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1 INTRODUCTION

Background

1.1 Christchurch City Council (CCC) commissioned *Abley Transportation Engineers Limited* (ATEL) to build a Central City Core Walking Network Geographic Information System (GIS) layer. It was agreed that the walking network is being developed principally for walking linkage analysis concerning the relocation of the central city bus exchange. It will be possible to expand, add further detail and sub section the walking network for use with other projects as needed.

1.2 This project was undertaken concurrently with the development of the city wide walking network, which is principally intended for the development of PTAL analysis within Christchurch City. It was agreed that in addition to the wider walking network produced by ATEL for CCC that a detailed walking network of an area in the central city would be produced primarily for the assessment of walking linkages to the proposed bus exchange and including the location of the proposed new offices of CCC. The area included in the detailed walking network, as agreed between ATEL and CCC is included in **Appendix A.**

1.3 The difference between a walking network and a road network is particularly important when assessing potential impacts of shifting pedestrian concentration in areas where demand peaks in a concentrated area over short time periods, for example, the 9am peak period. A walking network allows for analysis to include real world scenarios where pedestrians will take the shortest route, often utilising off-road network links. In the central city these off-road network links often include indoor links and shortcuts taken through thoroughfares and car parking areas.

1.4 Tools, data and information have been procured from a number of sources and have been used for the evaluation, testing or interrogation of data to assess its suitability for use with the development of the central city core walking network.

1.5 When undertaking this work ATEL has, where appropriate, verified information via reference to other data sources and observation.

Report Structure

1.6 This report is divided into sections to aid understanding:

Objectives

- Outlays the objectives of the Central City Core Walking Network.

Methodology

- A non-technical section which outlines the steps taken to create the walking network; from the data sources used through to the analysis of the data after it had been manipulated. It is divided into three sections; data sources, data collection and data manipulation.

Technical Details

- This technical section gives a brief overview of the software used in the creation of the Central City Core Walking Network. It then provides technical information on the steps taken to manipulate the data used to create the network and technical details of the analysis undertaken. It is divided into three sections; software, data, and processes.

Discussion & Recommendations

- Provides a summary and list of recommendations

1.7 A number of quotations are taken from other references. Typically these are noted in the text and all quotations are *"italicised"*. Important or especially relevant sections of quotations are **bold**.

2 OBJECTIVES

Relocation of the City Bus Exchange

2.1 The majority of bus routes in Christchurch travel through the Christchurch City Bus Exchange, currently located on Colombo and Lichfield Streets. Improvements to the public transport system in Christchurch have resulted in a growth of more than 70% in bus patronage between 2000 and 2005 (CCC, 2007). Subsequently, the current bus exchange is close to reaching full capacity. As part of the discussions on a suitable location for the new bus exchange, and its impacts, the Central City Core Walking Network will allow for service analysis and the impact of potential pedestrian demand to be assessed. The use of GIS allows for the automation of the analysis through walking network analysis and the creation of a walking model. Furthermore a GIS is able to edit, analyse and display the information about potential pedestrian movements and impacts. The use of ArcGIS Network Analyst on the completed walking network will allow for such a model to be built.

2.2 The creation of a Central City Core Walking Network is an ambitious project that has utilised many different forms of data, the combination of which has resulted in a comprehensive, detailed network. It will enable the testing of bus route and frequency influence, walking connectivity, and analysis of service areas of both the current, and the proposed bus exchange locations.

2.3 The citywide walking network was prepared primarily for the analysis of PTAL throughout Christchurch City. The bus exchange plays an important role on PTAL classifications as it is considered the benchmark for the highest Public Transport Accessibility Level in Christchurch. PTAL results for all locations in Christchurch will fall between nothing and that of the bus exchange. For this reason, it is essential that the PTAL is correctly recorded through the use of accurate access assessments. The central city core walking network will allow for accurate assessment of accessibility to the bus exchange from central city locations.

