

Changing the safety culture – my contribution to a large infrastructure project making a significant difference

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1. Introduction

1.1. The Works

The Waterview Connection Project in New Zealand was the extension of State Highway 20 (SH20) as part of the completion of the western ring route. It aimed to change the travel patterns of vehicles travelling from the south of Auckland to the North Shore by diverting traffic away from the city centre and into the western suburbs via SH20. The project was split into three sections;

1. The southern approach – a one kilometre stretch of three lane highway at surface level.
2. Two 13m internal diameter bored tunnels – each tunnel is 2.4km to create a three lane highway, using one Tunnel Boring Machine (TBM), with 16 cross passages at 150 metre intervals.
3. The northern approach – four overpasses connecting the SH20 to SH16.

1.2. Alliance

In 2010 the New Zealand Transport Agency (NZTA) awarded the main works to an Alliance led by McConnell Dowell NZ and Fletcher Construction, to construct and manage the works. The remaining companies within the alliance were Obayashi Corporation, Parson Brinckerhoff NZ, Beca Infrastructure and Tonkin and Taylor.

The project was managed by the Project Alliance Board (PAB). Each Alliance member had one representative, and the client the NZTA, had two representatives.

1.3. Cost and size of project

The construction of the 3 sections is estimated to have cost \$1.4billion NZD and was fully funded by NZTA. The project was designated as a 'Road of National Significance' to fast track environmental and local government approvals.

The project employed approximately 11,000 people during its five-year period. This included the main works sites, the concrete segment manufacturing site, and the disused Wiri Quarry for treating the excavated ground. The recycled excavated materials were used to reinstate the empty quarry to allow the area to be regenerated.

As one of the cross-passage engineers, I was responsible for the works carried out on site as well as the safety and wellbeing of the gang that I worked with.

1.4. Workforce

The Project is the largest tunnel construction in New Zealand. Its workforce was diverse in experience, skills, and included engineers and operatives from inside and outside of New Zealand. There were a number of workers who did not have any construction work experience.

2. History of Health and Safety in NZ

2.1. Pike River Mine Incident

On the 19th November 2010, there was a methane explosion at the Pike River Mine situated in the West Coast region of the South Island of New Zealand. The explosion was closely followed by a second on 24th November. It was determined that the 29 miners and contractors who were present in the mine during the initial explosion had died. It was the worst mining incident in New Zealand since 43 men died at Ralph's Mine on the North Island in 1914.

Following the incident, new Health and Safety laws were brought in that applied to the Waterview Project.

2.2. Safety Laws and Regulators

In 2013, following the Pike River explosions and a Royal Commission reviewing the tragedy, ‘The Health and Safety (Pike River Implementation)’ Bill was introduced to the New Zealand Parliament. The bill was split in to three parts:

- The establishment of WorkSafe New Zealand, a new workplace health and safety agency; and the WorkSafe High Hazard Unit.
- Amendments to the Health and Safety in Employment Act 1992 ("the HSE Act"); and
- Creation of a new Mines Rescue Act 2013ⁱ.

3. Implementing Change

3.1. Monitoring Change

At the commencement of the Waterview project, a Key Results Management Plan was written to lay out the systems to be used to ‘establish, reinforce and drive positive behaviour’ⁱⁱ amongst the project team, from the PAB to the working operatives on site. These behaviours were linked to a series of objectives agreed between the Project Management team and the NZTA, e.g. Quality and Efficiency, Cost and People (wellbeing).

These were tracked and reported monthly. Safety on the project was tracked as part of these key results as per Table 1 below:

Measure	Target
Zero Harm Shifts	Zero Harm
Hazard ID and near misses reported	Over 1200 per million man hours (PMMH)
Fatigue	No one works more than 60 hours per week

Table 1:- The targets set for each measure in January 2013ⁱⁱⁱ

The measures and targets were set by the PAB. A scaled scoring system was used to measure the results of each team. The scores were scaled as follows: -

1	Breakthrough	2	Step Ahead	3	Business as Usual	4	Step Behind	5	Breakdown
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In July 2013, when the project was moving into the tunnelling phase of the works, the key results, shown in Table 2 showed that there was a high number of shifts were there were safety incidents on site despite the hazard reporting also being high.

