

Australian Construction Achievement Award 2008

North West T-way Project

Abstract

The North West T-way is a significant NSW Government initiative and represents a critical and essential piece of infrastructure. It provides Western Sydney with a dedicated bus based rapid public transport system that substantially improves access to existing and developing urban areas.

The T-way network system links people with education, employment, health, recreational and other essential services, including existing public transport networks. The project delivered by Leighton Contractors integrates with existing major transport hubs at Parramatta and Blacktown and creates the transport backbone for new residential and business hubs at the newly developed Rouse Hill Town Centre and at Kellyville for the future Balmoral Land Release area.

The key achievement of delivering the T-way has been in the development of relationships at every level. From the workforce through to senior management, a culture of working together, through difficult times and celebrating the key milestones was core to the success of delivering the T-way.

The complexity of the T-way project is best illustrated by the carrying out of high risk works within a heavily congested and built up environment along a narrow 24km corridor. Nothing was easy it was totally a brown-field environment. The team had many technical and construction challenges that had to be innovatively dealt with to ensure the success of the Project. Interface issues were considerable. Safety was paramount. Stakeholder engagement required something special. Productivity was constantly being challenged by the surrounding environment and operating issues and design required ultimate scrutiny to leverage value for money. All of this was successfully overcome and some of the achievements were:

- Completed the project 60 days ahead of contractual completion;
- Implemented best practice systems achieved one million LTI free work hours twice in the life of the project, no environmental breach, fines or notification with recognition from a third party auditor as truly best practice and near defect free handover.
- Implemented unique technical solutions to major items of infrastructure such as redesigned bridges and precincts to minimise impacts and or improve traffic flows, use of large span steel box girders and concrete stitches in bridges, and use of precast panelling solution in a major steep cutting adjacent to the TWay and Old Windsor Road.
- Successfully managing hundreds of multidiscipline subcontractors with flexible construction techniques to suit the narrow urban corridor congested with major existing service infrastructure to deliver a high quality product;
- Delivered a project that looks like it “was always there”

The legacy which the T-way leaves behind positively captures the current and future transport needs of people in Western Sydney. It is indeed a critical piece of Sydney’s infrastructure and one which all project team members from the RTA through to Leighton and its partners are immensely proud.

Keywords: – North West T-Way, Bus Transitway, RTA, Leighton Contractors, Parramatta, Rouse Hill, Blacktown.

1.0 Project Details and Scope

Leighton Contractors Pty Limited was engaged in January 2005 by the NSW Roads and Traffic Authority (RTA) to design, construct and maintain a 24km bus only transitway, the North-West T-way (T-way) through the north western suburbs of Sydney.

The design and construction components of the project were completed in two stages, Parramatta to Rouse Hill along Old Windsor Road and Blacktown to Parklea along Sunnyholt Road, with full project handover to the RTA occurring in October 2007. Leighton Contractors has since taken on the role of maintaining the T-way for 10 years (to 2017).

The overall contract value, including a 10 year maintenance phase, is around \$350 million

Key components of the project were:

- Thirty easy to walk to bus stations with modern, state of the art platforms;
- Five architecturally designed bridges to carry T-way buses over major roadways and creeks;
- One pedestrian/cycle way bridge across Old Windsor Road joining the local communities separated by the busy road corridor;
- One dedicated pedestrian bridge providing safe pedestrian and cycle access across busy Sunnyholt Road, linking with a kiss and ride station at Bessemer Station;
- Two park and ride stations that allow local commuters who do not live within walking distance of a station to drive and park at these open and safe car parks, then ride a bus to their destination;
- Three underpasses that allow the T-way buses to avoid some very busy intersections and major roads like Old Windsor Road, reducing the travel time for T-way buses and reducing the impact on the local road network;
- 8km of noise barriers, varying in height, providing noise attenuation to the local residents from the existing road corridor adjacent to the T-way corridor;
- 15km of new 3m wide shared path dedicated for pedestrian and cyclist use alike, connecting to existing footpaths and bike routes;
- 375 hectares of landscaping softening the transport corridor and blending the T-way into the surrounding environment adjacent to Old Windsor Road; and
- New service roads and changed road alignments to improve amenity and maintain access for local residents, as well as reduce traffic impacts for T-way operations.

From an operational perspective, the T-way is supported by an Intelligent Transport System (ITS) comprising a fully independent optic fibre communications system linking to the RTA's Traffic Management Centre.

The ITS system allows effective management of the T-way. This includes up to date electronic timetables; remote monitoring of newly created T-way intersections with existing road ways and existing intersections through close circuit cameras; and over 60 infringement cameras to ensure appropriate use of the T-way

2.0 Complexity, Difficulty and Optimisation of the Construction Task

The complexity of constructing the multidiscipline T-way required detailed design review, planning and continuous review and improvement to overcome major hurdles. The design and construction of some of the key infrastructure such as the bridges and underpass had to be carefully designed with construction input to ensure the works were constructed to best practices

within the site constraints. Other issues such as managing earthworks and pavement construction in a narrow corridor also tested the project team.

