



Pavement Delivery System Review

Workstream 6: Industry Capability

PDSR authors

1 November 2022

V1 Final

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1.0 Purpose of this Report

The ‘Review of State Highway Pavement Delivery’ report was communicated to the New Zealand Pavement Industry by Waka Kotahi in March 2020. This holistic and collaboratively sourced review examined the steps Waka Kotahi and the wider industry could take to improve their collective performance in the end-to-end delivery of new and rehabilitated pavement construction in New Zealand. The review was guided by Waka Kotahi’s value for money investment principle; *“the delivery of the right outcomes, at the right time, at the right cost and financed at the right level of risk”*.

Whilst the review was not expected to generate a fundamental change to systems and processes, it did identify areas where further focus, refinement and discipline would improve design, delivery and reliability confidence. Opportunities to improve, clarify and supplement existing pavement specifications, design processes and construction delivery were also highlighted. These opportunities were summarised within nine recommendations that were subsequently endorsed by Waka Kotahi. The recommendations of the Report are summarised in Figure 1.

“To review the current NZ Transport Agency end to end system delivery requirements for new pavement and rehabilitation construction and to assess these requirements in terms of best value for money to deliver on New Zealand’s land transport objectives.”

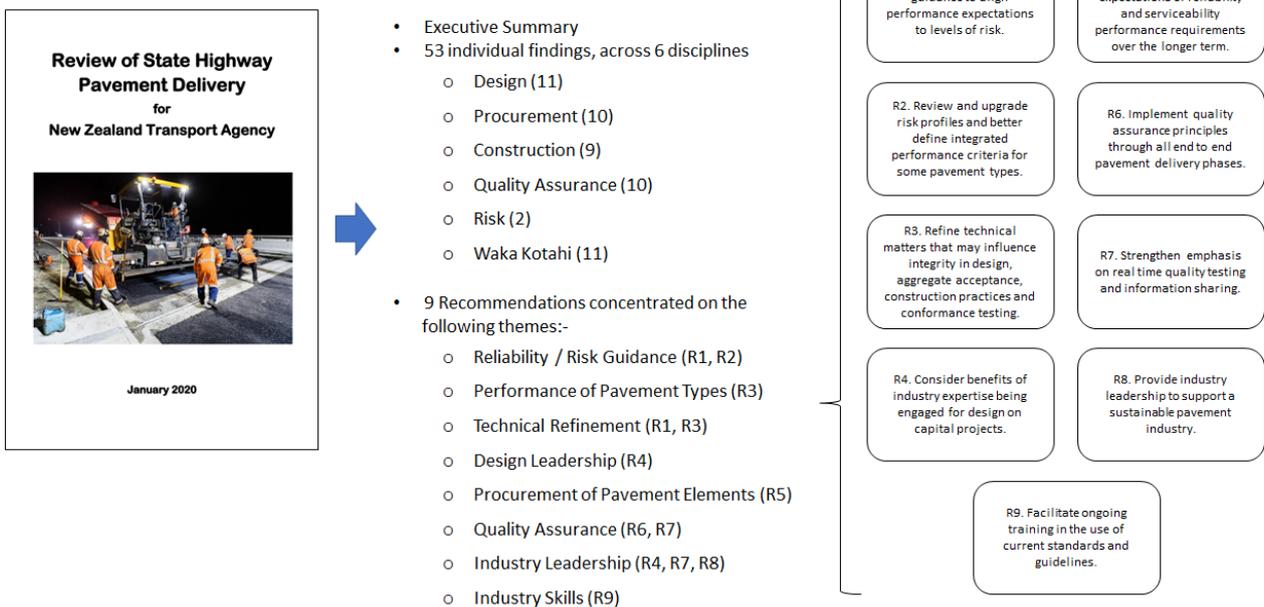


Figure 1: A summary of the outputs from the ‘Review of State Highway Pavement Delivery’ report.

An Industry Steering Group was then established to plan, resource and enable the implementation of the nine recommendations. The Industry Steering Group, shown in Figure 2, is chaired by Janice Brass of Waka Kotahi and is supported by senior industry representatives across its targeted workstreams.

- Workstream 1 – Technical Matters
- Workstream 2 – Whole of Life
- Workstream 3 – Procurement
- Workstream 4 – Strategic Risks
- Workstream 5¹ – Quality of Project Delivery
- **Workstream 6 – Industry Capability**
- Workstream 7 – Cross Industry Communications

¹ In June 2022, the Steering Group agreed to combine the outputs of a separate workstream, targeting improved awareness of Z01 and Z08 quality related documentation, into the scope of Workstream 5 – Quality of Project Delivery.

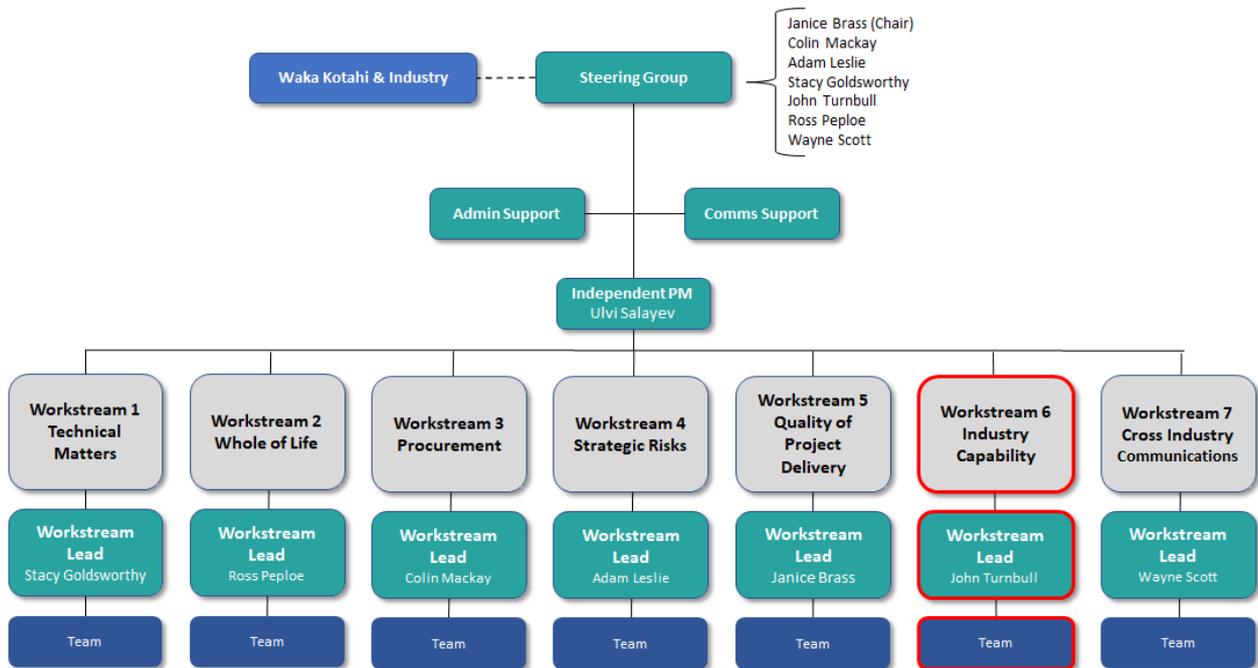


Figure 2: The structure of the Industry Steering Group, showing the Workstream 6: Industry Capability Team

