THE LOOMBAH PROJECT

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ABSTRACT

North East Water manage the Loombah catchment dam which supplies the water treatment plant for the city of Benalla. Over the years operators have experienced water quality issues with iron and manganese when the catchment volumes get low, and then become challenging to treat. This paper will explain how North East Water worked with contractors to engineer ways to maintain a more consistent raw water quality to supply the water treatment plant, so operators had comfort with the drinking water quality supplying the town. The project included engaging divers to explore and then improve the operating system of the Offtake Tower at Loombah dam. The project included the removal of decades of silt, (through vacuuming) that had settled at the bottom of the tower structure and finding a buried 450mm diameter flange that would eventually become the connection for a newly designed floating offtake. The use of divers is not unusual at North East Water but they typically work in clear water applications. The use of divers that specialize in raw water environments is less common and the differences between the two are interesting.

1.0 INTRODUCTION

The Loombah dam was constructed in the 1940's and serviced the Benalla water treatment plant and town of Benalla for 80 years. Raw water was controlled using 3 offtake sets at various heights.

<u>Figure 1:</u> ***The construction drawings of the Loombah offtake tower – circa 1940, and the standing platform of the tower.***

The top two offtakes were used as required depending on where the water levels were at the time. The bottom one was never used principally because it was generally never required but also because of the water quality issues. The screens over each of the top two offtakes required considerable ongoing maintenance due to ongoing operational issues. These issues were due to the retrieval mechanism being manual lifting chains to hoist up the screens which were aged and deteriorated as well as weed and rust barnacles on occasions clogging the screens. In addition to the ongoing maintenance required the water quality issues of increased levels of Iron (Fe) and Manganese (Mn) were a constant challenge and resource drain for the operators.

The water quality issues of increased Iron and Manganese levels would present when the dam levels lowered, and the operators would close offtake 1 and open offtake 2, which were 3m apart. The water treatment plant had a treatment system established to manage the issues and to treat the Iron and Manganese. The treatment used Potassium Permanganate ($KMnO_4$) but it was a challenging system to maintain and operate. The inconsistent levels of Iron and manganese arriving at the water treatment plant increased the risk of getting it wrong which would result in purple water in the clear water storage.

The combination of the ongoing physical maintenance required on the offtakes as well as the ongoing water quality issues and challenges in treating those issues were what led us to undertake a project to investigate whether it would be possible to upgrade the offtake structure through the installation of a flexible offtake, thereby addressing water quality issues, or whether we would need to continue to manage the water quality issues at the water treatment plant, which also would require upgrades.

2.0 DISCUSSION

2.1 The Problem

Whether or not the dam could be upgraded to a flexible offtake system depended on what was at the base of the structure. The challenge faced was that the dam was built in around 1940 and the design drawings on file were over 70 years old. This made them difficult to confidently interpret because of their poor readability. They did show some form of an offtake at the bottom of the tower and stories circulated word of mouth over the years from prior operators also suggested there was a flexible offtake structure at the base. Beyond old drawings and old stories there was no definitive picture of what was at the base of the tower and therefore no understanding of what genuine options there were.
Before we could progress and consider engaging our internal engineers and dam specialists, we needed to complete the picture.

2.2 The Investigation

A decision was made to engage the services of a specialist dive company, who specialize in raw water diving, with the purpose being to confirm what was at the base of the tower and depending on what was found, if anything, to assess its condition to determine whether it was usable.

North East Water went to market and issued a tender and received three quotes from businesses based from Western Australia to Melbourne. The dive company who was the successful tenderer, had recently been engaged by NEW for an emergency event at a major sewerage pump station where they successfully dealt with a blockage caused by a pneumatic plug that had been caught in a pump set. This gave the NEW operating team comfort in their capabilities.

The dive project commenced in April 2019 and completed in November 2020. There were five stages of the dive project:

1. Exploratory

2. Dredging
3. Salvage
4. Fabrication
5. Installation

The dive team included a dive crew of six underwater dive and salvage experts who travelled from Port Melbourne, working in rotation. The challenges faced by the dive crew were many. The isolation of the site, the altitude, the water temperatures and depth all made the dive project particularly difficult in terms of managing risk and safety. The visibility, in diving terms known as black water, they needed to overcome to successfully complete the project. It was also what made the project interesting in terms of how they managed the risk and their work methods. It was also a unique project experience within the business of NEW.

2.3 The Dive Methods and Challenges

The dive team needed to plan their methods to accommodate the conditions faced. Those conditions and how they were managed included.

Accessibility

Accessibility was difficult and limited due to the Dams location and design. Because of where they had to park their equipment, and the line of sight between divers they needed two spotters to perform the works safely. In addition, there was no established boat ramp which meant launching the boat had its challenges and required a four-wheel drive to help with entry and exit of the Dam. Also because of its remoteness and the fact it was frequented by hunters the divers couldn't leave their equipment overnight and had to pack up all their equipment at the end of every day.

Altitude, water temperature and depth

The Dam was 421 meters above sea level. Water temperatures ranged from 10 to 16 degrees Celsius and the maximum dive depth was 14 meters. All these factors are critical safety risks needing to be managed by the dive team to avoid nitrogen narcosis and decompression sickness, otherwise known as the bends. It also impacted on the diver's ability to work effectively under water as the cold, in time, affected their fine motor skills.