Some of the key challenges and constraints that had to be managed for the design and construction of these major elements of infrastructure for the Tway included;

- conducting activities safely next to, above, below and through major traffic corridors and intersections with minimal impact to live traffic,
- managing extensive night-works in sensitive areas,
- working around major congested critical utilities servicing major parts of Sydney,
- property owners and businesses sharing boundaries along the route of the Project,
- working adjacent and over 15 creeks/waterways; and
- Other difficulties such as unknown underground services, contaminated sites and introducing a state of the art traffic system to integrate with existing intersections.

2.1 Design & construction

To optimise the management and delivery of such a geographically large project, the project was split into four definitive zones, each with a Zone Manager and team. Establishing four autonomous Zones allowed works and resources to be scheduled and prioritised to manage day to day challenges.

The design team and construction teams worked closely together to establish the priorities for elements of the Tway construction that would be designed first to allow early commencement of works on site along with addressing some of the critical path activities such as the Celebration Drive underpass and the major bridges to be constructed at Mons Rd, Cumberland Highway, Johnstons, Toongabbie Creek, and Abbott Rd. This resulted in mobilising a larger bridge team and utilising resources of Maunsell in offices in Melbourne and Brisbane to facilitate the fast track design process.

The design was fast tracked with the production of over 3000 drawings timed to maximise the construction and procurement period. The design program was linked into the construction program and weekly coordination meetings ensured that the developing design matched the requirements and expectations of the construction team. Additional resources were utilised in other Maunsell offices to assist with producing design in a timely manner, however the bulk of the design team were co-located with the Leighton engineering team to ensure prompt feedback on optimal design in terms of cost, constructability and safety. This resulted in the production of design that met the requirements of the construction team in terms of quality of information and an appropriate solution.

Part of this included developing a system to procure and commence construction of critical items off detailed design (pre IFC design). This included developing a Corrective Action system in design in collaboration with RTA and the Project Verifier to ensure that the early works activities were consistent with the developing design.

This integrated design and construction team approach resolved the many construction challenges and produced a number of innovations to the benefit of the Project. Examples of some of the technical and construction innovations are as follows:

2.1.1. Bridge at Westmead Station

The Original design concept consisted of:

- Use of existing bridge for 2 traffic lanes and 2 bus lanes
- Construction of a new separate 2 lane bridge for general traffic and an additional footway over the rail lines.

The construction and design teams recognised that the original concept had a number of issues such as:

- Conflicting traffic movements with local traffic and Tway buses
- Unsafe local thru traffic movement on southbound Hawkesbury Road with a large deflection

A revised concept was devised to address these issues consisting of:

- conversion of the existing bridge to a 5 lane structure and providing inbound and outbound bus lanes with a single lane bridge constructed next to the existing bridge to accommodate southbound T-Way and eastern footpath. All utilities remained in place within existing bridge structure.
- provision of exclusive bus lanes along Hawkesbury Road, from Alexandra Parade to Darcy Road; and
- provision of four traffic lanes from north of Railway Parade to Darcy Road.
- Coordination of phasing control of three closely located traffic signals at Hawkesbury Road, Alexandra Parade and Darcy Road (within 300m) to optimise the operational efficiency for buses and local road traffic through these heavily-trafficked intersections

To verify the traffic impacts of this revised design LCPL carried out a detailed a intersection performance analysis at Alexandra Avenue /Hawkesbury Road in three design scenarios.

- Scenario A - Existing situation with 4 lanes on Hawkesbury Road before T-way work;
- Scenario B – Revised Design proposed 5/6 lanes on Hawkesbury Road (with deletion of Westmead Bridge and installation of bus lanes); and
- Scenario C – Original Concept Design Central dedication T-way lanes

Results of the analysis indicated that the greatest delay for buses on Hawkesbury Road occurs for the original design (Scenario C). Queues along Alexandra Avenue from Hawkesbury Road will extend an estimated 147m in Scenario C from Hawkesbury Road in the PM peak compared to an estimated 95m for Scenario B – the revised design.

This design change resulted in a subtle widening of the existing bridge creating the appearance of a unified structure but with major improvements to the traffic flow at this intersection along with providing 2 dedicated Tway lanes.

