LOCKING THE MURRAY: THE HERITAGE OF ENGINEERING PROCESS

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The South Australian Government (SAG) took the lead in planning and construction of the River Murray locks and weirs, from Lock 1 at Blanchetown, SA, to Lock 9 in NSW, and the Lake Victoria Storage in western NSW. Construction stretched over 20 years, starting at Lock 1 in June 1915. Planning however had begun much earlier with a survey of the Murray to identify potential lock locations (1906-1914) and the engagement in 1912 of Captain Johnston, of the US Army Corps of Engineers, to advise on design and construction. In 2001 the Institute of Engineers nominated the River Murray Works as a National Engineering landmark. But the heritage of the works includes more than the structures themselves, encompassing many aspects of the process. There are two associated heritage riverboats: PS *Ruby*, used by Johnston for determining the size of the larger locks, and PS *Captain Sturt*, custom-built at Cincinnati, Ohio, as a stern-wheeler to push barges of stone into place. This paper provides a broad approach to the heritage of the River Murray works, covering the remarkable set of maps and field books, the photographic record held by SA Water, the construction villages, and some surviving physical items relating to the construction phase.

KEYWORDS: River Murray, locks and weirs, riverboats, Captain Johnston

1 INTRODUCTION

When we think of built heritage, it is usually the finished structure or place that come to mind – the public building, the magnificent house, and in the case of engineering, the bridge, dam, or other structure. The heritage significance is assessed on a range of criteria: historic importance, social value, aesthetic appeal, technological or scientific advance. Behind the finished the heritage item, however, is the process of creation: the idea, the planning and the construction. This is perhaps more important for engineering heritage than, for example, a church or pastoral homestead, which may have high aesthetic or historic significance but which did not require a long creative process.

This paper examines the heritage of the locking of the Murray River in the early 20th century from the point of view of the process of creation, and considers the range of heritage items, some built, some documentary, which could be included, beyond the actual locks and storage structures themselves.

The locking of the Murray was one of the first major projects of the newly federated Australia (Figure 1). While the River Murray Agreement between South Australia, New South Wales and Victoria was signed in 1915, and the Murray River Commission established in 1917, serious planning started well before that, with the 1902 Interstate Royal Commission inquired into the conservation and distribution of the Murray River and its tributaries waters for irrigation, navigation and water supply purposes.

The concept had in fact been around for a long time, with eleven inter-state conferences and Royal Commissions between 1863 and 1913 (Eaton 1945). The politics of this long drawn-out process are beyond the scope of this paper, but it seems that it took Federation before any agreement could be reached. From 1908 to 1912, discussion took place between the three states, New South Wales, Victoria and South Australia, which resulted in the Lake Victoria Agreement Act 1913, the Murray Waters Agreement Act 1914 and the River Murray Act 1915.

Both before and after the agreement and legislation, the South Australian Government (SAG) took the lead in planning and construction. Lock and storage construction stretched over twenty years, starting at Lock 1 in June 1915. Planning, however, had begun very much earlier with a survey of the Murray to identify potential lock locations (1906-1914) and the engagement in 1912 of Captain E. N. Johnston, of the US Army Corps of Engineers, to advise on design and construction.

Locks 1-6 were on the South Australian Murray, but the SAG also built Locks 7-9 on the NSW Murray, and the Lake Victoria Storage in NSW. Lake Victoria was transferred to SA Government ownership, as a guarantee of water for the downstream state. Today, Lake Victoria Storage and Locks 7, 8 and 9 in NSW are still managed by small outposts of SA government employees.

In 2001 the Institution of Engineers nominated the River Murray Works as a National Engineering landmark (Black 2001, Institution of Engineers 2001). Few of the items are recognised on state heritage registers: just Lock 1 (William Randell Lock) on the SA SHR. None of the Murray locks are on the NSW State Heritage Register, but Lock 10 and the associated Lockmaster's Cottage are on the Wentworth Shire LEP section 5 register.

But the heritage of the works includes more than the structures themselves, and encompasses many aspects of the process. For example, there are two associated heritage riverboats. The PS *Ruby*, restored and based at Wentworth, was used by Johnston as the basis for determining the size of the larger locks, and the PS *Captain Sturt*, now a wreck at the Goolwa Marina, was custom-built at Cincinnati, Ohio, as a stern-wheeler, for the purpose of pushing barges laden with stone into place.

This paper provides a broad approach to the heritage of the River Murray works, covering the remarkable set of maps and field books, the photographic record held by SA Water, the construction villages, and some surviving physical items relating to the construction phase, such as a drag-line excavator and timber wave-break at Lake Victoria Storage.

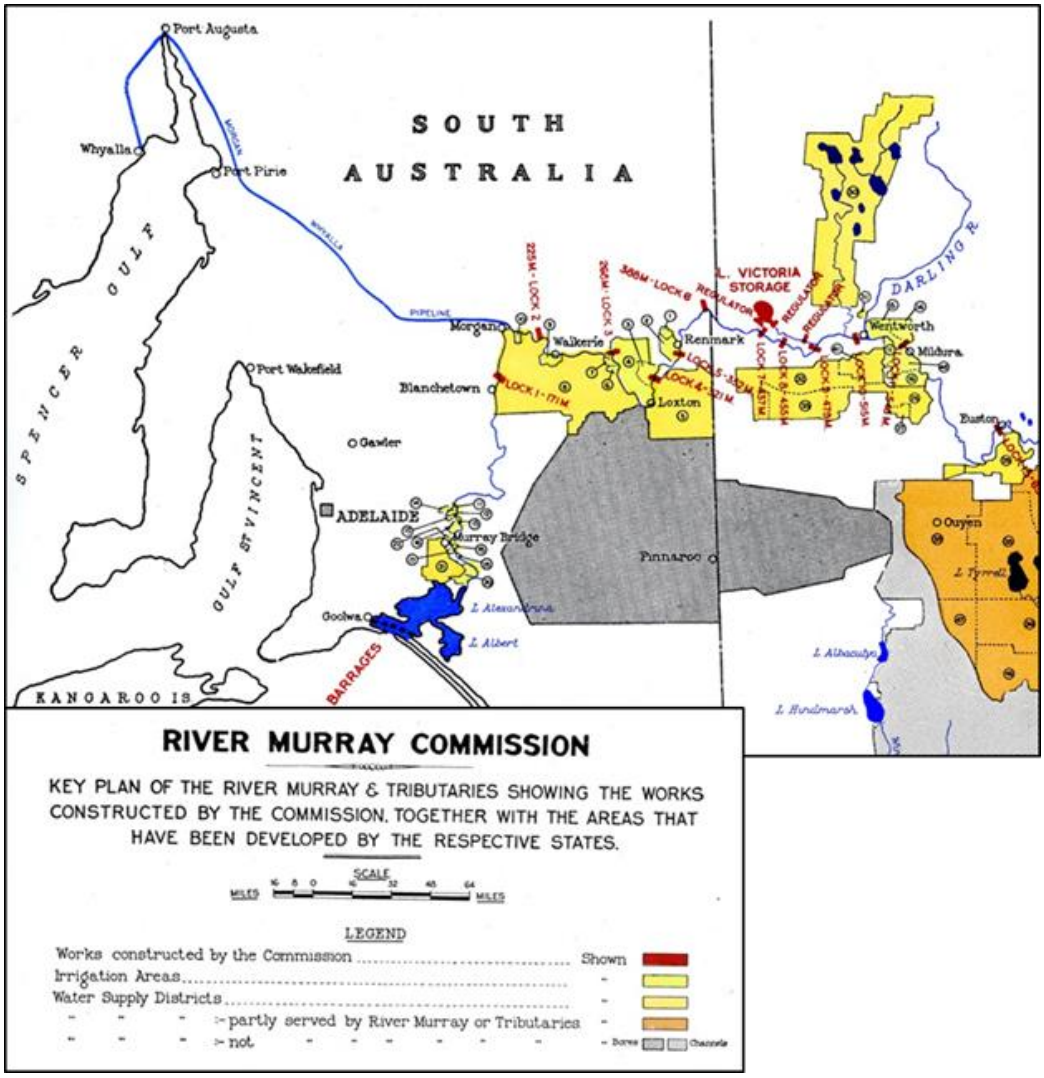

Figure 1 River Murray Works, Euston to Murray mouth. (Eaton 1945).

