

**SUBMISSION
FOR
ENGINEERING HERITAGE RECOGNITION
OF
ENOGGERA DAM and PIPELINE
Submitted by
Queensland Engineering Heritage Committee**



Photo: Kyler Coghlan 2021

Prepared by: Paul Coghlan – Committee Member

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BASIC DATA

Item Name:	Enoggera Dam and Pipeline	
Location:	Brisbane State Forest The Gap, Brisbane, Queensland 27.45° S 152.93 ° E	
Local Government Area:	Brisbane City Council	
Owner:	Seqwater	
Current Use:	Reserved Water Supply Recreation	
Former Use:	Water Supply to Brisbane City	
Designer:	Joseph Brady	
Contract Builders:	Donavan & Hulse	
Year Started:	1864	Year Completed Dam 1866 Pipeline 1868
Physical Description:	Earth filled Dam Cast Iron Pipeline	
Physical Description:	Dam Good	Pipeline collapsed
Modification & Dates:	1976	Dam Heightened Concrete Spillway added Pipeline duplicated

INTRODUCTION

Enoggera Dam, built in 1866 was Queensland's first major dam, and the second major dam in Australia. The first was the Yan Yean Dam in Victoria. It is an earth filled dam built on Enoggera Creek. Its headwater with its tributary is in the D'Aguilar Ranges west of Brisbane. Enoggera Creek enters the Brisbane River at Breakfast Creek, of John Oxley fame.

The dam was built to give Brisbane its first reliable water supply. It was 7 miles from the city, connected with a cast iron water main to service a reservoir on Wickham Terrace adjacent to the historic Windmill Observatory, Brisbane's highest point at the time. The difficult terrain required tunnelling and creek crossings for the pipeline construction.

The dam was Queensland Heritage listed in 2007.

HISTORY

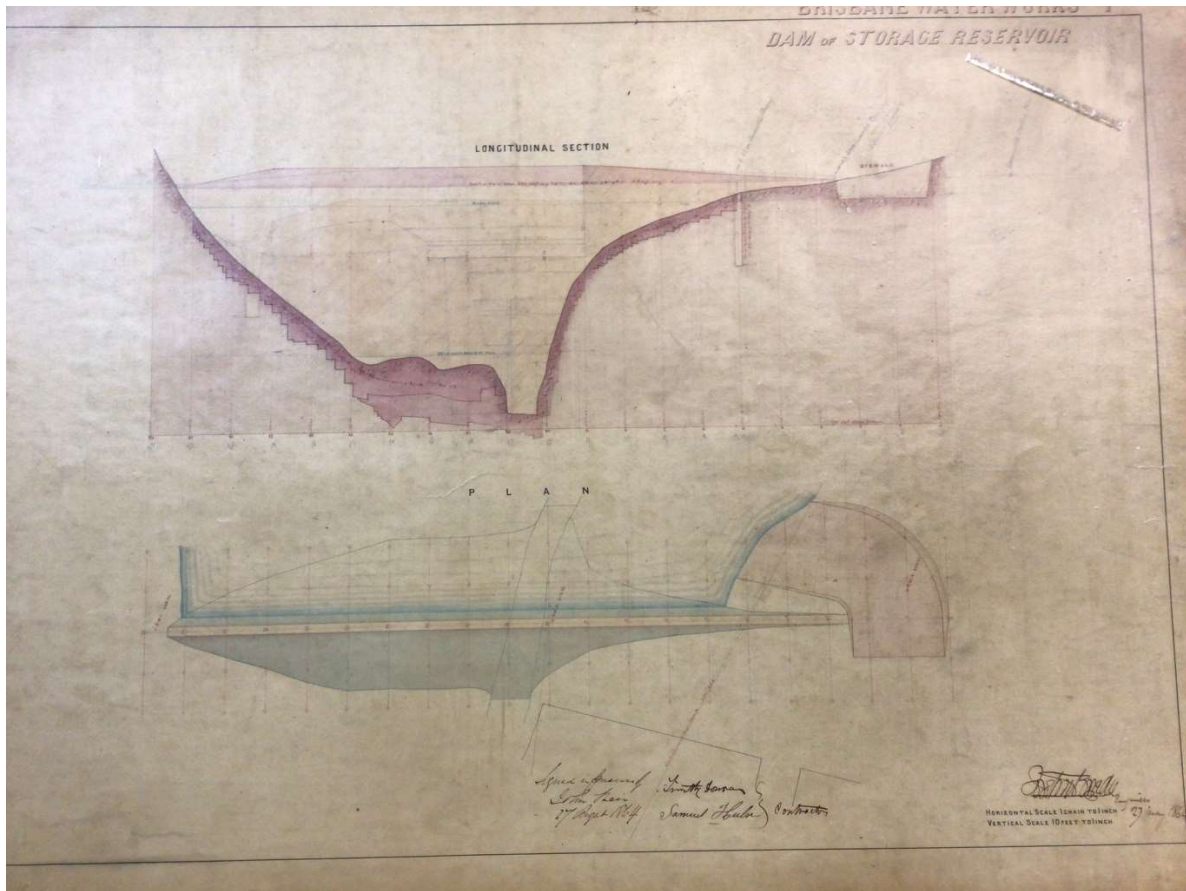
Initial water supply to the Brisbane Convict Colony and early free settlement was wells and a small creek flowing through the area (as described later in Brisbane Water Supply section.) With the growth of settlement, the supply became inadequate and grossly polluted. With the establishment of Brisbane as a Municipality, the Brisbane Municipal Council appointed a Water Supply Committee to investigate a permanent adequate water supply for the town.

The Committee engaged Thomas Oldham, an engineer who had advised on the location of Melbourne's first water supply, to conduct similar investigations for Brisbane. In 1863 Oldham reported the most suitable service for a gravity fed system was the Enoggera Creek water shed. The Surveyor general, A.C. Gregory, a Queensland Government employee also submitted a proposal for Ithaca Creek. The more far sighted proposal for Enoggera Creek was chosen. Conflict between the Council and State Government over control and ownership of Brisbane Water Supply has characterised the history of Brisbane Water Supply. In 1863, this conflict was temporarily resolved by the appointment of a Board set up by Parliament under Brisbane Waterworks Act 1863.

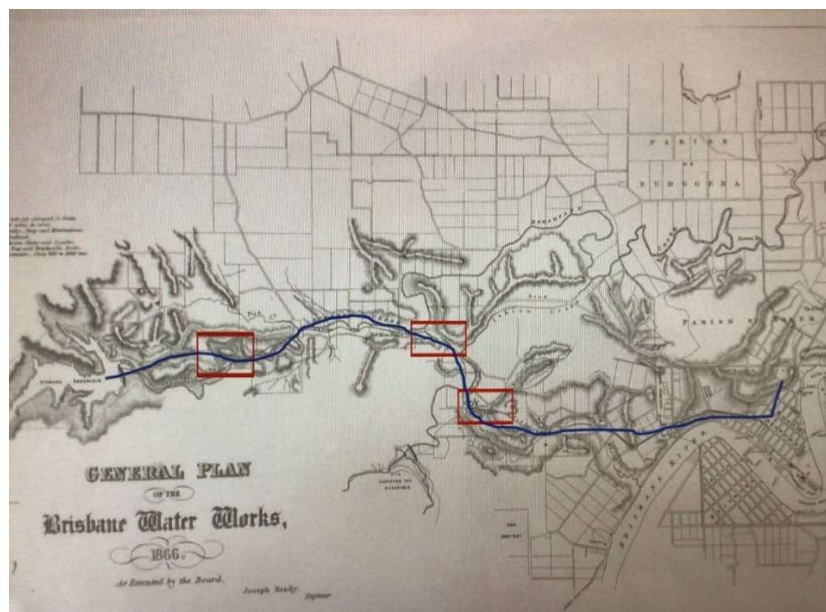
Oldham, originator of the Enoggera scheme became a victim of the Government and Council politics and was passed over with the Board appointing Joseph Brady to design and supervise the construction of the scheme. Brady was an energetic engineer with experience with the Yam Yean scheme in Victoria. He completed design plans for the Enoggera section within three months. The signed contract plans between Brady and the Contractors, Donovan and Hulse are held in the Brisbane City Council Archives. It was claimed that the public would not understand engineering drawings so they were coloured for public understanding. The Enoggera plans are described as vertical artistic masterpieces. Regrettably there is no colour code describing the various construction materials.

BRADY'S DESCRIPTION OF PROJECT

Detailed description of the Project is given in Appendix I, "Paper The water Supply to the City of Brisbane Queensland 1866" by Joseph Brady, Engineer to the Board of Waterworks.



Signed Contract Plans Elongated scale longitudinal section and plan of dam
Brisbane City Council Archives



Plan of works



Tunnels

Pipeline

SUMMARY

Capacity of Storage Reservoir	..	..	..	1,000 millions of gallons *
Area of Water Surface	..	..	..	186 acres
Area cleared of timber for Reservoir	..	..	..	261 acres
Greatest length of Reservoir	..	..	..	2,000 yards
Greatest breadth	..	..	..	700 yards
Breadth of dam	..	..	..	363 yards
Length round water edge of Reservoir	..	..	..	8 miles
Length of Dam	..	..	..	374 yards
Greatest height of Dam	..	..	..	65 feet
Top width of Dam	..	..	..	15 feet
Inner slope of Dam, 3 to 1; outer, 2 to 1. Inner slope covered with dry granite pitching	..	..	..	
Top of Dam above water level	..	..	..	10 feet
Width of Byewash	..	..	..	150 feet
Earthwork in Dam	..	..	..	125,000 cubic yards
Granite Masonry in valve houses	..	..	..	11, 400 feet **
Level of Water above high-water mark in Brisbane	..	..	..	239 feet
Level of Outlet Valves for town supply	..	..	..	224 feet
Level of Syphon for compensation to Creek	..	..	..	198 feet
Length of Main from Reservoir to Queen Street	..	..	..	7 miles, 14 chains
Intended daily supply	..	..	..	300,000 gallons *
To be increased if required, to One Million Gallons daily, by laying a second main.				

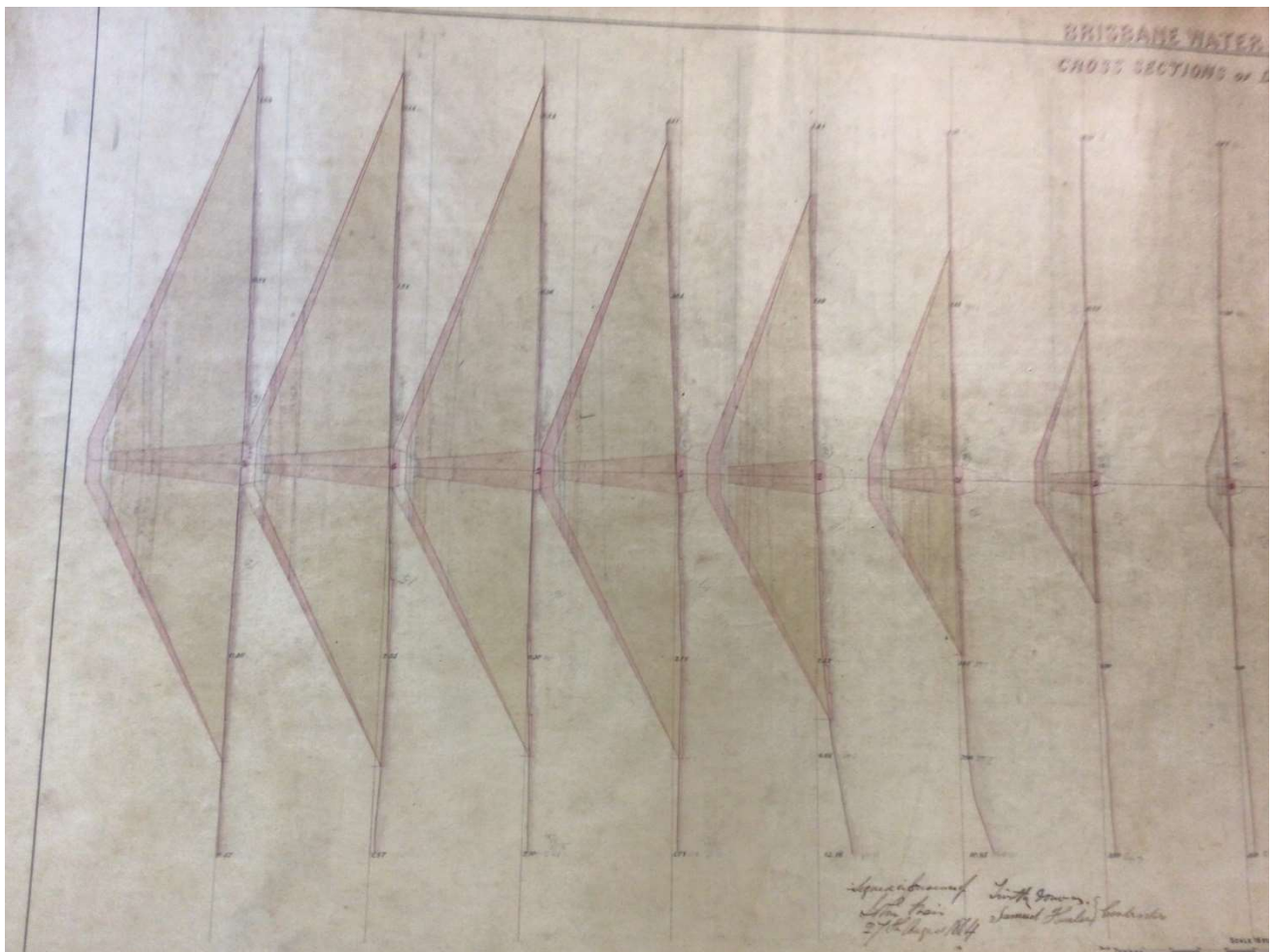
**See Appendix II for revised figures*

*** Feet from Brady's paper probably should be cubic feet*

Original design of water main was 12 inch diameter, but to save cost it was reduced to 8 inch for the first 5 miles and 9 inch for the last two miles.