The key benefits of this change included:

- Improved urban design outcome through reduced impacts to curtilage of UWS;
- Provided a continuous green run for buses through the three intersections at Hawkesbury Road/ Darcy Road, Hawkesbury Road/Railway Parade and Hawkesbury Road/Alexandra Parade;
- no reduction in performance or operational efficiency through adopting the new design relative to the reference design.;
- Improved road alignment for general traffic at Hawkesbury Road/Alexandra Avenue intersection, especially for southbound through traffic, improving safety;
- Reduced the risk of congestion at Alexandra Avenue/Hawkesbury Road intersection;
- Providing an opportunity to improve the streetscape along Hawkesbury Road with additional planting, reducing the retaining wall required and softening, and thereby improving, the urban edge treatment;
- The removal of Tway median structures along Hawkesbury Road reduced the extent of pavement and allowed for additional planting along Hawkesbury Road;
- Minimised impacts on local road traffic network during construction.
- Minimised construction impacts on westmead Rail Station and provides additional room and flexibility for potential future extensions to the platform.

2.1.2 Cumberland Highway and Toongabbie Creek Overpass

The T-way design was significantly influenced by the surrounding site conditions with Old Windsor Road, Cumberland Highway and Toongabbie Creek. Through consultation with the construction team and workforce a particular strategy was developed and applied to the design and staging of the bridge works in this area.

As part of the T-way works 2 bridges were constructed to allow buses to pass uninterrupted over Toongabbie Creek and the Cumberland Highway, and also allow pedestrians and cyclists to cross Toongabbie Creek from Briens Station to the Cumberland Highway.

Toongabbie Creek was a relatively small creek with wide banks, and the busy intersection at Cumberland Highway and Old Windsor Road posed some major constraints for both the design and construction teams.

Pier positions were chosen based on keeping construction impacts on the surrounding traffic at Cumberland Highway to a minimum, as well as not impacting on the embankments of Toongabbie Creek. This resulted in large girder spans, so steel trough girders were selected for the bridge over Toongabbie Creek and Cumberland Highway due to their ability to span the large distances required between piers. The largest of the spans across Cumberland Highway required a 52.5m long girder approximately 2m deep which was one of the largest steel trough girders in NSW at the time. The project team also used the construction of reinforced “concrete stitches” to join the girders over the Cumberland Highway avoiding welding and other works directly over live traffic. The use of a concrete stitch was unusual for RTA as the typical connection is a welded detail. The Project’s design team worked with RTA’s inhouse bridge design team to review and finally approve the use of the concrete stitch. Due to the construction benefits over trafficked areas, concrete stitches were also used to join the bridge girders over Abbott road.

Due to the narrow project site, both bridges would need to be constructed within metres of each other leading to construction staging issues. Since the bridge over Toongabbie creek and Cumberland Highway (Cumberland Bridge) was critical to the overall project, the construction of this bridge was selected to be done first followed by the construction of the pedestrian and cyclist bridge over Toongabbie Creek (Pedestrian Bridge) using precast concrete girders. However this construction sequence meant access to lift the concrete girders into position for the Pedestrian Bridge was cut off by the new Cumberland Bridge.

Therefore the design and construction teams worked in collaboration to develop a complex lifting plan based on working off the Cumberland Bridge to lift the girders for the Pedestrian Bridge into position.

This was a significant engineering task as the girders of the Pedestrian Bridge were precast concrete Vee girders, the largest weighing 80tonne and requiring major lifting equipment to erect the girders into position. The most difficult girder erection was the third span “span 3” which spanned over the middle of Toongabbie creek. This involved a dual crane lift with a 400t rough terrain crane and a 250t rough terrain cranes positioned on the piers of the Cumberland Bridge as well as two specially geared trucks to position the girders for lifting.

The complex lift plan for the “Span 3” was based on the following:

- Due to the length of the 80t girder there was insufficient room to setup both cranes above the piers and then deliver the girder for lifting into position. The setup of the cranes was carried out in stages.

- Firstly a 400t rough terrain crane was erected on the bridge directly above pier 2. The cranes had to be positioned using survey to ensure that the loads imposed on the deck were in the correct positions, keeping the loads within the allowable limits for the Cumberland Bridge. The crane was erected on half outriggers so the outrigger loads were acting directly above the outer flange of the trough girders and high density closed cell polyurethane was positioned under the 3.5m x 3.5m crane outrigger pads to eliminate areas of increased loads due to slight imperfection in the concrete surface.
- The girder was positioned using two specially geared prime movers, the configuration involved one pushing and the other pulling. With the girder in the correct position the 400t crane lifted one end of the girder of the leading prime mover and slewed out over the edge of the bridge. At the same rate that the crane was slewing the prime mover at the rear of the girder was pushing the rear end of the girder closer to the 400t crane.
- The girder was suspended by the 400t crane until the 250t crane was erected and picked up the other end of the girder. Both cranes then slewed simultaneously and lowered the girder onto the piers below.

Similar lift plans were used to erect the remaining 3 spans of the pedestrian bridge keeping impacts on the surrounding environment to a minimum and traffic impacts on the intersection of the Cumberland Highway and Old Windsor road were avoided as no lane closures were required to deliver or erect the Pedestrian Bridge girders.