The Workstream 6 Team were tasked to consider the Report’s Recommendations that targeted improvements related specifically to Industry Leadership and Industry Skills, these being: -

Ref.	Report Recommendation
R8	<p>Industry Leadership.</p> <p><i>Recommendation statement from page 5 of the Report:</i></p> <p><i>Strategically, give importance to leadership for sustainable pavement industry through training, R&D, partnerships, economic aggregate availability, and personnel talent and construction capability.</i></p>
R9	<p>Industry Skills.</p> <p><i>Recommendation statement from page 5 of the Report:</i></p> <p><i>Facilitate ongoing training in the use of the current Guides and Standards to raise the holistic capability industry wide (i.e., design to construction) and encourage technology and innovative methodologies, which contribute to the opportunity of efficient construction control, quality and productivity and adherence to best practice.</i></p>

2.0 Structure of this Report

The Workstream Team were quick to understand the complexity of the challenge associated with assessing Industry Capability and the way it affects the various aspects of the pavement delivery system. They determined the need to produce Required Responses that offered targeted and pragmatic solutions. To achieve this, and to provide a logical structure to both the work they undertook and the structure of this report, a sector-analysis approach was adopted. This considered the 'leaders' (or influencers) working within three defined sectors. These sectors were: -

Sector Title	Leaders or Influencers operating in this Sector
Government Level	Considering both Central and Local Government separately, within the same Sector. Other Road Controlling Authorities such as Department of Conservation (DOC) may also have an interest.
Industry Level	CCNZ, ACENZ, EngNZ, AQA, CETANZ, technical groups, forums and committees. Other industry level collectives such as IPWEA, REAAA and Austroads may also have an interest.
Organisational Level	Those organisations covering pavements related education and training, principals, consultants, designers, contractors and suppliers.

A consistent process was employed using a gap-analysis approach to assess certain factors. This helped to define differences (gaps) between the industry’s perception of the leaders required performance levels, versus the performance level that is currently being provided. The factors considered were: -

1. The role the leader operating within the sector plays in the pavement industry.
2. The existing skill levels that exist in the sector, versus the skill levels considered as being a core capability requirement.

In all instances, the Workstream Team have remained focused on issues affecting a leaders’ ability to improve and maintain industry capability levels. Using this process, the Team have then structured this report to summarise findings and practical Required Responses for any improvement opportunity that was identified. As such, the structure of the contents of this report became defined. This is shown in Figure 3, overleaf: -

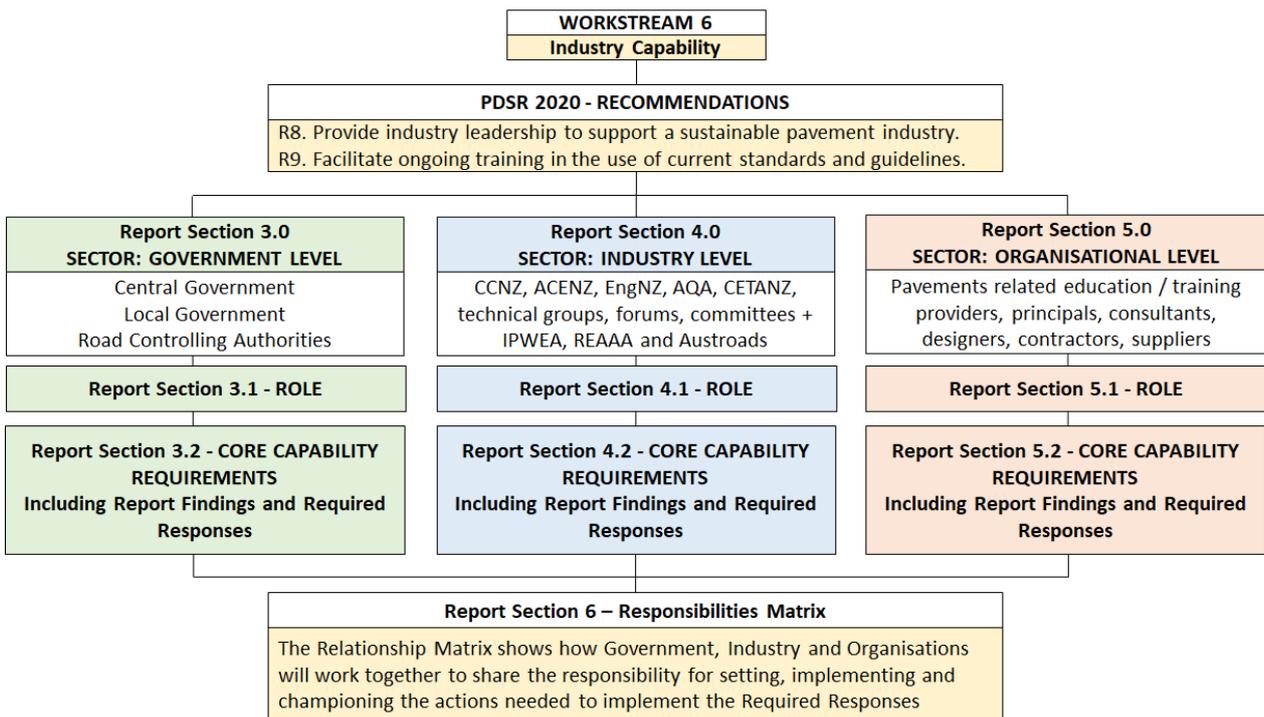


Figure 3: Report structure

2.1 Prioritisation of Required Responses:

The Required Responses made by the Industry Capability Workstream are identified by sector.

Given that each of the separate workstreams described in Figure 2 is challenged to produce its own report, and recognising that some considerations between these workstreams overlap, the decision has been made by the Steering Group to consider and prioritise the Required Responses as a whole, once all reports are complete. The full list of prioritised Required Responses is provided within an overarching PDSR Steering Group Report, titled **PDSR Summary Report** which is accessible via this [link](#).

Several of the Required Responses seek to either build upon or re-energise initiatives which may already be in place, but to do so will require a greater commitment to cross-sector collaboration. This will help to ensure that the improvement we all strive for, is achieved in a coordinated way where government, industry and organisational resources are consulted and considered, and therefore on the same journey.

3.0 Sector: Government Level (or Road Controlling Authorities)

3.1 The role of Government

3.1.1 Central Government

For many decades, Waka Kotahi and its predecessors have provided a leadership role for pavement technology and construction development, as well as overseeing the provision of industry standards and specifications. This leadership role takes many forms, with Waka Kotahi guiding and promoting the wider pavement delivery system and incentivising its success through the creation of procurement practices, funding arrangements, general industry training or secondment opportunities. This leadership was necessary to establish and maintain pavement standards for government funding and investment of New Zealand's roading network. State Highways are fully funded and local roads, whilst under the authority of local government, have substantial financial assistance from the National Land Transport Fund.

Waka Kotahi's leadership of technology and standards provides benefit and value to the pavement delivery system by demanding industry competence and performance. This has been particularly necessary as the industry has progressed through evolving change in procurement models since 1990 (i.e., the introduction of the Transit NZ Act 1990). This change has caused progression from method prescription to performance outcome contracts, with corresponding competency and commercial influence on all industry participants.

