Engineers Australia

Engineering Heritage Victoria

Nomination

under

Engineering Heritage Australia Heritage Recognition Program

for the

ELDORADO GOLD DREDGE

July 2015

Cover photo:

Stern view of the Eldorado Dredge,

photographed at dusk, with rising moon.

Photo by Peter Ham,

reproduced with permission

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Appendices:

The following appendices are included in this document, but do not continue the above document page numbering system.

Appendix A: ***Cocks Eldorado Dredge,*** **by D.P. Fletcher and G.B. O'Malley**

Appendix B: ***Treatment Plant of Cock's Eldorado Dredge*****, by J.C. Watson**

Appendix C: ***The Story of Eldorado*****, by D.G. Swift**

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Appendix E: ***Annual Production Statistics for the Eldorado Dredge***

Appendix F: Interpretation Panel & Mounting Frame Drawings

1 Introduction

The long-disused Eldorado Gold (and Tin) Dredge, sitting in its last working pond near the small township of Eldorado in north-east Victoria, is the largest and most intact surviving bucket dredge in Australia. Bucket dredges of the same basic design were used to dig up and collect alluvial gold or alluvial tin. Some - like the Eldorado Dredge - collected both gold and tin simultaneously, and so represent both applications.

The heritage value of the dredge has been recognised by the Australian Heritage Commission, by Heritage Victoria, by the National Trust of Australia (Victoria), and by the Rural City of Wangaratta (wherein the dredge is located).

The dredge is now being nominated to be recognised by Engineering Heritage Australia.

This nomination discusses at some length the processes that went on in the Eldorado Dredge, the equipment involved in those processes, and the current condition of that equipment. It also discusses briefly the condition of a number of other dredges still “surviving” in Australia. This is done to make clear the high degree of significance, integrity and rarity of the Eldorado Dredge in comparison with those other Australian dredges.

2 Heritage Award Nomination Letter

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

Name of work: **Eldorado Gold Dredge** (aka Cock's Eldorado Gold Dredge)

The above-mentioned work is nominated to be awarded recognition under the terms of the Engineering Heritage Australia Heritage Recognition Program.

Location: The dredge is sitting in its last operating pond on the east side of Reedy Creek (aka Reids Creek), about 200 metres north-east off Eldorado-Byawatha Road, and approximately 300 metres due north of the intersection of Eldorado-Byawatha Road and Wangaratta-Eldorado Road. It is approximately 1.5km to 2km WSW from the centre of Eldorado township, in north-east Victoria. [Google Earth has a good aerial photographs showing the Eldorado Dredge, the dredge pond and Eldorado township.]

Map Grid Reference: 36° 18' 50.2" S 146° 30' 11.6" E

Owner (name & address): State of Victoria, through Parks Victoria, Level 10, 535 Bourke Street, Melbourne 3000 Victoria.

The owner has been advised of this nomination and a letter of agreement is attached. {Brian Pritchard and Chris Smith of Parks Victoria are supportive. Parks District Manager Daniel McLaughlin wants info about numbers attending and liability insurance. EA would need a Parks Event Permit if numbers are over 30. Will get a Letter of Agreement closer to the date of nomination? }

Access to site: The dredge is sitting in water, in the last pond it dug for itself, next to and connected with Reedy Creek. The axis of the dredge runs approximately east-west, with the bucket (bow) end at east, and the discharge chutes (stern) at west.

The dredge hull is rusted and leaks. The dredge has settled unevenly onto a shallow gravel bed, with the deck and deck-mounted equipment (eg forward winches) partly underwater depending on the level of water in the creek and pond. The bow is close to an earth bank at the edge of the pond, but direct access from the bank is risky and is prohibited.

Access to the land around the pond is normally open to the public, and cars can be driven to a parking area close to the dredge. From Wangaratta-Eldorado Road, turn northwards into Eldorado-Byawatha Road and go about 200 metres NW. Turn right onto a dirt track and go slowly about 200 metres NE through an open gateway in a farm-style fence and on to an open parking area close to the dredge and its pond.

Visitors can walk freely around the perimeter of the pond and view the dredge from all sides. Small interpretive panels are located at viewing points around the edge of the pond, and a comprehensive set of panels is located near a picnic table, close to the car park.

A steel walkway erected by Parks Victoria now gives the public free (and safe) access to the control room of the dredge, allowing visitors to look down onto the dredge buckets at the roughly eastern end of the dredge, and onto some of the equipment inside the dredge. However, wire fences and locked gates limit onboard visitors to the control room, and prevent public access further into the interior of the dredge from the control room.

Visitors should not climb onto other parts of the dredge, and should not climb safety fences around the edge of the pond. Also, visitors should not swim in or dive into the pond - it contains hidden hazards.

Special interest visitors (such as heritage engineers) can request access onto the whole dredge by prior arrangement made with the Parks Victoria Heritage Planner (at 03 8627 4714), or the Ranger in Charge (at 03 5720 8802). However, full access to the dredge interior is rarely granted because it involves climbing around dirty, cramped ladders and walkways, muddy decks etc., which can sometimes be slippery and risky depending on weather conditions, pond water level, etc.

Nominating Body: **Engineering Heritage Victoria**

Owen Peake

Chair, Engineering Heritage Victoria

Date: ADD APPROPRIATE DATE

3 Heritage Assessment

3.1 Item Name: **Eldorado Gold Dredge**

3.2 Other/Former Names: **Eldorado Dredge; Cock's Eldorado Dredge**

3.3 Location: The dredge is sitting in its last operating pond on the east side of Reedy Creek (aka Reids Creek), about 200 metres north-east off Eldorado-Byawatha Road, and approximately 300 metres north of the intersection of Eldorado-Byawatha Road and Wangaratta-Eldorado Road.

Map Grid Reference: 36° 18' 50.2" S 146° 30' 11.6" E

3.4 Address: To north-east off Eldorado-Byawatha Road, near the intersection with Wangaratta-Eldorado Road.

3.5 Suburb/Nearest Town: Eldorado (The dredge is approximately 1.5km to 2km WSW from the centre of Eldorado township, in north-east Victoria.)

3.6 State: **Victoria**

3.7 Local Govt. Area: **Rural City of Wangaratta**

3.8 Owner: State of Victoria, through Parks Victoria, Level 10, 535 Bourke Street, Melbourne 3000 Victoria.

3.9 Current Use: **Historical Monument, Tourist Attraction**

3.10 Former Use: **Gold (and tin) Dredge - now long disused**

3.11 Designer: Douglas Percy Fletcher, Mining Engineer, Fellow of Mining & Metallurgical Institute of Australia.

3.12 Maker/Builder: Thompson's Engineering and Pipe Co. Ltd., Castlemaine & Williamstown, Victoria

3.13 Year Started: **1935**

3.14 Year Completed: **1936**

3.15 Physical Description: (See following pages)

3.16 Physical Condition: (See following pages)

3.17 Historical Notes: (See following pages)

Figure 1: Eldorado Dredge viewed from SE, partly obscured by trees and by the earthen banks of its pond. Bow end with bucket ladder and fore-gantry at right, superstructure at centre, stern with discharge chutes at left. (Photo by Phelan, from the Web.)

3.15 Physical Description:

3.15.1General:

The Eldorado Gold Dredge was a gravel excavation and screening machine, designed to recover fine alluvial gold (and tin) from river gravel in north-east Victoria, in a process a bit similar to gold panning but on an industrial scale. The dredge worked in still man-made ponds dug into gravel beds alongside Reedy Creek in north-east Victoria, and along the original bed of the creek - but only after the water flow had been redirected away from where the dredge was working.

The dredge dug up gravel from the creek banks or former creek bed in front of the dredge, then screened and filtered the gravel to extract fine particles of alluvial metallic gold and grains of non-metallic "tin" (actually tin oxide or cassiterite, looking like black sand). The dredge gradually moved forwards and side-to-side, digging up gravel at the bow end, screening out the fine gold and tin onboard, and discharging unwanted gravel out the back, in effect dragging its pond along with it.

The dredge was built on a large near-rectangular steel pontoon or hull. On top of the hull was a tall superstructure with a strong steel frame clad with corrugated iron roof and walls, looking like a factory or very large farm shed, but floating on water in a large pond. At the bow end there was a long steel "bucket ladder" (cantilevered arm) carrying a "bucket-band" (a continuous loop of large iron buckets joined together like links in a bicycle chain) that dredged gravel from the bottom or banks of the pond.

There were also several large winches on the forward deck, powered by large electric motors. One winch raised or lowered the outer end of the bucket ladder to dredge at various depths. Several other winches had steel cables connected to anchor points on land (eg trees) and would slowly pull the whole dredge forward or side-to-side to change location and/or to excavate more gravel. These winches were controlled by the Winchman, in effect the driver or captain of the dredge, who worked in the Control Room located at the upper level of the forward end of the superstructure, starboard (right) side. From there the Winchman could see the forward end of the bucket ladder and the banks of the pond, and see how much gravel was being picked up by the buckets. Using various levers, switches and electrical meters the Winchman could manoeuvre the dredge, monitor and control the electrical motors, adjust the dredging depth, and so on.

At the upper centre of the superstructure was a pivot for the upper end of the bucket ladder, and the drive gears and drive pulley for the bucket-band. Immediately behind, in the stern half of the dredge, was an initial rotary screen to separate the fine gold-bearing gravel from unwanted coarse gravel, large stones, old bits of timber, etc.. Alongside the rotary screen and further towards the rear of the dredge were banks of "jigs" (agitated filter beds) to separate the particles of gold and tin from the fine gravel. Protruding out the rear or stern of the superstructure were several long steel chutes or pipes to deposit the unwanted gravel back into the pond, behind the dredge.

Figure 2: General view of the dredge, seen from East, with bow end in foreground. Note the upper end of the inclined bucket ladder emerging from an opening in the tall central section of the superstructure, and the lower end with buckets at bottom left corner of the photo. Also in foreground is the fore-gantry frame with pulleys and steel cables to raise or lower this end of the bucket ladder. (Photo C. Doring 1994)

Figure 3: General view of the dredge from NW, showing the bow end at far left and the stern end at centre, with gravel-disposal chutes protruding from the stern at right. . (Photo by C. Doring 1994.)

Figure 4: Stern view of the dredge, seen from SW. Note the tilt towards the front-right corner. Note also how the upper part of the tall central superstructure protrudes to allow the manual overhead crane to move heavy equipment on or off a barge alongside. (Photo by C. Doring 1994.)

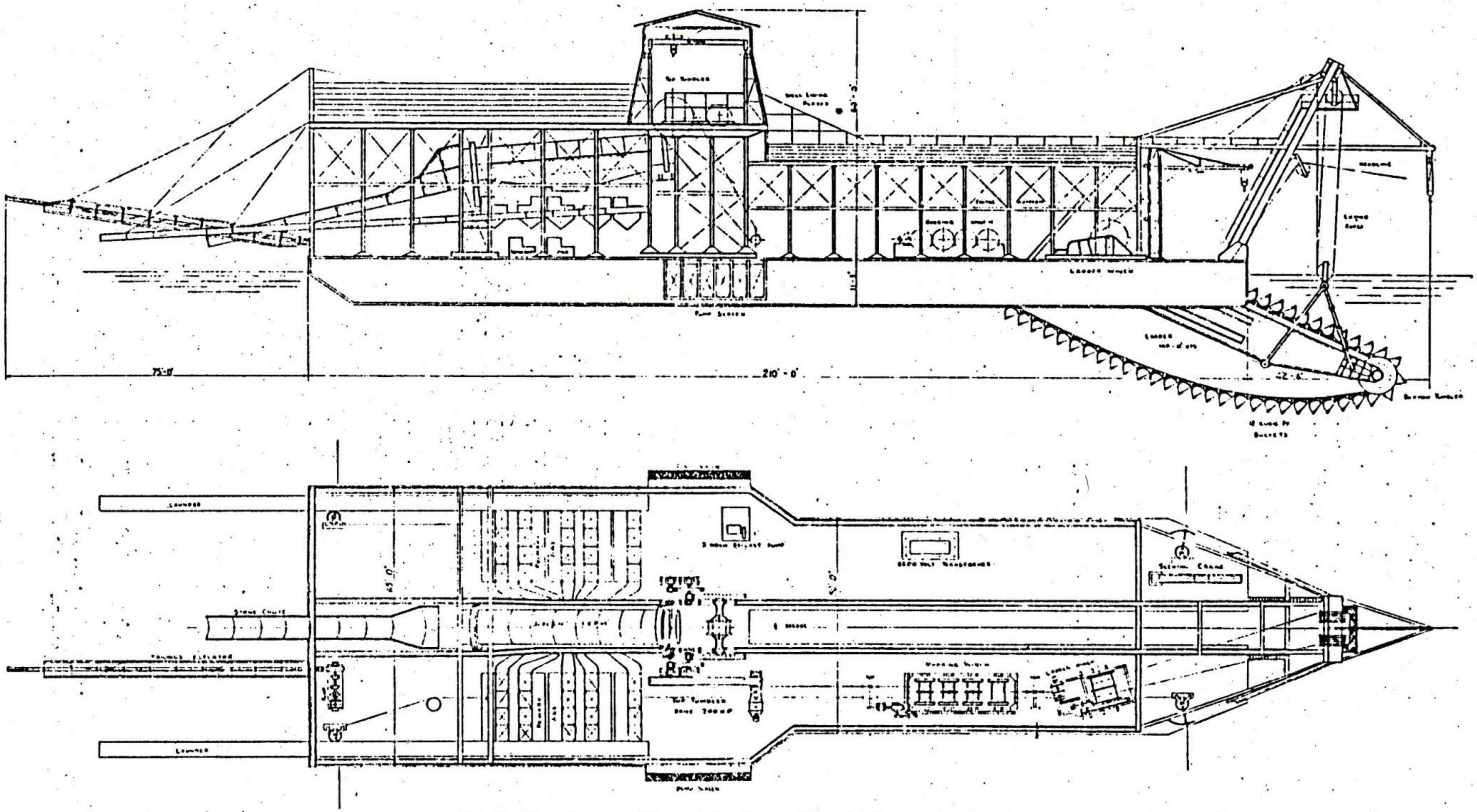

Fig. 2.—Elevation and Plan of the Cocks Eldorado Dredge showing the layout of the Various Components and the Electrical Equipment