2 MAPPING THE MURRAY 1906-1914

The initial survey of the South Australian Murray was carried out in 1906-08. Three teams of surveyors (Figure 2), each made up of a Surveyor, Assistant Surveyor and Field Assistant, worked on various sections of the river, recording their work in 21 Sketch Books, and a large number of Field Books and Level Books. The Sketch Books contain plans of the river and extend to the edge of the floodplain, Level Books contains plans along survey transects and Level Books list survey data (but also contain sketches and notes). These books are held in the SA State Records, but have not been digitised. For this project the 21 Sketch Books have been scanned (5 GB) but the Field and Level Books have not yet been investigated. By comparison with the later survey described below, it is estimated that there could be about 40 Field Books and as many as 400 Level Books. The result of all this work was 72 maps, which can be downloaded free from the SA State Library website (Figure 3).

Figure 2 Surveyors at work at the mouth of Ral Ral Creek, near Renmark, surveying in connection with the proposed locking of the Murray. (Image courtesy State Library SA PRG 3280/1/30/2230).

From 1912-14, the survey was extended upstream, between the SA Border and the Murray-Darling Junction (Figure 4). The process was the same, teams of surveyors working on different stretches of the river. The area surveyed was geographically wider than in the Murray Gorge of SA, and included the Rufus and Frenchmans floodplain in NSW and similar channels and floodplain to the south in Victoria. This survey generated 6 Sketch Books, 15 Field Books and 127 Level Books and resulted in 34 maps. These maps have been digitised by the National Library of Australia, and are now also downloadable. The survey books are accessible in the SA State Records, and the Sketch Books, Field Books and some of the Level Books have been scanned for this project.

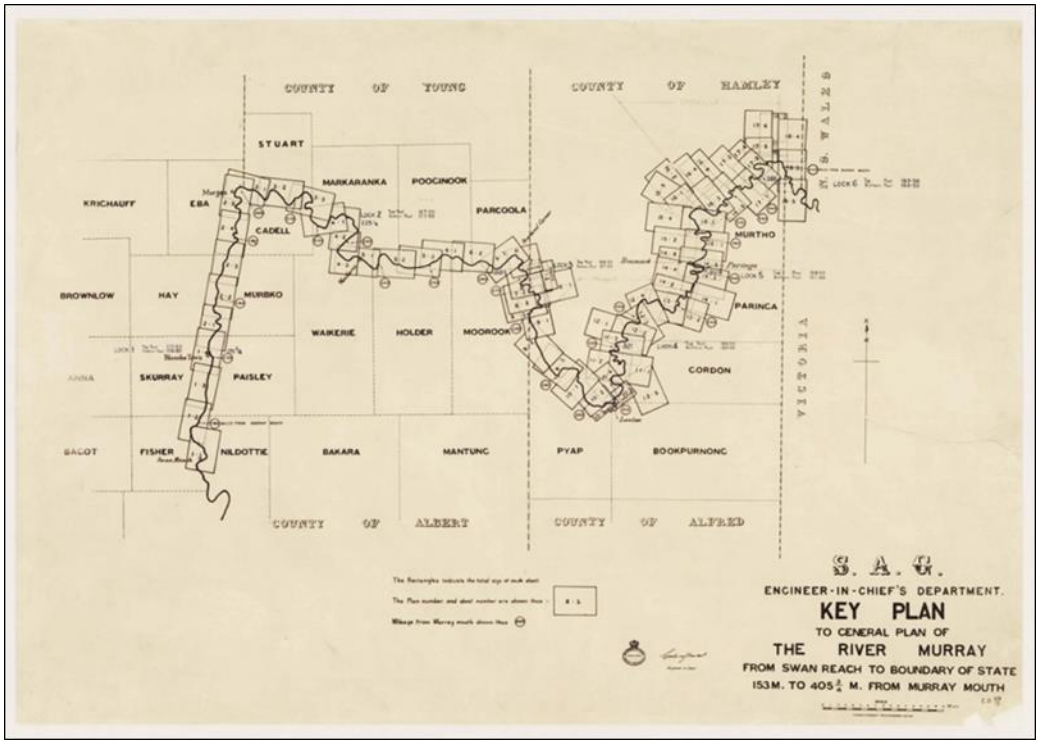

Figure 3 General Plan of SA map sheets, SA Government Engineer-in-Chief's Department survey for determining positions of locks and weirs. (Image courtesy State Library SA, series 833.2 aj 1:9,600 C40 F12)

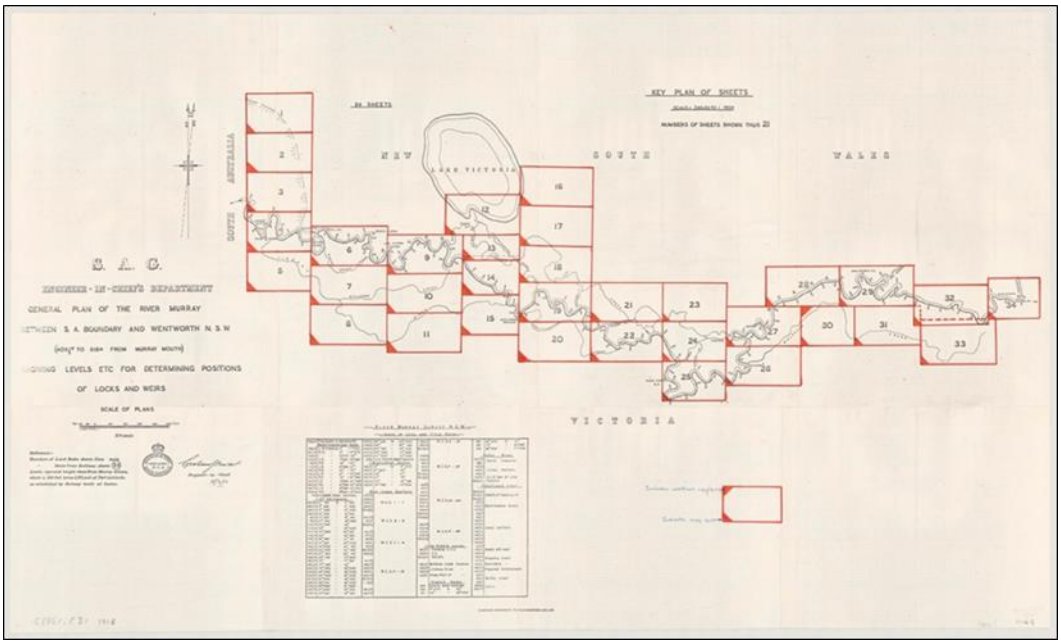

Figure 4 General Plan of NSW-Victoria map sheets, SA Government Engineer-in-Chief's Department survey for determining positions of locks and weirs, 1916. (Image courtesy State Library SA, series 810 aj 1:9,600).