To support its leadership status, Waka Kotahi has sought to maintain a centre of pavement technical expertise, which has an active research and development programme and collaborative relationships with industry technical interest groups. Pavement standards and specifications are founded on these programmes and the collaboration that supports them.

Waka Kotahi procures its pavement design, construction, maintenance and renewals works through private sector suppliers, either directly or through other road controlling authorities. It is important to note that: -

1. Pavements are Waka Kotahi's second most depreciable asset by asset value. Also, the road surface is a highly important factor to the road user, influencing both road safety and comfortable travel.
2. As a leader in the pavement industry, and as the owner of high quality pavements, Waka Kotahi's expertise in pavement technology, research, procurement and construction quality is critical.

Finding 1: In order to perform and maintain its leadership role, Waka Kotahi needs to retain a sustainable skills base within its organisation. While Waka Kotahi does not do the work directly, it must have the capacity to specify its requirements accurately and then provide the assurance that these requirements are being consistently achieved.

To do this Waka Kotahi, as a Government Agency, needs to remain proficient in the following Core Capability Requirement areas: -

- Pavement Investigation
- Pavement Design
- Pavement Materials Technology
- Pavement Construction Methodologies
- Pavement Performance Measurement
- Pavement Deterioration Modelling
- Failure Mode Analysis
- Pavement Treatment Selection
- Pavement Quality Assurance
- Assessment and management of risk

As an industry leader, Waka Kotahi must continue to employ and utilise the right people, with the appropriate succession plans in place to maintain this level of leadership function, supplementing these resources with external subject matter experts (SMEs) where required.

Required Response WS6.1: Waka Kotahi should place a high priority on resourcing 'expert capability' to sustain their leadership function.

3.1.2 Local Government

The interests of the local government sector are strongly aligned to those of Waka Kotahi. Typically, local government organisations are the Road Controlling Authorities (RCA) responsible for the long-term performance of their roading assets, while simultaneously delivering short term service level outcomes. As with Waka Kotahi, the majority of RCA services are provided through separately procured physical works contractors. However, unlike Waka Kotahi, some councils have elected to provide some of the engineering and asset management functions through internally employed resources, as opposed to externally procured consultancy.

Finding 2: The scale of local government organisations varies significantly. The large metropolitan councils having well-resourced teams to manage their assets, but many others are small organisations in provincial towns that have difficulty in attracting and retaining appropriately qualified people. Further budget control measures can limit succession planning and the creation of career pathways for engineering graduates.

This drift of staff away from councils can act as a disincentive to invest in the training and development of their staff.

The Road Efficiency Group (REG) is actively looking at this challenge and is developing a capability framework to assess the asset management skills in local authorities. This work needs to be supported.

Required Response WS6.2: Waka Kotahi is to place greater emphasis on its work with the Road Efficiency Group (REG) to develop and sustain the pavement engineering capabilities of local authorities.

3.2 Core Capability Requirements

3.2.1 Technical Proficiency & Skills Development

Pavement and surfacing construction and renewal activities are a technical discipline within the broader civil engineering profession. At its extreme, this is a complex area of engineering with sub-disciplines in areas such as pavement materials, design, surfacing and long-term pavement performance. At the other end of the spectrum, there remains a need to maintain a body of knowledge around design, construction, maintenance and renewals.

It is essential that Waka Kotahi employees hold a high degree of proficiency in their respective positions. The skill requirements vary, dependent on the role with different levels of knowledge required for different positions. For the purposes of this report, the discussion and Required Responses that cover developing and sustaining higher level specialist skills, are described in the section on Leadership and Policy Implementation (Section 3.2.2).

The Pavement Engineering responsibilities most commonly needed by Waka Kotahi reside in six general roles:

1. Lead Technical Advisor
2. Pavements & Surfacing Engineer
3. Construction Project Manager
4. Maintenance Contract Manager
5. Senior Network Manager
6. Lead Advisor Asset Quality / Pavements & Road Maintenance Advisor

Waka Kotahi needs to implement a skills development programme, appropriate for people who are responsible for the day-to-day pavement engineering functions. The programme should contain the following elements:

- Inventory of skills required, against each position.
- Methodology to assess and recognise prior learning.
- Training materials available online.
- Training provided by subject matter experts, using either internal resources, or external resources
- Recommended course work, for example NZIHT Courses.

- Provision for targeted work experience with contractors. This might include (for example) the full time onsite monitoring of pavement and surfacing works.
- Allocation of time in a testing laboratory, performing key materials tests, in order to gain a first-hand appreciation of material characteristics.
- Practical work experience, so that learners can develop their skills by using them in a monitored environment.
- Failure mode assessments – reviewing, analysing and learning from past problems.
- Formal assessment of capability conducted at key milestones in an individual’s learning programme.

The skills developed in this programme should be transferable across the sector. It is noted that there is a strong emphasis on practical experience, not only to enhance the ‘work ready’ skills of the training programme, but also because many adults learn easier by doing and reflective practice. It is expected that the programme will provide Waka Kotahi with a stream of proficient pavement practitioners. This could be expanded over time to allow others to join the programme.

Once learners are seen to reach an acceptable level, consideration could be given to some form of accreditation, with opportunities for in-house mentoring explored.

Finding 3: Waka Kotahi must develop and retain a sustainable pool of skills to enable it to continue to function as the entity responsible for the continued maintenance and development of the State Highway system. To do this, it needs to ensure that those responsible for supervising the construction, maintenance and renewal of the pavements systems, have a base level of competency.

Required Response: Required Responses reference WS6.3A and WS6.3B have been developed to address this finding. These Required Responses are provided on page 11 of this report.

3.2.2 Sector Leadership and Policy Implementation

In addition to the technical and base skills outlined above, Waka Kotahi has the responsibility to provide technical leadership to the wider sector. The wider industry looks to Waka Kotahi to be responsible for providing guidance, in setting out the majority of pavement and surfacing specifications that are used across the industry. Other government agencies and politicians rely on the pavements advice that Waka Kotahi provides. An example was the input Waka Kotahi provided into allowing an increase in vehicle loading with the High Productivity Motor Vehicle policy. Waka Kotahi also represents New Zealand in international forums. This includes its engagement with Austroads, the not-for-profit organisation formed from a collective of the Australian and New Zealand transport agencies. As a member of Austroads, Waka Kotahi recognises the opportunities to draw greater benefit and knowledge alignment with their outputs.

Given these responsibilities, Waka Kotahi must sustain a high degree of pavement engineering knowledge. While some of this can be outsourced to specialists, it is essential that core internal capability is retained. Even when work is outsourced, technical capability is required in the initial scoping phase and then in the interpretation and challenging of the outcomes. This higher-level technical capability is maintained in several ways:

- Skills acquired through targeted recruitment, hiring people with appropriate qualifications and experience.
- Links to international forums e.g., Austroads, International Roads Federation (IRF), PIARC (World Road Association), Road Engineering Association of Asia and Australasia (REAAA). Internal practice groups.
- Knowledge gained through the operation of Waka Kotahi’s Road Research Centre (CAPTIF).

