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KEEPING CHRISTCHURCH MOVING – POST EARTHQUAKE

Presenter:

Michael Blyleven, Transport Planning Manager, New Zealand Transport Agency (NZTA)

Co-convener of the Christchurch Strategic Routes Team

with Paul Burden, Road Corridors Operations Manager, Christchurch City Council (CCC)

Introduction

February 22, 2011 will be a day that many people will never forget. For what they felt, what they saw, what they lost and how they coped. Everyone has their own stories. Once the dust settled there was a city in turmoil. Roads broken, power out, buildings destroyed and bridges buckled. Car parks became bubbling ponds of silt, and those lucky enough to get their cars out had a slow and tedious drive home. When their passage was blocked, the road became the parking lot. People walked, people biked, and most of all people helped each other.

So what of our transport system? This paper gives a précis of the immediate response, the innovative measures to relieve congestion in the months after, the processes developed for ongoing traffic management and the collaborative partnerships that evolved to Get Christchurch Moving and to Keep Christchurch Moving after the earthquakes of 2011.

The Christchurch Earthquake – 22 February 2011

At 12.51pm, on 22 February 2011, Christchurch and the surrounding areas were rocked by a 6.3 magnitude earthquake, with horizontal earth forces of up to 2 G. In total 185 lives were lost, and around 1200 buildings so extensively damaged that they would need to be demolished. This was the biggest natural disaster that New Zealand had ever experienced. It followed the 7.1M quake of September 2010, that struck in the middle of the night and mercifully saw no one killed. This was just the precursor to prepare us for the catastrophic one that followed. The February quake resulted in:

- 300km of sewer pipes damaged
- 895km of roads damaged
- 124km of water mains damaged
- 50,000-plus individual road faults

The force of the quake saw many building destroyed and piles of rubble spewed out onto the roads making them impassable. Bridges buckled and approaches failed. The resultant liquefaction causes roads to fail, and craters formed that literally swallowed cars up. Travel was difficult to say the least. Many people abandoned their cars where they were and resorted to walking home. Those with

bikes were the lucky ones, unless they were trapped in the basement of their buildings. For the ensuing hours, even days, it was people caring for each other and doing the best they could with whatever they had available. Travel was kept to a minimum with emergency vehicles, heavy machinery and the army ruling the roads.

The Initial Response

The immediate priority was to find out what was damaged, and get a basic network up and running. Bridges were inspected, and opened where possible, but many remained closed. A large team of contractors, consultants, Council and NZTA staff was deployed to inspect the roads. Over half of the roads were damaged. Silt from people's houses was barrowed onto the edge of the streets, to be cleared away by trucks later. Debris from collapsed buildings blocked many lanes.

It quickly became apparent that the recovery was going to be a big task, and a long and slow job. Emergency road repairs were made as best they could, knowing that they would need to be revisited. But the roads were opened thanks to the huge efforts of all involved. But things were not moving freely. Christchurch was congested.

The first priority was to get key routes re-opened to Get Christchurch Moving again. Routes for emergency recovery works was top priority, and other strategic routes. Building debris was cleared from the roads to enable at least one lane of traffic. Where buildings were precarious, they needed to be demolished, stabilised or barriers erected so as to remove the risk. Many a cargo container was put to good use, especially in the cliff-side suburbs and around large buildings.

Christchurch is the traffic signal capital of New Zealand, so what happens when the signals fail? It causes a real headache for the people at Christchurch City Council responsible for operating them. With the power out generators were used for key locations. But the fuel ran out, so someone was continuously refuelling the generators. What about a temporary power line? That worked for some, but not helpful for the poles and lanterns that had fallen over, they had to be left. And then there were the signal controller's filled with silt. These couldn't just be hosed out, even if there was water available. They needed to be brushed by hand to clean the controller panels. After a few days some signals were working, but what about the SCATS server? It was locked in a building that was inaccessible, initially with the power out, and no water for some time, so was overheating. The dramas went on, so spare a thought for the signals engineers that eventually got things up and running.

The Strategic Routes Team – a One Network approach

The Christchurch City Council (CCC) and the New Zealand Transport Agency (NZTA) are the road controlling authorities responsible for the local road and state highway network in Christchurch. To the public a road is a road, and they expect the network to be easy to get around. With the traffic congestion being experienced after the Christchurch earthquakes, CCC and NZTA formed the Strategic Routes Team to Keep Christchurch Moving. This team is headed by Paul Burden, the Road Corridor Operations Manger of CCC and Mike Blyleven, the Transport Planning Manager of NZTA.

They draw upon the many operations, safety and traffic management personnel of both organisations, their consultants and contractors. In addition the services of the Auckland Traffic Operations Centre was utilised to assist with signal optimisation.

This collaborative approach treated the entire road network of Christchurch as "One Network", to ensure our customers, the public of New Zealand, get the best possible level of service under the trying times following the earthquakes. Through contacts with CCC planning staff and Environment Canterbury public transport operations staff, we are able to ensure the best possible transport outcomes are delivered for Christchurch.