DAM DESIGN

The dam is an earth filled dam with inner slope of 3 to 1, and outer slope of 2 to 1. The inner slope was covered with “dry granite pitching” and outer slope was rock. The dam has an impervious clay core called puddle built 10feet from top of dam (water storage level) to bedrock to prevent passage of water through the dam. No specifications could be found to give details of the material used. Brady merely states the dam was composed of good stiff clay laid in layers 9 inch to 12 inch in thickness and continually carted over. He does not distinguish between puddle and body of the dam. This compares with the specifications for the Gold Creek Dam built twenty years later where the puddle was to be best tough clay of approved quality well compacted, and the body of dam of less quality clay. Brisbane’s third water supply Lake Manchester(1916), and the fourth, Somerset Dam (1953), are mass concrete dams. The fifth , the larger Wivenhoe Dam (1985) is a complicated earth filled dam employing modern soil mechanics.



Contract Plan Cross Sections of Dam

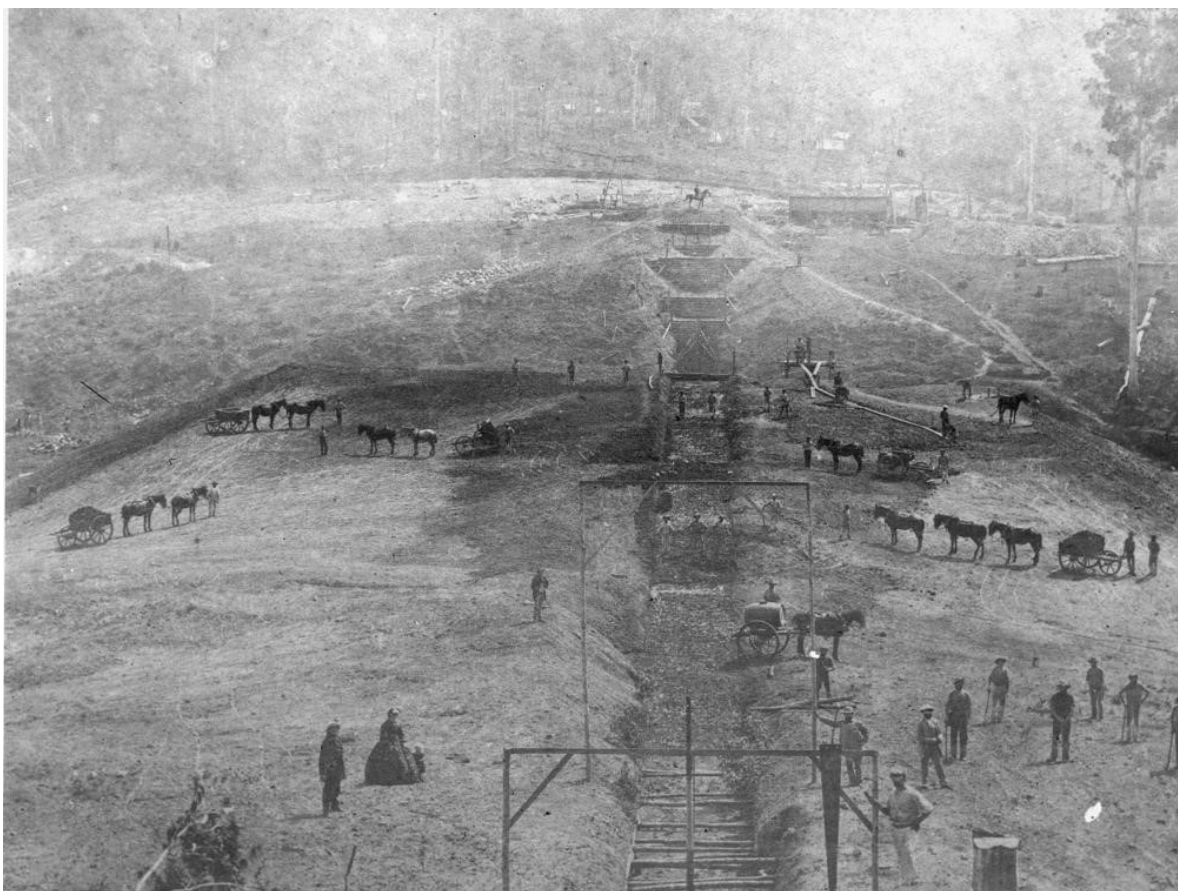
Note material colouring but no colour code
Brisbane City Council Archives

The construction plans provided for a Byewash (spillway) cut into the rock on the northern end of the dam. It was not constructed. Brady describes a Byewash 150 ft. wide, outfall being over a granite curb, 10 ft. below the top of dam. It was over the northern section of the dam. The fall of the creek below the base of the dam was 1 in 15, so Brady did not anticipate any scouring at base of dam. However, the Byewash over the dam damaged the rock face as early as 1865 and 1870, resulting in widening the Byewash on two occasions.

The compensation flow to the creek, a 16 inch diameter cast iron pipe siphon was provided. (Details page 9). However in practice the syphon was used to drain off decaying vegetation polluted water from the lower levels of the reservoir. Polluted water was a continuing problem till filters were installed in 1912.

CONSTRUCTION OF THE DAM

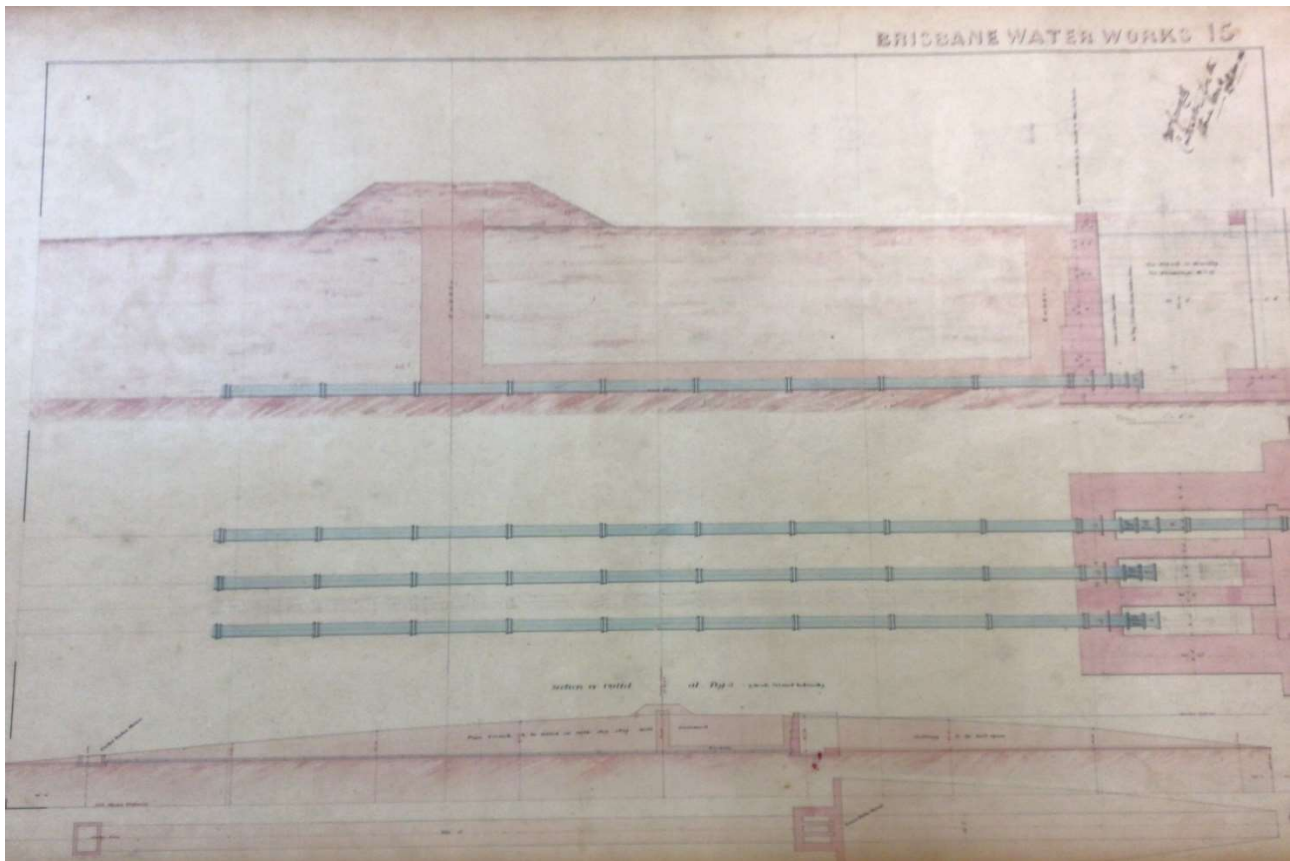
The Dam was commenced on 18th August, 1864, and despite difficulties was finished remarkably by May 1866. (21 months), using hand labour. A layer of shingle (gravel) below the ground surface (probably an ancient bed of the creek) required the puddle trench to be excavated to an average depth of 14 ft. below the surface with extensive timbering of the sides of the trench. In September 1865 unseasonable heavy rain resulted in flooding carrying away 18,000 cubic yards back down to bedrock. Brady's paper gives comprehensive details of the construction (Appendix 1)



Dam Construction Puddle Trench Excavation Photo: John Oxley Library of Qld

PIPELINE

To provide for the pipeline for the water supply to the town, three 12 inch cast iron pipes were laid in a 15 ft. wide trench cut into the rock on the northern side of the dam. The trench was 38 ft. above the bottom of the creek and 27 ft. below the top of the dam. One pipe was for initial supply, one for duplication, and one for the syphon. As the trench went through the impervious puddle core, it was back filled with rammed clay.



The Valve house was constructed adjacent to the dam wall, not as shown above, probably for easier access and shorter rock excavated trench. Note: Rammed clay backfill to puddle core

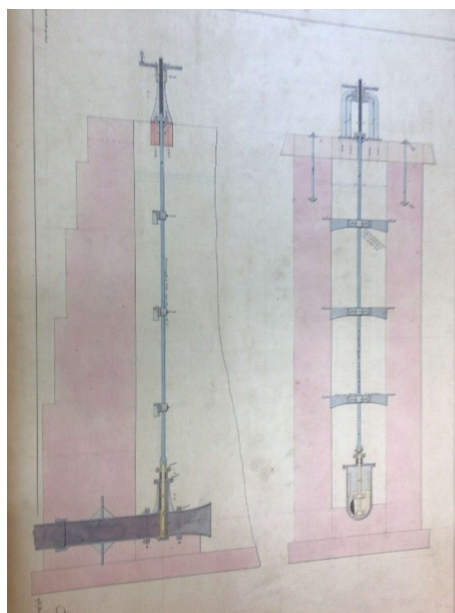
Photo: Brisbane City Council Archives

The inlet tower valve house was constructed of Masonry. There were three water inlet ports 10 feet below the top of reservoir water level. The bottom of tower was divided into sections to allow maintenance to any of the pipe inlets. Pipe inlet valves were controlled by spindle rods to top of tower. A small structure at outlet end of the trench contained sluice outlet valve on each pipe. Each pipe was then extended 110 yards downstream.

