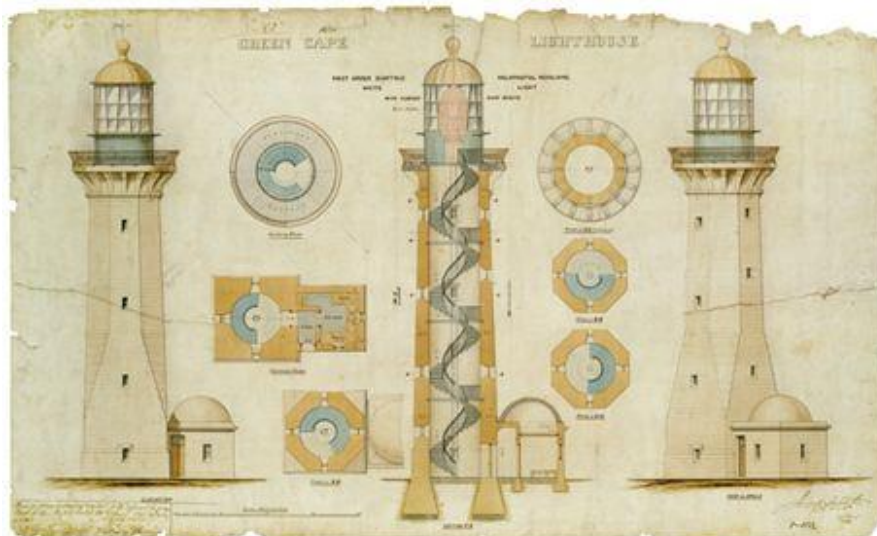


Nomination of
GREEN CAPE LIGHTSTATION

For Recognition as a National Engineering Heritage Landmark



Green Cape Lightstation showing 1883 lighthouse and 1994 lattice light tower



Barnet's drawing for the 1883 lighthouse at Green Cape NSW

by
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Glossary

Acronyms

DECC	NSW Department of Environment and Climate Change
NP&WS	NSW National Parks & Wildlife Service – a Department of DECC
DPW	Originally, The Department of Public Works, NSW, then Department of Public Works and Services NSW, now NSW Department of Commerce
AMSA	[Commonwealth] Australian Maritime Safety Authority [came into being 1 January 1991] <i>Previously</i> Department: Trade and Customs 1913 -1930, Transport 1930-1932, Commerce 1932-1942, Supply & Shipping 1942-1948, Shipping and Fuel 1948-50, Fuel, Shipping and Transport 1950-1951, Shipping and Transport 1951- 1969, Transport 1969-1991

Terms

also refer Appendices 3, 4 and 9 drawings and photos

Apart	the same as long eclipse .
Apparatus	that portion of the light generally consisting of the optic panels – glass refracting and reflecting prisms, mounted in a gun-metal framework, whose function is to send the rays from the burner in the required direction – same as optic, Optical Apparatus
Fixed Apparatus	a light that neither the lamp nor optic moves and shows a fixed and unvarying beam round the horizon through whatever angle the apparatus is designed to cover
Flashing or Revolving Apparatus	a light consisting of a number of optic panels. When the apparatus is revolved, an observer stationed at a distance can see each of these beams in succession and the apparatus presents a series of flashes.
Catadioptric	reflected light passed through a lens, focused and forming a beam. <i>[brighter than catoptric – light reflected from a bright surface eg mirrors]</i>
Character	lighthouse lights, during the hours of darkness, exhibit a distinctive appearance by which they are recognised. eg Fixed, Rhythmic – occulting, flashing, etc. Those properties by which they are distinguished from one another are referred to as the characteristic of a light. These are generally the sequence of intervals of light – flash , and darkness – eclipse , exhibited and in some cases the sequence of colours of light exhibited. The whole sequence of light and darkness is repeated identically at regular set intervals. Each element of the sequence [flash and eclipse] is called a phase [Where the possibility of confusion might exist, no two lighthouses exhibit the same character.
Candela	is the SI unit of luminous intensity.
Candlepower	an older definition of light intensity related to a standard candle. It was replaced as the standard unit in 1948. It is approximately (0.981) the same as a candela <i>abbrv cp</i>
Clock	used with Revolving or Occulting Lights. This is driven by a falling weight and serves either to revolve the Apparatus or work the mechanism which occults the light. – clock motor
Dioptic	light passed through a lens only [i.e. having no reflectors]
Elevation	the vertical distance between the focal plane of a light and Mean High Water Springs
First Exhibited	when the lighthouse light officially comes into service for the first time.
Flash	for a revolving light, the approx duration the light is seen. <i>[For a dioptic optic panel it is approx the time taken by the light to traverse the diameter of the bulls-eye.]</i>
Group Flashing	a flashing light in which a group of flashes, specified in number, is regularly repeated
Height [of a lighthouse]	the distance from ground level at the bottom of the tower to the top of the lantern house – excluding any weather vanes or lightning conductors.
Illuminant	energy source that powers the light eg vegetable oil – colza, kerosene, acetylene, electricity

Intervals	the same as short eclipse .
Lantern	consists of the ventilating pedestal, plates, glazing, roof and ventilator, and forms a chamber for protecting the Apparatus
Lighthouse	a building or structure fitted with a lantern to exhibit a light as an Aid to Navigation. Lighthouses once classified as <i>ocean</i> , <i>highway</i> and <i>harbour</i> are now more commonly referred to as <i>landfall</i> , <i>wayfall</i> , <i>coastal</i> and <i>harbour</i> . As well as being a location marker during the hours of darkness, they are often also day marks.
Lightstation	established place for an <i>Aid to Navigation</i> which may be located on the mainland, reef, island etc. and includes the lighthouse, keeper accommodation and ancillary buildings
Long eclipse	<i>for a revolving light</i> that has blacked out panels, the elapsed time between the end of one flash and the start of the next. i.e. the period of darkness between flashes
Occulting	a steady light suddenly and totally eclipsed at regular intervals. The period of darkness is greater than the period of light
Optic revolving light	a complete lens assembly consisting of lenses built up into panels, each being a gigantic bullseye lens, and are composed of separate glass elements known as refractors and reflectors which are formed into rings having their centres on the horizontal axis of the optic
Pedestal	the column or other similar arrangement on which the <i>apparatus</i> rests.
Mercury-float Pedestal	a pedestal fitted with a mercury float and trough for Revolving Lights
Period	the time taken to exhibit one complete sequence of the light. Each element of the sequence [e.g. a series of flashes, and the following eclipse] is called a Phase
Range [luminous]	is the maximum distance at which a light can be seen at a given time, as determined by the intensity of the light and the meteorological visibility prevailing at the time; it takes no account of elevation, observer's height of eye or the curvature of the earth
Range [nominal]	is the luminous range when the meteorological visibility is 10 sea miles
Short eclipse	<i>for a revolving light</i> , the elapsed time between the end of the flash from one optic panel and the start of the next [adjacent] optic panel
Trough	an annular vessel [vat, bath] which is integral with the lantern pedestal that is filled with mercury. The lantern – optic and light “float” on the surface of the mercury. The mercury – in the case of Green Cape L in which mercury is contained and upon which the lantern floats and so is rotated with little power.
Visibility	the same as range

Introduction.

Romantic icons from a more hazardous era of coastal navigation, lighthouses helped in the development of safe coastal trade. Today they are important reminders of when Australia's colonies communication and economic life were dependent on an efficient and safe functioning shipping service.

Green Cape defines the northern entrance to Bass Strait and lies 26 km SSE of Eden on the eastern Australian seaboard. It is a conspicuous promontory that extends into the Tasman Sea - a significant obstacle to coastal shipping, particularly northbound traffic that has to contend with the East Australian current that sets to the southward at up to 3 knots *Ref 5*. The strength of this adverse current lessens significantly close inshore and creates a reverse eddy that can boost a ship sailing inside the main current. From the north, Green Cape presents no particular difficulty and vessels proceeding southward from Sydney generally stand out to sea. From the south, Green Cape juts out in the path of vessels that may be hugging the shore to avoid the current. The danger if caught on the wrong side of the Cape in thick weather or at night is significant and the waiting shoreline of Disaster Bay is aptly named.

Heavy fogs are not uncommon, and they and treacherous seas along with poor seamanship have been the main causes of a number of sinkings and collisions of ships.

At the time of its exhibition [when the light was first lit] – 1 November 1883, the seas off Green Cape Lightstation had experienced many shipwrecks *refer Appendix 2 and Appendix 6*

The decision to construct a lighthouse at Green Cape was taken as an integral part of a plan to provide warning beacons at the more dangerous gaps in the Australian coastline. The decision had its origins in a resolution of the Inter-colonial Conference of 1873. Therefore, the impetus for the construction of a first order light at Green Cape did not come solely from NSW but was the combined decision of all the Australian Colonies Marine Boards.

The lightstation – lighthouse, accommodation and services buildings, is the southernmost lightstation of 25 coastal lightstations placed along the 1586km NSW coastline. The facility was one of 14 designed in the office of the NSW Colonial Architect James Barnet *Appendix 6*. While the lighthouses were designed in the office of the Colonial Architect, the necessity, location and operating parameters – luminous intensity and character of the light and height of focal plane were dictated by the Marine Board of New South Wales. The accommodation requirements were also the prerogative of the Marine Board which was responsible for the staffing and operation of the lightstations.

The need for lighthouses was more often than not on isolated locations on the Australian coast. This was the case for Green Cape. Such sites were only accessible with great difficulty – usually only by sea, and their construction demanded no less a level of planning and management than is required today with any major construction project. To carry out and complete their contract, contractors were expected to be resourceful; as far as possible using local materials and a lot of ingenuity.

Green Cape was the second of Barnet's three major lighthouse towers built of rendered mass concrete. At the time of its construction it was the tallest mass concrete structure in NSW *Ref 2 and 7 [Comment 1]* and remained the tallest lighthouse in NSW until it was decommissioned in 1992. It was also at the time purported to be the first mass concrete of such size in Australia *Comment 2*.

The 98 ft [29m] high lighthouse stands 75ft 6in [23m] above the sea [HWM]. The height of the tower from the ground floor to the balcony is 68 feet [20.7m], and the top of the copper-domed lantern house a further 31 feet [9.4m]. The focal plane of the light is approximately 144ft [44m] above the High Water Mark.

Comment 1: 48m high, Cape Wickham [1861] lighthouse on King Island in Bass Strait is the tallest light in the southern hemisphere. *Ref 7*
Point Hicks [1891] at 39m is the tallest lighthouse on the Australian mainland *Ref 7*

Comment 2: Australasian Builder and Contractor's News 5 January 1889, p17

A 920mm focal length first order dioptric holophotal [Fresnel prism] revolving white light was originally installed, with a four-wick kerosene –burning lamp that had a light intensity of 100,000 candlepower, and was visible for 19 nautical miles [35km]. The lens rotated on a revolving pedestal driven by a weight-machine [a substantial clockwork motor] that in turn was driven by counter-balanced descending weights.

The original character of the light was one flash every 60 seconds.

The British Admiralty List of Lights accorded it International Number 694 ¹

Green Cape lightstation and the other lightstations built along the NSW coast in the period 1870 to 1910 [Appendix 6] were all built during {the lighthouse} *Age of Magnificence* when lens design and manufacture reached its zenith.

At the time of decommissioning on 17 April 1992, the light source was a 120 Volt, 1000 Watt tungsten halogen lamp. The light gave a character of Group Flashing –[*a flashing light in which a group of flashes, specified in number is regularly repeated*] in the case of Green Cape, a white light 2 flashes every 15 seconds - FI(2) W 15s, with an intensity of 1,000,000 candelas resulting in a nominal range of 26 nautical miles.

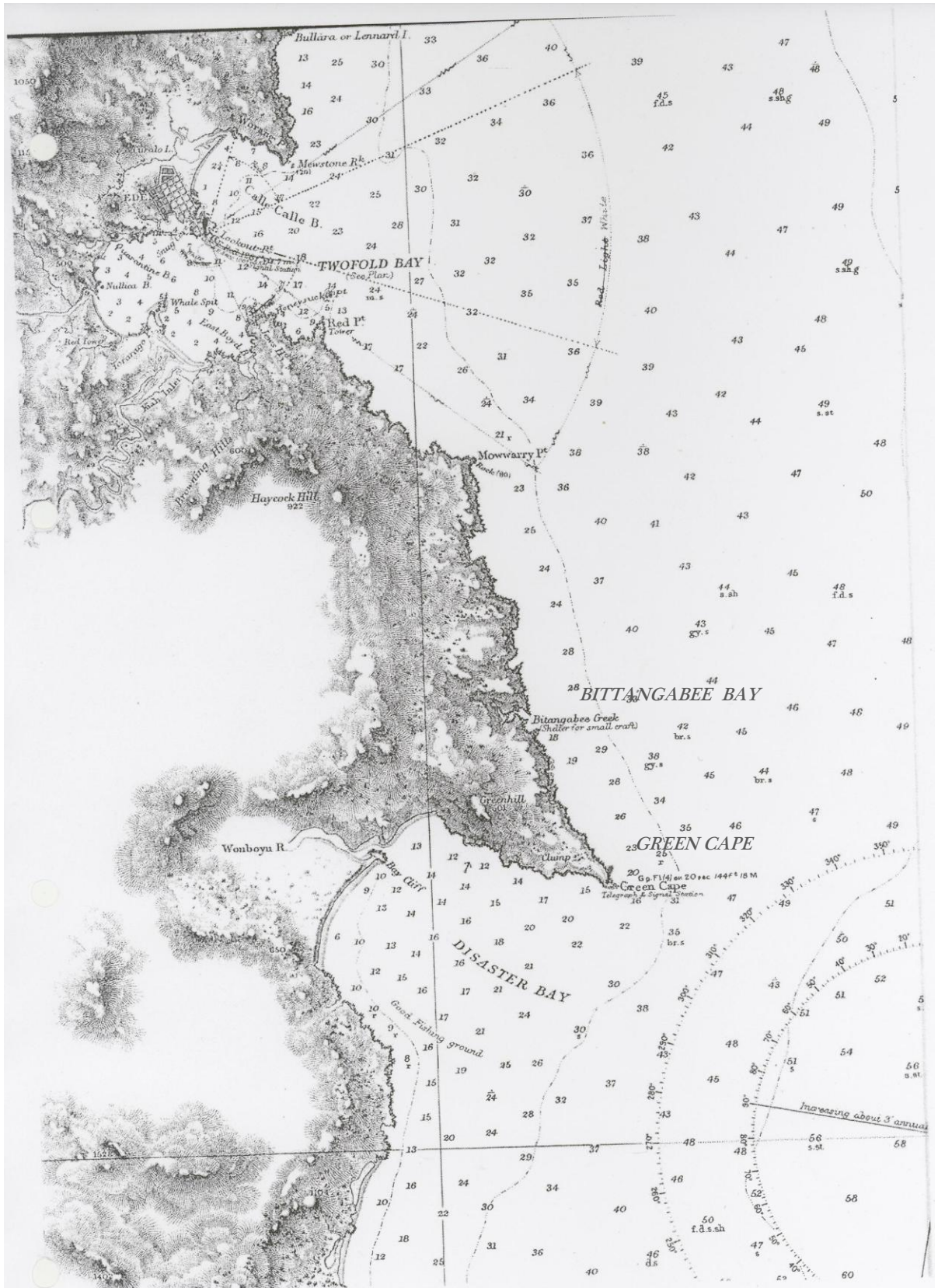
The Green Cape Lightstation is of heritage significance because of:

- its place in the history of providing warnings to mariners along the Australian coastline;
- its association with important colonial figures;
- its height, architectural design and construction;
- its strategic importance in both World Wars;
- its research potential in both lighthouse-keeping and Aboriginal occupation; and
- its place as a focal point for the isolated local community.

Following evaluation of these values *refer Appendix 10*, it is recommended that Green Cape Lightstation be recognised as a **National Heritage Engineering Landmark**.

¹ In 1926 the light's International Number was 2509 and in 1962 the number was 2570

Location of Green Cape Lightstation and Other Relevant Places



British Admiralty Hydrographic Chart BA 1017 15 September 1870, 1949 Edition

see also p 24

Basic History

Pre European Basic History

The original occupants of the Green Cape area for the last 6000 years were the Tauaira/ Thawa people of the Yuin [Murrin] nation. The Yuin nation extended from Cape Howe to the Shoalhaven area. It is believed that the Cape [Bundooro] was a men's area; in particular a teaching place for young men. Bittangabee Bay [Pertangerbee] was an important camp place and teaching ground. The southern side of Disaster Bay [Tartarerer] is said to be the resting place of the rainbow serpent [Ref 9]

European Basic History

The Green Cape lightstation area has a rich history of European settlement. The first known European occupation of the area occurred in the late 1830s and early 40s because of the expansion of pastoralism and whaling in Twofold Bay 16km to the north. The Imlay brothers expanded their operation to the south, including Bittangabee, into their pastoral run and commenced construction of a stone building. The brothers fell victim to the economic depression and Benjamin Boyd of whaling fame took over the Bittangabee run in the late 1840s.

After the completion of the first Macquarie Light in 1818, there was a gap of 40 years² before another lighthouse was built on the NSW coast. When the NSW government began to systematically light the Colony's coast it did so with a consistency of approach not matched by other Australian colonies. With few exceptions, the lights constructed after 1860 follow stylistic principles established by Francis Greenway and their designs up until the turn of the century were supervised or influenced by the Department of Public Works NSW Colonial Architect James Barnet who played a seminal role in the Colony's architecture for nearly 30 years.

In 1863, a select committee of the NSW Legislative Council heard evidence from several experienced master mariners, including Captain Francis Hixson, concerning the requirements for lights on the NSW coast. The Committee deemed no new lights were necessary south of Sydney.