2.1.3 Celebration Drive Underpass

The original design of the underpass consisted of a 100m long underpass structure to be constructed via a traditional top down cut and cover method with bored piers of up to 1050mm diameter and a 1m thick in-situ deck, with open trough approaches. The initial concept required a number of construction stages including three separate traffic switches impacting all traffic on Old Windsor Road.

It became very clear this sequencing would not meet the accelerated finish date and the structure was redesigned by shortening the underpass and tightening the skew of its alignment under Old Windsor Road resulting in the elimination of a number of construction complexities and reducing the construction sequence to a 2 staged process. Due to the very tight road corridor the skew of the deck resulted in a very acute design, as such a combination of tie-back anchors and strutting beams were designed to support the underpass walls. Temporary works such as sacrificial piling was installed in the centre of Old Windsor Road in order to add flexibility in the construction staging and minimise the impact on the travelling public. Excavation of the Class 2 shale began prior to the deck completion, while capping beams were being constructed in parallel. Soft fill materials were later reinstated to allow for the deck slab to be cast in-situ in the traditional way.

The revised staging saved a significant amount of time allowing drainage and pavement works through the underpass to commence earlier than otherwise would have occurred under the original concept.

2.1.4 Burns Road Interchange

One major innovation for the Project was the Burns road Interchange. The original concept design involved a 300 space car park and bus interchange constructed in a 7m deep cut adjacent to Old Windsor Road and Burns Road. The interchange was linked to the T-way via two underpasses under Burns Road and Old Windsor Road

In the early stages of the Project from discussions with RTA it became apparent this design was not practical since Old Windsor Road / Burns Road / Sunnyholt Road intersection would be

eventually realigned as a grade separated intersection and placing major infrastructure such as two underpasses close to the intersection would hinder future design options for the intersection.

It also created significant crime and security concerns from an urban design best practice principal, since pedestrians / passengers would not be passively seen from passing Old Windsor Road traffic in a cutting below ground level.

Due to a project consent requirement, consultation had to be sought with the parties involved in the Balmoral Road release area development. This included liaising with Department of Planning, Baulkham Hills Shire Council and property developer Mulpha Norwest. It also seemed reasonable to expand this consultation to include Railcorp and the Rail Infrastructure Corporation in reference to their future North West rail development.

From this thorough consultation process it was clear the approved design did not suit the future Balmoral road release nor the future Northwest rail link and if constructed as approved, the interchange would need to be redesigned and partly rebuilt in the future.

To accommodate these new factors and give the best outcome for RTA and future works in the area, the design team developed a new design resulting in the deletion of the 2 underpasses and bringing the interchange to grade level with Old Windsor Road. The bus interchange was also located in such a way that it could be operated without major impact from the construction of the future Norwest Rail project, which would ultimately link with the bus interchange.

The development process for this innovative design change was as follows:

LCPL proposed a design change in February 2005 that was driven by the following:

- Desire to improve station amenity, visibility and safety by lifting the station out of the 6m cutting and placing the station at grade.
- Providing additional flexibility to the RTA for future intersection upgrade options for Old Windsor Road (OWR) / Sunnyholt Road (SHR) intersection.

The proposal had the following key features:

Key Features	<ul style="list-style-type: none"> • Improved functionality • A single grade separated Old Windsor Road crossing (underpass) near Celebration Drive • T-way links operational as per deed dates • Provision for future grade separation of Old Windsor and Sunnyholt Road/Burns as either overpasses or underpasses • Allows for future development with no permanent structural constraints • Provides an access point to Old Windsor Road • Removal of station and T-way infrastructure from the NWRL alignment corridor • Significant reduction of the Burns Interchange footprint, thereby maximising adjacent land use for NWRL and a future town centre development
Pedestrian Safety	<ul style="list-style-type: none"> • At grade station solution • Improved station safety through guardianship potential from surrounding road network
Access	<ul style="list-style-type: none"> • Interchange readily accessible for pedestrians at existing grade from: <ul style="list-style-type: none"> ○ Carpark

	<ul style="list-style-type: none"> ○ Proposed town centre development ○ Residential development to west of Old Windsor Road ○ Proposed future rail station • Pedestrian access from carpark does not require crossing of Tway lanes • Left in and left out access from Old Windsor Road to carpark is possible which will further improve passenger access from the road network
Alignment	<ul style="list-style-type: none"> • Future extension to Castle Hill catered for in revised scheme • Future Burns Road overpass for the T-way caters for the future North West Rail Link alignment
Road development	<ul style="list-style-type: none"> • Future grade separation of Old Windsor Rd, Sunnyholt Rd and Burns Rd is not limited to an overpass configuration . This provides design flexibility for the form of grade separation to be determined in the future • Facilitates future grade separation of Old Windsor Road/Sunnyholt Road and Burns Road, with options for grade separation in both directions and for both underpass and overpass options available, for 4 or 6 lane options

The new design also took account of the future interchange that would need to occur between bus and rail networks in that area and would allow the construction of the future rail link with minimal impact on the infrastructure and operation of the Tway.