The inlet from one of the pipes was connected to a 16 inch diameter pipe rising to the top of the dam level, and down into the reservoir terminating on a stone pillar 41ft. below reservoir level. This formed a syphon, with an air extraction pump, which was used initially for a compensation flow to the creek till a reservoir level reached the inlet ports in the inlet structure. Subsequently used to drain vegetation water from lower level of the reservoir.



Valve House Note three inlet ports at water level
 Photo: Kyler Coghlan 2021



Inlet valve control spindle rod
 Control tower masonry walls (pink)
 Brisbane City Council Archives

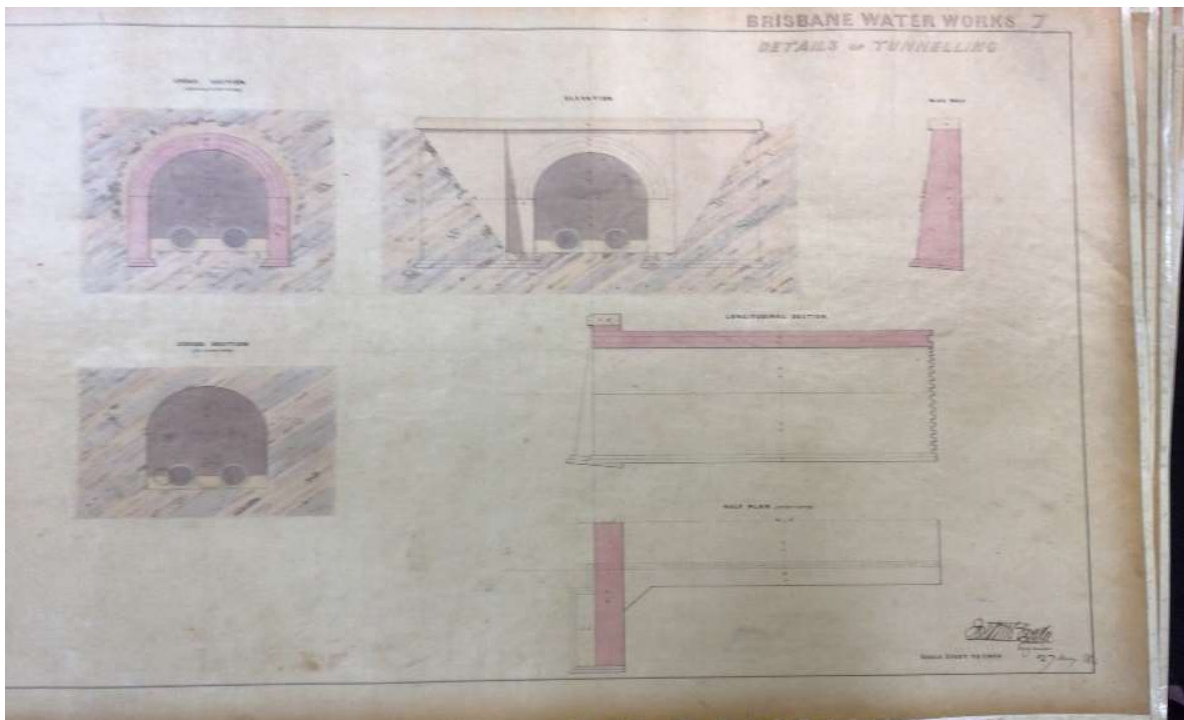
To save cost the 12 inch pipeline water main to the town was constructed as an 8 inch main for 5 miles, then 9 inch for 2¼ miles. They were cast iron pipes with lead filled bell shaped sockets. It was a gravity main. Inlet water level was 229 ft. above sea level with highest point of town being 170ft. above sea level. The population of Brisbane in 1864 was 12,581. Brady designed the water supply for 300,000 gallons per day for a population of 15,000 at 20 gallons per head per day to be increased with duplication of the main. By 1900, the population was 120,000 at 43 gallons per head per day.

The pipeline was to terminate in a masonry service reservoir on Wickham Terrace (town's highest point). Initially it was not built because of lack of funds. Three stand pipes (water columns) were used instead. By 1868, without the reservoir and consumption being 41 gallons per day, high levels of the town were poorly served. The Wickham Terrace Reservoir was built in 1871 in red brick. A second reservoir was added alongside in 1882. Because of leakage problems they were decommissioned in 1886 but repaired and put back into service in 1903 till 1962. Now used as a theatre. It was Queensland Heritage listed in 1992.

With the water supply still inadequate, a 12 inch main was constructed from Enoggera Dam to the service reservoir in 1876.

CONSTRUCTION OF PIPELINE

Tunnels were driven to accommodate the pipeline 5-6 ft. high by 4 ft. wide to accommodate two men working, and two 12 inch pipes. Brady describes (See Appendix I) the difficulty in driving the tunnels through slate rock of **flinty** hardness. The tunnels were designed 5ft. 6 inches wide by 6ft. 6 inches high, masonry lined. Apparently the hardness of the rock did not require the masonry lining enabling smaller sized tunnels. Plans show three tunnels, but Brady describes only two tunnels 187 yards and 412 yards in length.



Original tunnel design

Brisbane City Council

As the creeks downstream rise 10 to 18 ft. in flood, for the three pipe crossing of Enoggera Creek and one crossing of Ithaca Creek, the pipes were enclosed in a wall of masonry not more than 1 or 2ft. above the creek bed and were carried down to a solid foundation. Despite construction work on the mains being delayed by late arrival of the cast iron pipes from England, the water supply to the town was completed in 1886.

ADDITIONAL WORK

An 1876 Proposal to raise height of the dam by 5 ft. to increase water supply did not proceed as funds were not available. The Board's Engineer, Foster, Barham's 1901 plan to heighten the dam was not approved. (Refer Appendix IV, Plan No. 1.), but the plan shows outline of the dam at that date. In 1903 four alternatively detailed plans for heightening dam and a concrete spillway also did not eventuate.

The proposal for the construction of the neighbouring Gold Creek Dam at nearby Gold Creek was to improve the capacity of the Enoggera Reservoir by connecting it to the Gold Creek Reservoir by a tunnel through dividing ridge. When constructed in 1866, the Gold Creek Dam connection was not made, but a trunk water supply main from the dam to the town was constructed instead. The connection was finally made in 1928 with a 16inch concrete main. (See Enoggera Connection)

In 1976 for flood mitigation the dam was raised by 7 metres, and a concrete spillway constructed on northern end. (Refer Appendix IV, Plans Nos. 2&3) Reservoir storage was not increased. The increased height was by rock fill with upstream face sealed with concrete. A feature of the spillway is for low flows, it has two inlet ports at original reservoir level but this did not prevent the flood mitigation storage capacity of the increased heights of the dam for major floods. Major flood overflow level of the spillway is at a level 4 metres below the increased height of the dam.



1976 Spillway – note outlets for low level flows

Photo: Kyler Coghlan 2021

OPERATION

The dam continued as a part of Brisbane Water Supply until it was decommissioned in 2003. It was recommissioned in 2006 for Inner North Brisbane water supply when drought had reduced South East Queensland water supply to a critical level. Subsequently it was decommissioned after the millennium drought ended in 2011 but remains as a backup water supply. The Lake behind the dam is in Brisbane Forest Park and is used for recreation purposes.

Ownership of the dam passed from Brisbane City Council to SeqWater in 2008 in accordance with *"South East Queensland Water (Restructuring) Act October 2007."*

HERITAGE LISTING

Enoggera Dam was listed in Queensland Heritage Register in 2007.

Net Reference: <https://apps.des.qld.gov.au/heritage-register/detail/?id=602458>

THE EARLY ENGINEERS

THOMAS OLDHAM.

Thomas Oldham was born in England. He started his engineering experience s in 1837 on railway and water supply projects before migrating to Victoria in 1852. Within a few weeks of his arrival he reported on the water supply and sewerage of Melbourne recommending the construction of the Yan Yean scheme, the first water supply scheme in Australia to involve a major dam and a water supply. In 1862 Brisbane Municipal Water Supply Committee appointed him to investigate a water supply scheme. He recommended and costed the Enoggera Dam water supply scheme. He became a victim of Council and Government in fighting when the Government's newly established Board of Waterworks appointed Joseph Brady to design and construct the Enoggera scheme.

JOSEPH BRADY

Joseph Brady was born near Enniskillen, Northern Ireland, and as an apprentice surveyor with five years' experience in railway location construction, he was just 22 years old when arriving in Sydney in 1850. He was employed on survey and design and Resident Engineer for construction of Railway Line to Parramatta.

In 1851 Brady spent six months in Victoria surveying and drafting for Melbourne Yan Yean water supply. He returned to Victoria in 1858 working on various water supply and railway projects. In 1864 he came to Queensland and obtained a contract for improving the Brisbane River. He relinquished the contract on being appointed Engineer of the Board of Waterworks to construct the Enoggera Dam scheme. In 1865 he was given the additional appointment as the First Engineer responsible for all port and harbour work in Queensland and for provincial water supplies.

Brady returned to Victoria in 1869 to work on Railway and Water Supply contracts. In 1877 he was appointed First Engineer at the Melbourne Harbour Trust. He planned and constructed extensive works which became the bones of development of the Port of Melbourne. Most of the planned work was completed when he retired in 1891.

Few engineers have personally investigated, designed , constructed and operated in as many fields as Brady. The speed at which he worked is *most* impressive; he completed the survey and drawings for Yan Yean in six months, located and marked out two alternate rail routes between Parramatta and Mittagong in six months and had contract work started on the dam for the Enoggera scheme less than four months after his appointment. This was fast by any standard and shows a well-informed man of vigour and decision. After retiring Brady worked as a consulting engineer and arbitrator until 1894; he died at Elsternwick, Victoria on 8th July 1908, survived by seven children.

CHARLES SIGLEY - The Amateur Engineer

Little is known of the qualifications and early experiences of Charles Sigley beside some railway experience in Victoria. From 1864 he was employed by Joseph Brady as Clerk of Works for construction of Enoggera Dam. Being often away on his Harbours and Rivers duties, Brady relied on Sigley to push the construction of the dam in record time.

Brady's appointment with the Board ceased in February, 1867, retained as a Consultant but never consulted. Sigley was appointed Clerk of Works and acted as Board's Engineer till October 1879.

Sigley's achievements included designing and building the Wickham Terrace Reservoir; specification and construction of 12 inch water main which included widening of the tunnels; laying a 2 inch lead pipe across the Brisbane River to supply South Brisbane; repairing flood damage to Enoggera Dam; widening spillway to dam twice and design of pipe scraper for cleaning pipes. Sigley also played a role in identifying both the Gold Creek Dam and the Brisbane River at Mt. Crosby as sources for increasing Brisbane water supply.

BRISBANE WATER SUPPLY

“Starting from the first landing at Redcliffe in 1824, the water supply to Brisbane was in recurrent crisis for a hundred years until the partly completed Somerset Dam was placed in operation in 1943. It had always been a case between rising water consumption of a growing city, and the availability of funds to develop the next source of water supply.” (The Gold Creek Story by Geoffrey Cousins)

The population of Brisbane in 1864 was 12,581. Brady designed the water supply for 15,000 at 20 gallons per head per day. By 1900, the population was 120,000 at 43 gallons per head per day.

EARLY SUPPLY

Initial water supply for the convict settlement and early free settlers was wells and a series of water holes in a small creek running through future sites of Roma Street Markets and City hall to enter Brisbane River at Creek Street.

In 1839 a small earth dam was built at future Roma Street Market site with water pumped to Commandant's Quarters (Treasury Building site) through shallow logs by a convict operated treadmill pump. A tank was constructed (Tank Street) to assist in the cartage of water. With growing population, gross pollution of the creek and drying of wells, a new supply was required.



Early Brisbane Water Supply
Brisbane City Council Archives

ENOGERA DAM

The establishment of the Board of Water Works led to the building of Enoggera Dam with 8 inch and 9 inch diameter mains and stand pipes supplying water to the town in 1866.