By 1872 Hixson had been appointed President of the Marine Board of New South Wales and proclaimed his intention was to '*light the coast like a street with lamps*'³ Ref 3 by having lights at 25 nautical mile intervals along the NSW coastline. In 1873 he was appointed chair of the Conference of the Principal Officers of the Marine Departments of the Australian Colonies and at a meeting on 3 October 1873, Hixson moved and the conference resolved,

*That having in view the extent of the traffic on this coast, and that Green Cape forms a considerable projection on the line of coast after rounding Cape Howe, a first-order revolving light should be erected on Green Cape.*⁴

Having made their recommendations, and in particular that '*in the interests of the vast and increasing trade of these Colonies, the new lights should be erected with all reasonable expedition*', the officers returned to their Colonies to await the political process which would transform their recommendations into lighthouses.

In the case of Green Cape, it was not until 1879 that the decision to build a light began to be implemented. A sum of £17,000 was included in the (Consolidation Fund) Appropriation Bill in 1879 *for a lighthouse at Green Cape* and was duly passed.⁵

2 Hornby and Nobby's Island lights were first exhibited in 1858

3 Gordon Reid From Dusk til Dawn: a History of Australian Lighthouses AGPS; Canberra , 1988 p76

4 'Report of the Proceedings of the Conference of Principal Officers of the Marine Departments of the Australian Colonies' minutes of proceedings; p10 *New South Wales Parliamentary Papers 1873*

5 NSW Act 43 VIC No 10 . Additional sums - £2000 [1880] and £1500 [1883] were voted to cover increased costs.

Plans were prepared in the office of James Barnet ⁶, for a stone lighthouse and rubble quarters.

In November 1879, a party consisting of members of the Marine Board, James Barnet and Edward Moriarty Engineer-in-Chief Harbours and River Navigation Branch of the Public Works Department NSW; and others visited the Cape to select the most suitable site for the lighthouse and quarters.

Tenders were called in May 1880 and closed on 29th June. Not one tender was received - possibly because it was realised by prospective tenderers that the local sedimentary stone was too soft to be used as dimension stone for the construction of the tower.

Fresh tenders were called in July, closing on 29th July, allowing for an alternative price for building the tower using mass concrete. This method of construction for a similar design had been successfully used a couple of years earlier for the construction of the lighthouse on South Solitary Island. It is thought Barnet used the flat faced octagonal tower design transitioning from the square base intentionally so that in the event the construction of the tower in stone from local materials was not practical, it was possible to fall back on a mass concrete construction: the flat faced surfaces being more suitable for the wooden shuttering into which the concrete would be poured.

A tender of £12,936 from Albert Wood Aspinall – an experienced stone mason and builder, was accepted on 29 December 1880 ⁷ for the construction of a rendered mass concrete tower to the lantern room floor stage, erection of the lantern house and prism, three houses – one freestanding and the other two semi-detached, of double brick with cement render and associated structures. A further contract was let to Aspinall for £357 for the construction of the jetty and store house at Bittangabee Bay [and tramway from the Bay to Green Cape]. The contract construction period was 18 months.

Based on information on the 1875 Sugarloaf Point lighthouse that was the first major lighthouse designed by Barnet, it is reasonable to assume the construction work was also supervised by Moriarty's office [Ref 3 p77].

The only access to Green Cape was by sea and the nearest safe anchorage was some seven kilometres to the north – Bittangabee Bay, a small inlet only navigable by shallow draught craft. All supplies, building materials - other than those found locally, construction equipment and men, were brought from Sydney by steamer to the port of Eden and were transhipped on a small ketch owned by the contractor ^{8,9} on an almost daily basis ⁸ where they would be offloaded onto the newly built jetty. Considerable delays to deliveries occurred as a result of low tides and adverse weather conditions.

Aspinall began work in early 1881 ¹⁰ by erecting a 'substantial' wooden jetty - on 16 ft deep circular 4ft diameter concrete piers, and store house on the southern shore of Bittangabee Bay. To move the materials and supplies to the lightstation site, over a period of three months Aspinall constructed a 4 mile [6.4km] long hardwood rail tramline through the forest and the heath-land on which horse drawn wooden trolleys would be jinked to the work site at the Cape ^{8,11}.

Using a standing order, the Department of Public Works NSW placed a separate order on Chance Bros and Co., Limited Lighthouse Engineers and Constructors of Birmingham for the lantern house, light source and apparatus - a first order dioptric holophotal Fresnel prism with eight optic panels - revolving white light. The apparatus was mounted on a circular carriage [turntable] that rotated on equi-spaced rollers that were in turn mounted on a cast-iron pedestal *refer Appendix 8*. The light source was a four-wick kerosene-burning lamp that emitted a light with a luminous intensity of 100,000 candlepower that would be visible for 19 nautical miles [35km] for a cost of £3,108. Green Cape was only the second light in NSW to use kerosene as a fuel at a time when colza oil was the fuel of choice in the lighthouse world.

6 Barnet claimed that during his time as Colonial Architect he was responsible for over 1350 public buildings and 20 lighthouses

7 The acceptance of the contract notified by DPW as 17 January did not appear in the NSW Government Gazette until 21 January 1881

8 Aspinall's bankruptcy papers make reference to a ketch 'Elizabeth of 12 tons burden' and '4 miles of tramway and 4 trucks' as some of his assets.

9 Ref 13 reports that a small ketch owned by a Captain Glover was also used

10 Town and County Journal of 26 May 1883 reports the date as 18 February 1881

11 The estimated turn-around-time Bay to Bay was at best 4 hours

Included in the supply was a Chance Bros 'clock' ¹² – a powerful governed clockwork motor that would rotate the turntable at the required constant speed. The clock was driven by a falling weight. These weights – *est 150kg*, were connected to the clockwork mechanism by a driving chain and 'fell' under their own weight down a "weight'-tube consisting of a vertical metal tube that ran down the centre of the lighthouse tower. The tube was fitted with an arrangement to warn the keeper when the weight stack was nearing the bottom of its fall. The weight stacks were manually wound up from near the end of their descent every 30 – 40 minutes.

Once the Bittangabee Bay works were completed, Aspinall moved on to the Green Cape site clearing the area and constructing the workmen's camp, a cookhouse, the site foreman's office, carpenters and blacksmith's workshops, assorted storage shelters and a small dam to provide water for construction ¹³.

The site was bleak, windswept, and life for the workforce would have been arduous – long hours, supplies would be delayed by rough seas and progress delayed by gales, inclement weather and a shortage of labour.

Rock aggregate was quarried/ blasted from the rock platform at the bottom of the steep cliff below the site and hauled up a tramway, which had a 40 degree incline, using a 1 ton capacity bucket and three horses. The rock was knapped by hand to make the aggregate and was mixed with Portland cement shipped out from England in barrels, local sand, lime – for the render ¹⁴ and water ¹³ to make the concrete mix.

The 180,000 sandstock bricks to build the houses, stables, telegraph station, flag locker and other outbuildings and brick, cement-lined, underground rain-water tanks were made at Boydtown using the facilities that had already been established for the construction of Boydtown, and shipped in ¹⁵

Based on the inspection of the site, and as shown on the contract drawings, it was thought that bedrock would be encountered no more than 9 feet down. Aspinall immediately encountered difficulties, finding this was not the case and that the site chosen for the lighthouse had, five or six feet down, an underlying bed of 'pure white clay' some 20 feet thick that required unforeseen massive excavations to attain the bedrock level necessary for founding the light tower. The increased depth also meant that heavier footings were required than were shown in the original design of the tower. The foundations were redesigned by the Department of Public Works NSW. Aspinall's price to carry out the additional work that resulted, by reason of the revised design, was £1,827 12 s 6d. ⁵

This figure was accepted by the DPW and no doubt, an extension of time was granted.

The base of the tower was now to be 29 feet below the floor line of the tower.

Aspinall's men took several months to dig through the clay to the bedrock. However, by all account, construction proceeded smoothly and rapidly ¹⁴ *Ref 14*. Aspinall went about his task in an innovative manner designing a special iron bucket that allowed the lifting and pouring of one cubic yard of concrete in five minutes *Ref 14*.

Drifting sand repeatedly caused problems by covering the tramlines and building foundations with layers of sand several feet deep. By May 1882, construction of the tower was reported to be within 20 feet of its final height of 68 ft above ground level ¹⁶ *Ref 14*.

12 Comment: the clockwork mechanism was like that of a town-hall clock. More details are given in Appendix 9; see also the photo of second 'clock' Appendix 3.

13 .Comment: No evidence of a dam has been found and it could be possible, in view of no readily available fresh water in the area that salt water was used.[Iron reinforcing was not used in the construction]

14 It was reported lime for the lighthouse construction came from burning middens on the banks of the Pambula River Moruya-Tilba Times 3 March 1909. The T&CJ of 26 May 1883 says the lime was burnt at Bittangabee Bay

15 Comment:: Refs 1, 9 states a contract was let by Aspinall with a brick maker to make the bricks on-site. However, searches of the site by Richard Jermyn, a former caretaker, questions this as he has found no evidence of kilns on the site and believes the bricks were made at Boydtown where similar bricks for Boydtown had been made.

16 Notes on a Barnet drawing gives the progressive height of tower 3 March 1882 34ft 6in, 3 April 41ft, 24 June 1882 ~60ft

However, under the trying conditions, it would appear that by early 1883 with the work nearing completion, Aspinall ran out of money, was financially ruined and was compelled to sequester his estate¹⁷.

A Notice to Mariners issued March 1882 had anticipated that Green Cape light would be 'ready for exhibition by the end of the year'.

As the work was nearly complete, Aspinall's creditors took the contract over on 26 June, retaining Aspinall as a supervisor and a Mr Hugh Milligan to complete the tower's construction and the erection of the lantern house and optics.

The lightstation was handed over to the government on 29 October 1883; the final cost was £19,338:8:9.¹⁸

Green Cape Light was first exhibited on 1 November 1883;

Communication with the site was initially established through the daily trips – weather permitting, of the contractor's ketch from Bittangabee Bay to Eden. On 15 May 1882, the telegraph relay station built by Aspinall was opened providing the first direct telegraphic communication between Green Cape and Sydney. It was established so that Sydney could be informed of the arrival of vessels in Australian waters, and provided a vital communication link between Gabo Island and Eden.

Passing vessels could also come inshore and signal with maritime flags when they wished to send a message. The telegraph station was later to play an important role in the Ly-ee-moon disaster.

Despite the lighthouse having been newly built and the light operating, inexplicably on the night of 31 May 1886 around 9pm in clear weather, a major shipwreck occurred; the founding of the ex opium runner Ly-ee-moon en-route from Melbourne to Sydney. The two masted schooner-rigged paddle steamer of 1001 tons ran into rocks below the light at full speed of 12 -15 knots and quickly broke up. Only 15 of a total of 86 passengers and crew were saved¹⁹. Twenty four bodies were recovered and buried in a small cemetery near the lightstation. The subsequent Coronial Enquiry on 1 and 2 June attributed no blame to the lighthouse and commented favourably on the involvement of the lightstation personnel in the rescue of the survivors; several of whom were recommended for bravery awards. The jury's verdict read in part that '*gross neglect had been shown, but there has not been sufficient evidence before us to point to the guilty person or persons.*'

By order of the Marine Board of New South Wales, the 'revolution of the flash of light' was altered to 50 seconds on 1 May 1889. *Ref 2*

In 1900 as a result of enactment of the Navigation [Amendment] Act, the Marine Board of NSW was disbanded and its duties were now the responsibility of the NSW Navigation Department. From this time, NSW lighthouses were administered by the new Department and construction and repairs and the like were carried out by the Department of Public Works NSW. *Ref 5* Because most maintenance was carried out by the light keepers, except for major improvements, little was spent on NSW lighthouses.

The wick burner was likely to have been replaced around 1912 by a '*Douglas*' incandescent burner using vaporised kerosene and a glass chimney around a silk mantle. Made by Chance Bros, it was probably the most common means of illumination in lighthouses at the time. The intensity of the light was now 250,000 candle power²⁰

17 Albert Wood Aspinall Green Cape contractor sequestration date was 21 05 1883 Insolvency No 17992. He had been sequestered previously in 1870. *State Records Office*

18 Comment: DPW Annual Report 1894-95. Carleton in *Ref 12* also gives this latter amount]

19 Comment: There is disagreement in the literature about the spelling of the vessel's name, the numbers on board, those that lived and the tonnage of the vessel.

20 The Dept Transport 1967 information sheet gives this figure. The *Brewis Report* states that the intensity is 100,000 cp. It is more likely, if the burner was changed at this time it was to increase the light intensity and reliability.

In his survey of coastal lights of 1913, Commander Brewis had no criticism of the Green Cape light apart from its rate of revolution which he regarded a '*too slow for modern requirements*'. He recommended that the speed of the flashes be increased by inserting a new mechanism – [mercury-float] pedestal and clock, and converting the character of the light from flashing every 50 seconds to flashing every 10 seconds with a flash of 1 second duration. *Ref 5*

Following an amendment to the Commonwealth Lighthouses Act of 1911 in June 1915, the responsibility for each Colony's coastal lights was compulsorily transferred to the Commonwealth, taking effect from 1 July 1915.

The luminous intensity of the light was increased to 327,000 candle power on 1 April 1923 with the installation of a Ford-Schmidt burner. In 1926, the Brewis-recommended the existing roller turntable, pedestal and clock were replaced with a Chance Bros mercury-float turntable, pedestal and weight machine and the speed of rotation of the lantern was increased but with a markedly different characteristic to that recommended by Brewis *one flash every 10 sec duration of flash 1 second Ref 5 v Gp Fl [4] 20 sec - occulting to Group Flash*. The only reasonable explanation of the change is that four of the panels of the optic were removed and replaced with 4 blacked out panels *A description of the mercury-float arrangement is given in Appendix 9*.

When the diesel generators were installed on 20 February 1962, an electric motor replaced the manual winding system that up until then had been used to power the clockwork motor that rotated the lantern and an incandescent globe now provided the light source, increasing the luminous intensity of the light to 475,000 candelas. At this time the character of the light was changed by the reorganisation of the optic panels and replacement of four of the optic panels with blacked out panels in a 2, 2, 2, 2 arrangement to give a new character. The Abridged Description is written as: Gp Fl [2] 15 sec. [**Goup Flashing 2 flashes at intervals of 15 seconds.**

The flash duration is 0.05 sec, short eclipse 3.75 sec and long eclipse 11.16 sec, 1 rev every 30 sec *Refer Appendix 6 for discussion of optic panel details and discussion of changes to the light characteristic and rotation mechanism of the lantern.*

At this time, the manning was reduced from three to two keepers.

On 16 March 1967, with improved generators and a 1000W tungsten halogen globe, the luminous intensity of the light was boosted to 1,000,000 candelas, making the light visible over 20 nautical miles (40km). At this time the character of the light was changed to show two flashes, three seconds apart between intervals of 15 seconds by removal of four of the optic panels and their replacement with four blacked out panels.

The nominal range was now 24 nautical miles *ref AMSA Aid to Navigation Issue 2 Schedule Feb 1989*

From about 1975, there was a programme of automation and subsequent de-staffing of Australian lighthouses. This program was given political sanction with the 1983 report of the House of Representatives Standing Committee of Expenditure entitled *Lighthouses: do we keep the keepers?* The savings indicated for Green Cape over a 20 year period were \$860,000.

With the introduction of satellite navigation, improved shipping technology and new mandatory safety requirements, AMSA was of the opinion that commercial shipping would choose a sea lane that was further out to sea where the light could not be seen. The light would be now primarily a beacon for local fishermen and other small boat operators

Comment: In fact commercial shipping still plies the old sea lanes.

In 1992, the 1883 light at Green Cape was replaced with a much smaller solar powered API [Automatic Power Inc] light [*referred to by locals as the Tupperware light*] with the light and panel being mounted on the tower balcony.

The character remained basically the same – Flashing 2 in 15 secs, flash 0.1 sec, short eclipse 4.9 sec and long eclipse 9.9 sec but the new light's luminous intensity and visibility were greatly reduced – 37,000 candelas, 17 nautical miles.

The "big light" was taken out of service with the draining of the mercury from the pedestal trough on 17 April 1992.

The solar light longer needed to be manned and required very little maintenance. The lightstation was de- manned leased out to a private individual.

By 1994, AMSA had concerns that with the light mounted on the tower balcony it was responsible for the maintenance of the lighthouse and made a decision to build a separate lattice tower – some distance away from the 1883 tower, mount the API light on this shorter structure and construct a larger solar array to power the light.

The leasing out of the lightstation was deemed to unsuccessful and the lightstation was again manned.

Following ongoing discussions between the Commonwealth and NSW governments, in 1997 ownership of the lighthouse reserve and buildings was transferred to NSW government. The land was gazetted as part of Ben Boyd National Park.

The area where the lattice tower and solar array stood was leased back to the Commonwealth.

The 1883 Green Cape lightstation was no longer an official lightstation and was again de-manned.

DECC Parks and Wildlife Group, along with another eight lightstations along the NSW coast, were now responsible for the maintenance of the lightstation.

To celebrate Green Cape's 125th anniversary, a number of dedicated "pharophiles" with the approval of Australian Maritime Safety Authority [AMSA] and the NSW Department of Environment and Climate Change National Parks & Wildlife Service [DECC-NP&WS], restored the light to operating condition by refilling the trough with mercury - *Refer Chance Bros drawings Appendix 4*, reconnecting the power and turning the light on again on 1 November 2008 and for another two nights, from sunset to sunrise. The new light was darkened for these periods.

Nomination Form

Plaquing Nomination Form

The Administrator
Engineering Heritage Australia
Engineers Australia
Engineering House
11 National Circuit
BARTON ACT 2600

Name of Work: **Green Cape Lightstation and associated infrastructure at Bittangabee Bay**

The above mentioned work is nominated to be recognised under Engineers Australia Engineering Heritage Recognition Program as a **National Engineering Heritage Landmark**

Location: **Green Cape** *far South Coast of NSW 26 km south south-east of Eden*

Owner: **NSW Government Department of Environment & Climate Change**

The Owner has been advised of this nomination, and a letter of agreement consenting to the plaquing is attached *Appendix 1*

Access to Site: Turn off the Princes Highway 18km south of Eden onto the Edrom Road for 6km and then turn onto the Green Cape Road and travel for 21km. to the site. The lightstation at Green Cape is open for inspection at designated times. Bittangabee Bay and the Ly-ee-moon memorial site are open to the public.