3.2.2.1 Knowledge gained through the operation of Waka Kotahi’s Road Research Centre

Waka Kotahi owns and operates the Canterbury Accelerated Pavement Testing Indoor Facility (CAPTIF) Road research Centre which creates both excellent opportunities for the development and mentoring of specialist skills at the highest level and provides a vehicle for continuous learning through exploring pavement failure mechanisms and testing of new and innovative practices.

The Road Research Centre’s primary purpose has been to carry out accelerated road pavement testing. The facility tests different types of pavements and surfacing under a revolving, loaded dual-tyred truck wheel that closely replicates actual road conditions. Opportunities exist for the wider use of CAPTIF as a centre for learning with the pavement industry.

Waka Kotahi continues to develop its understanding of the behaviour of New Zealand's pavements. This deep understanding, built on scientific observations provides the evidence base for standards development and lessons learnt.

Finding 4: Operations of the CAPTIF Centre requires highly skilled engineers to develop research programmes, to implement and operate them and to then analyse the data and interpret the results. The knowledge created through these projects is essential for the future operation of the network, both in assessing its future use as well as understanding pavement design solutions.

However, these real-life pavement laboratories also create opportunities for engineers looking to deepen their knowledge in pavement engineering. Post graduate students have worked with the Road Research Centre team to conduct research leading to Masters and Doctorate degrees, thus deepening the pool of knowledge in pavement engineering. The Road Research Centre works with the Universities of Canterbury and Auckland and this linkage should be encouraged further will all NZ Tertiary Institutes.

In response to this finding, the WS6 and WS5 teams worked together to develop a combined Required Response, ref. WS5.7

The Required Responses related to this finding are: -

Required Response WS5.7, forming part of the WS5: Quality of Delivery Workstream Report.

The Required Response describes how the pavement delivery industry is to improve its Lessons Learned processes, providing a sustained reflection on how we are doing, through the use of: -

- a) established collaborative forums
- b) the faster promotion of key successes.

Required Response WS6.4, provided under Section 4.2.4 (page 13) of this report 'Engagement and Communication'.

3.2.3 Economic Evaluation and Prioritisation

Waka Kotahi is responsible for the end-to-end funding process. This starts at the assessment of the transport system needs, then uses this data to generate funding applications with sufficient justification to go through the robust government approvals processes. Once funding is approved, Waka Kotahi is then responsible for its distribution into work programmes for new construction maintenance and renewals. This applies both to work on system highways funding directly by Waka Kotahi, as well as local road controlling authorities which receive financial assistance. This entire process requires the fusion of economics and engineering to enable the most financially efficient outcomes to engineering needs.

The Review of State Highway Pavement Delivery report identified a general concern, being that the principles and economics of Whole of Life maintenance regimes are not well understood across the industry. This concern primarily relates to timing, costs and effectiveness for interventions to maximise sustainable pavement serviceability. A challenge regularly mentioned was with practitioner understanding the influence of a discount factor included within Net Present Value (NPV) evaluations, together with uncharacteristic and loaded treatment timings also influencing solutions.

Finding 5: In order to address this concern, people working in the Government sector need to have the skills to forecast future needs and be able to project future maintenance and renewals needs through the following processes:

- To understand the development of pavement forward works programmes to forecast future pavement renewal needs, including an understanding of pavement deterioration and intervention treatment options.
- The ability to apply net present values to future costs.
- Have proficiency in the use of risk management practices to identify and assess future uncertainties.
- The ability to develop renewals priorities using multi criteria analysis.

Training in these processes should not be limited to people in the Maintenance and Operations group within Transport Services. People involved in the long-term network planning and design groups also need to understand these issues so that they can be addressed early in the lifecycle of a project.

Required Response: Required Responses reference WS6.3A and WS6.3B have been developed to address this finding. These Required Responses are provided on page 11 of this report.

Further information on the topic of economic evaluation and prioritisation is also available within the **WS2 Report: Whole of Life.**

3.2.4 Quality Assurance

Please refer to [WS5 Report: Quality of Project Delivery](#)

3.2.5 Procurement

Waka Kotahi provides a leadership role in procurement, both in the contracts that it procures directly, and also in the contracts procured by local authorities. Through its procurement practices, Waka Kotahi can (to a degree) influence the way that industry responds. This comes through the non-price attribute evaluation methods that are typically used. These attributes include the provision for scoring the attributes of the people nominated for contract roles. By establishing or refining these criteria, Waka Kotahi has an opportunity to motivate contractors and consultants to focus more on the development of industry capability and commit in future contracts to adopt the relevant findings of this report. However, as this topic is already covered in within the Workstream #3: Procurement Report (Required Response ref. WS3.5), this group has made no further Required Responses as part of this report.

Please refer to [WS3 Report: Procurement](#).

4.0 Sector: Industry Level

4.1 The role of Industry

In the context of the Pavement Delivery System, the role of the industry sector is to provide an effective conduit between the procurers (who are often also the asset owner), and the supply chain companies that form the organisational sector. In this role, it is essential that the industry sector has strong relationships with key stakeholders in both of these parties.

Key organisations within the industry sector include: -

Civil Contractors' New Zealand

Civil Contractors' New Zealand (CCNZ) is an incorporated society that represents the interests and aspirations of over 600 member organisations. These include large, medium-sized and small businesses in civil engineering, construction and general contracting. CCNZ also has associate members, who provide valuable products, support and services to contractor members, as well as a number of technical committees. These committees include two that specifically consider pavement and surfacing topics.

Association of Consulting Engineers New Zealand

Association of Consulting Engineers New Zealand (ACENZ) is a firm-based member organisation representing more than 230 professional services firms, ranging from large global firms to employee-owned small to medium sized enterprises (SME). Their members deliver critical technology, construction, infrastructure and environmental solutions, providing the essential expertise needed to create remarkable outcomes for New Zealand. ACENZ act as the collective voice for their members, providing a system-level perspective to their unique challenges. They invest in initiatives that benefit firms of all sizes and sit at a macro-level within the sector.

Engineering New Zealand

Engineering New Zealand (EngNZ) is a not-for-profit [professional body](#) that promotes the integrity and interests of members, the profession, and the industry. It seeks to "bring engineering to life" and has more than 20,000 members.

Internationally Linked Road Engineering Collectives

There are a number of internationally linked road engineering collectives that members of the New Zealand transport sector are associated with. These provide an important link to understanding international practice, the sharing of road engineering practice, opportunities for technical visits and study tours, seminars and forums and participation in joint technical committees. These include:

- PIARC (World Road Association)
- REAAA (Road Engineering Association of Asia and Australasia)
- AustRoads (collective of Australian and New Zealand transport agencies)
- IRF (International Roads Federation)
- NAPA (National Asphalt Pavement Association)

National Industry Technical Forums

Industry has assisted the pavement delivery system by convening technical groups that discuss materials, pavements and the foundations and drainage systems that their structural integrity relies upon. These groups are the: -

- National Surfacing Technical Group (NSTG)
- National Pavements Technical Group (NPTG)
- Civil Engineering Testing Association of New Zealand (CETANZ)
- Aggregate & Quarrying Association Technical Committee (AQA)

4.1.1 Shared perspectives

In combination, the industry sector acts as a key enabler between the procurer and the outcomes they require the organisational sector to deliver. This includes those supply chain organisations that undertake outcome delivery, such as contractors and design consultants; the organisations that provide materials

products and supporting services, and the education and training organisations that provide the sector with learning outcomes and competency.