This little known body of work is significant in a number of ways. It is an integral part of the River Murray regulation project and the scale and detail of the survey and the maps surpassed anything done before or after, until modern satellite imagery became available. The maps (and also the survey books) are works of art, perhaps the most detailed ever made within Australia, with both natural features, topography, vegetation, and water, and cultural features, tracks, buildings, fence-lines, telegraph and telephone lines carefully detailed. The vegetation is mapped and identified in a way that it would allow the generation of contemporary vegetation maps.

Perhaps most unexpected are the detailed plans of built features in the Sketch Books, effectively comprising a census of all the cultural structures along the Murray at the time, in the towns and villages, and on the pastoral stations and farms. Measured plans are provided for every building: hotel, shop, church, school, hall, homestead, farm house, woolshed, stable, dairy, pigsty, fowl-yard, even the outdoor dunnies, labelled EC, earth closet. The physical fabric is also indicated, with each wall of a building (if different) carefully marked: stone, brick, GI (galvanised iron), log, log & bag, log & thatch, wood slabbing, ruberoid, mallee root wall. Floor plans are provided for a few buildings, with the rooms labelled. Most important for engineering heritage are the plans of all the pump-houses along the river at the time, and associated structures such as the pre-regulation irrigation pipelines (Figs. 5, 6). Benchmark trees are also marked, some of which are still standing, 100 years later (Figs. 7, 8).

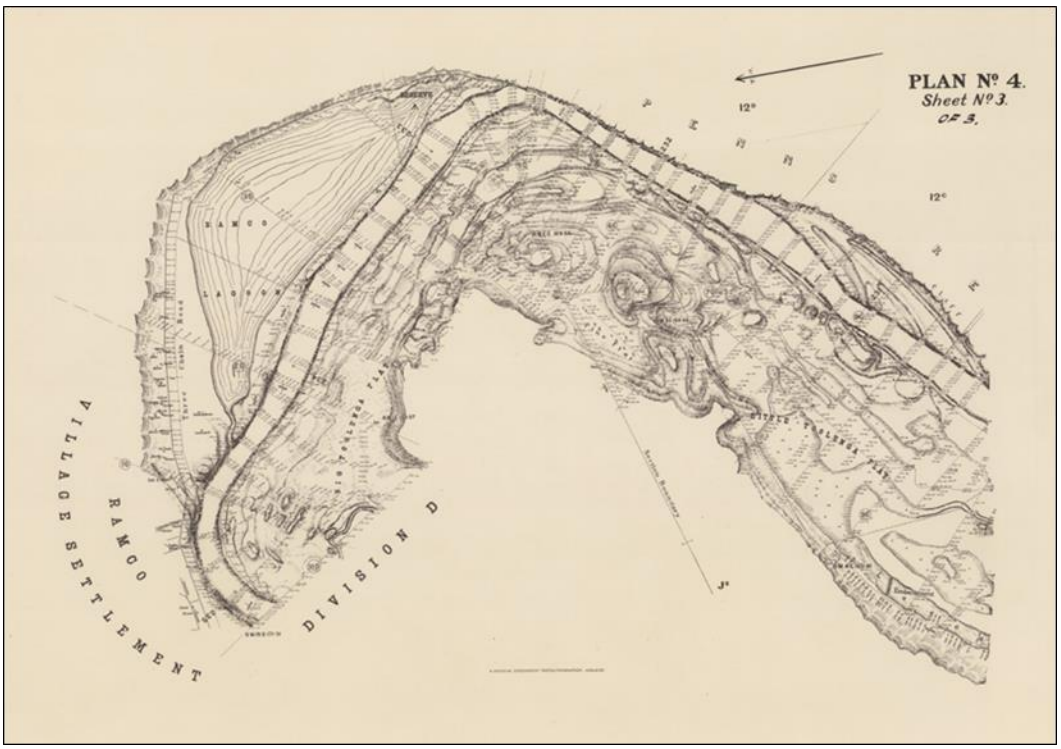

Figure 5 SAG Survey 1906 Plan No 4, Sheet No. 3 Ramco Village, near Waikerie SA. (Image courtesy State Library SA series 810 aj 1:9,600 C40 F5 c1)

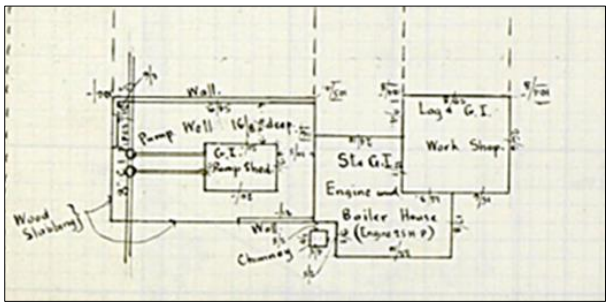

Figure 6 Plan of Pumping Station, Ramco Village, SA. (Image courtesy SA State Records, Sketch Book No. 222.)

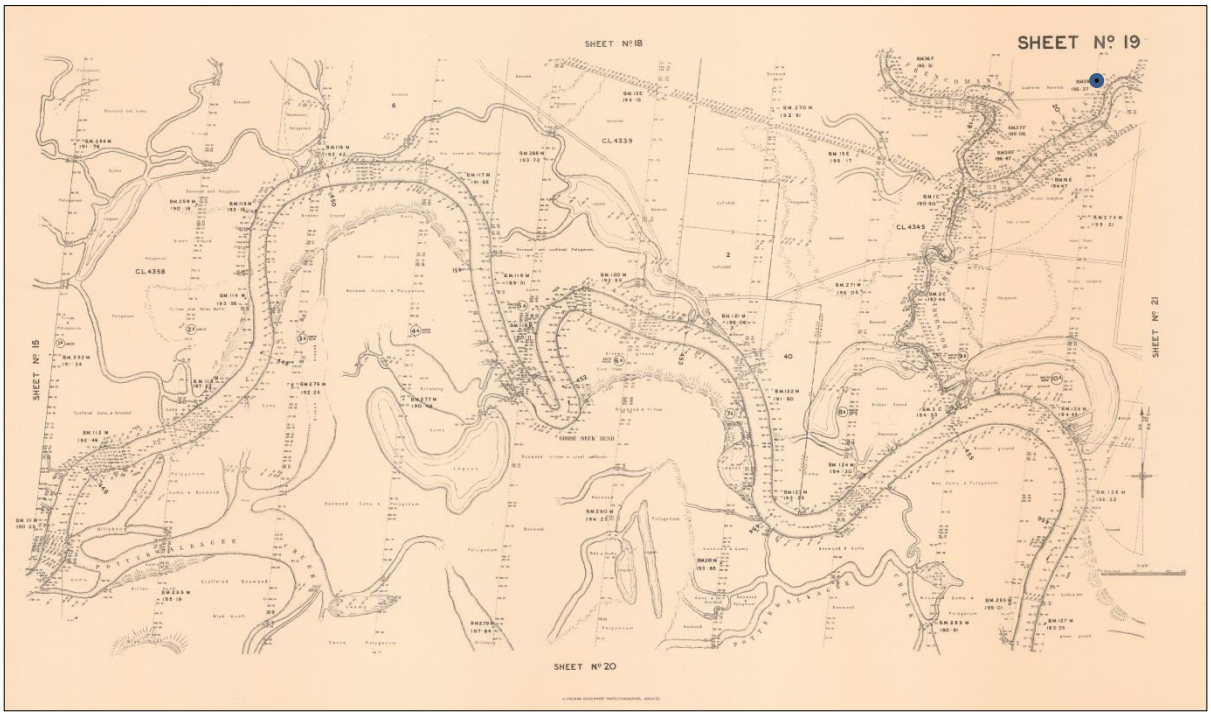

Figure 7 SAG Survey SA Border to Junction Sheet 19, showing Murray River and Frenchmans Creek, with location of benchmark tree BM39F, top RHS. (Image courtesy State Library SA series 810 aj 1:9,600 C40 F5 c1)