2.1.5 Managing Earth works

Managing the earth works in such a narrow corridor proved to be a major logistical challenge. The team had to rethink spoil management so as to avoid double handling as much as possible. A rigorous review of the vertical and horizontal alignment of the T-way was undertaken to minimise all impacts and maximise the efficiency of the earth works operation based on criteria ranging from satisfying the client’s design brief to minimising the amount of soil to be carted into/out of the site. The criteria also considered impacts on the community, on through and local traffic and underlying utility services.

One area that was particularly difficult was at a major cut just north of the Abbott Road overpass, requiring the removal of the side of a hill approximately 12m high with approximately 30,000m³ of material. Not a hugely complex construction issue, except the work site was bordered by homes less than 10m away and Old Windsor Road less than five metres away from the work front. The objective was to remove the 30,000m³ of rock resulting in a steep cut and construct a retaining wall structure of approximately 1,100m². The original design consisted of vertical face with rock bolts protruding into the private property stratum. After rigorous investigation and design, it was found that the quality of the rock was better than expected and coupled with alterations to the geometry the project team was able to eliminate rock bolts and their impact on private property. A more efficient design and simpler construction methodology resulted. Short soil nails were utilised instead to strengthen the top 4m of the cut, which consisted of weak shale and stiff clay. Large precast concrete panels were then installed adjacent to the cut producing a finished product that is iconic to the area due to its location, scale and aesthetics.

2.1.6 Optimisation

The co-located design team with the construction and engineering team ensured prompt feedback and provided an optimal design in terms of cost, constructability, quality and safety with examples such as:

- An integrated pavement design optimising site building constraints, especially at intersections

- Retaining wall and bridge structural solutions, such as cantilever in-situ concrete walls, minimising impacts on adjacent traffic.
- Traffic switching design input to minimise the disruption and impact to an adjacent road network carrying traffic volumes of up to 80,000 vehicles per day.
- The combined T-way/local road intersection design was a first for Sydney traffic management and required deliberate focus from all stakeholders, especially the RTA Traffic Management team. New signal standards were a result of this targeted approach. Adaptive engineering for signal design, phasing and operation was developed by the RTA specifically for the traffic signal sites.

2.2 Traffic Management

The full length of the project was constructed adjacent to some of the busiest commuter roads in Sydney. Over 68,000 vehicles travelled on Old Windsor Road and over 37,000 vehicles on Sunnyholt Road on a daily basis. Further, there were over 17,000 vehicles and over 3,000 pedestrians moving through the Westmead Precinct. The major stakeholders within the Precinct included Westmead Public Hospital, Westmead Private Hospital, a myriad of other medical establishments, two Catholic schools, University of Western Sydney and RailCorp.

Accordingly, the site environment was technically challenging and construction works had to be carried out safely and productively while not impeding upon the travelling public. Detailed traffic planning and cooperation with other project disciplines including the Design, Safety and Community Relations teams was the key to success. Supported by a dedicated and experienced Traffic Manager a strategic approach was adopted whereby over 1000 traffic control plans were implemented across the life of the project.

LCPL also insisted that a stringent and mandatory 3m exclusion zone from live traffic was implemented over and above the 1.2m industry standard. The use of physical protection including concrete or water filled barriers and shadow vehicles resulted in no personal injuries to the 600 strong workforce.

Given the scale of traffic risks, extensive collaboration with the Traffic and Transport Liaison Group, RTA and local Police ensured motorist, pedestrian and construction workers safety was paramount. In addition, extensive traffic management and planning coupled with advanced community and stakeholder notifications enabled all traffic challenges to be managed efficiently by the project.

2.3 Public Utilities

One of the biggest challenges on the Project was working around the existing major services infrastructure located within or adjacent to the T-way corridor. With the T-way corridor located within existing urban areas meant major services were throughout the alignment, generally located adjacent, on top of or underneath existing live under and above ground utilities, such as:

- Electrical services up to 132,000V;
- All sizes of water mains from domestic connections to 1200mm diameter water mains;
- Major communication cables and fibre optic services; and
- High pressure gas pipelines and a petrochemical pipeline.

The potential to damage these services was extremely high. The installation of new services to support the T-way infrastructure, including conduits for communication optic fibre cables, electrical and stormwater drainage added to the construction challenges around services.

Working in and around existing underground services is nothing new for the construction project teams, however the scale and intensity on the T-way was extreme.