Nominating Body: **Engineers Australia, Sydney Division Engineering Heritage Committee**

Simon Wiltshier

Chair Sydney Division Engineering Heritage Committee

Date

PLAQUING NOMINATION ASSESSMENT FORM

BASIC DATA

Item Name: Green Cape Lightstation

Other Former Names: the Cape was originally named *Green Point* by Flinders, referred to by the British Admiralty in 19th C as cape Green and was known to the aboriginal inhabitants of the area as *Bunooro*.

Location: 37° 15.8' S, 150° 03.0' E

Address: KIAH NSW 2551

Nearest Main Town: Eden [Green Cape is 45km south-east of Eden by road]

State: NSW

Local Government Area: Bega Valley Shire *Parish of Womboyne County of Auckland*

Owner: NSW Government - Department of Environment & Climate Change.
[Title to the lighthouse reserve previously owned by the Commonwealth was transferred to NSW and in 1997, the land down to the Low Water mark was gazetted as part of Ben Boyd National Park. The existing AMSA tower and a helipad are on small areas of the Park that are leased back to AMSA on a perpetual basis. The Bittangabee ruins have always been on Park.]

Current Use: AMSA navigational aid site. British Admiralty List of Lights K 2570
Australian Bureau of Meteorology automatic weather reporting station.
Heritage tourist site focusing on the history of the lightstation and memorial to persons lost in the founding of the Ly-ee-moon
The Assistant Lighthouse Keepers' cottages are available for holiday rental.

Former Use: Lightstation Landfall and Coastal light

Designer: Department of Public Works NSW, Office of Colonial Architect James Barnet

Builder: Albert Wood Aspinall *until he was bankrupted in June 1883*
Thereafter, until completion Aspinall's creditors

Year Started: Bittangabee Bay facilities early 1881. Lighthouse June 1881

Year Finished: 1883 exhibited [first lit] 1 November 1883

Physical Description: *A full listing of the buildings that make up the lightstation is given in Ref 1*

Green Cape lightstation is a compact and closely knit group of buildings. Together they are an aesthetically pleasing group and a fine representative example of a late nineteenth century lightstation.

Lighthouse *refer Appendix 3, photos and Appendix 4 for Barnet and Chance Bros drawings*

The light tower is a tapered octagonal column set on a deep square base, quite unlike a number of other lighthouses on the coast that are reminiscent of the cylindrical Ionic or Doric columns or concave 'wave-swept' profile.

The lighthouse tower is a mass concrete structure constructed using flat formwork that gives it a distinctive character. The walls are cement rendered inside and out - the render generally follows the form of the structure and are painted white. There are rectangular headed door and window openings in the tower. The tower windows are metal framed with fixed glass and the windows to the Oil Store are timber-framed. Doors are of timber.

The lantern house sits on a 'Melbourne' bluestone gallery of '16 stones [2 tons each] firmly bolted and ironbound together' and carried on equally spaced sixteen bluestone corbels [1 ton each]. The gallery is set off with an elegant double-curved gunmetal railing.

[The distinctive console, balcony table and double-curved gunmetal railing to the balcony are characteristic of the design of James Barnet.]

The lantern house is a conventional Chance Bros design with a domed copper roof and ventilator. A concrete domed oil store at ground level is an integral part of the tower.

Internally, the rendered walls are painted white, the floors, slate *[a 1980s addition]* on concrete. Access to the lantern house floor is by a prefabricated internal spiral cast iron staircase, manufactured by Gommeson of Newtown, supported by iron brackets set into the tower wall. A centrally located cylindrical iron weight tube runs from the first floor to the lantern-house floor

Comment: This tube originally ran from the ground floor. It is suspected this section was removed as part of the 1926 conversion.]

Residences refer Appendix 1, Appendix 3, photos and Appendix 4 for Barnet drawings and Appendix 2

The design of the lighthouse residences, in the late Victorian Regency style, follows the standard pattern of the late nineteenth-century Colonial lighthouse residences. They are typical of rural and larger urban houses with the style being replicated throughout NSW, and other Colony lightstation residences.

The style is characterised by simple forms, clearly defined rectangular masses arranged symmetrically, ruled ashlar stucco walls, austere mouldings of classical proportions in the treatment of doors and windows *Ref 11*

The buildings are constructed of double brick in lieu of rubble as mentioned in the contract drawings and are cement rendered and originally were roofed with flat galvanised iron sheeting – *now corrugated sheet stainless steel.*

The roomier Head Keeper's cottage closer to the lighthouse is free standing and contains three bedrooms – one of which was reserved for the sole use of visiting Inspecting Officers, living room, parlour and store room. Across from the southern veranda is a separate building containing a WC, bath room [1913], store room, kitchen and woodshed.

The semi-detached Assistant Keepers' quarters were somewhat smaller and contained two bedrooms, a parlour and living room. A separate semi-detached building included a WC and a kitchen.

Both buildings are surrounded on all four sides by a deep veranda – some sections now partially enclosed, and each residence had an underground rainwater water tank fed from the roof.

Comment: The two semi-detached Assistant-keepers residences were not constructed in accordance with Barnet's plans and two additional rooms were included.

Physical Condition:

The light tower and associated buildings at Green Cape are in excellent condition as a result of appropriate ongoing and regular maintenance.

However, the jetty and storage shed at Bittangabee Bay are in a derelict condition – *refer Appendix 3.* Much of the location of the connecting tramway has been lost but some bridgework remains including the remnants of a timber and stone bridge across Te-Miti Creek.

Modification and Dates:

Light Tower details of the changes to the lighthouse – mainly the light source, the method of powering the light and method and speed of rotation of the optic, are given in Appendices 2 and 9 and Ref 16

Lightstation Accommodation *Refer Integrity/ Intactness section.*

Other Lightstation Buildings *Refer Integrity/ Intactness section.*

Refer to Basic History section of this submission and Appendix 2 for dates and details of modifications to the lightstation.

Comment: Where changes have been made, the NP&WS has either obtained similar equipment – such as the later Chance Bros weight machine, or has photos on display of equipment such as the various light sources and the Barnet and Chance Bros drawings.

Historical Notes: *Refer to Basic History section and Appendix 2 of this submission for dates and details.*

Heritage Listings:

Name : Register of National Estate
 Title: Green Cape Lighthouse and residences
 Number: ID 1016
 Date: 1 November 1983

Comment: Ben Boyd National Park, in which the lightstation is situated, is also listed in the Register of the National Estate ID 1007

The Imlay Bros ruins at Bittangabee bay are also listed in the Register of the National estate ID 1017

Name: Department of Planning Heritage Branch
Not included in the State Heritage Register

Name: Dept of Environment and Climate Change S 170 Register
 Title: Green Cape Lighthouse Group
 Number: HOD Number 3914952
 Date: *first entered 04 12 1998 updated 07 12 2000*

Name: National Trust of Australia (NSW)
 Title: Green Cape Lighthouse and Cottages Group
 Classification: C
 Number: NTN *none allocated J Blythe 26 03 09*
 Date: June 1977

Name: Bega Valley Shire Council Local Environmental Plan 2002
 Schedule 2 Clause 33 Schedule 5 Heritage Items

- Greencape [sic] Lighthouse and residences group
- Bittangabee Ruins

ASSESSMENT OF SIGNIFICANCE**Historical significance**

Green Cape Lightstation has historical significance because:

- (a) It was constructed during the 1880s, the most productive phase of lightstation construction in NSW. These romantic icons from a more hazardous era of coastal navigation were essential to the development of safe coastal trade and as a consequence the economic development of NSW. Based on a history of the shipping losses in the area over time – *refer Appendix 6*, and bearing in mind the significant increase in traffic, it is reasonable to assume its presence greatly reduced the number of shipping losses and accidents in the area.
- (b) It is an important component of the system of great 19th century lighthouses designed to light the NSW coastline; the so-called '*highway of lights*'. Its placement and visibility at night allowed the northward bound traffic to safely use the reverse eddy inboard of the East Australian Current and so reduce shipping times.
- (c) The decision to construct the lighthouse at Green Cape was taken as an integral part of a plan to place lighthouses along the more dangerous gaps in the Australian coastline, a decision that has its origins in a resolution of the Inter-Colonial Conference of 1873. The 1873 Conference is significant as the principal marine officers provided the first Australia-wide evaluation of navigational needs.
- (d) The early 1882 telegraph station fulfilled an important link in the coastal communication chain and was an essential service to the local isolated community, Green Cape and Gabo lighthouses. It was used to notify Sydney of the safe arrival of overseas vessels in Australian waters and played an important part in the prompt despatch of the pilot vessel Captain Cook from Sydney to search for survivors and bodies from the founding of the Ly-ee-moon,
- (e) During World Wars 1 and 2, Green Cape was a strategically important link in the nation's defences – light-keepers were charged with watching for suspicious ships and aircraft. Several vessels were sunk or severely damaged in the vicinity from enemy action – mines, torpedos and shelling, and it is understood that many incidents are still buried in wartime censorship records *Ref 8*.
- (f) As part of a cohesive group of late 19th C and early 20th C lighthouses in NSW, it demonstrates the incremental changes in the design and construction of the various lightstation complexes *refer Modifications and Dates*
- (g) The lighthouse staff played a significant role in rescuing the survivors of the Ly-ee-moon. This is acknowledged in the newspapers of the day and the Coronial Enquiry.
- (h) Inter-Colonial Conferences, of which there were eight, were held between 1863 and 1880, represented the first political steps on the road to Federation. The decision to build Green Cape and other lighthouses was one of the first successful agreements made by all the colonies.

Historic individuals or Association

Green Cape Lightstation has association with the following eminent people:

- (a) James Barnet, Department of Public Works NSW Colonial Architect [1865-1890] who was responsible for the design of Green Cape Lightstation and many others *Appendix 6*, along the NSW coast. His people were also responsible for the supervision of the lightstation's construction.
- (b) Captain Francis Hixson, Marine Board of New South Wales President [1863 - 1901] who, as chair of the Conference of the Principal Officers of the Marine Departments of the Australian

Colonies in 1873, recommended placing a lightstation at Green Cape, and as the client, selected the site and specified its operational parameters and approved the design.

- (c) Edward Moriarty, Department of Public Works NSW Engineer-in-Chief Harbours and Navigable Waterways [1858-1889] who was involved in selecting the site for the lighthouse.
- (d) Commander C R W Brewis RN who was responsible to Commonwealth of Australia Department of Trade and Customs for an important in-depth review of the existing lights and recommending additional light requirements for the Australian coastline.
- (e) It has associations with early explorer Matthew Flinders who named the point.

Creative or Technical Achievement

Green Cape Lightstation shows important achievements in the following areas:

Technical Achievement

- (a) At the time of its construction, it was reputed to be the largest mass concrete structure in the Australian colonies and was the tallest lighthouse in NSW – *Refs 2, 10* and remained so until its decommissioning in 1992.
- (b) It was the tallest of the three mass concrete lighthouses designed by Colonial Architect James Barnet.
- (c) Green Cape was the second by three years of a pioneering group of mass concrete lighthouses. Although the faceted design facilitated easier construction using flat faced formwork; the remoteness of the site, the unavailability of major plant, the reliance on using local materials and the deep foundations, all combined to ensure its construction was not an easy task.
- (d) It demonstrates the degree of logistical management that was necessary to establish the infrastructure required for the construction of the lightstation in this isolated location.
- (e) It demonstrates the evolution of lighthouse technology over the period 1880 to the present day.
- (f) It was the second lighthouse in NSW – the first was South Solitary, to use kerosene to fuel the light when colza oil still ruled the lighthouse world.
- (g) In 1926, Green Cape was among the early lighthouses in Australia to replace the existing roller pedestal with a mercury-float pedestal, thus allowing the character of the light to meet modern international standards.

Creative/ Aesthetic

- (a) Its distinctive design with its square base transitioning into an octagonal form was a break from the traditional 'column' or 'wave-swept' tower found in many other lighthouses. It is one of the most notable designs of James Barnet. The cottage group is a good representation of Barnet's residential work. Barnet's juxtaposition of the 'prismatic' tower and Middle Eastern/ exotic domed Oil Store is also an interesting architectural feature.
- (b) Built on a prominent elevated headland the soaring octagonal tower juts out from a square base in dramatic contrast to the surrounding low-lying landscape. It is an important visual landmark and prominent feature within the local land and seascape.
- (c) The architectural significance of the tower is enhanced through the display of accentuated bluestone corbelling typifying the Victorian Mannerist style combined with the double curved gunmetal balcony railing employed by Barnet in his design.
- (d) The residences are representative examples of the Victorian Regency style and are important in the context of the stylistic development of NSW lightstation residences.

Research Potential:

Green Cape Lightstation and facilities at Bittangabee Bay provide an opportunity for research into:

- (a) the incremental changes over time in the philosophy, design, construction and technology of the various lightstation complexes, as part of a cohesive group of late 19th C and early 20th C lightstations in NSW.
- (b) the historical elements remaining at the Green Cape Lightstation – the original lighthouse, head and assistant keepers quarters, stables, flag locker, telegraph station, shipwreck sites, the Ly-ee-moon cemetery and day-to-day reminders of the occupation of the lightstation over 100 years such as the vegetable garden and rubbish tip, storehouse ruins and tramway from Bittangabee Bay may all be interpreted for both educational and scientific purposes.
- (c) The long aboriginal association with the area and the number of pre-white settlement, sites throughout the precinct that have archaeological potential, such as middens and initiation grounds.
- (d) The logistics involved in servicing of remote construction and operational sites that were only accessible by sea.
- (e) Manned light house operation and the living conditions of the lighthouse keepers and their families over the period 1880s to 1990s.
- (f) The logistics and implications involved in obtaining and processing local material for construction purposes.
- (g) The successful conservation of a lighthouse and associated buildings in a remote location.
- (h) The site shows evidence of earlier technologies and the continuous development of lighting technology - light and illuminant, applied for the same purpose over time.

Social:

Green Cape Lightstation is significant from a social and cultural perspective in the following ways:

- (a) It provides an insight into the life and times of an isolated nineteenth-century lightstation. For over 80 years, a compliment of three lighthouse keepers and their families and a telegraph officer lived at the Cape.
- (b) During the 100 + years of manned operation, the lightstation, the various light keepers and their families were closely associated with the local community. Until road transport became practical in the 1930s, Green Cape was the social focus for the surrounding villages and properties. Up to that time, stores for the lighthouse and surrounding communities came in by sea through Bittangabee Bay and were collected by the locals who made it a social event. The lightstation had a racecourse, tennis court, a well-established vegetable garden, at one time an airstrip and a mail service. Infrequent church services were held there as well as the occasional wedding *Ref 8*.
- (c) The still visible wreckage of the Ly-ee-moon and other vessels and the nearby cemetery, where at least 24 graves of victims are buried, are testament to the rescue and ministering role performed by the light keepers and their families. This involved not only performing rescues in dangerous sea conditions, but providing first aid, comfort and shelter to survivors and recovering and burying the dead.
- (d) The area is an important cultural one for the local aboriginal people. To them the Cape [*Bundooro*] was a men's area and also used for teaching purposes. Bittangabee Bay [*Pertangerbee*] was used both as a camp place and teaching ground. The land continues to have important traditional, spiritual, emotional and physical significance to the local Tauraira people.

- (e) The community of lighthouse keeper families had their own ethos with the members accustomed to adapting to living in isolated areas, and moving from lightstation to lightstation as keepers were rotated or promoted. In the early days, the small community effectively ran on naval lines and only married; preferably ex naval personnel, were appointed. This distinctive way of life has been lost.
- (f) Although still a relatively remote site, the lighthouse provides a focal point for visitors to the area and is a popular subject for artists and photographers.

Rarity

- (a) The lighthouse is substantially different from any other tower in Australia. Only the Smoky Cape tower, which is much shorter, bears any similarity to the Green Cape tower. The heavy square base, octagonal shaft, battered walls and sheer size of the visually impressive Green Cape Lighthouse and its domed oil store building boldly expresses the structural process that sets it apart from any other Australian lighthouse.
- (b) The Green Cape lighthouse optic is one of the rare pieces of optical craftsmanship which while still functional has been superseded by 20th century automation.

Representativeness

It is one of the so-called 16 '*coastal highway lighthouses*' that were erected along the NSW coastline between 1862 and 1903. It is a prominent landmark, with integrated natural, cultural and symbolic values.

Integrity/ Intactness:**Overall**

The lightstation remains an intact precinct and as such displays a very high integrity with most of the buildings of substance from the 1881-83 building period still remaining on the site.

Lighthouse

Green Cape lighthouse remains, in its current appearance, close to that of the year of its completion. Its interior is highly intact with only small changes to the ground floor surfaces and joinery details. The most noticeable changes are those associated with improvements in technology –

- changes in the light source to increase its luminous intensity – 4 wick burner to Douglass incandescent burner to a Schmidt-Ford burner to incandescent lamps,
- changes in the energy source for powering the light – kerosene to electricity,
- powering the rotation of the lens – replacement of the clockwork drive with an electric motor
- replacement of the roller pedestal with the mercury–float pedestal.

Some examples of the superseded equipment and photos where an example cannot be obtained are located in the tower along with copies of background documentation *refer Appendix 9*

In 1998 the lighthouse was painted internally and externally to its original colours.

Residences*Principal [Head] Lightkeeper's Residence*

The Principal [Head] Lightkeeper's quarters generally retains its original layout. The bathroom/ laundry addition was most likely done in 1913. – *refer NAA drawings*. Spatially the 1883 house remains virtually intact with only the entrance to the toilet altered from an outside to internal access. The only other substantial change in plan is the addition of a wall linking the main block of the house to the kitchen block on the north side.