Figure 5: Diagrammatic plan and elevation of the dredge, from article by Fletcher and O'Malley on the Cocks Eldorado Dredge, in Chemical Engineering and Mining Review, 8th July 1936. (See Referances and Appendix A.) The drawing shows the shape of the pontoon, and the location of the bucket well and bucket ladder, top tumbler, rotary screen, bucket winch (angled), mooring winches, bucket drive motor and drive gears, main pumps (in pontoon, amidships), ten primary jigs, and gravel disposal chutes.

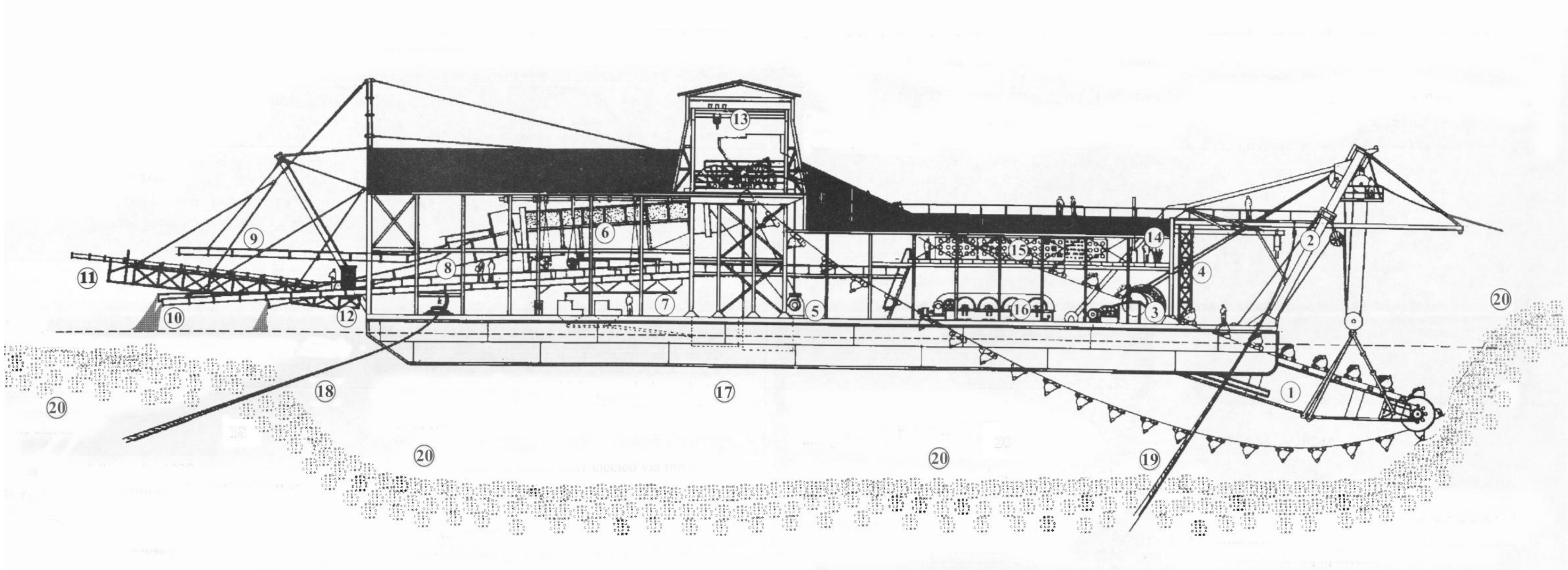

Figure 6: Diagrammatic sectional view of the dredge, with bow at right, stern at left. Original drawing by Peter Barclay in 1995, for 1996 pamphlet by Victorian Department of Natural Resources and Environment. Drawing modified here, with Item Identification Numbers 17-20 added. See KEY to item numbers below.

DIAGRAM KEY:

1 = bucket ladder and bucket-band; 2 = fore-gantry with pulleys to lift bucket ladder; 3 = winch for bucket ladder; 4 = swivel jib crane for changing buckets;
5 = drive motor for bucket-band; 6 = cylindrical rotary screen; 7 = gold-recovery jigs; 8 = disposal chute for coarse stones rejected by the rotary screen;
9 = chute to dispose of poor grade fine gravel, without processing; 10 = disposal chutes (launders) for fine gravel after processing by the primary jigs
11 = disposal pipe for fine gravel after processing in the secondary jigs; 12 = long-drop “dunny” suspended over water;
13 = upper superstructure, with the pivot for the bucket ladder, large gears and top tumbler to drive the bucket-band, and a manual overhead crane;
14 = Control Room; 15 = switchboard with switches and meters controlling motors for pumps, winches etc.; 16 = winches for mooring and manoeuvring;
17 = pontoon, with internal pumps amidships; 18 = stern mooring cables, at deck level; 19 = bow mooring cables, raised up on the fore-gantry;
20 = deep gravel bed being dug up at the bow, area already dug under the pontoon, and processed gravel being dumped back at the stern.

3.15.2 Pontoon:

The dredge was built on, and floated on, a very large hollow steel pontoon or hull, like a large specially shaped steel raft. The pontoon was about 210 feet (64 metres) long, 65 feet (20m) wide in the stern half, and 50 feet (15m) wide in the front or bow half. The pontoon was 11.25 feet (3.4m) deep, of which about 7.75 feet (2.3m) was normally underwater while the upper 3.5 feet (1.1m) was normally freeboard and deck above the water. [1]

The pontoon was made of steel plates mostly riveted together (before arc welding became commonplace), and was divided internally with further steel plates to form numerous watertight cells that could be individually filled with water or emptied as needed to trim the hull. The cells also provided security should the hull develop a leak. Some cells located amidships (near the longitudinal centre), held large electric pumps, to suck water from the pond and provide the copious amounts needed for gravel handling and processing.

On the deck area, the normally protruding rivet heads were countersunk flush with the deck to provide a safer and more comfortable area to walk on. There were also numerous small circular steel manholes in the deck with circular steel lids that could be opened if necessary for internal inspection and maintenance of individual cells. In the stern half of the dredge, near the centre, the pontoon deck had a sunken well area which held a pair of final gold-separating jigs (the “clean-up” jigs). (See description of jigs further below.)

At the bow end, the pontoon and its superstructure were both divided lengthwise by a wide vertical slot (bucket-well) running along the central axis of the dredge. The bucket well accommodated the bucket ladder, and allowed the forward end of the bucket ladder to be swung up or down to dredge gravel from various depths. The slot divided the forward half of the hull into two long parallel forks, connected at the bow end by a tall overhead gantry frame (fore-gantry) that straddled the gap between the two forks.

3.15.3 Superstructure and General Machinery Arrangement:

Almost the entire pontoon was covered with a tall rectangular steel-framed superstructure clad with corrugated iron roof and walls, giving the dredge the quite valid appearance of being a floating factory. There were very few windows, but there were large openings in the bow and stern walls, and along the bottom of the rear side walls. These openings admitted light and air - and in bad weather would also have admitted rain and cold winds.

The forward half of the dredge pontoon and superstructure held the bucket-band (an endless chain of dredging buckets) and the bucket ladder (a long hollow steel arm that carried the bucket-band and protruded out the bow end of the dredge). The bucket ladder and bucket-band were a bit like the bar and chain of a chainsaw, but much larger and running more slowly and in the opposite direction to a chainsaw. that dug up the alluvial gravel.

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[1] See text and diagrams in Fletcher & O’Malley, 1936, reproduced here in Appendix A.

The bucket ladder and bucket band sat in a large vertical slot on the centreline of the dredge. The slot extended horizontally from the bow to about midpoint in the dredge's length, and extended vertically from the roof down right through the pontoon, dividing the forward half of the pontoon into two long arms or prongs. This slot allowed the buckets and bucket ladder to swing down to dredge any depth up to a nominal 90 feet depth below water level. The ladder and buckets could also be raised above water level to excavate the exposed pond banks, or for maintenance access.

In the early design stages it was proposed to dredge down to 70 feet (21m) depth, but at engineer Fletcher's recommendation this was increased to a nominal 90 feet (27m), although some working reports said dredging reached depths of 95 or 98 feet. Increasing the depth was a good decision as much of the gold obtained by this dredge came from the deeper levels.

The rear end of the bucket ladder was secured by a pivot shaft set high in a tall central section of the superstructure. The forward end of the bucket ladder passed between the legs of a fore-gantry frame straddling across the slot in the forward pontoon, and was supported by two steel cables and two sets of pulleys hanging from the gantry. A winch on the forward starboard deck could wind in or let out the cables, raising or lowering that end of the bucket ladder and so controlling the depth from which the buckets dug up gravel.

Figure 7:   Bow end of the dredge viewed from north, showing the inclined fore-gantry, sitting on the partly submerged front forks of the pontoon. Also shows part of bucket ladder, and the supporting cables and pulleys, (now hanging slack).   (Photo from Heritage Victoria website.)

Figure 8: Forward end of the bucket ladder, near the submerged tip. Viewed from SW, with a Park Ranger for scale. The bucket band sits on rollers on the top face of the bucket ladder, and here passes between legs of the fore-gantry. The bottom tumbler and lower buckets are submerged. (Photo by C. Doring 1994.)

The buckets at the protruding tip of the ladder scooped up about one-third of a cubic metre of gravel each, then travelled upwards and rearwards along rollers on top of the sloping "ladder" until they passed around the slowly rotating top tumbler near the upper end of the ladder. The top tumbler was in fact a 6-sided drive sprocket designed to grip the underside of each bucket and pull the upper half of the bucket-band with enough power to force the far-end buckets through the bed of gravel and raise the heavy full buckets up the ladder.

As the full buckets travelled around the top tumbler they tipped their contents onto a short chute leading into the upper end of a large cylindrical rotary screen to begin the processing of the gravel - as described later. Jets of water made sure each bucket was emptied. The empty buckets then travelled in a slack loop beneath the ladder, back towards the bottom tumbler (an idling sprocket) at the protruding tip of the ladder, to begin the cycle again.

The top tumbler (drive sprocket) for the bucket band was driven by a series of large gear wheels high in the tall central section of the superstructure, which in turn were driven by a large flat-face pulley connected by a flat endless belt to a large motor on the deck far below. This belt and most other flat leather or rubber drive belts, typical of power transmission during the dredge's working life, are now missing. The bucket drive motor was originally 200 hp (horse power), but was early on replaced by a 320 hp motor. The more powerful motor was quickly blamed for several breakages in the bucket-band, but this soon settled down to just routine wear-and-tear of the buckets.

Figure 9: Large gears (right and centre) driving the top tumbler (hidden) that drove the bucket band. These are next to the top of the bucket ladder (also hidden), set high in the central superstructure. Power came from a large electric motor on the deck far below, via a flat belt onto the flat-face pulley at left (belt now missing). The waist-high guard railing gives scale. (Photo by C. Doring 1994)

The tall section at the centre of the superstructure also carried a manually powered overhead travelling crane on rails that ran across the width of the dredge and extended out an opening on the starboard (right) side of the superstructure, so that heavy bits of plant could be picked up from alongside the dredge, lifted up and then deposited at upper or lower levels inside the dredge superstructure. This crane would have been used during initial assembly of the dredge, and for later occasional repair or replacement of bits of plant.