The first task was to drive and fly the network and assess the performance to identify pinch-points, physical threats and areas where congestion relief was needed. The operations teams and additional personnel then brainstormed innovative ideas for traffic relief measures and prioritisation of these. Given the changing travel patterns experienced as households and businesses were relocating, due regard was given to whether the measure should be retained into the future, or were required only for the short term. Ongoing assessment using transport modelling tools has helped to understand where further network optimisation measures or network improvements need to be implemented.

Congestion Relief Measures

With damaged roads and buildings, changed traffic patterns, and difference types of increased activity, there were many different types of measures required to relieve congestion. A key task was to identify the buildings that had collapsed and were blocking roads, or lanes, and to coordinate with the demolition teams to get these cleared so as to re-instate lane capacity. Where buildings posed a threat of further collapse, these either needed to be shored up or barriers erected to prevent the risk of collapse onto the travelling public. This often involved cargo containers or other barriers that resulted in lane closures. To compensate for this loss of road capacity, traffic management initiatives such as contra-flow lanes were implemented to get traffic moving, such as on Moorhouse Avenue adjacent to the Science Alive building.

Many key bridges were damaged and needed either temporary repair, or the establishment of alternative routes to re-establish key travel movements. The Moorhouse Overbridge at Colombo Street was seriously damaged, but following structural inspection was able to be propped up with a supporting steel structure to allow for light vehicles to start using it again. At the Fitzgerald Ave bridge over the Avon River, lane restrictions required some turning movements to be banned or restricted to left in or out to ensure free-flowing movement on the reduced lane capacity, and encouragement of people to use the Stanmore Road bridge route instead.

Severe delays were occurring where-ever two travelling lanes were reduced to one lane, such as at the merge downstream of traffic signals. In these cases the downstream merge area was often extended by the removal of car-parking and reconfiguration of the lane marking. With careful consideration of the traffic signal cycle times, and green time allocation, the length of required treatment were optimised where-ever possible.

Where the reallocation of road space required the removal of parking and cycle lanes, this was undertaken with due regard being given to the local impacts and consideration of alternative routes. Curletts Road was experiencing severe congestion and the congestion relief measure identified was

to increase from two lanes to introduce a three lane, tidal flow arrangement. This required additional road space, which was facilitated by the removal of the cycle lanes. This was only done after due consideration of the alternative routes available that identified that Hansons Lane, one block to the east, also had a dedicated cycle lane that was promoted as the key cycling route given that it was well connected to the wider city cycling network.

In other areas, key cycle routes were re-established, such as through and around Hagley Park, where liquefaction and the forces of the earthquake had buckled and severed many pathways.

Traffic signals were a key area where congestion relief measures were possible. Given the change in travel patterns, often the key traffic movements shifted from being radial towards the Central City to become orbital accessing the new business areas in the western suburbs. A key difficulty in considering traffic management options was that traffic patterns were changing daily as people tested out various routes to their new destinations. Once a pattern was established, traffic signals were re-phased and timing altered to provide a more optimal solution. In some locations it also involved banning of right turns to optimise the through capacity of the intersection. These restrictions affected some local movements, but the greater benefits warranted these changes.

In total there were around 60 initiatives identified, of which over 40 were implemented. While these were delivered under the State of Emergency, they were all subsequently ratified by the local Community Boards and Christchurch City Council. There is an ongoing process of review of the measures to confirm their requirement as travel patterns continue to change as life settles into the "new normal".

Changing land-use locations and travel patterns

In parallel to the traffic operations initiatives, a picture of the changing land-use and travel patterns was established to ascertain the likely duration and requirements of the various initiatives undertaken. This work was undertaken jointly with the Greater Christchurch Urban Development Strategy Transportation Group (UDS TG) that comprises transport planning managers from all Councils and NZTA.

NZTA, CCC and Environment Canterbury (ECan) jointly own and manage the Christchurch Transport Model (CTM). This is a land-use based four step transportation model that has been used as the basis for estimating future travel demands and economic benefits of improvements for the greater Christchurch area. The CTM includes land-use by zone, and estimates the travel demands by trip purpose and time period between 400 zones throughout the Greater Christchurch Urban Development Strategy (UDS) area. Following the earthquakes there has been a significant change in land-use patterns that has resulted in the changing traffic flows observed around Christchurch. While there was little quantified information of these changes, anecdotal and informal surveys of many in the transportation fraternity helped to compile an estimate of changes.

We knew that many schools on the east of the city had closed and it took some time to work out how to get their classes back up and running again. In another example of great co-operation, schools on the west that were operational agreed to accommodate those on the east that were not. This involved the "host" school starting classes early to be finished by around lunch-time, so that the

"guest" school could arrive for afternoon classes that finished near 6pm. This involved changed travel patterns across the day, with many school bus services operating. In the greater scheme of things, this did not cause many traffic management issues.