Assistant Keepers' Residences

Based on an inspection of the residences, it would seem likely that these residences were not built in accordance with Barnett drawings and included two additional rooms *Ref 1p113*. As is the case for the Head Keeper's residence, the two 1883 residences remain substantially intact. Apart from these initial changes, the principal change to the Assistant Keepers' quarters has occurred through the conversion of the originally identical semi-detached residences into one larger one and one smaller unit through the incorporation of the living room of the easternmost residence into the other to provide an additional bedroom. As is the case for the Head Keeper's residence, there is a wooden addition to the side of both kitchen blocks, most likely done in 1913. There have been other changes such as the partial enclosure of the rear veranda and the two residences are now interconnected.

General Comments

The atmospheric conditions around the lightstation are very aggressive. However, although many features such as the roofs have been replaced several times, original features and materials have survived to a significant extent.

The original internal decorative schemes of the lightstation have not survived, primarily due to the cyclical repainting that was a feature of the regular routine of the keepers.

For all 3 residences, rooms such as the kitchens and bathrooms have been updated over time for the convenience of the keepers and their families. Electricity and gas has also been installed for the occupant's convenience.

The Head Keeper's residence is used currently for NP&WS staff/ caretaker accommodation. The other residences are available for short-stay holiday rental accommodation.

Outbuildings

While over time, some of the buildings that were associated with the original construction have been demolished – cook-house, stables, carpenters' shop and foreman's works office. The remaining outbuildings – generator shed [former oil store], workshop/ garage [former stables], retain a high degree of integrity. The former telegraph station appears to be of lesser integrity.

Bittangabee Bay

The roofless storehouse is in a derelict state and only the four circular concrete piers for the jetty remain – the 12in x 12in hardwood girders and 9in x 9in planking having long since gone.

While the start of the tramway formation can be seen, even though it was in use up to 1927, there is little evidence today of any of its construction.

Comment: An unfinished house lies on the northern shore of Bittangabee Bay is thought to have been built by the Imlay Brothers. From here the Imlays, and later Boyd could attack the northbound whales before their competitors operating from Twofold Bay.

Statement of Significance:

Green Cape lightstation is of National [and State] significance because:

1. Construction of the Green Cape lighthouse was an integral part of a plan to warn mariners of the more dangerous unlit places of the Australian coastline. The decision arose from a resolution of the Inter-Colonial Conference of 1873 at which the principal marine officers provided the first Australia-wide evaluation of navigational needs. The collective decision was an early example of the cooperation between the Australian Colonies that led to the creation of the Commonwealth of Australia.
2. At the time of its construction the Green Cape lighthouse was reputed to be the largest mass concrete structure in the Australian colonies and until the time of its decommissioning remained the tallest lighthouse in NSW
3. Green Cape light has associations with major and historically important figures; James Barnet, Colonial Architect Department of Public Works NSW, and Francis Hixson, President of the Marine Board of NSW.
4. During World Wars 1 and 2 Green Cape was strategically important; it is understood that many incidents are buried in wartime records that are still subject to censorship.
5. Green Cape was the second by three years of a pioneering group of mass concrete lighthouses.
6. It is one of the iconic lighthouses of Australia. Green Cape's distinctive design with its square base merging into an octagonal form was a break from the traditional circular tower of other lightstations; the styling is rare. It was the first of only two that were constructed to this design and the taller of the two.
7. As part of a cohesive group of late 19th C and early 20th C lighthouses in NSW, it demonstrates the incremental changes from 1880 to the present in the design and construction of lightstation complexes and in the evolution of lighthouse technology.
8. There is research potential in the long aboriginal association with the area and the number of pre-white settlement sites throughout the precinct, such as middens and initiation grounds.
9. There is research potential in the logistics involved in servicing remote construction and operational sites that were only accessible by sea.
9. During the 100 years of its manned operation, Green Cape Lightstation was a social and cultural centre for the local community and surrounding properties. A shared activity was the unloading of stores for both the lightstation and the settlers, which became a co-operative and social occasion.
10. The still visible wreckage of vessels and the nearby cemetery are testament to the rescue and ministering role performed by the light keepers and their families. This involved not only performing rescues in dangerous conditions, but providing first aid, comfort and shelter to survivors and recovering and burying the dead.
11. The area was an important cultural one for the local aboriginal people. To them the Cape [Bundooro] was a men's area and was also used for teaching purposes. Bittangabee Bay [Pertangerbee] was both a camp place and teaching ground.
12. The lightstation has a high degree of integrity; the lighthouse itself is substantially intact with items of replaced equipment being displayed on site, or photographs where equipment is not available. Most of the buildings of substance from the 1881-83 period still remain. Little different from the day the light was first exhibited, it readily allows the working conditions of the keepers and living conditions of lighthouse families in an isolated environment to be appreciated. The semi-detached Assistants' quarters have been modified into one smaller and one larger residence.

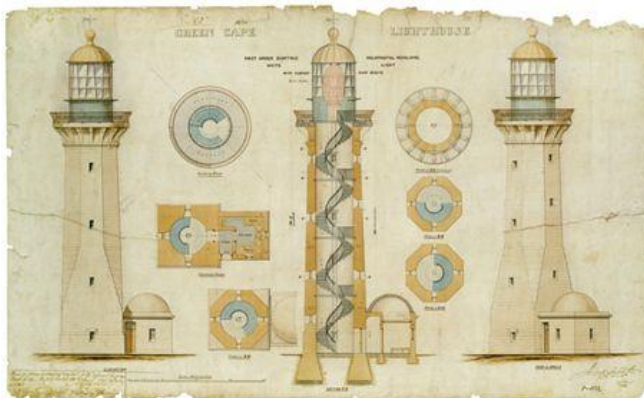
Assessed Significance:

National

GREEN CAPE LIGHTSTATION & ASSOCIATED INFRASTRUCTURE AT BITTANGABEE BAY

an Engineers Australia National Engineering Heritage Landmark

Since 1 November 1883, when it first came into service, the Green Cape light has warned mariners of this dangerous cape that projected into the sea lane. The construction of the lightstation was supervised by the designer NSW Colonial Architect James Barnet and was constructed by Albert Aspinall. Building materials and supplies were landed at Bittangabee Bay and transported to the site over a seven km tramway. The tower is constructed from mass concrete; the sand and rock being obtained locally. Its construction took three years. The lantern house and 1st order light were supplied by Chance Bros of Birmingham England. Green Cape is the most southern and tallest of the 25 coastal lightstations along the NSW coastline. The tower is 20.7m from the ground floor to the balcony and a further 9.4m to the top of the lantern-house. The focal plane of the light is about 52 m above High Water Mark. It was visible at sea up to 44km.



Barnet Drawing of Green Cape Lighthouse NAA



Why is Green Cape Lightstation Significant

It is an important component of the system of great 19th century lighthouses designed to light the NSW coastline; the so called 'highway of lights.'

When built, It was the tallest lighthouse in NSW and remained so for all its life and, at the time of its construction, was purported to be the largest mass concrete structure in Australia.

It is one of the iconic and, with its octagonal form, distinctive, lighthouses of Australia - a tribute to James Barnet's architectural skills.

The buildings remain largely as when they were built 1883; an excellent example of a late 19th century lightstation complex.

It shows the incremental changes over time in the philosophy, design, construction and technology of lighthouses for the last 130 years.

It provides an insight to the life and times of the lighthouse staff and their families in an isolated location.

During both World Wars it was an important link in the Australia's defences.

It demonstrates the logistics that were involved in servicing remote construction and operational sites that were only accessible by sea.

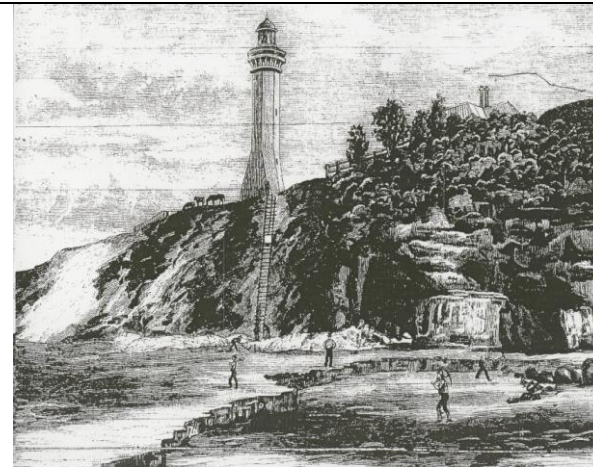
The Chance Bros lantern is one of the rare extant pieces of optical craftsmanship of 19th century.

Green Cape Lightstation

National Engineering Heritage Landmark

History of Green Cape Lightstation

- 1873 Decision taken to place a light at Green Cape
- 1879 Funding approved NSW Parliament
- 1879 Barnet prepares drawings and tenders called
- 1880 Contract awarded to Albert Aspinall
- 1881 Order placed with Chance Bros for the lantern and light
- 1881 Aspinall commences work at Bittangabee Bay building jetty and tramway. Tower construction starts in June
- 1883 Tower finished in July and lantern house and light erected on top
- 1883 Light first shown 1 November
- 1886 Ly-ee-moon wrecked on Green Cape. 71 lives lost
- 1926 Roller pedestal replaced by mercury-float pedestal and the intensity increased to from 100,000 to 327,000 candelas
- 1962 Light and lantern drive electrified
- 1967 Light intensity increased to 1 million candelas
- 1992 Light replaced on 17 March with a 'solar' light



Town & Country Journal 26 May 1883

The people involved:



James Barnet, Colonial Architect Department of Public Works NSW, the designer and whose staff supervised the construction



Captain Francis Hixson, President of the Marine Board of NSW: the client who selected the site and specified the requirements for the light.

Albert Aspinall: the builder

logo of DECC Department of Environment & Climate Change NSW and Institution of Engineers Australia 2009 logo of EA

Comment The layout and content of the panel will be the result of agreement by DECC - NP&WS. the National Panel and consultation with a firm specialising in producing similar interpretive panels.

Cited References:

This nomination has used information from the following documents, in particular Ref 1 and S170 document:

	Author	Title	Publisher	Repository/ Location	Year
1	Australian Construction Services for Australian Maritime Safety Authority	Conservation Plan Green Cape Lightstation NSW		Australian Marine Safety Authority Library	1993
2	Entries by James Barnet, James Skelton and Daniel Wheeler	Visitors Book Green Cape Lightstation 1883 -1934		Australian Marine Safety Authority Library	1988
3	Gordon Reid	From Dusk til Dawn a history of Australian Lighthouses	Macmillan	Wollongong City Library	1988
4	Suzannah Plowman Victoria Design & Management	Green Cape Lightstation Schedule of Archival Materials		NP&WS Library	June 1998
5	Commander C R W Brewis RN	Lighting of the East Coast of Australia		NSW State Library	March 1913
6	Graham Brooks and Associates Pty Ltd	NPWS Lighthouses Conservation Management and Cultural Tourism Plan		NP&WS Library	January 1999
7	Lighthouses of Australia	www.lighthouse.net.au		LoA website	
8	P Whitlock	Greencape Lighthouse Eden NSW	Magnet Printing & Signs	Eden Killer Whale Museum library	1992
9	Steve Merson	Light Houses of Australia Bulletin No 4		LOA website	2004
10		Australian Builder and Contractors News p17		NSW State Library	5 January 1889
11	Richard Apperley et al	A Pictorial Guide to Identifying Australian Architecture	Angus & Robertson	NSW Library	1989
12	Henry Richard Carleton	Lighthouses in NSW	Journal & Proceedings of Royal Society NSW Vol 32 pp82-123	NSW Library	1898
13	John Francis Scott	The Whimsicality of fate or the Long Arm of Coincidence		Eden Killer Whale Museum	unknown
14	Contemporary NSW South Coast newspaper articles				
15	Kenneth Sutton-Jones	Pharos The Lighthouse Yesterday Today and Tomorrow ISBN 085955 1188	Michael Russell [Publishing] Ltd	Privately owned R Jermyn	1985
16	British Admiralty Hydrographic Office & RAN Hydrographic Office	Notices to Mariners		British Admiralty Hydrographic Office & RAN Hydrographic Office	various
17	Various	Heritage listings – refer page 17		Various web sites	refer p 17

Source Material & Research Comments

The research on Green Cape Light Station has been protracted because few primary sources exist. Such information that has been obtained has at times been conflicting and the author has taken a 'best fit' approach based on the available information and his experience managing construction projects. Details such as exact dates of events relating to the lighthouse are difficult to determine without further prolonged research in archives – if such detail exists or indeed ever existed. Unfortunately, many early o Public Works Department NSW records were lost in the Garden Palace Fire of 22 September 1882 or may have been considered to be of little value and destroyed when responsibility for Australia's coastal lighthouses passed from Public Works Department NSW to the Commonwealth Lighthouse Service – now the Australian Maritime Safety Authority. Chance Bros records were destroyed in a fire around 1920 [*Kenneth Sutton Jones private correspondence*]

Appendix 1

Plaquing Letter of Approval from Department of Environment & Climate Change NSW, NSW National Parks and Wildlife Service

Our reference: ED08/381

Doug Boleyn
10 Noel Street
NORTH WOLLONGONG NSW 2500

27 APR 2009

Dear Mr Boleyn

I write in response to your letter dated 17 March 2009 regarding the Department of Environment and Climate Change's agreement for the Institution of Engineers Australia to recognise the engineering heritage value of the Green Cape Lightstation in the form of an inscribed bronze marker and interpretation panel. I apologise for the delay in responding.

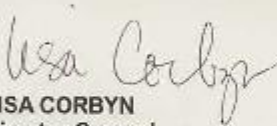
The Department welcomes your proposal to formally recognise the engineering heritage value of Green Cape Lightstation.

We would however prefer that the plaque along with the interpretive panel be designed as a stand alone display rather than affixed to the tower. They could possibly be located inside the Lightstation and be highlighted as a point of interest during daily tours.

I invite you to discuss these details, along with the plaque's wording and ceremony requirements with staff in the Department's Far South Coast Office at Merimbula. Please contact Craig Dickman, the Ranger responsible for Green Cape Lightstation, on (02) 6495 5020.

Thank you for your interest in conserving and recognising our historic heritage.

Yours sincerely


LISA CORBYN
Director General

PO Box A290 Sydney South NSW 1232
59-61 Gouldrum St Sydney NSW 2000
Tel: (02) 9995 5000 Fax: (02) 9935 5993
TTY (02) 9211 4723
ABN 30 641 387 271
www.environment.nsw.gov.au

Department of **Environment & Climate Change** NSW



Appendix 3 Photos of Green Cape Lightstation and Bittangabee Bay



Green Cape Lighthouse 125 years 1 November 2008 Ian Clifford



Green Cape Lighthouse and Residences Steve Merson

Green Cape Lightstation

National Engineering Heritage Landmark



Green Cape Lighthouse Optic Panels Ian Clifford



Green Cape Lighthouse Optic Panel Bulls-eye Steve Merson



Green Cape Lighthouse Distinctive Barnet Gun-metal Balustrade
Ian Clifford



Green Cape Lighthouse Spiral Cast Iron Stairway and Weight Tube



Green Cape Lighthouse a view of the residences



Green Cape Lighthouse – the old and the new Cyril Curtain



Green Cape lantern house gallery walkway showing ventilators



'Clock' – clockwork motor similar to the replacement one that was installed in 1926 *The governor is at the bottom and the adjusting screw of the pedestal can be seen on the right of the picture*