The dredge was moored and manoeuvred by a series of steel cables running from the dredge to anchor points (eg trees) on land nearby. A set of four linked winch drums at deck level, beneath the control room on the starboard pontoon, controlled four heavy steel mooring cables that originally ran across the deck to single-wheel pulleys at the four corners of the pontoon, then ran out sideways from the corner pulleys to four anchor points. Later, the two pulleys at the bow end were raised and crudely lashed onto the upper fore-gantry, presumably so those mooring cables could clear any high earth banks near the area being excavated.

A mooring cable from a fifth winch drum ran forward to a fifth anchor point on land, to pull the dredge towards the area being excavated, and then to anchor the dredge so that the buckets would bite into the gravel and the reaction force would not drive the floating dredge backwards.

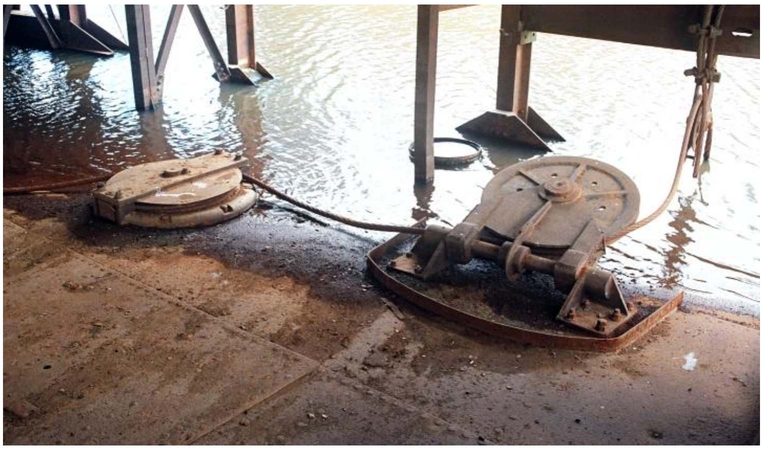

Figure 10: Mooring pulleys on the deck near the stern, starboard side. The left pulley is one of several guiding the exposed cable across the deck from the winch to here. Cable from the right-hand pulley goes to an anchor point on land, and the pulley swivels to accommodate variations in anchor height.
(Photo by C. Doring, 1994)

Figure 11: The linked winches for mooring and manoeuvring the dredge, on the semi-submerged deck beneath the control room, here viewed from stern end. (Photo by C. Doring, 1994)

The mooring and manoeuvring winch drums were all driven by the same electric motor and same drive shafts, via clutches, which allowed the Winchman to choose which winch drums to actuate and which to leave locked. When manoeuvring sideways the four drums (two shafts) nearest the camera normally ran together at the same speed and in the same direction. However, the starboard and port cables were wound onto the drums in opposite directions so that (say) the two starboard cables would wind out while the two port-side cables were winding in by the same amount, thus moving the dredge sideways to the port (left) direction.

Using this arrangement, the Winchman could sweep the dredge sideways to-and-fro, dredging more gravel on each pass, or could slowly move the dredge to a new location. When necessary, a different choice of clutches would be engaged to drag the dredge forward, or to adjust the four sideways cables independently, eg when connecting the four cables to a new set of anchor points on land.

As noted above, the superstructure in the forward half of the dredge was divided into two halves by the central axial slot (bucket well) that accommodated the bucket ladder. The control room used by the Winchman to “drive” the dredge was located at the forward end of the starboard (right) half superstructure, at an upper level above the winches. The control room had windows giving the dredge controller (the Winchman) a good view of the forward half of the bucket ladder, allowing him to see and if necessary adjust the position of the dredge and the height of the bucket ladder to control the amount of gravel being picked up by the buckets, or to cope with encountered obstacles - like buried trees, old abandoned timber-lined mine shafts, or solid rock.

Figure 12: Levers in the control room, mechanically controlling clutches or brakes on the winch drums below. The open front wall normally had windows and cgi cladding, stolen here but since replaced. At left is a small stove for warmth – a rare concession to operator comfort. (Photo by C. Doring, 1994)

The control room had a large vertical electrical switchboard with open blade switches controlling the various electric motors, and with meters monitoring the current or power being drawn by the various winch motors, pumps etc. The control room also had a row of steel levers about a metre long protruding from the floor, looking like the switch levers in a traditional railway signal box. These levers mechanically controlled brakes and clutches on the various winches on the deck below. The control room floor was partly made of sheets of steel chequer-plate and partly of a grid of spaced steel bars, the latter giving a view onto the winches below.

On the deck below the control room were two sets of electric winches, one set controlling the position of the dredge and the other controlling the depth of the dredging buckets, as described above. On the deck further behind the control room was a single large electric motor driving a wide flat leather or rubber belt (now missing) that drove the bucket-band via a large pulley and large gears mounted high above the deck, in the tall central section of the superstructure. The bucket-drive motor was originally 200 hp (horsepower) but was soon replaced by a 320 hp motor. The stronger motor was later blamed for several failures of the bucket-band.

In the port (left) half of the forward superstructure there was a more open deck-to-roof space, said to have been used as an onboard maintenance workshop. When seen in 1994 it was largely empty except for a collection of spare parts, and some heavy steel cables used for maintenance hoisting, etc. This area also held a large power transformer, converting the incoming 6,600 volt 3-phase power to 440 volt 3-phase or 110 volt single-phase power as suited the dredge motors, pumps, lights, etc. Near the transformer, but outdoors on the forward part of the pontoon fork, was a swivelling jib crane used to lift worn or damaged dredge buckets out of the bucket-band, and lift replacement buckets back in.

The various gears, pulleys, bearings etc needed frequent greasing or oiling, and were accessed by a network of steep ladders and narrow catwalks extending throughout the dredge, often running through cramped spaces or close to moving machinery.

3.15.4 Gravel Screening[2]

The stern half of the superstructure was like a single large gable-roofed shed clad externally with corrugated iron roof and walls. Internally it was one large open space with no dividing walls, but filled with various machines to separate the gold and tin from the gravel, and functionally divided into different areas according to the various types of gravel screening machinery contained there.

Gravel conveyed by the bucket-band up to the top tumbler was tipped into a short chute that fed the as-dug gravel into the upper end of a large open-ended cylindrical rotary screen set high in the stern superstructure. The axis of the cylindrical screen ran rearwards along the centreline of the dredge, and sloped downwards towards the rear. In this preliminary screening stage, the raw gravel was tumbled inside the rotating screen and was drenched with water as it slowly worked its way towards the rear of the screen. Relatively fine gravel (and flecks of gold or tin-oxide) passed out through numerous small holes in the perforated steel walls of the rotary screen, and was collected for further screening. For some reason, the screen had two cylindrical skins made of thick steel plates, an outer skin with 5/8th inch (16mm) holes, and an inner skin with 3/8th inch (10mm) holes.

[2] See description by J.C. Watson, 1938, reproduced here in Appendix B.

Figure 13: Part of the cylindrical sidewall of the rotary screen, made of curved steel plates with hundreds of small holes. The rest of the screen is difficult to see. (Photo by C. Doring, 1994)

Unwanted coarse gravel and large rocks that would not fit through the small inner holes tumbled out the far end of the rotary screen onto a wide chute that tipped the stones back into the pond a short distance beyond the stern of the dredge. This chute was subject to a lot of wear, and when seen in 1994 was heavily patched with welded-on wear strips.

The finer gold-bearing (and tin-bearing) gravel that passed out through small holes in the side of the rotary screen was sluiced and gravity fed into banks of multiple primary gold-separating "jiggers" or "jigs" located along the port and starboard sides of the stern superstructure, alongside the rotary screen and at about head height above deck level. The gold-bearing fine gravel was fed into multiple open-top rectangular steel jig troughs containing water agitated by a series of vertical rods and horizontal paddles driven up and down by eccentric crank bearings on long horizontal shafts running over the top of the jigs. As was common at the time, the multiple agitating shafts were powered by motor-driven overhead lineshafts via a series of pulleys and flat rubber or leather belts.

Figure 14: Three of the five primary jigs along one side of the rotary screen (which is out of view at right.) A similar set of five jigs was on the other side. Each jig had an overhead flat-belt driven shaft with a series of eccentrics that drove agitating paddles in the filtering chambers below. (Photo by C. Doring, 1994)

The agitated water in the jigs suspended and shook the fine gravel, which slowly washed across a series or cascade of filter stages, each with a filter bed layer of moderately-dense haematite particles. The very dense gold or tin-oxide particles (and some stray sandy gravel) would tend to sink through the moderate-density haematite filter layer and be collected in conical sections beneath each jigger stage. Most of the less dense fine gravel would pass over the top of the haematite in the jigger tanks and was discarded into open troughs or "launders" running down each side of the pontoon, to then be washed along the troughs, which projected a long way out the stern, dumping the fine gravel on top of the coarser stones already rejected by the rotary screen.

Initially there were five primary gold-separating jigs along the port side and another five primary jigs along the starboard side. The gold and tin collected by the primary jigs, and still containing some fine sand , was gravity fed to a pair of smaller "clean-up" jigs located in a central sunken deck well to remove most of the remnant sand. The cleaned-up gold and tin-oxide was then taken ashore to further separate the gold and tin oxide from each other (and from any residual sand), using a small processing plant located close to the dredge. From there the gold and tin-oxide were considered sufficiently well separated and pure to be sold.

In 1937/38, not long after the dredge was commissioned, an extra five jigs were added at deck level near the stern, apparently to carry out an extra intermediate (secondary) screening stage between the original primary jigs and the "clean-up" jigs. Thus for most of the working life of the dredge there appear to have been three stages of gold-separating jigs on board (plus the further separation done onshore). The fine gravel or sand etc removed by the secondary jigs was discharged out the stern as a slurry, pumped up a long inclined pipe and then dropped to settle onto the already dumped gravel from earlier stages. Fines rejected by the final onboard “clean-up” jigs were fed back into the primary jigs, just in case.

When the buckets tipped their raw gravel out at the top tumbler, it was common for some of the gold-bearing fine gravel or sand to cling to the buckets and fall out or be washed out just after the chute feeding the rotary screen. These droppings were collected in a tall steel box called the “save-all”, located on the deck beneath the top tumbler. Periodically, these gravel droppings were manually removed from the “save-all” and fed into the primary jigs.

The initial rotary screening process that selected fine gravel and fine gold that could pass out through the small holes in the sides of the rotary screen, and rejected the rest as unwanted coarse gravel, meant there was a risk that larger pieces of gold could be rejected here and discharged out the back with the coarse gravel. This risk was accepted because large nuggets were rare in the alluvial deposits, and the vast bulk of gold was in the form of fine particles or flakes. Nevertheless, it seems likely the men would have kept an eye out for the glint of gold in the rejected gravel from the rotary screen.

3.15.5 Water Supply:

The other main equipment on the dredge was a series of electrically driven water pumps, mostly located inside the pontoon amidships, with underwater intake grilles protruding from the pontoon on both sides. The pumps supplied the copious flows of pond water used to wash gravel out of the buckets, to help with the passage of gravel through the rotary screen and the jigs, to float the fine gravel through the separating jigs, and to help discharge the unwanted gravel and sand out the various chutes or pipes at the stern of the dredge.

Copious water was essential for the onboard processes involved in the recovery of gold and tin and disposal of unwanted gravel, but this left the used water murky and turbid. Using land-based pumps, turbid water was pumped from the working pond into one of several nearby static “settling ponds”, and relatively clean already-settled water from another settling pond would be pumped back into the working pond. At various times shortage of water forced the dredge to cease operation until rains replenished the creek and the ponds.

A small volume of clean rainwater was supplied to the men on the dredge for drinking or personal washing. Rain falling on the superstructure roof was collected in roof gutters and conveyed by gravity to a farm-style galvanised iron water tank set high inside the roof at the stern, then piped by gravity to taps at deck level.

3.15. 6 Dredge Power Supply:

Prior to the Dredge, companies mining or sluicing at Eldorado used electric power generated in small private power stations built nearby around the township, probably driven by steam engines and wood-fired boilers. By the time the dredge was being planned the State

Electricity Commission of Victoria (SECV, or more commonly just SEC) had been established, led by Sir John Monash.

From the outset the dredge was designed to use high voltage power provided by SEC. The primary source of power for the dredge was three-phase electric power supplied by the SEC at 6,600 volts, via a local on-shore substation. This power was conveyed to the dredge from onshore via a long flexible rubber-insulated 6,600 volt cable carried across the pond on a series of floats made of 44 gallon drums or similar. The 6,600 volt cable had to continually flex and move as the dredge worked from side to side along the bank being dredged.

