PIONEERING SINCE 1919

CLOUGH

THE CLOUGH STORY

100

1919 - 2019

CELEBRATING A
CENTURY OF CLOUGH

100

1919 - 2019

THE CLOUGH STORY

1919 - 2019

CONTENTS

FOREWORD

Clough is not only one of the nation's leading engineering and construction firms, but a genuine West Australian success story. Its 100-year history is inseparable from the growth and development of our great state.

Founded in 1919 by John Oswald Clough as a construction company, building quality homes, schools and commercial properties, John's son Harold eventually joined the company in 1954, following which the company would experience an amazing expansion.

From the construction of Perth's first high rise in 1955, the Narrows Bridge in 1957, the Barrow Island Oilfield development in 1965, Stirling Bridge in 1972, the Graham Farmer Tunnel in 1996, not to mention it's work on the across minerals, iron ore and LNG industries, it's easy to see how Clough has helped shape the face of modern Western Australia.

Clough should also be commended for its successful international expansions and operations, showing what Western Australians can do on the world stage.

Through their scholarships and internships, Clough has played a pivotal role in ensuring Australian engineering remains at the highest standards and our young West Australians have the skills they need to excel in the workforce.

The company and Harold Clough, have built a lasting a vital legacy for our state and Australia. Now part of the Murray & Roberts group, I am sure Clough will continue to play an important role in the economic development of the country, our state and its people.

I congratulate Clough on its 100th anniversary and hope the next 100 years are just as successful.

— Mark McGowan MLA
PREMIER

INTRODUCTION

Celebrating 100 years is a major milestone in anyone's language, and I can't help but feel especially proud of this Western Australian founded company for reaching this anniversary with so much still to achieve, and with the same pioneering disposition that defined its inception and paved the way for its early expansion.

It's said that the average life expectancy of a company today is less than 20 years, and for a Western Australian based EPC firm to be celebrating 100 years is nothing short of remarkable and a testament to Clough's founders and those who have worked in the company. It is no coincidence, nor the result of good fortune or a stroke of luck that has brought Clough to its centenary. It is the result of hard work, perseverance, adaptability, resilience, and countless people the world over, believing in the company's capabilities as well as their own.

As I reflect on all the company has achieved in business, across its multiple industries and markets, and its commitments to the community, I remain excited about all that will be accomplished in this next chapter of Clough as we embark on the next 100 years journey.

It is truly a privilege and honour to be leading Clough during this significant 100 year anniversary, and I welcome you to join me in Celebrating a Century of Clough.

— Peter Bennett, CEO & MD

HISTORY OVERVIEW

The early years

In 1919, a humble building company called Clough Brothers was formed in Perth, Western Australia, named after its two founders, brothers, John (more popularly known as Jack) and Bill Clough.

When they were just young boys around the year 1900, Jack and Bill arrived in Perth with their little sister and parents, William and Phoebe Clough. William was keen to try his luck in the Kalgoorlie gold fields after an unsuccessful attempt to establish a gold mine near the Dark River (later named Dart River) in the northeast mountains of Victoria, about 40 kilometres west of Mount Kosciusko in New South Wales.

Soon after the family arrived in Perth, sadly, William passed away. Typical of self-sacrificing young men of their generation, to help support their family, Jack and Bill left school and became apprentices: Jack, a bricklayer and Bill, a carpenter. Jack often found jobs by waiting at Claremont Station where trains from Midland Junction delivered loads of bricks and following the horse-drawn drays to building sites to ask for work.

When the First World War began on 28 July, 1914, Jack was quick to enlist in the army. He was sent to camp at Blackboy Hill outside Midland Junction and trained on No.4 gun. At the end of October, he embarked at Fremantle and left for Egypt. After some months training at Mena Camp outside Cairo, he joined thousands of other ANZACs in the landing at Gallipoli on 25 April, and remained with his battery at the Dardanelles for the next eight months until the allies were withdrawn on 19 December 1915.

Like many others, Jack was then sent to the Western Front with the 1st Australian Division fighting in Pozières, Ypres and Flers. He was injured for a third time in the Battle of the Somme in 1917 and awarded the Distinguished Conduct Medal. While recovering, he was commissioned and ended up a Lieutenant before returning to the front for most of 1918, when gunshot wounds to his arm and knee invalided him home.

Shortly after he returned home, Jack - along with his brother, Bill - formed Clough Brothers. Clough Brothers built homes and undertook other small building jobs around Perth throughout the 1920s. In February of 1922, Jack married his love, Lucy Hayes, and just over a year later, in April 1923, the couple welcomed their first child, Joan. They had two more children together, Harold in September 1926, and then Judy in 1931.

The Great Depression swept across economies worldwide in the early 1930s, and as a result, there was very little building work to be had for the brothers. To get through the time, Bill moved to Marble Loch to try his hand at gold mining, while Jack joined the militia. When World War II broke out on 3 September 1939, Jack joined the 3rd Field Brigade of the local militia, stationed at Karrakatta. He was soon promoted to Lieutenant Colonel and commanded the 2nd/3rd Field Regiment.

J O Clough (right)

During the depression his mother warned him "never be a contractor, it's the worst sort of business you can get in to. Get a good steady job at a bank or an insurance company." Neither brother heeded her advice.

During this time, Jack's son, Harold, attended Nedlands Primary School and Claremont Central School before completing a year at Scotch College. Harold wanted to follow in his father's footsteps by joining the army so he applied to the Duntroon Military Academy, but he was rejected because he was too young, so instead he took a job as junior clerk at AMP. After incorrectly writing out an overdue premium and being told he was "the dumbest clerk that had ever worked at AMP," Harold decided that he didn't want to spend his life behind a desk.

William Sommerville, a friend of Harold's father and then a leading member of the senate encouraged Harold to apply to study engineering at the University of Western Australia. None of his family had ever attended university, and he felt like an unusual option but the prospects of being a permanent soldier in peacetime wasn't as attractive as being an engineer.

Harold felt that his opportunities were running out when his application was rejected because the quota of 40 students had been reached and he wasn't one of them. A week before the first term started, Harold received a call to meet with the Dean of Engineering, who informed him that some late withdrawals meant there was now a place available for him in the course. Harold recounts:

'Well, Clough,' the Dean said, 'You're 40th of the list of 40. There's no way you'll ever get through.' That was enough of a challenge to motivate Harold.

After three years studying civil engineering, Harold decided to switch disciplines and study mechanical engineering; he graduated with first class honours. Harold was required to undertake internships as part of the course, and he was lucky enough to gain experience with Tomlinsons, the biggest engineering company in Perth, Western Australia at the time. He also worked for a surveyor from Albany, surveying the country between Moora and the coast. As Harold recounts:

'The surveyor I worked for was a tough cookie. He used to carry his theodolite over his shoulder in one hand and his chain in the other and I was his chainman and spike man. So, I used to carry a bag of steel spikes and a hammer and the chain, which would have been about 60 feet long.

'He used to walk all day at a hundred miles an hour. Gosh he was fit. And I thought I was pretty fit at the time. Each night we used to stop and cook our dinner because we used to camp out.'

Harold then worked at Co-operative Bulk Handling (CBH) for two years. The best thing about CBH for Harold was that it was associated with Wesfarmers who had the agency for Nash cars and he had the opportunity to buy his bosses' car, a big Nash. In 1949, Harold took off to drive across Australia in his car with Peter Wright, who later became a distinguished Australian mining entrepreneur and business partner of Lang Hancock.

Later, Harold worked as a consultant for W D Scott, one of the largest management consultancy firms in Australia, which was rolling out its Method Time Management technique across the country. However, it was only a short stint of work, as Harold was awarded a Fulbright Scholarship to study at the University of California, Berkeley. Before finishing his studies, Harold met Margaret McRae, the daughter of an Australian official, in the Australian Consul General's Office in San Francisco.

He completed his Masters of Science in Industrial Engineering in 1952, and landed a job with Bechtel Corporation, one of the largest engineering companies in the United States. As Harold recalls:

Harold Clough, circa 1950

'As a young engineer I was gung-ho. I wanted to get out onsite and build things, but Bechtel had a completely different idea. They put me in their estimating department where I sat at a desk all day estimating the cost of projects all over the world for which they were tendering. In hindsight it was the best training I could have ever had because Bechtel had great systems and knowing your costs is the single most important thing as a contractor' [1]

After a year of estimating, Harold was sent to the Shell Oil Refinery project in Wilmington, south of Los Angeles, as their cost engineer.[2] Shortly afterwards, he decided that he wanted to return to Perth to join his father in the Clough Brothers business, but before coming home, he and Margaret got married. They returned to Perth full of hopes but with no money. The return proved to be quite a culture shock for Harold; after working for one of the biggest engineering companies in the world, he was now working in his father's small business.

Construction of the National Mutual Building

Clough House

Working in the family business

With the Perth economy growing after the war, Clough Brothers moved into building small factories, office buildings, shops, and service stations for BP. The business had just three employees: Dudley Atwell; Jack who did the estimating; and Bill Hayes, a long-time friend and his wife's brother, who kept the books. Harold recalled joining Clough Brothers, saying his father set him to work as a builder's labourer. "Right, there's a concrete mixer and there's a shovel, so shovel stuff from here to there," his father would say.

'I'd come back all fired up, thinking I was a bright engineer from America going to set the world on fire. I was a builder's labourer for 18 months. You learn a lot about shovelling sand and aggregate and cement,' Harold said. [3]

Harold and his father had quite a difficult working relationship, so Harold had decided he wanted to leave the business and return to the United States. But, against the odds, Clough Brothers won the tender to build the first major office building in Perth since the beginning of the Second World War, and Perth's first high-rise, the National Mutual Building. At first glance, the small firm of Clough Brothers seemed to have had no chance of winning the contract. With just one or two tradesmen working with them, the largest contract they had completed at that time was a £25,000 service station. The National Mutual Building contract was for a 12-storey office tower valued at £500,000.

Jack Clough, had developed a close bond with a man called Athol Hobbs who served as the Commanding Officer in the 3rd Field Regiment with Jack in the First World War. After WWI, Hobbs was part of the architecture firm Hobbs, Winning & Leighton. It was Hobbs who put Clough Brothers in the bidding list alongside much bigger contractors.

Winning the National Mutual building bid

Harold recalls the whole process in vivid detail:

'Tenders closed at midday on a Monday and so my father and I worked the whole weekend completing our tender. My father declared that he'd very much like to win and that we should take £20,000 off the price. I protested that that was all our profit and made the tender far too risky, and persuaded him to delay a decision to the next morning.

'Next morning my job was to fill in the Bill of Quantities, which was a 100-page document with the detailed cost of everything involved, a painstaking task.

'At that time, we had no office and worked in a room on our back veranda, and about 9 o'clock my father was leaving and called in to see how I was going. I asked him if he still wanted to take £20,000 pounds off. He said no, he'd changed his mind; he wanted to add £10,000 pounds on. I said "You can't do that; take £20,000 off last night and add £10,000 on this morning. It's not a way to prepare a tender." He replied, "Make up your own mind" and took off.

'I completed the Bill of Quantities down to the last line where I could make an adjustment either way. I remember thinking, "God, what the hell am I going to do?"

'Then I did the smartest thing I've done in my career. I went and asked my wife what I should do. Having no knowledge whatsoever what it was all about, but as the Scots say, "She's very fey", she said to add £5,000 on. So that's what I did.

'At precisely midday, the tender box was opened, and the tender prices were read out. Our price of £488,000 was the second last to be read out and was £2,000 lower than the lowest tender price so far.

National Mutual Building

Harold Clough at the construction of the Narrows Bridge

'The last price read out was also higher, and so we were the lowest price by £2,000. My father couldn't believe it.'

'National Mutual agreed to award us the contract on the proviso that I worked full-time on it, which I did, and this meant our plans to return to America became history.'

Harold had one proviso of his own, that he control the chequebook, and that the business incorporate. From then, Clough Brothers became J O Clough & Son Pty Ltd. [4]

The National Mutual contract was a game changer for the company; from three employees, it grew to employ between 50 and 100 people.

Beginning of a New Era – J O Clough & Son Pty Ltd

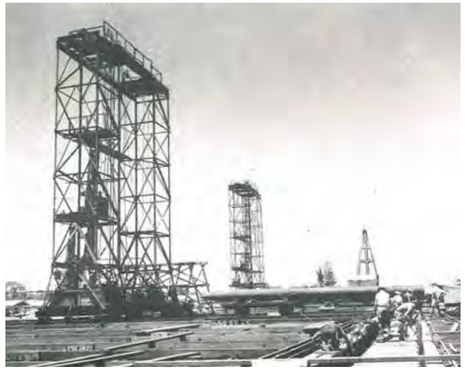
Throughout the 1950s and 1960s, Clough employed its own carpenters, bricklayers and plasterers rather than subcontracting them. The real challenge for the company began soon after; Harold had to find new projects so he could keep his expanded workforce employed.

Bridges to Civilisation

In 1957, the Department of Main Roads invited tenders for the Narrows Bridge, and one of the pre-qualification conditions was that the builder had to have built a bridge of similar magnitude. That eliminated almost all the contractors in Australia, including Clough. In what was to become a Harold Clough hallmark, he thought *"what I need to do is find an international partner who knows something about bridges and form a joint venture."*[5] Harold didn't know any international bridge builders, so he found a copy of the UK Civil Engineers Journal, picked out a dozen companies and wrote to them. Several companies responded, including a Danish company, Christiani & Nielsen.

Christiani & Nielsen sent one of their Directors, Knud H. Sorensen, out and he and Harold spent weeks working on the estimate for the bid in the back room of his accountant's office, as he didn't have his own.

'I found this fellow fascinating because we worked during the day and I'd leave him, and overnight he'd come up with a complete scheme of how we were going to build this thing. He was very smart, knowledgeable, very experienced, and completely confident in his own ability. He devised a completely new method to build the bridge, completely contrary to what the consultants had recommended. I learnt a lot from him.' [6]



Construction of the Narrows Bridge

The Narrows Bridge

Uffe Hansen, also from Christiani & Nielsen, joined the team in Perth, and recalls that the *'tender was finalised by Knud and Harold on the dining room table of Harold's house in Stanley Street, Nedlands, with babies crawling around on the floor.'* [7]

It was a huge leap for the small company, but Harold was up for the challenge and had a creative-entrepreneurial flair, working for the first time in a joint venture and shifting to strong in-house engineering, which continues to be a Clough strength today.

'We had a 20 per cent interest in the joint venture simply because we didn't have enough money to put up to subscribe to it. But it was the start of our company as an engineering company as distinct from a building company, and as the government started letting more contracts out we were seen as a capable and reliable contractor.' [8]

Against a strong local competitor and several other foreign bidders, J O Clough won the contract. The bridge was the first major infrastructure project undertaken in Perth after World War II, so the announcement of the winning tender was front-page news.[9] It was also a landmark in Western Australian history, because prior to that, all the engineering work for bridges, ports, power stations and roads had been carried out by what was then known as the Public Works Department.

At £1.5 million, it was by far the largest project J O Clough had taken on. It also involved a new construction method that was a complete break from the approach the consultants had recommended. While there were issues concerning some of the foundations underneath the water table, the Narrows Bridge was completed on time and within budget, and opened on 13 November 1959.

Sadly, Jack Clough passed away just three months before it was finished, but Harold and others recall 'he got a great charge out of the National Mutual contract and the Narrows Bridge contract.'

The Narrows Bridge was the finest of three metropolitan bridges of increasing scale built over 30 years but for many people at Clough, the Narrows was the event of a lifetime. Uffe Hansen remembers it as his "happiest job" particularly as the bridge, for his children, has always been known as "Daddy's bridge."

Several engineers, including Alf Taylor, Bob Walker, Albert Scott, Don Young, Peter Knight, Geoff Smith, John Mulheron, Ed Wells, Bob Browning, John Bromell, and Alan Moyle, who joined the company during the 1960s and early 70s, remained for over 20-30 years. Other long term 'Cloughies' include Jim Calder, Laurie Herbert, Bill Romaro, Geoff Spooner and Trevor Barry. Each of these individuals played significant roles in the making of modern Clough, with roles ranging from Engineering Manager, to Managing Director, and CEO. [10]

With the completion of the Narrows Bridge, Harold was focused on securing the next wave of projects for the company. He now had hundreds of people on the payroll, whom he needed and wanted to keep together. As former Clough Engineering Chairman, Albert Scott recalls:

'One of the reasons we moved into engineering was to try and keep the good people we had employed.' [11]

Ord River Dam Diversion

Muja Power Station

Building our early engineering capability

After the Narrows Bridge, Clough continued a base load of work in key infrastructure projects including the Kwinana Freeway overpass and Mitchell Freeway Stage 1 central section including the Parliament house cutting and bridges in 1966, followed by the Stirling Bridge in Fremantle in 1972 and Mt Henry Bridge in Mt Pleasant in 1982.

The company undertook a range of little jetties and boat anchorages, 'anything to keep their team employed'. It was also 'useful' that the 'forest of jarrah piles' used on the Narrows Bridge construction could be recycled. They ended up in many buildings around Perth, including the Royal Perth Yacht Club and the jetties at Dongara and Jurien Bay.

In the early 1960s, the company secured a number of major projects including the Ord River Diversion Dam in a joint venture with Christiani & Nielson, the USN Communications Station (the Harold E Holt Base) near Exmouth in West Australia in a joint venture with Koppers, and several sections of the Standard Gauge Railway.

The Ord River Diversion Dam continued Clough's joint venture arrangement with Christiani & Nielson and commencement of a three year project (1960 – 1963), in challenging conditions. The remoteness of the location, limited communications, seasonal climatic conditions and sudden river flows together with all construction materials except concrete aggregate being shipped into site contributed to project complexity.

A critical project for the company was the Muja Power Station located in Collie, Western Australia, both for its £3.5 million contract value, and because it was a four-year contract that underpinned the security of the workforce for that period.

Another game-changing project was the design and construction of the Mt Newman Power Station, the first multidisciplinary venture the company had undertaken. This involved the design of the civil, structural, electrical and mechanical parts of the station with Clough the prime contractor working with Sandovers.

The Millstream-to-Dampier pipeline was also an important project at a time when work was limited, as well as an example of Clough's innovative thinking as they had to build it from a longstanding Public Works Department (PWD) design. Soon after, Hamersley Iron invited tenders to build a pipeline to support additional water to the town of Tom Price and gave tenderers the option of using the PWD design or an alternative using steel supports. Clough chose the latter and perfected a prototype, which provided faster, cheaper construction that would be used in later pipeline projects. [12]

Parker Point Iron Ore Wharf Upgrade

The early days of iron ore projects

Australia's iron ore and oil and gas projects have dominated our export revenues over the past 40 years so much so that it's hard for most people to remember a time when neither were part of the Australian economy. However, up until the late 1960s, this was the case.

In 1938, Prime Minister Joseph Lyons placed restrictions on the export of iron ore on the basis that 'iron ore resources of the country were so limited as to compel their conservation.' [13]

The export of iron ore was restricted for the next 22 years. In 1958, the West Australian government continued to lobby for the lifting of restrictions.

The embargo was partially lifted in 1960 with a staged relaxation through to 1966.

Throughout the 1960s and 70s, Clough worked closely with Lang Hancock and Peter Wright through their company Hancock & Wright, conducting multiple feasibility studies and preliminary design work for loading and unloading facilities, ports, and jetties along the coast of Western Australia. They also undertook feasibility studies for the Hamersley Group, Cliffs Robe River Iron Associates, Texasgulf and the Western Australian Government for the Pilbara Study Group. [14]

Much of this work centred around Depuch, Dixon, Wight, Legendre and Delambre Islands off the Burrup Peninsula and up the coast to Port Hedland as part of the early investigative work to develop the Pilbara iron ore deposits discovered by Lang Hancock, Peter Wright and others. Being involved in various studies and evaluations for Hancock & Wright, including tidal evaluation, shipping movements, ports, railways and water requirements, meant Clough was an important part of the early development of Western Australia's iron ore industry.

The Parker Point jetty for Hamersley Iron, owned by Conzinc Rio Tinto, was a large project for the company. Hamersley Iron had contracted with the Royal Netherlands Harbourworks Company of Holland to negotiate a contract to design the Parker Point wharf as well as to submit a tender for the construction. Harbourworks director Johannes Wesselingh came out to Perth to look for a local partner and was referred to Harold Clough. When he asked what experience Clough had in building jetties, Harold proudly showed him the drawings he had done for the Shark Bay Salt jetty. *'That's precisely the type of construction that we'll be building at Parker Point on the Dampier Archipelago,' Wesselingh responded.*

Cape Lambert Iron Ore Marine Facility

Clough at that time, however, was busy with several projects, and Harold decided the company couldn't join them to bid but offered room in the Clough offices and assistance with any information and local insight needed to work out the tender. Several months later, Wesselingh called Harold to say they had won the tender and were keen to work with Clough. The Harbourworks Clough joint venture, a partnership that continues to this day as BAM Clough, was formed to build the Parker Point jetty on the Dampier Archipelago. [15]

An innovative design solution was developed for the jetty: a 'matchstick' structure for vessels up to 80,000 dead weight tonnage (DWT).

This type of structure was used for a much larger $27 million contract project the company secured in 1970, again in joint venture with Harbourworks: The Cape Lambert Iron Ore Marine Facility for Cliffs Robe River, later known as Robe River Iron Ore Associates. The project required a particularly long and complex jetty at less than ideal port sites. Upon completion, and after lengthy discussions about the type of design and height of the jetty required, the Cape Lambert jetties were some of the highest jetties above water in the world, at 60 feet (18 metres) above sea level. [16] With the laconic style so familiar to Clough engineers, Albert Scott commented that *'the safest place to be in a cyclone would be on the wharf. A wave high enough to reach the decking on the jetty would go over the top of the power station on the nearby shore.'* [17]

According to Albert Scott; *'Cape Lambert was a tremendous project. It really was the making of the modern Clough.'* [18]

Harold Clough recalls 'Clough did a lot of work in the Pilbara at this time, and we built most of the jetties on the Western Australian coast. The site camps attached to them had the atmosphere of frontier towns — red dust, mud and temporary housing — and we often had to supply water and electricity and build roads before we could start work on projects.' [19]

The beginnings of offshore oil and gas work

As surveys, feasibility studies and preliminary design works were being undertaken, the company became part of the early development of Western Australia's offshore oil and gas development under the leadership of Albert Scott.

The first major project was at Barrow Island for West Australian Petroleum (WAPET) in 1967, and involved the design and construction of a 10-km-long, 508mm submarine pipeline and marine terminal. Since there were no suitable deep-water approaches to Barrow Island to allow a jetty loading point, the oil had to be pumped through a submerged pipeline to an offshore anchorage site about 55 km off the east coast. [20]

Among other challenges was the fact that there was little existing infrastructure or services in the region, and Barrow Island itself was a Class A Nature Reserve. Harbourworks Clough established a pipe-welding facility on the island to fuse the pipes into strings that were then connected by a flanged and bolted joint on the seabed.

Harold recalls *'As we didn't have a pipe-laying barge, our solution involved connecting pipeline sections on the seabed which prompted the Texan who managed the overall project to say, "You've turned this thing into a bloody plumbing job."'* [21]

The growing business also required a different structure, and in 1969 Harold reorganised the company, forming a holding company, Clough Holdings, and a joint venture with Garrick Agnew called Agnew Clough.[22] Garrick, one of Western Australia's most entrepreneurial and mercurial mineral explorers, had interests across a wide range of resource and development projects and had been instrumental in Clough's engagement in the Shark Bay Salt operation.

Barrow Island Submarine Pipeline

The 1970s were a challenging time. While the company had a number of contracts, including the Fortescue-Tom Price pipeline in the Pilbara, the Stirling and then the Mt Henry Bridges in Perth, work at Port Stanvac in South Australia, and the Coates Vanadium Plant, large underpinning contracts were few and far between. The $80 million Wivenhoe Power Station in Queensland and The Swan Brewery in Western Australia, the company's first construction management venture, were their only major projects.

Lack of work in Western Australia in particular and Australia in general made Harold step up his search for work internationally. As Harold comments:

'I looked for opportunities and was presented with opportunities where we could use our skills and expertise. Ports, roads and bridges, pipelines, power stations, dams and reservoirs, industrial and commercial, mining, even defence systems – across Perth, Western Australia and around Australia and the world.' [23]


Tarang Water Supply Pipeline


Saudi Aramco

Expanding outside Western Australia

Seeking to expand outside Western Australia, Clough undertook work in other parts of Australia and ventured into Asia and the Middle East. This was partly driven by Harold's vision that the company should be open to new opportunities, as, and when they arose, whatever they were, and by a need to secure a diverse range of projects to protect against the inevitable ebb and flow of construction and engineering work.

Brisbane, Queensland

In the early 1970s, Clough bought a Queensland company, renaming it Pioneer Clough. This operation carried out some road construction at a heavy loss, as well as work stripping overburden for coal mines — again not that profitable.

Bob Browning was sent to Queensland to reorganise the operation and soon secured two pipeline contracts near Gladstone, one for water and the other for limestone. The slurry pipeline was particularly challenging, as it needed to sustain high pressures similar to the ones that would later be used on oil and gas pipelines.

Bob Browning remembers that in the 1970s there was considerable suspicion in Queensland of outsiders, and in that definition, Western Australia was almost foreign country.

'They didn't want to know about a small company from Western Australia.' 'We had to put much effort into convincing them that we could do the job and that we were there for the long run.'

Sydney, New South Wales

Clough's first office in Sydney opened in 1985 with focus on water treatment projects, including: Burrinjuck dam flood security for the department for land and water, bundeena Maianbar water cycle management scheme and silt removal from Southern and Western Suburbs Ocean Outfall Sewer both for Sydney Water. The office was located on the Pacific Highway at Lindfield and closed in 2001.

Clough reopened its Sydney office in July 2018, now located in North Sydney.

Papua New Guinea

Clough began bidding for projects in PNG from its Brisbane office, at first unsuccessfully, then later in the 1980s with substantial rewards. In 1989, Clough established Clough Niugini, the company's longstanding Papua New Guinea office which operates out of Port Moresby to this day. [24]

Clough Niugini first projects included the Porgera Gold Mine and some of PNG's biggest resource projects including the Kiunga Cooper concentrate load out wharf for OK Tedi, 600 km up the Fly River in the Western Province, and the installation of bridge caissons for Bougainville Cooper.

Over time, Clough has worked on some of PNG's most challenging projects and have developed specialist skills in landowner consultation, local workforce management, logistics, accessibility, and pioneering and forest clearing.

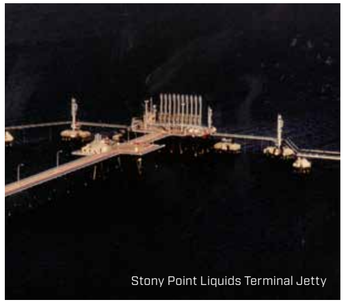
Asia and Africa

Harold travelled further afield, visiting countries across Asia to scout out opportunities. In the late 1960s, Clough embarked on a joint venture in Indonesia with Abdul Muiz, and in 1974 they won the contract to build the main highway from Medan to the other side of Sumatra. They were then given the soil investigation contract for the Arun LNG plant in North Sumatra, about 10 km from Lhok Seumawe being built by Bechtel – a challenging projet given its remote location and lack of any infrastructure. Peter Knight, who later became Managing Director of Clough Engineering (1989), was sent up to Singapore to oversee the Indonesian operations, and recalls that there was nothing at Lhok Seumawe except an empty beach and a World War II airstrip built by the Japanese.

He also remembers some advice he received on arrival from an old friend: *'Knighty, I don't know what you think you are going to be doing in Indonesia; all I can tell you is that you won't have started by the time you are due to finish.'* [25]

One of the more interesting projects was to develop agricultural operations in Nigeria, a project supported by the United Nations as part of their attempt to increase the production of protein in African countries. Asked by the West Australian Government if he could assist, Harold said yes, called Michael Kailis, and before long they had established prawn and cattle farms in Nigeria. [26]


Harriet A Field Development


Stony Point Liquids Terminal Jetty


Petrosea, 1980s

Oil and gas ramp up

The early 1980s resulted in some ambitious projects for the company in Australia, the most important being their first project for Woodside, North Rankin A. The $150 million pipelay project was the company's entry into offshore petrochemical and oil and gas processing work and was the precursor for many of Clough's future oil and gas projects.

Clough partnered with international subsidiary of French company Entrepose SA, Entrepose des Travaux Petroliers et Maritimes (ETPM), and the project was managed by Albert Scott. Scott recalls that it took 18 months to design and involved a pipe-laying barge with a crew of 400, support vessels, tugs and supply vessels with another 100 crew, as well as over 600 Clough designers, supervisors and skilled workers.

The Clough ETPM joint venture introduced the Saturne semi-automatic welding system that had never before been used on an undersea pipeline. It was also the first self-propelled pipe-laying barge ever used in Australia.

After a slow start, Clough had the team laying 3 km of pipe a day on a 24-hour, 7-day a week program. They then buried the pipeline — one of the first times in the world that a pipe 40 inches in diameter and one inch thick had been buried — and completed the project ahead of schedule. In addition, it was the first time that gas welding had been used on an automatic basis.

It was a highly successful and profitable project and involved some younger engineers who became leaders in the business later on, including Brian Hewitt and Rob Jewkes.

Soon afterwards, in 1982, Clough secured the contract for the berthing facility at Port Bonython in South Australia, followed by work on the Harriet Oil Field recently purchased by Australian businessman, Alan Bond. Both these projects were impressive in terms of their contract size and the innovative approach Clough took to the design and construction of the pipelines, wharfs and facilities.

The Harriet Oil Field was particularly challenging, given that the Clough Bechtel joint venture had just 12 months to build a production platform and link it to Varanus Island. [27]

A phased lump sum contract was created, which meant designing and ordering critical components could begin immediately. Using a broad, generalised budget prepared by Bechtel as a guide, work began immediately, with the partners paid a fixed lump sum for engineering, and more precise figures for components of the project throughout its life. It was an unconventional approach that paid off.

It was completed on January 18, 1986, with only days to spare, and oil flowed to Varanus Island the same day, setting a new record. [28]

The Harriet project also marked the breakthrough by Clough into the oil and gas business, not only in Australia but internationally.

In 1982, the world oil price dropped sharply, which resulted in losses for the Algahtani Clough joint venture in Saudi Arabia, and it was closed in 1984. As Harold describes it, 'the last couple of years were disastrous in Saudi Arabia and we lost our shirt.' [29]

One fortuitous event occurred in 1984, when Clough bought Indonesian company, Petrosea from CSR on extremely favourable terms. While it required considerable ongoing investment, it became a lifeline for Clough several years later when its profitability soared as the Australian side of the company was facing serious challenges.

Clough also played a decisive role in the development of fields in the Timor Sea. Through its joint venture with Stena Offshore, CloughStena, Clough developed world-class capability in subsea and deep water installation work, completing ambitious projects for BHP Petroleum's Challis Field in the Timor Sea, and Esso Australia's Bass Strait marginal field development.

Challis Field Mooring System Installation

The Challis project required the transportation of the 4,500 tonne Challis Riser, the largest in the world, from Singapore to the field (600 kms from Darwin), installation, tie-in, and testing of seven flow line systems connecting the Challis production riser to seven sub-sea wellheads up to six km away; all this in unsheltered waters, at a depth of 106 metres.[30] CloughStena deployed a dynamic positioning support vessel, the Stena Workhorse, as well as the semi-submersible Mighty Servant 2, another semi-submersible, a barge to pump 15,000 tonnes of iron ore ballast, and a heavy-lift craneship. [31]

BHP also appointed CloughStena to carry out similar work to Challis on its Griffin field off the North West Coast of Western Australia. One Griffin project involved installing the riser turret mooring and its associated network of flexible flow lines and umbilicals for the field, 65 km off the coast in 130 metres of water.

Further work also came from WAPET and Marathon Petroleum. As a result, Clough built up a well-earned reputation as a leader in the installation of technology for small, offshore fields, marginal at a time of low oil prices. [32]

Between 1985 and 1995 CloughStena installed the majority of the FPSOs in the Asia Pacific. Rob Jewkes, Manager Offshore Division and a Director of Clough Engineering Limited at the time, commented that the striking feature of the joint venture's success was that all the work was won and executed from Australia. Oilfields were created 'out of the ocean', requiring complex engineering and specialised equipment weighing thousands of tonnes with a high degree of precision.