Bittangabee Bay looking out to sea showing the storehouse and jetty site

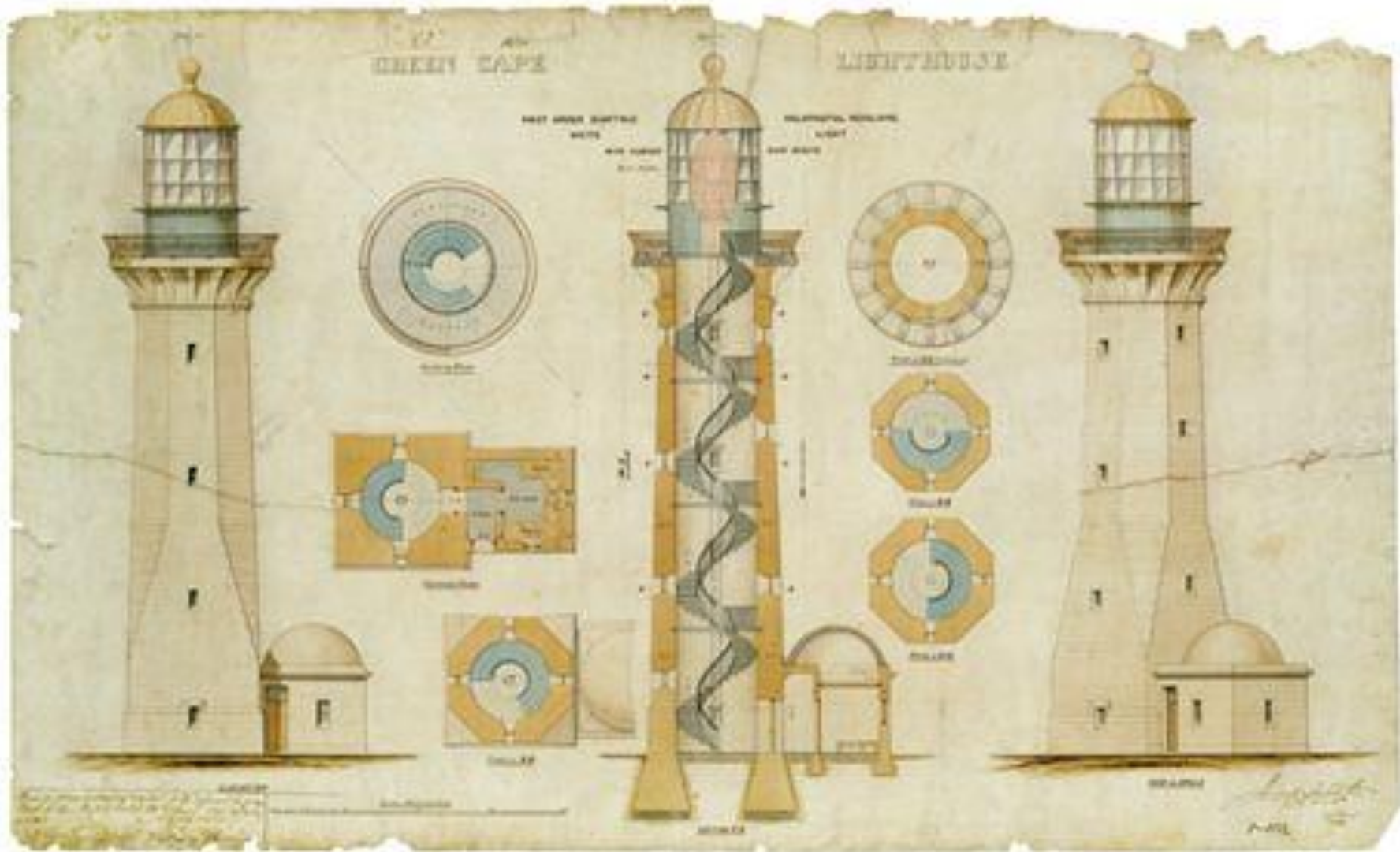


Bittangabee Bay ruins of store-house

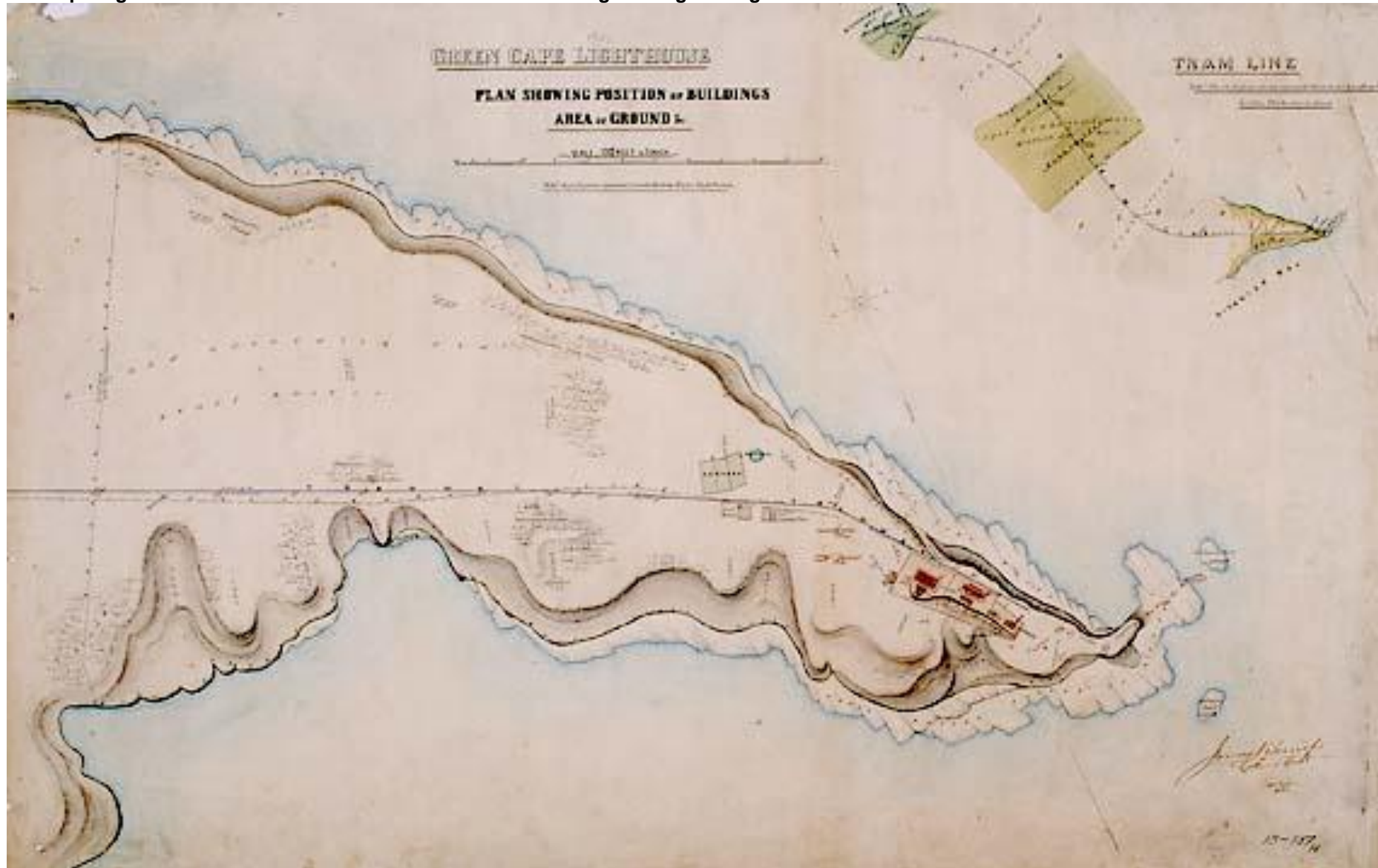
Note Additional photographs are included in the accompanying CD Appendix 9

Appendix 4 Original Drawings for the Construction of Green Cape Lightstation

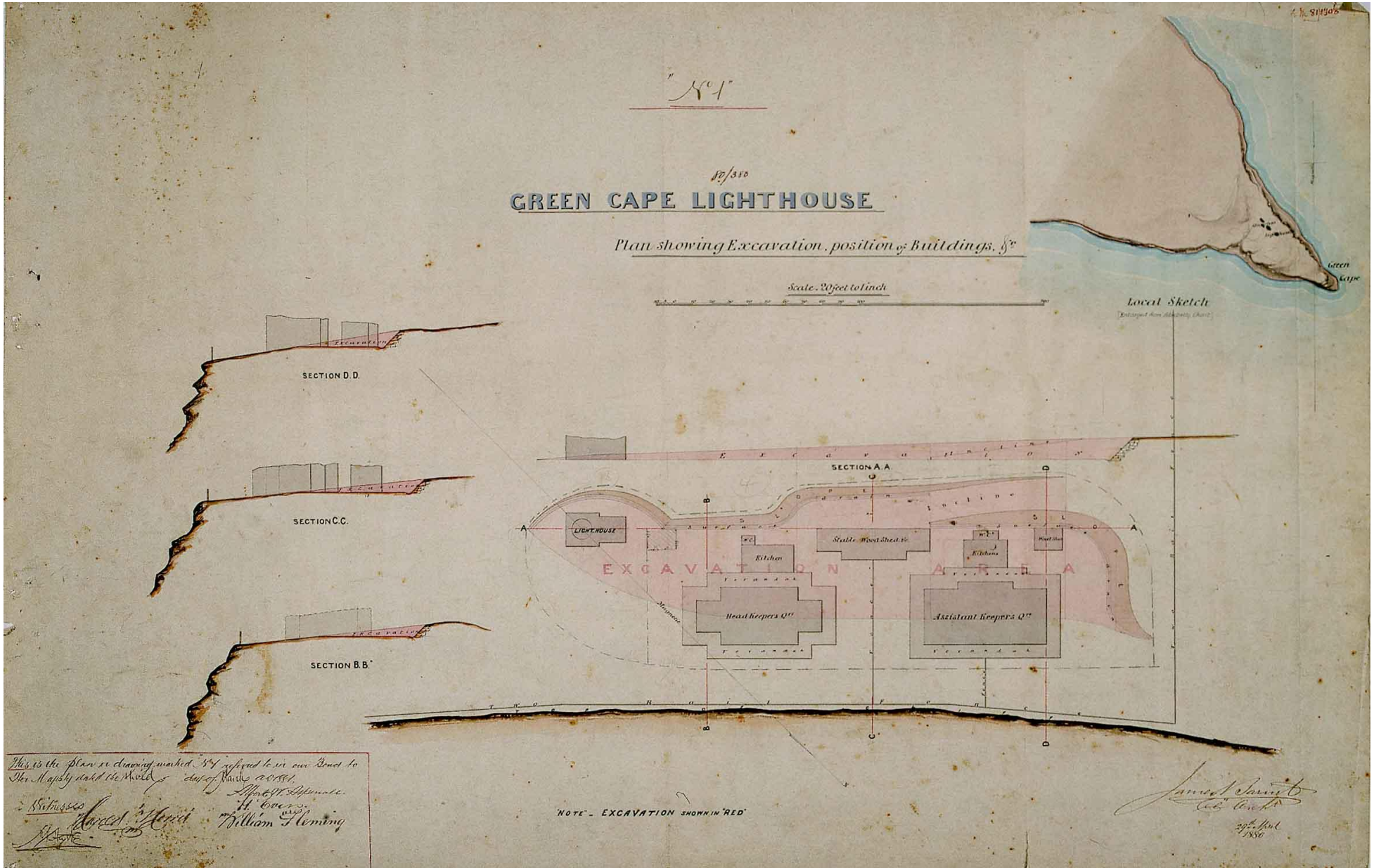
NSW Office of the Colonial Architect James Barnet NSW Public Works Department



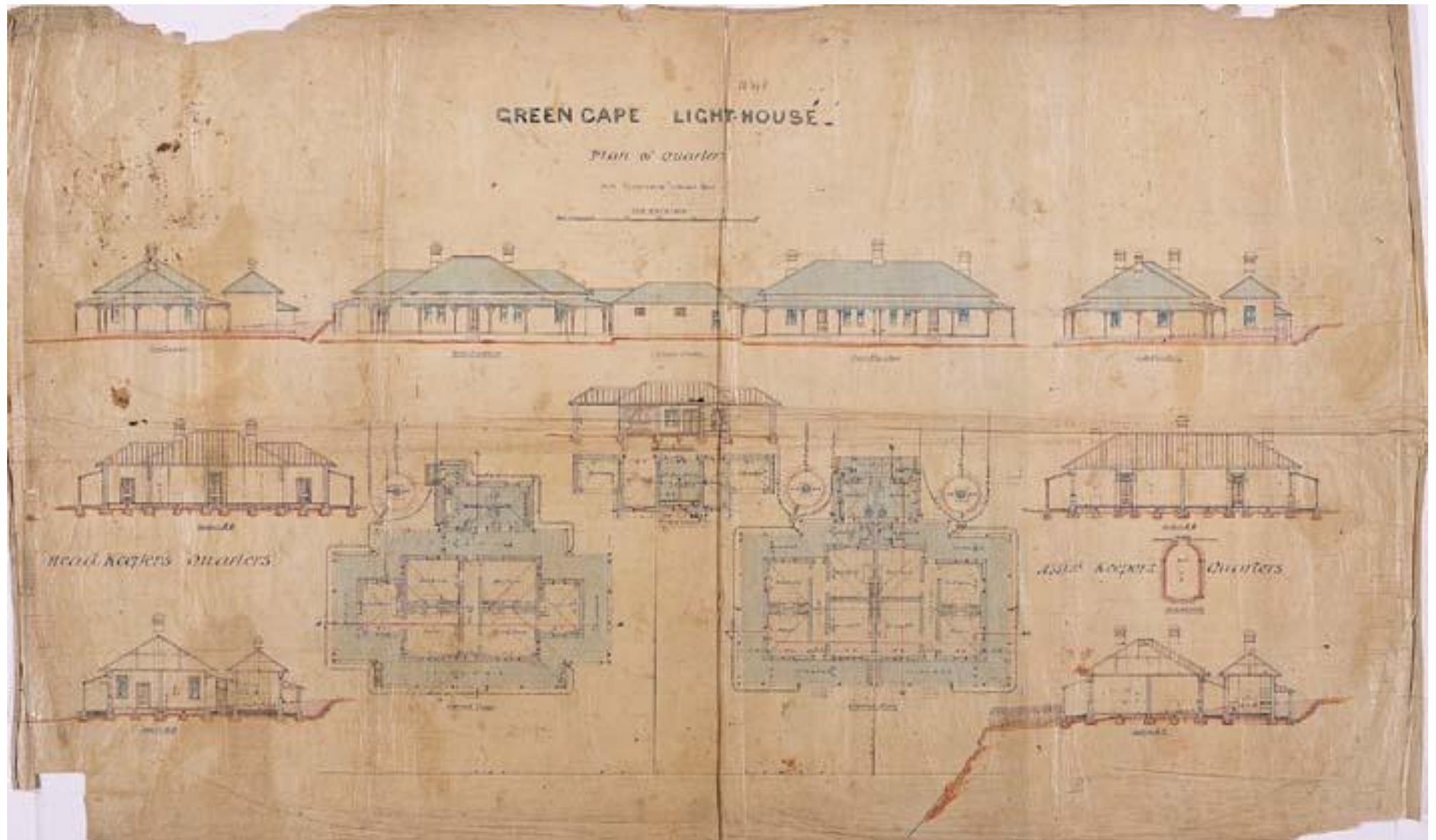
Green Cape Lighthouse National Archives of Australia



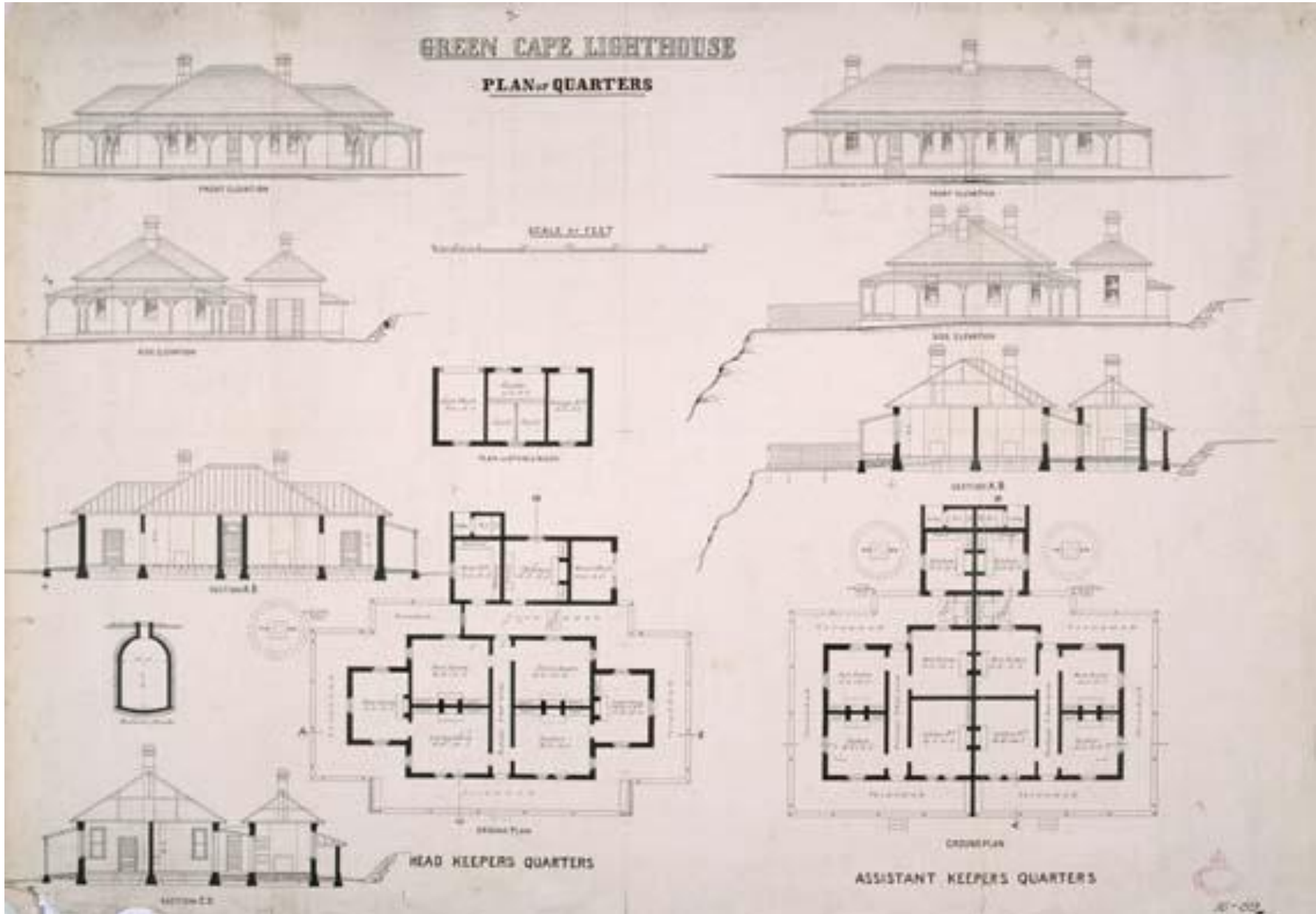
Green Cape Lighthouse – Plan showing Excavation positions of buildings etc National Archives of Australia