The flexible 6,600 volt cable reached the side of the dredge about amidships, then ran up the outside of the dredge to the level of the top tumbler, and entered through a hole in the side cladding to be terminated and anchored in a wooden trough attached to the working floor at that level. There the supply cable was joined to permanent 6,600 volt wiring inside the dredge, at terminals mounted on ceramic insulators inside a metal junction box. There were two sets of anchor blocks and junction boxes, one each side of the dredge, allowing the 6,600 volt supply cable to be brought in on either the port or starboard side, depending on the working location and direction of progress of the dredge.

Within the dredge, the 6,600 volt supply was taken via fixed wiring to a transformer cubicle at deck level on the starboard side, forward end, where part of the supply was changed to 440 (415?) volt three-phase supply to drive the main motors, and part transformed to 110 volt single-phase, to power lights and small motors. The nominal power consumption (motor power) for each stage on the dredge was:

bucket band: initially 200hp (horse power), soon upgraded to 320hp
pumps: 350hp
jigs: 100hp
winches: 200hp

The total amount of power actually consumed on the dredge was measured by a watt-hour meter next to this transformer. Reputedly this dredge was at one time the third-largest consumer of SEC power in Victoria, behind the cities of Melbourne and Geelong.

The reduced-voltage power from the transformer was taken to a central switchboard facing the control room, where a bank of switches and meters controlled and monitored the power going to the various motors and other equipment. The original switchboard and electrical installation was carried out by Bailey and Grimster of Carlton, Victoria. However, the original transformer tappings and the electrical switchgear must have been unsatisfactory, because the 1938/39 annual report notes:

"The new switchboard and re-arranged cables were installed during the year, and considerable alterations made to the main transformer, which now gives the correct voltage, and this in turn has increased the efficiency of all Dredge motors. Also, the high tension switch gear has been replaced, providing full margin of safety."

Figure 15: Switchboard in the Control Room as seen in 1994 with electric meters and manual switches (some open blade type) that monitored and controlled the various motors. Since then all meters have been smashed and some copper components and wiring stolen. Note the sparse safety guardrail. The grid floor panels gave the Winchman a view to the winches below. The cgi roof cladding above the Control Room was stolen, but has since been replaced. (Photo by C. Doring)

Subsequent annual reports noted that the electrical gear on the dredge was working well, with little or no further electrical problems other than the incoming 6,600 volt flexible cable being damaged on two occasions, during floods.

3.15.7 Staff and Staff Amenities:

According to Greene[3] the dredge operated 24 hours per day, in three 8-hour shifts, but with regular weekly shut-downs on Thursdays and Sundays for repairs and maintenance. Certainly there are many local stories of the continuous noise of the dredge keeping people in Eldorado awake, or waking them up if something went wrong and the noise stopped.

The crew numbers are uncertain. Greene says the on-board crew ranged from 5 to 13 at different shifts and at different phases of its history, plus about 7 on-shore jobs, all of which Greene lists. The Dorings' 1994 report[4] found little primary evidence of the staffing levels, but repeats Greene's job list with some qualifications. Greene's list is based on information from former dredge workers, and is fairly consistent with the few documentary sources found by the Dorings.

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[3] Ken Greene; *Eldorado's Golden Ship*
[4] C & MJ Doring P/L; *Cocks Eldorado Dredge – Conservation Study 1994*

We do not know much about the on-shore working conditions, but conditions on the dredge were pretty Spartan. As noted earlier, the dredge superstructure was open to cold draughts and some rain, and much water would have been splashing around anyway. It would have been very cold in winter or on frosty nights, and only the Winchman in the control room had a rudimentary wood stove for warmth. When seen in 1994 there was a small onboard rainwater tank for drinking water and hand-washing, but there were no provisions on board for showering, or for clothes storage, or for eating meals in clean conditions. Internal electric light for night-shift work appeared minimal in 1994. It seems likely that more lighting was provided during operation, but that most light fittings had been removed or stolen after closure. The main onboard staff amenity seen in 1994 was a makeshift “long-drop dunny” suspended out the stern, over the water - apparently added as an afterthought.

Working conditions on the dredge looked not very safe, with many tight walkways or ladders running close to exposed working machinery, and with exposed steel mooring cables running across the deck the men walked on - cables that could suddenly move or tighten without warning as the Winchman manoeuvred the dredge. However the only serious injury found in the records was the death of one man who was not on the dredge - he drowned when the small boat or barge he was on was swamped by a tall gravel bank that collapsed into the pond.

3.15.8 On-Shore Plant, Workshops and Offices:

As well as the dredge itself, the dredging operations included further on-shore treatment of the recovered gold and tin, maintenance workshops to repair the dredge and other plant, a store for various supplies, and administrative offices to keep accounts and personnel records, pay wages etc. The office, store and workshop facilities would have been fairly conventional, but the onshore treatment process is worthy of note.

The screened and concentrated gold fragments and tin-oxide grains from the dredge were taken ashore mixed with some residual sand, and were further treated locally to remove more impurities and to separate the gold from the much larger quantity (but lesser value) of recovered tin. The method of on-shore concentration was described by J.C. Watson, Chemist and Assayer, in the Mining and Geological Journal of January 1938, and in more detail in his unpublished notes for that journal article. [5]

The gold and tin concentrate came from the dredge jigs in the form of a black sand, containing primarily grains of cassiterite (tin oxide), plus tiny fragments of metallic gold and other minerals such as ilmenite (titanium ore). Onshore, the concentrate was tumbled in a drum with mercury, which formed an amalgam with the gold. The amalgam was caught and retorted in a furnace to separate the gold from the mercury. (This sounds a rather dangerous job, and may have left mercury contamination in the remaining machinery or at the treatment site.) The gold was then cast into ingots.

[5] See Watson, J.C. in References

The concentrate (minus gold) was passed through a further set of jigs, similar in principle to those used for primary separation on the dredge, but using lead shot as the filter bed. This produced tin ore of about 75% concentration, which was bagged for shipment. The material rejected by the jigs was then passed through a Wilfley shaking table and a Magnetic Separator, which recovered more of the tin oxide. The tailings from these later treatment stages was dumped, including the (then) unwanted ilmenite. Small amounts of semi-precious gemstones such as zircons and garnets were also recovered during this on-shore processing.

The treatment plant was upgraded at intervals. For example, an extra on-shore jig was added in 1939/40 *"to separate the topaz sand from the light tin"*. In the 1950s, improved separating methods allowed considerable residual tin to be recovered from dumps of material, but it is unclear whether this was material already treated, or material stockpiled earlier and awaiting treatment.

The on-shore workshop and ore treatment plant, and the store and administrative office, would also have needed SEC electric power, but that would have been conventional single or three phase power at normal commercial/industrial voltages.

Onshore there were also company houses built especially for the senior staff and foremen, and possibly for some of the crew. Other members of the crew would have probably lived in or close to the general Eldorado township.

3.16 Physical Condition:

When the dredge ceased operation in 1954, after 17 years of round-the-clock hard work, it was worn but still in operating condition, and remained so for many years. It was shut down in 1954 only because it was no longer operating profitably. Since then it has remained moored in a shallow part of its last self-dug pond for about 60 years, with little maintenance. Consequently the dredge has suffered considerable deterioration due to rusting and water damage, and other damage due to vandalism and theft.

The most serious deterioration has been to the hull or pontoon. Professional photographs of the then still privately owned dredge, taken by Le Dawn Studios of Wangaratta in 1975[6], show the dredge still floating with the hull in good even trim. However, in 1983 (during the transition to government ownership) the riveted steel hull/pontoon developed serious leaks in the forward area, and the bow end of the hull sank down onto the gravel bed in a (fortunately) shallow part of the pond.

In 1989-90 Peter Milner, of the Melbourne University's Department of Mechanical and Manufacturing Engineering, was engaged by the Historic Places Section of Victorian Department of Conservation, Forests and Lands to investigate the condition of the dredge, particularly the hull, and to attempt to refloat the dredge by pumping water out of the various hull compartments. His reports[7] show that the leakage through the external hull plates was severe (partly due to corrosion and partly due to operational damage), and that water could also get in via open manholes in the deck (after thieves or vandals had removed most of the

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[6] See Le Dawn in References.
[7] See Milner in References.

manhole covers), or through holes cut in the internal bulkheads during the dredge's working life to accommodate extra wiring or pipes.

Milner tried to refloat the dredge, but unfortunately Milner's pumps, with a combined capacity of about 3000 gallons per minute (about 13,000 litres per minute) could empty some hull compartments but could not keep up with the inflow of water through external holes in other compartments, and the refloating attempts failed. Milner's several reports from 1989-1990 show that by then the dredge was firmly settled on the gravel bed, and had sunk furthest at the bow end, particularly at the starboard (right) corner of the bow end, leaving the whole dredge tilting a bit towards that corner - as it is today.

The settling and tilting of the dredge hull means that the deck of the hull is now more or less permanently submerged near the starboard bow, and permanently above water near the port-side stern. The degree of submergence of the deck area would vary from about one-quarter to three-quarters depending on the level of water in the pond, which in turn depends on the level of water in Reedy Creek. The varying degree of deck submergence also means that much of the deck-mounted machinery will be partly submerged or exposed from time to time, including the main power transformer, various pumps, the final onboard gold-separating (clean-up) jigs, and the several large winches and large electric motors below or behind the control room (used for manoeuvring the dredge, driving the chain of buckets on the bucket ladder, or raising and lowering the outer end of the bucket ladder),

The intermittent submergence has caused corrosion and damage to the hull and to the deck-mounted machinery and electrical gear, and leaves a layer of often damp mud on the deck, which promotes further corrosion of the deck and of the lower superstructure frame where it meets the deck. The majority of the hull's volume is permanently sitting in water externally and permanently holding water internally, as is the lower end of the bucket ladder and bucket-band, all of which would be suffering corrosion. Most of the exposed above-water superstructure, upper buckets and upper bucket ladder is also rusting but more gradually - except that corrosion is rapid in the bottom of those upper buckets that are holding trapped rainwater and are pitting badly.

Vandals and thieves have also caused some damage, such as removal of most flat drive-belts, some cgi roofing, many of the circular deck-top manhole covers, most electrical wiring and most light fittings. Vandals have also smashed or removed all electrical meters on the Winchman's control-room switchboard.

In 1994 Solomon Corrosion Control Services (SCCS) was engaged by Parks Victoria to advise on means of stopping or slowing corrosion of the hull and other parts of the dredge. SCCS recommended an active Impressed Current Cathodic Protection System for the hull, plus some passive anodic protection (bolted-on zinc or magnesium anodic blocks) for the upper buckets and for parts of the hull. SCCS also recommended repair of leaking downpipes and gutters, and replacement of missing cgi roofing sheets.

The roof and plumbing repairs appear to have been done successfully. The Impressed Current Cathodic System was installed, but the onshore power supply and control cabinet and the exposed onboard wiring proved prone to vandalism, and the required power consumption proved expensive. This active system has since been removed. The passive zinc/magnesium blocks do not appear to have been installed, but possibly could be installed on a larger scale to provide passive protection to the whole dredge hull, bucket ladder and bucket-band (as has recently been done for Submarine AE2). This would be in lieu of the unsuccessful active system that was removed.

At some time during the operating life of the dredge an extra semi-circular chute was added at the stern to dump poor-grade fine gravel from the rotary screen straight out the back without going through the separating jigs - apparently an option found useful but not included in the original design. The additional chute protruding out the stern of the dredge was supported by two steel cables which were in turn supported by an inclined timber gantry made of two tall straight strong timber posts or stays rising at an angle from the top stern edge of the deck, and joined at several levels by horizontal cross-members. The timber gantry looked like a makeshift addition using locally available materials, not an engineered steel structure like the rest of the dredge. By 1998-99 the tall timber stays had become seriously weakened by rot and were replaced by new timber stays - as would have happened had the dredge still been operating.

Some other timber components are also suffering rot, particularly the timber planks used as the flooring in the narrow catwalks giving access to various bits of the dredge machinery. Some of those planks have been replaced or soon will need to be replaced for safety.

In summary, the dredge has withstood 17 years of hard work and 60 years of retirement fairly well, but with some deliberate damage and much unintended corrosion, causing amongst other things leakage of the hull and settling of the dredge onto the shallow gravel bottom of the dredging pond. Continuing the present minimal conservation regime will probably give the dredge a further life of several decades as an historical monument, before it collapses further and has to be scrapped. A more intensive and expensive program to reduce corrosion, particularly of the hull - and perhaps a major project to lift and resettle the dredge onto a level base with the deck above water - could probably extend its life as a static monument for many decades, perhaps a century. The dredge is not likely to ever be restored to operating condition.

For many years under government ownership, public access onto the dredge was prohibited, but many people ignored that and found ways of getting on board, usually at the bow end which rests within a few metres of an earth bank. The intruders then had free range of the whole dredge, often just to look at or dive from, but sometimes to steal or vandalise things. Such unauthorised access was dangerous for the dredge and for the intruders.