To minimise the risk of disrupting service to these utilities and remove the potential for any injury to the site teams, a process of non-destructive excavation to “Daylight” the services through an area (sometimes down to 5m intervals) in major sections of congested and critical services was implemented prior to any digging. On top of this a 500mm exclusion zone was agreed between all site Foreman as a “no go zone” whereby no mechanical excavation could be undertaken within 500mm of a live unprotected service. This meant the Project teams were committed to significant amounts of hand digging and non-destructive digging within 500mm of all services along the 24km corridor. The team also installed plywood boards and steel plates in sucker trucked trenches adjacent to live services when carrying out works such as the installation of drainage pits to ensure these critical services were not damaged. Any utility conduits discovered were tagged and noted on design drawings for reference during future excavation permits and construction activities in the area.

For example in the Westmead Medical and Educational Precinct, the area had some of the most critical underground services connecting with many of the medical and educational institutions in the area. Early in the planning phase a critical communications link was identified that was used by the hospital for remote communications during surgery and other vital systems. It was quite obvious this service could not be disrupted under any circumstances. The Project team in collaboration with Telstra designed an additional route for the telecommunications in the Westmead area eliminating any chance of construction impacting upon these existing services in the Westmead area during project delivery. While this additional route eliminated the risk of disruption to hospital services it also provided the Westmead Health precinct with additional capacity for telecommunications services in the future.

Another intense area for constructing major infrastructure was around the Celebration Drive underpass. This area contained over head and underground 22kV, 415V and steelighting, a 900mm and 150mm watermain, a 600mm recycled watermain and major copper and fibre communications services for Telstra and UECOMM. The construction of the underpass was critical to the overall project and the project team through close consultation with the service authorities temporarily relocated the overhead power, placed steel plates over the underground cables and relocated a section of the 150mm watermain to allow the construction of the bored soldier piles up to 1050mm diameter (under strict controls with intense potholing) to be carried out within 1m of the 900m diameter water main with a 80t piling rig without incident.

2.4 Program and Cost

Each Zone team developed their own program, reviewed by a centrally based Program Manager. This offered the Zones their autonomy but also meant a global approach to managing time, since each of the four programs were given individual attention at the Zone level and then combined to create an overall project program. This highlighted clearly activities that needed a “Best for zone” approach and those that required a “best for overall project” approach. The process used for cost control including daily cost sheets and program planning measures were vital to the Project to identify and understand areas where productivity and efficiencies could be maximised. Robust relationships with subcontractors resulted in the strategic use of lump sum, schedule of rates and labour hire contracts within specific Zones and across the project. LCPL also actively self performed works such as earthworks, LMC pavement and slip formed barriers.

Cleverly managing the movement of spoil (surplus or imported) within the confined narrow construction corridor was critical to the financial and program outcomes of the project. There was a net excess of spoil from the works of about 220,000m³, equating to over 16,000 truck

movements to the local environs so it was vital to co-ordinate the removal of this material centrally to the benefit of the project. Strategic construction of noise-mounds in consultation with RTA and the community was also important to re-use material on site.

2.5 Unique Risks

The inherent and significant risks posed extraordinary challenges to the project team including: significant and unknown utilities above and under ground; extensive work at heights; working in live traffic; pedestrian access to work areas; working around rail infrastructure; working around mobile plant up in a narrow corridor; hazardous and contaminated materials; considerable night works with sustained 24-hour working periods; and confined spaces. The innovation for the project in elimination/ managing risks came about through how the assessment was done in consultation with the field staff and workforce that resulted in “practical” implementation of systems to control or eliminate the risk.

2.6 Community Management

The overall communication strategy with the local public was to be proactive, transparent and continually engage with the local community. The team implemented a communications and engagement program targeting over 4,000 local residents and businesses, some 122,000 daily motorists and over 3,000 pedestrians, collectively using Old Windsor Road, Sunnyholt Road and moving through the Westmead medical precinct.

Relationships between the team and the community were developed over time providing a “human” element to construction via meetings with key design or construction personnel. This also allowed the community to feel comfortable to input during the project’s delivery phase proactively. By always being available to the community, via the 24-hour free call info line, the dedicated project website and the display centre open six days a week, opportunities for community members to participate in the project, engendering a community ownership for the project’s outcomes, were regularly provided.

An example of this involved the location of a prescribed noise barrier in the concept design which turned out to be impractical to construct when detailed design was undertaken. Three alternative designs were put forward for the community to consider. The outcome resulted in the community choosing the barrier they wanted and agreed to constructing the wall at a later time to suit construction activities.

Regular meetings with the major stakeholders was also implemented in order to provide timely construction program updates and discuss issues of community/stakeholder concern. Also through proactive personal contact works were planned early and communicated to key stakeholders such as Parklea Markets so the 50,000 market visitors were not adversely impacted. Community Days were also held as part of the communications program for the project including activities such as National Tree Planting Day with Seven Hills North Public School.