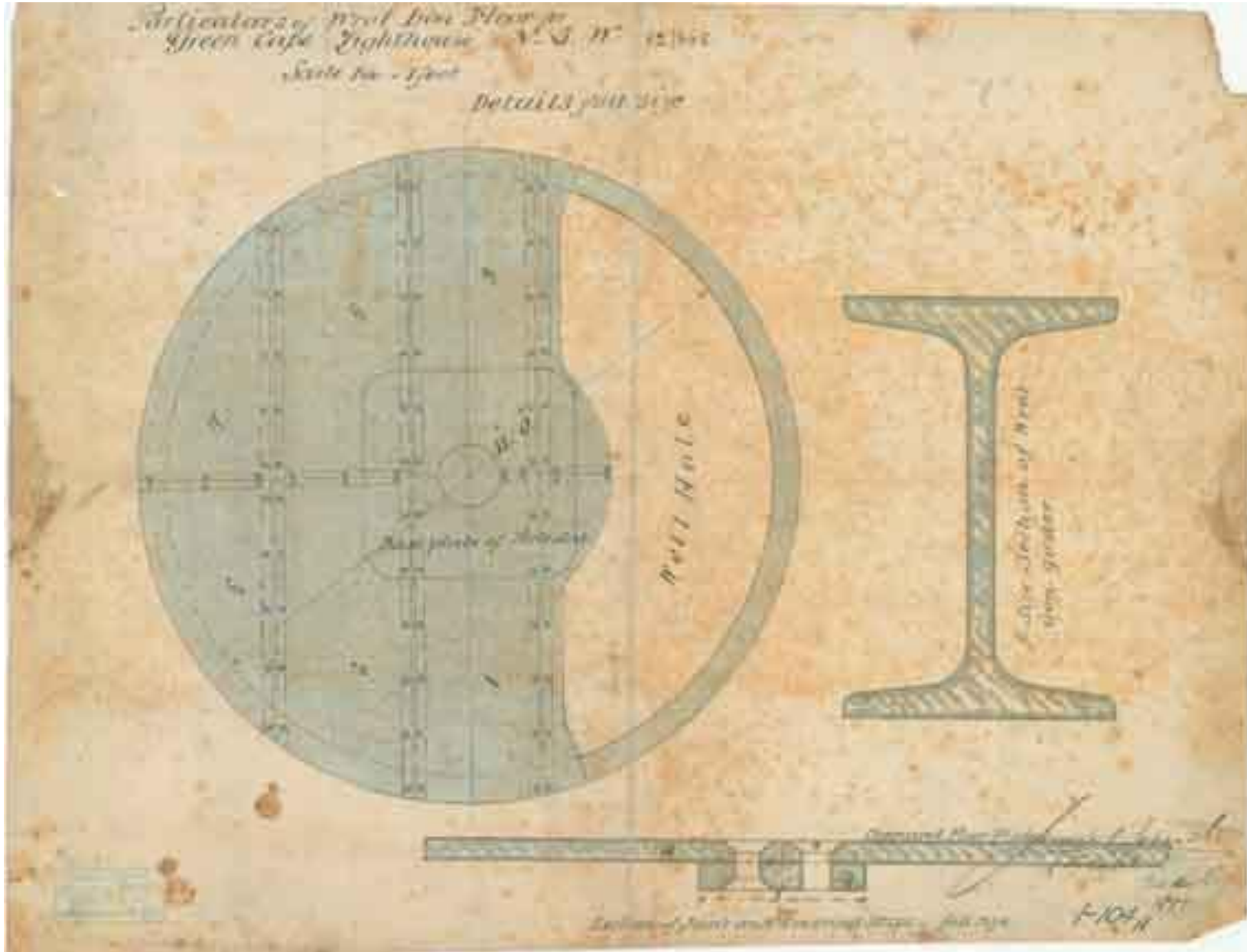


Green Cape Lighthouse - Plan showing Excavation, Position of Buildings etc



Green Cape Lighthouse - Plan of Quarters National Archives of Australia

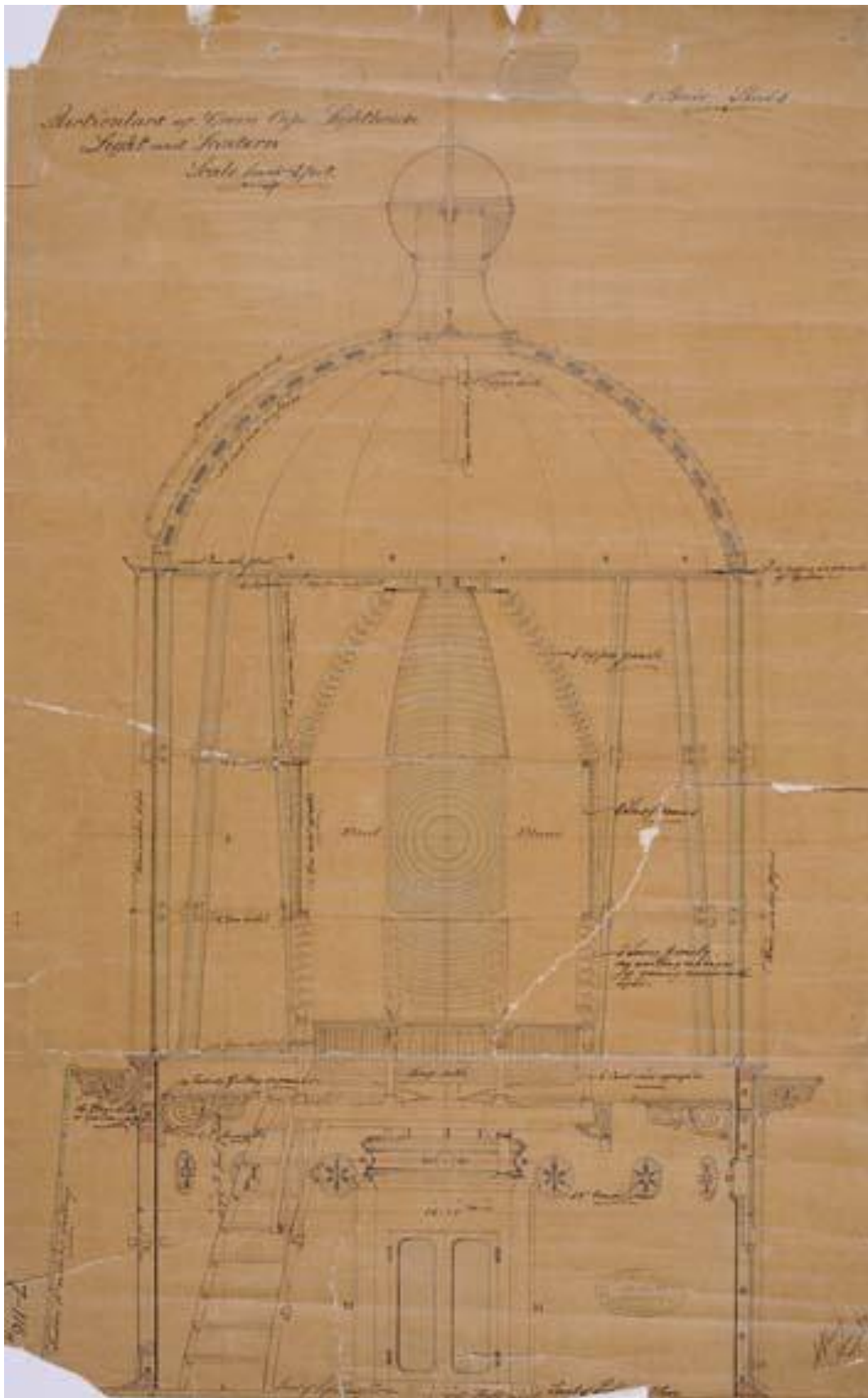




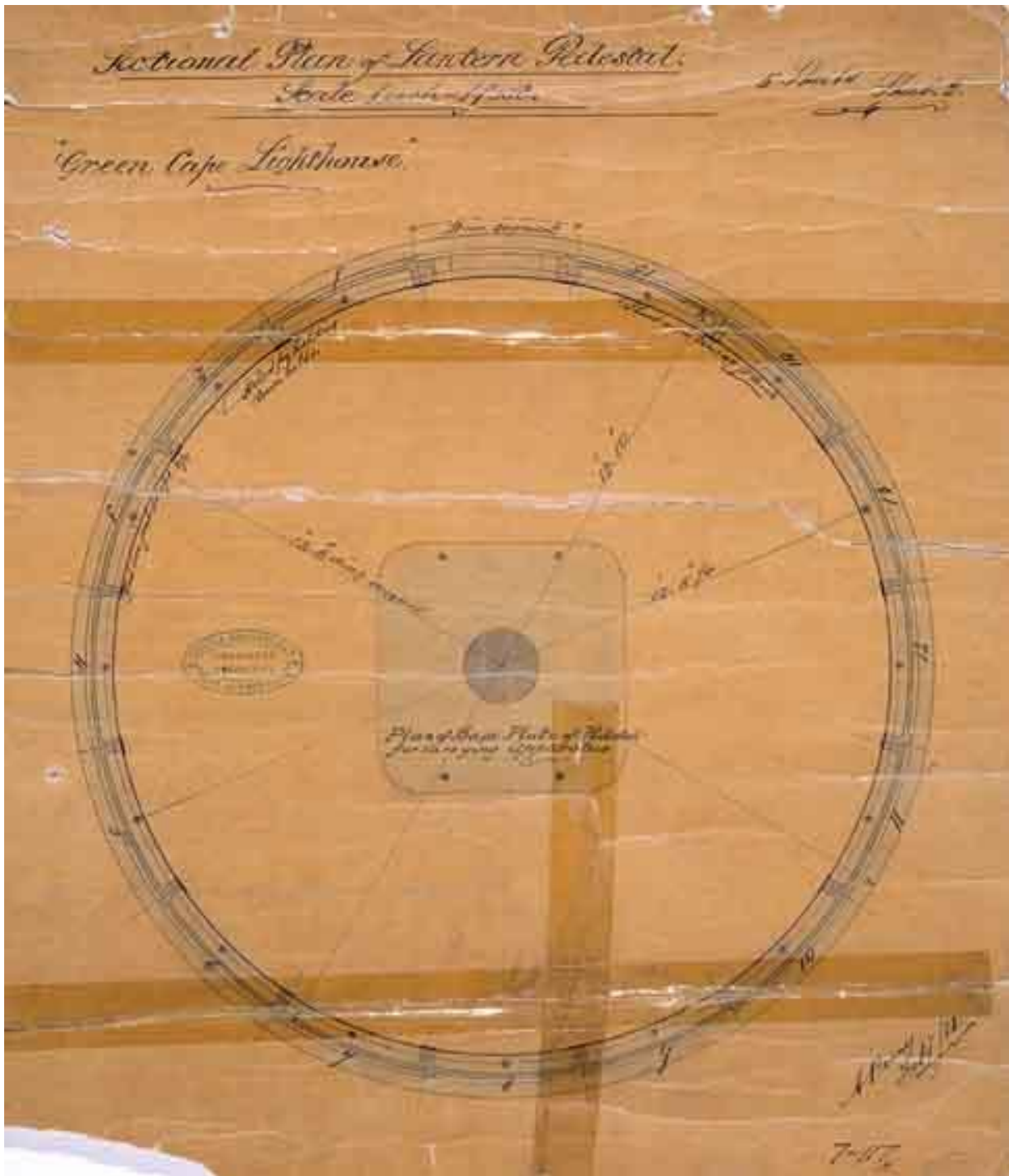
Green Cape Lighthouse Particulars of Wrought Iron Floor

National Archives of Australia

Chance Bros Drawings

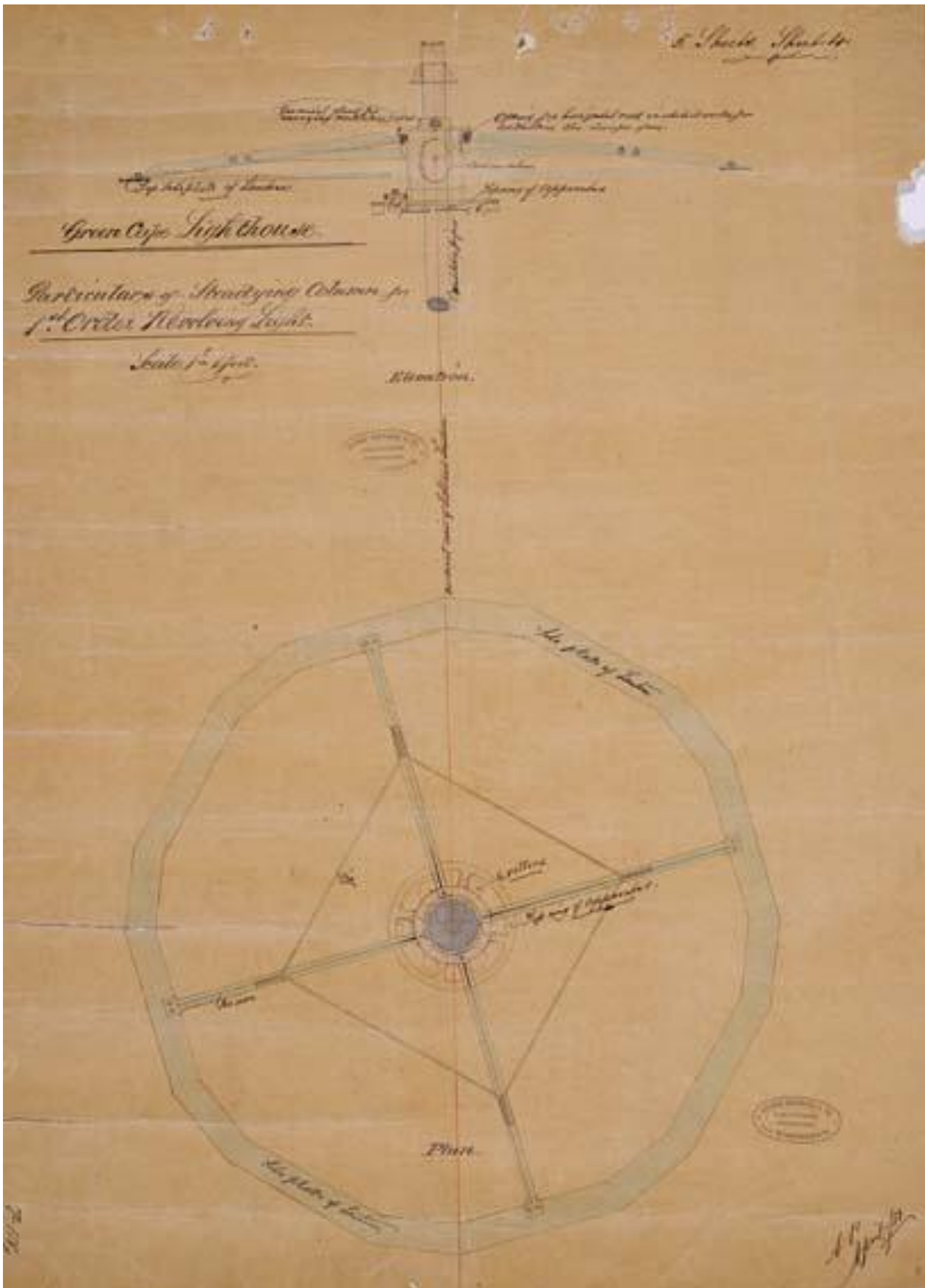


Green Cape Lighthouse - Sectional Plan of Light and Lantern National Archives of Australia



Particulars of Green Cape – Sectional Plan of Lantern Pedestal

National Archives of Australia



Green Cape Lighthouse – Particulars of Steadying Column for 1st Order Revolving Light

NAA

Appendix 5 Schedule of Drawings of Green Cape Lightstation held by Australian Maritime Safety Authority, National Archives, Lighthouses of Australia relating to the original construction

Barnet Drawings 1881

**Green Cape Lighthouse	Plan showing Position of Buildings Area of Grounds		
**Green Cape Lighthouse	Plan showing Excavation, position of Buildings etc	94 x 62cm	
**Green Cape Lighthouse	Plan of Quarters		
**Green Cape Lighthouse	Plan of Quarters		
**Green Cape Lighthouse	Particulars of Wrot [sic] Iron Floor		
**Green Cape Lighthouse	Details of verandah		
Green Cape	Details of Balcony Corbels	240 x 110cm	LOA

Chance Bros Drawing set of 5 1881

**Green Cape Lighthouse	Sectional Plan of Lantern Pedestal	Sheet 2 of 5
**Particulars of Green Cape Lighthouse	Light and Lantern	Sheet 3 of 5
**Green Cape Lighthouse	Particulars of Steadying Column for 1 st Order Revolving Light	Sheet 4 of 5

Other

1900 Green Cape Light House Light-keepers Quarters

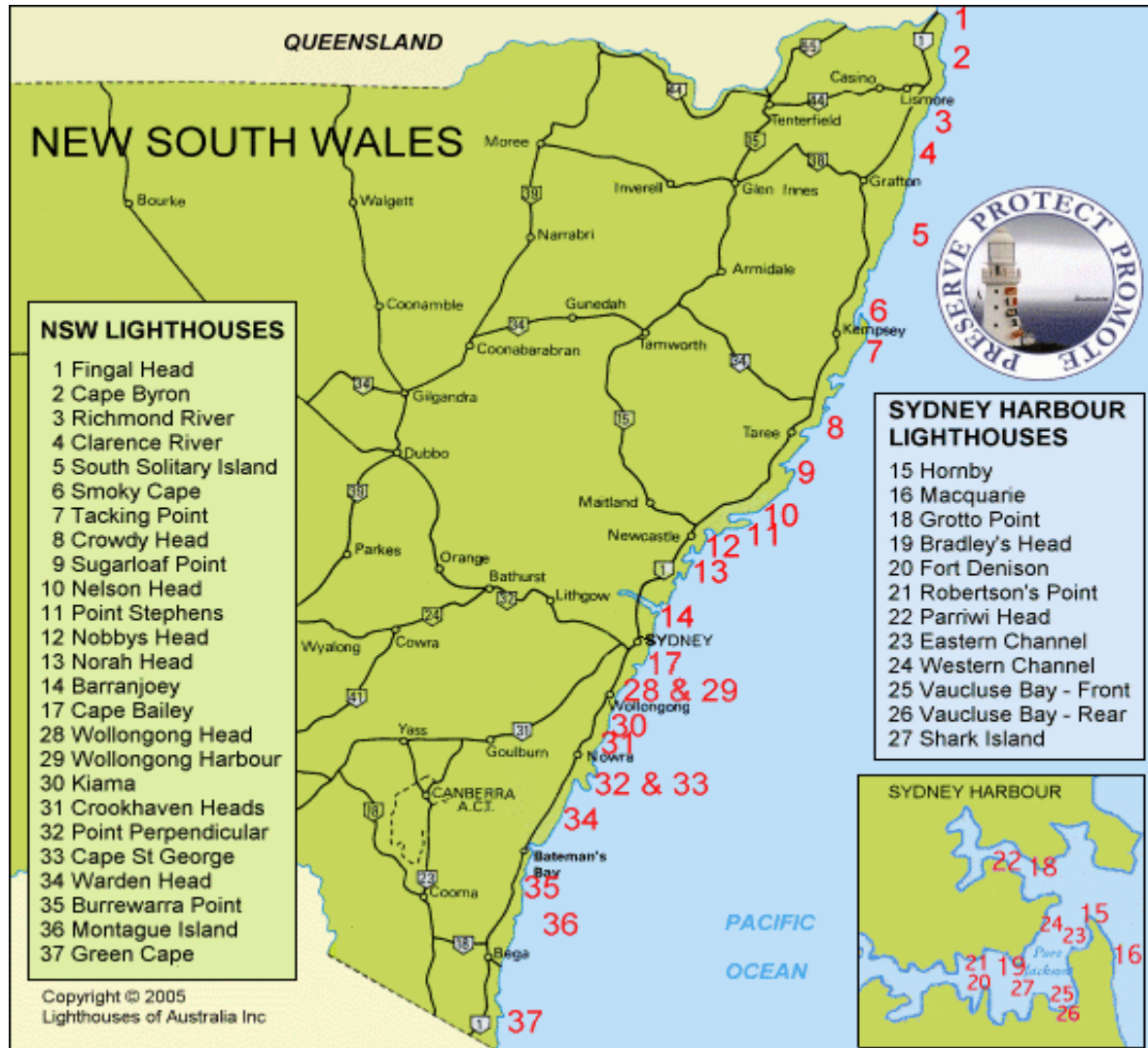
Comment: *I have been unable to discover the titles of the missing Chance drawings and if the Barnet set is complete.*

Note electronic copies of the drawings marked ** are included in the accompanying CD

Appendix 6 Schedule of Lighthouses Designed under the aegis of James Barnett whilst he was the Department of Public Works NSW Colonial Architect

Brief Histories of: James Barnett, Edward Orpen Moriarty, Francis Hixson and Albert Aspinnall

Shipping Losses around Green Cape – Disaster Bay



Responsibility for Design of NSW Lightstations

The legislation for the establishment of responsible government in NSW was enacted in 1855. From this time to 1887 the Colonial Architect's Office of the Public Works Department, NSW [later known as the Government Architects Branch] was responsible for the design and construction of lighthouses along the NSW coastline.