Survival in the late 1980s

By the late 1980s, there weren't many large projects, rather a steady flow of smaller contracts between $10-$20 million. Harold remembers it well:

'As it turned out, '85 was worse and '86 was worse again, and '87 was an absolute disaster. We lost money in Australia, we lost money in Asia, we lost money everywhere. If I could have given the whole thing away for two bob at that stage, I would have.'

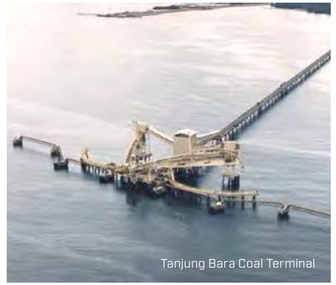
'Because we really had no other options, we soldiered on. During those three years, Petrosea just ate up our best people, our best plant, all our money, all our resources — as if it was a bottomless black hole.' [33]

In 1986-87, the company faced a major cost blowout on the construction of the Woodside LNG jetty. *'We could have easily failed in 1987,' recalls Harold, 'but Woodside and our bank supported us.'*

Three significant projects for Clough in the mid-to-late 1980s were Phase II of Woodside's Marine Structures, a first of its kind in Australia; a lesser-known project for Lang Hancock — one of the world's largest bulk-materials trans-shipment facilities at the Port of Constanza on the Black Sea in Romania — and the contract to build the Tanjung Bara Coal Terminal and mine site on the southeast coast of East Kalimantan, Borneo.

Clough had also become involved in the defence sector through an association with Trippett Allen and Associates called Clough Systems Ltd, which tendered for projects in the electronic engineering field. The initial efforts were not successful, but in 1986 its proposal to the Australian Navy to design, supply and install an underwater sound testing range at HMAS Creswell in Jervis Bay was

Port of Constanza



Tanjung Bara Coal Terminal

accepted. In 1986 Clough Systems teamed up with NEC to tender for a combined services contract known as Defaussat, the satellite communications section of the new Defence communications upgrade. They also won, with Universal Defence Systems, an Army project known as the Electronic Warfare Command and Processing Sub System (EWCAPSS), for the manufacture of training simulators for the then new Collins Class submarines, manufactured and tested at the Kewdale workshop and then installed at HMAS Stirling on Garden Island in Sydney Harbour. [34]

The company was also caught up in the train wreck that was Rothwells, Laurie Connell and Dallas Dempster, who were all linked to Petrochemical Industries Limited (PCIL), a $1.2 billion petrochemical project touted as the state's second largest industrial venture. PCIL had a lump sum, turnkey contract in partnership with JGL Engineers of Japan and Clough to build the plant. When the project foundered, Clough and its partner, JGC Corporation, were left in serious trouble.[35]

In 1987, Clough, in joint venture with Randall Process Systems of Houston, Texas (now ABB Randall Corporation) and T. O'Connor and Sons of Adelaide, undertook another iconic project in Western Australia, the EPC of the Kwinana liquid petroleum gas (LPG) plant for Wesfarmers LPG. The plant was designed to extract up to 150,000 tonnes of LPG, butane and propane per annum from natural gas piped to Perth from the North West Shelf. In addition to being a "hard money" lump sum contract, the client required that the plant be handed over in an operating state with a financial bonus/penalty scheme geared to plant performance. The plant was mechanically completed in just 17 months and commissioned two months later, over a month ahead of schedule, earning the joint venture a bonus.

In 1989 Harold Clough retired as Managing Director of Clough Engineering, remaining a director and Chairman of Clough Limited, and was succeeded by Peter Knight.

At this time, Albert Scott became Chairman of Clough Engineering. By 1990, Clough employed over 4,000 people in Australia, PNG, UK, Asia, the Middle East, India and Africa, and was battling with the Woodside II project, where costs had increased to double the original price. Borrowings that year peaked at $25 million.

In 1990 the decision was made to float Petrosea, which at the time was capitalised at $92 million, making Clough's shares worth $42.5 million, its single biggest asset and valued at more than its Australian operations.[36] The Petrosea float was only the second on the new Indonesian Stock Exchange and was 40 times oversubscribed, raising $30 million for 33 per cent of the equity. The years of pouring resources into it had finally succeeded just when Clough needed it. A little over a year later, the company had paid off its borrowings and regrouped.

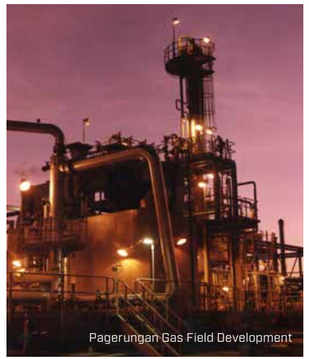
The 1990s – growth of offshore oil and gas, international propels the company

Despite the downturn in the Australian economy in the early 1990s, Clough was well positioned to take advantage of the massive investment in the offshore oil and gas developments in Western Australia. Its experience from the 1960s and 70s in remote areas combined with hundreds of feasibility studies and preliminary design work up the coast of Western Australia meant Clough was one of the few local companies with extensive knowledge of the onshore and offshore environments.

This knowledge was also used to market the company internationally and was a major factor in securing the earthworks, mining operations, port construction and building works at Kaltim Prima Coal Terminal in Sangatta, East Kalimantan, and the exciting Pagerungan Besarungan Island gas field development for Atlantic Richfield between 1991-1993.[37] Pagerungan Island was the biggest project the company had undertaken on its own and was run out of Surabaya. Clough built everything from scratch, including an airstrip, roads and a town for the workers, as well as providing power and water. All equipment and materials had to be bought in.

Brian Hewitt, who was project manager on Pagerungan, proudly remembers the achievements of the project: it made a profit, finished ahead of schedule, had a perfect safety record and a highly satisfied client. It also highlighted, yet again, Clough's ability to operate in remote areas. Clough's purchase of Petrosea and experience in Indonesia were critical to all these outcomes. The project also enabled Clough to develop the in-house process design engineering capability that was then deployed across new projects.

MSV Maxita


Pagerungan Gas Field Development

In addition to Pagerungan Island, Clough secured several other overseas projects across Indonesia, Pakistan, and China. Oil and gas projects closer to home included the Apache East Spar project, the first joint operator/contractor alliance in Australia.

During this time, Clough Niugini was finding success with the award of several contracts. In 1990, the business was awarded the civil works at the Porgera Gold Mine that required 5,300 metres of concrete foundation in 24 weeks in a remote, mountainous region. Clough Niugini also worked on some of PNG's biggest resource projects, including the Kiunga Cooper concentrate loadout wharf for OK Tedi, 600 km up the Fly River in the Western Province, and the installation of bridge caissons for Bougainville Cooper.

CloughStena also increased its operations in subsea installation and deepwater installation. Stena was subsequently acquired by Coflexip, who terminated the joint venture. Keen to keep growing offshore construction work, the Clough offshore team formed a joint venture with Saipem of Italy to acquire a 50 per cent interest in the Dynamic Positioning (DP) Multifunction Support Vessel (MSV) Maxita in 1995.[38] Sixty million dollars was a considerable investment for the company, but it was felt a strong international business could be built around this capability and protect Clough from competitive pressures in this market.

Meanwhile the construction division of the company was busy with projects across the resources and infrastructure sectors with major projects including the Jimblebar Iron Ore contract for BHP, the Marandoo Iron Ore facility, the Telfer Underground Middle Vale redevelopment, the Crown Casino in Melbourne in a joint venture with Thiess, and the Graham Farmer Freeway with Baulderstone. Another joint venture with Entact focused on the commercial and industrial building sector in Western Australia.

The ports division was close to capacity with the Dampier Iron Ore port upgrade, the Dalrymple Bay Coal Terminal 38 km south of Mackay at the Port of Hay Point, and the upgrade of the Hamersley Iron Port facilities.

Clough's other interests rounded out the diversity of the company's operations, including Mount Resources (formerly Agnew Clough, and manager of the Shark Bay Salt joint venture), the Wundowie Foundry, Kewdale Structural Engineers and Clough Mining Services. [39]

Between 1990-1998 Clough's revenue increased from $189.6 million to $605.3 million and profits soared from $4.7 million to $29.4 million. The company had 21 offices worldwide and more than half its work was in Asia. As a result of a long-standing policy of giving 10 per cent of the company's profits as share bonuses, a number of senior executives now owned close to 20 per cent. The challenges of funding this rate and scale of growth were becoming obvious, so the decision was made to float the company on the stock exchange and Clough was listed on the ASX in March 1998 with a share price of .71 cents per share.

At the time of public listing, Clough had a team of over 800 professionals and employed over 4,000 people worldwide. Its order book was $1 billion, with Indonesian projects a substantial contributor, as well as its first contract in Brunei. Key project areas included oil, gas and petrochemicals, mining and minerals, infrastructure, manufacturing, property and operations, and maintenance. [40]

That same year, after successfully floating the company, Peter Knight retired as Managing Director; he remained on the Board until 2000. Brian Hewitt was appointed Managing Director of Clough Limited, succeeding Peter, and Rob Jewkes was appointed Managing Director and CEO of Clough Engineering Limited. [41]

In 1999 the company refitted the Java Constructor pipe-laying barge, which worked in tandem with the Clough Challenge shallow water lay barge. The MSV Maxita, operated by the Saipem Clough joint venture, had also completed a full season for British and Norwegian clients in the North Sea and extended its operations to Canada and Libya. [42]


East Spar Gas Field Development


Jimblebar Iron Ore Contract Mining

BassGas Project

Gorgon Project

Life as a public company

After Clough listed on the stock exchange, the early 2000s proved to be a fruitful era for the company with numerous project awards and work underway across industries and oceans, from Australia to Papua New Guinea, India to Mongolia, and beyond. It seemed there were not many parts of the world where Clough and its partners did not operate.

In 2002, InterOil awarded Clough Niugini the contract to build Papua New Guinea's first oil refinery, located across the harbour from Port Moresby. Clough Niugini was responsible for the engineering, procurement, construction and commissioning of the new petroleum refinery. A significant engineering and logistical challenge was the refurbishment of equipment from an mothballed oil refinery in USA for re-use in this plant. New equipment was also engineered and fabricated to augment the refurbished equipment. The project had a peak on-site workforce of more than 500 personnel with over 3.5 million work hours.

Also in 2002, Clough secured the $400 million BassGas project from a consortium led by Origin. This was its biggest turnkey deal and its first in the Australian offshore oil and gas industry.

The contract for the major gas development in Victoria at the time covered the engineering, purchasing, construction and installation of an offshore production platform, a pipeline under the ocean, a 32-km land pipeline, and an onshore gas plant at Lang Lang, 90 km southeast of Melbourne and 35 km north-north-east of Phillip Island.[43]

However, by late 2003-4, Clough and Origin were involved in 'one of Australia's biggest and most acrimonious contract performance disputes' concerning a $250 million claim against it. The dispute put extraordinary pressure on the company and resulted in a restructuring of the board and management. [44]

Harold Clough stepped down as Chairman and became a non-executive director 53 years after he had joined the business of Clough Brothers with his father. The Clough Engineering Limited Board ceased, and changes were made to the Clough Limited Board with Harold's eldest son, Jock Clough, appointed as Non-Executive Chairman. [45]

Another change in management included the resignation of Brian Hewitt as Managing Director; he was succeeded by David Singleton who was also CEO of Clough Limited from 2003-2007.

Shareholders agreed to back a deal where the Clough family ceded control within four years to South African contracting group Murray & Roberts, which acquired 120 million shares at 68 cents each to lift its stake in Clough from 4.9 to 29.3 per cent. [46] [47]

Later in 2005, Clough, in joint venture with Aker and Murray & Roberts, was awarded the EPCM contract for Newmont's Boddington Gold Mine to develop the 35 Mtpa Copper/Gold project located 135 kilometres south-east of Perth, a very important project at the time for the technically advanced equipment and largest ever used in the industry.

The BassGas dispute was finally settled through arbitration in 2006, but contributed substantially to Clough's loss of $15.08 million in 2006. This continued in 2007 when issues with two projects in India resulted in a loss of $105.3 million. Difficult contractual terms and the impact of the 2007 Asian tsunami which resulted in the onshore gas plant site sinking below sea level, this had a substantial impact on the business bringing it close to the point of collapse.

In August 2007 David Singleton was succeeded as Managing Director by John Smith. John joined Clough as a highly experienced leader in offshore project delivery, consistent with the strategy at the time to pursue offshore marine construction work with its vessels Java Constructor, Clough Challenge, Normand Clough, Normand Clipper

It was a tough period for the company and resulted in Clough selling its 82 per cent stake in Petrosea in 2009, in part to raise funds to cover the fallout from the BassGas and Indian contracts. [48]

These disputes overshadowed many projects that were performing well, including the HIsmelt Kwinana Plant for Rio Tinto, the Angel Gas Field Development off Karratha on the North West Shelf, the LNG Jetty-Train V Jetty Expansion, Dampier, followed by the Woodside Pluto LNG Jetty, and the Sanga Sanga coal mine located in the Kutai Kartanegara Regency, East Kalimantan, Indonesia.

In 2009, Oceanflow International, a Houston-based deep-water field development specialist, was acquired and in addition Clough secured one of its largest ever contracts, the $950 million PNG LNG upstream infrastructure project. Moreover, the company won the contract for the installation of offshore facilities for the Montara Field for PTTEP Australasia, valued at approximately A$116 million, the 300-metre-long approach jetty for the Pluto LNG loadout berth contract, and a contract as part of the Kellogg Joint Venture (KJVG) to finalise front-end engineering and design (FEED) and the Engineering, Procurement and Construction Management (EPCM) for all downstream facilities for the Chevron-operated Gorgon Project valued at approximately A$5 billion.

While Clough's primary focus was on oil and gas and petrochemicals, construction and other divisions took a back seat as the large oil and gas projects sucked up engineering, financial and management resources.

Clough's 'swings and roundabouts' existence throughout the 2000s is a classic example of the inherent risks associated with the whole construction-engineering consulting model. According to Harold Clough, *'everyone is always trying to shift the risks associated with projects onto the construction company, usually the entity with the least capacity to absorb risk. The construction company often takes on the risks, as they want to secure the work.'* Sue Murphy, a Clough executive for over 25 years supported Harold's view, saying:

'If you look at history, the value of construction companies over time — they erode because clients made them take risks they can't take. The alliance model is a much better way to undertake projects as you only allocate risk to people who can actually take it.' [49]

PNG LNG Jetty

Gladstone LNG Project

Mutineer Exeter Development

2010s – more change and going back to the future – diversification

In the early 2010s Clough won more valuable projects, including the PNG LNG Jetty; 20 kms northwest of Port Moresby on the Gulf of Papua. Then the Gladstone LNG contract, the company's first foray into coal seam gas for Santos, the Ichthys LNG IPMS contract and Jetty and Module offloading facility, the LNG trains for Gorgon, and the Anderson Point AP5 Facility for a Fortescue Mining Group partnership.

Led by CEO, John Smith, Clough persevered through the challenges of the global financial crisis and the highly volatile global energy market, to reshape itself as an engineering, procurement and construction (EPC) contractor focused on the oil and gas sector.

In 2010, Peritus, a pipeline and floating systems design house was established in Perth, London and Houston; the Clough Helix joint venture was set up and a 31.3 per cent stake was taken in the listed Forge Group (2010). Clough Seam Gas was officially launched in 2010 to provide a full turnkey coal seam development option.[50] Combined, these initiatives improved Clough's capability and performance so that by 2011 it could report an order book of $1.55 billion and a profit of $49.6 million.[51] As part of the ongoing restructuring of the company, the Marine Construction business was sold to SapuraCrest of Malaysia. In 2011 Kevin Gallagher replaced John Smith as CEO of Clough Limited. Kevin brought to Clough his experience in the oil and gas industry which set the pace for Clough during Australia's thriving oil and gas phase. [52]

Later in 2011 and 2012, important awards took place, the detailed engineering design, procurement, fabrication, and transportation of the Central Processing Facility (CPF) and Floating Production, Storage and Offloading vessel (FPSO) for the INPEX Ichthys project, the EPC for the Nitric Acid Plant and Ammonium Nitrate Plant Number 3 (NAAN3) in Kwinana, Commissioning Management Services contract on Santos Gladstone LNG and the hook-up and commissioning for the Wheatstone Platform, one of Australia's largest offshore facilities with a topsides weight of about 37,000 tonnes.

On 29 August 2013, the Clough Limited board announced that it would be implementing the previously announced proposal by Murray & Roberts to acquire all the shares it did not already own in Clough.[53] The scheme consideration comprised a cash payment of $1.32 per share paid by Murray & Roberts and special cash dividend of 0.14c per share paid by Clough.

On 12 December 2013, Clough was delisted from the ASX and became a fully-owned subsidiary of Murray & Roberts. Now part of Murray & Roberts, Clough's operations were restructured into four main business divisions and three main regions: Western Australia and the Northern Territory, Queensland and PNG, and international. As part of this, Clough also disposed of its shareholding in Forge. [54]

Clough acquired and partnered with a number of specialist companies around the world to support and grow its oil and gas offering. These included e2o, completions, commissioning and operational support company based in Adelaide (2013), the Clough Coens joint venture established in Korea (2013), Clough Murray & Roberts, oil and gas marine specialists based in Cape Town, South Africa (2014), and CH-IV, consultants to LNG asset developers, regulators and facility owners, operators and lenders, based in Houston (2014). The company also acquired EC&I engineering firm, Booth Welsh, based in Ayrshire, Scotland (2014), and Enercore, engineering and EPC services company based in Calgary, Canada (2015).

In 2014 Murray & Roberts restructured its operations and Clough became the key part of the new oil and gas platform, a logical decision given the company's involvement in some of the world's largest energy projects under construction in Australia, PNG and Timor that included Chevron's Gorgon LNG project, INPEX Ichthys' LNG project, and ExxonMobil's PNG LNG project.[55] Yet, just as these projects were being secured, the world market for oil and gas generally, and LNG specifically, plateaued and prices began falling. As a result, and as part of the natural flow-through of the move from construction into production, Clough's offshore oil and gas project pipeline declined dramatically.

The challenge for Clough was to diversify its offering. In many ways this meant Clough reaching back to its not too distant past and rebuilding its links to engineering and construction projects in mining, infrastructure sectors (water and power) and civil construction, as well as focusing on providing engineering and project delivery services and asset lifecycle management.

This shift in Clough's market focus coincided with Peter Bennett's appointment as CEO and Managing Director in February 2016. Peter took on the role just as world oil prices fell to their lowest level since 2003; prices dropped 50 per cent in 2015 alone. In addition, global energy producers – Clough's clients – deferred or cancelled several major new projects. [56]

Global diversification, as well as a focus on engineering, commissioning and maintenance work, much as Harold had undertaken in the 1970s and 1980s, provided some good news in an otherwise tough market.

Global expansion of Clough's markets was also added to the mix with a focus on engineering, construction and commissioning work in the international oil and gas space, similar to the efforts Harold had undertaken in the 1970s and 1980s. Another key focus at this time was to sharply refocus the organisational structure of the company so that it could ride out the depressed domestic oil and gas environment, while simultaneously developing the capabilities to address the new opportunities in mining and infrastructure projects in Australia.

In 2016, GCR Mongolia was established, a joint venture between Global Infrastructure Partners (GIP), Clough and RUC Mining. GCR Mongolia combines the strengths of three organisations each with compatible but diverse skill sets and since 2017, the joint venture has been part of the iconic Oyu Tolgoi development.

Clough in 2018 reopened an office in Sydney after 10 years of absence in that city to focus on New South Wales' current and future infrastructure projects and formed a joint venture with PSI (PSI Clough) to pursue projects in Kazakhstan.

In the same year, the company closed out the Wheatstone hook-up and commissioning project, utilising its integrated delivery model. This resulted in the most successful start-up of a Chevron offshore facility in the company's history. Similarly, the Karratha Gas Plant Life Extension were successfully completed. [57]

Clough re-established in the infrastructure market in Western Australia with the EPC to upgrade and refurbishment of the existing intake tower and outlet structures at Mundaring Weir and the EPC to expand the Beenyup Advanced Water Recycling Plant both for the Water Corporation and internationally through the award of the EPC to deliver POM Power Station near Port Moresby in Papua New Guinea and the earthquake recovery work for Oil Search also in Papua New Guinea.

South Flank Project

Oyu Tolgoi Project

Clough Today

The modern landscape of the business world and the engineering and construction sector is radically different from the 1960s and 1970s, and Clough is now part of a large multinational company in Murray & Roberts.

Today, Clough's pioneering spirit is thriving with a portfolio of challenging and rewarding projects throughout the energy, mining and infrastructure industries, with employee numbers close to 2500 people across project sites and offices around the world.

In Australia, the focus is set on the growing mining and infrastructure markets while the energy sector remains quiet and with focus on completing the hook-up and commissioning scope for the INPEX Ichthys project. Internationally, the focus is on energy projects in Canada, Kazakhstan, Mozambique, Papua New Guinea, and the USA.

The iron ore mining market in Australia continues to provide a large and reliable pipeline of projects as mining companies seek to maintain production output by extending existing mines or developing new ones. During FY2019, Clough has secured two project scopes, the EPC for non-process infrastructure and the EPC for the Ore Handling plant with BHP on its South Flank Iron Ore development and one with Rio Tinto for the Northern Rail of their Koodaideri development, both in Western Australia. Clough also continues to be part of the Rio Tinto Oyu Tolgoi project via GCR Mongolia.

The Australian infrastructure market is undergoing a major investment boom with a +10-year government funded program, particularly on the East Coast, and in April 2019, Clough was awarded the multi-billion-dollar contract for the civil and electro-mechanical scope for the iconic Snowy 2.0 project in New South Wales, Australia, as part of a joint venture with Italian hydro power and tunnelling specialist Salini Impregilo. This is a landmark project for Australia, and cements Clough's position as a tier 1 contractor in this sector. [58]

A major milestone for Clough in its centenary year has been the acquisition of Saulsbury's Gulf Coast downstream and chemical business unit in February 2019. This acquisition has created the platform for Clough to extend its service offering to the growing energy and petrochemical sectors in North America. Clough's USA EPC capability is a key component of Clough's strategic growth plans and opens significant new market opportunities to the business. In August 2019, Clough USA's first major award was announced, an EPC contract for a Petrochemical project in Texas.

Oyu Tolgoi is one of the world's largest known copper and gold deposits. Situated in the southern Gobi Desert of Mongolia, approximately 550 kilometres south of the capital, Ulaanbaatar and 80 kilometres north of the Mongolia-China border, Oyu Tolgoi is jointly owned by the Government of Mongolia (34 per cent) and Turquoise Hill Resources (66 per cent, of which Rio Tinto owns 51 per cent). Since 2010, Rio Tinto has also been the manager of the Oyu Tolgoi project.

Since inception, GCR Mongolia's vision has been aligned to be an employer of choice, a preferred contractor in the region, an industry leader in safety and quality through excellence in everything they do, a valued organisation in the community, a leader in engaging, training and upskilling their workforce and a recognised Mongolian entity. GCR Mongolia's vision is now a reality with the establishment of the GCR Training Academy, as well as their safety results and the constant meaningful work that GCR does to give back to the community.

In November 2018, GCR Mongolia opened its own Training Academy in Ulaanbaatar and is committed to providing increased opportunities to develop and upskill the mining industry workforce through theory and practical based training, coupled with on-the-job experience in the mining and construction industry. GCR Mongolia officially opened its GCR Training Academy in order to engage and upskill its 800-strong national workforce through skills transfer, diverse training programs, and certified education, alongside experienced Clough and RUC Supervisors supported by global management systems.[59] The GCR Training Academy has a 130-person capacity, with three lecture rooms and one e-learning facility equipped with computers. The facility also includes nine practical training showcase facilities, with more than 30 expatriate professionals from leading internationally-recognised companies providing training, skills and knowledge transfer, and instruction for working safely in the shaft sinking field.

GCR Mongolia's current scope for Oyu Tolgoi includes design, construction and commissioning of the blind sink and concrete line of Shaft No 3 and No 4 and the construction of the Underground Material Handling System for Stage 1.

CLOUGH PEOPLE

Just what is it that makes Clough different? While the answer depends somewhat on when you worked in or with the company - no relationship is static - there are some enduring values that make up the Clough DNA.

For many of the 'older Cloughies' it was Harold who created the unique environment that was Clough. So what were his values?

Encouraging young people

Throughout Clough's history, the company has always encouraged and supported young engineers and, to some extent, thrown them in the deep in and let them get on with it. As Harold comments:

'Clough has this philosophy and ability to try different things in new places. Clough has never been afraid to test the water by moving into new areas. It's a measure of the culture of Clough and the quality of the people. And it's all about people, we had a great team of people.'

Peter Knight

Peter Knight, who joined Clough in February 1961 and was Managing Director of Clough Limited and Chairman of the Clough Engineering Group for a number of years recalls his first meeting with Harold:

// Cloughy was about the only person around the place [not government], so I rang him up and came in for an interview. At the end he said "Fine, start on the 20th of February" — and I did.

'We always used to come together at lunchtime for a sandwich and we'd talk around our problems and things that were going on, and we began to know each other, build a camaraderie. Everyone was there together. . . and we still had a common lunchroom when I left.[60] //

Sue Murphy

// It was amazing nurturing ground. And I think, if you look back on it, we were given an almost insane level of accountability and responsibility and trust at a very young age. Harold's recruiting – largely through the scholarship program – fed his theory of recruiting smart people who were passionate about what they did.

'And, all through those years with expansion overseas, Harold was very big on if people had an idea or wanted to do something — he'd let them have a go. You were allowed to make mistakes, just not over and over again. We'd bid on things that were way beyond our scope — and we won them. //

Geoff Smith

// I loved every minute working for Clough. Harold was interested in people, and in the early days it was like an extended family. You were the master of your own destiny, but he was always there to help or provide advice. //

Gavin Croll

// When I joined I went to work at Petrosea in Indonesia. I worked long hours as I was the project engineer. I simply had to be a jack of all trades as we were working in remote areas. Quite apart from being on site during the day, I had to manage the day worksheets, procurement, supervise the work and handle technical queries. It was part of the proving ground in Clough.

'There was also an attitude that we (Clough) could do anything, that we could turn our minds to a project even if we didn't have the experience, and find a way to make it work.

'The company was incredibly adaptable at taking bright young people and letting them learn to be resourceful and giving them freedom to learn.[61] //

Developing the Clough way

Peter Knight

Peter Knight recalls a particularly difficult challenge getting paid for a project in Indonesia.

We were having issues getting paid and things were getting pretty tough so I decided I needed help. There were no phones — the closest one was three days' travel away — so I sent a telegram at the end of which I said "This is a help message."

'A couple of days went by and nothing happened, and then Harold turned up. He was the only one with a current visa. We sorted it out... and my lesson was that it demonstrated that if you need help, don't be afraid to ask for it.[63]

Gavin Croll

Clough was very good at throwing you in the deep end. I was 25 when I went up to Karratha and I was the only engineer on site. I had to live in the pub and manage 25-30 people with a couple of fax machines. Clough [Sue Murphy] had a great knack of building project teams.

'The great thing about Clough is that you're not pigeon-holed. You were given the freedom to make decisions when you were the person on the ground.

New Swan Brewery

Sue Murphy

When you think about the responsibility we had, it was probably crazy. But you'd go and see Harold if a job was going off the rails and say what you were worried about and he'd give you a pat on the back and say "You smart young people, you always come up with clever ideas." And you'd think oh my God, it's his money and he trusts me... and then you'd work even harder.[62]

Don Young

When we were growing up as an engineering company in the 1970s and 1980s, we spoke of companies like Bechtel, Kaiser and Fluor in awe. Companies such as Bechtel had 30,000 engineers working for them on oil refineries and other projects all around the world, in the Middle East in particular. We always thought by the way they carried on that they had a magic box of planning tricks on how to project manage, so we sat alongside them and we learnt a bit from them.

'By the time we got to the Swan Brewery project we were competent project managers in our own right. We knew there wasn't a magic box there; it was just good practice of principles, of planning a job properly and the design properly, going out to tender and preparing a pre-estimate as a project manager, and knowing what the price should be, so you wouldn't accept the price that was too low — or too high for that matter.

Courageous

Harold Clough

We were an engineering construction company. There were opportunities. We were asked to look at them and we grabbed them.

Geoff Smith

Clough has this philosophy and ability to try different things in new places. That might have been seen as an aggressive approach, but it's more than that, because we really put our necks on the line to try something new, and Clough has never been afraid to test the water by moving into new areas.

'A lot of companies can't and won't do this, but it's a measure of the culture of Clough and the quality of the people. It's an adventuresome attitude and an independent mind.[64]

Gavin Croll

Clough is not linear. We're resourceful, adaptable and adventurous. We've worked in some very remote places in the Southern Highlands of PNG, in Baluchistan province in Pakistan, islands in Indonesia.

Image courtesy of Main Roads WA

Hegigio Pipe Bridge

Dalrymple Bay Stage 6

Looking after families

Geoff Smith

The loyalty of the staff was profound. It was a family business with a corporate structure, and it was always about the team capability not the individual, and there was a strong commitment from those who worked in the company because of this.[65]

Lana King

We haven't deviated dramatically from our inherent family values. Sure, our ownership structure has changed, leadership has changed, but there are still large numbers of people here who have been with the company for a long time. And there's a reason they're staying. There's camaraderie and a sense of commitment. Clough has been committed to them, so they are committed in return.

Albert Scott

It's always been Clough policy to look after families on remote sites. In the early days we tried to keep families together, build houses for them even though it was quite a cost burden, but it made sense as our team worked harder and with a much better atmosphere.

Sue Murphy

There were lots of good projects; it was great fun. But we worked very hard and we cared a lot. I think every single one of us kind of behaved just as if it was our company, our business. All of our friends thought we were insane. It was good fun.

'In 2002 I'd worked for Clough for 25 years, and it was only in the last six months of my time there that it actually crossed my mind that I was an employee. At the old Clough we thought it was our business.[67]

Geoff Smith

When I joined Clough [1964] there were about 15 people in "the office", so it was really a family. Harold was involved in every estimate and every client meeting. Everyone knew everyone, including the carpenters and apprentices. And that was the way it was, so it was a true family group, and it's from this that we grew.[68]

Ivor Peries

Ivor Peries also recalls an early lesson when working for Clough when it was a private family company:

I was the project manager on the Pilbara Pipeline project, and were having some challenges with the weather and all the rock that we'd come across that we had to blast out. It was a $20 million project, and at one point we were looking at losing $5 million. I remember the usual monthly project review meeting: Harold and all his children — now adults of course — attended the review meeting.

'It brought it home to me and no doubt others that we were spending his family's money. Harold and the family put a lot of trust in the key staff, and I was keenly aware that I wasn't just working with numbers on a spreadsheet.[66]

Diversity

Emma Moebius

I was always impressed by the way the company engaged and supported women and their families. When we had people working on our vessels around the world someone would make sure their families were looked after — small things, like remembering the wives' birthdays, major family events.'

'And the company has ensured I had the time I needed to have my two children and then come back to work part-time and in a flexible capacity, and this changes as my children get older.

Lana King

The thing that strikes me is that over a long period of time I've had lots of different opportunities, with many changes in roles. Clough has always – irrespective of the leadership at that time – been very supportive of me and the flexibility that I needed to have.

'So I consider myself fortunate to be given the level of responsibility, but at the same time with that the requisite support. It really says a lot about where the business is. The majority of my team are part-time and we all work well together.

Sue Murphy

My final year at UWA was 1979, and I got a Clough's scholarship and everyone at Uni said "Oh Clough don't want to take a graduate because they've given the scholarship to a girl." I didn't know much about construction – I was a bit naive – so I took the job at Clough.

'I joined as a graduate engineer. There weren't that many engineers at the time, about 30 in total. But we were all young and very keen. My first job was to build the three-tiered stand at Subiaco Oval which, incidentally, they are about to demolish. The last AFL game was at Subiaco Oval last Sunday.

'There weren't girls in construction then, but it really didn't matter at Clough. The directors and board were very gentlemanly, very decent people. Harold was always a lovely man. Don Young, Peter Knight and Geoff Smith were all very decent people and they were probably protective of me, but I wasn't aware of being protected .[69]

COMMUNITY

The relationship between Clough and the communities around its projects and offices has been defined by mutual communication, collaboration and understanding. Through the years, Clough's people have valued the importance of leaving a positive legacy, and through financial, training, and employment support Clough has given back to the communities around its diverse operations to promote education, health and wellbeing.

Aboriginal & Torres Strait Islander Peoples

Clough acknowledges the Traditional Owners and Custodians of the land in which we live and work. We honour and respect the cultural heritage, customs and beliefs of all Aboriginal and Torres Strait Islander People and we pay our respect to their Elders, past, present and emerging.