Improvements soon became necessary as follows:

- 1871 Wickham Terrace Reservoir
- 1872 Heightening of Reservoir
- 1876 12 inch main from dam to town
- 1878 Report on five sites for additional source of supply
 - (a) a dam on Ithaca Creek; (b) a dam on Gold Creek with connecting tunnel to Enoggera Dam; (c) raising Enoggera Dam by 5 feet; (d) an auxiliary reservoir on Enoggera Creek; (e) a pumped supply from the Brisbane River at Mt. Crosby

Ithaca Creek action was dismissed on score of cost and poor yield from small catchment area and the auxiliary dam on Enoggera Creek for fear of an overflow damaging Enoggera Dam. The Brisbane River supply was dismissed on initial cost not less than \$250,000 as well as cost of operating pumps. The preferred scheme was the raising of Enoggera Dam. None proceeded at this stage.

GOLD CREEK DAM

The Board of Water Works submitted the Report to the Government. The Government requested their own engineer, J.B. Henderson, Hydraulic Engineer, Resident Engineer for Waterworks in Queensland, to investigate the supply. In 1882, Henderson was appointed Hydraulic Engineer in charge of newly formed Water Supply Department.

In 1881, Henderson reported on building on the Gold Creek Dam which was accepted by the Board. Henderson's original proposal was to connect Gold Creek Dam to Enoggera Dam either by channel along the contours or more direct route by tunnel through intervening ridge, and thus increase Brisbane water supply.

The elite citizens of the time who lived at Toowong pressured the Government for a direct water main from the dam to Brisbane as this would pass through Toowong. In 1882 the Board adopted a 16 inch water main from the dam to Taringa through Toowong. The tunnel connection of the dam was eventually built in 1928.

Construction of the earth filled dam similar to Enoggera Dam commenced in 1882 and water was turned on to the city on 2nd August, 1886.

Except for the tunnel connection to Enoggera Reservoir, Gold Creek direct supply to Brisbane water supply was decommissioned in 1931. See Appendix II for capacity of Reservoir and rate of water supply.

In 1889 to improve the water supply to South Brisbane, a 16 inch pipe was laid across the Brisbane River at Toowong Ferry site and a service reservoir constructed at Highgate Hill. Despite 1889 flood disrupting the pipe laying, it was completed and was placed in service on 23rd September 1889, and the reservoir in service on 28th October 1889. The pipes corroded and failed in 1915 just after a 24 inch diameter pipe had been installed just downstream from Davies Park.

MT. CROSBY

The next source of supply was to develop the Brisbane river in the vicinity of Mt. Crosby immediately above the reach of the tidal influence. The scheme involved a steam driven pumping station on the north bank of the river; an open concrete storage reservoir nearby, capacity 2.43 million gallons; and a 24 inch diameter gravity trunk main, 17¾ miles long to the city. Subsequent 48 inch and 36 inch gravity mains were added. The capacity of the reservoir was a day's supply for the citizens of Brisbane allowing the pumping station to be closed at night to save labour costs.

An extra high cast iron standpipe was incorporated to increase the pressure in the trunk main. The 24 inch Mt. Crosby trunk met the 16 inch Gold Creek trunk main at Kenmore allowing water to be pumped into the Gold Creek Dam.

1899 – 1902 drought resulted in low flows in the Brisbane River. In January 1901 a 18 inch timber weir was constructed across the river. Cost £10. In December 1901 a 4ft. 10 inch sandbag and clay weir was constructed. A concrete weir was built in 1902. Water to the weir was only maintained by dredging through sand bars upstream, and then pumping from upstream reaches of the river. Before drought broke at end of 1902 it was reported only 3 to 4 week supply of water was available.

Additional source of supply was required and in 1906 plans were drawn up to increase Enoggera Reservoir with heightening and a concrete spillway. But the government would not fund it. Allen Hazen, an eminent American engineer was engaged to investigate various proposals for development.

LAKE MANCHESTER

Allen Hazen's report in 1907 rejected the raising of Enoggera Dam and also the other proposed scheme for water from Stradbroke Island sand hills as too expensive. He recommended the construction of a dam on Cabbage Tree Creek, a tributary of the Brisbane River 11 miles upstream of Mt. Crosby. A mass concrete dam was commenced in 1912 and completed in 1916, with a capacity of 700 million gallons. In 1974 this was increased to 7,000 million gallons with construction of a dwarf weir. The reservoir was named Lake Manchester. Hazen's report anticipated the Somerset Dam.

The purpose of the reservoir was to supply water to Mt. Crosby pumping station when normal flow of the Brisbane River was insufficient to meet the water supply demand. Originally this was done by allowing water to flow from the reservoir down the creek and the Brisbane River. To eliminate the between 20% and 33% estimated water losses, particularly down Cabbage Tree Creek, a 42 inch diameter pipeline was laid between the reservoir and the mouth of the creek.

The capacity of the reservoir could not be relied on as it was seriously depleted at start of dry times. Two electrical driven pumps were installed at the mouth of the Cabbage Tree Creek pipeline to pump water from the Brisbane River to the reservoir when the river was flowing in excess of requirements. This was to keep the reservoir full at all times.

Pollution of the Brisbane Water Supply was a continuing problem until the construction of the filter treatment plan in 1912 at Enoggera Dam, and finally major treatment plant at Mt. Crosby. *(This is a project in itself – not included here)*

ENOGGERA CONNECTION

Plans were drawn up in 1918 for a 16 inch” concrete cast iron trunk main and a tunnel driven through the ridge between the Gold Creek Valley and Enoggera Reservoir. (Refer Appendix IV, Plan No. 4.) The connection was not constructed until 1928 with a 16 inch” concrete trunk main and tunnel.

This effectively added the catchment of the Gold Creek Dam to Enoggera Dam which increased the city’s water supply via the Enoggera Treatment Plant. Gold Creek Dam was decommissioned in 1931.

MAJOR ADDITIONS

The year to year solutions of the Brisbane Water Supply ended with two major additions to the supply, viz. the Somerset Dam on the Stanley River, a Brisbane River tributary, and the Wivenhoe Dam on the Brisbane River. The Somerset Dam was Australia’s first flood mitigation and water supply dam. Wivenhoe Dam was also a flood mitigation and water supply project. Initial supply from Somerset Dam was in 1943. Full supply available with dam completion in 1953. The North Pine Dam, north of Brisbane, constructed in 1976 also added to the water supply and flood mitigation. Wivenhoe Dam was completed in 1985.

Water from the dam flowed down the Rivers to the Mt. Crosby Treatment Plant. The inadequacy of these dams were severely tested in the Queensland drought of early 2000 necessitating the recommissioning of the Enoggera Dam and building a pipeline from Brisbane sewerage plant to Wivenhoe Dam to use effluent treated water. It has never been used.

<u>TIMELINE</u>	1866	Enoggera Dam
	1886	Gold Creek Dam
	1892	Mt. Crosby
	1916	Lake Manchester
	1918	Enoggera Connection
	1943	Initial Somerset Dam Supply
	1953	Somerset Dam completed
	1976	North Pine Dam
	1985	Wivenhoe Dam

SOCIAL

The construction of the Enoggera dam and Pipeline permitted the growth in population of the City of Brisbane. From its earliest days a visit to Enoggera Dam was considered a social event. Enoggera, Gold Creek and Lake Somerset Reservoirs are all situated in the extensive Brisbane Forest Park which has trails for bushwalkers through the forest close to Brisbane. The Enoggera Lake is also a popular site for recreational water activities



Hand Coloured Post Card – turn of 20th century
John Oxley Library



Recreational area - 2015
en. Wikipedia.org

SIGNIFICANCE

Enoggera Dam was the first major dam built in Queensland, an earth dam built with little knowledge of soil mechanics, but still in existence today and being a forerunner to other earth dams built in Queensland.

The significance of the pipeline was its construction through difficult terrain requiring excavation of tunnels.

The project was remarkable in that the construction was completed in two years using only hand labour

The dam, constructed in 1868 is still in good condition providing an emergency water supply and flood mitigation.

ACKNOWLEDGEMENTS

“Water Supply to City of Brisbane 1866 ” by Joseph Brady.

“The Gold Creek Dam Story” by Geoff Cousins

The Brisbane City Archives - Annabel Lloyd

Seqwater - Anne McKenzie



Brisbane City showing Enoggera Reservoir location – Electoral Commission Qld.



Six dam sites - Seqwater

Our ref:AM:LAB:D22/6013

19 January 2022

Suzanne Burow
President | Queensland
Andrew Barnes
Chair | Engineering Heritage Queensland
Engineers Australia Queensland

Via email: gld@engineersaustralia.org.au

Dear Suzanne and Andrew

Enoggera Dam and Pipeline: Engineering Heritage Award Nomination and Acceptance Request

Thank you for your letter dated 23 November advising Engineering Australia would like to publicly recognise the Enoggera Dam and Pipeline with an Engineering Heritage Marker award.

Seqwater is pleased to have this important historic and engineering heritage recognised through the Engineering Heritage Recognition Program, and gladly accepts this award nomination.

As a Queensland Heritage Place, Enoggera Dam is a place of historic significance to all Queenslanders. Acknowledging the engineering heritage of this place brings public recognition of its engineering significance, and the engineers who created it.

Please co-ordinate with Anne McKenzie, Seqwater's Cultural Heritage Officer in the development of the formal submission and interpretation panel design, and we look forward to working with your team to co-ordinate the unveiling ceremony in due course. Anne can be contacted at anne.mckenzie@seqwater.com.au or 0448 501 143.

Yours sincerely


Neil Brennan
Chief Executive Officercc. HKomene@engineersaustralia.org.au

The School of Arts

Brisbane

*to City
Le Grand*



P A P E R

DESCRIPTIVE OF

The Water Supply

TO THE

CITY OF BRISBANE, QUEENSLAND,

1866:

TOGETHER WITH THE GENERAL PLAN AND SECTION.



By JOSEPH BRADY,

Engineer to the Board of Water Works, Brisbane.

BRISBANE WATER SUPPLY.

The Brisbane Water Works, as executed, are intended for the supply of 15,000 inhabitants, at the rate of 20 gallons each per day—say a daily delivery of 300,000 gallons, on the gravitation principle. The works were originally designed for the ultimate supply to 50,000 inhabitants, and the immediate supply to 25,000 inhabitants. The limit of expenditure (£50,000) was, however, found inadequate, as the engineering works alone were estimated to cost £68,491. A revision of the plan was considered by the Board, and it was resolved to execute the dam of the storage reservoir, as designed for the larger supply, as also the service reservoir, and to reduce the works on the pipe track, so as to keep the expenditure below £57,000. This, it was hoped, would be effected by reducing the main from 12 inches to 8 inches diameter, and by reducing the work in the tunnels on the pipe track. [See plan and section attached.] The actual cost, however, will stand as follows:—

Works in connection with Storage Reservoir	£32,558 13 3
Works on the Pipe Track and Town Service	24,010 13 5
Extension of Mains and Services	4,659 1 6
Contingent Expenses	3,771 11 10
TOTAL	£65,000 0 0

The works comprise a Storage Reservoir 200 feet above the town; a single line of 8-inch Cast Iron Main, seven miles in length, and the town supply service. This latter is as yet but of limited extent, and only supplies three of the principal streets. Provision is, however, made for consumers residing in other localities by means of water columns erected in suitable places.

The supply of water is obtained from the upper watershed of the Enoggera Creek, and is dammed back to a level of 232 feet above the sea (high water,) at a distance of seven miles west of the city, in which latter the levels vary from 10 feet to 176 feet—the principal business portion of the city averaging about 25 feet above high water level. The intervening country in the line of the pipe track is extremely broken, necessitating tunnelling in two places. [See the plan.]

The watershed is not yet surveyed; it is about 7,000 acres in extent, comprising steep and mountainous and thickly timbered country. The formation is composed of silurian slates and syenites, with intrusive trap and porphyritic rocks. The summits are from 800 to 1,000 feet above sea level.

Observations have been kept of the rainfall in Brisbane for 6 years, at a level of 70 feet above the sea, as follows:—

1860	54.63	1863	68.32
1861	49.44	1864	47.00
1862	28.27	1865	25.50

giving an average of 48.36

The rainfall in the Watershed was probably much greater. Taking 33 per cent, or say 16 inches, as available rainfall (allowing 66 per cent. for loss by evaporation, percolation and overflow in floods,) leaves as an average annual result 406,560,000 cubic feet, or 2,541,000,000 gallons. The capacity of the Reservoir being 1,000 million gallons, the available supply in average years is thus two and-a-half times its capacity for storage.