There were also major shopping centres closed. A review of the Eftpos transactions by Marketview, confirmed which remaining shopping centres retained their nucleus catchments of customers, and which attracted people from further afield. The most noticeable of these was Riccarton Mall that had quite a disparate customer base. While these changes existed and resulted in localised impacts, we estimated that shopping centres would re-establish and people would incorporate their shopping activity as part of their wider trip making requirements.

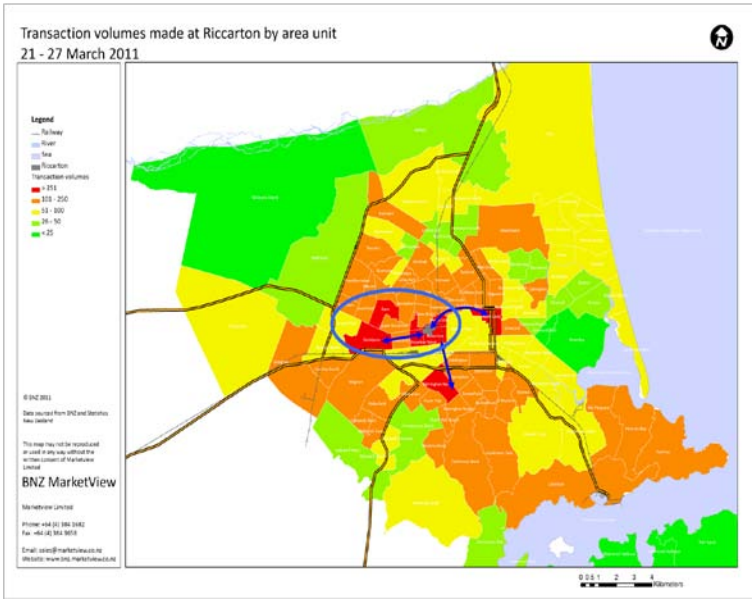

Figure 1: Riccarton Mall – Post EQ home location of EFTPOS Card Transactions,

Source Marketview, March 2011

For households, we utilised the EQC red-sticker and New Zealand Post re-direction notices to develop a picture of where people had moved from and where they had gone. This provided a very clear picture of the shift from the east to the west as shown in Figure 2.

We knew that Central Christchurch was closed off for businesses, either due to direct damage or to enable the emergency recovery work to take place. Of around 50,000 people employed in Central Christchurch, we estimated that 100% of the Cordoned Red Zone had re-located, around 50% of the businesses on the edge of this area, and only 10% of those closer to the Four Avenues may have re-located. See Figure 3.

The key question for the transport modelling was, where had these businesses re-located to. An informal survey of transport colleagues and business contacts was undertaken to identify where people and businesses had moved to. This information was further "ground truthed" with real estate professionals with some knowledge of where new business leases were being taken up. This lead to the identification of intensification in areas like Addington, Middleton, Birmingham Drive, the Wairakei Business Park, the airport, Hornby and Wigram areas.