Since Clough's early beginnings, the importance of working to create opportunities for Aboriginal and Torres Strait Islander People has been identified and supported through career and mentorship programs, supply chain initiatives, and Clough Foundation, however, it was recognised that Clough, as an Australian business, needed to do more. With that in mind, 2019 was the year that Clough officially developed and committed to introducing its first Reconciliation Action Plan (RAP).

Clough's journey with Aboriginal and Torres Strait Islander communities reflect our reconciliation goals of creating meaningful change for First Australians. Our efforts to date, while modest in comparison to what we plan to achieve by implementing this RAP, provide a solid foundation on which we can build.

Our vision is to be a leader in Reconciliation by engaging with Aboriginal and Torres Strait Islander people, improving employment, education and business prospects of Aboriginal and Torres Strait Islander people, and to create a workplace that understands, values, and celebrates Indigenous culture.

'For me Reconciliation is a few different things.

'It is a journey to understand and embrace each other's differences and appreciate how those differences shape who we are and the views that we each hold.

'It is an opportunity to promote and deliver change. If we don't make changes, then how is the outcome going to be any different in the future?

'It is a framework which allows us to create opportunities for individuals to participate on an even playing field with the rest of our community.'

- Richard Simons – Chief Financial Officer

International engagement

When Clough ventured into international projects in the late 1960s, not only did it bring about the challenge of delivering complex projects in remote locations, it also brought the opportunity to touch the lives of communities around the world.

With Clough's Corporate Social Responsibility commitments in Australia already a solid foundation; education, health and wellbeing were also embraced to be the focus for community involvement internationally.

Clough is committed to ensuring the legacy that is left behind after each completed project is a positive one. Examples are endless but some of the most memorable ones include the support Clough gave to the Indonesian community through Petrosea, working with John Fawcett Foundation and Dilts Foundation to provide education and health facilities to disadvantaged children in Jakarta.[70] In Afghanistan and India, Clough first task was to build sport facilities for the communities around the project and over 30 years of work close to the communities in Papua New Guinea.

Community Engagement in Papua New Guinea

Clough began pursuing opportunities in PNG in the 1980s and since then, every project that Clough has completed in PNG has left a positive legacy in the community.

Clough's connection with the PNG community has provided many mutual benefits throughout the years.

PNG Communities benefit from Clough's projects through local employment, engagement of local business, improvement of local infrastructure and support to education and health initiatives. Clough in turn gains the knowledge and diversity of the local community to effectively deliver projects in the most remote locations of PNG.

Education

Since the early 80s, Clough has trained and employed tens of thousands of PNG nationals. Our training development and respect for the local culture has resulted in an excellent reputation among local communities; PNG people want to work for Clough due to the development opportunities that are provided.

In addition to training the local workforce, Clough supports the schools within its projects' vicinities through the provision of sports equipment, sports uniforms, and books.

The recent POM Power Station Project and Earthquake Response Project organised a book drive with Clough staff in Australia to donate school equipment and books for primary schools around the Southern Highlands of PNG. The target was to collect 1,400 books, but the outcome was an overwhelming 18,000 books. The books have been well received throughout the community with positive feedback from teachers, students and community leaders and are expected to make a huge impact in the schools.

STORY FROM BOB OLIK – Graduate Engineer

'My story with Clough began during my final year at PNG University of Technology in 2017. It started with a knock on my dormitory room door while I was studying and preparing for my final semester exams.

'Finding a job after finishing university is always a challenge for young people in Papua New Guinea due to the country's economic downturn, less employment opportunities, and worse the 'Wantok System'.

'On Saturday morning of October 2017, there came a knock on my dormitory room door. As I opened the door to my surprise, I was told that Clough wanted to interview me. I was shocked, and out of words, I thought to myself "this is the opportunity that I've been praying for."

'After a successful interview I was shortlisted for employment by Clough as a Graduate Construction Engineer to start at the POM Power Station Project in Port Moresby.

'I always wanted to give back to my country, and upon hearing about the Power Station Project, which will benefit this country, I grabbed it with all my fingers. There was never a dull day on site for me, everyone was there to help and push me to learn as much as I can.

'One thing that made me feel part of the team was the trust that was given to me by my superiors. Most importantly, I was always given the opportunity to do Safety talks in every morning pre-starts which made me more excited to go to work every day.

'I was given the opportunity to go and attend the Construction Management Academy (CMA) program in Perth. It was my first trip overseas, and I really enjoyed the training as well as the trip. My second trip overseas has been to Kuala Lumpur to give input into another project Clough is pursuing in PNG.

'There has been no point that I regret joining Clough because they have put a lot into my career to see me excel professionally, and I believe there are more opportunities ahead which I am looking forward to.'

Health and Wellbeing

Clough and ChildFund joined forces through the Clough Foundation with the aim to build a maternal health clinic in Waima, Kairuku District of Central Province, PNG. This centre was completed in 2017 and it provides support and advice for mothers and children, vaccinations, integrated maternal health clinics, and antenatal care.

In February 2018, a 7.6 earthquake hit the Southern Highlands, Hela, Gulf and parts of Western Province leaving destruction through the area. Clough provided two containerloads of food, clothing, building materials and basic tools as part of a massive relief effort co-ordinated by Oil Search. In addition, Clough embarked on a mission to repair road, bridges and school facilities.

'Repairing the roads and bridges along the KAR was the most challenging and most rewarding scope the Clough team has completed so far. Roads and bridges bring people together, it brings community together and the milestone could not have been achieved without a team effort from OSL, the local landowner companies and the support of the communities along the road. It's only because we all worked together that we were able to successfully and safely complete this project.'

- Rannie Prosser, Project Manager Earthquake Response Project


The Girls Academy


The Clontarf Foundation


The Starlight Children Foundation


ChildFund

The Clough Foundation

In 2014, the Clough Foundation was established to focus the company's community engagement and charitable support. A key element was to align the Foundation to Clough's existing six-pillars of Corporate Social Responsibility in a program that supported the charities and communities which represent Clough's diverse operations. The six key areas of focus for The Clough Foundation are Indigenous programs, empowering women, children and youth, the arts, education, and healthy communities.

The current Chairman of the Clough Foundation is former Olympic gold medallist, Rechelle Hawkes, who is supported by a Board comprising the Clough CEO and Managing Director, Peter Bennett and the Executive Vice President - Business Development and Commercial, and Executive Director, Raj Ratneser.

The Clough Foundation has carefully selected five community organisation to partner with:

- The Clontarf Foundation aims to improve the education discipline, life skills, self-esteem and employment prospects of young aboriginal and Torres strait islander men.
- Youth Focus works with young people to help them overcome issues associated with depression, anxiety, self-harm and suicidal thoughts.
- The Girls Academy program works within the school system to overcome obstacles that prevent aboriginal and Torres Strait islander girls from reaching their full potential.
- ChildFund aims at improving the health of children and mothers in Papua New Guinea which includes maternal and child health care, health clinic upgrades and immunisation patrols to remote regions.
- The Starlight Children Foundation alleviates suffering amongst children and teens undergoing medical treatment, by providing entertainment, laughter and relief. Promoting positive mindsets and brightening the lives of patients and families.

Clough Foundation

'With the Clough Foundation, we really wanted an independent body to give effect to our Corporate Social Responsibility and to bring about different ways of thinking in how to apply that so that we're not simply thinking through it purely with a Clough business lens, it's genuinely with a view to bettering our community by using different backgrounds and thought processes to come up with the ultimate solution.'

- Raj Ratneser, Executive Vice President - Business Development and Commercial and Clough Foundation Board Member

clontarf foundation

youthfocus

Proudly supporting Starlight children's foundation

ChildFund Australia

2000 Clough Scholarship Recipients

SCHOLARSHIPS & GRADUATES

Harold and the company's first major community focus began with the establishment of Clough Scholarships in 1972.

Harold graduated from the University of Western Australia (UWA) in 1947 with First Class Honours in Engineering; and later received a Fulbright Scholarship to attend the University of California, Berkeley before returning to Perth. As a tertiary scholarship recipient himself, Harold embraced the concept of a Clough Scholarship when it was presented to him as a way to repay the university's engineering faculty for the first-class education they provided. [71]

The Clough Scholarship was initially valued at $1600 per year with the only criterion that the awarded students undertake full-time study at UWA. The first of the scholarships were awarded later in 1972 to Dan Cunningham, Graham Collins, Tore Madafferi, and Mark Hewitt. Though it was not a requirement, they all subsequently joined Clough. The scholarship program, which was initially applicable only to undergraduates of UWA, was extended to Indonesia in 1987.

Since the establishment of its scholarship program in 1972, Clough has awarded more than 300 scholarships to tertiary engineering students across a wide range of disciplines including civil, construction management, mechanical, mechatronic, electrical, process, environmental and ocean engineering.

'To win a Clough scholarship you needed to be the cream of the cream and I believe the credit for the success and growth of our company goes in no small part to the contribution of our scholarship winners.'

'When I looked back to see how we had fared, a bit over 50 per cent of scholarship recipients joined us at Clough. And when they didn't join us they would go and work for one of our clients where they were even more valuable. It is amazing the positions the more mature ones had gone on to. They are now senior executives for major companies all over the world.' – Harold Clough.

Clough's graduate program coincides its scholarships to further develop young talent and provide a succession pipeline for the business. Today, the graduate program attracts hundreds of applications each year from graduating students to join the three-year structured program that provides them with professional and technical training, as well as practical, hands-on experience to begin their careers. Clough graduates have gone on to have successful careers in not only engineering but across all areas of the business, from managing large scale construction projects, to operations managers responsible for overseeing multiple projects, all the way through to executive management.

Clough's Head of Commercial, Supply Chain and Risk and EXCOM member Rob Radici began his career as a Clough Scholar and graduate engineer. *'The Clough Scholarship always attracted many applicants; it was the go-to scholarship during my undergraduate years. I still remember applying for my scholarship and drafting the letter which had to accompany it. I re-wrote it a few times; I knew how many applicants would be applying so I wanted to make it as good as I possibly could. I was interviewed by one of Clough's directors at the time, Geoff Smith, who explained exactly what type of projects Clough delivered around the world. I could tell Geoff was passionate about Clough and he did a great job selling Clough as an employer of choice. I remember leaving that interview thinking how good it would be to work for a company like Clough.*

'I couldn't believe it when I received the Clough Scholarship; I was over the moon. Clough formed a positive impression on me even before I became an employee. Here was an engineering and construction company prepared to invest in undergraduate engineers of all disciplines and introduce them into the engineering and construction world. On top of this, I got to meet Harold Clough himself and key staff from various parts of the business. This was incredibly exciting; it gave me a taste of all the different types of roles within Clough and a better understanding about the engineering and construction world that Clough specialised in. As an undergraduate I always felt welcomed when invited to Clough's offices at Markalinga House, you could feel that the staff were connected like a family.

'These early good impressions were further reinforced by the fact that Clough would offer graduate employment to all Clough scholars on a 'no-strings attached' basis. It was your call. For me it was an easy decision, I jumped at the chance of joining this company which treated its undergraduates as part of the Clough family. I think this was one of the reasons for the high conversion rate from scholars to graduate employment at the time. I wanted to give something back to Clough in return for its early support and confidence in me.'

By 2016 the Clough Scholarship program was contributing $15,000 a year towards the fees of four scholars. Each year two new scholarships for top engineering students in the first year of their engineering Masters are also awarded. [72]

Mark Musulin

Mark Musulin, a 2015 scholarship winner, describes the value of the scholarship to him.

'Clough is good in the sense you can learn the design work or you can learn the project engineering side of things.

'You work with the blue-chip companies.

'The highlight of the first six months is meeting the key people in the business, the heads of different functions, and seeing some of the work that goes on and their perspective. From that view you get to see exactly what Clough is.

'You're not just a number; you can meet all the people in the company. You can go up one or two floors and talk to them. It's very open; there are no barriers to getting something done. I pretty much met all the project managers, so when you see them you can have a chat. It's very friendly. It's quite different to people whom I know who work in large organisations who might not ever meet their project director or manager.

'You pick up on the culture quickly. It's a very welcoming place.' [73]

Emma Moebius

Emma Moebius, who commenced at Clough while at university on work experience and then as part of the Graduate program also shares her experience.

'I come into Clough through the graduate program and was rotated through different roles and liked the contracts management aspect of the work. There's a wide range of items of cover off in contracts, contractual risk, project risk, charter party arrangements and insurance. Once I had to look into insuring against pirate attacks in Asia.

'Through the program and afterwards I was exposed to different parts of the business, and at one point I was the only female project engineer on the Kalgoorlie Reservoir project.

'Clough has always been supportive of me working in different areas of the business, and that's part of the rotation of scholarship winners in their first two years, so we can see the different aspects and get to work with different leaders and teams.' [74]

SAFETY

From stubbies and singlets to full PPE, from working harder to working smarter, and from taking risks to eliminating risks, safety is an aspect of not only Clough, but also of the industries in which it operates which has had an unparalleled transformation over the company's tenure.

The evolution of safety practices has accounted for continually improved project outcomes across the business and Clough's safety performance today is proudly and significantly healthier than the global contracting industry average. However, Clough will always work towards a workplace that is injury free through effective safety leadership, personal accountability and developing its people.

Safety is a value on which Clough never compromises, and safety has undeniably been one of the most critical and contentious components of the construction industry since its inception. Clough's rich history of projects and locations has meant Clough has built a deep understanding of safety risks and what it takes to prevent our people from being harmed wherever we work.

'When you're in construction there's always high risk activities, you're lifting heavy loads, you're working at heights, you've got people using platforms you've got to make sure people are trained and skilled.

'It takes a lot to keep people safe. It takes a lot of effort; it's every minute of every day. You can't take your eyes off the ball, and you've got to be just constantly talking about the safety message.'

- Geoff Scott, Operation Manager, Eastern Australia and PNG

The event that spearheaded Clough's commitment to not only improve safety outcomes across the business but eliminate the occurrence of all major accidents was regrettably the loss of a life on a project in 2013. Prida Chumpla was a pipe welder working on Clough's EPC5a gas pipeline project in The Hides in the Hela Province of PNG when he was tragically, and fatality struck. It was the first fatal incident the company had encountered in the last 20 years, but one is too many.

Prida's death was the catalyst to develop Clough's Major Accident Prevention (MAP) Program aimed to prevent serious injuries, including fatalities, from ever occurring again across Clough-managed projects. The breadth of experience and understanding of safety risks across multiple industries enabled an in-house team, led by Clough's Head of HSSE, Roberta Selleck, to adapt the best aspects of industry fatality prevention programs and develop MAP.

MAP is a Critical Control management program which leverages offshore safety case principles into the onshore construction environment. By analysing activities with potential for major accidents or events, and implementing critical controls, MAP provides lifesaving tools in real-time giving the supervisor the authority to stop work if they are not satisfied with the controls.

The development and implementation of MAP within Clough has instilled a fundamental belief we can deliver innovative, quality, cost effective solutions to our clients and zero harm.

The MAP Program has been a fundamental shift in the way Clough manages high risk activities; it has also been implemented around the Murray & Roberts group. This means 50,000 employees around the world are safer, and this is Prida's true legacy.

'As a safety professional working in high-risk industries for over 25 years I have experienced the soul-destroying devastation of workplace fatalities and the impact it has on all involved. The futility of recurring fatality events across the construction industry often has me questioning - why? The frustration has led to my determination to eliminate these events, a conviction also held by Clough leaders.

'The MAP program has enabled our frontline teams to own, control and manage high-risk activities. Stopping work for MAP related causes is celebrated and supported. It is making a difference every day across Clough projects.'

- Roberta Selleck, Head of HSSE

Completing zero harm project is now a reality for Clough. Since 2017, four projects have been completed with zero harm results, three in Western Australia: the Woodside Karratha Gas Plant Life Extension (KLE), Water Corporation Mundaring Weir Outlet Works Upgrade, BHP Mining Area C Overpass, and one in Port Moresby, PNG, POM Power Station. Several other projects are on track to achieve this same remarkable safety status.

The KLE Project was Clough's first zero harm achievement; Luke Munro, KLE Project Manager credits the achievement to open, honest communications, the willingness to listen and take on feedback, and understanding that everybody has got something valuable to contribute when it comes to safety. *'To actually achieve that at the end, and to walk away know that we hadn't hurt anybody in any way through the entire duration of the project was something that we all felt really proud of and it was something that we as a team felt we'd collectively achieved.'*

Clough is committed to investing in its most important asset, its people. A focus on the health, welfare and safety of workers, whether in an office or on offshore platforms, down mines, out in the desert or high in the mountains, is a core part of Clough's operations. Clough's focus on achieving zero harm also extends beyond setting new safety and performance benchmarks, to its people, the environment and the community; it encompasses the core business principle to make a positive impact by enriching the lives of those in the communities in which we work and live.

Ok Tedi Project

INFRASTRUCTURE / CONSTRUCTION

National Mutual building (1955-1959)

Narrows Bridge (1957-1959)

Muja Power Station (1962-1966)

Standard Gauge Railway (1962-1966)

Ord River Diversion Dam (1963-1963)

Shark Bay Salt and Gypsum Loading Facility (1964-1965)

Parker Point Marine Facility and Upgrade (1965-1982)

Mt Newman Mining Power Stations (1966-1968)

Mitchell Freeway (1966-1973)

Stirling River Bridge (1972-1974)

New Swan Brewery (1976-1979) / Expansion (1984-1985)

Mt Henry Bridge (1979-1982)

Port Bonython, Wharf / Gas Liquids Terminal (1982-1983)

Graham Farmer Freeway (1996-2000) and Maintenance (2000-2007)

Woodman Point Environmental Enhancement Project (1999-2002)

Kwinana Freeway Bus Transit way (2000-2002)

Brisbane Inner Northern Busway Section 5 (2002-2004)

Roe Highway Stage 7 (2003-2006)

Toowoomba Pipeline (2009-2010)

Mundaring Weir Outlet Works Upgrade (2017-2018)

Beenyup Advanced Water Recycling Plant Stage 2 (2017-2019)

PNG Earthquake Response Project (2018-2019)

National Mutual Building (1955-1959)

CLIENT: National Mutual

ENTITY: J O Clough

LOCATION: Perth, Western Australia

For most of the Clough family, the defining moment in the history of the company was the National Mutual project in 1955.

For the two-man building company of Jack and Harold Clough with Dudley Atwell in support, it was a massive step up from any projects it had previously undertaken.

For Harold Clough this was the pivotal moment for the business his father had started. If the business was to survive and thrive, the National Mutual Building had to be operated and managed under a new regime. Winning it, while not easy, compelled a change in the structure and operation of the business, which was incorporated as J O Clough & Son Pty Ltd, 'a condition of me staying and controlling the cash' comments Harold.

To put the National Mutual Building into context: it was only the third high-rise building in Perth. The SGIO and MLC Buildings were the other two office towers of around 10 stories, which according to Albert Scott 'was considered to be pretty big in those days.'[75]

Harold recalls that up until then:

'We were mainly building service stations for BP and a number of other factories like the Tip Top Paint factory in West Perth. Dad was really a one-man band working out of home, and my uncle Bill Hayes used to do the books. The National Mutual building was the first high-rise to be built after the War, so it was a big thing.

'We were bidding this thing, and the biggest contract we had done before was probably £25,000 and we were bidding on this £500,000 project.'[76]

'Instead of employing myself and Doug Atwell, we had 50-100 people working on the site. This changed things quite dramatically.'

The National Mutual Building was completed in 1959, and was the start of Clough's early growth and development as well as its move to employing engineers and a larger workforce.


Jack Clough, one of Clough's founding brothers

About Jack Clough

'I used to work with Jack Clough a lot. He used to love bending the elbow, especially Scotch, but he was probably the best mathematician I have ever seen in my life. He could just sit on a bill of quantities and extend and add it up faster than most modern computers could do. He was a highly intelligent sort of bloke and taught me a tremendous amount about estimating that is a key part of running an organisation like Clough.'

'When we were doing the footbridges, he used to get me to come to his home at, would you believe, four in the morning, because that was when he was at his best. And we used to sit down and go through these bills of quantities for bidding on more multi-storey work which he knew very well and building work in town, and from his head he would extend all these things and add them up and my job was to just make sure there were no glaring errors, that everything added up. With my slide rule and my little, old-fashioned calculator I found it hard to keep up with him. He was pretty good at it.'

- Albert Scott

Man not machines

'In those days (late 1950s) you didn't have cranes or anything, you just had a little hurdy-gurdy scaffold tube arrangement on wheels with a winch on the back that was stuck on the roof.

'One day the boss on the site (National Mutual Building), Bob Walker, said to me "We're lifting the heavy air conditioning plant up to the top storey. Just go up and make sure the crane can lift it."

'I thought "Cripes, what do I know about cranes?" Bob then followed up "Bill, the bricklaying foreman will take you up there and show you where it is."

'There were no lifts or anything and we went up these 10 storeys at catapult pace, and when we got to the rood it was blowing a gale from the southwest and Bill struggled to open the door out on to the roof. He said "They've just poured some concrete here" and he jumped the last six feet from the floor onto the narrow parapet wall over which there was a 150-foot drop down to the bottom. He said "Follow me." And I said "Absolutely, no way." He then arranged for a plank to be brought over.

'Then I looked down at the hurdy-gurdy and there was another foreman there who said "OK, we're going to lift it now." So I said, " OK, start lifting and don't stop." They lifted it off and it came, and the rear wheels of this machine lifted right up in the air and I instinctively jumped on the back of it with a whole lot of others to hold it down. Eventually it came up to the top. In those days that was the sort of thing you did. Things were very Heath Robinson, and not as sophisticated as they are today.'

- Albert Scott

The Narrows Bridge (1957-1959)

CLIENT: WA Public Works Department

ENTITY: Christiani & Nielsen Clough

LOCATION: Perth, Western Australia

Up until the Narrows Bridge project, the Western Australian government had undertaken all public works – bridges, ports, roads, power stations – through the Public Works Department. In 1957, the government invited tenders for the Narrows Bridge and, due to its importance, decided to invite international tenders.

Image courtesy of Main Roads WA

Image courtesy of Main Roads WA

One of the pre-qualification conditions for the tender was that the contractor had to have built a bridge of similar magnitude. This eliminated all the contractors in Australia except Hornibrook up in Queensland, who had built the Hornibrook Bridge across the Brisbane River during the War. As Harold recounts:

'We obviously couldn't pre-qualify for ourselves, but because I'd worked in Bechtel I realised how little foreign companies knew about the costs (and therefore estimating) in other countries.

'I didn't know any international bridge builders, but I got a copy of the UK's Civil Engineers Journal, looked through this, picked out half a dozen companies and wrote to them. One of those companies was Christiani & Nielsen out of Copenhagen. They sent someone out here, we made an estimate and we were successful in the bid and built it'.[77]

The Narrows Bridge was the start of Clough as an engineering company as distinct from a building company. It also marked the next step up in terms of contract size, from the £500,000 National Mutual contract to the £1.5 million Narrows Bridge.

In its day, the Narrows was one of the longest prestressed concrete spans that had been built. The consultants who designed it had developed a construction method that required a very large crane to handle spans of between 250-300 tons. However, back in the 1950s there was no crane in Australia, let alone Western Australia, that could lift them.

Clough's Danish partner and director Knud Sorensen decided on an alternative approach, erecting a falsework of timber piles across the river and erecting each of the elements in their final positions, then prestressing them, after which the falsework could be removed.

Harold recalls that this required both lateral and courageous thinking because engineering consultants were then regarded as the final arbiters on matters of design, and the challenge from Christiani & Nielsen was badly received.[78]

The joint venture with Christiani & Nielsen was Clough's first, and established the model through to the present day. It helped that many of the Danes who came across to work on the Narrows Bridge formed strong relationships with the growing Clough team of engineers. Uffe Hansen, the senior engineer, became particularly close to Clough. Harold recalls:

'Uffe was a tremendously capable engineer. I remember his job was to make all the concrete elements and it was a most meticulously difficult job. The detail was mind-boggling. He did it in a completely capable way and everything fit. There wasn't one that was wrong.'[79]

Albert Scott, who joined Clough in March 1957 to 'supplement the team that was building the National Mutual Building', recounts how the business and all construction companies worked at this time:

'In those days we used to have all our own bricklayers, carpenters and plasterers. We used to sublet very little and we mixed all our own concrete. National Mutual was the first time, on some areas towards the end, where Readymix concrete was used. It was a vastly different game.

'Organisations like Clough had a predominance of trades and very few professional engineers. As far as I know, I was the first civil engineer in mainstream Clough. Harold was a mechanical engineer.

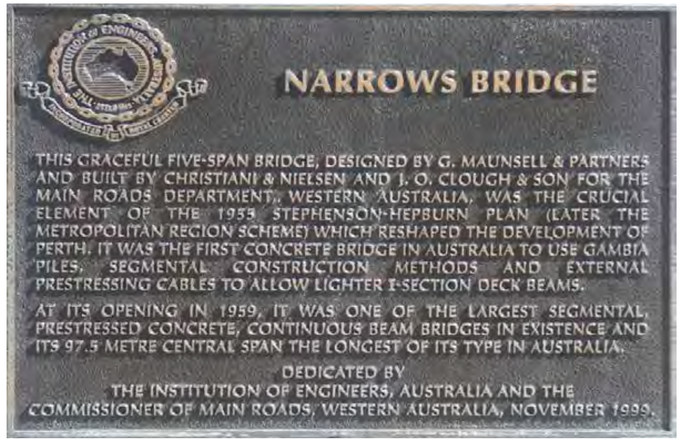
'You used to get close to the foreman and people used to rag engineers quite a lot.' [80]

Sadly, Harold's father, Jack, died just a few months before the Narrows Bridge opened, but Harold knew that 'he'd got a great charge out of us winning the Narrows Bridge because one of our competitors was Harold Doust and we beat Harold.

I think my father left on a high note.'

'We tend to forget today, but I remember we had to send telegrams to these people (international companies Harold had written to about the Narrows Bridge project) and then I wanted to talk to one of them. I had to book the call with what was then the PMG, and a day and a half later the call comes through. Making an international phone call in the '50s was a major, a really major exercise, and astronomically expensive. In today's terms, it would have probably cost at least several hundred dollars. We tend to forget today when everything's direct dialling. We call London as if we're calling home and think nothing of it.'

- Harold Clough



Bending piles

The construction of the Narrows Bridge went well, but there was a challenge with the piles. As recounted by Harold:

'Soon after we'd finished piling the temporary piles right across the river, I was walking across with Leif Ott Nielsen, and he was complaining because the pile caps weren't straight, and when you looked along it there was this great bend. The pile caps were 12-inch by 6-inch karri members; they were big lumps of timber. He said 'You've got to straighten them up.' No one in their right minds would have put a bend in like that. Then he said 'That's been pushed over.' We looked at the others, and they all had this bow in them.

'What we then realised is all this fill they had been placing on the interchange, it was all mud of course down to nearly 100 feet; it was going to be pushed out to the side. And that's what was happening. So a whole wall of mud was being pushed over and, of course, was pushing the pile over with it.

'To push our temporary piles over was one thing, but what we also realised was when we put the permanent piles down, they'd be pushed over too.

'We had a real problem with the movement of the mud.

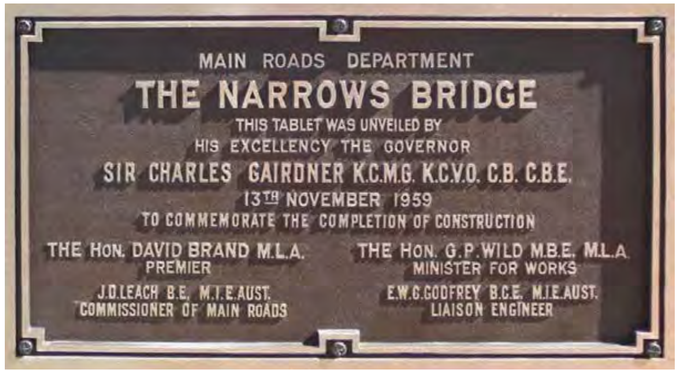
'They (the Danes) went away to try and find a solution to dealing with the flow of mud. What they decided to do is, around each of the piles they'd drive a big caisson, which was probably a metre and a half to two metres in diameter. They were going to offset it so the caisson could push over a long way before it hit the pile. And that's what we did.'

'Harold and I were the two Clough engineers on the Narrows Bridge project and we were soon joined by the Danish engineers. I was only 24 at the time when I started and I was very influenced by our Danish engineering friends who were technically very competent and, with Harold and myself, we formed a very cohesive, efficient team to plan and supervise the bridge construction.

'The construction was not without its difficulties. There were technical problems associated with the driving of the large steel tubular piles – gambia piles – which were eventually overcome at some extra cost.

'The prestressing was the Gifford Utile strand system for the longitudinal prestressing. It was the first time in the world that 19 wire strands had been used in a major bridge for longitudinal prestressing, and the use of these strands exposed some deficiencies which had to be resolved in the design of the anchor blocks which then had to be redesigned.'

- Don Young



Rottnest Ferry

'Another amusing incident was the Rottnest Ferry. We had a timber bridge along the downstream side of the permanent bridge which was used as an access-way, and there was a steel span in the middle of the bridge to allow ferries to go through the navigation span. Late one afternoon the steel beam bridging the gap got stuck on a timber pile and could not be lowered to allow ferries and other boats waiting to pass through under the bridge. We had to urgently telephone two divers to come to the site with their scuba gear to dive down and free the obstruction with a pneumatic saw.'

- Harold Clough

'Concurrently with the Narrows Bridge J O Clough & Son had a contract to build five concrete footbridges over the Kwinana freeway south of the Narrows site. After this contract was completed J O Clough was short of work but fortunately at the end of the Narrows contract it was given the task of extracting the forest of jarrah timber piles which had supported the temporary timber trestle falsework which in turn supported the bridge beams before they prestressed.

We were in a very competitive position to tender for timber jetties with piles ex the Narrows and built several jetties for Swan River yacht clubs, including Royal Perth, as well as jetties at Dongara and Jurien Bay.' [81]

- Albert Scott

Muja Power Station (1962-1966)

CLIENT: State Electricity Commission

ENTITY: J O Clough & Son

LOCATION: Collie, Western Australia

Situated near Collie, this power station has a capacity of 240 MW and up to four 60 MW units which were commissioned in July 1965, January 1967, April 1968 and February 1969.

Clough undertook all the civil work including the foundations at a cost of $2.2 million. This included all the earthworks and foundations.

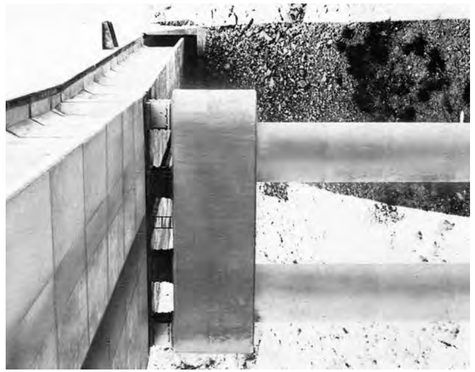
'What we really needed at that time [mid-1960s] was a long-term base load. It was a two-year contract with another two years if they decided to proceed with the second stage. It was a difficult contract and the big advantage was a long-term contract. As a result of Muja, we had a stable base from which other Clough activities could grow. And one of those was the Standard Gauge Railway project.'

'I was sent down there [Muja] and we couldn't afford too much, so as a young engineer I had to do all the organising, all the engineering, accounting, payroll. I used to stay up until 2 in the morning doing all the administrative stuff.'

'We had to flatten the virgin jarrah forest and build all the infrastructure, which was all the drainage and sewerage. I think we worked out that there's about 40 miles of pipes – enormous cooling water pipes, water supply, cooling water dams. All that infrastructure had to be done first, and then the foundations. As well as the roads and the coal handling plant.'

'We also mixed our own concrete. We were the biggest users of bulk cement for two to three years while we were building Muja. We had the concrete supply contract as well, which was $500,000.'[82]

- Albert Scott



Standard Gauge Railway (1962-1966)

CLIENT: West Australian Government Railways

ENTITY: J O Clough & Son

LOCATION: Perth to Kalgoorlie, Western Australia

Although the National Gauge Railway project was started in 1912, it stopped at Kalgoorlie. It was not until 1962 that construction of the Perth (via Kwinana) to Kalgoorlie standard gauge railway commenced.