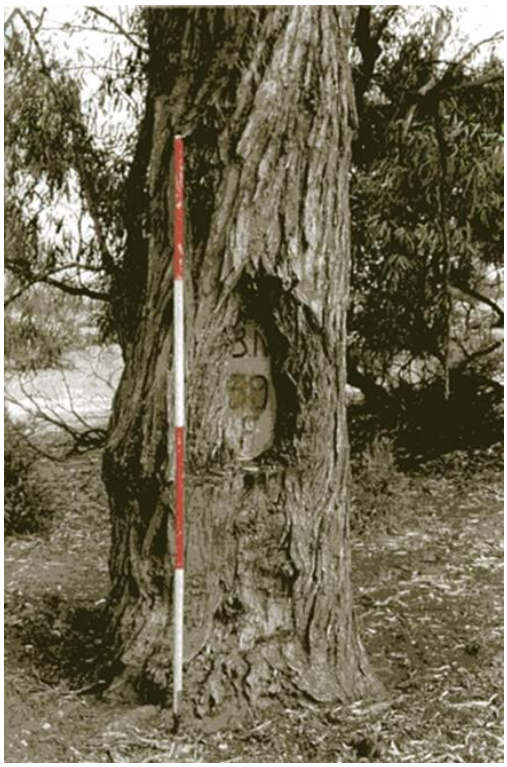

Figure 8 Benchmark Tree 39F, Frenchmans Creek, Lake Victoria. (Lake Victoria EIS photograph collection, 1997.

3 ROLE OF THE US ARMY CORPS OF ENGINEERS

The SA Government sought advice from the United States Army Corps of Engineers regarding the design and construction of the locks and weirs. The Corps of Engineers, while part of the US Army, also acted as an arm of the federal government in civil construction works. It was responsible for the survey and planning of Washington from 1791, and in the mid 19th century had a similar role there to the ACT National Capital Development Commission, managing construction of public buildings and overseeing municipal affairs (Scott 2011).

More importantly for the River Murray Works, the Corps of Engineers had, and still retains, a similar role to the Murray Darling Basin Authority and its predecessors. Its Civil Works Program includes water resource development activities including flood risk management, navigation, recreation, and infrastructure and environmental stewardship. This was the earliest Civil Works mission, starting in 1824. Now, the Corps maintains more than 12,000 miles (19,000 km) of inland waterways and operates 235 locks.

In January 1911, the SA Engineer-in-Chief, Mr Graham Stewart, left Adelaide on a tour which took him to London, Holland, Belgium, France and the USA (*Daily Herald* 15 December 1911). A letter from the US Ambassador in London introduced him to the Secretary of State in Washington, who in turn passed him onto the Secretary of War, thence to General Bixby, Chief of Engineer of the War Department. Stewart then interviewed the chief officers of the department, accompanied by Captain E. N. Johnston.

In October 1911, the SA Commissioner of Public Works (Hon. J. Verran) read Stewart's report in State Parliament **(***Express and Telegraph* 25 October 1911), making the following recommendations:

> (a) Captain E. N. Johnston, Assistant to the Chief of Engineers, U.S.A., to be employed as consulting engineer for the River Murray work, and to visit South Australia each year for two or three years, as may be required, remaining for such length of time as an absence from United States would allow, say, about 50 days.
>
> (b) An officer with previous experience in this class of work, chosen by Captain Johnston, to be appointed resident engineer under my department, to carry out the work in accordance with Captain Johnston's designs and instructions from time to time.
>
> (c) The work to be carried out in connection with the Engineer-in-Chief's Department, and the engineers to be under the general control of the Engineer-in-Chief.
>
> The above recommendations are, of course, subject to the approval of the United States Government, as previously explained to the Commissioner.

Captain Edward Neele Johnston (Figure 9) was born in St. Louis, Missouri, in 1876. The following biographical information is from the Arlington Cemetery website (Arlington Cemetery 2017).

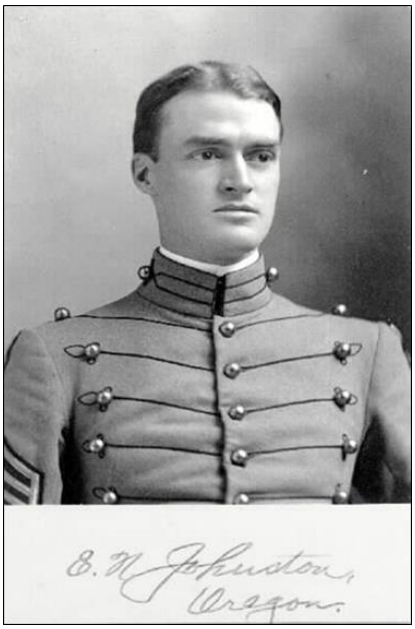

Figure 9 Captain Edward Neele Johnston. (1901 USMA Class Album, Special Collections, US Military Academy Library).

Johnston graduated from the United States Military Academy West Point in 1901. He had previously attended Leland Stanford University in California. After graduation, he was assigned to the 2nd Battalion and stationed at Fort Totten, New York, in charge of road and bridge construction. He studied at the U.S. Engineer School and was an instructor at US Military Academy A in the Department of Civil and Military Engineering. He worked on the construction of the Lock and Dam Number 4 on the Ohio River, and was involved in many river and harbour projects on the Mississippi and Ohio Rivers, and elsewhere. He was in charge of the U.S. Engineer office at Wilmington, Delaware, and was a member of the Board of Engineers for Rivers and Harbors.

In 1916, after his work in South Australia, Johnston was placed in charge of all new construction and improvements of the Chesapeake Bay on the Delaware, New Jersey, and Maryland coasts. In 1917, he was assigned as Commander of the 23rd Highway Engineers, and went with this regiment to France in 1918. He then served as Assistant Chief of Chemical Warfare Services, A.E.F., in France until 1918. Colonel Johnston retired in 1924, died in San Francisco, California, in 1936 at the age of 60, and was buried in Arlington National Cemetery.