In summary, the industry sector strives to provide the following key functions: -

- Provide a conduit for procurer policy, including those of the New Zealand Government, and other requirements to be communicated, enabled and actioned through the supply chain and its associated partners.
- Provide a conduit for collating sector wide knowledge and experience that can then be formulated into learning outcomes and the development of Standards and Specifications.
- Partner with education and training providers, and employers to build the capacity needed for the delivery of learning outcomes.
- Aid the recruitment of trained and competent people into the supply chain, such that the supply chain has adequate resourcing to meet delivery expectations.
- Partner with key stakeholders to agree and deliver an effective engagement and communication strategy.

4.2 Core Capability Requirements

4.2.1 A collaborative approach

The goal of having a successfully pavement delivery system relies upon all sectors working collaboratively to improve training and competency levels. As an industry, we are better when we do things together.

To be successful in raising the capability of all participants in the pavement delivery system, the relevant government, industry and organisational sectors must work collaboratively to understand the wider skill sets that are required to ensure consistent pavement outputs. Such collaboration would establish and define clear definitions of the skill set requirements for specific roles. As this is a complicated task and some agreement needs to be reached on a competency framework model for Pavement delivery a lead organisation is needed to take responsibility for facilitating and assisting education and training providers with the development of training and competency materials that target specific roles. The Workstream Team believe that due to the level of collaboration required, a new 'Pavement Leadership Team' (PLT) should be created, under the facilitation of Waka Kotahi. The PLT will draw together leaders from across the pavement delivery industry. Working against a written terms of reference, the PLT would champion the delivery of Required Responses ref. WS6.3A and WS6.3B, described below.

Finding 6: The current system is weakened by a failure to accurately define the skill sets needed for specific roles. As a consequence of this, capability across sectors is not aligned. The determination of how training is conceived and then developed is sometimes fragmented, due to the isolation that occurs between those that hold the knowledge, those that develop the guidance and those that develop the educational material. This has led to a piecemeal approach that more commonly results in the reliance on in-house training courses and mentorship to improve the knowledge of employees. This can lead to gaps in learning and/or the misalignment of industry accepted good practice.

Required Response WS6.3A: All sectors are to collaborate on undertaking an assessment of the skills needed within the pavement delivery system.

Required Response WS6.3B: Armed with the list of skills developed under WS6.3A, a gap analysis should be completed, and skill set requirements for specific roles developed.

4.2.2 Knowledge and Capability Development – Promoting a learning culture

The modern workforce is becoming more transitory than previous generations. People have the ability to switch between careers more readily in the modern economy. This reduces the knowledge base that is acquired over a long period of time working in a single role or working across an industry. This can result in a failure to collect and transfer practical knowledge and learning at an organisational or even industry level. At a pavement delivery system level, this can often come at a cost to the wider industry rather than one single sector. Knowledge capture, and the formulation of a programme of learning outcomes, requires a coordinated approach.

In 2015, CCNZ worked with industry training organisation Connexis to create the Civil Trades apprenticeship scheme. Civil Trades was developed to better recognise and encourage skill development within the industry, up-skilling the workforce 'on the job' and putting civil trades on an even footing with other trades around New Zealand. Civil Trades was developed with industry, for industry. It set out to combine a recognised trade qualification with certified hours of practical experience, leading to registration as a Certified Tradesperson.

Whilst this work and the resultant Trade Certification outputs are now a nationally recognised accreditation programme for civil contractors, there continue to be improvements that could be made to further ensure that those entering the industry are 'work ready', including the requirements for continuing professional development (CPD). Using funding provided by MBIE, CCNZ and the Civil Workforce Forum have commissioned research into developing a skilled civil construction workforce. The key findings of this research were: -

- An impending labour shortage is developing, spurred on by a changing labour market.
- Pathways to enter the civil construction workforce are unclear.
- Training programmes find it hard to scale up and connect with industry.
- New entrants to the industry are not 'work-ready'.
- Schools do not give people the right skills to succeed in infrastructure construction.
- The level of investment required to start a sustained training partnership is high.
- Social procurement is not well understood.
- Civil infrastructure construction is a high-performance, demanding industry.
- Few programmes share success or templated approaches widely.
- Contractors are not widely supportive of external training programmes.

Finding 7: Constant feedback received from the organisational sector highlights that graduates of learning institutions have a lack of work-ready skills that are relevant to an employer. A recent review by CCNZ identified that people coming into the industry are not considered to be 'work ready'.

Once the outputs of Required Responses WS6.3A and WS6.3B are known, industry and organisational sectors should work collaboratively with education and training providers to review and challenge the balance of theory and practical training within the courses undertaken by those entering the pavement delivery system.

In order to achieve the outcomes targeted by Required Responses WS6.3A and WS6.3B, further emphasis should be placed on creating quality training packages that improve skill levels and efficiency, in order to: -

- Attract, retain and reward competent people. All sectors should work together to elevate the image of the pavement industry, to reflect it as being a challenging, stimulating, socially important and ultimately well rewarded career.
- Build better pathways for people to join the industry.
- Improve the retention of the existing workforce.
- Explore more ways to promote diversity.
- Maximise the use of technology to improve project efficiency.

The use of Partnering Agreements should be explored, between education and training providers, contractors and design consultants, to provide a course participant with the opportunity to complete an appropriate level of practical work experience. While input into the review should be industry wide, there is also the opportunity to seek formal recognition of newly developed training courses via the allocation of NZQA Skills Standards. This will be achieved with the guidance of Waihangā Ara Rau. Once requirements and Skills Standards are known, the responsibility for content and format development best sits with an education and training provider such as TePūkenga or independent training providers. Content development should be supported by select senior representatives from the industry and organisational sectors. Dedicated resourcing should be allocated to ensure that contributors have the ability to achieve required outputs. This will allow for the coordination of activities as well as the administration of a 'shared-ownership' based delivery programme.

Required Response : Required Responses reference WS6.3A and WS6.3B have been developed to address this finding. These Required Responses are provided on page 11 of this report.

4.2.3 Engagement and communication

Changes in essential documentation e.g., Technical Standards and Guidelines and materials testing and construction specifications that informs stakeholders operating within the pavement delivery system are not always communicated well. Not all stakeholders get this important information at the time it is issued. A previous review² into the accessibility of the Waka Kotahi online resources suggested that access to published information required improvement in order to allow information to be more easily accessed in a timely manner. Industry organisations could also support that wider dissemination of industry guidance and technical information.

Finding 8: We are not maximising the benefits offered by modern media tools. Modern media allows for a range of mediums through which information can be produced and disseminated through various channels. The style of delivery can be adjusted to meet the needs of the intended audience. In recent times, online learning and information platforms have been the primary means of education.

Required Response WS6.4: Waka Kotahi is to develop a Communication and Implementation Plan describing the process to be followed for the communication / dissemination of new industry guidance, technical information and learnings to industry organisations. The identification of training requirements relevant to the new information, will be determined by the Pavement Leadership Team (described in Section 4.2.1 of this report). All industry organisations will support the implementation of this process.