The catalyst for this initiative was the conclusion in 1961 of an agreement between the Western Australian Government and BHP Co. Ltd for the development of an integrated iron and steel works at Kwinana. This was contingent upon the construction before the end of 1968 of a standard gauge railway from Kwinana and Fremantle to Kalgoorlie, connecting to BHP's Koolyanobbing iron ore deposit.[83]

Clough secured the construction bridges and culverts along the Perth to Kalgoorlie route at a cost of $1.5 million in joint venture with Thiess/Perron Bros, one of the four main contractors. The project included the sections of the national standard gauge railway from Kwinana to Fremantle and from Koolyanobbing to Kalgoorlie. The Wooroloo Brook Bridge was just one of many bridges Clough built along the route.

'I remember we bought two CEK cranes and I had one for the Wooroloo Brook Bridge. We had some quite demanding times there. It was a segmental construction, a 100-foot span, dual-lane rail bridge, and we were making the units. We had a little batch plant and we used to carry the aggregate and sand up there and then we'd batch it, make the concrete and place it. We were having trouble with the concrete strength, and when it was tested it just sheared off, which led to premature failure of the concrete. We had a few arguments with the consultants, Maunsell.

'I remember going to their office, and as Harold and I were going up in the lift it dawned on me that perhaps there was another source of the problem, that we hadn't taken the moisture content of the sand into consideration and that led to a variability in the water-cement ratio. Harold wasn't very pleased to have this information in the lift as he was about to go into the meeting, but he coped with it alright.'[84]

- Peter Knight

Ord River Diversion Dam (1963-1963)

CLIENT: WA Public Works Department

ENTITY: Christiani & Nielsen Clough

LOCATION: Kununurra, Western Australia

The Ord River Diversion Dam at Kununurra was the company's first dam project for the Public Works Department, and came just two years after it had completed the Narrows Bridge contract and after Clough had won the contract to build the Dongara Service jetty for the then Harbours and Rivers Department of the Western Australian Government.

Clough joint ventured with Christiani & Nielsen on this project, a concrete structure with steel radial gates for storage and flow control. All the cement was carried to the site in bulk by the State Shipping Service between Fremantle and Wyndham and carted by road to the site.

The project was an 85/15 joint venture with Christiani & Nielsen that eventually ended up as a 95/5 joint venture. As Peter Knight recalls:

'Harold was supposed to be the site project manager, but he realised that if he went up there for two years his business in Perth was going to die. He said 'To hell with that, I'm not going to go up there; I'll work on it from here.' And C&N said 'Well, if you're going to work on it from Perth, 15 per cent is too much, so they negotiated it down to 5 per cent. As it was we made a loss on that, so it was a bloody good thing[85].'

The project value was $6 million and it was completed in 1963.

The Clough Holdings 'Building a Nation' brochure, published in 1969, notes that 'The Ord drains a catchment area of some 18,000 square miles and during the summer wet season pours into Cambridge Gulf at 56,700 cubic metres a second, one of the highest flows of any river in Australia. The diversion dam is strategically located on Bandicoot Bar, near the town of Kununurra, providing gravity flow to the first irrigated farm lots.'

Peter Knight, CEO of Clough from 1989 to 1998 recalls this project well:

'I graduated in 1960 and didn't want to work for the Government. Cloughy was about the only private contractor around the place so I rang him up and went in for an interview and they had just won the Ord River Diversion Dam. He said 'Fine, start on the 20th of February." And that was it.

'As it was the wet season, no work was going on so I worked in the office with Bent Schou C&N's accountant.

'It was a very exciting project and it had a very strong feeling of togetherness with the Danish engineers and ourselves, particularly Uffe Hansen.'[86]

Don Young, Deputy Project Manager on the Dam Oct 1961 to Oct 1962 (replaced Uffe Hansen):

'I was looking after the project during the wet season when the Project Manager and a lot of the engineers and workforce were back in Perth because work could not continue in the river. We kept on working as long as we could. We had an earth cofferdam upstream of the dam to retain the river during the dry season. We eventually had to get out of the river, and one afternoon we moved all the equipment out of the river. Only a matter of hours later the river came down with an awe-inspiring flood and washed away the cofferdam. Several of us were sitting on top of the abutments watching this magnificent sight.

'It was a tough project. Working conditions were not easy. There was no R&R leave; the workforce went up there for the whole year. Air conditioning was a novelty.'

Ord River Diversion Dam in 2018 - Courtesy of Water Corporation of WA

'The windows in the workforce's accommodation hut were fly screens only and the dividing walls had fly screens at the bottom and the top to allow maximum air circulation. The room next to me was occupied by six alcoholics, who every night bought back from the wet canteen all the beer bottles they could carry. Most nights drinking continued to 4am, and as the site had a 6.30am start not much time for sleep for my neighbours.

'Jens Johna Huusom arrived on site after the wet season. He was a Viking type who had spent many years in Burma, Turkey and Greenland, but he was not quite ready for Kununurra. On the day of his arrival we took him for a swim in the local waterhole in the Ord River. He dived happily in from our usual diving rock but panicked as he reappeared at the water surface and faced two of our friendly Johnstone crocodiles. He swam to shore in record time and was not very impressed with the other swimmers sitting on the rocks laughing.

'During the year of 1961 I was assisted by two young engineers one of whom was Peter Knight. After Peter had been on site for a couple of months it was time for the great social event of the Kimberley district, the races in Wyndham. On his request I agreed to him spending the day of the main races in Wyndham, but he must have fallen into bad company as we only saw him again three days later looking somewhat dilapidated and not at all like the future MD of the Clough company.'[87]

- Uffe Hansen

Shark Bay Salt and Gypsum Loading Facility (1964-1965)

CLIENT: Shark Bay Salt Pty Ltd

ENTITY: J O Clough & Son

LOCATION: Shark Bay, Western Australia

The design and construction of a jetty for berthing bulk carries up to 25,000 DWT for loading of bulk cargoes of salt or gypsum at the rate of 700 tons per hour. This was the first jetty in Western Australia to be built from steel, using tubular steel piles and high-tension, flexible steel dolphins.

Shark Bay Salt Pty Ltd had been established by Garrick Agnew, a long-standing friend of Harold Clough's, on the back of a long-term contract with Mitsui to supply them with 200,000 tonnes of salt. Agnew convinced the Adelaide Steamship Company to invest in the salt field at Useless Loop and a port at Topper Island. Harold was asked to quote for designing and building the port. He designed the jetty, but realised that the considerable cost of getting timber piles up to Shark Bay meant steel piles would be much better. He also found a German steel group producing high tensile steel column sections which locked together to form efficient, flexible dolphins and offered to provide an engineering design. It was a new concept in Western Australian ports and he was 'pleased to have someone knowledgeable designing the most difficult part.'

Harold also needed a floating barge and pile driver and didn't own one. He solved the problem by acquiring six large beer tanks from the Emu Brewery, which were tied together to form two pontoons with three tanks in each hull on which they built a pile frame. He then acquired a large diesel hammer and trucked all the gear to Useless Loop.

The team made six pile dolphins for berthing, and connected these to Topper Island with a steel pipe frame jetty about 300 metres long on which a conveyor was built to take 1,000 tonnes of salt per hour.

The jetty took a year to build and the contract was valued at $342,000. It was designed for a 20-year life, but it's still operating today.

After a series of failures and disappointments, Adelaide Steamship decided to sell out and at that stage Harold invested in the business with Garrick and Mitsui. A causeway to the mainland was built and, after several years, large areas of Useless Loop were closed off and larger areas of Useless Inlet ponds were created and lined. These improvements enabled the company to produce one million tonnes of high quality salt per year and, according to Harold, 'it's where most of my grey hairs came from'.[89]

'I had a job offer from Clough and after three days I was on my way to Shark Bay without knowing what Clough did, what the job was or even where Shark Bay was. So we [Alf Taylor] drove up there. I'll never forget the first day. We went out on the piling barge and they were pitching and about to drive a pile. Just a few minutes after we got on to the barge, they cranked up the piling hammer and the guide frame broke, the pile fell off the lead and the hammer went to the seabed. It was quite an eye-opener.

'The project had, only two months earlier in June 1964, been ravaged by a major cyclone and the barge and piling had ended up on the beach and only just been reactivated.

'At the time the Broome jetty was being built by the Government, Des Kelly was the project manager of what is now the Department of Resources and Commerce. They had a dredge up there with its own crew working. The state government was doing most of the engineering work then, and building companies were just that because the government (Public Works Department) did all the engineering work. And then that changed'.[88]

- Geoff Smith

Parker Point Marine Facility and Upgrade (1965-1982)

CLIENT: Hamersley Iron Pty Ltd

ENTITY: Harbourworks Clough

LOCATION: Parker Point, Western Australia

Soon after the completion of the Shark Bay jetty, Harold received a visit from Johannes N Wesselingh, a director of Royal Netherlands Harbourworks from Delft in Holland. Harbourworks had secured the contract to design the Parker Point Wharf and was also permitted to submit a tender for the construction. Wesselingh wanted a local partner and spoke to Harold and Don Young.

Clough had several projects going on, the Muja Power Station, Standard Gauge Railway, and they had just secured the North West US Navy Communications Base at Exmouth, and didn't have the capacity to join Harbourworks in the bid for Parker Point. However Harold offered Wesselingh an office and assistance with local information on labour, materials and industrial matters. Wesselingh spent several weeks working on the tender, then several months later he returned and 'knocked on the door and said "Well, we've got the job. How are you placed now to help us?"' Clough now had the capacity so a 75/25 joint venture was formed to undertake the project.[90]

In those days the Dampier Archipelago was separated from the mainland by mud flats, and access across the causeway was restricted.

The project was completed in 1966 on time and on budget for $2.4 million, with the first shipment taking place on 16 August 1966 when the MV *Tachikawa* sailed to Japan with a cargo of 20,000 tonnes of lump ore.

The wharf could load iron ore at rates of up to 6,000 tonnes per hour and was designed to accommodate 100,000-tonne ore carriers. Hamersley Iron was the first company to open up once restrictions on iron ore exports were lifted, and got into production in less than two years.

J N Wesselingh

Dutch Master Engineer, Wesselingh was one the world's leading jetty and port builders. He had been erecting marine structures all over the world since the 1920s, along the coasts of China, Sumatra, Portugal, Spain, Turkey, Iran and Libya. He was building jetties in Indonesia when the Japanese invaded in World War II and was made a prisoner of war for the duration. After the War he continued working. One of the company's key clients was Conzinc Rio Tinto, which had formed Hamersley Iron, which asked Harbourworks to design and build a port for 65,000 DWT bulk carriers at Parker Point near Dampier.

Wesselingh was dispatched to Perth to inspect the site and coordinate its construction. He decided that a partnership with an Australian company would be beneficial. When Harold's jetty at Shark Bay caught his attention, as it was similar to the design he was planning, he approached Harold and asked about his experience.

Harold pulled out the drawings of the Shark Bay Salt jetty he had designed and Clough had built, and Clough's longest joint venture commenced.

Three separate upgrade contracts were completed for Hamersley Iron between 1977 and 1982.

Ore Wharf Upgrade (1977)

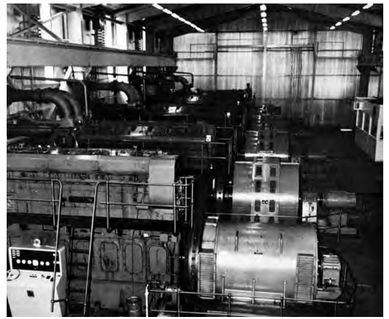
This was a design and construction contract to upgrade the existing ore wharf to accommodate vessels up to 120,000 Dead Weight Tonnage.

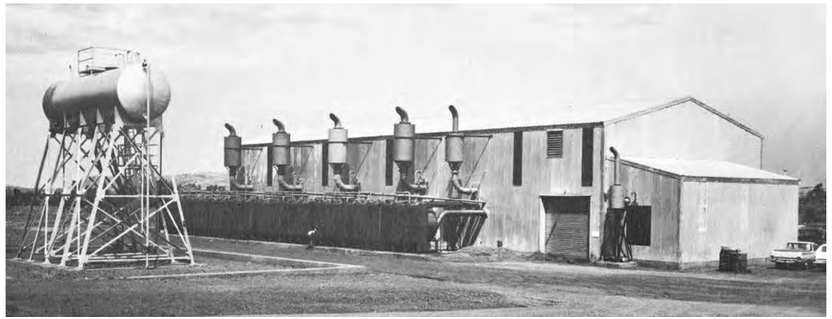
Ore Wharf Repair and Upgrade (1978)

Following a shipping accident early in 1978, Clough was commissioned to remove, redesign and replace two breasting dolphins and remove and realign all dolphin fenders at the wharf. Pile replacement included drilling and driving to additional depth to provide the first of a 160,000 Dead Weight Tonnage berthing capacity.

Ore Wharf Upgrade (1982)

This was a design and construction contract to upgrade the existing ore wharf to accommodate vessels up to 160,000 Dead Weight Tonnage. The upgrade was achieved by a combination of reverse circulation drilling and socketing dolphin piles below the level of new dredging for the berthing basin and by utilising an innovative technique of strutting the existing dolphin to auxiliary dolphin piles driven behind the wharf structure. The mooring dolphins were upgraded with the addition of new dolphin piles.





Mt Newman Mining Power Stations (1966-1968)

CLIENT: Mt Newman Mining (today BHP Iron Ore)

ENTITY: J O Clough and Sons

LOCATION: Port Hedland and Mt Newman, Western Australia

The Mt Newman power stations were split up almost equally between Port Hedland and Mt Newman. At the time they were some of the largest diesel power stations in Australia with total capacity of approximately 20 megawatts.

It was the first time Clough had bid on a multidiscipline project that included the design and construction of everything: civil, structural, electrical and mechanical parts of the power station. Clough was the prime contractor and worked with Sandovers, who were the agents for Rusten diesel alternators.

Finished four months ahead of schedule at a cost of $1.7 million, the Mt Newman Power Station was designed to withstand cyclonic winds of 130 miles per hour (sic) and was pressurised to minimise dust hazards by an airflow of 150,000 cubic feet a minute.

A second power station was designed and built by Clough at Port Hedland at a cost of $1.6 million.

Clough's team were the first people on to the sites, even before Utah started dredging in the harbour and the reclamation of the berth and storage areas.[91]

'I remember talking to the Bechtel bloke who was looking after the construction at Mt Newman and Port Hedland as we walked over the prairie at Mt Newman, and asking him "How do you decide in this huge area where to put the town site and that sort of thing?" He said, "Albert, the way we do it is we bring the most senior guy from both companies in; they walk around and one of them puts a heel mark in the ground and that's the centre of the town site and from then on everybody's to work within 1/8th of an inch of that." [92]

'Life for the Clough management group was hectic with quick trips to construction sites hundreds of kilometres apart. The sites, and the camps attached to them, had the atmosphere of frontier towns – dust, mud, box-like temporary housing, an open-air mess where beer was drunk by the jug rather than the glass. Every building and vehicle was covered with red dust.'

- Albert Scott

Mitchell Freeway Stage 1 (1966-1973)

CLIENT: Main Roads Department

ENTITY: J O Clough & Son in joint venture with Kier Ltd

LOCATION: Perth, Western Australia

The first contract of the Mitchell Freeway Stage 1, the Central Section, was awarded to the Clough Kier Joint Venture.

It involved the construction of three cast insitu box girder concrete bridges, supported on reinforced concrete piers, over the freeway at Malcolm and Hay Streets, and over Murray Street where the freeway crosses it. In addition it required a deep cutting through a built up area involving 230,000 cubic metres of excavation, 1800 lineal metres of reinforced concrete retaining walls with heights varying up to 6.6 metres, freeway standard roadway pavements and connections to adjoining streets.[93]

This $20 million project was named after former State Governor and Premier Sir James Mitchell. It was built in three stages: Central Section, the Narrows Interchange and Hamilton Interchange. Its major structures included 14 road bridges, two of which were bigger than the Narrows Bridge. Two of them cross each another above a ground-level roadway to create three levels of traffic. On completion the project had consumed 100,000 tons of concrete and 3,300 tons of steel.[94]

The Mitchell Freeway Stage 1 was declared a National Engineering Landmark by Engineering Heritage Australia, an award that recognises that a work of engineering is of national significance to the people of Australia.

'The standard of finish of the structures demanded by the Main Roads Department were exceptional and our workforce achieved the highest standard of workmanship required to meet those standards. The Main Roads Department set standards for the road construction (compaction and tolerances) which they had never achieved themselves, and we had to run what I called an open-air laboratory to convince their supervisory staff that they had set impossible standards. That took a lot of time and money.'

'After the bulk of the Barracks had been demolished there was a huge public outcry about removing the arch. We were in a difficult position. We were building this freeway and the government couldn't decide whether the arch should be knocked down or left there, and we were under a great deal of pressure to make sure that it didn't inadvertently get knocked down.'

- Don Young, Project Manager Clough Kier


Image courtesy of Main Roads WA

Stirling Bridge (1972-1974)

CLIENT: Main Roads Department

ENTITY: J O Clough & Son

LOCATION: North Fremantle to East Fremantle, Western Australia

The Stirling Bridge won the Award for Concrete Excellence in 1975.

The Stirling Bridge was the second major precast and stressed concrete structure across the Swan River. It was 415 metres long and 18 metres wide, and consisted of seven spans with prestressed concrete segments and 292 box-shaped cell precast concrete units in rows of two.

The precast concrete units were supported on steel falsework trusses, which in turn were supported partly on the permanent pier pile caps and partly on temporary pile caps. The tubular steel piles supporting the bridge piers were driven in with an automatic diesel hammer weighing 3.5 tonnes.

The company was able to use equipment that had become surplus from the Cape Lambert jetty project including a barge and cranes, and built additional cranes at the Kewdale yard.

A feature of the construction was the use of large fabricated steel trusses to support the 50-ton precast concrete deck units prior to their post tensioning. The precast units were manufactured at the company's Kewdale yard to high levels of precision. Every one of the individual precast units has ducts going through it and the ducts have to match exactly. There was not one error in any of the 350 units.[95]

Clough's bridge experience was invaluable in bidding for building jetties. One Clough engineer pointed out that 'a jetty is just a bridge with no land at the other end.'[96]

Peter Knight – Clough Construction Manager, Stirling Bridge

'When we were negotiating the contract, they called us in for a meeting as we had put a clause in our tender that said "In the contract (this is on the pilings) the engineer has to be reasonable about the set of the piles." We'd done this because the contract document stated "the piles had to be driven to refusal." We said "What's refusal? If it's reasonable, that's fine." They argued up and down, and I said "This is ridiculous, you could drive them to China and still not get refusal." "No," was the response, and we were told to go out and price it. So we came back and priced it and we doubled it. They said "That's ridiculous." We said "Well, so's the other thing." There was plenty of robust discussion, and eventually they agreed to put "reasonable at the discretion of the engineer."[97]

'The Stirling Bridge has two rows of beams, A and B. It has a very attractive appearance because from south to north the spans decrease in length, the beams depth decreases, and the height of the beams soffit above the roadway and water decreases.

'All the precast beam units were cast at Clough's precast yard at Kewdale and transported to the site on a lowloader. Clough chief design engineer Ed Wells designed the falsework trusses, precast yard gantry cranes and site handling cranes.'

New Swan Brewery (1976-1979) / Expansion (1984-1985)

CLIENT:	The Swan Brewing Company
ENTITY:	The joint venture of Clough-Kaiser Engineers and Kappele, Wright & MacLeod
LOCATION:	Canning Vale, Western Australia

The joint venture designed, administered and constructed the new Swan Brewery at Canning Vale. At $80 million in total, it was the largest project Clough had worked on by a wide margin and was built over a 30-month fast-track schedule.

Separate buildings housed the brewing process facilities and a packaging plant with all operations fully automised by a state-of-the-art, computer-based, automatic valve and process control system. There were also a wastewater treatment plant, an administration building and a Solar Centaur diesel fuelled gas turbine generator. [98]

An interesting part of the Brewery was the 46.8 metre high reinforced concrete water tower. The tower was designed to harmonise with the surrounding buildings and environment using slip-formed cast-in-place concrete. The shaft was slip-formed in 13 placements each 3.6 metres in height. The bowl was cast at ground level and lifted up to its final position using a system of hydraulic jacks and cables. [99]

Clough won a Certificate of Merit from the Concrete Institute of Australia in its 1979 Awards for Excellence for the tower.

When the Swan Brewery was commissioned in 1978, it was described in the industry as one of the most sophisticated in the world.

In 1984, Clough was invited to supervise the expansion of the brewery, and added some refinements and new equipment to the existing plant.

'I was out on the Swan Brewery project full time for two years. It was quite interesting. The Clough head office then was in Mount Street opposite the old Emu Brewery and I think that was one factor in us being asked to join Kaiser, Kappele, Wright & MacLeod, because the Swan Brewery executives knew us, could trust us, and if something went wrong could cross the road and say "Harold, what's going on here?"

'It's easy to remember the time of clinching that assignment because several of us flew to Sydney on an early morning flight on November 11, 1975, and we were told by the Sydney taxi driver on the way from the airport that Governor-General Sir John Kerr had dismissed Gough Whitlam.'

- Don Young

Don Young – on project management skills:

'I remember that the Swan Brewery executives were irritated at the consultants' inability to forecast with any accuracy the cost of designing the brewery.

'It confirmed what some of us at Clough suspected, that the bigger North American project management companies such as Kaiser, Bechtel and Fluor didn't have a magic box from which only they could access the secrets of managing large engineering projects. Rather, the training that Clough executives had in managing projects where it was vital to make every dollar work also fitted them for project management.'

Don Young – on Alan Bond and light beer

'You probably couldn't help but know about the Alan Bond saga. Clough on its own project-managed the expansion of the Swan Brewery to make light beer, which was becoming very popular. And we, with the Swan Brewery, designed an extension to their plant at Canning Vale. We had a team of engineers and construction people working on it, because by removing the alcohol from the beer they were producing a hell of a large quantity of alcohol.

'I can remember sitting at a board meeting with Swan Brewery executives, convened to reach a conclusion that this was the way to go and what it was probably going to cost. They called in Alan Bond and said "Here's the sample Alan." So he had a taste and licked his lips and said "Go ahead", just like that.' [100]

Mt Henry Bridge (1979-1982)

CLIENT:	Main Roads, Western Australia
ENTITY:	Clough Engineering Group
LOCATION:	Salter Point to Brentwood, Western Australia

The Mt Henry Bridge crossing the Canning River is 660 metres long and 29 metres wide (six lanes) with a deck area of nearly 20,000 square metres. Its nine spans used 258 box-shaped double cell precast concrete units which weighed up to 110 tonnes each, significantly larger than those used on the Stirling and Narrows Bridges. The Clough Site Construction Manager was Tony Quinlan.

Image courtesy of Main Roads WA

At the time it was the longest road bridge in Western Australia. An unusual feature of the design was the pedestrian walkways and cycleways cantilevered from the lower flanges of the superstructure.

Clough worked with BBR, a Swiss-based specialist prestressing company, and Zurich-based Cepas Plan AG design consultant, and the result was a novel, innovative construction, which included a full span steel truss, a short cantilever steel truss and a massive cable-stayed steel tower which doubled as a supporting medium for the truss support at its mid-span, and also as a crane for lowering the 110-tonne precast units onto the falsework.[103]

The construction consisted of nine continuous spans of precast double-cell, single box post-tensioned concrete segments supported by sculptured reinforced concrete piers.[104]

The value of the project was $10.2 million.

The cable-stayed falsework system won the 1981 Award for Engineering Excellence from the WA Division of the Institution of Engineers.

Bridge Construction in Perth Metropolitan Area

In the sequence of the three bridges — Narrows, Stirling and Mount Henry — the precast concrete segments on the Narrows were about 10 tonnes each, on the Stirling they were about 50 tonnes each, and on Mt Henry they were 110 tonnes each.

'I was given the job of preparing the tender for the Mt Henry Bridge. It was a similar type of precast concrete bridge to the Stirling Bridge, but three times bigger. We needed to come up with a competitive tender, and one evening when I was thinking about the options I thought we could use the cable-stayed technique which so impressed me when I visited Germany a few months prior and had seen this on the Norderelb Bridge in Hamburg. In other words, support a falsework truss from above with reusable cables instead of from below with expensive consumable piles.' [101]

- Don Young

Economies of scale and further advances in construction techniques resulted in Mt Henry being built for 19 man-hours per square metre of bridge deck. This compares with 71 man-hours per square metre for the Narrows, and 42 man-hours per square metre for the Stirling Bridge.[102]

Port Bonython, Wharf / Gas Liquids Terminal (1982-1983)

CLIENT: Santos Limited

ENTITY: Harbourworks Clough

LOCATION: Stony Point, South Australia

In a joint venture with Harbourworks, Clough was brought in to complete a turnkey design and construction contract for the installation of a shipping terminal to link a 659 km liquids pipeline with the seaboard load-out facility at Stony Point.

The contract involved the design and construction of a 2.4 km approach jetty, complete with support for multiple pipelines, concrete access roadway, a loading platform, four breasting dolphins, four mooring dolphins, and a continuous fendering system, connecting walkways and all the mooring equipment.

The approach trestle included two major structural platforms, one for pumping equipment and the other for services and amenities.

The project was delivered on time in one year and eight days.

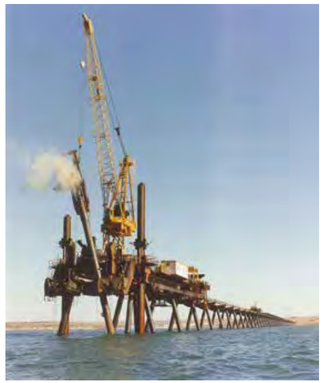
Many cranes, barges, cargo barges and tugs were mobilised for the project, including 63-metre Marlin from Holland, and an 80-metre long cantilever bridge system designed in Holland and constructed in Whyalla, containing hydraulic components, was also employed.

Nico Dirkzwager was the Construction Manager on the project and recalls:

'The schedule was incredibly tight, as we had to complete the load-out for the first shipment 12 months after we received the letter of intent.

'Also there was a spirit in Clough, "you go for it and you never give up."'

- Nico Dirkzwager



Sue Murphy, Section Engineer on the project

'We worked crazy hours; we worked seven days a week, 12 hours a day and then had a rostered day off every fourth Monday, and we'd always get the Sunday off before that.

'There were four of us in four one-bedroom apartments. They bought us a four-piece cutlery set and we got one each, so each of us had one plate, one knife, one fork and one spoon. And then they bought one saucepan set. We took turns cooking, and whoever was cooking, someone else had to drop off the saucepans beforehand so they could cook dinner.

'When I first arrived in Whyalla, I had a meeting with the local fabricator who had given us a price to build up the form work, which was quite complicated. He was a very, very nice Italian man. I met with him and I could hardly understand what he was saying. He'd given me a price for the work via fax, and he kept banging on and I was trying to be very polite, saying 'I'm sorry, I'm sorry' as I couldn't understand him. He got more and more agitated and he just wrote this number down and stormed off. So I thought, oh okay, and looked at the note and he'd dropped the price. He thought I was haggling and I was just trying to understand him.

'He apparently later said to Harold "Don't you send that little girl here again, she's a really hard deal maker."'

Images (left and right) courtesy of Main Roads WA

Graham Farmer Freeway (1996-2000)

CLIENT: Main Roads Western Australia

ENTITY: Baulderstone Clough

LOCATION: Perth, Western Australia

The Phase One bypass linked into the Mitchell Freeway and extended to East Parade in East Perth. This design and construction project incorporated one of the largest underground traffic tunnels of its kind (1.6 km) in Australia and a 250-metre rail tunnel and realignment.

The tunnel was constructed using the 'top down' method and included tie-in roadworks and pedestrian traffic ramps and bridges. The traffic tunnel comprised a six-lane tunnel (three carriageways on either side) totalling 7 km of freeway connecting East to West Perth. Construction of the Northbridge Tunnel commenced on the west side of the Perth city area.

Graham Farmer Freeway Maintenance (2000-2007)

CLIENT: Main Roads Department Western Australia

ENTITY: Baulderstone Hornibrook Clough joint venture (BCJV)

LOCATION: Perth, Western Australia

Clough was awarded a 10-year contract for the operation and maintenance of Perth's Graham Farmer Freeway Tunnel. Carrying over 80,000 vehicles each working day, the tunnel and freeway are a vital part of Perth's road transport infrastructure.

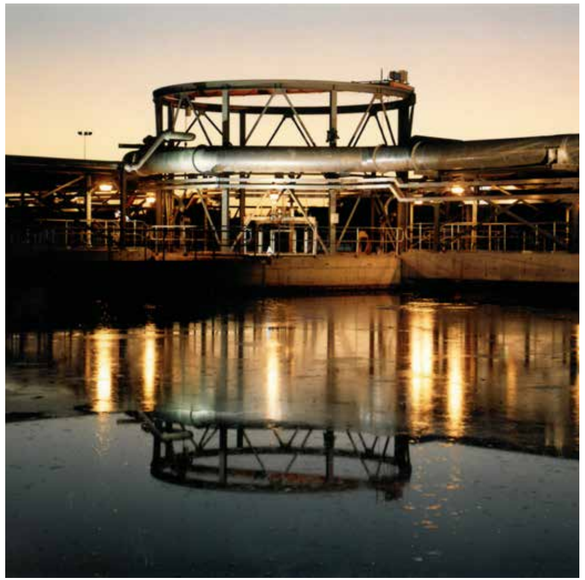
With the expertise gained from its prime role in the project's construction, the Baulderstone Clough Joint Venture was responsible for operations, ongoing routine inspections and the maintenance of the tunnel and its systems and surrounds. Operational requirements included:

- Ensuring a smooth and uninterrupted traffic flow in normal operating conditions
- Providing a secure environment for the public and BCJV personnel
- Responding to traffic incidents quickly and effectively
- Maximising traffic flow.

The operation of the Graham Farmer Freeway tunnel and Graham Farmer Freeway is controlled and monitored in real time from the Tunnel Control Centre that is staffed 24 hours a day. The centre monitors all vehicle activity and controls traffic with a comprehensive range of supporting facilities, including remotely operated signals, signs, video systems, traffic counters and an emergency communication network.

Clough sold its interest to Bilfinger Berger in December 2007.

Images (left and right) courtesy of Main Roads WA - Graham Farmer Freeway construction



Woodman Point Environmental Enhancement Project (1999-2002)

CLIENT:	Water Corporation of WA
ENTITY:	Woodman Alliance
LOCATION:	Coogee, Western Australia

The Woodman Point Wastewater Treatment Plant is the largest wastewater treatment plant in Western Australia. It treats wastewater for a population of about 680,000 people living south of the Swan River in the Perth metro area.

The Woodman Alliance was a partnership between Clough, Kinhill Brown & Root, and the Water Corporation of WA for the $140 million Woodman Point Wastewater Treatment Plant project.

The Alliance was the first public infrastructure project of this scale in Western Australia, and was based on the concept of relationship contracting. The project increased the treatment capacity of the plant from 100ML to 160ML per day to cater for the growing population in Perth's southern corridor.

Kwinana Freeway Bus Transit way (2000-2002)

CLIENT:	Main Roads, Western Australia
ENTITY:	Clough Henry Walker Eltin
LOCATION:	Perth, Western Australia

This included the design and construction of two 6-km dedicated bus lanes, a passenger transfer station, a bus-only bridge, three new footbridges, modifications to an existing footbridge and widening the existing Canning Highway overpass to accommodate a dedicated bus lane and passenger platform.[105]

The 10.2m-wide dedicated transit way incorporated 1.2m safety walls topped with steel rails, allowing buses to operate at optimum speed without interference from other traffic.

Brisbane Inner Northern Busway Section 5 (2002-2004)

CLIENT: Queensland Transport

ENTITY: Clough Seymour Whyte Constructions

LOCATION: Brisbane, Queensland

The design, construction and commissioning of a 1.6 km dual lane carriageway and associated works, including three bridges and two 'cut and cover' tunnels with a combined length of 400 metres.[106]

An arched busway through a sunken roadway adjacent to a golf course was an architectural challenge requiring an unusual blend of aesthetics and functionality. Once the busway was constructed, a special mesh was fitted to protect traffic and passengers from wayward golf balls from the neighbouring Victoria Park Golf Club.[107]

As much as 98 per cent of construction waste materials were either recycled or reused, leaving only two per cent to be disposed of as landfill. This included the remodelling and reuse of the Countess Street Rail Bridge as a new busway bridge.

Greenhouse gases generated by construction vehicles, plant and equipment were completely offset by planting trees in the Greenfleet programme. The project offices were fully powered by energy generated from renewable sources.