On his first visit in 1912, Johnston spent a busy month in South Australia. Arriving in Adelaide on the 27 April on the P&O steamer *China*, he set off with Graham Stewart for Morgan on Monday 6 May. Their planned itinerary was a four horse conveyance to Overland Corner on Tuesday, then onto Loxton and Renmark the next day, Thursday to Chowilla, Lake Victoria on Friday or Saturday, back to Renmark on the Sunday and coach to Adelaide Monday or Tuesday (*Daily Telegraph* 3 May 1912). This was an ambitious schedule for 1912, but in fact they went further, reaching Moorna Station and examining Frenchmans Creek as well as Rufus River, though not without some adventure:

> Captain Johnston and Mr Eaton came through to Chowilla by pulling a boat. The recent foot rise in the river enabled the boat to navigate the river without trouble. The only inconvenience experienced was that they had to camp out two nights and as they were unprepared this was unpleasant, (*The Advertiser* 20 May 1912).

On 31 May 1912, Johnston submitted a draft report immediately before returning to the USA (Johnston 1913a). The final report, to the Commissioner of Public Works in SA, is dated 25 October 1912, and in it Johnston notes the perennial consultant's problems of tight time-frame and insufficient data:

> May 31st, 1912, I submitted to you, upon completion of my stay in SA, a preliminary report. Up to the present I have received detailed borings etc. for the sites for only two locks, but was informed before I left Adelaide that my report would have to be submitted in time to permit action during the present session of Parliament. …It is impossible to prepare estimates that are thoroughly reliable. (Johnston 1913b:7)

In his report, Johnston explicitly limited his advice to the engineering issues of lock, weir and storage construction. He noted that his report would not discuss, except incidentally, the effect of storages on the flow of the rivers, whether the effects of both irrigation and navigation could be met by storage, what areas of irrigated land could be developed,

> nor enter into the subject of the proper and equitable division of the waters of the river, since it is my understanding that those subjects are to be reported on by other engineers representing the states of South Australia, New South Wales, and Victoria. (Johnston 1913b: 8).

There were in fact several such engineering conferences between the chief engineers of the states, including an important one in 1912 (Inter-state Conference of Engineers 1913).

Johnston does, however, discuss the possibly of hydro-electric power generation based on the storage at Lake Victoria and another proposed for Parcoola near Renmark. Such power, he suggested, could be used for the development of factory towns or for pumping water for irrigation. The proposal was heavily qualified, as 'based upon data which I regard as being entirely insufficient for the preparation of estimates for a work of this magnitude and importance'. (Johnston 1913b: 35)

Captain Johnston visited South Australia at least once more, in 1912, but the subsequent oversight of the lock construction was done by another American, the 'officer with previous experience in this class of work' whom Johnston recommended. This was Robert Curtis Cutting (1881-1953) a civilian employee of the Army Corps of Engineers. Cutting and his wife spent seven years in South Australia from 1914-1922. He initiated the planning and construction of Lock 1 at Blanchetown, including orders for heavy machinery and equipment from overseas (Stagg 2015). No information has been found about Cutter's background and later activities; he is not mentioned in Eaton's (1945) history of the works.

4 THE RIVERBOATS

Three riverboats were pivotal to the construction of the Murray River Works, one, the PS *Ruby*, in the design of the locks and the others, PS *Captain Sturt* and PS *Industry*, in their construction.

4 .1 PS *RUBY*

The designs for all the locks and weirs, except Mildura and Torumbarry, were developed by Captain Johnston. He recommended the following: a lock chamber, for use by boats during normal flow periods; a navigable pass consisting of steel collapsible trestles supporting Boule shutters, which can be removed during high flow to allow boats to pass; a sluice section consisting of openings between concrete pylons normally closed by stop logs, which can removed during floods.

Two sizes of locks on the Murray were proposed. Those upstream of the Darling Junction (in fact only one lock was built, Lock 11 at Mildura) were to be shorter than those between Blanchetown and Wentworth. The larger locks were adopted for the Lower Murray because of the greater volume of traffic below the Darling Junction in the early 1900s. The locks were to be sufficient 'to accommodate one of the large steamers now in use, two of the large barges, probably abreast, at one lockage.' Alternatively, if that size proved too costly 'a lock to pass vessels singly, but capable of being enlarged in future, if necessary' (Johnston 1913b).

After a detailed study of the dimensions of the boats and barges operating on the Murray at that time, the two sizes Captain Johnston recommended were:

1. A large lock, 275 x 56 feet (843 x 17 metres), which was 'large enough to contain two standard barges and one steamboat at one lockage…with allowances for rudders and clearances at each end'. The size was arrived at by using the dimensions of the PS *Ruby*, 130.9 x 18.8 x 6 feet (39.7 x 5.7 x 1.8 metres), towing barges such as the *Ukee* and *Emerald* 130 x 26 x 6.5 feet (39.4 x 7.9 x 2.0 metres). These were considered the most suitable sized vessels for the Murray and Darling rivers.
2. The smaller lock, 170 x 56 feet (51.5 x 17 metres) 'would pass at one lockage two suitable barges, or the largest barge, *Cowie*, alone. It would also pass any steamboat on the river alone at one lockage. Ordinarily, steamboats towing one or more barges would be locked through separately from the barges.'

The PS *Ruby* was one of the early 20th century passenger boats on the Murray, built in 1907 (Figure 10). At the time of Johnston's design, she would have been considered an example of the latest modern riverboats. The PS *Ruby* was out of service by the 1930s, but after 12 years restoration work, she was back on the river in 2007, and is based at Wentworth, NSW (Hope 2007). She is on the Wentworth Shire LEP section 5 register, the Register of Australian Heritage Boats, but not on the NSW State Heritage Register.

Figure 10 PS Ruby in Lock, probably Lock 9. (Image courtesy State Library SA B12204)

4.2 PS *CAPTAIN STURT*

It was probably Captain Johnston who arranged for a stern-wheel steamboat, the PS *Captain Sturt*, to be built in Ohio for the work, and this was shipped to South Australia in sections and re-assembled by the third American employed on the project, Captain Washington Meredith, of Cincinnati, Ohio. He spent a year in South Australia (1915-16) assembling the steel-hulled paddleboat built in Ohio by the Charles Barnes Co. No information has yet been found about Meredith's background beyond an interview in the Adelaide *Advertiser* in 1916.

The hull was re-assembled and the engines installed at Mannum (Figure 11), then the boat was towed to Blanchetown where the superstructure was installed (Stagg 1915). The PS *Captain Sturt*'s primary role was pushing barges loaded with granite from the quarry near Mannum (Figure 12). (The granite quarry itself is an important part of the story, with a crusher plant, small railway, and elevated bins carrying the material to the barges.)

In an interview with the Adelaide *Advertiser* (25 November 1916, p 8), Captain Meredith said:

> He has been building river boats for 65 years… the Captain Sturt is an experiment as far as river navigation in Australia is concerned inasmuch as it pushes its freight ahead instead of towing the barges astern but it is by no means an experiment as regards the United States, where the Charles Barnes Company, the constructing firm, has 100 craft of the same type plying up and down the Mississippi, Wabash, Kentucky, Alleghany, and various other rivers. The Captain Sturt is the eleventh of the type Captain Meredith himself has superintended in construction, and in his opinion they have no equal for the handling of barges and derrick and dredge boats.