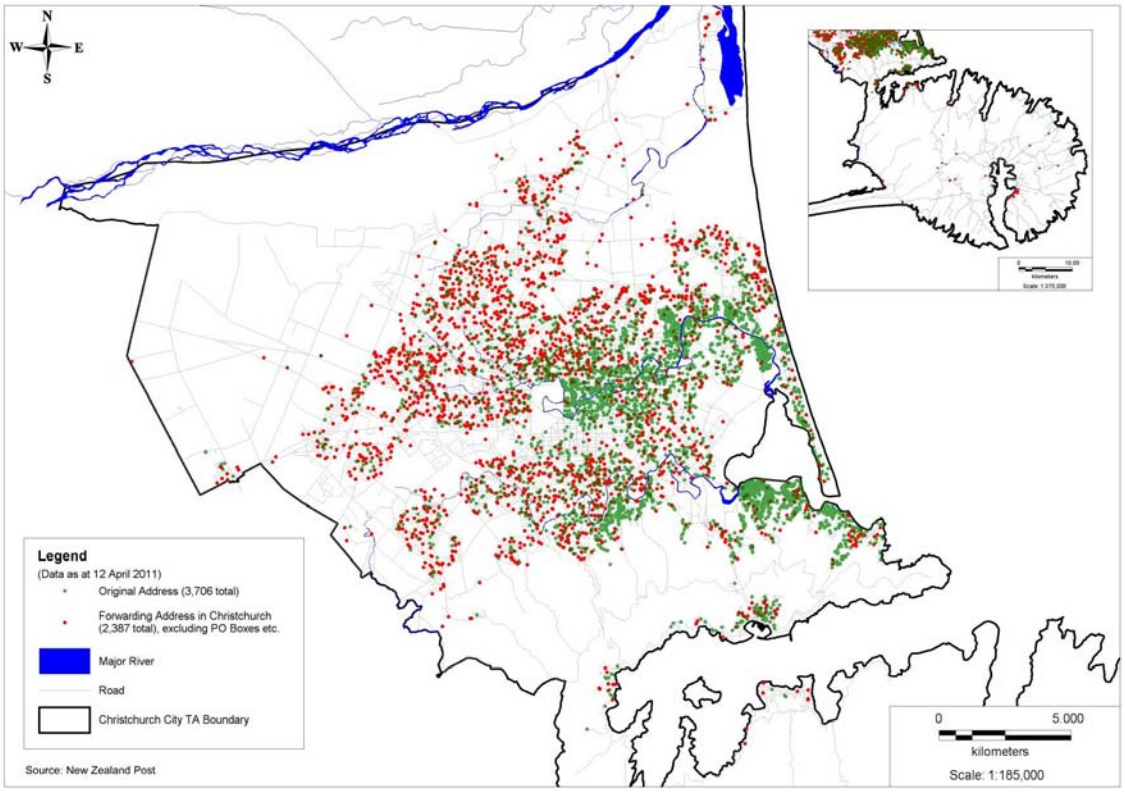

Figure 2: Christchurch Post EQ Postal Redirection Notices, Source NZ Post April 2011

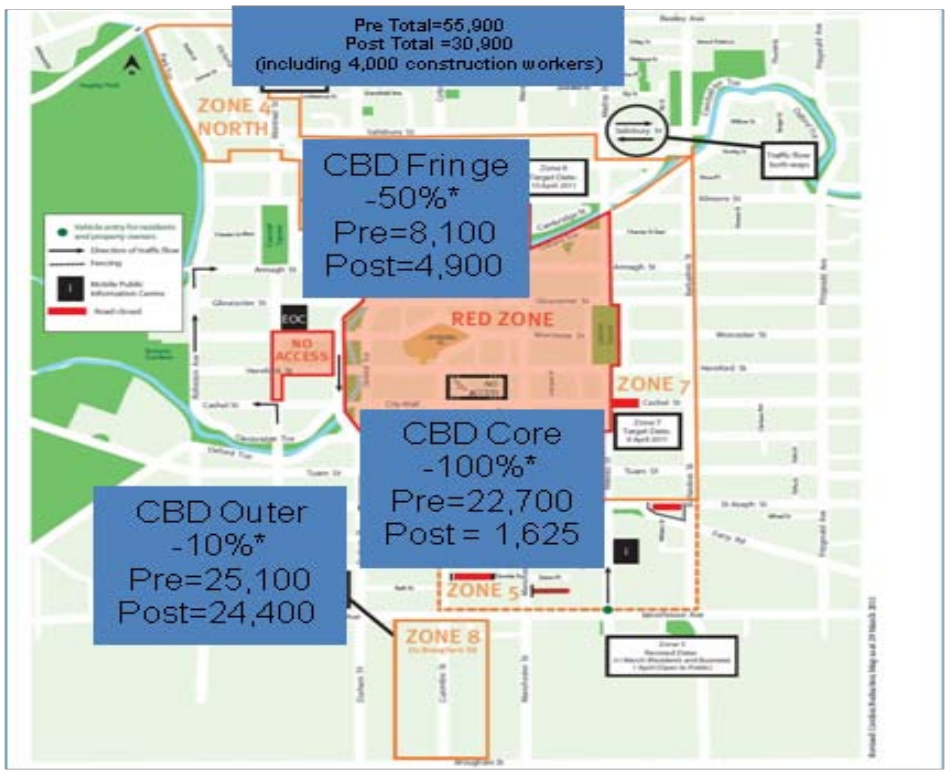

Figure 3: Christchurch Business Re-locations, Source Anecdotal Survey April 2011

These shifts in land-use activity, and the modelled travel demand changes between the various areas (Figure 4), reinforced the anecdotal observations of traffic flows on the road network (Figure 5). The radial movements towards the Central City had reduced, while the orbital movements on the western side of the city had increased dramatically. While these corridors were always expected to increase, the shift in activity following the earthquake, led to these corridors becoming instantaneously congested.