The ‘zero harm’ performance measure was calculated from the number of days in any given month that have passed without any first aid, medical treatment or lost time injuries.

Measure	Result	Score
Zero Harm Shifts	12/30 harm free days	5/Breakdown
Hazard ID and near misses	Hazard ID=228 1423 PMMH Near miss= 13 81 PMMH	3/Business as Usual
Fatigue	35 people working more than 60 hours	3/Business as Usual

Table 2:- Keys results for July 2013

With tunnelling works due to commence, it was considered that this new phase of works be used to renew the push to improve the safety statistics on the project

In early 2015 the Key results were reviewed and to highlight the importance of reporting all incidents, hazards and near misses on the project. The measure was presented as a combined rate for Hazard ID cards and incidents reported, rather than two separate scores as in Table 2. An additional reporting measure was also tracked to monitor the frequency of serious near misses or incidents the new

measure was tracked as a reverse of the other measures, where the lower the number of incidents taken place in the month, the better the score was given.

I reported the key results for the tunnelling team at the monthly tunnelling toolboxes. I collated the safety data including number of incidents, and hazard and good stuff cards submitted for the previous month and presented it to the team. I tracked the progress of my team against the targets and suggested one measure which we should focus on to improve, feeding back to my team with the results. One month, I would encourage hazard reporting using the Hazard cards, see below. The following month I would promote the use of the 5x5 cards. This was a good technique to promote health and safety within the team and something I utilise on projects in the UK, as it encourages active participation across the work force in health and safety.

3.2. Methods for Improving Safety

3.2.1. Hazard and Good Stuff Cards

The cards were strategically placed around the site and in the offices. Everybody was encouraged to complete the cards and report any hazards and good practices they saw on site. The completion of cards was promoted on a weekly basis by team management and reinforced daily by shift bosses.

The structure of the card actively encouraged conversation between the members of the team on site, to ensure the hazard that was seen was rectified as soon as practicable. The conversation also ensured that lessons were learnt, and poor behaviour was amended as soon as possible. As one of the cross passage engineers I took the lead to change the safety behaviour of my crew. Following one incident where the tip of a forklift blade bruised one of the operative's foot, I discussed it with him. I reminded him the importance of reporting any injury, however minor, to ensure the whole team can learn and improve. He took on the responsibility to brief the team on the accident and how it can be avoided in the future. The lessons learnt were also highlighted to whole tunnelling team at the weekly tunnel toolbox talks.

Monthly, the best 'Good Stuff' card was given for an award. This was done publicly and normally presented by a member of the PAB to the winner. Additionally, to promote the use of the cards the number of cards submitted were tracked as part of the Key Results in November 2015.

As a visible member of the site team, I would ensure that I wrote on these cards every shift. The cross-passage team would often work along 500m stretches of the tunnel, we would often interact with other members of the tunnelling team. One shift, I noticed a member of the maintenance team fixing a pipe on the side of the tunnel. The operative was standing on the top rung of the ladder with no fall arrest system. I approached the operative and asked him to come down the ladder. We discussed why he was using the ladder and what he could do better. I helped him find a Haki Tower which enabled to work safer. We then used the Hazard card to record the conversation.

3.2.2. 5x5 Cards

These were A6 sized cards to be filled out by a shift boss or crew leader when a new task was to be started during the shift. The size of the card was to ensure that the shift boss could carry them in their pocket.

The idea behind the cards was to encourage the team to take 5 minutes to review the new task and highlight any new hazards that the team were unfamiliar with. The card could be used if a sub-group of the gang were required to carry out work separately from the rest of the team.

These cards were very effective in reducing incidents and near misses happening in the middle of the shifts, as crews were reviewing their methodology and hazards before starting a new section of works. There was also an increased input from all sections of the shift team as the small group and informality of the process, encouraged more operatives to ask questions and provide input into the discussions.

As the shift engineer I saw my role to encourage the quieter members of the team to speak up, and ensure that ideas were well thought through, and technically correct.