The newspaper article continued:

> The new steamboat is specially adapted for carrying stone from the Mannum quarry to the lock sites. She was submitted to a stiff test a fortnight ago, with excellent results. The down trip from Blanchetown to Mannum was made in five hours. On the following morning she went to a spot 18 miles below Mannum, where a barge had been sunk and raised, and brought it to Mannum the same evening. The next morning three barges full of water were pumped out and hitched on to the Captain Sturt, which backed out from Mannum in a high wind with the four barges ahead of her. To continue the narrative in the American skipper's word, 'She straightened them up and started right on up the river to the quarries, took on some wood, and continued the voyage. Her average push up the river with all this load was four miles an hour. The barges were in front, spread out to a width of 81 ft and the whole fleet was 265 ft. long. She made every bend of the river with-out once slowing down the engines. Five barges could have been steered up the river equally as well as the four. Coming down stream the Captain Sturt could bring 16 barges and handle them. With big boats of the same type we have pushed 60,000 tons at a time from Pittsburg to New Orleans, about 1,750 miles'.

A copy of the plan of the PS *Captain Sturt* is on display at Riverboat Rod's Model Paddlesteamer Display, Wentworth, NSW. The plan legend describes it as an 'Ohio River Steel and Iron Hull Tow Boat Sturt, Guyandot, Scioto', with the plan showing the outboard profile, boiler-deck plan etc., prepared under the direction of Lieut. Col. H. Jervey, Corps of Engineers, USA; R.J. Carpenter As Engineer, dated 26 November 1912. A note says 'to show tow boat Sturt as actually built and the Guyandot and Scioto are practically the same as the Sturt'. The *Guyandot* was used by the USACE and the *Scioto* was still registered as a towboat in 1945, with 1912 as date of construction and Cincinnati as location (Grover 1987).

The PS *Captain Sturt* worked from 1916 to 1938 in the construction of locks and weirs and the Goolwa Barrages. She was refitted as a houseboat in 1946 and moored at Goolwa, but by 1997 had fallen into a state of disrepair. The upper decks were removed and her hull filled with cement to become the centre of Goolwa's Captain Sturt Marina, where her paddle wheel is still visible.

4.3 PS *INDUSTRY*

The PS *Industry* was built at Goolwa in 1911 for the SA Government, and was later owned by the Murray Darling Basin Commission (Parsons 1996). She was a typical Murray River side-wheeler, and was used for river snagging, lock repairs and dredging. Decommissioned in 1968, she was given to the town of Renmark, and opened as a museum in 1975. After restoration, she was recommissioned in 1995 and now runs cruises from Renmark. Other riverboats used on the lock construction were the derrick boats, the dipper dredges *Milang* and *Manno*, seven barges and the motorboat Antigone (Stagg 1915).

Figure 11 PS Captain Sturt under construction.
(Image courtesy of SA Water Book 78, page 33, image 87)

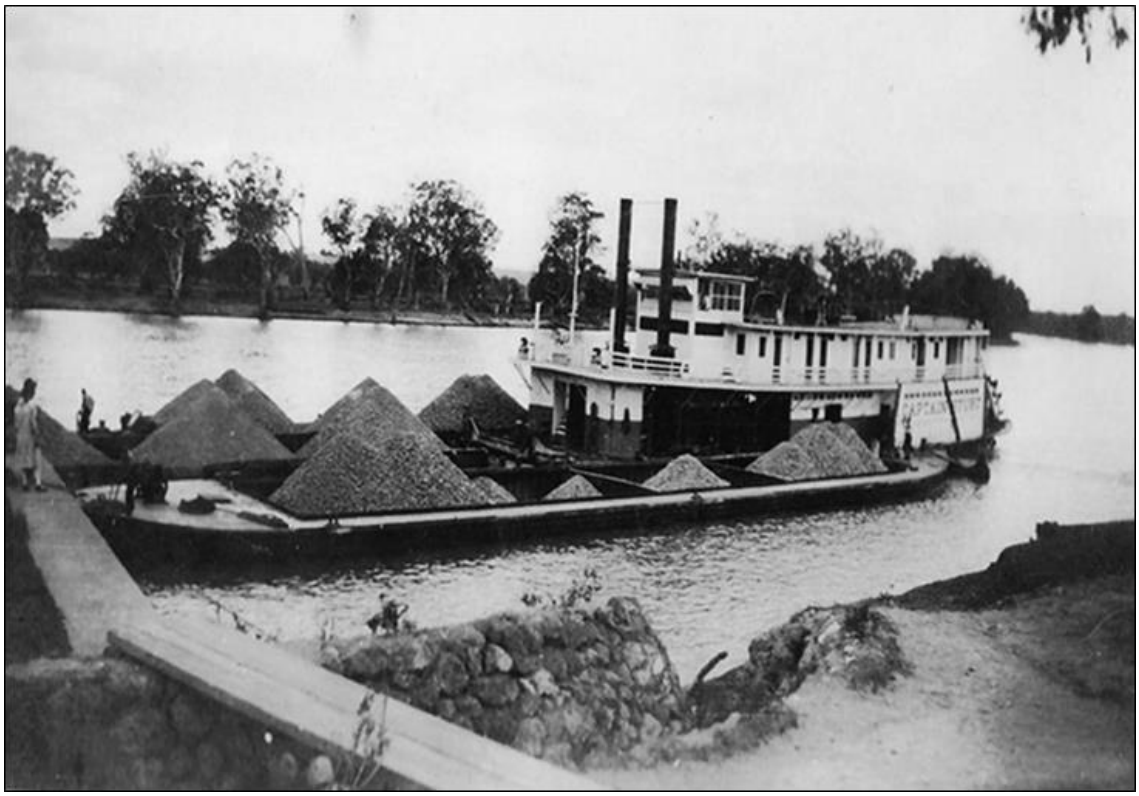

Figure 12 PS Captain Sturt pushing rock barges. (From Rodney Hobbs, source unknown).

5 THE MURRAY LOCKS

The locks of the Murray River are well known but there has been surprising little written about them since Eaton's (1945) history of the Murray Works. This has recently been redressed by Helen Stagg's book *Harnessing the River Murray: Stories of the People Who Built Locks 1 to 9, 1915-1935* (2015). As the title indicates, this is a social history as much as an engineering one. Stagg's mother, Evelyn Smith, nee Rains, grew up on the locks, as her family moved from one construction site to another. The book is important because it introduces us to the people and the infrastructure behind the engineering construction.

To give an idea of the workforce, Stagg (2015:14) quotes from the SA State Records:

> At the end of June 1927 five hundred and twenty-six casual wages men were employed altogether at Lock 2(108), Lock 4 (179), Lock 65 (57), Lock 6 (13), Lake Victoria (139), Mannum Quarry (22), PS Industry (5), and PS Captain Sturt (3). The core of permanent workers who stayed as a community, moved together to the next location. The following figures from Lock 6 also serve to illustrate the labour requirement at the other sites. The average number of men employed during preliminary work (construction of buildings, clearing the site, and receiving plant and material from Lock 5) was 28. The average number of men employed during the main works was 103. The average number of men employed during the whole period of operations at Lock 6 was 80.6 while the greatest number of men employed at any period was 156 and the lowest was 5.

The trades and skills needed included: foremen, carpenters, rigger/pile drivers, enginemen, firemen, blacksmiths, fitters, watchmen, general labourers, horse-drivers, timekeepers, oxy-welders and storemen. There were also professional engineers, officers and clerks, men employed on the steamboats, and by contractors supplying stone and timber (Stagg 2015). The permanent employees lived with their families in construction villages at each lock site (and at Lake Victoria), and when construction was finished, a smaller workforce has continued living at the locks up to the present day.