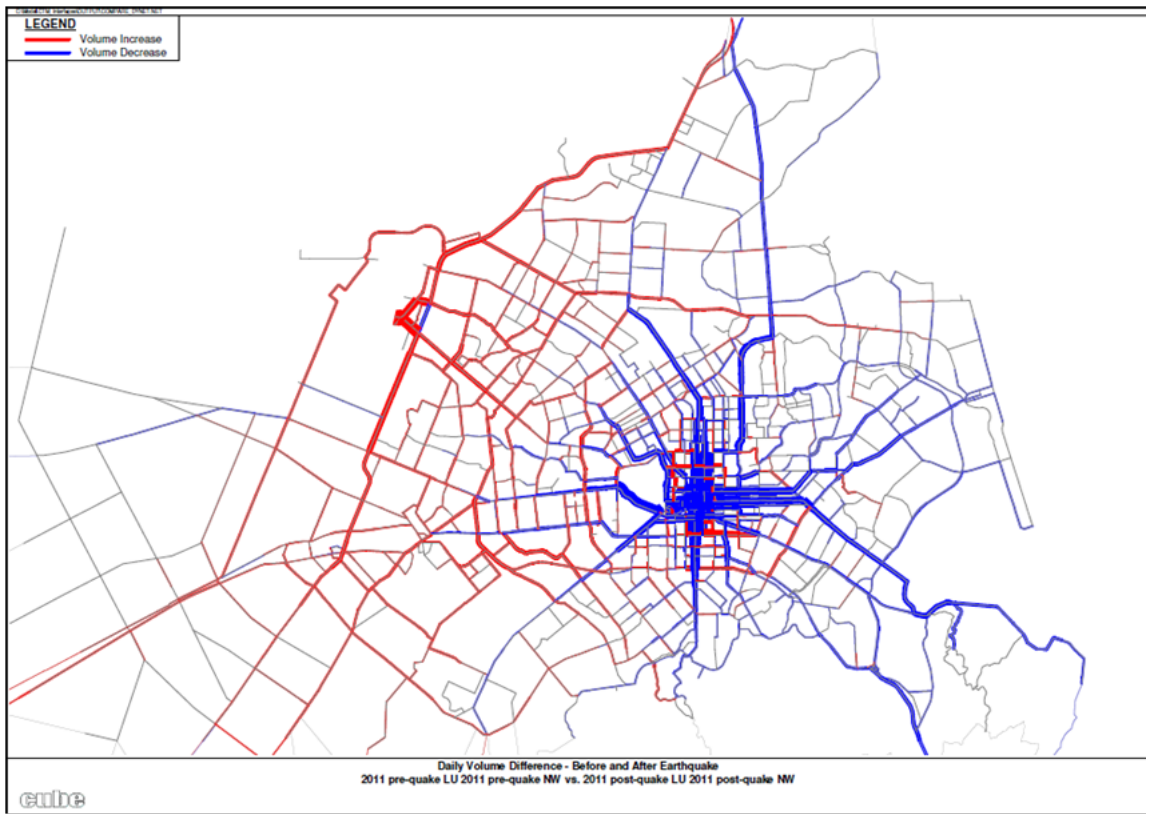

Figure 4: Christchurch Post EQ Change in Travel Patterns, Source CTM April 2011

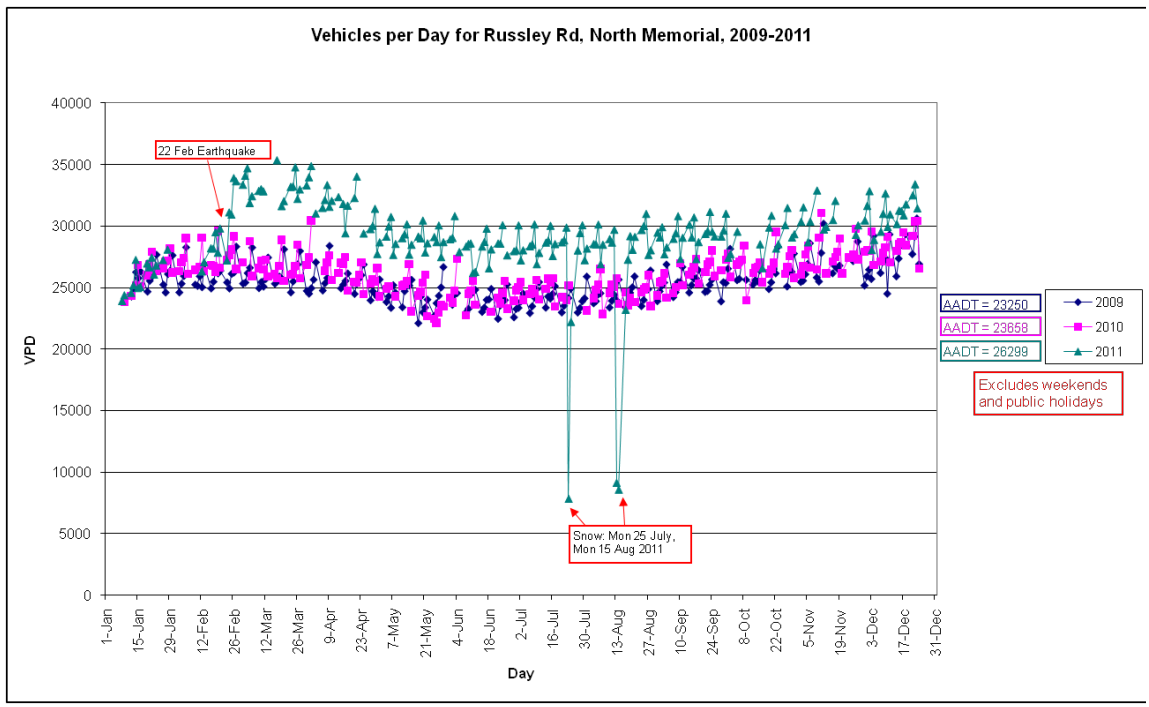

Figure 5: Daily traffic flows: Russley Road, north of Memorial Ave, Source NZTA traffic counts

Furthermore, knowing that many businesses were being tied to multi year leases, we knew that the travel patterns would continue for some time, and hence many of the congestion relief measures were worth developing to remain for a long period.