As a result of the 1887 Board of Enquiry into the Civil Service the function was partly taken over by the Public Works Department, NSW Harbours and River Navigation Branch from 1887. This Branch employed an architectural staff under Charles Assinder Harding, to design lighthouses and associated buildings from 1890 until 1904, when the responsibility returned to the Government Architects Branch.

The Commonwealth government took over all public works for navigation in 1909 and responsibility for the design and construction of lighthouses from 1 July 1915.

Lightstations built under the aegis of James Barnet

In 1858 a lighthouse was built at Newcastle on Nobby's Island at the entrance of the Hunter River.
After the wreck of the Dunbar in 1857, another light, the Hornby Light, was also built in 1858 on the southern headland at the entrance to Sydney Harbour.

In 1860 the Cape St George lighthouse was built on the southern headland of Jervis Bay.

From then on until 1890, the Colonial Architect, James Barnet, was responsible for the design and construction of fourteen lighthouses.

	Lighthouse	First Exhibited%	Height	Elevation above HWM	Tower Const'n Material	Comment
1	Fingal Head	1872	7m	24m	masonry	
2	Sugarloaf Point [Seal Rocks]	01 12 1875	15m	79m	rendered brick shaft, bluestone gallery	
3	Crowdy Head	1878	7.3m	61m	stone	
4	Tacking Point	1879	8.0m	34m	cement rendered brick	
5	Richmond River Heads	1880	7m	35m	masonry	Replaced 1866 structure with a permanent tower
6	Clarence River Yamba	1880	7m	30m	cement rendered brick?	Replaced 1866 structure with a permanent tower which in turn was demolished 1956
7	South Solitary Island	March 1880	20m	58m	mass concrete cement rendered	
8	Montague Island	1881	21m	80m	dressed granite	
9	Barrenjoey	1881	19.75	113m	Nepean sandstone	Replaced 2 earlier wooden structures Southern headland Broken Bay
10	Shoalhaven Crookhaven Heads	1882	7m	22m	brick	Timber tower replaced with brick tower 1904
11	Macquarie	1883	26m	105m	sandstone	Replacing the 1818 Greenway/ Gill lighthouse at South Head Sydney Harbour
12	Green Cape	01 11 1883	29m	89m	mass conc cement rendered	
13	Kiama	1887	15.5m	36.3	rendered brick	
14	Smoky Cape	15 04 1891	17.4m	128m	mass concrete cement rendered	Completed by Cecil West Darley

% First Exhibited is when the light is first brought into service

Three more lighthouses that show Barnet's influence were designed in the Government Architect's Branch under Walter Liberty Vernon, the first Government Architect and Barnet's successor.

Lighthouse	First Exhibited*	Height	Elevation	Tower Construction Material	Comment
Point Perpendicular Jervis Bay	1899	21.4	93m	Concrete blocks	Replaced the incorrectly sited Cape St George light Charles Harding?
Cape Byron	1901	18m	118m	Concrete blocks	Built in the Barnet style Charles Harding
Norah Head	1903	27m	46m	Mass concrete bluestone gallery	Built in the Barnet style Charles Harding

The above information was taken from *From Dusk till Dawn A History of Australian Lighthouses* Ref 3 and from Lighthouses of Australia web site www.lighthouse.net.au

James Barnet

James Johnstone Barnet was born in Arbroath Scotland in 1827. The son of a builder, in 1843 he went to London where he was apprenticed to a builder. He studied drawing and design and then architecture, becoming Clerk-of-Works to the Worshipful Company of Fishmongers.

After marrying in 1854, he migrated to Australia, entering the building trade, became Clerk-of-Works at Sydney University and in 1860 joined the Department of Public Works NSW Colonial Architect's Office. Barnet had very little practical experience as an architect when the Colonial Architect Alexander Dawson retired in 1862 and, perhaps for that reason, had to act in the position of Acting Colonial Architect from 1 November 1862 until 1 January 1865, when he was confirmed as Colonial Architect, a position he held until his forced retirement in 1890

Over the 25 years that Barnet had responsibility for public architecture in NSW, his responsibility extended to building defence works in Port Jackson, Botany Bay and Newcastle as well as schools, courthouses, lock-ups, police stations, and post offices throughout the Colony. Under his direction, his office designed many important buildings including a new wing of the Australian Museum, the Customs House at Circular Quay, Lands Building, Colonial Secretary and Department of Public Works Office in Bridge St, Public Library Building in Macquarie St, Callan Park, the Colonial Exhibition Building of 1879 and the General Post Office in Martin Place.

The designs of James Barnet were strongly influenced by his training under William Dyce and Charles Richardson in London and he retained an inclination of Classicism and the influence of the Italian Renaissance. Despite the fact that Barnet has been judged as a "competent architect of the second rank", he executed many fine designs and his works occupy prominent and honoured positions in towns and cities throughout New South Wales.

His career with the DPW ended in unfortunate circumstances when a Royal Commission in 1890 found that Barnet was grossly indifferent towards his duties and guilty of insubordination to the Minister for Public Works. The outcome of the Royal Commission precipitated his resignation. He served through a period when New South Wales was a wealthy state because of gold and wool, and the construction of public buildings boomed for three decades. By 1881 he had been responsible for over 1490 public works.

Later in life, Barnet claimed that he had been responsible for the design and construction of 20 lighthouses. A more reasonable number appears to be 14.

Précised from James Barnet, Colonial Architect Peter Bridges, Don McDonald Hale & Ironmonger 1988 p75

Edward Orpen Moriarty

1825 -18 September 1896

Moriarty was born in Ireland and educated at Trinity College, Dublin. After working briefly as a

cadet engineer in England, he came to Sydney with his family. In 1849, he established his own practice in Sydney as a civil engineer and later carried out work for Governor Darling preparing designs for improving navigation of the Hunter River. He was appointed the first Engineer-in-Chief for Harbours and Navigable Rivers in the Department of Public Works NSW from 1858 and up until his retirement in 1888, he was responsible for many important harbour and river improvement works in the Colony of NSW. He was an exceptional engineer whose achievements included the design of improvements to the mouths of Clarence and Richmond Rivers, Morts Dock at Balmain, Sutherland Dock at Cockatoo Island, the Upper Nepean Water Supply Scheme for Sydney, lighthouses for Wollongong and Ulladulla Harbours, Lake Parramatta Dam and Newcastle Harbour.

Engineers Australia has declared the last two, together with Tathra Wharf National Engineering Landmarks.

In this time, Moriarty was chair or member of a number of important engineering focused Boards and various Royal Commissions and throughout his career, other colonial governments frequently sought his advice on related engineering matters.

Captain Francis Hixson 1833 – 2 March 1909

While Barnet and his assistants designed lighthouses and were responsible for their construction, the recommendations to build them came from others, chiefly Hixson who dominated the Colony's marine services from 1863 until the end of the century.

Born in Dorset in 1833, Francis Hixson joined the British Royal Navy in 1848 and helped survey parts of the Australian east coast, New Zealand and the South Pacific, resigning in 1863 to become Superintendent of Pilots, Lighthouses and Harbours in New South Wales. Following enactment of the 1871 Navigation Act, these duties were incorporated into the functions of a newly created Marine Board. On 2 April 1872 Hixson was appointed its President. He advocated the building of more lighthouses, claiming he wanted '*the coast illuminated like a street with lamps*'. He succeeded. The true impetus for navigational aids in NSW in the second half of the nineteenth-century came from Hixson, who was fortunate that he lived in a colony which could afford to build them and had governments willing to accept his proposals.

With James Barnet, in 1875 he designed the NSW state flag.

He represented NSW in 1893 and 1898 at marine conferences in Hobart and New Zealand. Hixson was best known for his work with the Volunteer Naval Brigade; its numbers steadily increasing after he took command. In the 1880s, an artillery unit was added and after a visit to England, he reorganised the Colony's naval forces. In the Boxer Rebellion of 1900, he took a contingent to Hong Kong where the Royal Navy took over.

For 40 years he had been chairman of the Sailors' home in Sydney; he also served on the Committee of the Royal Naval House, helped found the Royal Shipwreck Relief and was President of the Royal Humane Society.

Albert Wood Aspinall 27 December 1839 – 15 December 1903

Aspinall was born in Yorkshire and with his parents and siblings, came to Australia in 1857. He moved frequently to wherever his building contracts took him. He carried out much of his early work in Sydney. However, he spent one year – 1865 in the Maitland district.

Aspinall moved his family to Liverpool for about 5 years from 1876 while he constructed stone buildings in the area. During this period, he constructed the Police Station and Lockup at Penrith. The next mention of him was that he contracted to construct the brick-firing kilns of the St Peters brickworks. His longest project was the partial construction of the Green Cape lightstation. The construction drained him physically and financially and it became necessary for Aspinall to accept other contracts elsewhere during the period of construction of the lightstation.

John Francis Scott said in *The Whimsicality of Fate or the Long Arm of Coincidence* Ref 13, *Aspinall spent more time attending champagne parties in his honour than he did on the site of construction. When the climax came, he was left high and dry and owing money to his creditors*

Aspinall committed suicide in Eden by placing a plug of gelignite in his mouth. The jury found that he died on 15 December 1903 *from the effects of an explosion brought by his own act, whilst suffering from mental depression.*

Shipping Losses

Although NSW had been relatively free of wrecks during the early colonial period, the boom in trade that followed the gold discoveries and the granting of self-government in the 1850s led to increased shipping and consequent mishaps. Only the more notable wrecks were recorded before the Marine Board of New South Wales was created in 1872 as an outcome of the 1871 Navigation Act. However, between 1873 and 1896 there were 419 wrecks on the coast, consisting of 96 steamers and 323 sailing ships. Total tonnage lost was 68,817 tons and the number of lives lost was 595 *Ref 12.*

The greatest number of lives lost in the founding of any one vessel was 71 in the Ly-ee-moon.

Recorded Shipwrecks in the Green Cape – Disaster Bay Area are, [based on the NSW Heritage Office's *Historic Shipwrecks Database, 1996*]:

Name	Type	Built	Lost	Details
City of Sydney	paddle wheel steamer	1854	06 11 1862	south side of Green Cape fog
Ellen Simpson	barque	1847	17 05 1866	9-10 miles south of Green Cape
Ann and Maria	Brig	1849	05 07 1869	10 miles S of Green Cape
Storm Bird	schooner	??	13 03 1870	3 miles inside Green cape ashore
Ly-ee-Moon	steamer	1859	30 05 1886	Green Cape off shore reef
Mina	brig	1867	23 06 1888	east of Green Cape
New Guinea	steamer	1884	13 02 1911	between City of Sydney and Ly-ee-moon fog
Cumberland	Steamer		11 08 1917	5 miles south-east of Green Cape Enemy action
William Dawes	Steamer			off Tathra Head torpedoed
Iron Crown	Steamer		04 06 1942	torpedoed off Gabo Is
Iron Knight	Steamer		08 02 1943	torpedoed
Terrence Star	Trawler		19 08 1994	

It should be noted that the Green Cape – Disaster Bay area is subject to heavy fogs.

Most of these losses are the result of heavy seas, foundering on reefs or the shore as a consequence of these heavy fogs.

Whether the reduction in losses from when the Green Cape light came into service in 1883, bearing in mind the significant increase in traffic, is attributable to the presence of the light or improved seamanship is a matter of conjecture but the former is likely to be the case.

There was a lot of damage to shipping as a result of enemy action – mine fields, shelling and torpedos, in both world wars.

Vessels that were damaged during World War 2 in south-east Australian waters

Cambridge	Steamer	1916	07 11 1940	German mine
<i>1st Allied vessel lost in Australian waters from enemy action</i>				
Barwon	Steamer		04 06 1942	torpedoed
Coolana	Steamer		27 07 1942	30km north of Cape Howe
Recina			11 04 1943	off Gabo Is torpedoed

Appendix 7 Lightstation Design Philosophy

Green Cape lightstation is similar in layout to many other nineteenth-century Australian lightstations.

The form of lightstations in Australia generally followed a set of principles modified by local topography.

The first principle was that the Principal or Head Keeper and his family occupied a detached dwelling in proximity to the tower and two Assistant Keepers and their families occupied nearby smaller semi-detached houses. These three men were required to man the light - three four hour shifts per night [as was the case in the Navy]. In practice, this meant three families, since, in the early days, it was mandatory for a lighthouse keeper to be male and married, lived at the lightstation.

Comment: *The Head Keeper always kept the first watch and ensured the light was operating correctly. The mandatory three keepers derived from UK Trinity House experience.*

At Green Cape, the privacy of each family was ensured by each having a separate residence and the group, as originally planned, had individual yards to each residence with a brick mortar lined underground rainwater tank [cistern] to each, and different pathways to the tower.

A second principle, whenever practical as the placement and orientation of the residences and ancillary buildings at lightstations varied according to site conditions, was that the lighthouse had to be within sight of the residences to ensure constant monitoring of the light. [At Green Cape, the view of the light from the residences is restricted by the wide verandas, which surround them, and the only direct view of the light is from the kitchen of one of the assistant's quarters.]

The most common site plan generated by the layout of the two residential blocks within sight of the light tower was a symmetrical arrangement with the residences equidistant on either side, and usually to the rear, of the tower.

Green Cape lightstation generally follows a second arrangement – a linear arrangement with the lighthouse at one end of the residential group although the alignment is offset because of adverse site conditions. Green Cape shares this layout with other NSW lightstations such as Smoky Cape [1891], Point Perpendicular [1899] and Cape Byron [1901].

Appendix 8 Construction Details of Green Cape Lightstation Tower and Details of Optic Panels

Construction Details of Green Cape Lighthouse

Extracts from James Barnet foreword for the Visitors Book in 1883 and Barnet's drawings

The design of the Tower is octagonal transitioning from a square base surmounted on top by a bluestone gallery carried on 16 bluestone corbels. Attached to the Tower is a small Oil Store with a domed roof of concrete.

The whole of the tower and attached Oil Store is carried out in concrete – [although it is said there are 4 encircling iron bands ¹ as is the case for the second Macquarie light,] and is the most extensive concrete job as well as the highest light tower that has yet been erected in the Colony.

The height of the tower from the Ground floor to the balcony is 68ft 0in and the focal plane of the light above High Water Mark is 144 feet ² and the overall height to the top of the weather vane is 99 feet.

The tower is battered on the outside and walls diminish from 4 ft [Barnet drawing 3ft] thickness at the bottom to 2ft 6in [2 ft drawing] at the top and the walls are cemented inside and out.

The internal diameter of the tower is 11ft 0in

On top of the tower is placed a glazed lantern supported on an iron light room 12ft 0in ³ in diameter inside which is placed the Optical Apparatus, Clockwork machinery, etc, etc of a First Order Dioptric holophotal revolving white light flashing every minute.

The interior of the Tower is divided into four storeys by cast iron floors approached by flights of cast iron stairs with wrought iron handrail and balusters.

The tower is entered by a door placed on the North Western side as being the most sheltered from the stormy weather.

The lantern Optical Apparatus and top floor carrying the same were provided by the government and were executed by the well known firm of ?? Chance Bros & Co. near Birmingham England for the sum of £3108

1 Private correspondence with Richard Jerymn

2 Incorrectly shown on Barnet's drawing as 169ft 6in

3 Chance drawing shows 12ft 1 ½ in

Comparison Between Original Light and New Lattice Tower

	1883 Light <i>in 1992</i>	1992 Light
Height	29 metres	15 metres
Globe	1000 Watt	55 Watt
Intensity	1,000,000 candelas	37,500 candelas
Visibility	19-26 nautical miles	12-15 nautical miles

Optic Panel Details 1883

Manufacturer	Chance Bros West Smethwick [Birmingham]
Focal length/ radius	36in [920mm] 1 st Order dioptric holophotal revolving white light
Number of Optic Panels	8
Optic Panel Construction	(a) central dioptric section focused on the true focal point (b) upper catadioptric prisms section focused on the wicks (c) lower catadioptric prism section focused on front of wicks to avoid obscuration by the base
Arrangement	octagonal
Lantern diameter	12ft 1½ in

Extract from H R Carleton New South Wales Lighthouses
Royal Society of NSW Journal and Proceedings, 32 LXXXII-CXXIX 1898 Ref 12

The focal distance determines the order of the light. The focal distance of a 1st order light is 36.22 inches; the width of the central disc is 11 inches; the annular rings which surround the disc vary in width from 2 ¾ to 1 ¼ inches and are so arranged that the lenses are, nearly as possible, uniform in thickness and thus equalise the absorption. There are 20 in number, placed half above and half below the central disc
Below these zones are six triangular rings of glass ranged in cylindrical form and above are thirteen rings diminishing in diameter as they recede from the optic axis, thus forming a dome which completes the apparatus.