Stagg drew on oral history from several descendants of lock families and on archival records. Among the latter is the extensive collection of contemporary photographs held by SA Water. These comprise a series of old photograph albums, where the photos are mounted on black pages and annotated with titles. The photographs record both the process of lock construction (Figures 13, 14, 15) and the supporting infrastructure of the workshops and houses of the lock villages (Figure 16). The collection includes many oblique air photographs and at least some of these were taken by the newly formed Royal Australian Air Force (RAAF). One aerial view of Lock 3 is annotated 'photo by No. 1 Squadron RAAF Point Cook 24.5.25'. In 1913 Point Cook became the first military flying school; the Australian Flying Corps (AFC) was established there in WW1. When its successor, the RAAF, was formed as a permanent and separate air service in 1921, Point Cook was its sole base.

The SA Water photograph collection is now digitised, and some images of lock construction are available on the SA Water Flickr site (https://www.flickr.com/photos/sawater/albums.)

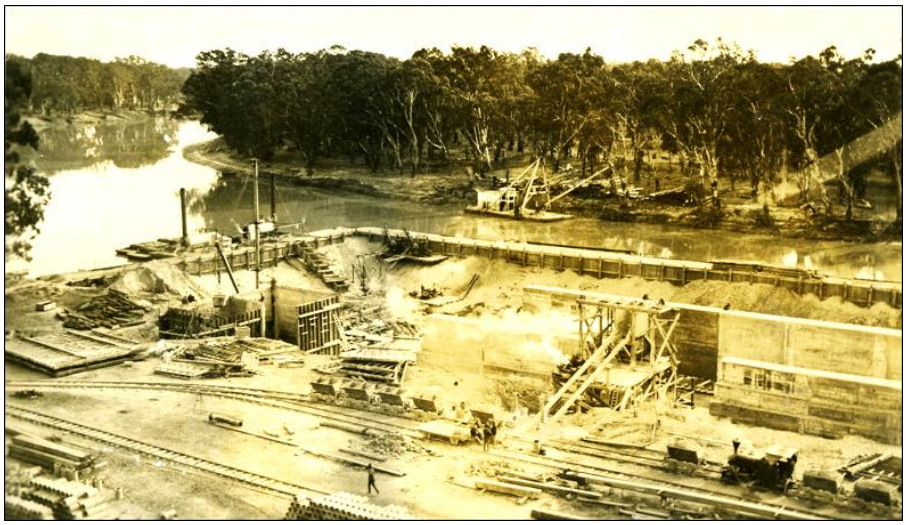

Figure 13 Lock Construction (Lock 7, 8 or 9).
(Image courtesy SA Water, Book 58, page 28, image 105)

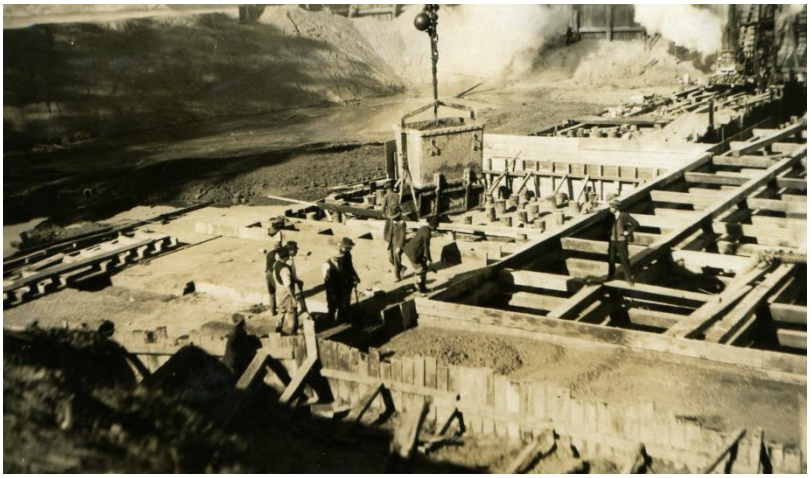

Figure 14 Lock construction: pouring concrete.
(Image courtesy SA Water, Book 58, page 33, image 123)

Figure 15 Steam train carting crushed granite, Mannum Quarry.
(Image courtesy SA Water, Book 58, page 31, image 115)

Figure 16 Lock village (Image courtesy SA Water Book 68 Page 9 Image 35).

6 LAKE VICTORIA STORAGE

Lake Victoria as a water storage was part of the planning from an early stage. The South Australian Lake Victoria Agreement Act 1913 ratified a deal between the premiers of South Australia, NSW and Victoria that allowed the SA government to 'compulsorily or otherwise purchase take acquire or lease or enter occupy or use land in the said States of New South Wales and Victoria respectively', and to 'dam, set back, divert, drain, impound, store or release, or otherwise control the waters of or embank, narrow, widen, or deepen, cleanse, clear, scour, dredge, open, straighten, and remove obstructions from the Murray River or its banks between its junction with the Darling River and the eastern boundary of the State of South Australia.' This was a remarkably broad remit. The SA Government did undertake most of these activities, but they were mainly restricted to the lake and its inlet and outlet channels, Frenchmans Creek and Rufus River respectively, not the full extent of the Murray from the Darling junction to the border.

Consideration of the Lake Victoria Storage was included in Captain Johnston's brief, and the topographic survey of the lower Murray was extended to the NSW section between the border and the junction in 1912-1914. Preliminary works involved the construction in 1916-17 of a temporary timber regulator in the Rufus River, very close to the existing regulator, and a small dam of clay and logs was built in the Frenchmans Creek to prevent water stored behind the regulator from running back into the Murray.

The detailed plans for the construction of the storage: the regulators, the artificial inlet channel, and the embankments, were approved in December 1918, the first contract was let in July 1919, and work commenced on 7 August 1919 on excavating Channel No. 1, the artificial Inlet Channel from Frenchmans Creek into the lake.

Three regulators were built: the Inlet Regulator on Frenchmans Creek about 3k from its junction with the Murray, the Control Regulator on Frenchmans Creek near the southern edge of the lake, and the Outlet Regulator on Rufus River where it crosses the edge of the old Pleistocene lake basin. Three locks were constructed on the Murray, Lock 7, just east of the Rufus-Murray junction, Lock 8, further east at Wangumma, and Loch 9 downstream from the Frenchmans-Murray junction, to maintain a weir pool for the Inlet Regulator. Several new channels were dug, and in all 52k of banks were built (Figure 17).