Congestion Monitoring Surveys

Every year the New Zealand Transport Agency, with funding contribution from Christchurch City Council and Environment Canterbury, undertakes a congestion monitoring survey of travel times on key strategic routes in Christchurch. This is typically undertaken in March and November, and identifies the average travel speed across the network and the travel time variability.

The Christchurch earthquake in February 2011 caused major road damage and changes in travel patterns, leading to severe congestion in many locations. With many roads and bridges closed, building debris restricting road lane capacity, and traffic signals in-operable, the congestion monitoring surveys were delayed, but undertaken in April 2011. It was acknowledged that given the severe traffic disruptions, these surveys would bear little relevance to previous surveys, but would give a picture of the effects, and more importantly a baseline from which to measure future improvements and transition to recovery following the earthquake.

The average pre earthquake network speed and the post earthquake speed at April 2011 are shown in Table 1. Each congestion monitoring route is surveyed in both directions during each time period, and hence the average reflected both the congested peak direction, and the less congested reverse direction. On many routes the average travel speeds showed large variability, and some segments had speeds of less than 10 km/hr.

The equivalent time for a "virtual" ten kilometre journey is also reported, and the additional minutes of travel shown. Again, for some journeys, additional travel times of greater than 10 minutes have been experienced.

All Christchurch Routes	Average Speed pre EQ (km/hr)	Average post EQ speed (km/hr)	% difference	Average pre EQ time for 10km journey (mins)	Average post EQ time for 10km journey	Additional minutes
Am peak	34.7	30.8	-11%	17.3	19.5	+2.2 (13%)
Inter peak	42.7	39.0	-9%	14.0	15.4	+1.4 (10%)
Pm peak	36.0	30.4	-16%	16.7	19.7	+3 (18%)
Christchurch State Highways	Average Speed pre EQ (km/hr)	Average post EQ speed (km/hr)	% difference	Average pre EQ time for 10km journey (mins)	Average post EQ time for 10km journey	Additional minutes
Am peak	68.4	44.3	-35%	8.8	13.5	+4.7 (53%)
Inter peak	79.1	66.5	-16%	7.6	9.0	+1.4 (18%)
Pm peak	77.8	60.5	-22%	7.7	9.9	+2.2 (28%)

Table 1: Congestion Monitoring Survey Results

Ongoing Traffic Management during the Rebuild

The task of re-building Christchurch cannot be under-estimated. While our key interest is on the transport system, and the roads and pathways that contribute to that, beneath the surface there is an extensive network of water, waste and sewer lines that are extensively broken. Even if the road surface is ok now, hidden damage beneath the surface will lead to road works and further traffic disruption. These repairs are being delivered for CERA, CCC and NZTA by the Stronger Christchurch Infrastructure Rebuild Team (SCIRT) set up under an "Alliance" procurement model involving five key contracting companies. The quantum of work being undertaken by SCIRT is estimated to peak at around $40m per month, working on around 100 different worksites for five years.

While the repair work of SCIRT is substantial, SCIRT is not the only show in town. CCC and NZTA continue to undertake their own maintenance, operations and improvement programmes, and various utility companies are similarly undertaking work that affects traffic management. With such a complex and intense period of activity expected over the next few years, the Strategic Routes Team has been developing improvements to the current processes for traffic management. This includes working closely with the SCIRT traffic management people to develop processes, procedures and a clear understanding of forward work programmes. This collaborative approach is key to minimise any inconvenience to road users, residents and businesses of Christchurch.

The Strategic Network and early identification of potential impacts

The SRT has identified the Strategic Network of importance for transport operations. This includes all key arterial roads, some collector roads, core public transport bus routes (especially those with less than 15 minute headway between buses), and cycle routes. To Keep Christchurch Moving it is

imperative that there are no significant delays on these routes, or that if this is unavoidable, that the travelling public is well informed of this likelihood. The overall aim is to minimise inconvenience to the travelling public and the communities of Christchurch.

Where any works will involve a road closure during peak or inter-peak periods, or a lane or movement closure that is expected to cause a significant delay, early "heads-up" notification to the Strategic Routes Team is requested. This will enable all possible alternatives to be considered. As a rule of thumb, a significant delay is likely to occur where two lanes merge into one (a bottleneck), when there is around 1200 vehicle per hour. Should this be anticipated then the traffic management plan (TMP), the method of construction or the scheduling of work may need to be reviewed. In other cases it can be the detour routes that may cause issues, and these are reviewed to ensure that multiple work sites don't overload the remaining road network.