4.2.4 Combining the work of International and National Technical Forums and Government led organisations

Over time, Waka Kotahi has led or otherwise been involved in various technical committees in the pavement engineering sector as well as others that have been pertinent to its sphere of operations. Such committees discuss surfacings, pavements and the foundations and drainage systems that their structural integrity relies upon. These include: -

- PIARC (World Road Association)
- REAAA (Road Engineering Association of Asia and Australasia)
- AustRoads (collective of Australian and New Zealand transport agencies)
- IRF (International Roads Federation)
- NAPA (National Asphalt Pavement Association)
- National Surfacing Technical Group (NSTG)
- National Pavements Technical Group (NPTG)
- Civil Engineering Testing Association of New Zealand (CETANZ)
- Aggregate & Quarrying Association Technical Committee (AQA)
- Geotech Forum

CCNZ also operate two related Technical Committees, namely the CCNZ Pavements Committee and the CCNZ Technical Surfacing Group. The representation of these technical groups is from the wider sector. This includes representatives from client organisations, consultants, contractors and organisations that represent the supply chain. This mix of participants offers a range of perspectives that leads to the development of innovative practices and lessons learnt.

Finding 9: (i) Each of these groups tend to work autonomously. Each has been formed using the resources of willing participants drawn from the public and the private sector. The terms of reference of each group have been drafted by the individual group, to address the issues they believe require discussion and resolution and explore the opportunities for sharing of the science and practice of road engineering. Whilst each group may operate with an open agenda, there is no formal mechanism in place for the sector to collectively have input into the work and priorities of these groups.

² Standards Guidelines Development Project: Report on Phase One Industry Survey: 2 June 2020 (Waka Kotahi / Resolve Group)

(ii) The groups, while effective in their own right, do not have a systematic means of connection, needed to understand the issues that are being tackled. This autonomy does not allow for sharing of information, knowledge, issues or learnings.

(iii) There are growing opportunities for alignment with the practices and standards developed by Austroads and other international forums.

Required Response WS6.5: Waka Kotahi, CCNZ, ACENZ and EngNZ are to investigate how they can work more collaboratively to develop a combined approach to the sharing of working group issues, outcomes and learnings with key stakeholders. This work should also include exploring and resolving the growing opportunities for alignment with the practices and standards developed by Austroads and other international forums.

Each of the technical groups has a considerable amount of diverse knowledge, skill and experience. The mechanism for the consistent capture and dissemination of this knowledge through the industry is not formally recognised. Work that each of the groups undertakes typically results in the production of learning material. This can take the form of a webinar, Waka Kotahi Technical Advice Note, updates to industry guidance, records of general discussions or other learnings. The shift in industry best practice that is generated through these groups is not well communicated to the wider industry, with each group determining those it believes the outcomes should be disseminated to.

Finding 10: The wider communication of these outcomes is not delivered in a structured way to the wider sector, resulting in learning outcomes sometimes failing to reach those that could best benefit. There is too much reliance on information being shared through the Waka Kotahi public website which can result in limited coverage across the wider sector.

Required Response: Please refer to Required Response WS6.4 shown on page 13 of this report. Required Response WS5.7, forming part of the WS5: Quality of Delivery Workstream Report, also supports this approach in describing how the pavement delivery industry is to improve its Lessons Learned processes, providing a sustained reflection on how we are doing, through the use of: -

- a) established collaborative forums
- b) the faster promotion of key successes.

The challenge of commercial sensitivities that may surround such 'lessons learnt' are recognised. In the resolution of Required Response WS6.4, focus should be placed on determining practical guidance for managing this issue. Such guidance should highlight the benefits that the wider pavement delivery system will gain from greater transparency.

5.0 Sector: Organisational Level

5.1 The role of Organisations

Tier One Contractors

The fundamental role of all roading contractors operating within the Pavement Delivery System is to build effective and compliant pavement layers and associated works. This role extends to the life-cycle maintenance or renewal of such pavements under Road Maintenance contracts. Tier One contractors comprise the handful of large, nationwide contractors that specialise in the construction of major civil engineering projects. In the roading category, these projects are normally let by Waka Kotahi or Territorial Local Authorities (TLAs).

Typically, Tier One Contractors have the capability to construct virtually all components of a roading project, and in particular those elements that are directly related to pavements. These include items such as temporary traffic management, earthworks, drainage, sourcing and (sometimes) the production of materials, pavement layers and surfacing.

In addition to the physical works, Tier One Contractors must have the capability to secure construction contracts across a range of procurement methods, manage complex, high-value construction contracts, plan and implement construction programmes, establish and maintain construction plant, and resource all parts of the business with appropriately skilled personnel.

All of the contractor's functions must be carried out in a safe, efficient and high-quality manner. Accordingly, Tier One Contractors must have the ability to attract and maintain a workforce with a wide range of skillsets. In addition, some Tier One Contractors have a technical capability which enable them to carry out their own pavement analyses and perform research for product development.

Tier Two Contractors

In general terms, Tier Two Contractors are just smaller versions of the Tier One Contractors. Their main function is in the construction of smaller scale projects or acting as subcontractors on larger projects. Compared with Tier One Contractors, Tier Two Contractors tend to specialise in a reasonably narrow band of tasks, e.g., Temporary Traffic Management (TTM), drainage, earthworks, etc., and where necessary they outsource inputs for other tasks.

Tier Two Contractors still require the ability to tender for work, and then plan and implement construction tasks using appropriately skilled personnel, but on a scaled-down basis compared with Tier One Contractors. Tier Two Contractors require their personnel to have a high level of understanding of plant and machinery, construction processes, quality assurance, and health and safety. They generally do not have an in-house pavement design or research capability.

Pavement Design Consultants

Only a relatively small number of civil engineering consultants specialise in pavement design. This may be due to pavement engineering not being perceived as a particularly inspiring discipline within the wider civil engineering profession. It is also viewed by many as having a relatively high risk profile.

Pavement design consultants have a number of inputs to the pavement delivery process depending on the procurement model being used for a given project, and the various roles that are required within that model. In addition, those inputs are required before, during and after the construction of a roading project. These inputs will typically start with a preliminary design for feasibility assessment, followed by the specification, management and interpretation of results for a site investigation, economic assessment of design options, final pavement design, preparation of specifications and drawings, and monitoring of construction activities in terms of safety and quality.

Pavement design consultants may also be involved on the Client's side, acting as an advisor, reviewer, contract manager, or Engineer to the Contract.

Design consultants require a wide knowledge of pavement design theory, economic assessment of options, materials testing and response to loading and environmental conditions, and at least a working knowledge of constructability. Irrespective of the importance of these skillsets, pavement designers require a sound knowledge of practice and theory, and on that basis, there is no substitute for experience and sound engineering judgement.

Testing Laboratories

Testing laboratories perform an important role in the delivery of roading projects. Testing laboratories carry out site investigation testing including both field and laboratory test methods, materials and construction Quality Assurance (QA) testing, and performance testing to ensure that the construction outcomes that are implicit in the design are ultimately achieved.

Civil engineering testing is a highly technical task. It has the added complication of requiring the use of complex equipment, with staff often being located in a very hazardous construction site setting. Equipment used by testing companies must be well-maintained and calibrated to ensure that it provides accurate and reproduceable results. In addition, staff must have a thorough knowledge of test methods and limitations. Reliability is very important, as QA testing has the potential to have contractual implications. Accordingly, testing laboratories will typically need to be endorsed by a quality standards organisation such as International Accreditation New Zealand (IANZ).