The scheme development allowed part of the busway to be constructed on the QR corridor by remodelling rail tracks and platforms at Queensland's primary rail passenger hub, thus freeing up the existing street networks during and after construction.[108]

Construction was carried out with minimum disruption to commuters, pedestrians and golfers.

Roe Highway Stage 7 (2003-2006)

CLIENT: Main Roads WA

ENTITY: Roe 7 Alliance (Clough, Maunsell Australia and Main Roads WA)

LOCATION: Canning Vale to Leeming, Western Australia

Clough was a major participant in the Roe 7 Alliance, formed with Main Roads Western Australia, to deliver Stage 7 of the Roe Highway development.

The project formed a vital link in the planned Perth metropolitan regional road network between the National Highway "gateway" in the Eastern Corridor, strategic industrial areas in Perth's eastern and southern suburbs and the South West region of the State.

The Stage 7 project extended the Roe Highway from South Street to the Kwinana Freeway. Works included:

- 4.5 kilometres of four-lane controlled access highway to freeway standards
- Grade separation at South Street and Karel Avenue, with associated bridges and on/off ramp connections to Roe Highway
- A grade separated "freeway - freeway" interchange at the Kwinana Freeway
- A Principal Shared Path along the northern side of the new Highway alignment
- Pedestrian/cyclist facilities with grade separation
- Fauna facilities linking the road reserve and adjacent nature reserves
- Widening adjacent sections of the Kwinana Freeway and associated rail bridges
- Landscaping and public art works.

The Alliance was responsible for the finalisation of work scope planning, detailed design and construction of the works, and maintenance of landscaping works. An integrated project team was established with representation from Main Roads, contractor and designer organisations.

The highway was opened to the public on 12 March 2006.

The Roe Highway Stage 7 won the Western Australian Excellence in Environment category (projects over $15M) Case Earth Awards in 2006 'for delivering a $75 million 4.5 km freeway extension through pristine urban bushland, tailoring the project along the way to minimise the environmental impact.'[109]

Toowoomba Pipeline (2009-2010)

CLIENT: LinkWater projects, Department of Infrastructure and Planning, Queensland Government

ENTITY: Toowoomba Pipeline Alliance Clough Diversified AECOM joint venture

LOCATION: South-East Queensland

The project involved the fast-tracked design and construction of the Toowoomba Pipeline that connects the Wivenhoe Dam near Brisbane and the Cressbrook Dam close to Toowoomba in South East Queensland. The pipeline has a length of 38 km and a capacity of 14,200 mega litres a year and was undertaken by LinkWater Projects on behalf of the State Government's Department of Infrastructure and Planning (DIP).

The $187 million project involved the design and delivery of a pumped raw water pipeline from Lake Wivenhoe to Lake Cressbrook. The pipeline runs approximately 38 kilometres through rural properties and State forest within the Somerset Regional Council boundaries. From there it is reticulated by the Toowoomba Regional Council according to its needs and using its own existing infrastructure. The pipeline is designed to pump in only one direction, east to west.

The pipeline has the capacity to deliver 14,200 megalitres of water a year to Cressbrook, or 39 megalitres per day if needed. The mild steel cement-lined pipe at least one metre below the surface is 762 mm in diameter. The Toowoomba pipeline was installed to cater for the final flows and pressures at the planned 2026 capacity.

The elevation at Cressbrook Dam is approximately 250 metres above the pump station, measured at the current top of the Cressbrook Dam wall.

The pumping station consists of a low lift pumping facility on a structure in Lake Wivenhoe feeding water to tanks onshore. The low lift pumps operate down to the equivalent of 10 per cent of Lake Wivenhoe's storage level. A high lift pump station then transports the water at a rate of 39 megalitres per day from the tanks to Lake Cressbrook.

The vertical profile of the pipeline through the rolling hills and up the range required special design attention to air and silt management at the start-up, shutdown and surge phases. The route required micro-tunnelling underground to minimise impact at major highways. There are two crossings under Main Roads highways and several creek crossings.

The project was completed ahead of time and within budget, and also achieved the desired environmental outcomes and significantly lower pipeline operational energy costs.[111]

Although ground conditions were generally good, approximately 6 km of the 14 km of the route right-of-way was obstructed by hard bedrock, which could not be trenched by WDS's T1055 Vermeer Trencher or excavated by conventional means.

Crushing and screening of the line blasted rock (blue metal) was undertaken using a mobile rock crushing and screening plant established for this project in the previously inaccessible Cressbrook Creek gorge.

Welding procedure qualification used a mix of manual metal arc welding and flux cored arc welding practices, with full integrity testing of each welded joint by magnetic particle/non-destructive testing methods and holiday testing to ensure coating integrity.

Once each joint and its coating integrity were verified, the location and elevation of each of the 3,600 pipe joints was surveyed for as-constructed record purposes and recorded in a GIS geo-database along with the barcode identifier of the two pipe elements adjacent to each joint. In this way, the manufacturing and construction quality records were fully integrated with the as-constructed position of the pipe in the ground.[110]

The Toowoomba Pipeline was awarded the Australian Water Association 2010 Queensland Infrastructure Project Innovation Award.

Mundaring Weir Outlet Upgrade (2017-2018)

CLIENT: Water Corporation of WA

ENTITY: Clough

LOCATION: Mundaring, Western Australia

The project finished with a consistent safety performance of over 66,000 work hours without an incident.

As a result of on-going drought conditions in WA the Water Corporation decided to undertake a range of upgrades and refurbishments to the existing intake tower and outlet structures at Mundaring Weir, 39 kms from Perth.

These upgrades meant the Water Corporation could lower the minimum operating level of the reservoir by 6.6 metres reducing the dead storage capacity and reduce the surface area of the weir that, in turn, lower annual evaporation.

Clough secured the EPC contract for the upgrade and refurbishment of the existing intake tower and outlet structures. This included the replacement of aging infrastructure and updating of the intake and outlet works to meet future climatic requirements.

Among other elements the project involved a 400 tonne crane lifting a 42 metre long steel pipe into the intake tower.

The original Mundaring Weir was part of C Y O'Connor's scheme that transported water some 560 kms to the Eastern Goldfields of Coolgardie and Kalgoorlie in the eastern part of Western Australia. Built between 1898 and 1901 it is considered to be one of Australia's greatest engineering achievements.

The dam was raised in the 1940s. In 2011 a new water treatment plant was constructed and commenced operation in 2014.

Beenyup Advanced Water Recycling Plant Stage 2 (2017-2019)

CLIENT:	Water Corporation of WA
ENTITY:	Clough SUEZ
LOCATION:	Craigie, Western Australia

The Clough SUEZ Water Partners joint venture secured the contract to design and construct the Stage 2 expansion at the Advanced Water Recycling Plant in Craigie.

As part of Water Corporation's Groundwater Replenishment Scheme, the plant had the capacity to treat secondary treated wastewater and recharge up to 14 billion litres of recycled water into groundwater supplies each year.

The scope of the expansion project included doubling the plant's capacity to recharge up to 28 billion litres of recycled water each year to provide further water security to the residents of Perth.

Given that 80% of the wastewater collected across WA is treated in the Water Corporation's three largest treatment plants, one of which is Beenyup, increasing its capacity was an important part of the Corporation's plan to meet current and future demand.

Clough has a long-standing history with the Water Corporation of WA spanning over 50 years. In 1961-3 Clough worked on the Ord River Diversion Dam for the then Department of Public Works, then the Wanneroo Reservoir for the Metropolitan Water Supply, Sewerage and Drainage Board (1975) and Hamilton Hill Reservoir (1975).

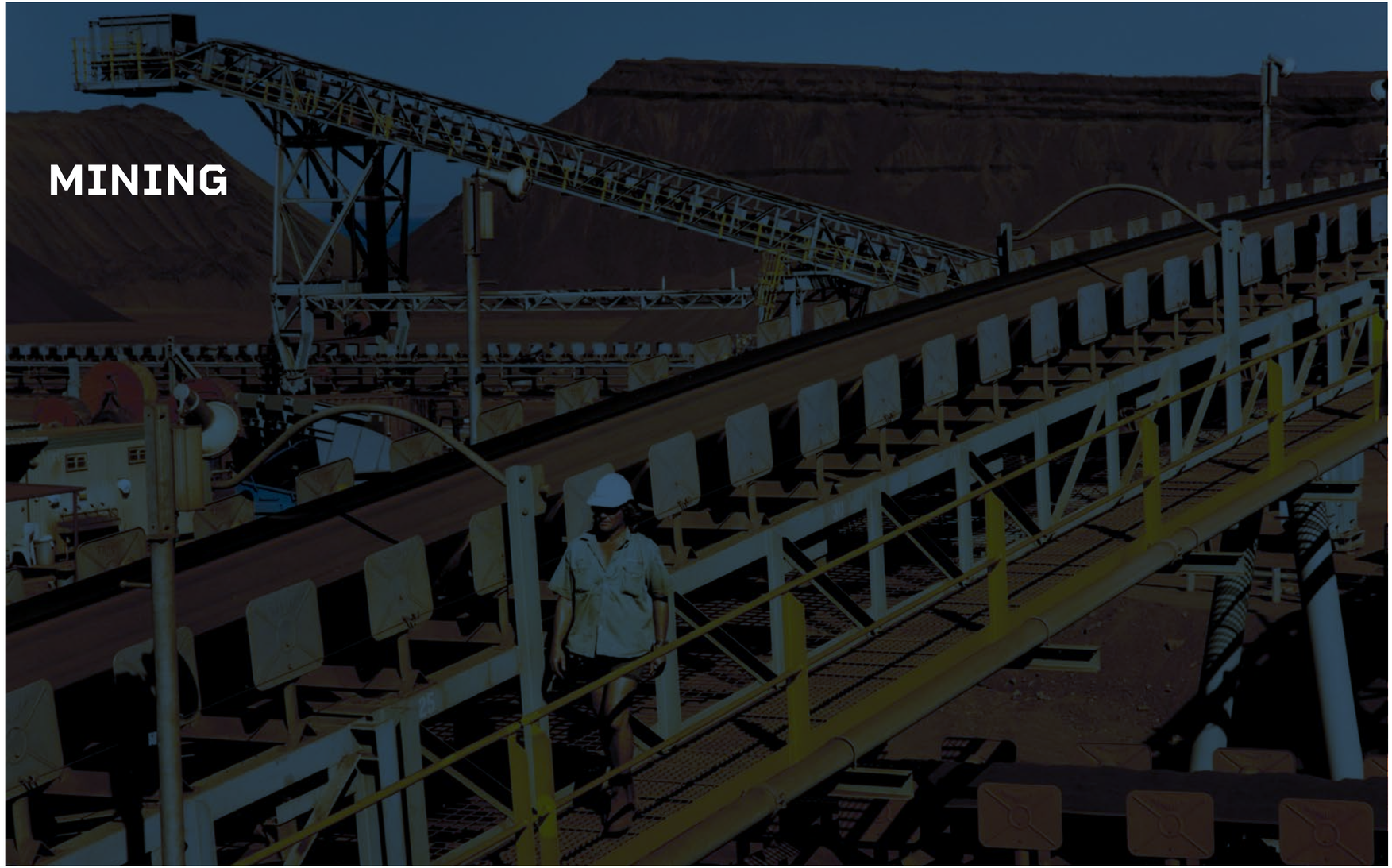
PNG Earthquake Response Project (2018-2019)

CLIENT:	Oil Search Ltd (OSL)
ENTITY:	Clough
LOCATION:	Kutubu region, Southern Highlands, Papua New Guinea

The project team completed many major and high-risk repair scopes without an incident.

Clough and the Oil Search Earthquake Response project team worked to repair roads, bridges, camps and infrastructure damaged by the 7.6 magnitude earthquake that hit the Southern Highlands, Hela, Gulf and parts of Western Province in February 2018.

Clough worked together with Oil Search Limited (OSL), local lanco companies and the local community to rebuild the roads and bridges which link the Kutubu region with the Highlands highway; this major access road provides a crucial logistics route for supplies and access for OSL as well as the rest of the communities along the Kutubu access road.



MINING

- Cape Lambert Iron Ore Marine Facility (1970-1973) and Upgrade (2001-2002)
- Worsley Alumina Plant (1981-1983)
- Constanza Sud Iron Ore Ship Unloaders (1987-1989)
- Porgera Gold Mine Stages 1 and 2 (1989-1990)
- Kaltim Prima Coal Loading Facility (1989-1991)
- Jimblebar Iron Ore Contract Mining (1993-1999)
- Telfer Underground Mine Development (1994-1999)
- Lihir Gold Mine Development (1996-1997)
- Dalrymple Bay Coal Terminal Stage 3 (1996-1998) and Stage 6 (2001-2003)
- Gunung Bayan Coal Project (2000-2008)
- Hismelt Kwinana Plant (2002-2005)
- Boroo Gold Project Process Plant (2002-2003)
- Boddington Gold Mine (2005-2009)
- Sanga Sanga Coal Mining (2005-2009)
- Anderson Point AP5 Wharf (2014-2015)
- Oyu Tolgoi (2017-Current)
- South Flank Iron Ore project (2018-Current)
- Koodaideri Rail Formation North (2019-Current)

Cape Lambert Iron Ore Marine Facility (1970-1973)

CLIENT:	Cliffs Robe River Iron Associates
ENTITY:	Harbourworks Clough
LOCATION:	Cape Lambert, Western Australia

Completed in 1973, the project was a design and construct joint venture with Royal Netherlands Harbourworks valued at $26 million. At the time it was Australia's biggest resource marine facility.

It involved the design and construction of 2,340 metre jetty to accommodate 100,000 and 150,000 DWT ore carriers simultaneously, loading iron ore pellets (fines) at rates of up to 6,000 tonnes per hour, as well as a service wharf.[112] The service wharf consisted of an approach trestle 460 metres in length with a loading platform measuring 155 metres x 18 metres.

The ore wharf comprised a massive trestle structure 2,340 metres long. The trestle carried a single lane roadway, a conveyor belt and a walkway out to the 280-metre long loading wharf.

Towering 18.6 metres above the spring low water level, the wharves stand on cylindrical steel piles driven into the sea floor. That made the Cape Lambert Jetty the highest jetty anywhere, the height of a six-storey building.

The remote Pilbara site presented Clough with a number of logistical challenges, no infrastructure to service the construction community, and an inhospitable, cyclone-prone climate.

To convey the scale of the project, Albert Scott recalls: 'the joint venture needed to dredge about 580,000 cubic yards (sic) of material, deliver and install 10,000 tons of steel piling, 7,000 tons of structural steel, six acres of wooden deck, five miles of oil and water lines and 50 tons of lighting systems. In addition, the company had to build single workers' and family staff housing, storage workshop, fabrication and administration facilities, and essential utilities.'[113]

It was Clough's first major lump sum, turnkey design and construction contract, and it won a Construction Achievement Award in 1973 from the Australian Federation of Construction Contractors.

'Mr Wesselingh was always at his best during negotiations,' recalls Harold. 'We met with the clients in Tokyo. We increased the deck level by a couple of metres because it was more exposed to the elements, but thought this would be resisted by the client. An American oceanographer ridiculed such a modest height increase and suggested an additional five metres.

'Taken aback, Mr Wesselingh quietly suggested that if the sea levels being quoted by the oceanographer were correct, the ocean would not only submerge the power station and plant onshore but would also flow up to the first floor of the Raebourne Hotel a few kilometres inland.'[114]

- Harold Clough

'Cape Lambert was a magic project, an amazing feat for the joint venture. The older I get and look back, the more I think how classic the project was in terms of being involved from the basics through to the end.'

'Previous weather and tidal studies up in that area had been primarily related to fishing. Nobody really knew much, except that every year there were cyclones and they were a bloody nuisance.'

- Geoff Smith

'Cape Lambert was a tremendous project for us. It really was the making of the modern Clough. It caused a lot of headaches, but it finished up with a substantial profit and a happy client. Our client puts this facility up against any other in the world.'[116]

- Albert Scott

Cape Lambert Jetty Upgrade (2001-2002)

CLIENT:	North Limited
ENTITY:	Clough
LOCATION:	Cape Lambert, Western Australia

Wharf extension to accommodate increased volume from the West Angeles deposit.

Extending the wharf by 125 metres to provide for a second ship loader, and widening of the 2.7 km approach jetty to facilitate the installation of a second ore conveyor system.[115]

Worsley Alumina Plant (1981-1983)

CLIENT: Worsley Alumina

ENTITY: Raymond Engineers Australia prime contractor.

LOCATION: Collie, Western Australia

Clough was involved in many contracts for Worsley, including piling for the Power Station which incorporated 14 km of H-pile sections that were driven in a period of three and a half months, construction of a concrete stack for the Power House, civil work associated with the Demineraliser Plant, and another piling contract for the foundations at the shipping facilities in the inner harbour of Bunbury.

Construction of the chimney for the Power House was challenging and involved slip-forming the 10.5-metre-diameter windshield 76 metres high. Six intermediate concrete floors were cast at approximate 12-metre intervals. These slabs support the three acid-resistant brick flues. This design and construct contract was in joint venture with Danalith A/S, which carried out the detailed design work.[117]

In addition, in just four weeks Clough also installed 4.5 km of H-Pile sections for Worsley's shipping facilities in Bunbury's inner harbour.[118]

Constanza Sud Iron Ore Ship Unloaders (1987-1988)[119]

CLIENT: Hancock Mining Limited

ENTITY: Clough

LOCATION: Romania, Europe

The contract with Hancock Mining was for the engineering and project management of two large ship unloaders for the port of Constanza Sud in Romania.

By 1988 both units had been commissioned with the balance of the plant supplied by Romania brought into use so that Australian iron ore could be taken either to an interim stockpile or directly to the barge for passage via the new Black Sea/Danube Canal system to steelworks on the Danube River.

The two unloaders, two of the largest units in the world, were constructed in Vienna by Voest Alpine AG and barged in pieces down the Danube to Constanza Sud Port.

Each unloader could lift a total load of 50 tonnes and reached out over the water to a distance of 40 metres, enabling the servicing of vessels up to 250,000 DWT. Rail centres were 28 metres and the back boom allowed for a reach of 30 metres beyond the land side rail for emergency stockpiling behind the unloaders.

The 170,000 DWT MV Magandang Ilog carried a trial Australian ore shipment for the ship unloader No. 1 and the MV Mineral Diamond, 140,000 DWT, for the ship unloader No. 2.

The ore from the Mt Newman fines stockpile was loaded at Port Hedland.

The agreement between Hancock Mining and Mineral ImportExport also called for the delivery of 53 million tonnes of ore over a 12-year period.

The supply and installation of the two unloaders enabled Hancock Mining to enter new, largely untapped markets.

Trucks and iron ore wagons

Clough also project-managed the construction of five, 120-short-ton heavy haulage trucks manufactured by the Intreprinderea Mecania works in Misra Romania. The trucks were designed for Pilbara operation and for use in future Hancock projects in the northwest of Western Australia.

In a countertrade deal with Romania involving the supply of the two ship unloaders, Hancock Mining accepted as part payment the receipt of components for 250 iron ore wagons specifically designed for use on the Mt Newman rail system. Clough project-managed the manufacture and delivery of the wagons to Australia.

Porgera Gold Mine Stages 1 and 2 (1989–1990)

CLIENT: Placer (PNG) Pty Ltd

ENTITY: Clough Niugini

LOCATION: Porgera Gold Mine, Enga Province, Papua New Guinea

Clough Niugini utilised a full complement of multi-disciplinary engineering skills in a range of civil works at the Porgera Gold Project for Placer.

Over 100 people were employed on the Phase 1 construction for Placer (PNG) Pty Ltd Porgera Gold Project.

The project called for the installation of some 5,200 cubic metres of reinforced concrete over a 20-week period. Within the first 12 weeks, more than 5,000 cubic metres of concrete had been completed, and then the scope of work was increased so that by early 1990 more than 10,000 cubic metres had been poured and it was 'still in progress.'[120]

Clough Niugini operated under the management of Clough Construction Queensland.

Kaltim Prima Coal Loading Facility (1989–1991)

CLIENT: Kaltim Prima Coal

ENTITY: Petrosea

LOCATION: Kalimantan, Indonesia

In Kalimantan, Indonesia, Petrosea provided extensive services to the major coal companies, Kaltim Prima Coal and Arutmin Indonesia. These included the initial mine development works, haul road construction, port construction, overburden stripping, mining of large test samples (120,000 tonnes) and construction of permanent infrastructure facilities including power earthworks for a power station.[121]

This was the largest single coal mine project to have been awarded to a contractor in Indonesia and meant the removal of 7,500,000 cubic metres of overburden and the winning and haulage of 2,150,000 tonnes of coal over a four-year period.[122]

The Kaltim Prima Coal marine offloading facilities were carried out in joint operation with PT Ballast Indonesia and PT Decorient. They entailed the design and construction of a 2,500-metre-long approach structure consisting of an earth fill causeway and steel jetty trestle, a wharf head supporting two radial quadrant ship loaders, and berthing and mooring structures that could accommodate vessels of up to 180,000 DWT.[123]

The project also involved the design and construction of a large barge unloading service wharf suitable for mooring and transport as well as fuel barges and RORO vessels.[124]

Separately, PT Petrosea was contracted to construct major buildings and infrastructure at the KPC development site in Kalimantan that included port and mine camps, housing accommodation, site offices, a school, a laboratory, a clinic and airstrip buildings to service the coal mining operations.

Jimblebar Iron Ore Contract Mining (1993-1999)

CLIENT: BHP Iron Ore

ENTITY: Clough

LOCATION: Pilbara Region, Western Australia

For five years Clough provided services for mining, transportation, operations and maintenance of a crushing and screening plant, and train loading of ore.

The development of detailed operating procedures, maintenance strategies and plans were vital to increased production and efficiency over the period.[125]

By 1995 Clough was achieving production rates of 6 million tonnes per annum.[126]

The initial three-year contract was extended. Works included drilling, blasting and train loading the ore and operation of a crushing and screening plant.[127]

Telfer Underground Mine Development (1994-1999)

CLIENT:	Newcrest Mining Limited Australia
ENTITY:	Clough
LOCATION:	Pilbara Region, Western Australia

The Telfer operation is located in the Pilbara region of Western Australia, approximately 400 kilometres east-south-east of Port Hedland. The mine opened in 1977 as a joint venture between BHP Billiton and Newmont Mining. In 1990, a merger between Newmont Australia Limited and BHP Gold Limited resulted in the creation of Newcrest Mining, Australia's largest gold producer, which now owned the Telfer Mine. In 1997, the mine reached the milestone of having produced five million ounces of gold.

Clough worked continuously at Telfer between 1994-1999 on projects including mine development, ore production, and civil and mechanical works.[128] The 1994 contract for the Middle Vale Reef development entailed challenging underground conditions. A project extension in 1995 for upgrading equipment and facilities ensured greater production,[129]and in 1996 there were the construction of two surface leach pads covering an area of 180,000 sq metres, the supply and installation of the main underground pump station and emergency escape ladderways, and the ongoing underground mine development and ore production contracts.[130]

Mine development was extended again in 1999 on the strength of financial and technical performance and a milestone safety achievement of 500 days lost time injury free. Clough's projects included ore production for the I 30 decline and M 10 and M 30 reef development.

The mine was closed in the early 2000s and then reopened in 2004.

Lihir Gold Mine Development (1996-1997)

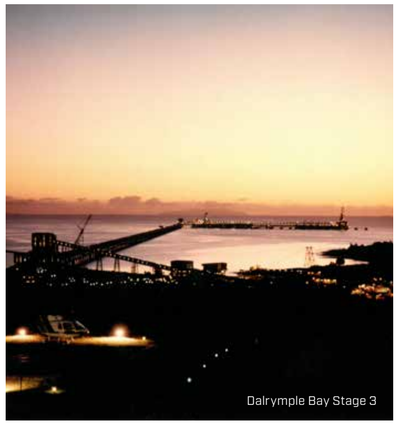
CLIENT:	Lihir Management Company
ENTITY:	Clough
LOCATION:	Lihir Island, New Island Province, Papua New Guinea

One of the world's largest undeveloped gold deposits at the remote Lihir open cut gold mine in the Bismarck Archipelago of Papua New Guinea.

From January 1996 through to May 1997 Clough employed 600 people to service six substantial contracts.

Clough's work included the design and construction of a unique tailings disposal system to deposit mine waste 120 metres below sea level. This included a state-of-the-art solution involving the installation of a 1200mm-diameter HDPE telescopic disposal pipeline.

Other project components included boat landings and vessel access channels, the installation of 23,000 cubic metres of concrete structures, structural mechanical and pipework erection and pre-commissioning services for the crushing, conveying and grinding facilities, pressure oxidation building erection and equipment installation, and a self-contained hospital and medical centre.[131]


Dalrymple Bay Stage 3


Dalrymple Bay Stage 3

Dalrymple Bay Coal Terminal Stage 3 (1996-1998) and Stage 6 (2001-2003)

CLIENT: Ports Corporation of Queensland

ENTITY: Clough

LOCATION: Mackay, Queensland

Dalrymple Bay is part of one of the largest coal exporting facilities in the world and moves around a quarter of Australia's export coal. The terminal ships coal from the Bowen Basin in central Queensland to overseas markets including Japan, India, Korea and Europe.

The Stage 3 expansion of the coal loading facility for the Ports Corporation of Queensland.

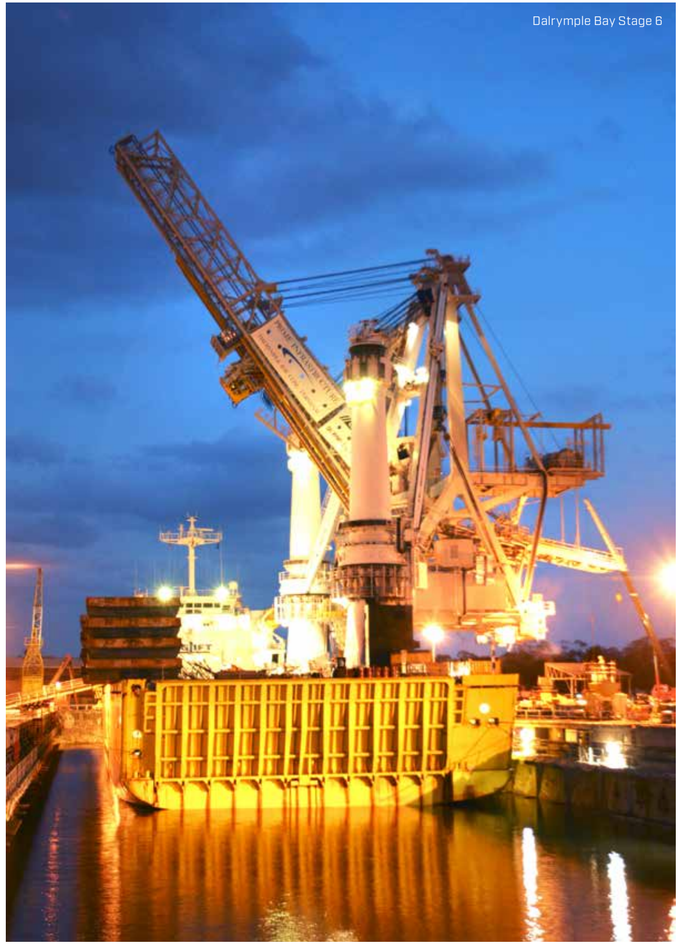
This involved the installation of a second ship loader and feed conveyors from the shore. New conveyor galleries were prefabricated offsite for the existing 3.7 km-long approach jetty and 800-metre-long wharf head. A series of piles were installed along the entire length of the wharf head to support a second feed conveyor and tripper. A new 1,050 tonne ship loader was built in Brisbane and transported to the Hay Point site by a heavy lift ship.[132]

In 2001, Clough was awarded the Stage 6 expansion project to deliver greater throughput of coal tonnages from the terminal. Completed mid 2003, it increased capacity to around 53Mtpa. [133]

Ivor Peries remembers working on the Stage 6 expansion project well.

'It was one of the most challenging projects I've worked on. It involved the construction of a self-contained, 1,500 tonne machine built to very fine tolerances, and we had to deliver it fully functional. There was no room for error. And we had to transport it by ship from Brisbane, which meant it had to be built so that it could fit underneath the Gateway Bridge in Brisbane.'[134]


Dalrymple Bay Stage 6


Dalrymple Bay Stage 6

Albert Scott recalls that:

'In the 1970s we did a lot of design work to stay alive. It's not commonly known that we actually designed the layout of the Dalrymple Bay Port Facility for then Hail Creek Thiess Peabody, and eventually they sold all that design work to the Queensland Harbour Authority, and that very large facility has been built and has been operating almost identically to the conceptual design of Harbourworks Clough.' [135]

Gunung Bayan Coal Project (2000-2008)

CLIENT: PT Gunung Bayan Pratama Coal

ENTITY: Petrosea

LOCATION: East Kalimantan, Indonesia

Petrosea was awarded the contract for overburden stripping operations at the Muara Pahu coal mine in East Kalimantan, one of Clough's biggest Indonesian deals at the time.[136]

This contract provided a solid foundation for Petrosea's contract mining business in Kalimantan.

The resources from this mine were exported to Asia and Europe through Balikpapan as semi-soft coking coal and high calorific value coal.

The initial contract in 2000 was for stripping 132 cubic metres of overburden over four and a half years, and generated $172 million in revenue. By 2001 Petrosea had mined 24 million cubic metres of material from 12 pits.[137]

Petrosea's contract was extended for another four years in 2004, and in 2007 production continued at the accelerated rate of three million bank cubic metres per month.[138]

HIsmelt Kwinana Plant (2002-2005)

CLIENT: Rio Tinto

ENTITY: Clough Kvaerner

LOCATION: Kwinana, Western Australia

Clough Kvaerner E&C jointly developed Rio Tinto's innovative new HIsmelt pig iron processing plant at Kwinana. HIsmelt is an iron making process in which fine iron ores and non-coking coals are injected directly into a molten iron bath, contained within a smelt reduction vessel to produce high quality molten pig iron.

The contract involved engineering, procurement and construction management (EPCM) of a world-first 800,000 tonnes per annum pig iron processing facility plus assistance with commissioning.

Included in the project were the dismantling of the original pilot plant and engineering support for key process systems sources from specialist technology providers and operators.[139]

The project won the Western Australian Engineering Excellence Award in 2007 for the most outstanding engineering project in the state across all categories.

Boroo Gold Project Process Plant (2002-2003)

CLIENT:	Boroo Mongolia Mining Corporation
ENTITY:	Clough
LOCATION:	Solenge Province, Mongolia

Boroo was Mongolia's first carbon-in-leach gold processing plant and was designed to process 1.75 million tonnes per annum at Boroo in the remote Solenge Province.

The project included the construction of water bores and a collection system and central storage tank, as well as a tailings pipeline and distribution system.

The project materials supply route was logistically challenging, as it required delivery by road and rail across China into Mongolia.

Boddington Gold Mine (2005-2009)

CLIENT:	Newmont
ENTITY:	Clough Murray & Roberts and Aker Kvaerner Australia (AKCMR)
LOCATION:	Boddington, Western Australia

Over the 20-plus year mine life, the plant will produce an average of 850,000 ounces of gold and 30,000 tonnes of copper per year.[140] The project achieved its first gold pour on 29 September 2009 and, at peak production, will be Australia's largest gold producer, accounting for 8 per cent of the nation's gold.[141]

The joint venture secured a $350 million contract as part of the larger $1.5 billion new plant expansion of the Boddington Coal Mine.

It was constructed in Western Australia with process engineering taking place in Santiago, Chile, and infrastructure engineering, contract administration and major procurement functions undertaken from the joint venture office in Perth.

Site construction included extensive earthworks and major civil works, a 2,300-bed village, water supply for the village, and plant operations, design and construction.

The project was recognised with an Engineering Excellence Award in 2010.

Sanga Sanga Coal Mining (2005-2009)

CLIENT: PT Mitra Internusa Persada

ENTITY: Petrosea

LOCATION: East Kalimantan, Indonesia

This was a four-year mine services contract involving overburden stripping and coal mining activities at the greenfields Sanga Sanga coal concession located near Samarinda in East Kalimantan, where approximately 1.8 million tonnes of coal were excavated and hauled by Petrosea.

Anderson Point AP5 Wharf (2014-2015)

CLIENT: Fortescue Metals Group

ENTITY: BAM Clough

LOCATION: Port Hedland, Western Australia

This project involved the design and construction of a fifth iron ore loading berth at Fortescue Metals, Port Hedland facility, in Western Australia. It included a 306-metre wharf extension and maintenance platform to accommodate a travelling ship loader from the existing AP4 berth, seven berthing dolphins, and the supply and installation of wharf conveyor modules.