Visible horizon	14 nautical miles [Carleton Ref 12]	in clear weather 19nm [Brewis Ref 5]
Visible between	S ½ W and N ¾ W [C] Through an arc of 210° from 164½° [S. 25° E. Mag] to 14 ½ ° [N.5° E. Mag]	

Appendix 9 Changes to the Character of the Light and Revolving Apparatus**Changes to Character of Light 1883 to present***Ref British Admiralty List of Lights and Fog Signals and Notices to Mariners***1 November 1883 – 1 May 1889 Original Lighthouse**

Abridged Description	Occ [Occulting]
Rotation speed	1 revolution every 8 min 0 sec
Lens Arrangement	8 panel octagonal arrangement.
Light Source	4 wick kerosene burner white
Light Power	100,000 candle power
Flashing	showing light every 60 sec for ~6 sec duration

1 May 1889 – 19 April 1926 *refs Notice to Mariners No 120 188 , Ref 2 and Brewis Report 1913*

Abridged Description	Occ [Occulting]
Rotation speed	1 revolution every 6 min 40 sec <i>changed 1 May 1889</i>
Lens Arrangement	8 panel octagonal. Chance dioptric 920mm focal radius
Light Source	<i>to 1912</i> 4 wick kerosene burner white <i>from 1912</i> Douglas 55mm incandescent burner white
Light Power	<i>to 1912</i> 100,000 candle power <i>date to be confirmed</i> <i>from 1912</i> 250,000 candle power
Flashing	showing light every 50 sec for ~5 ½ sec duration

19 April 1926 – 20 February 1962 *ref Notice to Mariners No 451*

Abridged Description	Gp FI [4] 20 sec [Brewis recommended flash every 10 sec of 1 sec duration]
Rotation speed	1 revolution every 20 sec <i>changed 19 April 1926</i>
Lens Arrangement	8 panel octagonal.
Light Source	Ford Schmidt burner white
Light Power	<i>to 1962</i> 327,000 candelas <i>changed in April 1923?</i> <i>from 1962</i> 475,000 candelas
Illuminant	<i>to 1962</i> vaporised kerosene <i>from 1962</i> electricity
Character	Flashing four flashes every 20 sec Flash 1/3 sec Short Eclipse 2 1/3 sec Long Eclipse 11 2/3 sec
Panel Arrangement	possibly 4 original optic panels together, 4 blacked out panels together or, 8 original optic panels eccentric/ offcentre <i>similar to the UK Pendeen light</i> **

Brewis makes no comment on reducing number of optic panels from 8 to 4 or that the light should be changed to Group Flashing as he did for a number of other lights Ref 5

****Comment:**

After consulting many people, I have been able to come up with one logical explanation for this configuration of the optic panels based on the British Admiralty publication Symbols and Abbreviations used on Admiralty Charts. It is unreasonable that the rotation speed with a clockwork apparatus in 1926 - 1 rev/ 20 sec is faster than the rotation speed in 1962 1 rev/ 30 sec, after the drive of the lantern was electrified and comments from the person responsible for making the changes in 1962 do not support my conclusion. It remains a mystery.

20 February 1962 – 17 March 1992 *ref Notices to Mariners No 110 1962 & AMSA Aid to Navigation Schedule Issue 2 Feb 1989*

Following removal of 4 of the 8 optic panels and conversion of drive to electricity

Abridged Description	Gp FI [2] 15 sec
Rotation speed	1 revolution every 30 seconds
Lens Arrangement	8 panel octagonal - 2 panels, 2 panels blacked out, 2 panels, 2 panels blacked out
Light Source	120V 1000W tungsten halogen globe white [replaced every 3000 hours]
Light Power	1,000,000 candelas
Illuminant	electricity
Character	Flashing two times in 15 sec Flash 0.03 sec Short eclipse 3.72 sec Long eclipse 11.22 sec
Panel arrangement	2 panels original optic panel, 2 panels blacked out, 2 panels original optic panel, 2 panels blacked out

17 March 1992 – ref *AMSA Aid to Navigation Schedule Issue 3 April 1992*

Abridged Description	Gp Fl [2] 15 sec
Rotation speed	1 revolution every 30 seconds
Lens	
Light Source	12V 55W QH, H2 envelope
Light power	37,000 candelas
Illuminant	electricity from solar cells
Character	Flashing two times in 15 sec
	Flash 0.1 sec Short eclipse 4.9 sec Long eclipse 9.9 sec

Revolving Gear for Lighthouse Apparatus

Note in lighthouse tower

The Swedish engineer Johan Nordberg invented the manual clockwork system in 1781-2. This was a major advance in lighthouse technology enabling each lighthouse to have its own characteristic

Extract from New South Wales Lighthouses H R Carleton

This is a clockwork motion, the motive power of which is a heavy weight suspended and working through a wrought iron tube in the centre of the tower. The cage itself revolves upon and is supported by a roller base, consisting of a series of small rollers, kept equidistant, which revolve round the centre, and on their own spindles, thus reducing the friction to a minimum. The gear is fitted with a governor to regulate the speed of rotation and is of the conical pendulum type. The centre weight consists of a metal disc connected to the governor arms, and the lift and speed is regulated by two set screws projecting from the main framing. The motion can also be stopped at any time by means of a similar set screw which can be made to press on the edge of the disc. The weights, which are suspended by a pulley from an endless chain, are wound up periodically according to the speed of the cage, the act of winding having no effect upon the revolving gear. In case of accident or repair to the gearing, the gage can be disconnected and caused to revolve by manual power from a winch handle.

Changes to Lens Rotation Drive Mechanism

1883 1926 refer extract from Ref 12 above

The apparatus on the original installation was mounted on a **turntable**, refer drawings, that rotated on 16 horizontal rollers. It, in turn was driven by the output drive of a 'clock' [a large governed clockwork motor,] - a pinion at the end of a vertical shaft which engaged with a ring gear that was integral with the turntable. The 'clock' was driven by a falling weight, at the end of an iron link chain coiled around a drum. The stack of cast iron weights "fell" down a cylindrical iron tube that ran between the lantern house floor and the ground floor. The speed of descent of the weights and hence the rotation speed of the apparatus, was regulated by a conical pendulum type governor. The weight stack required rewinding every 45 minutes or so taking the on-duty light keeper 10 -15 minutes to wind the weight stack up. refer included DVD Moore Point Lighthouse drawing

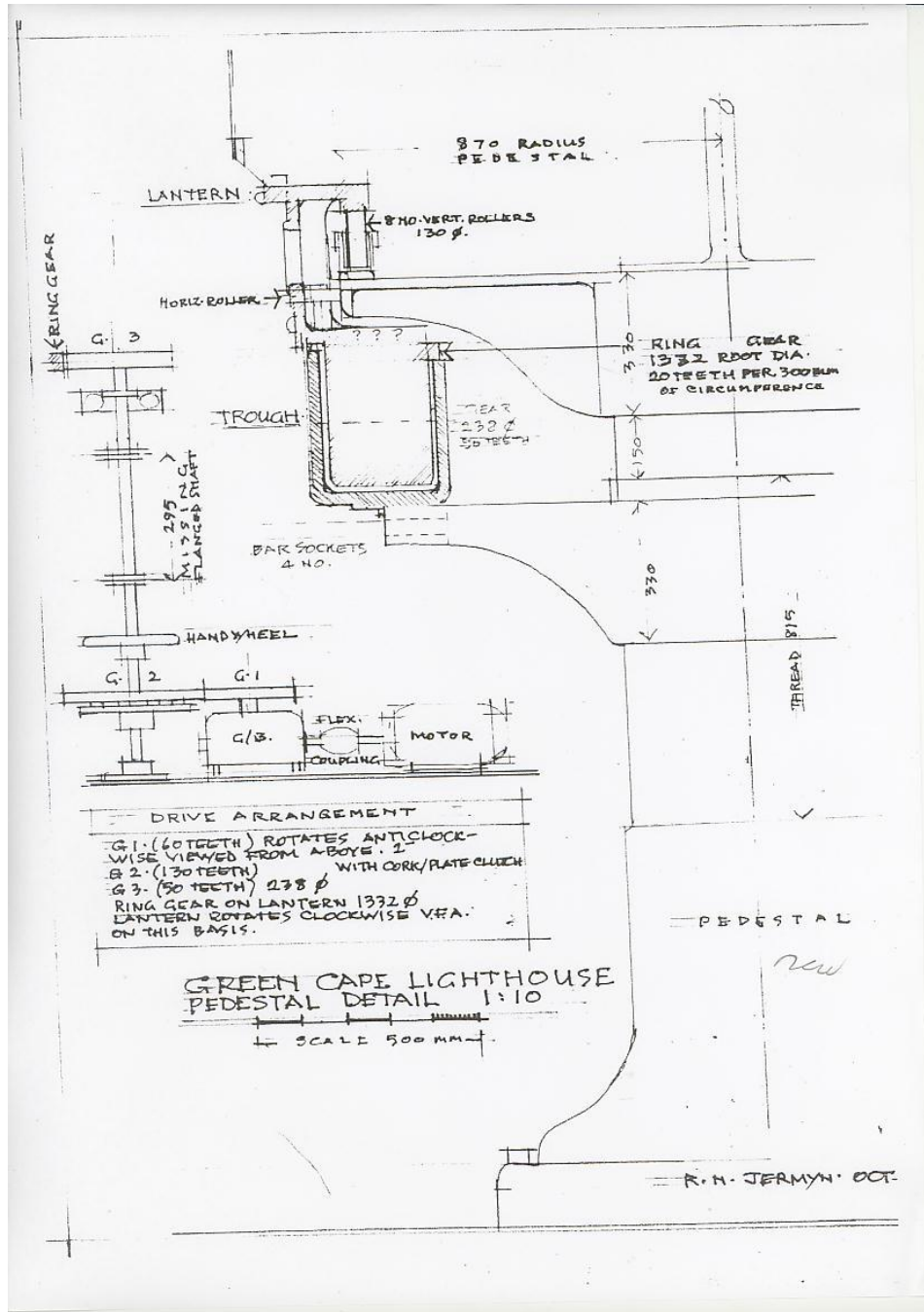
Comment *Kenneth Sutton-Jones private correspondence*

About 100 years ago [in the late 1890s] the heavy roller carriages were replaced progressively by the new mercury-float pedestal which dramatically reduced the friction and permitted the optics to rotate more rapidly and for the employment of fewer but much larger panels to be required with higher stationary intensity but shorter flashes [with consequential attenuation of the effective intensity]

1926 – 1962

Following the change out of the roller turntable with a mercury-float turntable, the lantern and apparatus was mounted on a hollow cast iron circular vessel that "floats" on a corresponding circular bath containing mercury thus reducing to a minimum the friction to be overcome in revolving the apparatus. The apparatus was driven by a replacement Chance Bros 'clock' – that was similar in arrangement to the first 'clock' but was a much smaller. A small diameter wire rope connected the "clock" drive drum to the weight-stack that "fell" down inside the central weight tube of the tower. refer Appendix 3 for photo. The smaller weight stack now required rewinding only every hour.

The speed of descent and hence the rotation speed of the apparatus was controlled by a "Slight" governor.



Comment: The first mercury float turntable was first used for a lighthouse for China 1893. The mercury float turntable was part of the original equipment supply for later lighthouses such as Cape Byron [1901] and Norah Head [1903]. Lights were converted from roller pedestal to mercury float pedestal were; South Solitary 1924, Green Cape 1926, Montague Is 1926, Macquarie Jan 1933, Nobbys 1935. Point Perpendicular [1899] - the last light to be supplied with a roller turntable, Smoky Cape [1891], and Sugarloaf Point [1875] were converted in the 1960s. The lantern/float sits floats on the mercury in the part filled trough with a ~4 -5mm clearance. The trough is integral with the pedestal

1962 – 1992

Same as previously, except that the clock was replaced by a geared fractional horsepower electric motor. AMSA has drawings of the conversion.

Appendix 10 Contents of Accompanying Computer Disk

Nomination: Green Cape should be recognised under the Engineers Australia's Engineering Heritage Recognition Program

Historic and current photos of Green Cape Lightstation and Bittangabee Bay

Original Barnett and Chance Bros drawings *that remain*

Australia's Tallest Lighthouses

Barnett Drawings

- | | | |
|----|-----------------------|--|
| 1. | Green Cape Lighthouse | Plan showing position of buildings, Area of Ground |
| 2. | Green Cape Lighthouse | Plan showing Excavation, position of Buildings etc |
| 3. | Green Cape Lighthouse | Plan of Quarters |
| 4. | Green Cape Lighthouse | <i>shows elevation of tower from several aspects</i> |
| 5. | Green Cape Lighthouse | |
| 6. | Green Cape Lighthouse | Detail of Veranda |
| 7. | Green Cape Lighthouse | Particulars of wrought [sic] iron floor |

Chance Bros Drawings that remain

Green Cape Lighthouse	Sectional Plan of Lantern Pedestal	Sheet 2 of 5
Particulars of Green Cape Lighthouse	Light and lantern	Sheet 3 of 5
Green Cape Lighthouse	Particulars of Steadying Column	Sheet 4 of 5

Aid to Navigation Schedule 1989 Commonwealth Dept of Transport

Light keepers Duties

Green Cape Visitors Book entry by James Barnett *Ref 2*

Green Cape Lighthouse Newspaper Clippings

Green Cape Communications History

Lighting of the East Coast of Australia Commander Brewis RN *Ref 5*

From Dusk Till Dawn ***A History of Australian Lighthouses*** selected pages *Ref 3*

NSW Lighthouses Carleton *Ref 12*

Other selected pieces

Appendix 11 Author's Assessment of Significance of Green Cape Lightstation
[EA Guide to Engineering Heritage Recognition Program]

Historical Significance	Indicate "Agree" or leave blank		
	National significance	State significance	Other than National or State
Guidelines for inclusion			
Shows evidence of a significant human activity			Agree
Is associated with a significant activity of historical phase		Agree	
Maintains or shows the continuity of a historical process or activity		Agree	
Guidelines for exclusion			
Has incidental or unsubstantiated connections with historically important activities or processes			
Provides evidence of activities or processes that are of dubious importance			
Has been so altered that it can no longer provide evidence of a particular association			

Association with important person or group	Indicate "Agree" or leave blank		
	National significance	State significance	Other than National or State
Guidelines for inclusion			
Shows evidence of a significant human occupation		Agree	
Is associated with a significant event, person or group of persons		Agree	
Guidelines for exclusion			
Has incidental or unsubstantiated connections with historically important people or events			
Provides evidence of people or events that are of dubious historical importance			
Has been so altered that it can no longer provide evidence of a particular association			

Creative or Technical Achievement	Indicate "Agree" or leave blank		
	National significance	State significance	Other than National or State
Guidelines for inclusion			
Shows or is associated with, creative or technical innovation or achievement		Agree	
Is aesthetically distinctive		Agree	
Has landmark qualities		Agree	
Exemplifies a particular taste, style or technology		Agree	
Guidelines for exclusion			
Is not a major work by an important designer or artist			
Has lost its design or technical integrity			
Its visual or sensory appeal or landmark qualities have been more than temporarily downgraded			
Has only a loose association with a creative or technical achievement			

Research Potential	Indicate "Agree" or leave blank		
	National significance	State significance	Other than National or State
Guidelines for inclusion			
Has the potential to yield new or further substantial scientific and/ or archaeological information		Agree	Agree
Is an important benchmark or reference site or type		Agree	
Provides evidence of past human cultures that is unavailable	Agree	Agree?	
Guidelines for exclusion			
Has little archaeological or research potential			
Only contains information that is readily available from other resources or archaeological sites			
The knowledge gained would be irrelevant to research, human history or culture			

Social / Cultural	Indicate "Agree" or leave blank		
	National significance	State significance	Other than National or State
Guidelines for inclusion			
Is important for its association with an identifiable group		Agree	
Is important to a community sense of place		Agree	
Guidelines for exclusion			
Is only important to the community for amenity reasons			
Is retained only in preference to a proposed alternative			

Rarity	Indicate "Agree" or leave blank		
	National significance	State significance	Other than National or State
Guidelines for inclusion			
Provides evidence of a defunct custom, way of life or process	Agree		
Demonstrates a process, custom or other human activity that is in danger of being lost	Agree		
Shows unusually accurate evidence of a significant human activity		Agree	
Is the only example of its type			
Demonstrates designs or techniques of exceptional interest		Agree	
Shows rare evidence of a significant human activity			
Guidelines for exclusion			
Is not rare			
Is numerous but under threat			

Representativeness	Indicate "Agree" or leave blank		
	National significance	State significance	Other than National or State
Guidelines for inclusion			
Is a fine example of its type		Agree	
Has the principal characteristics of an important class or group of items		Agree	
Has attributes typical of a particular way of life, philosophy, custom, significant process, design, technique or activity		Agree	
Is a significant variation to a class of item		Agree	
Is part of a group which collectively illustrates a representative type		Agree	
Is outstanding because of its setting, condition or size	Agree		
Is outstanding because of its integrity or the esteem in which it is held		Agree	
Guidelines for exclusion			
Is a poor example of its type			
Does not include or has lost the range of characteristics of its type			
Does not represent well the characteristics that make up a significant variation of its type			