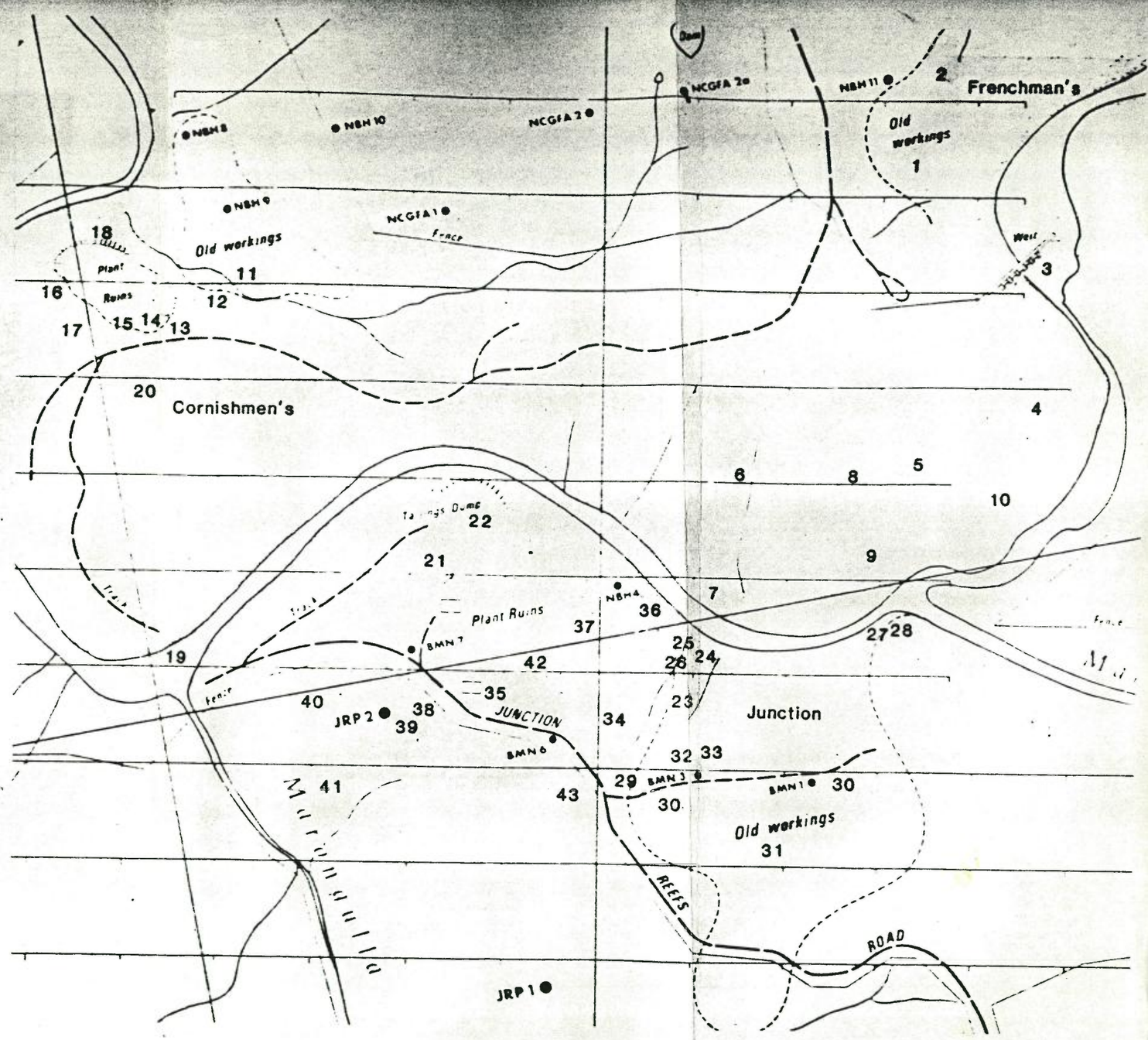

Figure 8. Plan of Junction Reefs, N.S.W., indicating the location of items 1 to 43 in the inventory (appendix 2). (Sketch plan).

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