The wharf extension enables ship loader access to both the AP4 and AP5 berths.

A concrete roadway along the full length of the AP5 wharf provides vehicle access to both berths.

Seven independent berthing dolphins were designed and constructed to handle iron ore carriers over the 6-metre tidal range in Port Hedland.[142]

Oyu Tolgoi (2017-Current)

CLIENT: Rio Tinto

ENTITY: Clough as part of GCR Mongolia Joint Venture

LOCATION: Gobi Desert, Mongolia

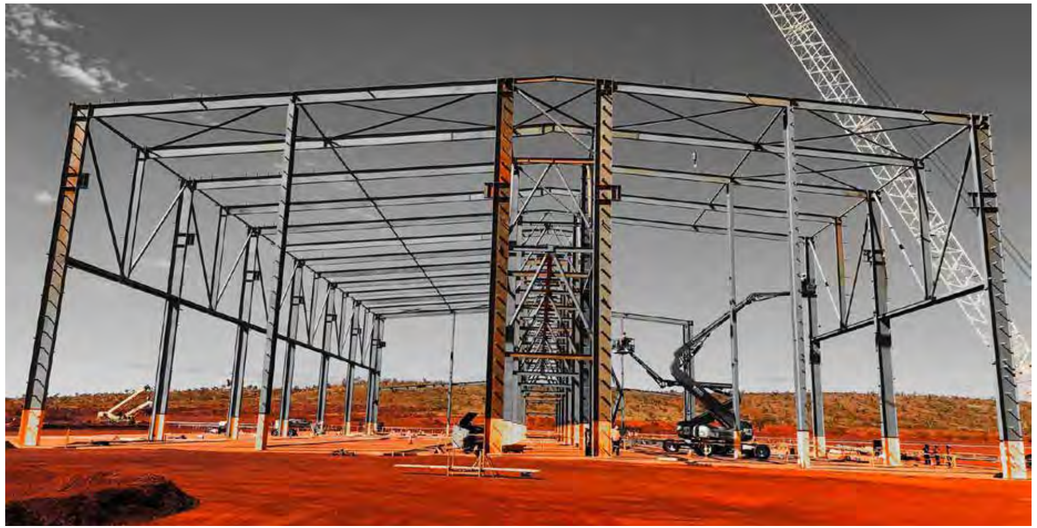
Clough, as part of its GCR Mongolia joint venture, is participating in one of the most exciting developments in copper and gold mining. Oyu Tolgoi has reserves and resources that make it one of the world's largest copper and gold deposits.

Situated in the southern Gobi Desert of Mongolia, approximately 550 km south of the capital, Ulaanbaatar and 80 km north of the Mongolia-China border, Oyu Tolgoi is jointly owned by the Government of Mongolia (34 per cent) and Turquoise Hill Resources (66 per cent, of which Rio Tinto owns 51 per cent). Since 2010, Rio Tinto has been the manager of the Oyu Tolgoi project.

The first scope of work included:

- Bulk and detailed earthworks
- Civil and concrete works for major concrete structures
- Buried services works including, 35kV, 10.5kV electrical cabling and multiple pipeline scope works consisting of HDPE and carbon steel
- Decommissioning of 35kV overhead power lines, including the removal of eight tower structures.

In 2018, the joint venture secured two additional scopes of work: the construction and commissioning of the blind sink and concrete line of Shafts No 3 and No 4 and the Construction of the Underground Material Handling System for Stage 1.



South Flank Iron Ore Project (2018-Current)

CLIENT:	BHP Billiton
ENTITY:	Clough
LOCATION:	Pilbara Region, Western Australia

Since 2018, Clough has been part of the BHP South Flank Project in the Pilbara with two scopes of work: the Non-Process Infrastructure (NPI) and the Ore Handling Plant (OHP).

The NPI scope includes the engineering and construction of the facility including civil, structural, mechanical, piping, electrical and instrumentation.

In addition, in 2019 Clough was awarded the construction of the Ore Handling Plant (OHP). The project will be self-performed by Clough's Western Australia based team, with the scope including structural, mechanical, piping, electrical and instrumentation for the OHP structures, including the interconnecting conveyors and transfer stations.

The South Flank deposit is located approximately 130 km by road north-west of the town of Newman, and approximately 8 km to the south of the Company's existing Mining Area C operation. The South Flank project will fully replace production from the 80Mtpa (100 per cent basis) Yandi mine which is reaching the end of its economic life.

Koodaideri Rail Formation North (2019-Current)

CLIENT:	Rio Tinto Iron Ore
ENTITY:	Acciona Clough Joint Venture (ACJV)
LOCATION:	Pilbara Region, Western Australia

Clough, as part as the Acciona Clough Joint Venture (ACJV) was awarded a civil works contract for the construction of the northern rail formation for the Rio Tinto Iron Ore Koodaideri Project.

The Koodaideri project is a greenfield mine development for Rio Tinto Iron Ore, in the East Pilbara mining region.

The Koodaideri mine will initially be developed with an annual capacity of 43 million tonnes. To allow the transportation of iron ore product to either Dampier or Cape Lambert, the project requires a 170km rail spur to connect the Koodaideri mine to the existing Rio Tinto Iron Ore rail network, just south of Lyre Siding at Numbat.

The scope includes 100km of rail formation earthworks, culverts, bridge construction, access roads and level crossings.

ENERGY

- Barrow Island (1966-1967)
- North Rankin A Gas Trunkline (1981-1982)
- Woodside Marine Structures Phase I (1983-1984)
- Woodside Marine Structures Phase II (1985-1987)
- Wesfarmers LPG Plant (1987-1988)
- Goodwyn A Modules (1990-1992)
- Harriet A Field Development Offshore Facility (1984-1986) / Varanus Island Wet Gas Pipeline (1987-1988)
- Challis Field Facilities (1988-1989)
- Jabiru Field Development Phases 1-4 (1986-1989)
- Hides Field Development (1990-1991)
- Griffin Field Development Project Mooring and Flowline Installation (1993-1994)
- Pagerungan Besar Field Development Project (1990-2003)
- Kutubu Infield Pipelines (1991-1992)
- Dhodak Field Gas Condensation Plant (1992-1995)
- East Spar Development Onshore and Offshore Facilities (1995-1996)
- Liuhua 11-1 Field Development Project Phase 1 and Phase 2 (1994-1996)
- Uch Gas Transport Pipeline (1996-1997)
- The Gorgon Project (1998 / 2009-2016)
- Bayu-Undan Floatover and Completions Project (2001-2004) / Operations and Maintenance services (2004 - Current)
- PNG Oil Refinery (2002-2005)
- Maari Field Wellhead Platform (2005-2009)
- Hegigio Pipe Bridge (2004-2005)
- Train V LNG Jetty Expansion (2005-2007)
- Pluto LNG Jetty (2007-2009)
- PNG LNG Project Hides Gas Conditioning Plant (2009-2014)
- PNG LNG Project Upstream Infrastructure (2009-2014)
- PNG LNG Project Marine Jetty (2010-2013)
- Nitric Acid Plant and Ammonium Nitrate Plant Number 3 (NAAN3) (2011-2014)
- The Ichthys Project (2011-Current) – Integrated Project Management Support Services Jetty and MOF, Hook-up and Commissioning
- Wheatstone Project (2012-2018) – Product Loading Facility and Tug Berths / Offshore Hook-up and Commissioning
- Arrow Upstream FEED (2014-2016)
- Karratha Life Extension (KLE)Project Marine Installation Services (2015-2017)
- Port Moresby (POM) Power Station (2017-2019)
- Snowy 2.0 (2019-Current)

Barrow Island Oilfield Development (1966-1967)

CLIENT:	West Australian Petroleum Ltd (WAPET)
ENTITY:	Harbourworks Clough
LOCATION:	Barrow Island, Western Australia

The Barrow Island project was important for Clough for a number of reasons. It was the first offshore project for the relatively new Harbourworks Clough (now BAM Clough) joint venture and proved its ability to operate in remote locations. It was also challenging, as the island was a Class A Nature Reserve that required the joint venture to minimise disruption to the environment.

Commercial quantities of oil were discovered on Barrow Island, 55 kilometres of the North West Coast of Western Australia, in 1964 by WAPET. Full-scale drilling began in November 1966 and the first shipment of crude oil left Barrow in April 1967.

Since there were no suitable deepwater approaches to Barrow to allow a jetty loading point, the project required the construction of a 10-km-long, 508mm submarine pipeline and the associated marine terminal[143] for conveying crude oil from Barrow Island and loading into tankers. While a small project in current terms at just $2.25 million, it was the fourth largest project for the company at the time, after the Narrows Bridge, Ord River Dam and Jetty at King Bay.[144]

It was also the first submarine pipeline construction for the offshore industry that had been built in Western Australia, a significant milestone for Clough and the State.[145] At this time there was little in the way of infrastructure and few services available in the region – limited roads, limited sea transport to the site and a small workforce.

With little infrastructure and few services in the region, the joint venture established a facility on the island to weld pipe into strings approximately 700 metres in length. Each string was connected by a flanged and bolted joint on the seabed.

The joint venture established its own pipe welding facility on the island, and skilled welders were recruited in the US and bought to Western Australia to train local tradespeople.[146]

A railway was built to take the pipes down to the shore, and then a jack-up platform pulled the pipes out, lowering them to the seabed. Divers would bolt it up and then the process would be repeated.

'As we didn't have a pipe laying barge, our solution involved connecting pipeline sections on the seabed, which prompted the Texan and who managed the overall project to say "You've turned this thing to a bloody plumbing job."'[147]

- Harold Clough

North Rankin A Gas Trunkline (1981–1982)

CLIENT:	Woodside
ENTITY:	Clough ETPM
LOCATION:	North West Shelf, Western Australia

The 1981 North Rankin A Platform to the Burrup Peninsula was the company's first major thrust into offshore oil and gas work. The trunkline was to carry gas and condensate from the North Rankin A Platform to the processing facilities onshore.

The contract to lay 135 km of 1016-millimetre-diameter submarine pipeline from the production platform that stands in 125 metres of water to the Burrup Peninsula near Dampier by using the first self-propelled pipe laying barge ever used in Australia was awarded in 1981 and completed in 1983. This was a world first for subsea technology. After a year of training and procedure development, the pipelaying barge was mobilised to site on schedule on 1 May 1982.[148]

It was also the first time that gas shielded welding had ever been used on an automatic basis.[149] The system employed a solid fusion wire with gas shielding, which allowed precision welding with four torches working simultaneously.[150]

Clough ETPM brought in the Saturne semi-automatic welding system that had never been used before on an undersea pipeline.[151]

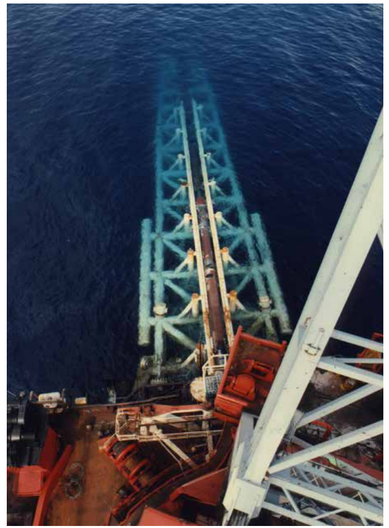
Their joint venture partner was Entrepose pour les Travaux Petroliers et Maritimes (ETPM).

ETPM

In 1969 Clough formed an association with Entrepose SA of Paris to tender for the Dongara to Perth gas pipeline. The tender was unsuccessful, but Clough retained an association with Entrepose SA and its offshore subsidiary ETPM. After their first association, the two companies considered other pipelines throughout Australia and offshore work in Bass Strait.

In 1980 Entrepose SA and ETPM set up an office in Perth to explore new opportunities.

ETPM brought the latest technology in piping and pipe welding in both onshore and offshore pipelines. They also had a large pool of specialised offshore equipment, particularly lay barges and derrick barges of all types as well as associated and support equipment. One specific barge was the DLB1601, a third generation combination derrick lay barge with a 180m x 35m self-propelled hull with revolving 1600 Clyde 76 crane and a central pipe laying ramp able to accommodate four working stations of double-jointed 24-metre pipe.[153]



'It was a very large project, and Clough's first flutter with the offshore industry, and it was probably on a larger scale in the beginning than we'd done. It was $150 million, which was virtually spent over a 6-month period, so it was very big cashflow and very large amounts of money, which were frightening.

'The spread we had for laying the Rankin pipeline — the cost of it was $300,000 a day — so work had to be designed to the minute. When the spread arrived it was large. We had over a thousand people working on it. The laying barge itself carried a crew of 400, and the support vessels, tugs, supply vessels, etc. had another 100 people or so.

'The project too was quite frightening in that a lay barge of that order lays about 2 kms a day and our bid was based on that rate. When we first started we were laying 200 metres a day, and that was the headache we had. We thrashed the problem around and in the end we thought the only way was to offer these people a bonus to help them produce. The unions and Woodside were against it but in the end, in desperation, we did it. Then the whole thing took off at a hell of a rate.

'It was the same thing with the ploughing we did. We buried the pipe afterwards — the first time in the world that a pipe of that size (40 inch diameter, one inch thick) was buried like this.

'It made our profits. We had to pay $300,000 per day whether we did 200 metres or 2 kms! In the end we finished the pipe laying ahead of time.'[152]

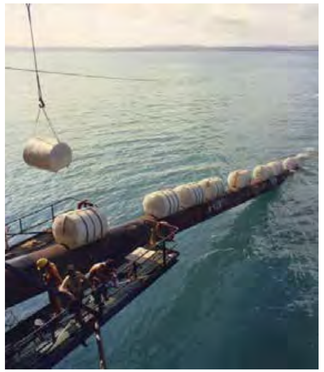
- Albert Scott

'In the early '80s we had a joint venture with a French company called ETPM. I went to Paris and was talking to the boss, who decided that they must have an Australian Project Manager and he wanted Albert Scott. So I said, "Let's ask him." Paris was eight hours behind Perth and I called when it was about 7.30 in the morning in Perth and I got someone in the office. I said I wanted to speak to Albert Scott, and they responded, "It's 7.30 in the morning and no one's here." I said, "You haven't tried Albert Scott's phone. You'll find that Albert Scott's there." Because I knew that he always used to come in early. And he was. And so I asked him and he said, "Sure."'

'When you're laying pipe with a lay barge, you have to coordinate eight anchors, two from the bow going forward, two from the stern going aft and two each from the forward and aft going either side. As the barge moves forward laying its pipe you're constantly picking up anchors and laying ahead, and for that you have several anchor barges continually picking up anchors and placing them ahead, and all the time the barges are moving forward and laying the pipe behind them. The pipes were in 40 foot lengths, about 12 metres, and we double joined them on the shore, taking them from 12 to 24 metres. And the double joints were towed out to the barge and lifted onto the barge, so as the barge went forward lifting the pipe the joints were welded and it's always a balance between wanting the pipe to have a high tensile strength and at the same time wanting it to be flexible.

'We had to heat the pipe before we welded it. The pipe was also weight-coated: it had two inches of concrete encasing it on the outside so that it would sink, and so when you formed the joint you first had to heat it, bring it together, weld them together, weight-coat the joint, and it could then go down the aft 'stinger' as it was called, which was a steel truss which guided it down from the back of the barge. When the pipe came off the end of the stinger at the back of the barge it had to go down to the seabed, and to allow it to do that without bending and breaking you had to keep the tension on the pipe. If you lost the tension the pipe would bend and buckle, and you could then have two types of buckle, a dry buckle or a wet buckle. A wet buckle meant the pipe filled with water, which was hard to fix. You had lots of winches to make sure the barge maintained the correct position. You had to teach the operators how to set it up and so we had a small model. I tried it for hours and all I got was wet buckles all the time. It was a very sophisticated operation. We went about 100 kms in water depths up to 20-30 metres.' [154]

- Harold Clough



Woodside Marine Structures Phase I (1983-1984)

CLIENT:	Woodside Energy Ltd
ENTITY:	BAM Clough
LOCATION:	North West Shelf, Western Australia

BAM Clough was awarded the contract for the construction of the complete mooring facility including subsea pipelines, pipe line end manifold, risers and electrical installation and navigational aids, to load out condensate from the North Rankin A gas drilling and production platform.

The facility had to be capable of handling vessels from 20,000 DWT up to 100,000 DWT.

The design called for six breasting dolphins and four mooring dolphins to be constructed one kilometre from the shore in 16-metre-deep water.

As Nico Dirkzwager notes:

'For the first time in Australia we used 3.1-metre-diameter, 36-metre-long piles that were fabricated in Perth in 12-metre sections and transported to site by trucks. These were unique at the time, because rather than a cluster of eight-to-12 much smaller piles the mooring dolphins only needed one big pile.

'The problem was that they had to be driven with a heavy special steam hammer and they were very hard to get to the right depth. Certain piles buckled like newspaper, posing a big problem.' [155]

Woodside Marine Structures Phase II (1985-1987)

CLIENT: Woodside Energy Ltd

ENTITY: BAM Clough

LOCATION: North West Shelf, Western Australia

Following the successful completion of the Marine Structures Phase I contract, the BAM Clough Joint Venture undertook the construction of the LNG and condensate export facility, the first structure of its kind ever built in Australia.

The second phase involved the construction of LNG storage tanks, process plants and a LNG loading jetty that consisted of an 850-metre approach fitted with a 4.5-metre-wide road, two pipe tracks and three platforms.

The primary construction equipment included the IB-901 jack-up platform barge and the Garrath jack-up barge. A total of 8,500 tonnes of substructure piles up to 40 metres in length each formed part of the structure, many of them concreted to the seabed rock. The total structure utilised some 10,000 cubic metres of concrete and 67,000 tonnes of structural steel.[156]

The project was carried out in a tropical cyclone zone and presented enormous challenges. Woodside gave substantial financial support to ensure the jetty completion, but Clough lost a considerable sum of money on the project. [157]

'The quality measures, testing and tracing for LNG construction were unlike anything we'd ever seen. It was a far difference from ore jetties, and not without their own constraints. We quickly found early issues that soon became big issues in terms of productivity.' [158]

- Rod Kuipers

From Nico Dirkzwager

'We bid something like A$56 million, but the project was running late and we had to double our equipment input. That largely resulted in doubling the cost, because most of our costs were tied up in the equipment. It was a difficult period, but we helped each other get over it. We doubled our resources to approach a new agreed financial package and completion date thanks to the good relationship with Woodside who understood the challenges.[159]

'It was a challenging project for a variety of reasons. Amongst others, we had huge problems in the near shore area to install the piles, which led to one of the supervisors (John Poole) creating a cartoon of me. It said 'These piles are a pain in the arse' [160]

'At the time I was Construction Manager on the job. We were working very hard and on a 24/7 schedule. I sometimes had a Sunday off and mostly left at 5am and came back at 8pm at night, as did many others on the project.'[161]

'Phase II taught us a lot of hard lessons, particularly the high quality demands of the LNG industry. To give some idea of the extent of the quality scrutiny, the client's inspection teams would walk along the jetty and use dental mirrors to look through the small cope holes. These holes are very difficult to access and apply proper paint thickness.

'So all the inspectors, including ours, would each have a handful of dentist mirrors for such a purpose. At one time there were no dentist mirrors available anywhere in Australia because they were all being used by people on the site.'[162]

Wesfarmers LPG Plant (1987-1988)

CLIENT: Wesfarmers Kleenheat Gas Pty Ltd

ENTITY: Randall O'Connor Clough

LOCATION: Kwinana, Western Australia

Clough's joint venture with Randall Process Systems of USA and T O'Connor & Associates of Adelaide undertook the complete engineering, procurement, construction and commissioning on a turnkey, lump-sum basis. It was the first turnkey gas processing contract for the company and, in addition to being a lump-sum contract, the plant had to be handed over to the client in an operating state with a financial bonus/penalty scheme agreed. As the Clough corporate profile proudly stated, 'The joint venture earned the bonus.'[163]

Clough's responsibilities included lead engineering in civil, mechanical, electrical, instrumentation, architecture detailed engineering in all disciplines: site construction, commissioning and the provision of project management support services of scheduling, cost control and accounting.

The operation of the plant is controlled via a distribution control system (DCS), which handles all emergency shutdown operations as well as tuning the fractionation train of the plant. The system uses a number of mathematical models, which provide very high product recovery rates. The design and configuration of the control

systems together with the development of most of the necessary software were carried out in-house by the joint venture team.[164]

The plant was designed to extract up to 150,000 tonnes of LPG, butane and propane per annum from natural gas piped to Perth from the North West Shelf. LPG for the domestic market is stored in two 250-tonne capacity storage vessels while three 13,000-tonne capacity, double integrity refrigerated storage tanks are used to store propane and butane for export sales.

LPG shipments are loaded via a 2.5-km-long pipeline system to a marine facility at Kwinana.

The plant was commissioned in July 1988, two months ahead of schedule.

'All client-ordered variations and other claims were less than two per cent of a total cost of $85 million, a very small variation for a project of this complexity, and a tribute to both the client and his understanding that he wanted a fit-for-purpose plant and the form of contract where the contractor took all responsibility and guaranteed the performance of the plant.'[165]

- Harold Clough

'Part of the technique for these joint projects is always to select the right joint venture partner, somebody that complements you rather than someone who does the same work as you. Randall were an ideal group, they had a lot of new techniques and they were represented in Australia by O'Connor.

'That plant works well and the client was happy. As a spin off from that plant we worked on a gas plant locally for Alan Bond at Harriet, at Lowendal Islands and Varanus and others. Our people got their gas experience from the Wesfarmers Plant with Randall. Then we won projects in Bangladesh, Pakistan and Indonesia competing against some of the very heavy international groups.'[166]

- Albert Smith

Goodwyn A Modules (1990-1992)

CLIENT:	Woodside Energy Ltd
ENTITY:	Clough Press Offshore
LOCATION:	Jervoise Bay, Western Australia

The Goodwyn platform was the centrepiece of the $1.6 billion development program of the Goodwyn gas/condensate field. This represented the third phase of work in the $12 billion North West Shelf project.

In a joint venture with Press Offshore Limited of the United Kingdom, Clough was awarded a contract for the fabrication of the Goodwyn A accommodation and utilities modules for Stage 3 of the North West Shelf Gas Development project. At $79 million, it was the largest and most complex fabrication contract of its type ever undertaken by the company.

The project called for the fabrication of a 2,300-tonne accommodation module and a 2,650-tonne utilities module at a new fabrication facility set up by the company at Jervoise Bay, south of Perth.[167]

Harriet A Field Development Offshore Facility (1984-1986) / Varanus Island Wet Gas Pipeline (1987-1988)

CLIENT: Bond Oil

ENTITY: Bechtel Clough / Clough

LOCATION: North West Shelf, Western Australia

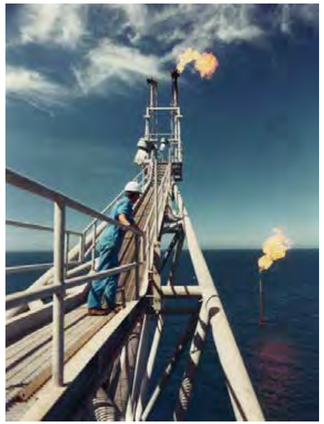
Clough gained a reputation for the cost-effective development of small, offshore fields in the late 1980s and early 1990s that were marginal at a time of low oil prices.

Clough was a leader in installation technology for these small offshore fields and in engineering major fixed structures for offshore facilities.

The Harriet Oil Field on the North West Shelf off Western Australia was developed and operated by Bond Oil Pty Ltd. Clough in joint venture with Bechtel carried out the concept, front end and detailed engineering and procurement and construction of the offshore platform, pipeline and other facilities under a fast-track, negotiated phased lump sum contract, a first for Clough. [168]

The project called for an eight-leg, 10,000-bpd oil production platform sited in 22 metres of water, a 6.5 km x 219mm-diameter submarine pipeline from the platform to the nearby Varanus Island terminal, with a 750,000 barrel capacity tank farm, product pumping facilities, accommodation for field operators, a 4 km x 762-diameter submarine loading line and a spread mooring tanker loading facility. [169]

Fast-track construction enabled the first oil to flow from the Harriet A Platform on 19 January 1986, just 12 months after the contract had been signed.



In 1987, Clough performed a contract for the design, fabrication and installation of a 150 nominal bore, 6.5 kilometre long wet gas submarine pipeline from the Harriet A production platform to nearby Varanus Island. The pipeline was installed adjacent to a 200 nominal bore crude oil supply pipeline previously installed by the Bechtel Clough joint venture during the original Harriet oilfield development. The *Trojan* barge was used on this project and enabled Clough to install the pipeline using the pipe-laying technique rather than the tow technique used for the original pipeline.

Albert Scott:

'We joint ventured with Bechtel on Harriet, and it was difficult because Clough came from a construction background and Bechtel from a management-type, design background. We had numerous discussions around the remuneration. Our philosophy has always been to design to suit the construction techniques. Bechtel, after having given the client a fright as to what the design costs would be, a terrible fright, nearly lost us the job before we started. I can remember having to take off with an hour's notice for San Francisco to go and try and talk some sense into them [Bechtel], which is one of the hardest things I've ever had to do in my life.

'Eventually, because they were such nice people, they took a punt. I always had this hanging over my head. We did a tremendous job and that project created a lot of milestones. It really made our name.' [170]

Brian Hewitt:

'The phased lump sum contract concept was exciting, but it needed a very aggressive and courageous client as well, because there had to be a considerable demand on the client. They had to have considerable faith in our ability to get the job done and our ability not to exploit the situation as we went on.

'We engineered, procured and constructed the entire project in the space of 12 months. It was a hell of an achievement, and the consequence of a very successful joint venture — and a nice combination of technical and commercial expertise.

'This happened to be an offshore facility bringing oil to an island terminal in an extremely remote location in a cyclone prone area. We had a great client under those circumstances.

'They [Bond] were getting cash out of the oilfield before we left site, about $300,000 a day after 12 months, when it usually takes several years.' [171]

Challis Field Facilities (1988–1989)

CLIENT:	BHP Petroleum
ENTITY:	CloughStena
LOCATION:	Timor Sea, Australia (600km north west of Darwin)

Contracted to US-based Imodco in December 1988 to undertake the transportation, offloading, installation/hook-up and commissioning of the mooring riser and floating production system, [172] the joint venture was responsible for receiving BHP Petroleum's components in France, testing them and preparing them for the long journey to the Challis field. Among other things this required transporting the 4,500 tonne Challis Riser, the largest in the world at the time, from Singapore to the field in the Timor Sea on the floodable central deck of the 115,000 tonne *Challis Venture*.

CloughStena then secured a second contract to transport, install, tie-in and test seven flowline systems (23 kms in total) connecting the Challis production riser to seven subsea wellheads up to six km away.

The CloughStena joint venture employed a dynamic positioning diving support vessel, *Stena Workhorse*, fitted with special equipment to carry out these tasks.

The field was in unprotected waters at a depth of 106 metres and, once installed, had to withstand tropical cyclones, which required a huge quantity of iron ore ballast.[173] The Challis Field facilities were brought into production in early December 1989 and BHP shipped the first cargo of 400,000 barrels of Challis crude on 31 December 1989. [174]

Australian Federation of Construction Contractors' Construction Achievement Award, 1990

There was an anxious wait for moderate weather conditions to unload the tower, as ocean swells had to be at a minimum. When this occurred, the central deck of the Challis Venture was flooded and the riser released and gently floated off.

Once the tower was in place, in 110 metres of water, the most demanding operation of the contract followed, the linking up of the field production system on the seabed to the riser. CloughStena assembled a small fleet of bizarre vessels to complete this work, including the semi-submersible *Mighty Servant 2*, another sub-submersible, a barge to pump 15,000 tonnes of iron ore ballast, and a heavy-lift craneship.

Jabiru Field Development Phase 1 and (1986-1987) and Phase 2, 3 & 4 (1987-1989)

CLIENT: BHP Petroleum

ENTITY: Bechtel Clough (Phase 1) and CloughStena (Phases 2-4)

LOCATION: Timor Sea, Australia

In 1986, Clough began working with BHP Petroleum in the Timor Sea, the first oil venture in this region. The Bechtel Clough Joint Venture, in association with J. Ray McDermott (Aust.) Pty Ltd, undertook the installation of the Jabiru Field Floating Production Storage and Offloading Facility mooring system. The scope of work was carried out with the support of the derrick barge DB20 from Singapore.

The Jabiru Phase 2 contract was for the installation and testing of the flow line system to the Jabiru 5A subsea well and was carried out by CloughStena, as were phases 3 and 4.

In 1988 CloughStena was awarded the contract to install flow line systems to connect two wells to the Jabiru Venture floating production facility (Phase 3). The work was performed while the Jabiru joint venture was disconnecting from its mooring and underground modifications to expand its crude and oil separation capacity.

The flow lines were manufactured by Coflexip of Paris and delivered to Singapore in separate spools, the spool for the longer 17 flowlines being the largest yet constructed with a diameter of 8.6 metres.

A total of 800 tonnes of project materials were loaded onto the pipelay vessel, *Seahorse II* at Clough's Petrosea marine base in Jurong, Singapore. [175]

Phase 4 involved recovering and relaying several existing systems, and inspections with some modifications to the project. [176]

'Following on from the Dom Gas phase of Woodside, we developed a project team and got more involved in offshore construction work. We started out in a small way, and the Jabiru project for BHP was as a joint venture partner with McDermott who had the derrick barge DB20. We installed Jabiru with McDermott. It was formerly a sub-contract, but in reality it was set up as a joint venture agreement between ourselves, Bechtel and McDermott.

'This was the first of our work in the Timor Sea for BHP Petroleum.

'We tendered to BHP Petroleum as Clough Engineering for the second phase of Jabiru, which was a step out, the tie-in of a step out well. BHP suggested they'd like to award us the contract, but encouraged us to joint venture with the vessel owner rather than chartering it. So we then set up a joint venture with the vessel owner, Stena Offshore, which became a long-term joint venture.' [178]

'On the back of these and other projects – Marathon, Skua, Griffin – we set up a project team, virtually an engineering department within the offshore group, to service the project teams, and those engineers were seconded to the project teams on a dedicated basis. All the work is essentially executed in Perth with the teams moving to Singapore or into the field whenever a project is mobilised.

'Clough is not a company that gets particularly frightened by having to do something that's a little out of character with the general work that Clough does. In offshore execution we basically count the minutes. For example, when we were executing the Griffin Field development, we had two spread out there working on different parts of the project, but each one was costing us our moorings of the flow line installation spread, and was costing us about $150,000 a day and our pipelay spread was costing us about $275,000 a day.' [177]

- Rob Jewkes

Trojan Barge

Clough's *Trojan* barge came about as the Clough team realised that there wasn't a cheap way to lay pipe in shallow water near shore oil and gas fields.

Clough engineers designed a shallow draft pipe laying barge to solve this challenge. They converted an all-steel former dumb barge, building in pipe storage, handling, welding and tension equipment. It also incorporated a 10-point mooring system and crane support system — two cranes, a 63-tonne capacity crane at the stern and a 31-tonne capacity crane at the bow. The *Trojan* could carry 350 tonnes of pipes in racks.

Hides Field Development (1990-1991)

CLIENT:	BP Petroleum and Chevron Niugini
ENTITY:	Clough Niugini
LOCATION:	Hides Gas Field, Southern Highlands Province, Papua New Guinea

Clough Niugini was established in 1989 after several years operating in PNG on the Porgera gold mine and other projects, and secured the contract for the construction of the first hydrocarbon pipeline and process plant to be built there.

The Hides gas field is a natural gas project located in Papua New Guinea's Hela Province, previously part of the Southern Highlands Province, 80 km north west of Kutubu. The production was used to develop the Hides gas to electricity project (GTE), which comprised a pipeline that connects Hides 1 and 2 wells to a gas conditioning facility in the Hides production plant in the Tagari River Valley.

The second contract included the construction of a 5-15 million standard cubic feet per day gas processing plant in the valley adjacent to the power generating plant, as well as the installation and connection of all piping and associated fitting at both well sites.

Much of the pipework and structural steel were prefabricated and spooled at Clough's facility in Perth and then transported to the site.

The location of the well sites on top of a mountain meant the components were lifted and set by helicopter, and assembled on location.

'We launched into PNG from Brisbane through our relationships in the oil and gas area working for Shell. They asked us to build some well heads for them, so Brisbane has been the office that looks after Papua New Guinea, one of the more successful regions for the company.'