In the year of least rainfall (1865, one of drought) the available surplus (8 inches) would have yielded 1,276 million gallons, or over two years supply for 50,000 inhabitants. For all practical purposes, therefore, the storage is most ample, and the question of delivering a larger quantity than at present provided for is only one of laying down a second main of sufficient

diameter. The united areas of the 3-12-inch pipes laid for the first 100 yards from the Reservoir is 339 inches, whilst that of the 8-inch main laid thence to town being 50½ inches, it follows that the delivery can be increased to six times that at present, whenever it may become necessary to do so.

The Byewash is 150 feet in width—the outfall being over a granite curb set in cement. The fall of the Watercourse leading from the Byewash is at the rate of one foot in fifteen, so that it will form a cataract, and there will be no risk of the Byewash gorging.

The following statement affords some of the principal figures connected with the storage:—

Capacity of Storage Reservoir	1,000 millions of gallons
Area of Water Surface	186 acres
Area cleared of timber for Reservoir	261 „
Greatest length of Reservoir	2,600 yards
Greatest breadth	700 „
Breadth at Dam	363 „
Length round water edge of Reservoir	8 miles
Length of Dam	374 yards
Greatest height of Dam	65 feet
Top width of Dam	15 „
Inner Slope of Dam, 3 to 1; outer, 2 to 1. Inner slope covered with dry granite pitching	
Top of Dam above water level	10 „
Width of Byewash	150 „
Earthwork in Dam	125,000 cubic yards
Granite Masonry in Valbrehouses	11,400 feet
Level of Water above high-water mark in Brisbane	239 „
Level of Outlet Valves for town supply	224 „
Level of Syphon for compensation to Creek	198 „
Length of Main from Reservoir to Queen Street	7 miles, 14 chains
Intended daily supply	300,000 gallons
to be increased, if required, to One Million Gallons daily, by laying a second Main.	

At the commencement of the work, nine tenders were received for the clearing of timber from the Reservoir, varying from £8 10s. 0d. to £15 per acre. Ten distinct parties undertook this work, several of whom failed, and finally it was let in blocks at £21 to £30 per acre. The average was £27 10s. 0d. over the 261 acres cleared.

The tunnelling, which it was anticipated would be chiefly through sandstones and shales, requiring partial lining with brick-work, turned out, after the face lengths were opened, to be in slate-rock of dirty hardness, interspersed with veins of spar, so hard that the steel drills had to be tempered so as to nick the face of the anvil, any harder they would splinter, any softer would cause them to hurt up at a few blows. The size of the tunnel is 5-6 feet high by 4 feet wide, just room for two miners to work. The average rate of progress throughout was 3 inches per day at each face.

In the tunnelling the greatest difficulty was experienced, as owing to the extreme hardness of the rock few miners could work it, and many even of the best hands were so dissatisfied at the apparently hopeless nature of their task, that they left after a short trial. There are two tunnels, (besides a short heading of 133 feet in length, which was driven to avoid breaking up a farm-yard, through which the pipe track passes; but there was no difficulty with this.) The others, known as No. 2 and No. 3 tunnels, are respectively 187 and 412 yards in length; in the former two shafts were sunk; in the latter, four. Blowing fans were used in each for ventilating the workings, as in certain states of the atmosphere great difficulty was experienced in clearing the headings of powder smoke. Ordinary blasting powder and double tape fuse were used in the mining operations. It sometimes happened that the holes had to be charged a second time, owing to the powder blowing the tamping out without breaking the rock. A sample cartridge of gun cotton was tried in one of the hardest holes, and the result surprised the miners, who had not previously seen this material used. The rock round the hole was shattered like glass, and there was no smoke. This latter recommendation alone would have led to its use in preference to the powder, but there was no more of it to be had in this Colony.

13,900 lbs. of powder were used in this work, and 4,300 lbs. of octagon steel for drills. The open ends of the tunnels were worked by means of tramways and small box waggons; the shafts, by the ordinary windlass and skip.

The work of greatest interest connected with the Brisbane Water Supply is the Dam of Storage Reservoir, a short account of the construction of which follows.

In a report to the Board of Waterworks, dated 27th May, 1864, I pointed out that the construction of the Storage Dam would be a work of great risk, on account of the large quantity of water discharged by the creek during floods, and that greater precautions would have to be taken than are usually required in works of this class. I also stated the time required for the work would be from two to three years. It will be seen that I did not over-estimate the difficulty of constructing the Dam.

The Dam was commenced on 18th of August, 1864; A. C. Gregory, Esq., the Surveyor-General, performing the usual ceremony of cutting the first sod. Operations were begun at the northern end of the Dam, where the ground was already clear of timber; the southern end was in a dense scrub, full of heavy timber, and the contractors for the earthwork did not get possession of this part for a considerable time.

The whole of the soil was removed from the surface of the base of the dam, and the ground was benched into level steps preparatory to the commencement of the embankment. In the southern portion of the dam it was found necessary to cut the puddle trench to an average depth of 14 feet below the surface down to the bed rock, owing to the presence of a stratum of shingle, forming probably the ancient bed of the Creek. The sides of this trench were closely timbered until the completion of the puddle to the level of the surface. The formation of the embankment was proceeded with simultaneously from both ends, leaving the course of the Creek open for the passage of the water, until such time as an attempt could be made to close the gap. The open ends of the puddle wall were upheld by heavy timbering well stayed and strutted. The trench cut through the rock at the northern end for the delivery pipes (15 feet below permanent water level) was left open for use as a temporary byewash, when the embankment in the central gap should have been raised to its level, and until the level of the permanent byewash was reached by the whole of the dam.

On July 1st, 1865, a commencement was made in closing the Creek. The bed of the Creek was cleared of shingle and rubbish for its full extent, preparatory to putting in a course of puddle. On July 3rd and 4th heavy rain stopped the work. On the 6th work was resumed, and a small dam of dry puddle faced with stone was commenced across the bed of the Creek in advance of the foot of the slope on the upper side. Arrangements were made to discharge the water thus dammed back by means of box sluices of timber resting on framework. Two sets of these were laid at a difference of three feet in level, and were shifted alternately as the work advanced in height. The work proceeded slowly, on account of wet weather, to the 17th, on which day the foundation of the middle portion of the dam was inspected by the Board.

On 21st July the first barrowful of puddle was deposited in the lowest part of the trench by the Hon. A. Macalister, Chairman of the Board. The work of raising the dam was then proceeded with; but owing to its great width at the bottom (320 feet) the advance was slow.

(As it is necessary to refer to levels hereafter, I mention now that the level of the lowest point of the puddle trench is 177.50 above high water in Brisbane; level of Creek, 184; inner end of syphon, 198 (centre of pipe); bottom of pipe trench, 222; level of byewash, 239.

On the 8th, 9th, and 10th of August we had rain, and the works were stopped in consequence—resuming on the 14th. The level of the water on 12th was 194.30, being 10.80 above bed of creek. Work now proceeded rapidly, and on 25th August the timber sluices were removed after the water was run off to the lowest possible level, and all available force was put on to raise the dam to syphon level (198,) with a view of using the syphon instead of the sluices for running off the ordinary water of the Creek. On the 23th of August the puddle trench was at 202 level, the water (rising one inch per day) 192.80. The work now proceeded without interruption until the 18th September, on which day rain set in heavily, and stopped the works. The level of water was then 193.50, and the bank in the gap 214. The rain continued on 19th and 20th, and at

9 p.m. on the latter day the Creek was in flood, and the water level with the bank in the gap. The water still continued to rise, and there being no hope of preventing the water overtopping the work, arrangements were made to lead the water through a narrow cut, with a view of losing as little of the bank as possible. A length of 30 yards of the dam was gradually washed down, and the pent-up waters escaped about 9.30 p.m., carrying away about 10,000 cubic yards of the embankment, and cutting the work down to the bed rock. The rainfall registered at Brisbane from 17th to 20th September amounted to 3.10 inches—the heaviest fall during this month recorded since 1860. After the breaking away of the dam the creek continued running in considerable volume for several days.

As the nature of the country did not admit of a diversion of the creek being made, except at a very great outlay and loss of time, the only course left was to re-construct the Dam as before, with the additional precaution of cutting a second temporary Byewash in the solid ground at the south end of the Dam at 210 level. This temporary Byewash was accordingly cut and the work of closing the Dam once more resumed. The weather, meanwhile, being favorable, on the 6th of March the bank in the gap was raised to 219. The level of the water was 190.32; the work being now nine feet above the temporary Byewash was considered tolerably safe. On the 11th the bank had advanced to 220.18, the outer side being 300 (at this time we had one hundred and thirty men on the work, and twenty horses.) Steps were now taken to bring up the surface of the Dam to level courses, and by the 27th of November the Dam was raised to a level surface of 230.50, the water standing at 192.5. During all this period the main body of the Dam at the southern end was in progress. On the 11th December the level of the gap was 229, water 194.10. Heavy rain set in on this evening of the 11th December, and the water rose by next morning to 195.62, and continued to rise slowly; work was resumed on 13th. On the 14th the Board visited the work, when the bank was 232, and the water 199.24, or some four inches over the top of the inner end of the Syphon. A trial was made of the working of this latter with satisfactory results. On 3rd January the water stood at 199.70, flush with the masonry of the inner end of the Syphon. On the 16th January we commenced to close the temporary Byewash at the south end; on the 20th the level of the gap was 234, the water standing at 199.70. On 25th January the Dam was closed, the level being 240.44, or 1.44 above the permanent Byewash, the water remaining at 199.70. The masonry of the delivery valves had by this time been completed. On the 31st the Chairman and the Board visited the work, which, with the exception of some soiling and pitching, was now finished. Water had risen to 199.77. The top of the Dam was finished fifteen feet in width, at ten feet above the water surface, grading off to five feet at the north and south ends; the extra five feet being provided in the highest part to allow for any possible subsidence. On March the 3rd, the soiling being finished, the certificate of completion was granted to the Contractors, who have to maintain the work for six months longer. During April there were some showers, and on the 14th of that month the level of the Reservoir had risen to 200.53. The creeks commenced running.

The Dam was composed of good stiff clay laid in layers nine to twelve inches in thickness, and continually carted over. In the latter part of the work twenty dobbin carts and six silt drays were employed. No rails were laid, as no waggon work was allowed.

The following were the rates of wages paid, and the time worked by the several trades employed:—

Masons	..	..	13s. per day	..	..	..	8 hours
Blacksmiths	..	..	11s. "	..	..	..	10 "
Milners	..	..	10s. "	..	..	..	8 "
Fitters	..	..	10s. "	..	..	..	8 "
Excavators and other Labourers	8s.	..	..	..	..	..	10 "

On the works of the Dam the time was nominally ten hours; the actual time worked being nine hours twenty minutes, excepting Saturdays, when work ceased at 4 p.m. Throughout the summer months work was commenced at 5 a.m. (The horse drivers having already fed, groomed, and harnessed their horses.) The breakfast hour was eight until nine; at eleven work was suspended for twenty minutes for smoking. Dinner time was from 12.30 until 2.30 p.m. At four o'clock the men stopped again for twenty minutes, and, finally, at 5 p.m., the work ceased for the day, except for the horse drivers, who had their horses to attend to at intervals up to 8 p.m.

The men were paid in cash on the works once a month, subject to a drawback of one shilling per week per man, which money went to the sick fund, and provided the regular attendance of a doctor, and a large occasional contribution to the local Hospital. The cases of accident or sickness were very few, and, as a general rule, the men were very steady; any quarrels they had were settled amongst themselves.

The outlet pipes are three in number, each 12 inches in diameter, laid 3 feet apart, centre to centre, at a level of 13 feet below the surface of the water. They are laid in a cutting through rock at the northern end of the dam. Within the line of the dam a valve house is built of solid granite ashlar, set in Portland cement, the side and end walls being four feet thick, and the intermediate walls between each pipe two feet thick, connected by bond courses running through. The valve pit is thus divided into three chambers; in the side walls of each are three parallel vertical chases cut to admit of stop boards being let down, to cut off the connection between the reservoir and the valve in each case, so as to admit of ready access to the latter in the event of repairs being required. This is effected by letting down two rows of stop boards, and forming a coffer dam, by filling in with puddle. An outer chase is also cut 12 inches wide and 6 inches deep in the wing walls facing the reservoir; by dropping timbers into this, and filling behind with sandbags and earth, the water from the reservoir may be completely cut off. One of the three pipes is taken into the body of the reservoir, and terminates on a granite pier at 26 feet lower level than the outlet. This is continued on the outer side to the creek below the dam, and forms a syphon by which the lower waters may be drawn off for compensation to the creek. The valves of the inner valve house are of brass, worked by means of long spindles screwed at their upper ends, and fitted in headstocks. Brass screens will be fitted in the inner valve house, so arranged as to take the water from the surface of the reservoir.