Suppliers

Suppliers in the pavement industry include companies that produce, promote and sell construction products such as construction plant, aggregates, concrete, asphalt, bitumen and other additives, geotextiles and geogrids, drainage products, testing equipment, etc.

Suppliers need to have a thorough knowledge of their products and their appropriate usage. This includes knowledge of the standards that apply to the various products and any constructability factors. Suppliers also need to understand any potential safety and environmental effects of the production and use of their products.

5.2 Core Capability Requirements

All Organisational Sector businesses need to understand the contractual, material, methodological and performance requirements that sit across the pavement delivery system. Whilst these requirements are broad, they emphasise the need for organisations to have the ability to: -

- Demonstrate high levels of professionalism and integrity.
- Receive, interpret and implement construction drawings, specifications and other associated contract documentation.
- Plan for successful outcomes in the topics of health and safety, quality and environmental management, particularly in respect to understanding legal and regulatory requirements.
- Understand the material performance requirements that are involved in their investigation, selection and testing.

5.2.1 All Organisational Sector Level businesses

Finding 11: It is critical that everyone in the industry carries out their roles with a high level of professionalism, integrity, skill and attention to detail. These behaviours must start at the top of the organisation and must be promoted through all parts of the business.

Required Response WS6.6: Professional membership should be promoted and facilitated by organisations for all professional and technical staff, so that professional development can be monitored and maintained. Professional membership goals should be considered for inclusion within employment Key Performance Indicators (KPIs).

5.2.2 Civil Contractors

5.2.2.1 Personal Development and Training

As stated earlier, the fundamental role of all contractors is to build and maintain pavement layers and associated works. This involves a wide range of skills, not just the operation of construction plant. Contracting staff should have at least a reasonable level of understanding of the functions of each element of a pavement and how the materials they are working with respond to different loading and environmental conditions. To achieve these outcomes construction staff must be fully proficient in the efficient and safe operation of plant, skills that can be attained from a combination of plant operating courses and on-the-job training. Contractors should place further emphasis on encouraging their construction staff to become involved in more complex activities as their general levels of skill and experience develop. This approach

allows careers to develop, which helps with staff retention as well as the succession planning of senior staff as they move up the company ranks.

Finding 12: To achieve the ambition of improving industry skills, capability and integrity, senior construction staff should continually monitor less experienced staff and offer constructive advice where needed, such that the working environment becomes a place of learning.

Required Response WS6.7: It is critical that all senior staff see mentoring as an important part of their role. Industry groups should consider the use of Annual Performance Reviews to promote and assess the performance of senior construction staff in mentoring those who report to them. The Organisational Sector could look to introduce an Industry Awards based system that identifies and celebrates those senior leaders who champion the importance of passing on key skills and experience in their day-to-day duties.

5.2.2.2 Quality Assurance Requirements

The topic of Quality Assurance is a significant one in its relevance to Industry Capability. However, as this topic is already examined in detail within the Workstream #5: Quality of Project Delivery Report, this group has made no further direct Required Responses.

Please refer to **WS5 Report: Quality of Project Delivery**.

5.2.3 Pavement Design Consultants

5.2.3.1 Maintaining a skilled workforce

Consultants must show a high degree of skill, professionalism and integrity. The basic measure of professionalism is to be accepted as a member of Engineering NZ (EngNZ), either in a chartered or technical capacity.

Consulting company personnel should be encouraged to meet EngNZ membership standards. Senior staff should provide mentorship and the company should allow personnel the time to prepare for membership interviews and assessments, with companies funding their professional membership. Appropriate time should also be provided for staff who wish to participate in professional society events. This could include a range of engineering industry groups, in addition to EngNZ. Staff should be encouraged to join the National Pavement Technology Group (NPTG) as corresponding members, and in turn, the NPTG should invite young designers to participate in group meetings.

It is critical that a design consultant is able to communicate often complex concepts by written, verbal and graphical means. This is not always a natural skill and younger engineers should receive feedback on their reports from senior staff who are reviewing their work as part of a consultant's normal quality assurance processes. Reports must be clearly formatted and follow a logical sequence. The information presented must be concise but still provide a suitable level of detail so that interpretations and conclusions hold up to review scrutiny.

Report and technical writing courses are available through industry training providers, and these should be mandatory for all young engineers.

FINDING 13: Achieving professional membership provides recognition that a consultant understands and abides by industry ethics as well as having achieved a suitable level of technical competence. Ongoing professional membership also requires regular maintenance and/or the updating of a consultant's skills. EngNZ membership provides a means to manage this by way of Continuing Professional Development (CPD) records and a formal periodic reassessment process.

Required Response WS6.8: Consulting companies should continue to assist staff with maintaining a high level of Continuing Professional Development.

5.2.3.2 A focus on Pavement Design

Pavement design involves equal parts theoretical analysis and engineering judgement. Pavement designers must have a thorough understanding of pavement design principles, but most importantly they must have a feel for what makes sense and what does not. The analysis part can be taught but there is no substitute for experience when it comes to applying engineering judgement. Currently there are limited

opportunities for in-depth pavement analysis and design training other than the current New Zealand Institute of Highways & Technology (NZIHT) courses. These courses run only intermittently as the industry is reasonably small. In addition, university courses are limited and only involve a few lectures on the basics of design theory. Industry and tertiary courses could be extended by offering instruction in more diverse topics such as materials behaviour, site investigations, pavement asset management, heavy duty pavement performance, pavement forensics, economic analyses, etc.

FINDING 14: The limited courses available at New Zealand's Tertiary Institutes may in part be due to pavement design not being seen as an overly attractive career path for students. However, the reasonably small nature of the pavement design industry means that skilled people are highly sought-after and therefore they have the opportunity to advance their careers quite quickly.

Required Response WS6.9: Industry organisations such as ACENZ, EngNZ and NPTG are to work with regional universities and other tertiary institutes to develop a programme of guest lectures, which can be used to promote the importance of the pavement design industry.

5.2.3.3 Materials Knowledge

A vital element of pavement design is understanding how materials perform. While university courses in engineering geology and geotechnical engineering are valuable, there is a need for additional training that is specifically targeted at pavement materials. Addressing this gap could provide a significant opportunity for industry training providers.

The judgement part of pavement design can only be attained by garnering information from more experienced designers and by being involved in the construction phase of projects. The best way to achieve this is to encourage mentorships for young designers. The aspect of sustainability is another topic that is likely to have an increasing influence upon material selection in the coming years. It is important that the knowledge needed to evaluate such influences is developed, alongside other factors.

FINDING 15: Pavement designers must have at least a reasonable understanding of construction activities as all designs must be constructable in terms of efficiency, quality, safety and sustainability. Spending time on-site during the construction phase of a project is the best way to acquire constructability experience. There is an opportunity to extend the secondment concept to the client's office for both Central and Local Government authorities. This would have the benefit of increasing the knowledge and experience of staff members from each sector while also fostering relationships between the respective parties.

Required Response WS6.10: Seconding design staff to a contracting company is to be encouraged and reciprocated with construction staff spending time in the design office. Seconding design staff to a client office could take the form of cadetships where inexperienced staff spend (say) six months in each of the design office, construction site and client's office, with mentors assigned at each.