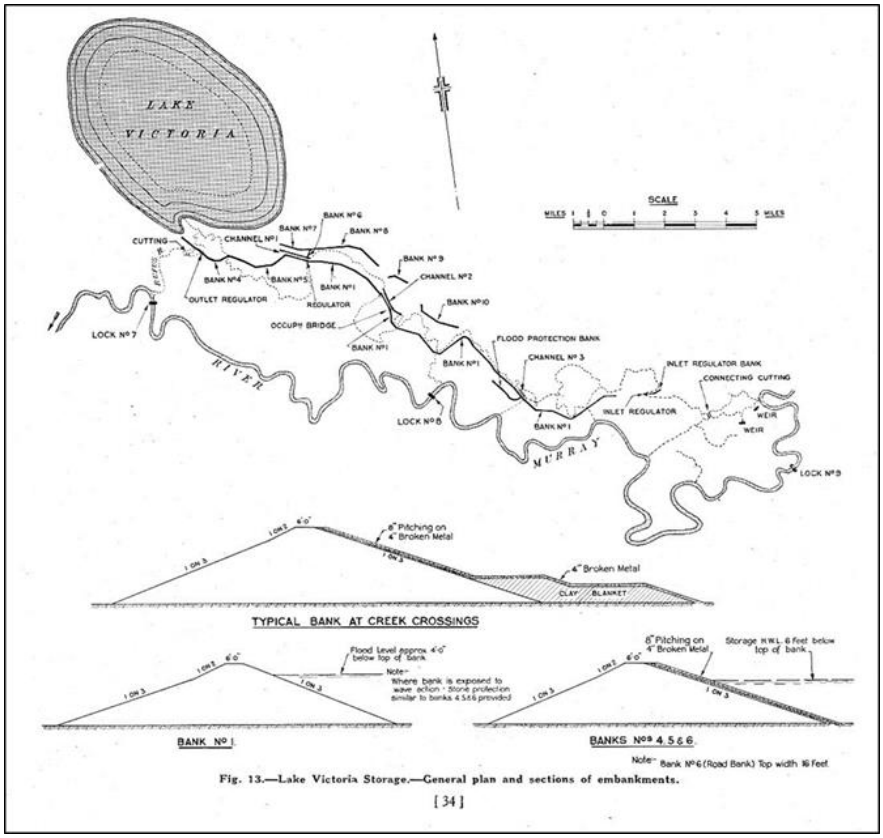

Figure 17 Map of Lake Victoria Works, from Eaton (1945)

The works were carried out between November 1919 and September 1927. On 18th September 1927 the bank at the mouth of Frenchmans Creek was cut and the inlet channel flooded. In 1931, high flood waters cut through Banks 7 and it was subsequently rebuilt.

The physical evidence of the Lake Victoria construction is represented today by a complex system of earthworks and structures. A historical account of construction, including many drawings and plans, was written by Schmitt in 1984, and some archaeological evidence was recorded during the Lake Victoria Environmental Impact Study (Hope 1998, Hope and Gottschutzke 1998, Gottschutzke 1998).

The main existing structures are the three regulators built to regulate the inflow and outflow of water at Lake Victoria (Schmitt 1984). The Inlet Regulator is located on Frenchmans Creek, 7km from the Murray River. Constructed of concrete with three steel sluice gates, this regulator which controls the flow of water into the lake. The Controlling Regulator is also of concrete construction and originally had four steel sluice gates which have since been removed. It is situated on Channel 1 which diverts water from the natural Frenchmans Creek. It also acts as a road bridge for the Renmark-Wentworth road. The Controlling Regulator had only been operated twice in its history before its gates were removed. The Outlet Regulator on the Rufus River is constructed of concrete and has three steel sluice gates. The Renmark-Wentworth road bridge has been incorporated into its structure. This regulator controls the flow of water from the lake back into the Murray, and was also designed to keep Murray flood water from entering Lake Victoria.

The banks were constructed using horse drawn scoops that cleared material from borrow pits that ran parallel to the banks (Figure 18). Material excavated through the process of forming channels was also used, as was the case with the construction of Bank 1, the main bank. The material was loaded onto wagons and dumped to form the bank. The excavation of borrow pits ceased about 900mm above the sand that the clay covered. The material piled to form the bank was consolidated by the passage of the wagons that were not permitted to cross transversely over the banks. Water sprayed on the fresh layer of material aided in compaction. Some banks, particularly those that faced the lake and crossed water channels, were pitched with stone in order to protect them from wave action and water pressure. There was an extensive timber wave-break built on the lake-side of Bank 1 and the Outlet Regulator to provide protection from waves (Figure 19). Remnants of this still exist.

Figure 18 Frenchmans Creek, Lake Victoria, channel and bank construction (Image courtesy of SA Water, Book 0687, page 009, image 087).

Figure 19 Timber wave break. Lake Victoria. (Image courtesy SA Water).

The channels and deviations were designed to cut out meanders and allow for a direct and efficient route of water flow in and out of the lake storage area. Channel enlargement was carried out using a dragline excavation structure or tower on the bank of the channel (Figure 20). An article in the *Murray Pioneer* (2 July 20) refers to this 'tower scraper' as 'the first of its kind in Australia'. The design of the excavation tower was American in origin with the engine that drove the device also coming from America. The rest of the tower and its components were constructed in South Australia. The tower scraper:

> is so called from the large wooden tower (in this case 40 feet high) from which the wire ropes that operate the scraper, or dredger, are directed. The tower, as also the engine which works the plant, is on a stout wooden platform below which are double-flanged wheels running on iron rails laid parallel to the bank of the river. Half way up the tower there is a platform fitted with levers by means of which the operator directs the movements of the scraper. A lower wire rope attached to the bridle draws the scraper up the bank and another running from the top of the tower tilts it to release the spoil. The pull of a rope anchored to a tree across the river draws it back into the water on its release, and so the work goes on.'

During the Lake Victoria EIS, an abandoned scraper or bucket, 1.5x1.5m, and items from a winch or pulley, possibly remnants of a dragline excavator were found along the west bank of Rufus River (Gottschutzke 1998).

Figure 20 Dragline excavator (tower scraper) Rufus River.
(Image courtesy of SA Water, Book 68, page 07, image 26).

A large labour force was involved in the construction works at Lake Victoria in the 1920s. Historic photographs show that there were a number of buildings and equipment dumps on the east bank of the Rufus River just south of the Outlet Regulator. This area is today used as a fishermen's campsite. There are references to a store and a school, and dances were held probably in the hall which was on the shores of the lake, but which was demolished a few years ago.

As with the lock villages no specific investigation has been made of the village sites, but it is believed that some of the houses from Lake Victoria were sold and moved elsewhere. This was certainly the case for Lock 10 houses, several of which were sold, moved and survive elsewhere in Wentworth (Crang 2006).

7 CONCLUSION

While the built engineering structures of the Murray River, the locks, weirs, storages and regulators, stand as important heritage items, there are many other tangible objects, physical and documentary, and also intangible ones, such as the oral history of lock-builders' families, that enhance the significance. As discussed here, the ancillary aspects lead along many byways, into the stories of Australian-American relations, the Murray riverboats, the early days of the RAAF and even the development of towns, through the dispersion of houses originally built for the lock villages.

The American connection in water engineering goes beyond the locking of the Murray River. In the 1950s, Australia turned to American expertise again, when the United States Bureau of Reclamation provided technical assistance and training of engineers for the Snowy Mountains Scheme. That bureau is a federal agency responsible for water resource management in the western United States, making it the uplands equivalent of the Army Corps of Engineers, responsible for the water resources on the central plains.

Apart from Helen Stagg's historic research and oral history, and a small amount of historical archaeology carried out at Lake Victoria, these aspects are little known and have generally been overlooked. Some of the materials described here provide great opportunities for future research. The pre-regulation surveys offer a snap-shot of the river, with both its natural and historic cultural features, at a crucial moment time in Australian history, between Federation and the first World War, and the SA Water photographic collection contains visual details of the actual construction methods. Both these sources would underpin historic archaeological investigations around the lock sites, at Lake Victoria, and perhaps also at places like the construction site of the PS *Captain Sturt*, and the Mannum Quarry.

While it is important to acknowledge important historic phases and events by recognising heritage items, perhaps that should not be an end in itself, but a starting point for a broader and deeper understanding of the context of those items and the complexity of the processes that led to their creation.

8 ACKNOWLEDGEMENTS

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