2.7 Environment

A “can do” approach by the Environment team, including the Approvals team early in the life of the project, in assisting and advising the construction teams allowed the project to continue on schedule whilst maintaining and raising the bar on environmental standards. The largest impact from an environmental perspective included bus way crossings at 15 creek locations. The environmental team was always involved with the construction team and visible on site. A comprehensive but simple inspection and planning process allowed for diligent site management and follow up action tools to be implemented. This led to collaboration between Site Engineers

and Foremen in fostering a site environment culture of initiative and best practice in implementing environmental controls.

The management of heritage issues was an important part of the project. Part of the corridor included heritage listed sections of Old Windsor Road built in the early 1800's. Both European and Indigenous heritage items unexpectedly found were also managed with very little impact on design or construction. Soil contamination proved to be a major problem on the T-way site. The Project Team undertook detailed compliance testing and monitoring, and established additional safeguards to provide a safe work site while also preventing further contamination of the local environment.

2.8 Management Systems

Interaction of the functional teams (safety, environment, quality assurance, traffic management and community relations) with each other and with construction teams was a critical success factor on the project. This enabled a whole of project approach to delivery, with consistent implementation and responsive management in accordance with LCPL's systems.

All systems were implemented and subjected to regular auditing both internally and externally. For instance it wasn't enough to just have a good quality assurance system documented. The success of the project was driven through leadership and collaboration to work together and to do better than "business as usual". Lessons learnt were communicated back to the delivery team resulting in an almost defect free handover to the RTA in 2007.

3.0 Leadership and Management of the Project

The T-way project was not your traditional road project. It was a highly complex, multi discipline engineering project that required a committed, innovative and flexible team with the right attitude and right culture. It was constructed in highly urbanised environments and adjacent to some of Sydney's major arterial roads and thoroughfares.

By building strong and dynamic relationships at all levels, the project team was able to deliver the T-way with ground-breaking innovations and with foresight beyond traditional project delivery. A culture of always looking for a better way was instilled across the entire project, involving everyone from subcontractors to service authorities all the way to local residents.

3.1 Team Spirit and Culture

Breaking the project into four zones increased the project's program chances of early delivery providing focus to specific challenges within each zone, flexibility with earth works and procurement programs, closer management of the many open work fronts and best use of resources.

Each of the Zones was supported by project functional teams and specialists were embedded in each of the Zone teams for these functions which allowed sensitive and important aspects of project delivery to be better integrated and understood across the wider project delivery team. Options and methodologies were constantly reviewed and genuine input and consultation with the workforce undertaken to ensure the best approach was taken under difficult circumstances.

A spirit of camaraderie was developed through the life of the project with open communication actively encouraged by all. Issues and challenges were met with determination and were worked

through as a team. Mutual respect and collaboration was fostered between management and field teams.

3.2 Design Innovation

Value engineering ordinarily “show stopper” issues into “best for project” outcomes was a key distinguishable feature of the project. Having an integrated design process involving all key project disciplines and RTA personnel, improved the construction and operability of the T-way and took account of future developments and introduced a series of “best for project” design changes without major impact on the overall delivery timetable of the project.

3.3 Training and Skilling

The strong focus on training created opportunities for people to increase their skill levels and develop their careers beyond the project. By the end of the project in October 2007 the project team, consisting of over 600 people at peak construction program, received over 25,000 hours of training. The training initiatives pioneered on the T-way helped LCPL establish a Graduate Development Program (GDP) in partnership with Engineers Australia for the project that has since been developed across Leighton’s NSW/ACT operations.

3.4 Safety Leadership

The project’s safety record with a Lost Time Injury Frequency Rate (LTIFR) of less than one is an exceptional result. It is rare within the construction industry for any project having achieved one million hours LTI free on two separate occasions. This is what the T-way delivered.

This was achieved through a process of safety culture change, underpinned by:

- mandatory and specialist training;
- empowering site supervisory and management personnel;
- extensive site communication;
- dual review processes of Safe Work Method Statements and
- having a focus on identifying and eliminating hazards/ potential hazards.
- Openness in reporting, learning and continuous improvement

The T-way approach to safety ensured everyone on the project felt cared for. This ultimately ensured a safety culture across the project where incidents were not covered up but shared with others so as to learn how to avoid the same situation in future. The learnings from the project have since been applied to other projects across Leighton Contractors operations in NSW/ACT and for which a Safety Behavioural Program is currently being implemented.

3.5 Environmental Approvals and Sustainability

Early and concerted attention to the environmental approvals phase established a solid foundation for getting it right the first time. This was supported through the development of easy to understand Environmental Approvals and Management Plans.