Key components of any design are the materials and the construction specification. Waka Kotahi maintains a large number of standard specifications and accompanying notes. While these documents are publicly available on the Waka Kotahi website it would be useful for Waka Kotahi personnel and other subject matter experts to present workshops and webinars on the most common specifications, especially with respect to some elements of the documents that are not well understood. This would also limit any confusion or misunderstanding in the interpretation of the technical standards and guidelines, thereby leading to a shared consistent and common perspective across the sector.

FINDING 16: Specialist pavement design and analysis courses are relatively scarce in New Zealand. Online courses are currently available through various Australian training providers, but a range of New Zealand based courses would be beneficial.

Required Response: Required Responses reference WS6.3A and WS6.3B have been developed to address this finding. These Required Responses are provided on page 11 of this report.

5.2.3.4 Learning Culture / Knowledge Sharing

There is an opportunity for pavement designers, and the industry as a whole, to make significant improvements by the dissemination of 'lessons-learned' information. This is a largely untapped

opportunity, often due to contractual constraints, but the industry should find a way to learn from real life experiences and not run the risk of unsuccessful outcomes repeating themselves. This opportunity is not solely related to large State Highway projects; significant learnings can also be achieved from smaller projects including those on Local Roads and road maintenance contracts.

FINDING 17: There is an opportunity for pavement designers and others within the pavement delivery system, to make significant improvements by the sharing and dissemination of 'lessons-learned' information.

Required Response: Required Response WS5.7, forming part of the WS5: Quality of Delivery Workstream Report, supports this approach in describing how the pavement delivery industry is to improve its Lessons Learned processes, providing a sustained reflection on how we are doing, through the use of: -

- a) established collaborative forums
- b) the faster promotion of key successes.

This Required Response reflects the principle that the actual road pavement is the best laboratory possible. This innovation would not be without risk, and while performance risk would be closely managed, it would ultimately need to be accepted by the Client. Innovation opportunities could be proposed by the designer, contractor or Client, however, matters of IP would need to be worked through.

There is a role for the client to promote the capture of 'lessons learnt.' Recognising the perception-based challenges of communicating such lessons during the lifetime of a project, an approach could be formulated where project lessons learnt are communicated by a client after the Defects Liability Period.

5.2.4 Material Suppliers

Suppliers must have a thorough understanding of the properties of the materials and products they produce or supply. This includes where their products are suitable and any constraints that may compromise their ability to perform in particular applications and settings.

As with all branches of the pavement industry, a thorough understanding of Health and Safety requirements is essential. This not only relates to the way their products are used on site, but also in their production, transportation and handling.

At least a basic understanding of pavement design principals is beneficial so that the influence that various products might have on the balance of a particular design can be appreciated. The constructability of products is also extremely important so secondment of inexperienced personnel to a construction company would be beneficial.

6.0 A collaborative ownership of Required Responses

6.1 Share Responsibilities

This report identifies the challenges that need to be overcome if we are to achieve the level of industry capability improvement we strive for. It also highlights that the challenges occur across all sectors, at the Government, Industry and Organisational level.

As those responsible for the success of our pavement delivery system, we have a shared responsibility to create, implement and champion improvement in all its forms. We know from experience, that we deliver our best, when we work together. This ethos sits at the heart of our approach to improve our knowledge base, the capability of our people and the level of collaboration across our industry.

Whilst the 10 Required Responses described in this report appear under defined sector specific sections, we are determined to recognise and respond to them together as one industry.

The enclosed Responsibility Matrix summarises these Required Responses and defines how the responsibilities necessary to achieve them will be shared through the Implementation Plan.

A copy of the Implementation Plan describing all of the Required Responses developed from the Pavement Delivery System Review is available within the [Summary Report](#).

Responsibility Matrix

Ref.	Required Response	Enabler	Proposal for Ownership and Implementation <i>(Who creates, champions, implements the Required Response?)</i>			
			Government <i>(Waka Kotahi)</i>	Industry <i>(e.g. CCNZ, ACENZ, EngNZ)</i>	Organisations <i>(Supply Chain, Training Providers etc)</i>	All
WS6.1	Waka Kotahi is to place a high priority on resourcing 'expert capability' to sustain their sector wide leadership function.	1. Industry Leadership	Create & Implement			
WS6.2	Waka Kotahi is to place greater emphasis on its work with the Road Efficiency Group (REG) to develop and sustain the pavement engineering capabilities of local authorities.	1. Industry Leadership	Create & Implement			
WS6.3A	Under the facilitation of Waka Kotahi, all sectors are to collaborate on undertaking an assessment of the skills needed within the pavement delivery system.	5. Gen. Ind. Training	Create & Implement	Create & Implement	Create & Implement	Implement
WS6.3B	Armed with the list of skills developed under WS6.3A, a gap analysis should be completed, and skill set requirements for specific roles developed.	5. Gen. Ind. Training	Create & Implement	Create & Implement	Create & Implement	Implement
WS6.4	Waka Kotahi is to develop a Communication and Implementation Plan describing the process to be followed for the communication / dissemination of new industry guidance, technical information and learnings to industry organisations. The identification of training requirements relevant to the new information, will be determined by the Pavement Leadership Team. All industry organisations will support the implementation of this process.	7. Industry Communications	Create & Implement	Champion	Support	
WS6.5	Waka Kotahi, CCNZ, ACENZ and EngNZ are to investigate how they can work more collaboratively to develop a combined approach to the sharing of working group issues, outcomes and learnings with key stakeholders. This work should also include exploring and resolving the growing opportunities for alignment with the practices and standards developed by Austroads and other international forums.	4. Tech. Groups and Forums	Create & Implement	Create & Implement	Support	
WS6.6	Professional membership should be promoted and facilitated by organisations for all professional and technical staff, so that professional development can be monitored and maintained. Professional membership goals should be considered for inclusion within employment Key Performance Indicators (KPIs).	2. Technical Excellence	Champion	Create	Implement	
WS6.7	It is critical that all senior staff see mentoring as an important part of their role. Industry groups should consider the use of Annual Performance Reviews to promote and assess the performance of Senior construction staff in mentoring those who report to them. The Organisational Sector could look to introduce an Industry Awards based system that identifies and celebrates those senior leaders who champion the importance of passing on key skills and experience in their day-to-day duties.	2. Technical Excellence	Champion	Create	Support	Implement
WS6.8	Consulting companies continue to assist staff with maintaining a high level of Continuing Professional Development.	5. Gen. Ind. Training	Champion	Champion	Create	Implement
WS6.9	Industry organisations (such as ACENZ, EngNZ and NPTG) are to work with regional universities and other tertiary institutes to develop a programme of guest lectures, which can be used to promote the importance of the pavement design industry.	2. Technical Excellence	Champion	Create (NPTG)	Implement	
WS6.10	Seconding design staff to a contracting company is to be encouraged and reciprocated with construction staff spending time in the design office. Seconding design staff to a client office could take the form of cadetships where inexperienced staff spend (say) six months in each of the design office, construction site and client's office, with mentors assigned at each.	2. Technical Excellence	Create and Implement <i>(through NOC, TLA or Major projects)</i>	Create and Implement <i>(through NOC, TLA or Major projects)</i>	Implement	