2.4 GIS also allow for features within a layer to be identified. For the purposes of this project, all links on the walking network have been classified to allow for information to be easily retrieved and displayed. Definitions used for classification labels have been included in **Appendix B**. Diagrams showing how these categorisations are connected are included in **Appendix C** and **Appendix D.**

3 METHODOLOGY

Introduction

3.1 The creation of the Central City Core Walking Network was achieved by using a wide variety of data from different sources and combining the data to form a single GIS layer. Other GIS layers were also created to provide additional information for routing and further potential for analysis. As well as using existing data, field work was undertaken to locate internal walking links and collect and verify spatial data relevant to the project. Such links had previously not been used as part of this type of analysis. The Citywide Walking Network was used as a base for the Central City Core Walking Network.

Data Sources

3.2 The data collected and used is shown in **Table 3.1**

Table 3.1 Data Sources Used to Create the Central City Core Walking Network

Data	Details	Source
Road Centreline	Contains road hierarchy and other detailed information related to each road.	Christchurch City Council
Aerial Photographs of Christchurch City	Most recent aerial photographs, taken in January 2007. Pixel size 0.125m.	Christchurch City Council
Bus Route	2006 Metro bus routes	Environment Canterbury, Christchurch City Council
Bus Stop	2006 Metro bus stops	Environment Canterbury, Christchurch City Council
Traffic Signals	Plans for each set of traffic lights operative in Christchurch including phasing and pedestrian links.	Christchurch City Council

Data Collection

3.3 As well as data sourced as shown in **Table 3.1**, field work was carried out in order to ensure accuracy and collect information that has not been previously recorded.

3.4 Information added to the walking network base layer included footpath widths and an over walkability score. The walkability rating is a value from 1-5; a higher score shows that a path is accessible and attractive to all users; a lower score indicates that is overall unattractive to all users. These values are further defined in **Appendix B.**

3.5 Indoor walking links, off-road walking links and shortcuts through car parks were added to the walking network base layer. This information was collected by walking through these areas to assess whether it is a viable shortcut likely to be used by pedestrians. Input accuracy was aided with the use of aerial photographs. Characteristics of the off road link were also recorded, such as whether it is a public link, indoors or outdoors and whether it is able to be restricted, for example buildings are not available for pedestrian access at night.

3.6 As well as expansion to the walking network base layer, further layers were created showing the location of street furniture and photograph locations of the walking links. Street furniture includes amphitheatres, bike stands, phone boxes, post boxes, rubbish bins, seats and trees. Photographs were taken at the corner of each on road walking link and provide for additional visual analysis of each link. The central point of a set of traffic signals has also been recorded.

3.7 The location of pedestrian crossings and refuges was manually recorded during the data collection process using onsite reference and aerial photographs. As well as information about their location, characteristic information was recorded including whether the crossing had a kerb ramp; this affects it's accessibility by those with limited mobility.

3.8 Walking links containing stairs were recorded also. Stairs are not able to be used by those in wheelchairs and many users with limited mobility may find stairs difficult to navigate. Recording stairs separately allows for analysis to take into account how fully mobile users will slow down when walking on stairs. Each link containing stairs also includes information on the total number of steps and the tread and lift of each step.

3.9 The addition of steps adds a new dimension to the central city core walking network. Walking links now have to be treated as three dimensional and in addition to having 'x' and 'y' co-ordinates to locate features; links also need a 'z' value to reflect the height (or level) attribute of walking links. Links that cross each other but do not share a common height value will not form an intersection within the network.