In recent years Parks Victoria has installed a fence along the edge of the pond, near the dredge, and has erected a safe metal walkway built from the nearby bank up to the Winchman's control room. This allows unsupervised public access onto the dredge at any time, but with introduced internal fences and locked gates that restrict casual visitors to just the control room area. From there the visitors can view the Winchman's controls and the already-vandalised switchboard, and view some of the dredge interior and equipment - including a number of large winches and electric motors, some of the bucket ladder and bucket-band, and some of the separating jigs. People with a special interest in the dredge, such as engineers or heritage practitioners, can sometimes arrange with Parks Victoria to get escorted access to the all of the dredge. However, due to the difficult and sometimes risky access via narrow catwalks, steep ladders, etc, such access is rarely granted.

3.17 Historical Notes:

3.17.1 Prior to the Dredge at Eldorado

Reedy Creek (aka Reid's Creek) flows roughly westwards down from the hilly Woolshed area north-west of Beechworth township in north-east Victoria, bringing gravel and stones, and small alluvial gold particles and black grains of tin oxide washed down from some as-yet undiscovered source. As the creek left the steep and narrow gullies of the Woolshed area and reached the flatter valley floor, its velocity and turbulence diminished, depositing a deep bed of gravel interspersed with a tiny percentage of fine particles of metallic gold and grains of tin-oxide, near the present-day Eldorado township. When gold was first discovered there and the initial gold rush started the area seems to have been called El Dorado, but by the time the rush had transformed into a small number of large deep-lead mining companies and the township was established, the name had been conflated to Eldorado, as it is today.

Gold was discovered at what is now Beechworth in 1852, then at the nearby Woolshed Flat in 1853, and downstream at what is now Eldorado in 1854. This sparked a local gold rush and brought decades of prosperity to the Eldorado/Beechworth area. The main method of getting gold near Eldorado from c1860 to c1900 was by a dozen or so "deep lead" mines run by companies that employed teams of miners who dug vertical mine shafts down through poor gravel until they reached one or other of several gold-rich gravel strata, then extended horizontal shafts into the paying gravel strata.

At Eldorado the main gold-bearing strata were found at about 30, 50, 70, 90, and 220 feet depth.[8] (One foot = approximately 0.3 metres. Feet are used because the mining was done and accounts written long before metric units were used in Australia.) The deepest gold was at the level where the gravel deposit met bedrock. At the higher strata, the alluvial gold was sitting on bands of clay running through the gravel. The total depth indicates the huge quantity of gravel that has been deposited there over millennia.

Deep lead mining was concentrated around Eldorado township area, and for many years yielded good results. However, mining in deep loose gravel beds with a large creek flowing overhead was both difficult and risky, and in July 1895 the prominent McEvoy Mine shaft at Eldorado had a huge inflow of water and sludge which trapped and killed six miners.

The McEvoy tragedy, the falling profitability of the deep lead gravel mines, and the reluctance of the miners to work in dangerous conditions for low wages led to a switch at Eldorado from deep mines to surface sluicing, mainly using strong jets of water from electric pumps powered by nearby small private wood-fired steam-driven power stations. Sluicing turned the finer gravel deposits into a semi-liquid slurry which was then taken to sluice boxes for separation of the gold. The jetting technique was variously known as sluicing, "hydraulicking", hydraulic dredging, (just) dredging, or open cut. This technique was used at Eldorado from the late 1890s and was continued at Eldorado by several companies well into the 1920s and 1930s. Mechanical bucket dredging arrived at Eldorado in 1935/36, and sluicing faded away - with the last hydraulic sluicing operation at Eldorado closing in 1942.

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[8] Fletcher and O'Malley.

Figure 16: Sluicing nozzle on display at Eldorado Museum. (Photo by C. Doring, 1994.)

Mechanical bucket dredging was invented in New Zealand in the 1860s, and was developed commercially in NZ in the late 1880s and 1890s, generally with steam-powered machinery floating on wooden hulls. The bucket-dredging process worked well, and was widely adopted internationally, including in Australia. Carole Woods[9] noted that in 1915 there were 42 bucket dredges working in Victoria, of which 35 were in the Beechworth Mining District, which stretched as far as Bright. However, in these early years they were relatively small dredges, mostly with wooden hulls, mostly powered by steam, and only capable of dredging to a shallow depth. By the mid 1910s Charles Ruwolt, engineers of Richmond, Victoria were making larger steel-hulled bucket dredges, but those seem to have been primarily for export to SE Asia, presumably for mining tin. None still exist in Australia, so they have not been researched.

After WW1, a rise in costs and fall in profits caused a slump in gold mining. In the late 1920s and early 1930s a dramatic rise in the price of gold and the successful dredging of rich alluvial gold deposits in New Guinea revived strong interest in mechanical gold dredging in Australia, including around Eldorado. Several of the old small dredges were revived and reused around north-east Victoria, and a number of new larger steel-construction electric-powered dredges were built during in the 1930s and early 1940s. G.M. Ralph[10] lists seven steel dredges from that era totally or partly built by Thompsons for use in NSW or Victoria, including the Eldorado Dredge at the top of the list - implying it was the first of the Thompson dredges. By then Thompsons appears to have been perhaps the most important maker of dredges in Australia.

[9] Carole Woods, *Beechworth, A Titan's Field*
[10] Ralph, Gilbert M., *Gold Dredging in Central Victoria*

3.17.2 Construction and Operation of the Eldorado Dredge:

In 1934 the Cocks Eldorado Gold Dredging No Liability company (also known as Cocks Eldorado NL) was formed specifically to build and operate a large modern dredge to work the Eldorado field. That dredge is the subject of this nomination. The larger dredge size was not just for economy of scale, it was also aimed at dredging deeper gold-bearing gravel strata that the earlier deep lead mines and exploratory drills had identified, but that small dredges or surface sluicing could not reach.

As noted earlier, Cocks Eldorado NL quickly commissioned mining engineer D. P. Fletcher to design the Eldorado dredge, and he completed the design by about October 1934 - including increasing the dredging depth from an initially proposed 70 feet to a nominal 90 feet (about 27 metres depth). According to some sources the dredge actually reached to 95 or 98 feet depth. The design was said to be based on the latest dredges developed in Malaya (presumably for tin).

The manufacture of the dredge was put to tender in late 1934, and the construction contract was won in January 1935 by Thompsons Engineering and Pipe Company of Castlemaine and Williamstown, at a cost of about 90,000 pounds. Thompsons fabricated components of the dredge in their works at Castlemaine and/or Williamstown, then transported the components to Eldorado by rail and road for assembly in a shallow pit excavated in an open field near Reedy Creek. According to Fletcher[11], this dredge was noteworthy as the first of the large 1930s gold dredges, and first to be built in Australia using predominantly Australian materials and Australian machinery and components, rather than imported ones.

The dredge was assembled in the field at Eldorado by Thompsons, under the supervision of Fletcher. Initial assembly of the pontoon was done in a shallow excavated paddock near Reedy Creek and north-east of the Eldorado township. When the pontoon was completed the excavated assembly area was flooded and the pontoon was floated to another deeper pond nearby, where final assembly and commissioning was carried out. At the same time, 6,600 volt SEC electric power was brought to the dredge's (initial) working area, and facilities were built onshore for maintaining the dredge and for more thoroughly separating and concentrating the recovered gold and tin from the dredge. Several settling dams were dug to hold and clarify the turbid water produced by the dredging operation and the onboard washing of the gravel. These included the pond used for assembling the dredge.

Assembly of the dredge at Eldorado started in June 1935, the partly built dredge was floated in November 1935, and the completed dredge was officially "opened" (switched on) by Mr Hogan, Victorian Minister for Mines, on 1st May 1936. At that time the Eldorado dredge was said to be the largest bucket dredge built in Australia, and the largest in the southern hemisphere (although later surpassed in size by the Tronoh Dredge that operated near Harrietville in Victoria, and was also built by Thompsons).

During May 1936 the Eldorado dredge was tested and fine-tuned by Thompsons, and was handed over as fully operational on 1st June 1936. However, the chrome-steel buckets made by Thompsons broke several times during June-July 1936, and it was decided to shut down the dredge and get better-quality manganese-steel buckets made by Commonwealth Steel

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[11] See Fletcher and O'Malley, *Cocks Eldorado Dredge* in Refs and in Appendix A.

Company of Newcastle. The ComSteel bucket-band was fitted in November 1936, and dredging resumed, but further problems with the Comsteel buckets caused another bucket-band to be bought and fitted in 1938, and yet another in 1939 - which failed in 1940-41. Comsteel claimed that the failure of their later buckets may have been due to overloading by the installation of a much larger drive motor for the bucket-band in April 1939, when a 320 hp (horse power) electric motor replaced the original 200 hp motor. After c1941 the bucket replacements seem to have been fewer and due to normal wear-and-tear rather than catastrophic failure.[12]

By the time World War Two started many other all-steel dredges had been built in Australia, at least six of which were built completely or in part by Thompsons[13] (who also built more dredges after the War). Depending on the mineral resources at their location, some of the dredges dug for gold, some for tin, and some - like Eldorado - dug for both gold and tin. The Eldorado dredge was one of the more successful gold dredges, and paid its shareholders handsome dividends most years, although another Victorian dredge - at Newstead - was said to have recovered the most gold in Victoria. The Eldorado Dredge was also, in its time, the most important producer of tin ore in Victoria.

The Eldorado dredge continued operation throughout World War Two, but with some difficulty in retaining men who wanted to join the armed forces. Management reports from that time seem to consider men who left as being disloyal to the company, rather than loyal to their country. After WW2 the dredge continued operation - mostly returning good dividends to the shareholders - but conditions changed in 1953/54 and the dredge was shut down in 1954 when its operation was no longer profitable.

Over its working life of about 18 years, from 1936 to 1954, the dredge had gradually worked its way downstream along the course of Reedy Creek, from the dredge's starting location north-east of the Eldorado township, to its final working pond (and resting site) south-west of the town. The dredge did not dig at random, but worked within a defined mining lease, and was guided by about 100 exploratory test borings scattered over the lease area.

3.17.3 Closure of the Dredge, and thereafter:

As noted above, the generally profitable Eldorado Dredge earned only a small profit in 1953, and was shut down in 1954 because the total value of gold and tin being recovered failed to repay the operating costs of the dredge. This was in part because the price of gold and tin had fallen, partly because the cost of processing the gold-bearing gravel had risen sharply, and partly because the quantity of gold and tin being recovered by the Eldorado Dredge, and its profitability, had been falling for several years.

By the time it closed down, the Eldorado dredge operated by Cocks El Dorado Gold Dredging Company (aka Cocks Eldorado NL) ceased operations in 1954 it had dug up and

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[12] See *Cocks Eldorado Mine Superintendant's Annual Reports etc.,* held in Melb. Uni. Archives.
[13] Ralph, Gilbert M., *Gold Dredging in Central Victoria*

treated 39 million cubic yards (about 30 million cubic metres) of gravel along the present or former creek bed. It had recovered a total of 70,664 ounces of gold plus 1,356 tons of tin ore. [14] It was said that the gold paid for the operating costs of the dredge, and the tin gave the profits. It is not said how much of the then unwanted titanium ore was discarded.

The gold and tin recovered by the Eldorado Dredge was a lot less than the 117,000 ounces of gold and 1,673 tons of tin ore recovered by the unrelated gold sluicing company Cocks Pioneer Gold and Tin Mines NL, but the bucket dredge did not start at Eldorado until after the best deposits had already been worked over by sluicing and/or by deep lead mining.

The unprofitable conditions also caused the few other gold dredges still working in Victoria in the 1950s to fail. The biggest dredge in Victoria (and probably Australia) - the Tronoh Dredge which worked along the Ovens River near Harrietville from 1942 - was shut down in 1954 a few months before the Eldorado Dredge. The Tronoh dredge caused a huge amount of damage along the banks of the Ovens River, damage still visible today, but is said to have never made a profit in Victoria, whereas the smaller Eldorado Dredge made good profits most years. The Tronoh Dredge was dismantled, shipped to Malaya/Malaysia and reassembled there to dredge for tin. It appears now to be retired as a museum relic and tourist attraction in Malaysia. During the 1950s several other remaining Victorian gold dredges, all smaller than or about the same size as the Eldorado Dredge, were also in financial difficulty and the last ones were shut down during 1954-56.

Some tin dredges or small gold dredges survived longer in other states (see further below). In particular, bucket dredges digging for tin continued operating in Queensland and Tasmania for many more years, but all have now shut down and most no longer exist.

After the dredge operations closed, and after remaining small amounts of onshore tin and gold concentrates had all been processed, the Cocks Eldorado company’s onshore assets at Eldorado were sold for removal in 1955. Remnant onshore machinery and concrete pads seen near the dredge in 1994 suggest that the onshore treatment plant, (for more complete separation of the gold and tin ore from fine gravel) was probably located close to the dredge’s current position south-west of Eldorado township at the time when dredging operations ceased in 1954. However, it is likely that those on-shore activities were originally located to the north-east of the town, close to where dredging started in 1936.