I completed these cards when carrying out the early strength concrete tests on the sprayed concrete panel. These tests were carried out in a different area of the tunnel to where the rest of the team were working, and these 5x5 cards ensured that I took five minutes to ensure I was aware of the risks and took the correct mitigations.

The 5x5 cards were also utilised to advise the crew on exclusion zones for the shotcreting works. This highlighted the importance having a clearly marked physical barrier to stop anyone from entering an area that had recently been shotcreted. Learning from my experiences in the UK, I ensured that the cross-passage crews were aware of the risks of an unauthorised entrance into an excluded area and the importance of the early strength testing.

3.2.3. Safety Representatives and Committee

The project established a Safety Committee, in compliance with the new law, for each section of work. The tunnel team elected a committee of Safety Representatives from each sub-team. Each shift had a committee representative, as well as the mechanical team and cross passage team. The representatives were from within the workforce and not supervisors or Engineers. The committee met once a month and was chaired by a member of the safety team. The committee was given the responsibility of reporting issues from the site teams and discussing workable solutions. They also discussed good practice that had been taking place within the shifts to ensure that everyone was aware of any new innovative solutions.

3.2.4. Safety Audits

Weekly audits were carried out across the various sites involved in the tunnelling works. The audit team would be made up of a manager of a section of tunnelling works, a Site Engineer and a site representative from the Safety Committee. This mix of levels ensured that different points of view and experiences were brought to the safety audit and helped increase the number of hazards that were identified and rectified. Effort was also put in to ensuring that the audit team did not work in the area that they were auditing. This reduced the risk of hazards being missed from the team being too familiar with the environment that they were inspecting.

As a site engineer I took part and took the notes of the safety audits I carried out. I would ensure that we noted all hazards seen and encourage discussion between the audit team and the operatives working in the area.

3.2.5. Innovative Shift Pattern

At the commencement of TBM works, a 24 hour, 6 days a week shift pattern started. To reduce fatigue, the project leadership team stated that no team should work more than four nightshifts in a row. In the past tunnelling and mining projects in New Zealand, there had been no restrictions on the number of night shifts in a row, and work crews had worked 6 days in a row, with a one day break.

Figure 1, below, shows an extract from the first drive of the TBM, with the colours representing the TBM crews and the bottom two rows showing the two shifts for each day.

When the initial rota was organised, the tunnel team leadership asked each shift to discuss the rota and bring any questions or concerns to them. An open discussion was led amongst the team and the decision of accepting the rota was made amongst each crew. The safety representative and shift boss led the team conversations to encourage open discussions and ensured that all members of the crew understood the benefits and possible issues with the shift rota.



Figure 1:- An extract from the Shift Rota for the TBM crews

During the first drive, the shift rota was reviewed and discussed again with the crews. Minor changes to the rota were made to reflect comments from the crews regarding shifting from day to night shift and the effect on their sleep patterns. The shift pattern was also revised to ensure that operatives that did not live in Auckland could spend as much time with their families as possible. Once the changes had been made the crews accepted the

3.2.6. Safety Team on shift

A safety advisor (SA) was with each TBM shift crew, although on a different shift pattern to the crews. This allowed the safety team to create a good bond with the team and confidence of the crews. It encouraged immediate and open reporting of near misses and hazards during the shifts. It also allowed the safety team to run planned emergency drills at any point on shift, day or night, and practice emergency evacuations from the TBM. Although the SA was part of each shift, they reported to the safety manager, not the Shift Boss or Person in Charge (PIC). This initiative worked well, as it improved reporting of all hazards and injuries allowing a quick turnaround to find the root cause. It also allowed the safety documentation to be reviewed and signed off by the safety team more efficiently.

3.2.7. Training of Project Team

Training of the workforce to understand the hazards of the work was undertaken continuously throughout the tunnelling phase. The training was both formal and informal. – run by outside companies on various tunnelling and construction related topics. Often training was carried out at the site to encourage attendance. Formal training was also offered around soft skills. I went on a training course for future leaders where we were taught how to lead our teams and to have challenging conversations with team members.