Plans were developed for each major area of work and were practical, concise documents that contained summary details of environmental issues, mitigation measures, reporting time frames, stakeholders, team responsibilities, drawings and sketches. This process achieved approvals in record time typically an 8 to 10 week process was reduced to 5 to 6 weeks and has since been adopted by RTA on other road projects.

3.6 Industrial Relations

Coordinated by Leighton Contractors Superintendent and involving the Master Builders Association (MBA), compliance checks were undertaken during the tender period on all companies that expressed interest on working on the T-way. Any issues or concerns identified during these compliance checks were communicated to the company involved and the MBA assisted the company in satisfying any unresolved non-compliances.

This approach ensured any potential IR issues were dealt with before contracts were awarded and random checks were then carried out to ensure the ongoing compliance of companies working on the T-way project. Total engagement at all levels of the workforce produced qualitative and quantitative results in productivity and an IR incident free site

4.0 Outcomes Achieved Against Planned Targets

The project team has achieved outstanding performance within a traditional Design and Construct delivery framework and an environment where the majority of the project was confined to very tight corridor (sometimes only a matter of a few metres wide) adjacent to high daily traffic volumes of up to 80,000 VPD. Being in an urban Sydney environment adjacent to and on a major road network meant meeting and exceeding the Project's Key Result Areas was not easy, particularly when the achievement of some were potentially in conflict with the achievement of others.

4.1 Time and Cost

- Completed the project sixty days ahead of contractual completion while maintaining exceptional performance.
- Delivered value for money through demonstrated best value whole of life cost on high standards of technical excellence.
- Intensive daily program and cost management ensured a whole of project focus towards maximising productivity in cost and time.
- A Commercial Risk and Opportunity register was developed and engaged across all four Zones with a mindset of maximising opportunities and minimising risk.
- Careful consideration of the "whole of life" was given at each stage of the DC&M project to ensure the best value for money for all project parties.
- Four autonomous Zones operated within a fine balance of being independent of each other but were linked via the same project guidelines and key objectives to meet the overall project requirements.

4.2 Quality

The team worked collaboratively with hundreds of subcontractors to deliver high quality product through good processes and ensuring adequacy and competency of resources to deliver what was required. This was shown through an almost defect free delivery of works on handover of the project to the RTA.

4.3 Health and Safety

- Achieved one million LTI free work hours twice in the life of the Project (outstanding safety outcome).
- Low LTIFR of less than 1 (with well over 2 million work hours expended).
- Conducted over 5,200 site specific inductions throughout the 3 year delivery phase.
- Over 6,500 Toolbox Talks held within the three year delivery phase.

4.4 Environment

- Completed significant environmental approval process in a shortened period time through proactive environmental assessment and management techniques.
- External ISO:14001 auditor commented that the T-way environmental controls and processes were best practice.

- No breach of POEO Act and no fines or PINS issued
- Sustainability principles implemented through significant reuse of materials in the beautification of areas through landscaping

4.5 Stakeholder Satisfaction

- 13 targeted consultation programs developed engaging with over 4,000 local residents about detailed design prior to construction commencing.
- Monthly and specific notifications distributed to over 4,000 residents providing accurate and timely construction information.
- Urban design approval process effectively managed with all stakeholders.
- Monthly Community Liaison Group (CLG) meetings held with RTA, community representatives, environmental and construction teams resulted in trust and confidence at the community level with the project team. On completion of the project CLG members thanked the Chairperson, RTA and Leighton's staff for the professional way the team managed the Project and the dealings with the local community and waived the necessity to hold ongoing meetings for 12 months after completion as required by project approval conditions.
- Fortnightly Traffic and Transport Liaison Group meetings with local councils, police, RTA, bus companies and other stakeholders collaboratively planned temporary and final traffic management for the project.

4.6 Design

- Fast tracked production of over 3,000 drawings to maximise construction time, and strategically allowed construction to commence pre issue of IFC drawings.
- New signalling standards were implemented with 43 new T-way signal sites.
- Successfully integrated over 40km optic fibre, 36 CCTV cameras, 27 passenger information displays, and numerous incident management cameras into RTA's existing system.

5.0 Legacy

A definite T-way legacy is the finished product. The T-way fits with its surrounding locale as though it was always a fixture, while at the same time has added positively to the visual amenity of the area. Areas along the T-way have been purposely left unbuilt and become parkland creating a green corridor in a heavily urbanised and road dominated environment.

The T-way created personal legacies of a positive nature for those who were involved with the Project, despite the complex and challenging nature of the works. It inspired collaborative effort in difficult circumstances and challenged the team to make a difference on all aspects of delivering the project. The achievements in areas such as safety, environmental, quality and community were outstanding under difficult circumstances but are now seen as "business as usual" for the team who take this "continual improvement" and collaborative legacy to their next projects. To this end each member of the team is immensely proud to have been a part of the journey to deliver the T-way

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