After the 1954 shut-down, the Cocks Eldorado NL company that owned the dredge continued to exist for many years, but never operated the dredge again. The company did not sell the dredge, but left it floating in its last pond on a care-and-maintenance basis, apparently with diminishing maintenance as the years passed and chances of reuse faded.

In 1972 the company wrote down the value of the dredge to $20,000, but later that year increased it again to $100,000 after a rather optimistic estimate of the possible resale value of the used bucket-band, but the sale of buckets came to nothing. In 1974 they advertised to sell the whole dredge, without success.

In 1973/74 several other things happened to the slumbering giant. A revival in the price of gold and tin raised hopes of resuming operation of the dredge in situ, but that did not proceed. A local scrap metal merchant offered to buy the dredge as was for $40,000, but

[14] See Appendix E.

was refused. In early 1973 a demolition crew from Sydney started to demolish the dredge for scrap, until stopped by the caretaker because they had no authorisation. A Western Australian company considered shifting the dredge to WA for reuse, but a report on the condition of the dredge said the bucket-band was beyond redemption, and removal of all or part of the dredge elsewhere for reuse was unlikely to be feasible.

In 1973-75 there was increasing interest in the dredge as an historic monument and a tourist attraction. The National Trust (Victoria) added the dredge to its Industrial Heritage Register on 20 December 1973, and a local Eldorado Dredge Preservation Committee was formed at about that time. At the urging of the National Trust, the Victorian Historic Buildings Council placed an Interim Preservation Order on the dredge in 1975, followed by a full addition of the dredge to the Historic Buildings Register in 1976 (Item Number H386), giving the dredge protection under Victorian heritage legislation.

Over the next ten years there were several unsuccessful proposals for the dredge to be moved to other states for mining, or for the dredge to remain in situ and be bought by various government authorities or heritage organisations for preservation, but the Cocks Eldorado NL company raised its valuation of the dredge from $20,000 to $100,000 and then to $1,000,000, and all negotiations came to naught - until time and nature took over.

In 1981 the Cocks Eldorado mining lease expired. Initially the company had the usual 12 months period of grace to remove their property, including the dredge, or ownership would transfer to the state government - but the time limit for the period of grace was extended to 14th December 1984. In July 1983, during the extended period of grace, the rusty hull developed a serious leak and the dredge suddenly sank down at the bow end, settling on the shallow gravel bed of the pond.

Nothing was done to repair or remove the dredge, and on 14th December 1984 the company's extended period of grace under the mining lease expired. The ownership of the dredge - still on site - automatically transferred to the state government's Department of Industry, Technology and Resources without any payment due to the Cocks Eldorado NL company. However, the Department did not realise it was now the owner of the dredge until about November 1985.

In 1986 ambitious plans were proposed for an extensive series of Historic Reserves in the Eldorado-Beechworth area covering a range of mining sites and mining relics, including the Eldorado dredge, with the aim of encouraging public visitation to the area and public appreciation of its mining history. However, little was done then about the dredge itself.

On 15th December 1988 ownership of the dredge and pond was transferred again, this time to the Victorian Department of Conservation, Forests and Lands, presumably in recognition that the dredge was now an historic monument and tourist attraction, and no longer a potentially active mining machine. After several phases of departmental renaming and reorganisation, that transfer has led to the present situation where the Eldorado dredge and pond are now (2015) under control of Parks Victoria, within the Victorian Department of Environment, Climate Change and Water. The dredge is now a prominent and popular local tourist attraction with excellent on-site interpretative display boards and pamphlets explaining the history, basic design and operation of the dredge.

3.17.4 Other Australian Dredges:

According to a major dredge design engineer, the first practical mechanical bucket dredge for commercial mining of alluvial gold was built in New Zealand in 1881, and was powered by an onboard steam engine. Several more similar small bucket dredges were built and used in the 1880s and 1890s in NZ and were so successful that bucket dredging was widely adopted in the late 19th and early 20th centuries in NZ, Australia, the Americas, Europe, Asia and Africa.

Most of those early dredges were relatively small and had wooden hulls or pontoons, and most were powered by steam. A few early wooden-hulled dredges still “survive” as recognisable ruins, but with their hulls mostly rotted away and with little if any of their machinery in situ. None survive in Australia that could remotely be called intact.

Figure 17: Gungahlin (aka Gungarlin) Dredge, southern NSW. This is one of the best "surviving" early wooden-hulled bucket dredges in Australia. (Photo from NSW Environment & Heritage website.)

In the 1900s and 1910s some larger steel-hulled bucket dredges were being made by companies such as Charles Ruwolt Pty Ltd of Wangaratta, initially for local gold dredging. In the mid-1910s Ruwolts moved to Melbourne, and built many more dredges (and other machinery), although most of the Ruwolt dredges then were made for export to SE Asia, presumably for mining tin. (See Vickers Ruwolt [Image] Collection at Museum Victoria.) Still later the company became Vickers Ruwolt.

One small steel bucket dredge made by Ruwolts in 1929/30 for use in Australia was shipped to Cooktown, then trucked inland to Palmer River to dig for gold. Surprisingly at this late date it was powered by steam. It was not very successful, and only worked for a few years. It still partly survives, and is on the Queensland Heritage Register as Item 601871. The Register entry describes it as the earliest surviving steam-powered dredge in Queensland and possibly Australia. The steel pontoon (19m x 10m) is half-buried, the superstructure's steel frame survives without any cladding, the partly dismantled steam engine is lying onshore in bits, and most of the buckets have gone.

After World War One, an increase in the costs and fall in the profits of mining gold reduced the demand in Australia for dredges. However, during the mid 1930s there was a steep increase in the price of gold, and hence a resurgence in gold mining activity, and a number of larger steel-construction electric-powered bucket dredges were built in Australia during the 1930s and 1940s. As listed by G.M. Ralph,[15] many of the 1930s dredges were made by Thompsons of Castlemaine and Williamstown - probably by then the major Australian manufacturer of large all-steel bucket dredges. The first of the new 1930s all-steel dredges was the Eldorado Dredge, designed by Fletcher and made by Thompsons. The other 1930s steel dredges listed by Ralph were also made by Thompsons, but were designed by other engineers and were made for other mining companies.

Figure 18: Newstead Dredge. (Photo from Victorian Dept of Energy and Resources website.)

One well-known 1930s all-steel dredge, variously called the Newstead Dredge or the Victoria Dredge, was owned by the Victoria Gold Dredging Company and operated from 1938 to 1948 on the Loddon River near Newstead in the Central Goldfields area of Victoria, about midway between Bendigo and Ballarat. That dredge was designed by George Watson of Alluvial Mining Equipment, Sydney, and was made by Thompsons in Victoria.

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[15] Ralph, Gilbert M., *Gold Dredging in Central Victoria,*

Some sources say the Newstead Dredge was then the largest dredge in Victoria. In fact it was smaller than the Eldorado dredge with a hull/pontoon 112 feet long x 52 feet wide, while Eldorado's hull was 210 feet long x 65 feet wide (not including the protruding front part of the bucket ladder, or the discharge chutes protruding out the stern). The Newstead Dredge worked to a shallower depth than Eldorado, and for a shorter time, but it recovered 113,750 ounces of gold. That was about 60% more gold than recovered by the Eldorado dredge, and reportedly was the most gold recovered by any bucket dredge in Victoria.

The Newstead Dredge ceased operation in 1948, then was dismantled and its equipment was reassembled onto a new pontoon to become the Amphitheatre Dredge, at Amphitheatre in Pyrenees Shire, Western Victoria. It started working there in 1951, but had many equipment problems. It capsized and sank mysteriously in 1957, then in 1958 it was dismantled and sold off in bits. Consequently, the Newstead-cum-Amphitheatre Dredge as such no longer exists.

The largest bucket-style gold dredge in Victoria - and probably in Australia - was the all-steel Tronoh Dredge which worked on the upper reaches of the Ovens River, near Harrietville. It was roughly 50% larger and 100% heavier than the Eldorado Dredge, and had electric motors with about double the power. It could dig down to 130 feet depth, about 50% deeper than the Eldorado Dredge, and could dig up gravel at about twice Eldorado's rate.

The Tronoh Dredge was owned by Harrietville (Tronoh) Limited, a subsidiary of the London Tronoh Company. The dredge was designed by F.W. Payne & Sons, London, but again was built by Thompsons of Castlemaine and Williamstown, Victoria. Construction of the Tronoh Dredge began in 1939, but WW2 intervened and the dredge was not completed and operational until 1942. It then had trouble getting enough men to work it , so did not reach full production until about 1946.

Figure 19: Old postcard photograph of the Tronoh Dredge working near Harrietville, Victoria. (Copied from Web)

The Tronoh Dredge ceased work in Victoria in May 1954 (a few months before the Eldorado Dredge shut down), so operated in Victoria at full capacity for only about eight years. Despite its short working life, the Tronoh Dredge dug up a huge volume of gravel alongside the Ovens River, causing a large area of environmental damage still visible today, 60 years later. This gives the lie to the 1930s/1940s claims by dredging advocates that dredging caused little or no damage to the ground, but instead usually invigorated the ground and improved it for agriculture.[16] The Tronoh Dredge is reputed to have been unsuccessful financially in Victoria, returning little or no profits to the owners. If so, then all that damage around Harrietville was for nought.

After the Tronoh Dredge shut down in Victoria, it was dismantled and shipped to Malaya (Malaysia), where it was re-assembled and worked for many years dredging for tin. It is understood to now be retired as an historic industrial monument and tourist attraction in Malaysia.. Several other large overseas bucket dredges are known to be preserved as monuments, notably a large wooden-hulled dredge in the Yukon, now managed by Parks Canada. However, those other overseas dredges have no connection with Australia.

The departure of Tronoh left the Eldorado Dredge as the largest bucket dredge surviving in Australia. However, it should be noted there are several smaller steel-hulled bucket dredges that still partially survive in Australia, as discussed below.

Figure 20:
The Maldon Dredge,
stern view.
(Photo from Web)

Near Maldon in Victoria there is a remnant steel-hulled bucket dredge still with its short bucket ladder, bucket-band, and primary cylindrical gravel screen, but with little else of the gold recovery system or the superstructure still in situ. It is much smaller than the Eldorado Dredge. It is known generally as the Maldon Dredge, but is listed on the Victorian Heritage Register as the Porcupine Flat Dredge, Heritage Inventory Number H7724-0044, Hermes Number 8347.

[16] D.R. Dickinson, *Gold Dredging in Victoria.* See Appendix D.

Near Ringarooma in north-east Tasmania, in the Dorset municipality, a wooden-hulled bucket dredge known as the Dorset Dredge was built c1906-07, to dredge for tin. Later, a steel-hulled Dorset Dredge replaced the wooden one. According to a 1968 report on tin production in Australia, the (steel) Dorset Dredge was then still operating as a mid-level tin producer, but was becoming uneconomical. Today the long-disused steel Dorset Dredge is still in situ in its own dredging pond, but has been tipped on its side - probably during a flood. Judging by on-line photographs, its superstructure cladding, buckets and onboard machinery have been mostly or totally removed.

Figure 21:
Dorset Dredge, NE Tasmania, stern view.

(Photo by RF Erskine, from Bonzle website.)

Figure 22:
Dorset Dredge. Former top view, now side view, with bow end at right.

(Photo by RF Erskine, from Bonzle website.)

Near Gladstone in north-east Tasmania, not far from the Dorset Dredge, there is the steel pontoon of another dredge. That pontoon is right way up, but everything except the pontoon has been removed, and there are big holes in the deck where large areas of steel plate have been removed.

Apart from the Eldorado Dredge, the most substantial bucket dredge still surviving in Australia is a now-disused tin dredge at Nettle Creek, near Mount Garnet in Queensland. It has had a very chequered career, a bit like grandpa's axe. It was built in New Zealand in c1937 to mine alluvial gold on the west side of South Island. It was built by Oak Ridge Co. Ltd. of NZ, but was designed by F.W. Payne & Sons of England, and was fitted out with predominantly British equipment including British electric motors, bucket-drive gears and gantry crane.

In 1953/54 it was dismantled in NZ and the machinery etc (but not the original pontoon) was shipped to Queensland to be reassembled at Battle Creek over several years onto a new steel pontoon (No.2). It underwent extensive modifications to enable the overburden (topsoil) to be redeposited on top of the gravel tailings as required by the Queensland mining lease, to leave the dredged ground (theoretically) still suitable for agriculture.