- Ivor Peries

Griffin Field Development Project Mooring and Flowline Installation (1993-1994)

CLIENT:	BHP Petroleum
ENTITY:	CloughStena
LOCATION:	North Western Australia

The success of the Challis Riser project meant BHP appointed CloughStena to carry out similar work on the Griffin field off the North West Coast of Western Australia. This project necessitated installing the riser turret mooring and its associated network of flexible flow lines and umbilicals for the field some 65 km off the coast in 130 metres of water.

Once again the joint venture was responsible for carrying all the materials from Europe, the USA and Singapore, and building six 200-tonne reinforced clump weights for anchoring the middepth buoys.

A heavy lift vessel was needed to deliver the 30 reels of flow line products to a coastal anchorage from where a lay vessel collected them in eight journeys. A second contract provided for laying 67 kms of pipeline on the seabed, which connected to an onshore natural gas treatment plant.

A number of vessels were employed for this work, and two advanced underwater drilling rigs were designed and built by the joint venture to mechanically anchor the pipeline to the seabed.

Up to 12 construction vessels assembled in Singapore, other parts of Australia and in the North Sea for this, and it was completed on schedule by February 1994.[179]

Pagerungan Besar Field Development Project (1990-2003)

CLIENT: Atlantic Richfield Indonesia Inc

ENTITY: Petrosea

LOCATION: Pagerungan Besar Island, North of Bali in Java, Indonesia

This was the first gas project that Clough, through Petrosea, undertook on its own as the prime contractor rather than in joint venture. The tiny Pagerungan Besar Island is situated in the Bali Sea, 300 km east of Surabaya, East Java.

Phase 1 (1990-1991)

The Pagerungan natural gas project involved the initial engineering phase. This took over seven months and employed a peak workforce of 40 engineers and 60 drafting personnel. CAE and CAD systems were used in the development of engineering design and drafting. [180]

Phase 2 (1991-1993)

Procurement and construction of the onshore facilities for the large gas field in Pagerungan Island was controlled from project offices in Surabaya and Jakarta. The project included a gas processing plant, a complete condensate handling system including two condensate storage tanks, a loading facility, pumps and metering system, a single point tanker mooring system, onshore pipelines, a computerised distributed control system (DCS), an airstrip, a harbour and causeway, satellite communications and administration/accommodation. [181]

Inlet Compression Facilities (1997-1999)

In 1999 Clough commissioned the new inlet booster compression facilities, including two new gas trains each with 50 MMSCFD capacity. [182]

Inlet Compression Reconfiguration (2002-2003)

In 2003 a contract was undertaken for BP Kangean Ltd, Indonesia that included a Inlet compression reconfiguration and seal/fuel gas line modifications.

'In some ways it was fortunate that we lost the PICL Project as it enabled us to shift a large number of our staff to the Pagerungan Project.'

- Harold Clough

'We had to build everything — a harbour, a causeway, an export pipeline. We had a desalination reverse osmosis unit for fresh water, and we built an airstrip. We also learned to speak the language pretty quickly. You can either train 3,000 people to speak English or you learn to speak Indonesian, and so that's what we did.

'When I left Surabaya after a couple of months there and went out to the island, we were still living in a grass hut with the locals, eating chicken and rice, chicken and rice, chicken and rice.' [183]

'We chopped up the end of the island and built a gas plant on it. Little did we know that this end of the island, where we wanted to build the gas plant, was uninhabited for a reason. It was in the path of the prevailing wind and there was no vegetation growing because it's all coral. And when we started to dig a hole — you couldn't easily do it as coral is so hard — it added the level of challenge to the project right from the beginning.'

- Greg Kember

'It was a brilliantly executed contract from go to whoa. We managed to convince BP and Arco that we were the people to do it. I think they liked the fact that they could rely on us to get it done and we weren't the big Bechtels of the world. It worked very well and we performed, bringing the project in on time, on budget. When you think about the challenges of going out into the middle of nowhere and delivering such a big project — it was a significant achievement.

'It was the biggest contract that Clough had executed to that date and was done superbly well. And it was the forerunner to us getting into gas plants. We then built a couple in Pakistan — Dodhak and Uch — and another in Baluchistan.' [184]

'A dedicated project office was established in Perth that included some 40 engineers and 60 drafting personnel. The initial engineering optimisation study resulted in savings of some A$36 million prior to the commencement of Phase 2.' [185]

- Peter Knight

Kutubu Infield Pipelines (1991-1992)

CLIENT: Chevron Niugini Pty Ltd

ENTITY: Clough Niugini

LOCATION: Kutubu, Southern Highlands Province, Papua New Guinea

The Kutubu Oil Project, which was Papua New Guinea's first commercial oilfield development, is located in the Southern Highlands of Papua New Guinea and takes its name from nearby Lake Kutubu. Oil was first discovered at Kutubu in the Iagifu sandstone structure in 1986, and commercial production commenced in June 1992.

The Kutubu development comprises a network of wells that produce oil from the Iagifu - the Hedinia, Usano and Agogo fields - a gathering system and on-site processing facilities (the Agogo and Central Processing Facilities) and supporting infrastructure, as well as a 265-kilometre export pipeline to the coast, and a marine loading terminal in the Gulf of Papua.

The Kutubu field pipelines were mostly laid above ground in a pipe branch adjacent to well pad access roads. Running 133 km through rainforest and across steep limestone ridges meant much of the material was transported to site by helicopter.

The plant and equipment were taken from Clough's Brisbane plant depot to PNG's Lae Airport and then transported to site by Hercules aircraft.

Clough had a team of 30 expats, 130 nationals and 11 Australia-based employees working on the project and it was completed two weeks ahead of schedule.

'We were based on site in a remote part of the PNG Highlands that had an annual rainfall of six metres. Our accommodation was pretty basic. We shared a small 3m x 3m donga, with common shower/ablution block and mess that was inside the actual refinery grounds — and it was a small refinery. We had to rely on each other a lot as there wasn't a lot of outside support and the communications were extremely poor.'

- Ivor Peries

Dhodak Field Gas Condensation Plant (1992-1995)

CLIENT: Pakistan Oil and Gas Development Corporation

ENTITY: Clough

LOCATION: Dera Ghazi Khan District, Pakistan

Clough was awarded the turnkey Dhodak Field Gas Condensate Development, and then a 12-month management assistance contract to assist operations on the site.

During the project, Clough developed and implemented a training program for the client's employees, a comprehensive computerised maintenance schedule for the plant, safety training and troubleshooting assistance.[186]

East Spar Development Onshore and Offshore Facilities (1995-1996)

CLIENT: Western Mining Corporation Ltd - Petroleum Division

ENTITY: The East Spar Alliance (Western Mining Corporation, Kvaerner RJ Brown, and Clough)

LOCATION: North West Shelf, Western Australia

This turnkey project involved the design, procurement, fabrication, construction and commissioning of the total facility. Field infrastructure included two subsea wells tied to a subsea manifold, a 356mm-diameter pipeline to Varanus Island and the installation of two onshore 1000 MMSCFD gas processes and sales gas compression trains. [187]

'There has been a realisation that confrontation and legal haggling that was so often associated with competitive tendering is mutually disadvantageous and destructive.

'We are having great success with alliancing. On the East Spar project we worked for almost a year to develop the most efficient concept for an offshore project in 96 metres of water, 63 km west of Varanus Island.

'The initial feasibility of the project was based on the assumption that the site conditions would be similar to other offshore projects in the region, however after extensive site investigation the soil conditions were very different to those assumed — in fact much worse than expected and incapable of bearing the load, even with long piles.

'In a conventionally tendered project both sides would retreat to their bunkers and call in the lawyers. Under our alliance contract the opposite happened. All the parties got together to develop alternative solutions, one of which involved a novel mono tower supporting the processing facilities guyed to heavy anchors.

'We then changed the project again as a platform was no longer needed, so an all subsea concept was developed.

'Another novel innovation was to operate the electro-hydraulic controls at the wellheads from a radio-controlled buoy."[188]

- Harold Clough (1995)

East Spar was discovered in early 1993 during the rapid deregulation of the WA gas market when the concept of a gas pipeline to the goldfields was proposed. This created a window of opportunity for East Spar, but only if plans could be established quickly. A base case development plan was established to support gas marketing so that alternate plans could be matured in parallel.

The East Spar gas field off Western Australia commenced production in November 1996 from two subsea wells and a subsea gathering system controlled by an innovative unmanned Navigation, Communication and Control Buoy. The control room and gas processing plant are located 63 kms from the field on Varanus Island.

This was the 1997 winner of The Institution of Engineers, Australia, Sir William Hudson Award as well as national and state awards for Excellence in Engineering.

The East Spar Alliance

The development phase was executed by an operator-contractor partnership: the East Spar Alliance. The field was developed in 22 months from approval to first production - a record for a new offshore gas field in Australia. This was all the more remarkable given that initial development approval was for a platform-based control and gathering system. The Alliance, contracted on the basis of a performance specification, was able to further optimise the development plan in response to challenges and opportunities presented by new site data and new technologies. [189]

East Spar was the world's first unmanned buoy that remotely controlled an entire subsea gas field offshore in the Carnarvon Basin in the state's North-West.

Towed and fixed in position in North-West waters near Barrow Island, it remotely controls the production from two sub-sea gas wells, which pipe gas to processing facilities on Varanus Island. The treated gas is then piped to Dampier on the mainland via the existing Dampier-Bunbury sales gas pipeline.

Liuhua 11-1 Field Development Project Phase 1 and Phase 2 (1994-1996)

CLIENT:	Amoco Orient Petroleum
ENTITY:	CloughStena (Asia)
LOCATION:	South China Sea, China

The Liuhua Field lies 140 nautical miles south-east of Hong Kong in the South China Sea in 300 metres of water.

Phase 1

Phase 1 involved the hook-up of the drilling and production semi-submersible floating production, storage and off-loading (FPSO) system. [190]

A state-of-the-art mooring installation and tensioning system capable of handling any mooring configuration in any water depth was developed by Clough Engineering. The system was designed to meet the rigours of the project that included the installation of two mooring systems in water depths ranging from 290 to 320 metres.

The vertical lay and tensioning system was a world first for the offshore industry as it contained both a lay and a tensioning capability of up to 1000 tonnes in a single self-contained system. [191]

Phase 2

CloughStena deployed a fleet of two CSO vessels, the *Alliance* which laid the FPSO mooring components and the hook-up of the FPSO, and the *Flex Installer* which laid and installed two flow line systems between the floating production system (FPS) and the FPSO. These two vessels were supported by two high-powered tugs that were also used to tow the FPSO from Singapore to the site. [192]

Uch Gas Transport Pipeline (1996-1997)

CLIENT:	Pakistan Oil and Gas Development Corporation
ENTITY:	Clough
LOCATION:	Dera Murad Jamali Province of Baluchistan, Pakistan

The project work scope included the engineering, procurement and construction of a 660mm diameter x 50 km long buried gas transport pipeline, terminal facilities, and a control room and communications system to provide centralised management of the entire pipeline system.

Clough also established a construction camp in the harsh, isolated desert of Baluchistan Province to accommodate the 470-strong project workforce. [193]

'Uch was an interesting job. I was the main project engineer and worked with a project manager and about a dozen construction supervisors.

'It was in the middle of nowhere. Baluchistan is a bit tribal and it was under military law. We had two platoons of frontier corps with us, and everywhere we drove we'd have three blokes in the back with machine guns. It was never that there was any imminent threat; that was just what we did. We never had any issues, but we were in a middle of the desert on our own, working on our own.

'We had to build our own camp, build a canal and reverse osmosis plant where we got our water from, set our own gensets and all that normal stuff. That was Uch.' [194]

- Greg Kember

The Gorgon Project (1998 / 2009-2016)

CLIENT: Chevron Australia

ENTITY: GO Alliance / Kellogg Joint Venture Gorgon (KJVG)

LOCATION: Barrow Island, Western Australia

The Chevron-Australia operated Gorgon Project is one of the world's largest LNG projects and the largest single resource development in Australia's history. Located on Barrow Island, about 60 kilometres off the north coast of Western Australia, Gorgon is a three-train, 15.6 million tonnes per annum LNG facility and a domestic gas plant with the capacity to supply 300 terajoules of gas per day to the local market. Gas is sourced from the Gorgon and Jansz-Io Fields located between 65 and 130 kilometres off the west coast of Barrow Island.

Clough's involvement in the iconic Gorgon project began in 1998 and included three contracts:

- Development Plan
- Commissioning
- FEED and EPCM for all downstream facilities on the Gorgon Project.

Development Plan

In late 1998, a two-train development on the Burrup Peninsula was proposed, to be supplied with gas via a 230 kilometre pipeline from the Gorgon Field. The concept attempted to leverage existing infrastructure on the Burrup but was terminated when it became clear the proposed development would not be internationally competitive.

The final investment decision was made in 2009. In 2009 Clough secured the contract for the deployment of commissioning personnel to support the commissioning of the downstream facilities on the project on Barrow Island.

Commissioning

The same year Clough, as part of the Kellogg Joint Venture Gorgon, was contracted by Chevron to undertake the FEED and EPC for all downstream facilities on the Gorgon Project.

The Barrow Island facilities included the construction of a three-train LNG facility on Barrow Island, over 250,000 tonnes of modularised facilities, utilities and infrastructure, two 180,000-cubic-metre LNG tanks, a 2.1 km LNG jetty with two loading berths, and a domestic gas plant. [195]

FEED and EPCM for Downstream Facilities

This included the construction of a three-train LNG facility on Barrow Island and a domestic gas plant. In 2010 Chevron contracted Clough SeaTrucks joint venture for the domestic gas scope of work. The work involved the transportation and installation of approximately 90 km of 20-inch pipeline, both offshore and onshore, from Barrow Island to the Dampier Bunbury Natural Gas Pipeline.

Clough's derrick pipe lay barge, *Java Constructor*, was utilised for pipeline installation, together with Clough's shallow water laybarge, *Clough Challenge*.

The onshore cross-country portion of the pipeline was carried out by Clough, supervised by resources from its Clough Seam Gas division. [196]

Bayu-Undan Floatover and Completions Project (2000-2004)

CLIENT: ConocoPhillips Australia

ENTITY: Clough Aker

LOCATION: Timor Sea, Australia

The development of the Bayu-Undan gas and condensate field located in the Timor Sea north of Darwin, which was estimated to hold over 400 million barrels of hydrocarbon liquids and 3.4 trillion cubic feet of gas. [197]

The first contract involved the transport and float-over installation of the field's two major production decks; the Drilling, Production and Processing (DPP) platform and the Compression, Utilities and Quarters (CUQ) platform on top of pre-installed jacket substructures at site. The world's largest heavy lift vessel, *Blue Marlin*, transported and installed the two massive decks weighing 11,500 (DPP) and 15,000 tonnes (CUQ). [198]

The second contract involved the complete offshore hook-up and commissioning of the entire Bayu-Undan field production systems, including wellhead platform and floating condensate, and LPG storage and offloading facilities. [199]

Preparatory activities included fabrication site support in Singapore, Indonesia and Korea, and involved some 680 personnel at peak periods. The Clough Aker team worked as an integrated team with ConocoPhillips project members to ensure complex logistics management was in place to meet a demanding schedule.

The first gas flowed through the wellhead platform in December 2003, well ahead of schedule. [200]

Final hook-up and commissioning of the giant Bayu-Undan gas field was successfully completed in June 2004.

Bayu-Undan Operations and Maintenance (2004-Current)

CLIENT: ConocoPhillips Australia

ENTITY: Clough AMEC

LOCATION: Timor Sea, Australia

Clough AMEC then secured the contract for operation and maintenance services from 2004 for the floating storage and offloading facility, three fixed platforms, a remote wellhead platform, a compression, utilities and quarters platform, and a drilling, production and processing platform.

As part of this project Clough AMEC undertook training and capability development in Timor-Leste.

For the development of Timorese personnel and as a key feature of the Company's Local Content initiatives on Bayu-Undan, Clough delivered a comprehensive, structured learning and development program, consisting of a Trade Trainee program (Technical Workbooks and on the job training structure; Certificate II and Certificate III progression pathways in Engineering- Mechanical Trade and Instrumentation and Control), an offshore development program for the five disciplines (pathways for each discipline, supported by on the job mentoring by assigned offshore coaches and training material specific to the facility), and an onshore development program for the 20-plus Dili office personnel (on the job coaching programs in Perth, tailored English language programs and training related to specific discipline pathways training).

A new operations and maintenance contract was signed in 2016. Clough AMEC provided the resources and supervision to execute a complex offshore work scope on the Bayu-Undan platform, including maintenance, shutdown, infill drilling preparation and demobilisation of the accommodation support vessel.

Clough AMEC received a ConocoPhillips 2016 Supplier Recognition Award for 'Doing Business Better.'

Clough AMEC also received a ConocoPhillips 2018 Supplier Recognition Award for 'Focus on Execution' recognising the Company's strong focus on HSE performance and the completion of work on or ahead of schedule and below budget. [201]

PNG Oil Refinery (2002-2005)

CLIENT: InterOil Corporation

ENTITY: Clough Niugini

LOCATION: Port Moresby, Papua New Guinea

In 2002 Clough Niugini secured the engineering, procurement, construction and commissioning contract from InterOil to build Papua New Guinea's first oil refinery, located across the harbour from Port Moresby.

The commissioned plant's capacity meant that fuel products were processed in sufficient quantity to supply the PNG domestic markets as well as some export opportunities.

As part of this project, Clough refurbished equipment from a mothballed oil refinery in the US as well as installing new equipment.

The project included civil construction, a tank farm, a crude oil distillation unit, hydro-desulphurisation and catalytic reforming units, a jetty with ship loading and unloading facilities, utility systems, site infrastructure and support facilities. [202]

'We bid on a fixed price to take a disused oil refinery from Alaska and rebuild it in Papua New Guinea, and it worked from day one at the nameplate capacity. We were a bit surprised that it actually worked so well. That's very risky stuff, and this was an old plant not a new one and it was built to American specifications, which aren't the same as Australian from an electrical and mechanical perspective, but you take those risks and we did it.

'So we had a good reputation in PNG of being able to understand complex projects and engineer our way through those because we had a very skilled, young management and executive team.' [203]

- Ivor Peries

Maari Field Wellhead Platform (2005-2009)

CLIENT: OMV New Zealand

ENTITY: Clough

LOCATION: New Zealand

The wellhead platform for the Maari field development is situated in the Taranaki Basin in the Tasman Sea. The field lies in 102 metres of water and is located 80 km from the coast and 40 km from the Maui B platform.

The contract comprised the engineering, procurement, construction, installation, hook-up and commissioning of a new wellhead platform on the Maari Field Development.

A critical component of winning the project was the self-elevating DrillACE platform method that was used to install the Yolla Platform in the Bass Strait. The ACE (Arup Concept Elevator) platform concept was designed by Arup and Clough teamed up with them again to apply the DrillACE concept to the Maari Platform.

The DrillACE platform concept allowed rapid installation without relying on the mobilisation of large, offshore construction vessels.

The DrillACE Concept

DrillACE platform design utilises a gravity or suction base rather than piles to enable installation to be fast-tracked. The inherent floating stability of the design makes it more suitable for installing in extreme weather conditions. [204]

Hegigio Pipe Bridge (2004-2005)

CLIENT: Oil Search Limited

ENTITY: Clough Niugini

LOCATION: South East Mananda, Papua New Guinea

The project required the supply, fabrication, assembly and erection of a 470-metre-long, cable-stayed suspension bridge spanning the 500-metre-deep, 600-metre-wide Hegigio Gorge. The bridge was required to carry hydrocarbon transportation pipes, linking pipes from the South East Mananda oil field to the existing Agogo and Kutubu processing facilities.

The main cable was connected to a 33-metre-high A frame tower at the southern abutment and a 4-metre-high tower at the northern abutment. Due to the extreme terrain conditions, the southern abutment was constructed within an existing live well pad area with access to the northern abutment via helicopter.

Because of this project's specific challenges, Clough and Oil Search undertook it through a relationship form of contract agreement. [205]

For some time the Hegigio Bridge was the highest bridge in the world.

'In effect Oil Search had a stranded oil field due to the Hegigio Gorge. On the far side of the Gorge there were remote communities who had little or no engagement with white people. We had to fly everything in and build the far side of the gorge tower bit by bit. First we dropped in a small excavator to flatten a space for a small helipad and space for equipment. Then we helicoptered in a dozer to create a larger space for more equipment, to enable us to construct other equipment so we could construct the abutment, and so on. The end result was a great credit to the guys on the ground.

'It was high risk. There was a lot of low cloud, which meant we had very small weather windows to work, so we pushed the envelope on what the helicopters could do in terms of lifting capacity operating. And I'm scared of heights. When you look over the edge and all you see is this little thin black ribbon at the bottom, which is in fact a very wide river, you have an immediate appreciation of how high up you are working. Towards the end of it I was fine.

'It was really a technically challenging thing – because we had to design on the run – how this cable-stayed suspension bridge would come together, and we made it work.' [206]

- Ivor Peries

In February 2018, a magnitude 7.5 earthquake hit the Hela province of PNG including the Hegigio Gorge, causing significant damage to the pipe bridge. Oil Search engaged Clough to review the damage to the bridge and develop a solution for rebuilding it.

Train V LNG Jetty Expansion (2005-2007)

CLIENT: Woodside Energy

ENTITY: BAM Clough

LOCATION: Withnell Bay near Dampier, Western Australia

The $120 million Train V Jetty expansion was completed in 2007. It was the construction of a 150-metre long jetty extension to the existing LNG export marine terminal at Withnell Bay near Dampier. The extension provided an additional berth loading facility for LNG export tankers with a capacity of up to 145,000 cubic metres.

Key Train V project components included a six-span, 170-metre-long approach trestle consisting of five two-pile bents and one four-pile anchor bent, tie-in works to the existing loading platform, four breasting dolphins and four mooring dolphins connected by seven catwalks with a length of up to 71 metres, the installation of preassembled units supplied by the client, navigational aids and buoys, and upgrades and reinforcement of a material loading facility for landing the Train V modules.

'From 1988 to 2005 – 18 years – BAM Clough didn't undertake any further work for Woodside or other clients. We were putting in tenders, but didn't win, and there wasn't that much marine work about at the time.

'Eventually BAM Clough was invited to submit a sole source tender, negotiating directly for the Woodside Train V LNG jetty expansion project.

'More importantly for the joint venture, the lessons from the Phase II project had been learnt. Our pricing was more reflective of the rigorous quality controls . . . and we finally learnt to modularise. We started fabricating modular units overseas and shipping them to the project – pretty much echoing the entire LNG industry today.' [207]

- Nico Dirkzwager

Safety

Located in an area frequently hit by cyclones, the joint venture delivered the project on schedule, within budget and with an impeccable safety record of zero lost time injuries. Extensive planning and training were undertaken prior to and throughout the project to manage these challenging conditions.

Meeting the schedule

Piling and drilling operations utilised hydraulically operated piling templates that were designed and constructed to withhold the forces of the piles, the large hydraulic piling hammer and the reversed circulation drill. To maintain the schedule, pile drilling was continued during the night shift. [208]

Follow on Jetty work

'After BAM Clough completed Phase V for Woodside, we were asked to tender on an exclusive basis for Pluto and secured the project. The reality was that we had a lot of equipment and experienced staff in Australia for such projects. From this we won further work on PNG, Ichthys, Wheatstone and AP5. I think these projects in total represented a turnover of almost A$1.5 billion.

'We shared such challenging times.'

- Nico Dirkzwager

'Train V was an excellent project and we handed it over ahead of time.'

- Han Poort

Pluto LNG Jetty (2007-2009)

CLIENT: Woodside

ENTITY: BAM Clough

LOCATION: Burrup Peninsula, North Western Australia

The project involved the construction of a new LNG jetty as part of the Pluto LNG Project for Woodside on the Burrup Peninsula in Western Australia, and used the same project team that had completed the Woodside Train V Jetty between 2005-07.

The $200 million construction contract included building a 300-metre approach jetty, the placement of 10 PAUs for the approach jetty, a loading platform, four breasting dolphins and six mooring dolphins, the fabrication and installation of nine catwalks and the installation of five navigation leads and several floating buoys. [209]

The loading platform was fitted with a 50 x 30-metre concrete main deck that supports a steel-framed concrete upper deck and roadway.

The joint venture deployed Interbeton Jack-up barge IB909 for primary construction activities with a floating barge following to execute secondary concrete activities and complete topside installation. [210]

Woodside set an ambitious pace of development for the high profile project: the first LNG was due to be shipped just six years after gas was discovered.

'Wim Kemper, the Woodside representative, asked three questions, "Do you want to work with us? Is the jackup barge available? And is the delivery team available straight away?"

'So the same team with the same equipment and proven techniques moved on to Pluto.

'The target completion date was achieved, and set a pace that would have attained a world record for LNG projects executed in the shortest amount of time. In fact we delivered it so far ahead of schedule that the maintenance warranty had expired before the jetty was even used.'

- Han Poort

'A specific effort was made to manage the near-shore abutment and the pile bents that were constructed directly on to hard rock. This was the same part of the original Woodside jetty in the mid-1980s (Phase II) that caused significant problems and delays to the drilling and piling works of the first few bents.

'It wasn't all perfect: we had significant problems with our pile supply contract that the team had to overcome. But despite this our scope was increased.' [211]

- Greg Kember

PNG LNG Project Hides Gas Conditioning Plant (2009-2014)

CLIENT:	ExxonMobil PNG Limited
ENTITY:	CB&I Clough
LOCATION:	Hela Province, Papua New Guinea

The Hides gas fields, together with the Juha, Angore, Mananda, Kutubu, Moro and Moran fields, are used to supply the PNG LNG Project operated by ExxonMobil subsidiary, Esso Highlands Ltd. Hides alone supplies 70 per cent of the required natural gas to the project. It is located on Tuguba Tribal Land stretching from Hides to Angore to SE Mananda.

This was an integrated development that included gas production and processing facilities, onshore and offshore pipelines and liquefaction facilities, EPC work for the gas conditioning plant, nearby well pads and associated piping and infrastructure. [212]

In 2013, the project received the PNG LNG Project Executive SSHE Award.

PNG LNG Project Upstream Infrastructure (2009-2014)

CLIENT:	ExxonMobil PNG Limited
ENTITY:	Clough Curtain (CCJV)
LOCATION:	Gulf, Southern Highlands and Hela Provinces, Papua New Guinea

The project involved the upgrade of critical infrastructure for ExxonMobil, including multiple work fronts from the river port at Kopi to Hides and the Port of Lae on the East Coast.

The scope of work included the construction of roads, bridges, wharves, laydown and camp areas and other critical infrastructure. [213]

In 2013, the joint venture was awarded the additional EPC5a spineline scope to construct 5km of 22" carbon steel pipeline and associated 2" MEG line with HV cable and fibre optic cable in the Southern Highlands of PNG.

Delivered along a highly trafficked road, these works required detailed traffic management and included significant cold and hot bending as a function of the terrain which added to the complexity of delivery. CCJV were also responsible for the construction of 20km of right of way for the PNG LNG spineline and 5km of right of way for the PNG LNG mainline through the mountainous PNG Highlands near the Hides Gas Plant.

PNG LNG Project Marine Jetty (2010-2013)

CLIENT: Chiyoda JGC Joint Venture (for ExxonMobil PNG Limited)

ENTITY: BAM Clough

LOCATION: Caution Bay, Northwest Port Moresby, Papua New Guinea

In August 2010 the Chiyoda JGC Joint Venture awarded the contract to BAM Clough to design and construct the LNG and condensate offloading jetty for the LNG project 20 km north-west of Port Moresby on the Gulf of Papua. Later that year the joint venture was awarded the contract for the fabrication and construction of the jetty topsides.

The jetty was constructed using a purpose-built, travelling cantilever bridge. This meant that for the first 1.2 km of jetty a causeway was not required. The project was completed on time with an outstanding safety record and a workforce of 70 per cent local people from surrounding villages.

'We managed to construct the approach jetty without even touching the ground other than two spud piles every 24 metres. Our environmental impact was minor and our techniques superior to any other methods being used elsewhere.

'Fixed tower cranes were specially commissioned to develop the loadout berth while maintaining schedule and overcoming weather conditions.' [214]

- Han Poort

Nitric Acid Plant and Ammonium Nitrate Plant Number 3 (NAAN3) plant (2011-2014)

CLIENT: CSBP Limited

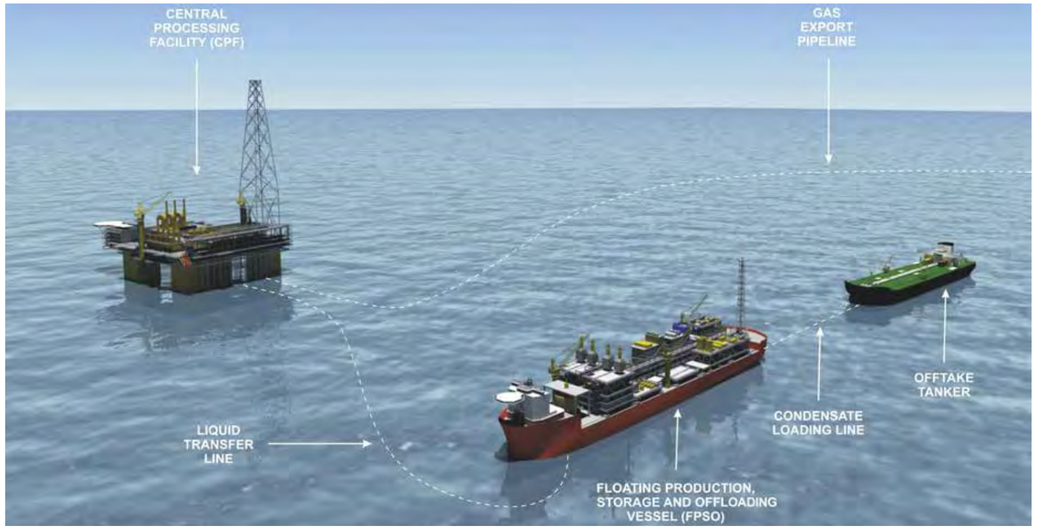
ENTITY: Downer Clough

LOCATION: Kwinana, Western Australia

Valued at $550 million (in nominal terms and excluding capitalised interest), the NAAN3 project is CSBP's largest single capital investment to date. The project increased CSBP's Ammonium Nitrate production capacity from 520,000 tonnes per annum to 780,000 tonnes per annum in order to meet demand for explosive-grade ammonium nitrate from the growing Western Australian mining sector. [215]

In 2011, the Downer Clough Joint Venture was awarded the Early Contractor Involvement phase for the project. This involved establishing an execution plan and budget for the construction of a Nitric Acid Plant and Ammonium Nitrate Plant, together with an upgrade of the existing prilling plant and other infrastructure work at CSBP's Kwinana site.

The joint venture was then awarded the Engineering Procurement Construction contract, which involved project management, engineering, procurement, prefabrication, construction and pre-commissioning. The project was completed in mid-2014.



Ichthys Offshore Integrated Project Management Support Services (IPMS) (2011-Current)

CLIENT: Ichthys Joint Venture

ENTITY: Clough DORIS

LOCATION: Browse Basin, Western Australia

Clough DORIS was awarded the contract for provision of Offshore Integrated Project Management Support Services for this venture, which takes gas from the Ichthys Field in the Browse Basin, 220 km offshore of Western Australia, to onshore processing facilities in Darwin after preliminary offshore processing.

The CDJV scope of work included project management of detailed engineering design, procurement and fabrication of the Central Processing Facility (CPF) and Floating Production, Storage and Offloading (FPSO) vessel for the project.

Ichthys Project Onshore LNG Facilities - Product Loading Jetty (2012-2015)

CLIENT: JKC Australia LNG (for INPEX)

ENTITY: BAM Clough

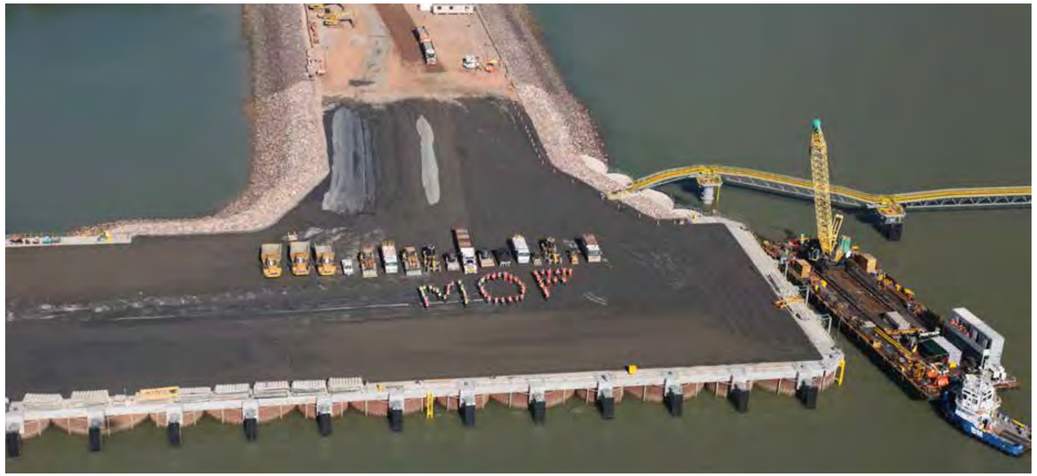
LOCATION: Blaydin Point, Northern Territory

BAM Clough was awarded the project to design and construct a product loading jetty located at Blaydin Point in Darwin. Gas from the Ichthys Field is transported from the offshore CPF through a subsea pipeline more than 885 kms offshore to the onshore LNG processing plant.