With many of the operatives in the cross-passage team being new to the industry the training gave me the tools to adapt the safety briefings to ensure every team member understood the risks and mitigations during the works. I utilised different formats and ensured that the briefings were interactive, so that I was confident that every member of the team, no matter their experience, was aware of the works to be undertaken.

This skill has been useful when working on future projects because I could share information clearly and in different formats, such as the use of images and text, where there has been language differences and experience gaps. I also encouraged questions by participants and used questions to check that they had understood the briefings. I found that briefings that were interactive with the participants were the most efficient in training members of the team in the methods and risks of constructing cross passages.

There were also toolbox talks run by tunnel team members with tunnel construction experience. I was asked to present a talk on sequential tunnelling methods, that were going to be used for Cross-passage construction. I presented the typical methodology, and highlighted the main risks involved.

4. Summary

At the completion of the tunnelling works in March 2015, the monthly Key Results shown in Table 3, were showing that the safety measures had improved during the tunnelling works.

Measure	Result	Score
Zero harm shifts-	82% shifts had zero harm	2 Step ahead
Hazard ID/ Near miss	220 cards = 1110 PMMH	2 Step ahead
Fatigue-	28 people over the 180 hours/ 3-week threshold	2 Step ahead
Serious near miss	4 SNM reports (22 PMMH)	3 Business as Usual
Positive reporting	98 reports (511 PMMH).	2 Step ahead

Table 3: - March 2015 – Key Results Safety Results for February 2015

Working with the two national safety taskforces, Workforce’s High Hazard Unit (HHU) and Mines Rescue, the relationship built during the tunnel works ensured that the experience and knowledge gained can be taken into consideration when forming new mining and construction legislation and guidelines. The sharing of best practices and lessons learnt at a national level will improve the safety performance across the industry. The tunnelling manager was appointed to the WorkSafe, Board of examiners.

When the HHU visited the cross passage works, I used my experience of open excavation and shotcreting, that I had gained in the UK, to guide the visitors through the works. I could answer their questions and concerns about the risks of open excavations.

The leadership’s ‘No Blame’ culture coupled with tracking inputs and changes showed that there was feedback and people were reading and listening to their comments. By highlighting the best inputs and behaviours of the team on a regular basis, the teams’ morale was boosted and they were encouraged to continue their good practices. The monthly update also acted as a reminder of the expectations that the leadership, at all levels, had for the safety culture of the project.

The innovations used on the project, such as promoting and rewarding the Good Stuff cards, looked at changing the behavioural safety of those working on the project. The training scheme that was completed for the project team, also ensured that the Hazard reporting was improved, and that hazards were reported and sorted before any further incidents took place.

Some of the ideas were initiated from the PAB, whilst other ideas worked best because they were promoted by the workforce. The best initiatives were those that encouraged the workforce to suggest their own safety improvements. Empowering the team allowed them to take ownership of improving their own safety and the safety of the team around them. The engineers on the project were also encouraged to take a lead on behavioural changes, as well as the technical leads

These cultural changes also encouraged respect for all team members. There was an acknowledgement that all opinions and ideas were to be heard and considered. This allowed newer members of the team and those with less construction experience to learn about safety ideas and take a leadership role in new initiatives.

The scores shown above suggest that the innovations and cultural changes had made a difference to the safety performance of the project. This achievement was made possible because of a complete buy in from the highest level of management to the crews working on site. There was an understanding that every member of the team, was a safety leader, and someone who could make a difference.

This experienced showed me how safety can be improved on the project when initiatives are not only lead from the top, but also grown and developed by the members of the team. I encourage all projects to develop a safety process that allows for input from all levels of the team. I have also learned that clear and improved communication between the various levels of the project team can bring change and learning to everyone, no matter their level of experience and expertise.

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Endnotes

ⁱ <https://www.al.nz/the-health-and-safety-pike-river-implementation-bill/>

ⁱⁱ Prepared By: Leon Field; Well-connected Alliance Key Results Management Plan, 300-MGP-00002, Rev 04 27th November 2015

ⁱⁱⁱ Prepared By: Leon Field; Well-connected Alliance Key Results Management Plan, 300-MGP-00002, Rev 02 31st January 2013