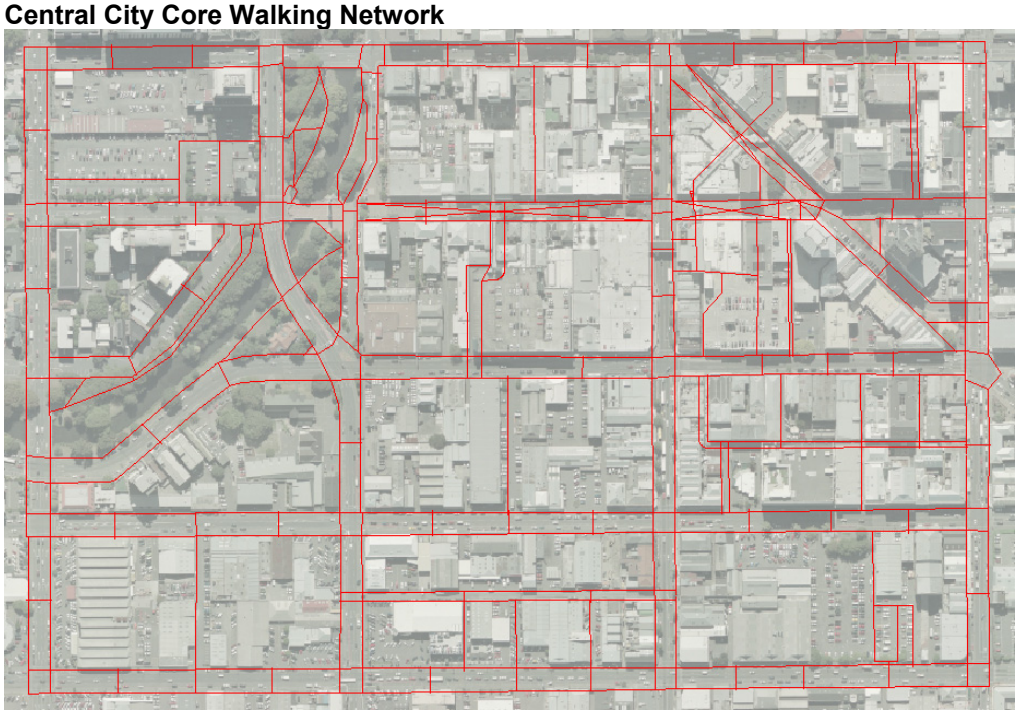
Data Manipulation

3.10 The citywide walking network formed the base of the central city core walking network. The citywide walking network was based upon the road centreline data from CCC for Christchurch City. A buffer was created using road hierarchy values to reflect road widths. Lines generated from the buffers formed the footpath links for the base citywide walking network. This process was important as it also transferred all attribute information from the road centreline dataset.

3.11 Aerial photographs were used to verify each footpath link created by the buffer within the walking network. Where the footpath links did not accurately represent footpath locations, the link was corrected to ensure accuracy using aerial photographs. This method resulted in the creation of accurate walking links which contain essential road centreline identification numbers and road hierarchy information.

3.12 Intersections that included traffic signals were identified on the walking network. These intersections were recreated using information on the frequency that the traffic light phasing allowed pedestrians to cross. A percentage value based on the number of pedestrian phases was assigned to each walking link that crossed the road at controlled intersections. In conjunction with the traffic light information, aerial photographs were used to ensure that these walking links were accurate. **Figure 3.1** shows the completed central city core walking network.

Figure 3.1 Central City Core Walking Network



4 TECHNICAL DETAILS

Software

4.1 There is a wide variety of GIS software available for use in spatial analysis. The creation of the CCC citywide walking network has used ESRI ArcGIS and MapInfo Professional for the primary data input and editing tools.

4.2 ESRI Network Analyst is an extension to ESRI's ArcGIS software product. Network Analyst enables network queries to be solved such as shortest path or service area analysis. Spatial data must be prepared correctly for Network Analyst to build a network for later analysis.

Data

4.3 ESRI ArcGIS works with in a number of different formats, most of which have been created by ESRI for primary use with ESRI products. A Shapefile is a set of related files that stores vector spatial data in a specified format, such as point, lines or polygons, and at a specified projection. The data stored for each feature in a Shapefile is stored in a DBF file. All outputs from the development of the Christchurch Central City Core walking network are in ESRI Shapefile format.