Work included a typical pile with crossheads trestle with concrete superstructure, a loading platform for LNG and LPG/condensate, navigation aids, marine operations and cathodic protection systems.[216]

The product loading jetty provides two separate berths, one for LNG carriers and a second for LPG/condensate carriers. The work included piles with crossheads trestle with a concrete superstructure, a loading platform, provision for seawater intake, wastewater outfall structures, navigation aids, marine operations, corrosion and cathodic protection systems.

The combination of a jackup barge, crane barge and cantilever bridge maximised work fronts and land-based activities, and allowed schedule flexibility. [217]



Ichthys Project Onshore LNG Facilities - Module Offloading Facility (MOF) (2012-2014)

CLIENT: JKC Australia LNG (for INPEX)

ENTITY: BAM Clough

LOCATION: Blaydin Point, Northern Territory

The MOF project ran parallel with the product loading jetty with the objective to mobilise to site in February 2013.

Located near Darwin in the Northern Territory, the MOF was used to offload modules to assemble the LNG liquefaction plant.

The MOF comprises a 160 metre x 65 metre heavy lift berth, a transition pontoon berth, a module carrier, Ro-Ro berths, general cargo, a Lo-Lo berth and associated breasting, and mooring dolphins and access catwalks.

The primary construction methodology involved the formation of cellular cofferdams to develop the perimeter of the MOF with selected landfill and sealed surface to complete the structure. This resulted in a much safer working environment and the ability to work across multiple work fronts and fast-track schedule requirements.

'This was a very fast-tracked project and we won it based on an alternative design tender which may not have been the cheapest, but it gave the client an alternative to dredging.'

- Han Poort

The INPEX-operated Ichthys LNG production process starts with preliminary processing offshore to remove water and extract condensate that is loaded onto tankers. The gas is then exported to an onshore liquefaction facility in Darwin via an 890 km subsea pipeline.

Ichthys LNG Hook-up of CPF and FPSO (2016-2019)

CLIENT: Samsung Heavy Industries Co. Ltd (SHI) (CPF) / Daewoo Shipbuilding & Marine Engineering Co. Ltd. (DSME) (FPSO)

ENTITY: Clough

LOCATION: Browse Basin, Western Australia

The Clough scope included hook-up design, procurement, fabrication, and offshore hook-up of the Central Processing Facility (CPF), and a Floating Production Storage and Offloading (FPSO) vessel in Australia's Browse Basin, 220 km offshore of Western Australia.

The *Ichthys Explorer* CPF, a 155,000 tonne vessel, is the largest semi-submersible facility in the world. Constructed in the SHI shipyard in Geoje, South Korea. [218]

The FPSO is a 336-metre-long, turret-moored vessel – one of the largest in the world. It is moored in 250 metres of water and designed to handle 100,000 barrels per day of condensate and store 1.6 million barrels of liquids.

This highly complex, internationally delivered project eventually employed over 2,000 people and drew on the experiences from the Wheatstone Hook-up and Commissioning Project to propel Clough into Australia's leading offshore hook-up contractor of choice.

Gas-in was achieved offshore in the third quarter of 2018, a significant milestone for the Ichthys LNG's operator, INPEX Australia.

The CPF and FPSO were designed for a lifespan of 40 years.

'It was a privilege to work on this iconic project with Clough and a subcontractor team of such exceptional dedication to safety and quality. Our teams succeeded on both the FPSO and CPF hook-ups in a remote, complex project, enhancing not only Clough's reputation, but also Australia's reputation as a centre of excellence for offshore delivery.'

- Matthew Taylor

Wheatstone Project Product Loading Facility and Tug Berths (2012-2016)

CLIENT:	Bechtel (for Chevron Australia)
ENTITY:	BAM Clough
LOCATION:	Onslow, Western Australia

BAM Clough designed and built the Product Loading Facility and Tug Berths on the Wheatstone Project, one of Australia's largest resource projects ($29 billion), at Ashburton North, 12 km west of Onslow in Western Australia.

This consisted of two LNG trains with a combined capacity of 8.9 million tonnes per annum and a domestic gas plant.

BAM Clough's scope was the construction of a 1.2 km jetty with a marine operations platform, a product loading platform incorporating a single LNG, and a condensate loadout berth with associated breasting and mooring dolphin structures. [219]

Wheatstone Project Offshore Hook-up and Commissioning (2012-2018)

CLIENT:	Chevron Australia
ENTITY:	Clough
LOCATION:	225 km offshore from Onslow, Western Australia

The Wheatstone Platform is one of the largest ever installed in Australia with a topside weight of approximately 37,000 metric tons and the largest float-over installation Chevron has delivered globally.[220]

It is also the largest project in Clough's 100-year history. It took over six years, commencing in February 2012, and included the provisioning of all project management services, engineering labour, materials, equipment and a 500-person accommodation support vessel for the hook-up and commissioning of the platform.

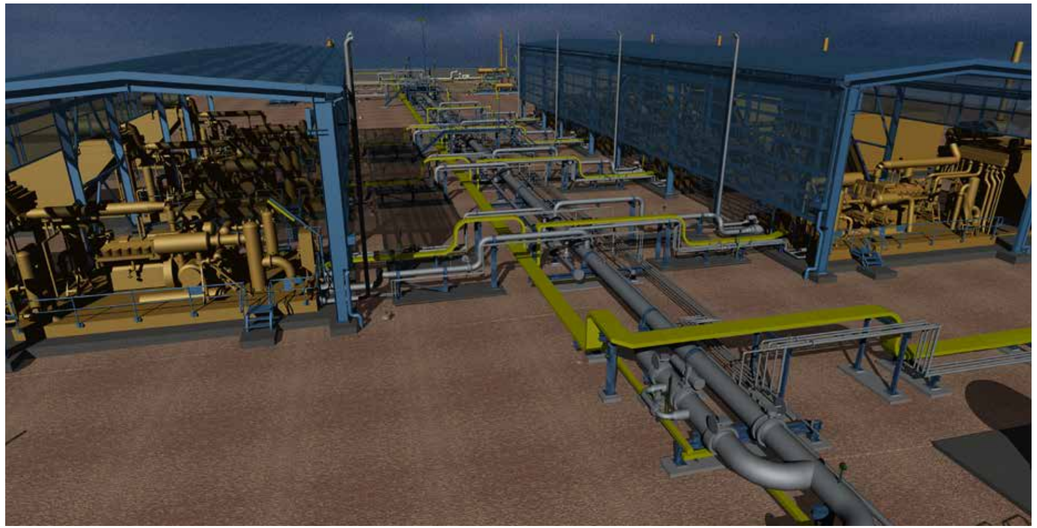
The topsides were built in South Korea and transported to a site just north of Barrow Island. The platform topsides, with a massive 20,000 square metres of deck area, were installed on the substructure, and Clough's team descended on the facility to complete the offshore portion of the project and move the facility into operation.

'This awesome project saw us working around the world' in Perth, the fabrication facilities in South Korea, Karratha, Dampier, Forrestfield, Barrow Island, and the offshore facility itself. We had a shifting pool of people working on the project across these locations — and in some areas in combination with the Chevron people — making it one of the most challenging logistical projects of recent years. One great outcome of our collaborative approach is an ongoing enhanced reputation with Chevron, one of the world's largest energy companies.

'We are also proud to have been instrumental in the most successful start-up of an offshore facility in Chevron's history. We've delivered thousands of activities within a complex and time-critical schedule with no industrial disputes and over two million man-hours without lost time and incident-free.

'I think Clough people should be justifiably proud that our company has successfully delivered a project of such global significance without reliance on other partners.' [221]

- Matthew Taylor



Arrow Upstream FEED (2014-2016)

CLIENT: Arrow Energy

ENTITY: Clough AMEC

LOCATION: Surat and Bowen Basins, Queensland

Clough AMEC was awarded the Arrow Energy Upstream FEED / EPCM Contract in September 2013 after completing the 9 month Pre-FEED activities to finalise the Surat Development 'Scope of Work'.

The project proceeded into the define phase delivering value improvements that focused on scope reduction, process simplification, technology advances and updated market enquires. Catalogue engineering was refined, specifically focusing on the value drivers associated with large volumes of skid mounted packaging and commodities.

Front end engineering was completed and the basis engineering design packages were handed over for the Surat and Bowen gas projects.

The Surat gas project FEED services were located in Arrow Energy's gas production acreage west of Brisbane and spans 8600km² from Wandoan, and south to Goondiwindi.

The Bowen gas project FEED / EPCM services project spanned 8000km² north and south of Moranbah, with the Bowen Basin covering an area of over 60,000km² in Central Queensland from Collinsville to Theodore.

Karratha Life Extension (KLE) Project Marine Installation Services (2015-2017)

CLIENT: Woodside Energy

ENTITY: BAM Clough

LOCATION: Karratha, Western Australia

The BAM Clough Joint Venture was awarded the Marine Installation Services contract in 2015.

This involved project management and installation of engineering works to replace existing equipment on two berths, including LNG and LPG marine loading arms, gangways and dolphin fenders, and the provision of marine equipment and resources to undertake the site works.

A marine lift campaign supported the refurbishment of Berths 1 (LPG) and 3 (LNG/Condensate) of the export jetties at the Karratha Gas Plant.

The project was part of a larger upgrade to extend the life and enhance the ability to continue as the export facility for the Karratha Gas Plant, and was completed in 2016 achieving zero harm to people, community and environment.

In August 2016, the project team was awarded Woodside's monthly Safety Culture Cup Award for their commitment to safety on the Karratha Life Extension project (KLE).

The project finished with a consistent safety performance of over 90,000 work hours without an incident.

Port Moresby (POM) Power Station (2017-2019)

CLIENT:	NuiPower
ENTITY:	Wartsila Clough
LOCATION:	Port Moresby, Papua New Guinea

Clough in consortium with Wartsila completed the engineering, procurement, and construction contract for the POM Power Station near Port Moresby in Papua New Guinea.

The POM Power Station is a nation building infrastructure project being developed by NiuPower, a partnership between Oil Search Limited (ASX: OSH) and Kumul Petroleum Holdings.

The POM Power Station uses natural gas supplied by the PNG LNG project to feed six high efficiency reciprocating gas engines and generators. It will produce 58MW base load power to the Port Moresby power grid through a new 66kv power line and substation network.

The project finished with a consistent safety performance of over 1 million work hours without an incident.

Snowy 2.0 (2019-Current)

CLIENT:	Snowy Hydro Limited
ENTITY:	Clough Salini Joint Venture, Future Generation
LOCATION:	New South Wales, Australia

The Clough Salini Joint Venture, Future Generation, was awarded a AU$5.1bn contract for the Civil and Electro-Mechanical works for the Snowy 2.0 Project. The value includes future escalation of prices.

Project owner, Snowy Hydro Ltd, operates the Snowy Mountains Scheme, an integrated water and hydro-electric power utility located in the Kosciuszko National Park which supplements the electricity needs of New South Wales, Victoria and South Australia.

The Snowy 2.0 project once completed will form part of the existing Snowy Mountains Scheme. Snowy 2.0 will add an additional 2000 MW of power to the existing 4,000 MW produced by this Scheme.

Snowy 2.0 is a pumped storage hydro project. It will generate electricity by having water pass through its turbines before pumping it back up for reuse. Water is recycled between the upper reservoir (Tantangara) and lower reservoir (Talbingo) and can be used to generate power during peak demand hours and pumped back to the upper reservoir utilising the surplus of energy during low demand hours, in a cyclic permanent manner.

The two reservoirs will be linked by 25 km of 9.8 m diameter tunnel with a 700-meter underground PowerStation between the upper and lower reservoirs. The six 340 MW pump-turbine and motor generator units can work both as generators when producing or as motors when pumping.

'Our team is very excited to launch this project into its execution phase and to contribute our part into the advancement of Australia's sustainable energy future.

'Clough is proudly a Western Australian engineering and construction company currently celebrating its 100th year in operation. With a proven history of delivering world-class projects in Australia, as well as overseas, our local expertise will be one of the key elements for the successful delivery of this vital national infrastructure development.'

- Peter Bennett, Clough CEO and Managing Director

FOCUS ON THE FUTURE

What began as two brothers' humble building company is now an international business that brings together over 2000 people around the world who share an adventurous frame of mind that always finds a way to deliver.

As Clough celebrates its 100th year in operation, it is invigorating to see its talent for adapting and refocusing itself is thriving, and the 'give-it-a-go' attitude that characterised Harold Clough's era is still applicable to this day.

New technologies, new territories, new materials, and new resources have always challenged and empowered Clough; they've definitively changed the way projects have been delivered over time, but Clough's approach has remained a constant. Clough will continue to push the boundaries and achieve many more firsts.

'Clough has this philosophy and ability to try different things in new places, in other words, that adventurous attitude...we are really putting our reputation on the line to try something new.

'Clough as a company, with Harold's motivation, has never been afraid to do this. A lot of companies can't and won't take such risks, but I think it's a measure of the character of Harold and I think it is also a measure of the culture he has engendered which has been developed by many people.

'A lot of companies can't and won't do this, but it's a measure of the culture of Clough and the quality of the people. It's an adventuresome attitude and an independent mind.' - Geoff Smith [222]

The future of engineering and construction is in the hands of the new generation of Clough, a generation spirited by diverse forward-thinkers, creatives, and pioneers, in every sense. It is this spirit that has been the cornerstone of Clough's success over its centenary and will continue to write the story of Clough. There are highs and lows in every good story but it's resilience that carries the journey through.

'There were opportunities coming up; we grabbed them. And it's all about people, we had a great team of people.

'An organisation which began as the builder of house and small factory buildings is now able to complete projects at the cutting edge of technology not even known when Clough was a small company.'

– Harold Clough

A lot has changed, but our pioneering spirit remains the same. As we turn the page on our first century, we look forward to the opportunities ahead. We've paved a long road so far, but we're only just getting started...

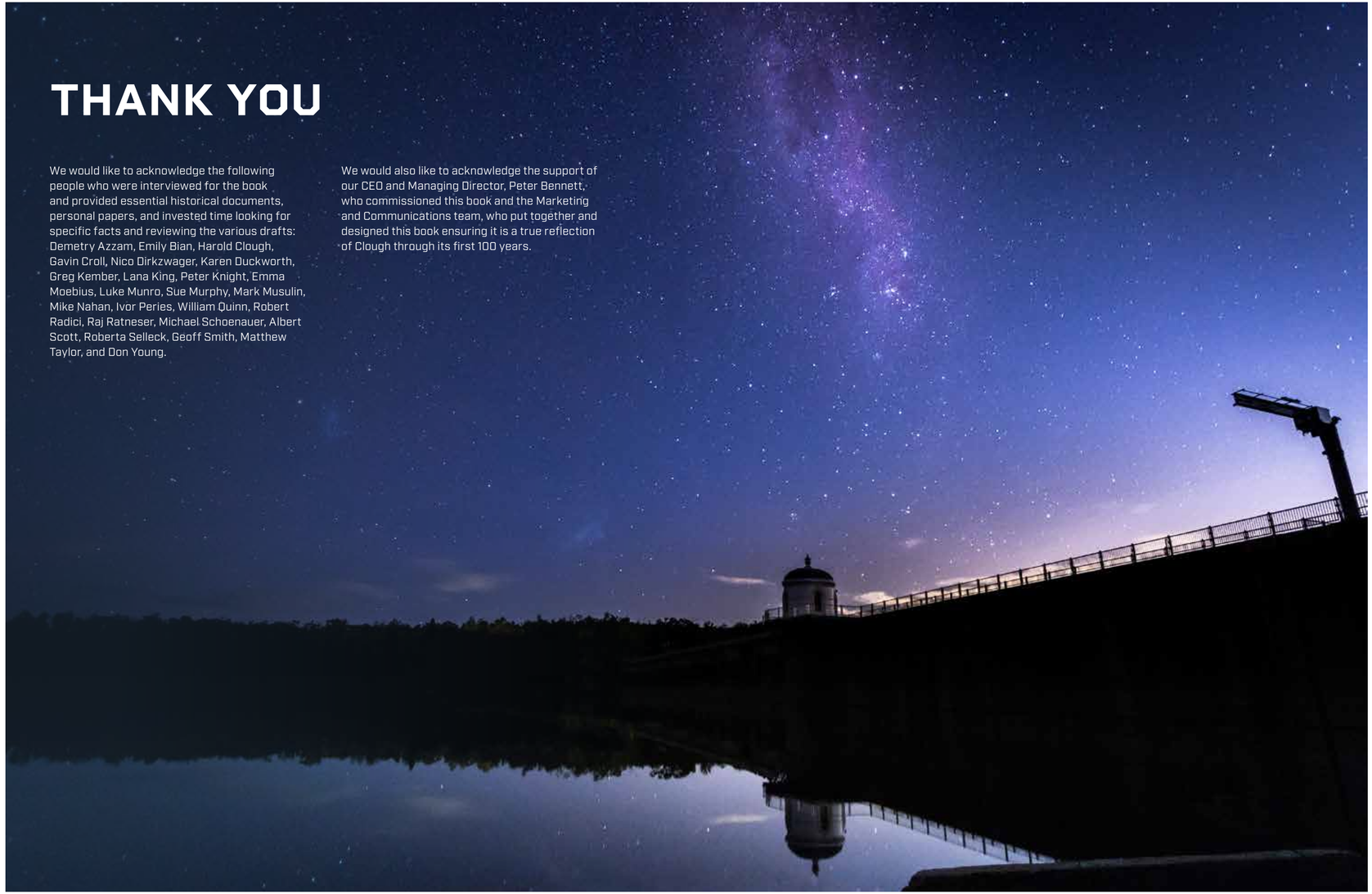
Endnotes

1 Harold Clough memoir, Mimi Packer, 2018
2 Harold Clough memoirs, Chapter five
3 Harold Clough memoir, Mimi Packer, 2018
4 CEG Annual Report, 1979, page 8
5 HC interview, 28 May 1993, page 13
6 HC interview 8 June 1993, page 2
7 Miscellaneous notes from Uffe Hansen, May 1993
8 HC interview, Ibid, page 13
9 There is a photo of John and Harold Clough on the front of The West Australian, and ongoing coverage throughout its construction.
10 From Clough Engineering Project Review, 1975
11 Interview, Albert Scott, 9 March 1993
12 McIlwraith draft page 39
13 Iron Country, Unlocking the Pilbara, David Lee, Minerals Council of Australia, 2015
14 Clough Engineering Group, Project Review, 1976
15 The original joint venture structure was 75/25 Harbour works Clough
16 Albert Scott interview, 9 March 1993 page 13. Also notes that from the seabed the jetties are about 120 feet (10 feet per storey = the equivalent of a 12-storey building)
17 John McIlwraith draft, page 38
18 Interview, Albert Scott, 9 March 1993, page 13
19 Harold Clough Memoirs, Mimi Packer
20 Building a nation brochure, Clough Holdings Pty Ltd, approx. 1989
21 Never enough for Clough, Mark Beyer, Business News 25 June 2009
22 Agnew Clough was unwound in 1977
23 Interview, Harold Clough, 25 October 2017
24 John McIlwraith draft page 44
25 Peter Knight. Address to the Weld Club President's dinner, 2013
26 Clough Project Review 1976
27 Clough Corporate Profile, Challenge is our tradition, approx. 1988
28 http://www.energynewsbulletin.net/australia/news/1100035/correction-varanus-a-hero-of-gorgon-s-past
29 Harold Clough interview, 28 October 1993, Tape 4, page 4
30 Clough press clippings, September 1990-December 1991
31 John McIlwraith draft page 75
32 Clough Engineering Annual Report, 1990, page 13
33 Harold Clough interview, 28 October 1993, Page 4, page 5
34 Don Young interviews, 4 March 1993 and
35 The great petrochemical dust-up. Mark Smith, AFR 1 August, 1969, page 15
36 Petrosea Corporate Profile, page 17
37 Petrosea Corporate Profile, page 17
38 Clough Annual Report, 1995 page 6
39 Clough Engineering 1990 Annual Report, pages 40-41
40 Clough Limited Annual Report, 1999, page 6
41 Clough Limited Annual Report, 2001, page 8
42 Clough Annual Report, 1999, page 11
43 https://www.smh.com.au/articles/2002/04/22/1019441223735.html
44 https://www.theaustralian.com.au/business/mining-energy/clough-settles-its-bassgas-dispute/news-story/0c959f5b181ed69d59f2939d883b64aa?sv=6e0a45197bbd1a636b5785e766f45d45
45 Jock had been a Director of Clough Limited since 1985
46 Half the increase will come from new shares, giving Clough a $40.1 million cash injection, and the other half from the Clough family's stake
47 http://www.energynewsbulletin.net/news-archive/news/1059076/bassgas-rough-on-clough 11 Nov 2004
48 https://www.smh.com.au/business/clough-completes-petrosea-sale-for-105m-20090707-db48.html
49 Interview, Sue Murphy, 29 August 2017
50 Clough Annual Report, 2010, pages 26-29
51 Clough Annual Report, 2011, page 5
52 Clough Annual Report 2011, page 4
53 Clough executes Scheme of implementation Agreement with Murray & Roberts, ASX/Media Release, 29 August 2013
54 Murray & Roberts Annual Report, 2013, page 83
55 Murray & Roberts Annual Report, 2014 page 67
56 Murray & Roberts Annual Report 2016, Oil and Gas overview, pages 44-47
57 Murray & Roberts full platform report 2018 page 4
58 Clough Media Release, 18 January 2019, Clough as part of Future Generation joint venture
59 Clough Media Release, GCR Mongolia Opens Training Centre
60 Interview, Peter Knight, 8 March 1993
61 Interview Gavin Croll 23 October 2017
62 Interview, Sue Murphy, 29 August 2017
63 Interview, Peter Knight, 8 March 1993
64 Interview with Geoff Smith, 18 April, 1993, page 13
65 Interview, Geoff Smith, 5 December 2017
66 Interview, Ivor Peries, June 2018
67 Interview, Sue Murphy, 29 August 2017, page 6
68 Interview, Geoff Smith,18 April 1993, page 3
69 Interview, Sue Murphy, 29 August 2017
70 http://diltsfoundation.or.id/site/profile
71 Clough Limited Annual Report, 1999 page 4
72 Clough Connect, Autumn 2016, page 22
73 Interview, Mark Musulin, 23 October 2017
74 Interview, Emma Moebius, 4 December 2017
75 Interview Albert Scott, 9 March 1993
76 Interview, Harold Clough 28 May 1993
77 Interview HC 28 May 1993
78 John McIlwraith draft page 18
79 Harold Clough interview, Ibid
80 Albert Scott interview 9 March 1993
81 Albert Scott interview 9 March 1993, page 5
82 Albert Scott interview, 9 March 1993, page 8
83 https://www.engineersaustralia.org.au/portal/system/files/engineering-heritage-australia/panel-title/WA%20Standard%20Gauge%20Railway%20Kalgoorlie%20to%20Perth.Panel___0.pdf
84 Interview, Peter Knight, 8 March 1993, page 9
85 Interview Peter Knight 8 March 1993, page 1
86 Interview Peter Knight 8 March 1993, page 1
87 Miscellaneous Background Notes for Clough Engineering 1957-1961 by Uffe Hansen, 5 May 1993
88 Interview with Geoff Smith 18 April 1993, page 1
89 Clough later sold out its share to Mitsui
90 Don Young 4 March 1993, page 6
91 Building a Nation brochure
92 Albert Scott interview, ibid, page 11
93 Mitchell Freeway Interpretation Panel, Engineers Australia/Main Road WA
94 Clough Building a Nation brochure
95 Peter Knight 8 March page 16
96 John McIlwraith draft, page 51
97 Peter Knight interview 8 March 1993, page 14
98 Clough Project sheet, The New Swan Brewery
99 https://www.concrete.org/publications/internationalconcreteabstractsportal.aspx?m=details&i=8926
100 Interview, Don Young
101 Don Young interview, 4 March 1993, page 13
102 Comparisons between the Narrows, Stirling and Mt Henry Bridges, Don Young
103 Don Young interview, 4 March 1993, page 13
104 CEG Annual Report, 1980, page 5
105 Clough Fact Sheet. https://clough.com.au/project/kwinana-freeway-bus-transitway/
106 Clough Fact sheet Brisbane inner northern Busway
107 http://www.orrconsteel.com.au/resources/case-studies/inner-northern-busway-section-5b
108 https://www.cpbcon.com.au/projects/inb-queen-st-to-upper-roma-st/
109 https://www.architectureanddesign.com.au/suppliers/case-construction-equipment/four-win-wa-case-earth-awards#
110 https://www.pipeliner.com.au/2010/06/05/toowoomba-pipeline-reaches-completion/
111 http://www.aeol.com.au/databases/news/toowoomba_pipeline_overflows_wit.htm
112 CEG Annual Report 1982, page 12
113 A fine tapestry, Albert Scott the man and his work, Marcia van Zeller, July 1991
114 BAM Clough history, page 18-19
115 Clough 2001 AR page 24
116 Albert Scott Interview, 9 March 1993, page 14
117 CEG Annual Report 1982, page 12
118 Clough Fact sheet, Worsley Alumina Plant
119 CEG Annual Report, 1988 pages 26-27
120 CEG AR 1990, page 18
121 CEG AR 1990, page 18
122 Ibid page 18
123 CEG AR 1990, page 21
124 Petrosea Corporate Profile (green) pages 16 and 17
125 Clough Annual Report 1999, page 31
126 Clough AR 1995, page 7
127 Clough 1007 AR page 16
128 Clough Annual Report 1999, page 21
129 Clough Annual Report 1995, page 7
130 Clough Annual Report, 1997, page 16
131 Clough AR 1997, page 17
132 Clough AR 1997 page 21
133 https://www.miningmonthly.com/markets/international-coal-news/1295094/clough-awarded-dalrymple-bay-expansion-contract
134 Interview, Ivor Peris, June 2018
135 Interview with Albert Scott, 9 March 1993, page 15
136 https://www.insideconstruction.com.au/site/news/1015066/clough-settles-indonesia
137 Clough AR 2001, page 22
138 Clough AR 2007 page 12
139 Clough 2001 AR page 24
140 Clough Limited Annual Report, 2009, page 18
141 Clough Limited AR 2010, page 22
142 BAM Clough 50 year book. Page 58
143 http://www.bamclough.com/projects/show/barrow-island-oilfield-development/
144 Clough Project Review circa 1979
145 Interview with Rob Jewkes, 27 May 1993, page 3
146 Speech to Australian Constructors Association, 12 November 1997 when Harold received the Services to Construction Award.
147 Never enough for Clough, Mark Beyer, Business News 25 June 2009
148 CEG AR, 1982, page 6
149 Interview, Albert Scott, ibid, page 18
150 CER AR 1982 Ibid
151 The West Australian, Woodside Offshore supplement, 12 September 1989,
152 Interview Albert Scott, 9 March 1993, page 18
153 CEG AR 1980, page 11
154 Harold Clough Memoir, Mimi Packer, 2018
155 The BAM Clough story, page 31
156 Ibid, page 34
157 Indonesia venture finally pays off, Robert Gottliebson, BRW 18 May 1990
158 The BAM Clough story, Ibid, page 33
159 The BAM Clough story, Ibid, page 35
160 See page 62 in the 50 years BAM Clough book.
161 Interview, Nico Dirkzwager, 16 December 2017
162 The BAM Clough story, Ibid, page 35
163 Clough Corporate Profile, Challenge is our tradition, page 3
164 CEG Group AR, 1988, page 6
165 CEG AR 1988, page 2
166 Interview, Albert Scott, 9 March 1993, page 21
167 CEG AR 1990 page 13
168 CEG Corporate Profile, Challenge is our tradition, page 5
169 CEG Corporate Profile, Ibid
170 Interview, Albert Scott, 9 March 1993, page 20
171 Interview, Brian Hewitt, 14 January 1994, page 4
172 CEG AR 1990 page 13
173 From Clough press clippings file September 1990 to December 1991
174 CEG AR 1990 page 12
175 CEG AR 1988, page 5
176 John McIlwraith draft page 77
177 Ibid, page 6
178 Interview Rob Jewkes, 27 May 1993, page 2
179 John McIlwraith draft pages 75 and 76
180 Clough project sheet
181 Clough project sheet, Field Development, Phase 2
182 CEG AR 1999, page 17
183 Interview Greg Kember, 7 December 2017
184 Interview with Peter Knight
185 Clough project summary
186 Clough Limited AR 1995, page 13
187 CEG AR 1995, page 12
188 CEG AR 1995, pages 4-5
189 https://www.onepetro.org/conference-paper/SPE-36461-MS
190 https://www.offshore-technology.com/projects/amoco/
191 CEG Annual Report, 1995 page 15
192 Clough Staff News June 1996, page 16
193 IClough Limited AR 1997, page 13
194 Interview, Greg Kember, 7 December 2017
195 Clough fact sheet Gorgon Downstream, EPCM
196 https://www.afr.com/business/construction/clough-wins-300m-gorgon-contract-20101216-j523h
197 Clough Bayu-Undan HUC project sheet
198 CER AR 2003 page 20
199 CEG AR 2001, page 20
200 Clough Bayu-Undan HUC project sheet
201 Clough Media Release 6 March 2019, Clough AMEC receives supplier recognition award
202 Clough project sheet
203 Interview Ivor Peries, 4 December, 2017
204 Clough Project sheet, Maari Wellhead
205 Clough Project summary, Hegigio Pipe Bridge
206 Interview, Ivor Peries
207 Interview, Nico Dirkzwager December 2017
208 http://www.bamclough.com/assets/Uploads/BC010cWoodside-LNG-Jetty-Train-V.pdf
209 Pluto LNG Clough fact sheet
210 Ibid
211 The BAM Clough Story, page 45
212 Clough Project sheet, PNG LNG Hides Gas Conditioning plant
213 https://www.smh.com.au/business/clough-joint-venture-wins-esso-contract-20090604-bw6h.html
214 The Bam Clough story, page 47
215 Clough AR 2011 page 18
216 Clough project fact sheet
217 The BAM Clough story, page 52
218 Clough Connect, Spring Edition, 2016, page 10
219 The BAM Clough story, page 56
220 https://www.chevron.com/projects/wheatstone
221 Clough Connect, Spring Edition 2016, page 13
222 Interview with Geoff Smith, 18 April, 1993, page 13

THANK YOU

We would like to acknowledge the following people who were interviewed for the book and provided essential historical documents, personal papers, and invested time looking for specific facts and reviewing the various drafts: Demetry Azzam, Emily Bian, Harold Clough, Gavin Croll, Nico Dirkzwager, Karen Duckworth, Greg Kember, Lana King, Peter Knight, Emma Moebius, Luke Munro, Sue Murphy, Mark Musulin, Mike Nahan, Ivor Peries, William Quinn, Robert Radici, Raj Ratneser, Michael Schoenauer, Albert Scott, Roberta Selleck, Geoff Smith, Matthew Taylor, and Don Young.

We would also like to acknowledge the support of our CEO and Managing Director, Peter Bennett, who commissioned this book and the Marketing and Communications team, who put together and designed this book ensuring it is a true reflection of Clough through its first 100 years.



ISBN

978-0-9953663-9-8

Publisher:

Clough

Authors:

Cynthia Calderon, Jaqui Lane, www.globalstories.com.au, Amanda Zampogna

Designers:

Stacey Collins, Ellie Boercamp

Proofreaders:

Clare Wadsworth, Cynthia Calderon, Stacey Collins, Amanda Zampogna, Ellie Boercamp

Printing:

Scott Print

www.cloughgroup.com

CLOUGH

WE'LL ALWAYS FIND A WAY TO DELIVER