Often TMP's are only submitted to the Road Controlling Authority immediately before the work is about to start. Given the fragile state of the Christchurch road network, if this work is expected to cause a delay, the works may need to be stopped. This is inconvenient to everyone and hence early notification is preferred to identify the optimised TMP or re-scheduling of the work. Through early consideration of TMPs during the preliminary design, this can identify alternative construction methods or work sequencing that can minimise the impacts on the travelling public. If there is still likely to be some delay, then communications plans and methods can be developed to better advise the public of the state of the transport system.

Early consideration of the TMP for the NZTA Christchurch Southern Motorway construction at Curletts Interchange, identified a potential bottleneck issue. Upon review, the existing central median was removed, and lanes shifted and narrowed sufficiently to retain two through lanes at this critical merge point in the network. While traffic is slowed, the delays are manageable.

The processes being developed jointly between the SRT and SCIRT, are being shared and utilised by all parties to improve traffic management in Christchurch. A web-based system has been developed call "TMP for Christchurch" that enables all work sites to be entered and viewed by all parties. This system replaces the traditional tabular TMP management systems of both NZTA and CCC with a map based system. This helps to coordinate work sites and minimise traffic impacts. This information is then assessed and the most significant works are plotted on a new developed web-site call "Transport for Christchurch" that will enable all people of Christchurch to view areas of likely traffic impacts.

Coordinating Forward Work Programmes

As well as early heads up, coordination between the various groups likely to be undertaking works in the road corridor is important. In the past each group has done its own thing and little coordination has occurred. NZTA and CCC are working with SCIRT to improve the collaboration between all parties, so that each group is aware of forward work programmes with the aim of "Dig once, Dig right". We are developing improved Geographical Information Systems (GIS), processes and liaison groups to facilitate this. This is timely with the introduction of the "National Code of Practice for Utility Operators Access to Transport Corridors". The aim is to understand 12 month, 3 month and 1 monthly programmes, in a cascading level of detail so that optimal scheduling of work is possible.

Performance Monitoring

Traffic signals in Christchurch are managed using the Sydney Co-ordinated Adaptive Traffic System (SCATS) as is commonly used elsewhere in New Zealand. Under normal circumstances traffic signals are monitored and adjusted for growth and planned changes. As we knew our problem areas, and the expected rate of growth, we could make changes where needed and had a great degree of historical and local knowledge to estimate the impact on the surrounding network.

Following the earthquake all the old rules are gone. We were spending a lot of time observing congestion at specific points and across entire routes, based on actual observation, SCATS alarms, and customer complaints. We could make changes, but without robust ways of measuring their effectiveness. We also didn't know when we had reached optimisation of an intersection, until we had gone past it.

A good example of this is the intersection of Clarence, Riccarton & Straven Roads. We have spent years observing traffic flows, doing vehicle counts, undertaking CCTV observation, and modelling different scenarios. We have put a lot of time since February 22 into studying this intersection, as this is an intersection of two major routes. We made some changes but these only made the traffic operations worse. We needed better tools to understand the network performance, preferably in real-time.

The best tool identified is the "Advanced Real-time Traffic Information System" (ARTIS). This is a system that is already being used by NZTA and Auckland Transport in the Auckland Traffic Operations Centre, which gave us the ability to call upon their expertise as required. ARTIS was trialed at the Clarence, Riccarton, Straven intersection and found that this intersection was at near-optimum settings on May 25^{th,} and subsequent changes only made things worse.

With over 200 traffic signals in Christchurch, ARTIS now gives us better transparency to spot the problem areas (at an intersection level, and a route level), and gives us a tool to measure the effectiveness of our changes quickly and easily. See Figure 6.