On the inside of the line of the Dam a second valve pit is constructed, also of granite and cement, this has no subdivisions, and the three pipes have cross connections with regulating and air valves, admitting of the use of any one or of all three delivery pipes for the town supply.

It will be observed, on an inspection of the map, that the pipe track crosses the Enoggera Creek thrice, and thence Creek once, as these Creeks rise from ten to fifteen feet in heavy floods, it was a matter for consideration as to the best mode of taking the pipes across, so as to run least risk of accident. What appeared the most economical and safest plan was to bury the pipes enclosed in a wall of solid masonry, rising not more than a foot or two above the creek, and carried down to a solid foundation; this plan was adopted throughout in every watercourse. The air and scour valves are also set in masonry.

The pipes are of Tan Yean (Melbourne) pattern, and were supplied by Messrs. Eddington and Sons, of Glasgow. The Valves by Messrs. Guest and Christmas. Special Castings and Valve Works were supplied by Messrs. P. N. Russell and Co., of Sydney. The works generally were let on the small contract system. Messrs. Donohoe and Hulme executed the earthwork of the Dam; Mr. W. W. Grimes the masonry of the Dam and pipe track; and Mr. George Cooper the Tunnel works and pipe track. The joining of the pipes was performed by day labour employed directly by the Board, under supervision of a Clerk of Works.

It is expected that the works will be completed and the water laid on early in July.

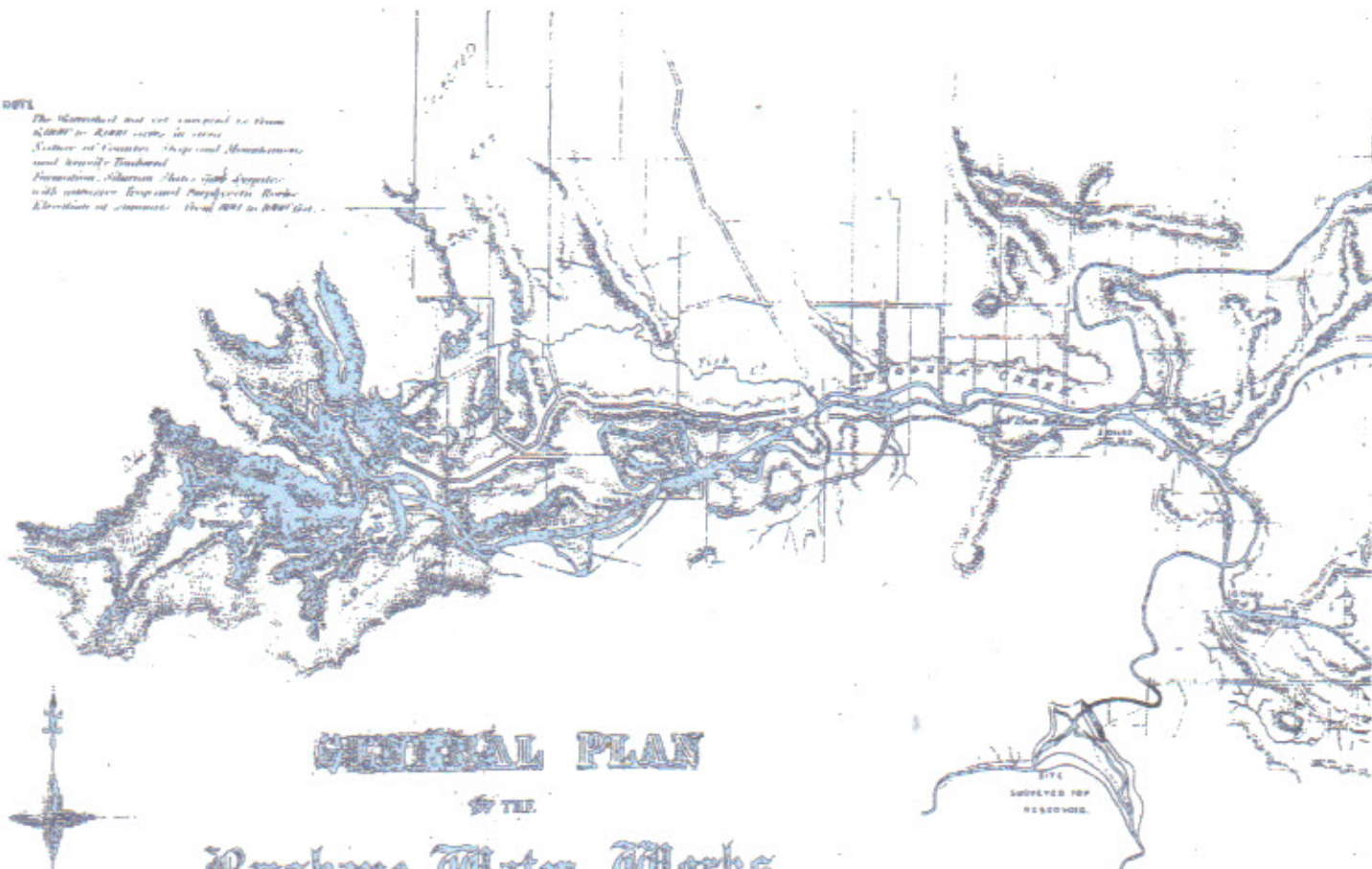
JOSEPH BRADY.

Brisbane, 24th May, 1866.



1861

The Government has not assigned to them
 1861 to 1866 with its own
 Nature of Country, Topographical Features,
 and general description
 Formation, Soil, and Climate
 with numerous engraved topographical views
 Elevations of mountains from 1861 to 1866 (ft.)



CENTRAL PLAN

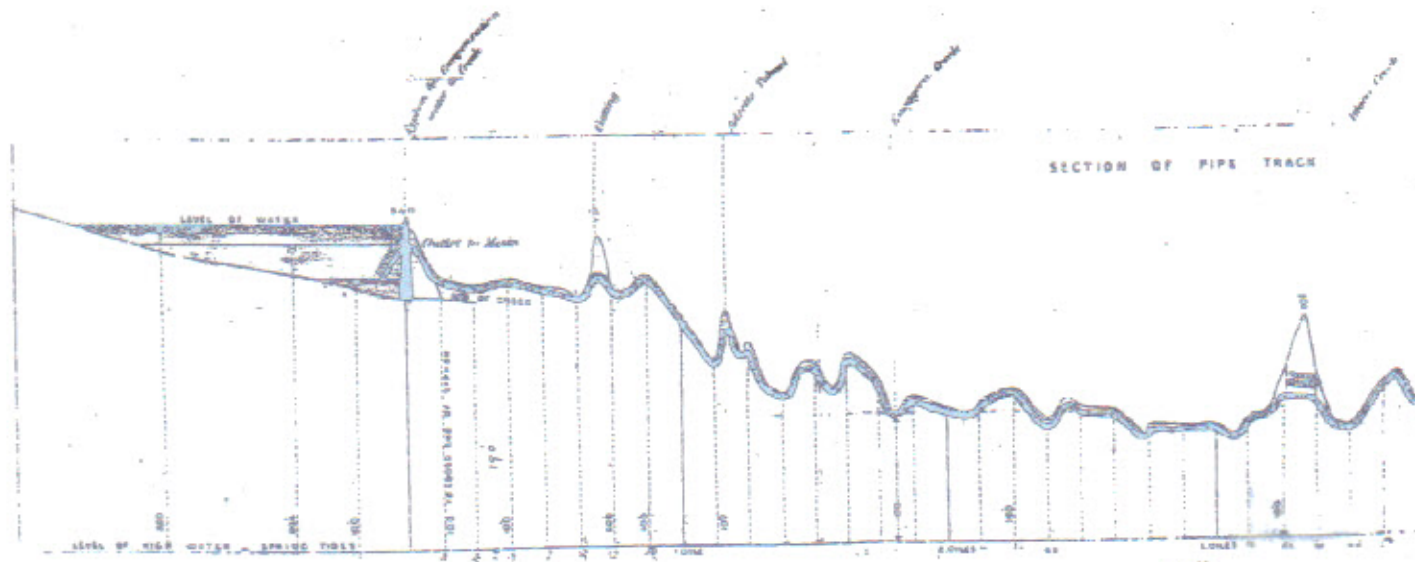
BY THE

Brisbane Water Works,

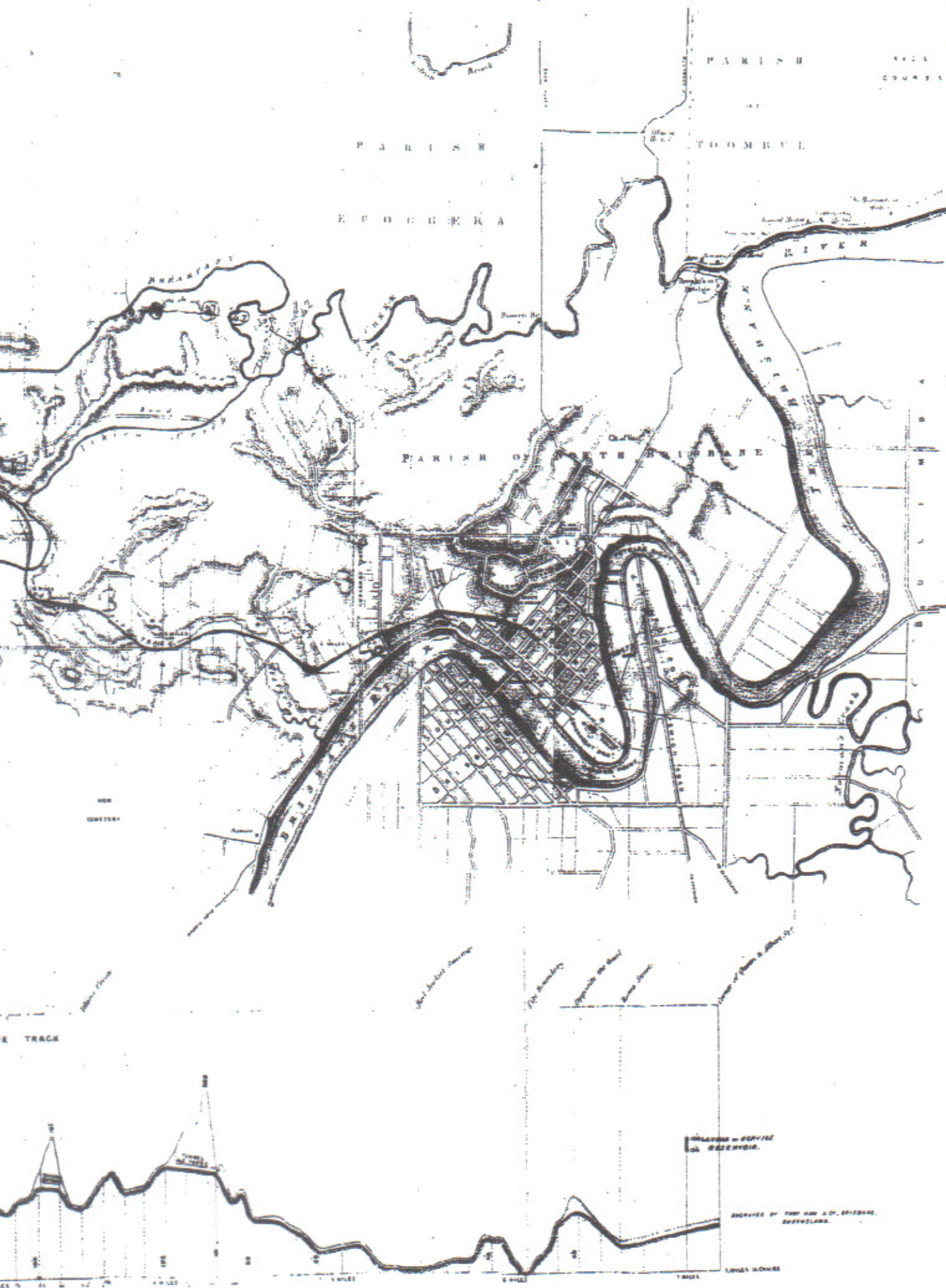
1866.