4.4 Mapinfo data is stored in native TAB file format. A TAB file is similar to an ESRI Shapefile in that it is made up of several files with each file playing a specific role. TAB files were used in the process of creating the walking network but are not featured in the final set of walking network data.

4.5 Data supplied for the walking network project came in a number of formats including predominantly Shapefiles and TAB files, files were converted and / or used as appropriate to project requirements.

Processes

4.6 An essential practice to undertake when manually entering or editing spatial data for a connected network is to use the 'snapping' tool. The snapping tool snaps feature end point to other feature end points when the mouse cursor enters the 'snapping range' of the specified destination point. Snapping ensures topological connectivity of the network. All spatial data was entered or edited using the snapping tool.

4.7 The planarize tool is a tool available in ArcGIS that splits and connects all line features together by creating intersections at all points where paths originally crossed but did not intersect (also known as spaghetti data). Planarizing has the effect of reducing complex 3D networks or unstructured linear data into simple, fully connected 2D networks.

4.8 An extra precaution taken when entering and editing the walking network was to not only snap all features, but also to slightly overlap crossing links to the base road network, then planarize the edits. This method ensures that if an intersection or road crossing link was not correctly snapped to the base network, then the link overlapping the base network would always connect through creating an intersection at the point of overlap.

4.9 Due to the three dimensional nature of the central city core walking network, elevation fields have been added to the links in the attribute table. Walking links in the network are directional in the sense that there is an elevation value for the start and the end of a link. The field 'F_ZELV' and 'T_ZELV' represent elevation values at the 'from' and the 'to' end of each link. After the planarizing process, network connectivity is established using the elevation fields. If two links ends share the same elevation value, then connectivity is established, otherwise the links simply cross over without forming and intersection.

4.10 The photographs GIS layer collected during the field work is a separate GIS layer. The point features display where the photograph was taken and the direction that the lens was pointing when the photograph was taken is recorded as an angle from 1 – 360 where the value 360 represents north and 90 represent east etc.

4.11 Information gathered in the data collection phase was added and verified using aerial photographs. The characteristics of each line within the walking network were coded, so that users can query the output map and identify characteristics of that particular walking link. The walking link GIS layer includes an extensive list of attribute information. A Complete list of all attribute information and an explanation of all possible values is contained in Appendix B of this report. Appendix C and Appendix D of this report explains how these attribute values relate to one another on a dependency basis, for example the attribute 'LIFT' is dependant on the attribute 'TYPE' having a value of 'STAIRS'. Appendix C contains this information for Path Lengths and Appendix D contains this information for Road Crossings.

5 DISCUSSION & RECCOMMENDATIONS

Discussion

5.1 The production of the Central City Core Walking Network has resulted in a highly detailed dataset which can be applied to transportation and planning issues in a variety of ways. With regards to the location of the new Bus Exchange and identification of potential effects, the central city core walking network will allow for analysis to be completed in an automated and iterative manner. A higher level of detail could be achieved through breaking walking links not only at intersections, but every time the type of pedestrian facility changes. Examples of this would include the addition of driveway crossings, commercial driveways crossings, street crossings other than main intersections and areas along roads where there are no footpaths. Recording this information could capture the different speeds at which pedestrians walk along these links because of the influences or barriers to movement for different user types.

5.2 The walking network contains detailed information about walking links within it, so as well as allowing for analysis to be undertaken it can also be used as an interactive source of information about walking links.

Recommendations

5.3 Abley Transportation Engineers Limited recommend that the Council considers:

- Development of a GIS based automated model that includes the ability to undertake iterative and 'what if' analysis to test for the effects of altering significant origin and destination locations such as the central city bus exchange or the council office buildings.

- Widening the Central City Core Walking Network area to include more of the CBD and areas where there are higher pedestrian volume to allow for further widespread analysis.

- Further detailing of the walking network by breaking walking links to specify types of walking links.