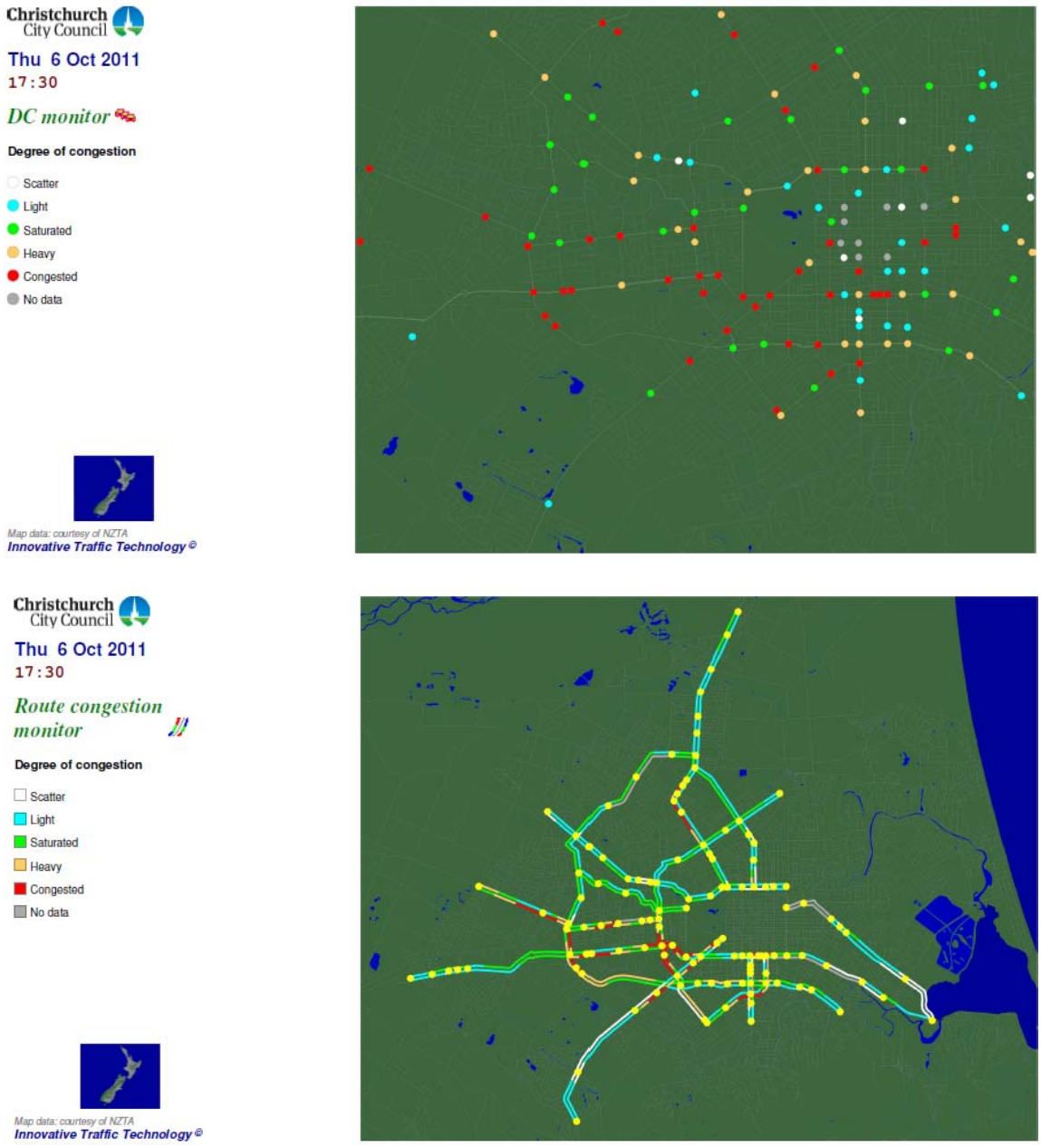

Figure 6: ARTIS Network Performance Monitoring

Customer Information

One of the key lessons learnt during the earthquake response period was that there needed to be a more robust source of information to the travelling public. There were a number of websites that had information about road closures, but they were not always consistent and hence people were not sure of the data integrity or reliability. To overcome this, the Strategic Routes Team are establishing a "Transport for Christchurch" web-site, that will be the one-stop shop for up to date information about the condition of the Christchurch transport network. While this will focus on road works and the status of the road network initially, there will also be information about other

transport options and road safety. The site will be map based showing where road works or closures are likely to cause delays, and the areas of congestion across the network.

The critical aspect of the website will be to ensure the data integrity of identified road works and closures. Once posted on the website these will be kept up-to-date with regular revision, and information will be circulated via electronic emails and other media to key stakeholders and interested parties.

Conclusion (Summary)

The Christchurch earthquakes have been challenging for everyone in Christchurch. Through these trying times, a greater level of collaboration and co-operation has been established between CCC and NZTA with the formation of the Strategic Routes Team to ensure that we Keep Christchurch Moving. This working relationship extends to SCIRT who are the delivery team responsible for the Christchurch horizontal infrastructure rebuild. The improved traffic management processes developed are being used collectively by all parties, including utility providers, who may affect travel efficiency on the Christchurch transport system.

In the immediate period following the earthquake, the transportation fraternity of Christchurch came together to assess the state of the network, understand how it was performing and develop innovative solutions to Get Christchurch Moving. Through the co-operation of many people processes have been developed in relatively quick timeframes, certainly quicker than would have otherwise occurred. We have responded to the needs of the travelling public, and while the network is not always congestion free, the level of information, tolerance and understanding is significantly improved.

The enhanced methods of monitoring the performance of the network will enable the Strategic Routes Team to further optimise the system on an ongoing basis to Keep Christchurch Moving. Meanwhile we continue to urge the public to be patient and courteous with their fellow road users.

We are not expecting a smooth ride in Christchurch for some time yet.

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