The approach to manage these factors included limiting dives to 40 minutes and using a nitrox blend of breathing gas of 36%. Nitrox, also known as Enriched Air Nitrox (EAN), is a mixed gas consisting of nitrogen and oxygen that was developed to reduce the risk of nitrogen narcosis and decompression sickness associated with compressed air. Unlike air, which contains about 21% oxygen, nitrogen has a minimum of 22% and a maximum of 40% oxygen. Most scuba divers use the 32% or 36% oxygen mix. Nitrox is a favourite among divers because it allows for increased bottom time. Two factors must be considered when using Nitrox: the pressure of oxygen in the lungs and the length of the exposure. These two factors make up the oxygen limit. Certified Nitrox divers learn to calculate and manage their exposure to oxygen while dive tables and dive computers provide all the necessary information to dive safely on Nitrox.

Visibility, black water

Once the divers enter the water, they stir the sediment and in effect have limited visibility. They need to continue their work by feel. The divers are all experienced in working in black water and as a rule of thumb it takes four times longer to perform works in black water as it is to perform works in clear water. As well as working blind they are using thermal rated gloves which means they lose some sense of feel and touch. As their time under water progresses the cold causes them to lose sense of touch making the work to be performed more difficult. This is where the divers experience and capability come to the fore.

Figure 2: ***Divers in their full gear, entering for another dive.***

2.4 What Was Found

In the exploratory stage of the project nothing was found initially because of the volume of the silt at the base of the tower. This silt had accumulated over many years after the bushfires of the early1990s and the floods of 1993 and was in effect hiding what was at the base of the tower. It was estimated that the offtake was one meter below the silt level.

The silt needed to be removed and contained for environmental reasons. A silt terrace was constructed to capture the silt and prevent recontamination of the raw water supply. A local earth works contractor was organised to excavate 100meters of terraced trenches to allow for the silt to settle out when pumped to that location.

The dive team then dredged 10m3 of silt from the base of the tower by using a six-inch trash pump to push the silt 400 meters to the silt terrace. This dredging took several days. This dredging stage was highly successful as the silt was removed without compromising the quality of raw water supply.

After removing the silt, a flexible offtake was discovered. The divers made an assessment that although degraded due to age it would be salvageable with some engineering work and a decision was made to salvage it. Salvaging it involved removing the old flexible offtake from the flange.

The salvage exercise was challenging as the fixings holding the flanges together had seized. This meant the exercise of removing them took time and the divers needed to, in black water, use hacksaws and a pneumatic jackhammer. Diver's dislike using jackhammers under water because the percussion is felt more acutely underwater.

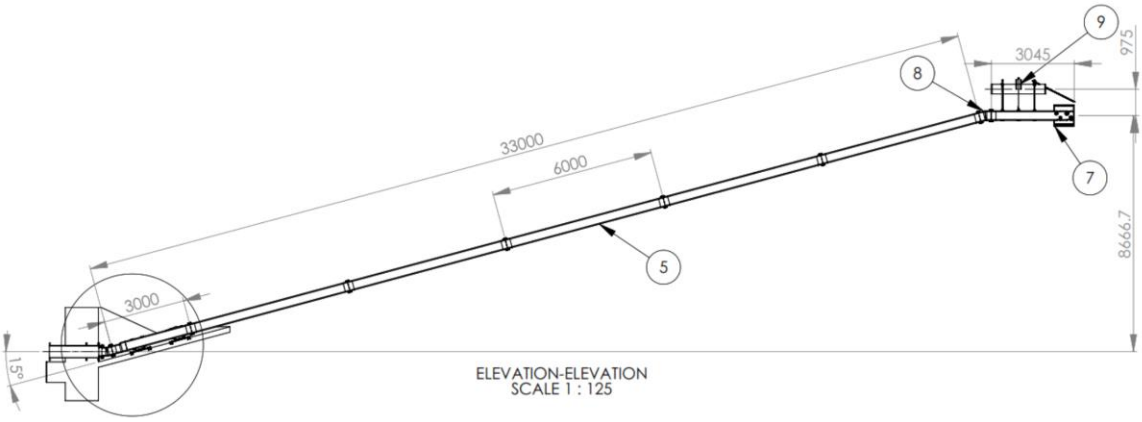
After some weeks the dive team successfully salvaged the 450-diameter offtake. It was assessed that the mechanical joint was fit for purpose and able to serve as the connection for the new offtake structure.

<u>Figure 3:</u> ***The silt terrace and the discovered flexible offtake.***

This information was given to NEW's internal engineers to investigate the options around redesigning the offtake system. The internal engineers developed a concept design and consulted with dam specialists within the business. The dam specialists within the business sought external specialist advice who advised on the design for the offtake.

Key design challenges included creating a flexible joint attaching to the new offtake to mitigate any structural pressure on the tower, designing the pontoon supporting the new surface offtake needed to be bullet proof, as the area is popular to hunters and there is a risk of damage to the pontoon (and potentially sinking) through vandalism and designing a retrieval mechanism so that the strainer could be retrieved for cleaning and maintenance purposes. It was agreed the set point would be 1.5 meters below surface level to make best use of the water quality offered.

A design was finalised, the new structure fabricated, and the dive team came back to site over a 2 day period to install the new structure. All the same challenges faced during previous stages needed to be managed during the installation but with additional challenge of drilling into concrete to anchor the pipe structure. The installation and project was successfully completed in November 2020.



<u>Figure 4:</u> ***Newly designed flexible offtake.***

3.0 CONCLUSION

The Loombah dam now operates with a flexible offtake system which effectively means the water quality issues previously experienced will resolve and the ongoing maintenance required reduced. Critical to the success of the Loombah dam project were the divers. The dive project itself spanned a 20 month period. During that period the divers were onsite for approximately 3 weeks and performed approximately 100+ dives.

Under challenging and extremely difficult operating conditions they successfully and impressively worked through all stages of the project from exploratory to installation. From confirming what the old drawings and stories suggested was true after safely dredging 10m3 of silt from the base, to assessing and salvaging the bottom offtake to the fabrication and installation of the newly designed structure.

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