As Executed by the Board.

Joseph Brady,
 Engineer.



Horizontal, 1/4 inch to 1 foot. Vertical, 1/4 inch to 1 foot.



dominant effect to 1 bar

JOSEPH BRADY

Minstce



Photograph by
courtesy of
Miss E. L.D.
Brady.

BRADY, JOSEPH (1828-1908), designer and builder of railways, water supply and harbours. Born near Enniskillen in north Ireland on 18 August 1828 and apprenticed on his thirteenth birthday to his father as a surveyor, he was just twenty-two when he arrived in Sydney in 1850, with five and a half years' experience on railway location and construction.

From the time of his arrival he filled various senior positions and after 1857 he was always in sole charge. His first job was as assistant to the Engineer of the Sydney Railway Co., which had recently been formed to build and operate the line to Parramatta; initially on survey and design he was Resident Engineer during construction after 1851. In 1851 Brady spent six months in Victoria, surveying and drafting for the Yan Yean scheme, and he returned to that Colony in 1858 as the first engineer to the Bendigo Waterworks Co; he designed a scheme to serve the goldfields, but there were funds for only one reservoir (No. 7, still in use), for the water-treatment plant and for the reticulation of Sandhurst (now Bendigo). In 1863 he managed a contract on the Melbourne-Sandhurst Railway, but resigned in order to investigate the Coliban River scheme, which is the basis of the present supply of the Castlemaine-Bendigo area.

Early in 1864 Brady was in Queensland, and he obtained a contract for the improvement of navigation between Brisbane and Ipswich (there was no rail

connection until 1875); this included underwater blasting for a channel through Seventeen Mile Rocks and for the basin at the port of Ipswich, and building a training wall at the junction of the Brisbane and Bremer rivers. He relinquished the contract in April 1864 when he was appointed Engineer to the Brisbane Board of Water Works, designing and supervising the first, permanent water-supply scheme in the Colony, including Enggerra Dam which is still in use. The work was completed in August 1865 but in January 1865 he was given an additional appointment as the first Engineer of Harbours and Rivers, responsible for all port and harbour work in Queensland, and for provincial water supplies; it included dredging in the Brisbane and Fitzroy rivers, and water-supply schemes for Bowen, Rockhampton, Maryborough and Ipswich. His Department was disbanded after the financial crisis of 1866, but Brady was retained as consultant, and in August 1867 took over for the Government the management of an unsatisfactory contract for the construction of the railway from Toowoomba to Dalby, completing the work at less than the contract price, and receiving a bonus from the Government and a civic reception and presentation from the citizens of Dalby.

Brady returned to Victoria, in 1868 to manage a contract on the Melbourne-Seymour Railway but he had continued as consultant to the Bendigo Waterworks Co., and he returned to Sandhurst in 1871 to extend the work, including the construction of Crusee Reservoir (still in service). In 1877 he was appointed the first Engineer of the Melbourne Harbor Trust, where his main task was to improve the Yarra River, and build the present Victoria Dock, the basic plan for which had been prepared by the English consultant, Sir John Coode. Brady was able to persuade the Trust to make two important changes: to develop the site as one large basin rather than three small separate docks, and to build timber wharves instead of masonry and concrete quays; this halved the cost of wharfrage, reduced the time of construction, made operation easier and allowed progressive modernization of the port. Most of Brady's piling is still in place, reinforced-concrete deck; most of the planned work was complete when he retired in 1891.

Few engineers have personally investigated, designed, constructed and operated in as many fields as Brady. The speed at which he worked is most impressive; he completed the survey and drawings for Yan Yean in six months, located and marked out two alternative rail routes between Parramatta and Mittagong in six months, and had contract work started on the dam for the Enggerra scheme less than four months after his appointment. This was fast by any standard and shows a well-informed man of vigour and decision. After retiring Brady worked as a consulting engineer and arbitrator until 1894; he died at Elsternwick, Victoria on 8 July 1908, survived by seven children.

ADB, vol. 3, pp. 216-17; Archives, State Rail Authority of NSW; C.F. Kerr, 'The Men from County Fermanagh', p. 101 of Melb. Q'ty, July-Sept 1965; VAP (LA Q'd), 1865, p. 1295, 1866, p. 1572, 1866, p. 557; Min. Proc. Inst. Civ. Eng'rs, vols. 56 (1878-9), 74 (1882-3), 159 (1905), 174 (1907-8); information from Mr K. Murray, Melbourne, Miss E.L.D. Brady, Bussellton, WA, and Mr F.L. Adelaide.

APPENDIX II

CAPACITIES AND DISCHARGE RATES

GOLD CREEK AND ENOGGERA DAMS

Gold Creek Reservoir

Table showing the available quantity of water in the reservoir at each 5 feet in depth on the gauge at the outlet tower from Stewart's accurate 1882 survey compared with Henderson's preliminary survey of 1879.

Height above datum	Height on gauge (feet)	Available (millions of gallons) <i>Stewart</i>	Quantity of water (millions of gallons) <i>Henderson</i>
315.00	50	400	406
310.00	45	325	321
305.00	40	242	248
300.00	35	181	187
295.00	30	130	136
290.00	25	89	96
285.00	20	58	64
280.00	15	32	37
275.00	10	15	21
265.00 Level of outlet	0	0	10

Enoggera Reservoir

Height above datum	Height on gauge	Discharge of 8 inch main		Discharge of 12 inch main	
		per hour	per 24 hours	per hour	per 24 hours
239.00	0	21,259	510,235	58,584	1,406,030
23,400	5	20,775	498,600	57,249	1,373,990
229.00	10	20,279	486,705	55,884	1,341,216
226.00	13	19,975	479,419	55,047	1,321,128
224.00	15	Level of outlet			
Capable of being increased to					2,682,436 gals

ENOGGERA DAM & PIPELINE (APPENDIX 111)
IMPERIAL TO METRIC CONVERSIONS

Inches" to Centimeters

2	-	5.1
8	-	20.3
9	-	22.9
16	-	40.6

Feet' to Metres

1.44	-	0.4
2	-	0.6
4	-	1.2
5	-	1.5
6	-	1.8
5'6"	-	1.7
6'6"	-	2.0
10	-	3.0
14	-	4.2
15	-	4.5
17	-	5.1
24	-	7.3
25	-	7.6
26	-	7.9
36	-	10.9
41	-	12.4
48	-	14.6
65	-	19.8
70	-	21.3
100	-	30.4
150	-	45.7
170	-	51.8
176	-	53.6
184	-	56.0
190	-	57.9
200	-	61.0
210	-	64.0
220	-	67.0
230	-	70.1
240	-	73.1
320	-	97.5
800	-	243.8
1000	-	304.8

Yards to Metres

30	-	27.4
187	-	171
363	-	332
374	-	342
412	-	377
700	-	640
2600	-	2377
11400	-	10424

Miles to Kilometres

2¼	-	3.6
5	-	8
7m 14 ch	-	11.5
8	-	12.8
11	-	17.7

Area

Acres to Hectares

188	-	76
261	-	106
7000	-	2833

Volume

Gallons to Litres

20	-	76
41	-	155
300000	-	1136000
2541000	-	9619000
2.43 million	-	9.2million
5700million	-	21577million

Cubic Feet to Cubic Metres

11400	-	323
406560	-	11513

Cubic Yards to Cubic Metres

18000	-	13762
125000	-	95569

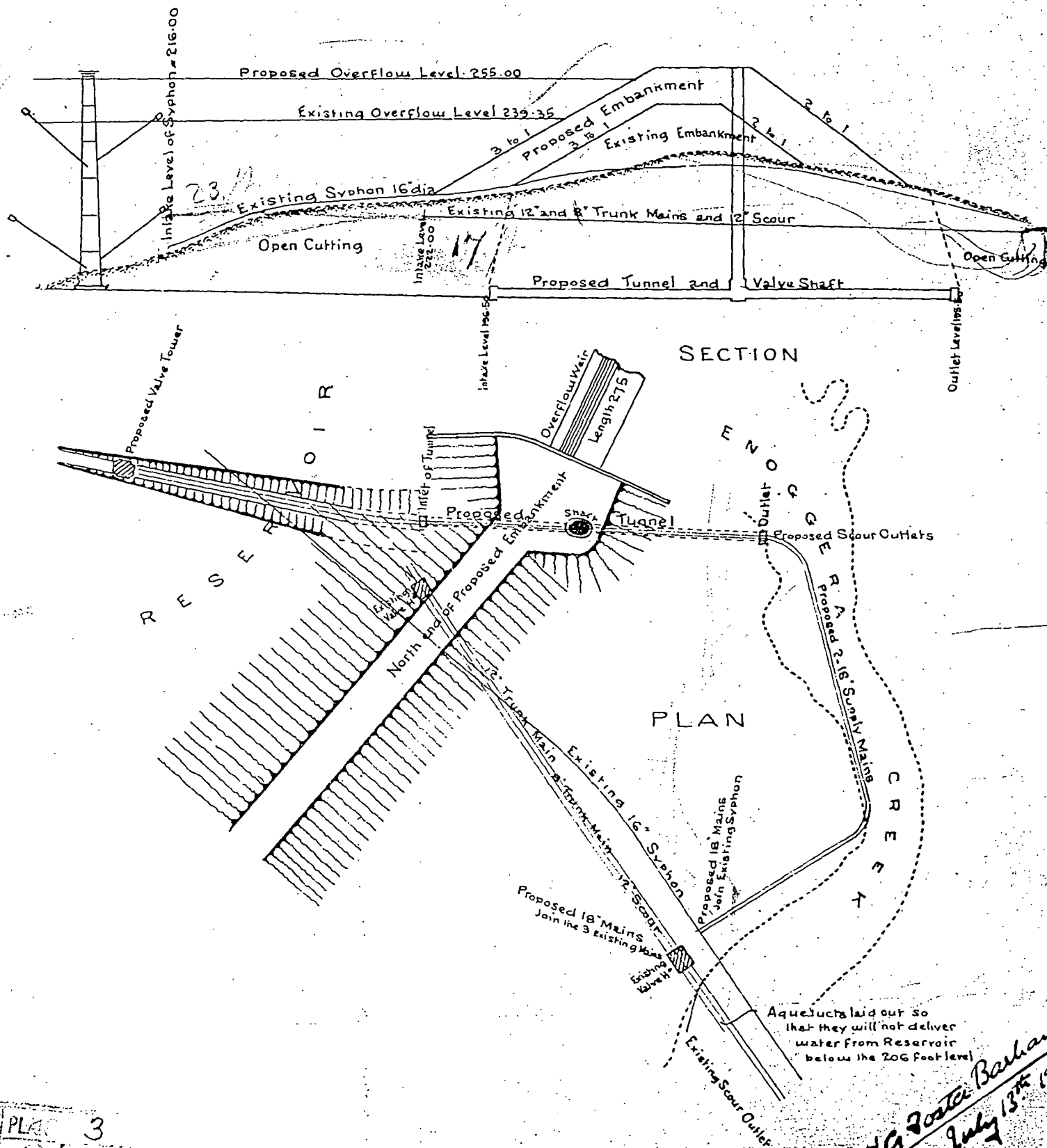
For Appendix 11

10foot	3.04metres
100 "	30.48metres

10000gallons	37854.1litres
100000 "	378541.1 "
1000000 "	3785411.7 "

Brisbane Board of Waterworks

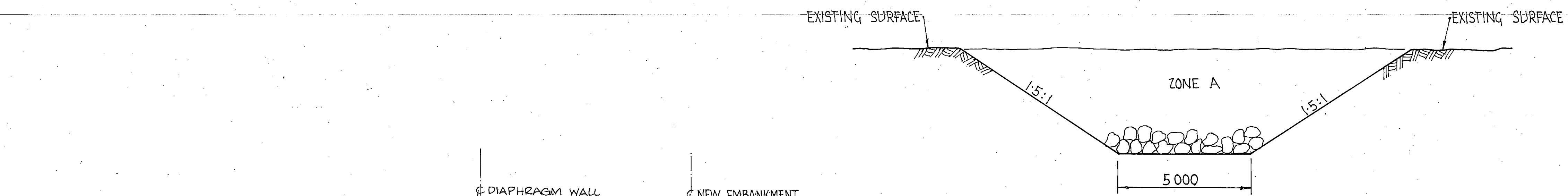
Sketch showing proposed alterations to Enoggera Reservoir.