The rebuilt dredge mined for alluvial tin along Battle Creek, near Mt Garnet, from 1957 to 1962. Its onboard equipment was then dismantled, transported a short distance and re-erected again on yet another steel pontoon (No.3) to dredge Nettle Creek for tin. It worked there from 1965 to 1992, when it was finally shut down.

Figure 23: Nettle Creek Tin Dredge, Queensland, in working order. (Photo from web, trimmed)

Figure 24: Nettle Creek Tin Dredge, present condition. (Photo from Innisfail Gem Club website.)

The now-disused Nettle Creek dredge still sits beached on the gravel bed in its last pond alongside Nettle Creek, about 14km east of Mt Garnet, but in a stripped-down condition.

In 1995 the dredge was entered on the Queensland Heritage Register - administered by the Queensland Department of Environment and Heritage - as Item Number 601534, *Nettle Creek Tin Dredge*. The Heritage Register entry describes the dredge as being 47 metres long, 23 metres wide and with superstructure 20 metres high above the deck. That makes it about the same width as the Eldorado Dredge, but much shorter. According to the Heritage Register entry, the dredge has suffered the removal of all of its buckets, most of its electrical gear, most of its corrugated iron cladding and most of its tin-recovery jigs. It still has its original British gantry crane and two of its original electric motors, and still retains its three-storey steel superstructure frame and its massive presence.

The above summary of other Australian dredges indicates that the Eldorado Dredge was probably the second-largest bucket dredge to ever operate in Australia, for either gold-mining or tin-mining. The departure of the huge Tronoh Dredge, the rotting or destruction of all timber-hulled dredges, and the partial disassembly or complete scrapping of all other Australian steel-hulled dredges, has certainly left the Eldorado Dredge as the largest and by far the most intact gold-mining (or tin-mining) bucket dredge still surviving in Australia. Indeed, the Eldorado Dredge is now one of the largest bits of historical gold mining equipment of any sort in Australia.

3.18 Existing Heritage Listings:

3.18.1 Australian Heritage Commission:

Name: Register of the National Estate

Title: Eldorado Dredge, Eldorado, Vic

Number: Database Number 004656 (or just 4656)

Date: Eldorado Dredge was registered on 21 March 1978.

Note that the Register of the National Estate (RNE) carried legal weight in 1978, but is now a non-statutory archive with no legal force.

In 1981, under Prime Minister Fraser, the Australian Heritage Commission published a fat book, *The Heritage of Australia - The Illustrated Register of the National Estate*, with some 6,600 entries - including the Eldorado Dredge (with a typical short description and tiny photograph). Yet more entries were added each year until 2007, when the then federal government decided the RNE already had an excessive number of items listed and froze the addition of any more items.

Two new national heritage registers were then established by the Commonwealth: firstly, the Commonwealth Heritage List (CHL) covering significant places owned by the Commonwealth; and secondly, the National Heritage List (NHL) covering places/items of national significance that are not owned by the Commonwealth.

The legal force of statutory protection of heritage places at the national level was transferred from the old RNE to the new CHL and NHL jointly. This leaves the old RNE as just an archival record of heritage places that used to be recognised and protected at national level, but now with no legal force. To date only a few of the most iconic heritage places have been registered or listed in the new CHL and NHL - and currently the Eldorado Dredge is not included in either of those exclusive lists.

3.18.2 Heritage Victoria:

Name: Victorian Heritage Register

Title: Eldorado Dredge

Number: H386 (Files number 603522 to 603524)

Date: Registered via Government Gazette No.7718, August 1976

3.18.3 Rural City of Wangaratta (RCoW)

Name: RCoW Planning Scheme - Heritage Overlay Schedule

Title: Eldorado Dredge

Number: Was HO1, now HO161

Date: Listed as HO1 prior to 2000 (probably c1976). Re-listed as HO161 in c2004-2014.

3.18.4 National Trust of Australia (Victoria)

Name: Industrial Heritage Register

Title: Eldorado Dredge

Number: 3380

Classification: State Significance

Date: Classified 20 December 1973

4 Assessment of Significance

The following factors contribute to the significance of the Eldorado Dredge, although some of the factors give local or state significance rather than national significance.

4.1 Historical significance:

The Eldorado Dredge has played a significant part in the history of the Beechworth-Woolshed-Eldorado goldfields and in the local gold-based economy. It is also representative of the various other gold and/or tin dredges that operated at many sites in Australia, contributing to the prosperity and development of Australia and to the viability of many Australian mining communities and townships.

The Eldorado Dredge represents the latter stage of alluvial gold (and tin) mining, with a transition to highly mechanised, efficient and capital-intensive bucket dredging, a process that transformed alluvial gold and tin mining and extended the prosperity and viability of many mining companies, mining communities and mining towns in Australia (and elsewhere in the world). Bucket dredges demanded heavy capital investment in machinery and tended to be used for gold mining after the easier gold had been won by the other methods. They were the logical first choice for mining alluvial tin.

The Eldorado Dredge was an early major industrial consumer of SEC electricity in Victoria.

As well as recovering profitable amounts of gold, the Eldorado Dredge was in its time also the most important producer of tin (ore) in Victoria, and is thus representative of both gold and tin dredging.

4.2 Historic Individuals or Association:

The Eldorado Dredge was designed by prominent and well respected mining engineer Douglas Percy Fletcher, Fellow of Mining & Metallurgical Institute of Australia.

The Eldorado Dredge was built by Thompson’s Engineering and Pipe Co. Ltd., Castlemaine & Williamstown, Victoria. Thompsons is itself historically significant as one of Australia’s longest established and most important manufacturers of heavy engineering equipment, mining machinery, pumps etc.

4.3 Creative or Technical Achievement:

The all-steel electric-powered Eldorado Dredge led the way for the 1930s resurgence in gold dredges in Australia.

When built it was said to be the largest dredge in Australia, and in the southern hemisphere, (although later surpassed in size by the Tronoh Dredge at Harrietville).

The designer of the Eldorado Dredge, D.P. Fletcher, claimed it represented an important advance at the time by being built almost entirely from Australian materials and Australian machinery (eg pumps), whereas earlier Australian dredges incorporated a lot of imported (mostly British) machinery and materials.

4.4 Research Potential:

The Eldorado Dredge is the best and only example in Australia of a physically complete bucket dredge with all structures and equipment virtually intact, in situ and in genuine working configuration (but no longer in working order).

The research potential of the Eldorado Dredge is enhanced by numerous photographs, by extensive documentation of its construction and operation, and by some oral history. At the same time, its relatively intact survival allows researchers and other people to look at, walk through and closely examine the huge dredge and its equipment, giving a very good understanding of the operational details, operating conditions, undocumented alterations, and its sheer scale – supplementing the documentary records and giving a much better understanding than documentary records alone can convey.

4.5 Social Significance:

The Eldorado Dredge is the best representative in Australia of the efficient bucket dredging process which revived and extended alluvial gold and tin mining, contributed significantly to the prosperity of many mining communities and states, and extended the viability of many gold or tin-based townships and communities.

The Eldorado Dredge demonstrates typical cramped, uncomfortable, dangerous and dirty industrial/mining working conditions of the 1930s, ‘40s and ‘50s in Australia. Those same conditions would not be tolerated today, and are rarely still so visible anywhere in Australia today.

The Eldorado Dredge operated 24 hours per day, and made a lot of noise which has left a still-lasting legacy in the collective memory of Eldorado township residents, who recall having trouble getting to sleep at night due to the loud noise, or waking up wondering what had gone wrong if the noise stopped. This reflects the similar effects of many other tin or gold dredges working near other towns, eg the Tronoh Dredge near Harrietville.

The Eldorado Dredge is representative of the huge industrial scale of the later gold-dredging phase of gold mining (or tin mining), when mining by individual miners gave way to mining companies that spent large amounts of capital on massive machines, and employed large numbers of people to operate them.

The Eldorado Dredge (and more extremely the Tronoh Dredge, if it was still in Australia) is representative of the era (perhaps still with us) when extensive environmental damage was accepted if it led to financial rewards, or at least gave the prospect of such rewards.

The Eldorado Dredge has become a major local landmark, and the public icon of alluvial gold mining in Victoria.

4.6 Rarity:

There have been perhaps 100 small bucket dredges and two or three dozen larger bucket dredges mining alluvial gold and/or tin in Australia at some time during the 19th and 20th Centuries. The Eldorado Dredge is the only large historical gold and/or tin dredge still surviving in Australia virtually intact. The other surviving bucket dredges in Australia are all smaller and are much less intact, or are in ruinous condition.

4.7 Representativeness:

The Eldorado Dredge is the best and almost only surviving representative of the large alluvial gold and tin dredges that operated in Australia in the 20th century, contributing significantly to their local, state or national economies.

4.8 Integrity/Intactness:

The Eldorado Dredge underwent some relatively minor modifications during its working life, for operational reasons. The most notable changes include: several changes to the design and metallurgy of the buckets; an increase in the power of the bucket-drive motor from 200hp to 320hp; the addition of some extra onboard gold-separating jigs; and, the addition of an extra gravel-disposal chute to allow non-gold-bearing gravel to bypass the separating jigs.

The dredge has also suffered some damage due to vandalism, theft or corrosion since the end of its working life - particularly corrosion of its mooring cables and corrosion of the pontoon, causing the dredge to settle onto the gravel bed in its pond and partially submerging the deck-mounted machinery. It has also suffered theft of some corrugated iron cladding (since replaced), theft or smashing of electrical instruments and electrical wiring, theft of nearly all the flat leather or rubber power transmission belts, and theft of the deck manhole covers.

However, the Eldorado Dredge is by far the most intact gold and/or tin mining bucket-dredge surviving in Australia, and it has a very high degree of integrity as to its real-life working configuration in its final working years.

5 Statement of Significance:

The Eldorado Dredge, at Eldorado, Victoria, is of national significance to Australia, and to Engineers Australia, for the following reasons:

The Eldorado Dredge is now the largest surviving bucket dredge in Australia. At the time it was built, the (Cock's) Eldorado Dredge was said to be the largest bucket dredge in the southern hemisphere. Within Victoria, and probably within Australia, it was surpassed in size only by the later Harrietville (Tronoh) Dredge, but the Tronoh dredge was less successful here and was long ago removed to Malaysia to dredge for tin.

The Eldorado Dredge is also by far the most intact bucket dredge surviving in Australia. Apart from relatively minor damage due to corrosion or vandalism, it faithfully displays its structure and operating machinery virtually as was in 1954, at the end of its working life 60 years ago. (The few other bucket dredges still surviving in Australia are smaller and have lost much if not all of their superstructure and/or their buckets and operating machinery.)

The Eldorado Dredge was designed by prominent and well respected mining engineer Douglas Percy Fletcher, Fellow of the Mining & Metallurgical Institute of Australia.

The Eldorado Dredge was built by the famous Thompson’s Engineering and Pipe Co. Ltd., of Castlemaine & Williamstown, Victoria. Thompsons is itself historically significant as one of Australia’s longest established and most important manufacturers of heavy engineering equipment, mining machinery, pumps etc. Following the 1930s resurgence of gold mining, Thompsons built about a dozen large all-steel dredges, and was probably the most prolific Australian maker of bucket dredges at that time.

The Eldorado Dredge is further significant as being (reputedly) the first of the large 1930s/1940s bucket dredges, and was claimed to be the first large Australian bucket dredge to be assembled with predominantly Australian equipment and materials rather than imported ones.

The Eldorado Dredge dramatically represents the bucket-style dredging technique, which was the last and most efficient technological phase of alluvial gold mining (after hand-panning, sluicing, and deep lead mining), and which also was widely used for mining alluvial tin (ie non-metallic tin oxide aka cassiterite, looking like black sand). Bucket dredges of the same basic design (although mostly smaller) were widely used in Australia to recover alluvial gold or alluvial tin. The Eldorado Dredge recovered both gold and tin, so is representative of both modes of use.

The Eldorado Dredge was one of the most successful gold dredges to operate in Victoria, and was in its day the most significant producer of tin ore in Victoria.

The Eldorado Dredge is probably the largest and most accessible above-ground relic of historical gold mining of any sort anywhere in Australia.

The Eldorado Dredge has scientific significance as the only surviving dredge in Australia still in intact working configuration, giving researchers and others a better understanding of the design and the real operating conditions of bucket dredges than can be obtained from documents alone. It provides the only intact physical evidence of the technology involved in constructing, operating and manoeuvring a bucket dredge, and in separating and recovering alluvial gold and tin onboard the dredge on an industrial scale. It is also a good example of 1930s industrial power transmission technology (except that most of the flat drive belts between pulleys have been stolen - but their former function is still obvious).

The historical and scientific significance of the Eldorado Dredge is enhanced by the existing good documentary, photographic and oral history records of the construction and operation of the dredge, and by the possibility that further documentary, photographic, and oral evidence might still be found.

6 Area of Significance:

The Eldorado Dredge is of **National Significance** (as well as State and Local Significance).