H. G. Foster Barham
 July 13th 1901.

3/4 3
 4 300

PLA 3
 No. 4 30

[illegible]

CREST RL 81.62.

ISO SURFACING - ZONE D.

1000mm ZONE B

ZONE A

ZONE B

ORIGINAL SURFACE LINE

LINE OF COUNTERFORTS.

FOUNDATION EXCAVATION LINE

WEIR

ZONE B1

1000mm

SPECIAL COMPACTION OF ZONE B MATERIAL FOR 1000 mm WIDTH AROUND STRUCTURES AS SPECIFIED.

A detailed cross-section diagram of a dam and embankment. The diagram shows the following features and labels:

- EXISTING DAM**: Indicated by a vertical line with a cross symbol at the top.
- NEW EMBANKMENT**: Indicated by a vertical line with a cross symbol at the top.
- ISO SURFACING - ZONE D.**: A horizontal line at the top right, labeled **R.L. 85.40**.
- 1000 ZONE B**: A triangular area between the intake structure and the embankment.
- ZONE A**: The area between the 1000 ZONE B and the embankment slope.
- LINE OF COUNTERFORTS**: A dashed line within the embankment.
- FOUNDATION EXCAVATION LINE**: A dashed line at the base of the embankment.
- 1000 ZONE B COVER AND SURROUND TO CONCRETE ENCASED PIPE TRENCH**: A hatched area at the toe of the embankment.
- 2,000**: A dimension line for the width of the cover area.
- BACKFILL TOE EXCAVATION**: A hatched area at the toe of the embankment.
- 1:5:1**: A slope ratio label for the embankment.
- INTAKE STRUCTURE**: A vertical structure on the left.
- ORIGINAL SURFACE LINE**: A dashed line on the left.
- INTAKE CHANNEL**: A horizontal channel on the left, labeled **R.L. 70.20**.
- SPECIAL COMPACTION OF ZONE B MATERIAL FOR 1000 mm WIDTH AROUND STRUCTURES AS SPECIFIED**: A note pointing to the area around the intake structure.
- WATER SUPPLY AND DRAINAGE PIPES**: A note pointing to the area around the intake structure.

[illegible]

ROADWAY

150

SLOPE 1:50

150 ZONE D SURFACING

15:1

8'

1:5:1

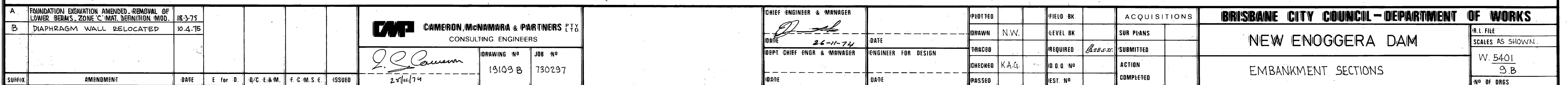
ZONE B

ZONE A

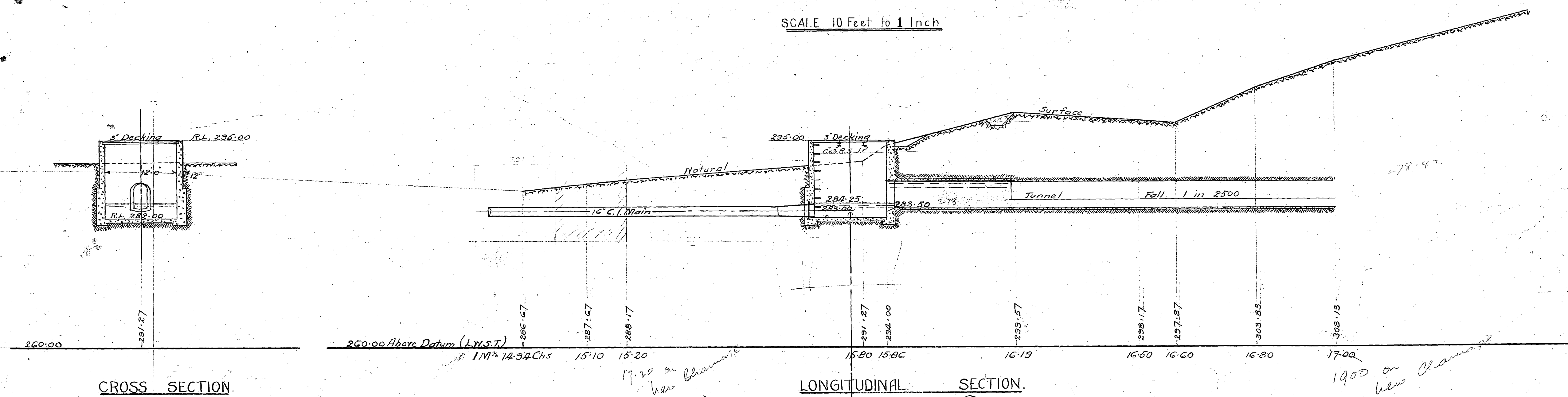
FOUNDATION EXCAVATION LINE

NOTES:

1. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE SHOWN.
2. ALL R.L'S IN METRES TO B.C.C. DATUM.
3. FOR CROSS SECTION LOCATIONS REFER DRG: W/5401
3
4. ACTUAL EXCAVATION MAY VARY FROM ASSUMED EXCAVATION LINES SHOWN.



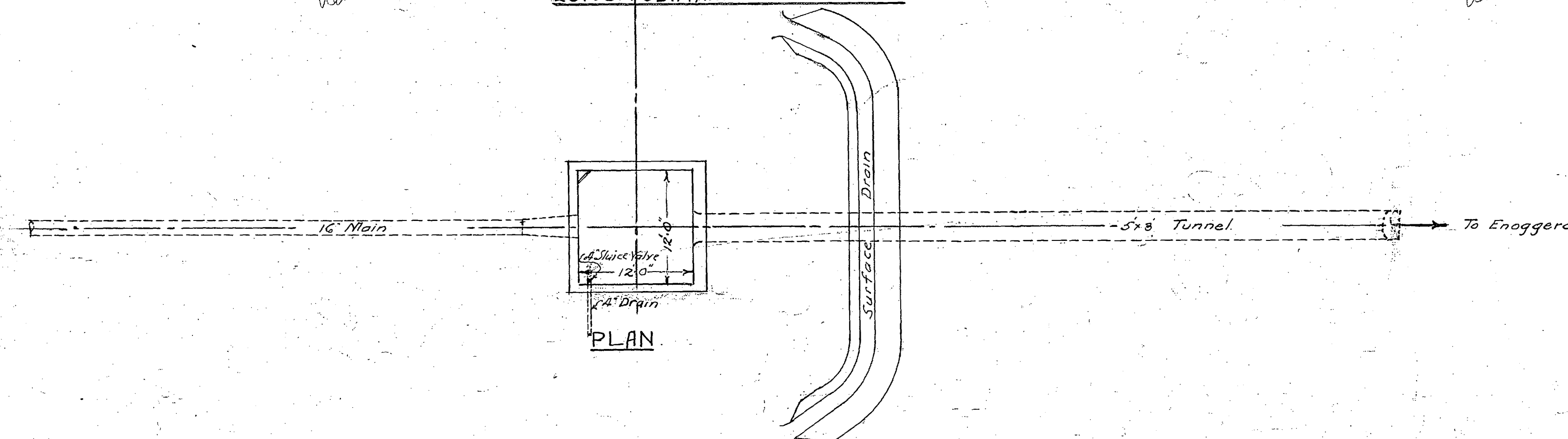
SCALE 10 Feet to 1 Inch



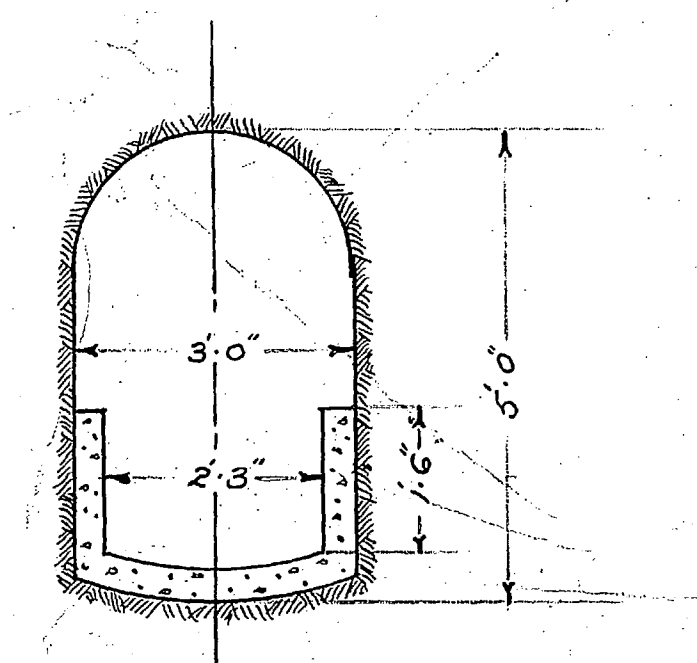
CROSS SECTION

LONGITUDINAL SECTION.

—TUNNEL ENTRANCE—

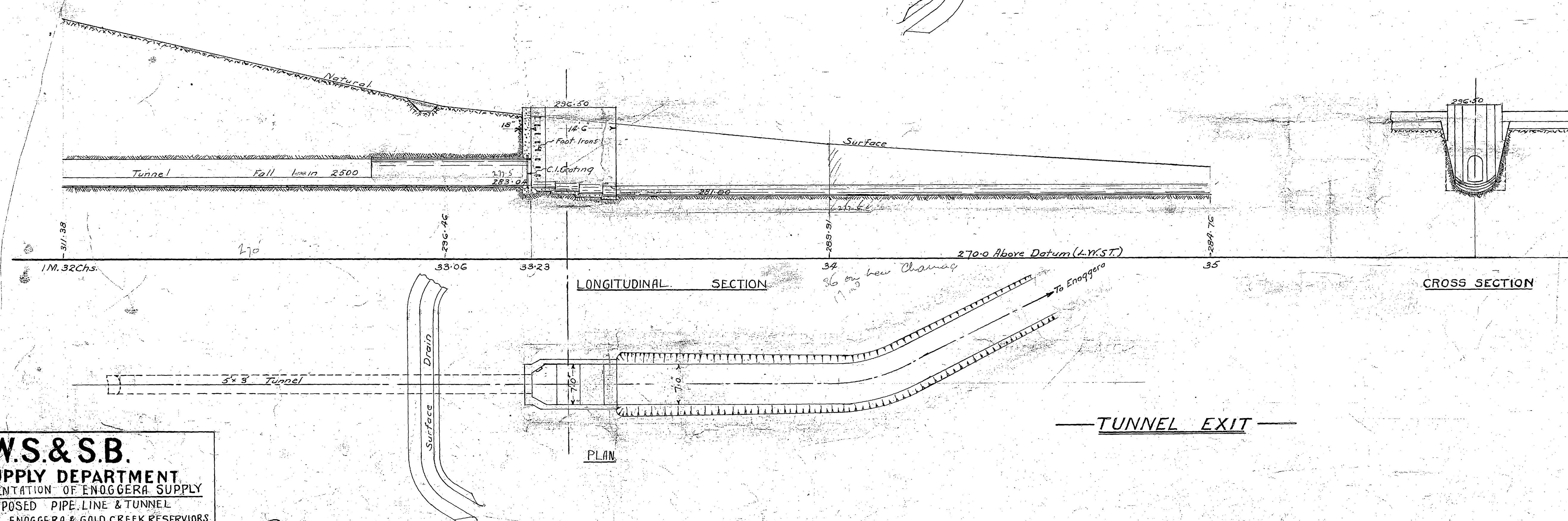


PLAN



SECTION OF TUNNEL.

Scale $\frac{1}{2}$ Inch to 1 Foot.



CROSS SECTION

-TUNNEL EXIT

M.W.S.&S.B.

WATER SUPPLY DEPARTMENT

SUBJECT: AUGMENTATION OF ENOGGERA SUPPLY
PROPOSED PIPE LINE & TUNNEL
BETWEEN ENOGGERA & GOLD CREEK RESERVOIRS
DETAILS.

Mr. Peant
E. W. S.
27/3/19

 $\frac{3}{4} \cdot 49$