7 Interpretation Plan

7.1 General Approach

The interpretation Plan will be carried out in accordance with the 2012 edition of the Guide to the Heritage Recognition Program which can be found on the EHA web site at www.engineeringheritage.com.au . This will consist of interpretation developed in liaison with the owner (Parks Victoria) and the Heritage Recognition Committee. The interpretation will be unveiled at a public ceremony, probably in October 2015.

Parks Victoria who own the Eldorado Gold Dredge site have not yet been contacted formally, however we would seek their co-operation for the following:

* Discuss suitable interpretation with Engineering Heritage Victoria.
* Agree to the placing of a marker and interpretation panel within their Eldorado Gold Dredge site.
* Agree to the conduct of an unveiling ceremony for the Heritage Recognition at their site. The proposed date for the ceremony is Sunday 11October 2015 in the morning, in association with the Regional Heritage Weekend.

Parks Victoria have already erected an excellent set of interpretation panels on site, although the panels have faded over the years and need to be renewed. Due to the existing comprehensive Parks Victoria interpretation panels, it is anticipated that the appropriate EHA interpretation in this instance will be most likely a “mini-panel” as used elsewhere where appropriate interpretation by the owner is already in place. This could be a panel in the vicinity of 400 mm wide x say 800 mm high formed of digital printing on vinyl film on an aluminium substrate. The panel would incorporate a representation of the award disc presented - which is likely to be an Engineering Heritage Marker or Engineering Heritage National Marker, subject to the decision of the national Heritage Recognition Committee.

7.2 General Attributes of the Interpretation Panel:

1) A title “**Eldorado Gold Dredge**”
2) A sub title: (to be developed)
3) Logos of Engineers Australia and Victorian Government and Parks Victoria to be incorporated.
4) A representation of the EHA marker plate
5) The date and other details of the marking ceremony.
6) Text should be 24 point Arial Bold
7) Maximum text should be 200 words
8) One photograph to be selected
9) Referral to nearby Parks Victoria interpretation panels for more information.

7.3 The Interpretation Panel:

1) Size to be nominally 400 mm wide by 800 mm high.
2) The panel to be constructed of vitreous enamel-on-steel plate or vinyl film-on-aluminium with flanges.
3) The panel to be mounted to match Parks Victoria requirements. This could be a timber frame or a steel frame.
4) The detailed location is to be negotiated with Parks Victoria. [Suggest just beyond the guard fence along the south bank of the pond, west of the access walkway, located so that the reader can also see the dredge.]

7.4 Preliminary Text Block for Interpretation Panel

Is a photo needed? The actual dredge will be in view directly behind the panel.

Text to be developed. A draft of the proposed text follows, at about 200 words.

ELDORADO GOLD DREDGE

This is the largest and most intact bucket-style dredge still surviving in Australia.

(There were many smaller Australian dredges mining gold and/or tin, but only a few survive – mostly in ruins. The Tronoh Dredge at Harrietville was larger, but was moved to Malaysia.)

The Eldorado Dredge was designed by Mining Engineer Douglas Fletcher in 1934, and was built by Thompson's Engineering and Pipe Co. Ltd., Castlemaine & Williamstown, in 1935-36. The dredge worked along Reedy Creek from 1936 to 1954, recovering alluvial gold and tin. It started north-east of Eldorado township and ended work here. The pontoon (hull) now leaks and sits on a gravel bed, leaving the bow end and part of the deck submerged.

The Eldorado Dredge is recognised by the Institution of Engineers, Australia, as being an engineering work of National Heritage Significance. The recognition plaque was unveiled on 11th October 2015. The significance of the dredge has also been recognised separately by the Australian Heritage Commission, by Heritage Victoria, by the Rural City of Wangaratta, and by National Trust of Australia (Victoria).

This dredge is now under care of Parks Victoria. For a more detailed history and description of the dredge, see the nearby Parks Victoria information panels.

8 References:

Angus, Colin; *Mining at Eldorado*, (pub. North-Eastern Historical Society, 1968).

An illustrated pamphlet with a brief text and an excellent collection of archival photographs, mostly from the N.E. Historical Society's files.

Barbour, Alex; *Dredge No.4, An Industrial Archeology Project*, (sic)

A paper presented to the (American) Society for Industrial Archeology (sic) 23rd Annual Conference, June 1994, held at Toronto, Ontario. An abstract was published in the *SIA Newsletter, Vol.22 No.4, Winter 1993.* The paper gives an account of Parks Canada's recovery and display of a large wooden-hulled bucket dredge in amazingly intact condition after spending years submerged in semi-frozen mud.

Chronicle, The; *As dredge sinks into the past*, The (Wangaratta) Chronicle newspaper, Monday 15 July 1985, pages 18-19.

Newspaper article written after the dredge partially sank at the bow end.

Cocks Eldorado Gold Dredging No Liability (company); *Prospectus, Mine Superintendent's Annual Reports*, etc., 1934 to 1954. (Melb. Uni. Archives)

A file held in Box 63 of the "Stock Exchange of Melbourne Collection" in the University of Melbourne Archives. This file contains the company's Annual Reports, including the Mine Superintendent's Annual Reports for the whole working life of the dredge.

Dept of Energy and Minerals (formerly Dept of Mines); *Annual Reports* for period c1935 to c1955.

Dickinson, D.R.; Editorial Article - *Gold Dredging in Victoria*, pub. Mining & Geological Journal, January 1939, pp. 13-20.

This article appears to have been written expressly to refute those who maintained that bucket dredging activities destroyed good agricultural land. The author argues "..... that poor land can frequently be improved by dredging ....", a polemic which would be refuted by history. It does have about a page of text on the operation of the Eldorado Dredge. (See copy here in Appendix D.)

Doring, C & MJ Pty Ltd; *Cocks Eldorado Dredge - Conservation Study and Management Strategy*. Report to the Historic Places Section, Department of Conservation and Natural Resources, Victoria, 1994.

Unpublished report including a timeline history of the dredge and a fairly detailed description and photographs of the dredge, as seen in 1994. Includes a discussion of conservation options, and photocopies of several of the references quoted here.

Eldorado Dredge Preservation Committee; *Submission to Historic Buildings Preservation Council,* 2nd May 1978, 6pp.

The Preservation Committee had representatives from the City & Shire of Wangaratta, the North-east Victoria Regional Tourist Authority, the Wangaratta Association for Tourism, and the North-East Branch of the National Trust of Victoria. The purpose of this report was to suggest that the idle dredge should be developed as a tourist attraction by the owners, and failing any action by the company, that the government should purchase the dredge and assist a local committee to operate it as a tourist attraction. The proposal includes some figures on the cost of operating the dredge thus, some strong representations on the historical importance of the dredge (if left in situ) and the impracticality of moving it.

Eldorado Historical Society; Collection of photographs, papers and publications held at Eldorado Museum, 136 Main Road, Eldorado, Victoria.

Fletcher, D.P. & O'Malley, G.B.: *Cocks Eldorado Dredge*, (pub. Chemical Engineering and Mining Review, July 1936).

Extensive article on the then new Cocks Eldorado Dredge, by the designer and Consulting Engineer to the mining company (Fletcher), and by the Senior Lecturer in Mining & Metallurgy at Melbourne University (O'Malley). (See copy in Appendix A here.)

Greene, Ken; *Eldorado's Golden Ship*, 17 PP., pub. Ken Greene, Eldorado, 1990.

A 17 page booklet, written and published by the keeper of The Greene Collection in Eldorado. It contains accounts of the tasks and processes on the dredge, a good diagram of the dredge, a plan of its route along the valley, and a list of the people who worked on it.

Historic Buildings Council of Victoria (aka HBC, now Heritage Victoria); Files 603522(L), 603523(E) & 603524(7), being Parts 1, 2 & 3 of the HBC file on the Eldorado Gold Dredge.

Historic Buildings Council of Victoria (now Heritage Victoria): *Recommendation to the Minister for Planning ... for addition of The Eldorado Dredge ... to the Register of Historic Buildings*, 19th Dec 1975. unpub..

This report recommends the Cocks Eldorado Dredge for inclusion in the (Victorian) Register of Historic Buildings. Registration was approved 20th January 1976, as entry No.360A.

Land Conservation Council, Victoria; *North-Eastern Area (Benalla - Upper Murray) Review*, January 1986.

This document gives recommendations for the management of various historic areas and reserves in north-east Victoria, including a number of former gold mining areas - eg. the Wallaby and Rechabite quartz gold mines, Cocks Pioneer "open-cut" (sluiced) alluvial gold mine cliffs and ponds, and the Cocks Eldorado dredge site.

Le Dawn Studios: *Photographs of the Eldorado Dredge,* July/August 1975.

About 48 photographs taken by commercial photographers Le Dawn Studios, Wangaratta, for the Historic Buildings Council (HBC). Some prints were attached to the HBC report of 19th December 1975 (see above).

McSweeney, C.L., *Description & Condition of the "Cocks Eldorado Dredge",* report for Griffin, McSweeney & Co. 30th November 1973.

An internal report on the condition of the dredge. It appears to be primarily concerned with the logistics and cost of dismantling the dredge, and the possibility of using parts of it in some other mining venture.

Milner, P.; *Memos and Reports to the Department of Conservation & Natural Resources.* A series of four papers numbered MILN-1 to MILN-4, and dated as follows:
MILN-1 = 31st May 1989;
MILN-2 = December 1989; (aka Technology Note No. TN-89/61)
MILN-3 = 12th April 1990; and
MILN-4 = May 1990; (aka Technology Note No. TN-90/2)

The papers describe the condition of the dredge in some detail, as revealed by close inspection of the dredge, and discuss two unsuccessful attempts to refloat it.

National Trust of Australia (Victoria); File No.3380, *Industrial History - Eldorado Dredge.*

National Trust of Australia (Victoria); *Submission to the Historic Buildings Council in Relation to an Application to Remove the Eldorado Dredge Interstate,* (18th February 1978) 11 pp.

Parks Canada; *Gold Dredges,* two-page pamphlet issued c1985.

A brief history of gold dredging in Canada, plus an account of the large wooden-hulled Yukon Consolidated Gold Corporation Gold Dredge No.4, submerged for years and now raised and parked (not floated) as an historical monument. See also SIA Conference paper by Alex Barbour, 1994.

Ralph, Gilbert M.; *Gold Dredging in Central Victoria*, conference paper published in *9th National Conference on Engineering Heritage: Proceedings,* Melbourne, Vic, Martin, Ray L. (Editor), Institution of Engineers, Australia, Victoria Division, 1998.

Sheppard, Dudley; *Possible Acquisition of Cocks Eldorado Dredge by Tourist and Preservation Interests,* Nov.1974, 3pp.

Sheppard, Dudley; *Eldorado of the Ovens Goldfields*, 1982, pub. Research Publications P/L, Blackburn, Victoria. About 150 pages.

Solomon Corrosion Control Services Pty Ltd; *Eldorado Dredge Corrosion Protection Assessment,* Unpublished report for Parks Victoria, 1994

Strahan, Frank; *The Eldorado Dredge*, 2nd May 1978, 2pp.

A report to an Historic Buildings Council Hearing, by the University Archivist.

Swift, D.G.; *The Story of Eldorado*, pub. Mining & Geological Journal, January 1938.

A brief history of gold mining at Eldorado illustrated with two photographs; one of sluicing, and one of the great dredge reflected in its pond. (See copy in Appendix C.)

Thompsons Engineering & Pipe Co. Ltd., Castlemaine & Williamstown, Victoria. *Construction Drawings Series W892.* Drawings held at Latrobe Library Picture Collection, Access No.LTAD-77

Vincent, F.W.; *The New Harrietville Dredge*, Mining & Geological Journal, March 1942.

An informative paper about the Tronoh Dredge, similar in content to the paper about the Eldorado Dredge written by Fletcher & O'Malley in 1935.

Watson, J.C.; *Cocks Eldorado Gold Dredging Treatment Plant*, 6 pp.

An autographed carbon-copy of a typescript dated 2nd December 1937, held by Department of Energy and Minerals in 1994.

The report is addressed from the State Laboratories, Gisborne St., Melbourne, and signed by J.C. Watson, Chemist & Assayer. It contains some background history of the district and discussion of the dredge, but is mainly a description of the gold extraction machinery and processes. It also gives some figures of gold and tin concentrates recovered per cubic yard of gravel treated.

Watson, J.C.; *The Treatment Plant of Cock's Eldorado Dredge*, pub. Mining & Geological Journal, January 1938, pp. 24-25.

A short technical paper published 1938, containing much of the text from the above 1937 Watson reference, but omitting the historical notes and chatty bits. (See Appendix B.)

Woods, Carole; *Beechworth, A Titan's Field*, pub. Hargreen Publishing Co., 1985.

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