University of southern Queensland

Faculty of Engineering and Surveying

INTERACTIVE MAP ASSOCIATED WITH TOURISM

A dissertation submitted by

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ABSTRACT

The Cartographer with the tools of today's visualisation , interactivity, multimedia and presentation media all made possible by the computer, has the ability to transform the traditional paper map view into a three – dimensional visualization voyage of discovery.

The general objective in this project was to develop an interactive map associated with tourism, using the cartographic tools of today using past data to develop a map product that will present the relevant material to a users associated with tourism, in an effective manner.

The challenge defined by the objectives was to convey the images of the quarry at Blue Circle Southern Cement's (BCSC) Waurn Ponds mine site to the user who was identified as, a sightseer, a student or a mine employee or a person or organisation involved in the tourism industry. The needs of the user were to see the dynamic ever changing terrain of the quarry, the processes of mineral extraction, the layers of geology all incorporated simply in an interactive multimedia display based on photo maps used in a way to aid the communication of information.

These images were created with the 3D visualization tools of Geographic information Systems (GIS) and generated from data associated with past land surveys, rejuvenated for this map and aerial photographs rectified to existing surfaces. The format of these 3 Dimensional (3D) visualisation has included an aerial photograph draped over a digital terrain model and rotated to present an 3D animation revealing an informative view of the site. A virtual 3D fly through was created along the haul road system slicing through the reclaimed landscape of past mining site. To highlight the past a temporal display dating back over six years was produced with colour and 3D enhanced landscapes in an effective display. The mining processes of the open cut quarry shows limestone removal and transportation to processing locations. The dumping of overburden that was stripped from above the limestone, this was all captured in digital video enriched by the sounds of powerful machines as they worked.

The final result is an informative interactive map that is presented simply, well within the potential of PowerPoint; a friendly, widely available and versatile multimedia presentation package. This has allowed the focus to remain on the user while utilising large data sources and presenting advanced forms of 3D visualisation.

The results have shown how effective the tools that have been used from GIS have been with the use of the appropriate data to display selected information in the this interactive map. How versatile the 'off the shelf' presentation software package was in the acceptance of this information for presentation to the user in a simple format. Following the comparison with other map formats, it has allowed the mind to enquire what level of interactive map could be produce if a fully integrated authoring system package was available via the internet and the possible effect this would have on the map and more importantly the user.

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CERTIFICATION

I certify that the ideas, designs and experimental work, results, analyses and conclusions set out in this dissertation are entirely of my own work, except where otherwise indicated and acknowledged

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Signature

31.10.2007

Date

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GLOSSARY OF TERMS

Abbreviation Description

BCSC – Blue Circle Southern Cement

ET – Earth Tech Engineering Pty Ltd.

ITM – Interactive Tourist Map

2D – Two-dimensional

3D – Three-dimensional

DTM – Digital Terrain Model

DEM – Digital Elevation Model

ESRI – Environmental Systems Research Institute

GIS – Geographic Information System

TIN – Triangular Irregular Network

DN – Digital number

USQ – The University of Southern Queensland

GPS – Global Positioning System

AMG66 – Australian Map Grid 1966

MGA94 – Map Grid Australia 1994

AVI – Animation file extension

MPG – Video file extension

CHAPTER 1

INTRODUCTION

1.1 Introduction

Blue Circle Southern Cement (BCSC), Waurn Ponds Site, is located to the south west of Geelong on its urban fringe. The interactive tourist Map I have developed does highlight the mining process which is to mine limestone to supply the factory that produces clinker, from the quarry limestone to produce 'Ordinary Portland Cement'. The interactive tourist map would be used by tourists including visitors, school groups for example and by BCSC as an educational and promotional tool.

The setting is a limestone, open cut quarry and factory producing cement from the limestone. Large machines are used to unravel the layers of time called overburden, to get to the limestone deposits and transport it to the factory. Processing of the limestone takes place and Clinker is the final product, which is bulk transported off site to BCSC bag handling plants, via rail and road.

1.2 Statement of the Problem

As time moves on, the mine also travels, searching for the limestone like a slow but persistent whale searching the oceans for krill. The mining machine devours a wall of overburden covering the limestone bed, deposited millions of years ago as the ocean receded. The overburden now falls as fill in the reclamation areas, as the beast moves forward and the trail is washed away by this reclamation. How do we transform and present this image of the mine to the tourist?

Knowing how to utilise and get the best result from the many data sources is a technical issue. Questions appear of do l use it, or just keep it simple, what will be the map readers reaction, will it convey its message, will people switch off, or simply blink and miss it?

A further challenge is the wide variety of possible users and the complexity of the interactivity of the map. Map users will have different standards of interaction and the map needs to cater for all levels. By developing this map a first hand impression of the mining process at this quarry could be gained with out setting foot in the Quarry. The information presented within the map can give rise to further exploration external to the map. With the supply of quality information at every stage of tourism more is gained by the user.

For effective communication of spatial data, videos and sound used to create an interactive tourist Map related software needs to be mastered. We also must make the map useable by the majority of users have simple interactivity tasks that are obvious and have more depth so that users can be encourage to explore and discover. Cartographic rules applicable to map design need to maintained.

The process of data collection has been undertaken for the past decade through regular surveys to create DTM's (Digital Terrain Models, for volumetric calculations Geological assay reports have been logged and triangulated to produce models of the stratum to determine where to mine. Aerial images referenced spatially and rectified for distortion.

With the aid of ArcGIS 9 data will be enhanced with the extensions of the ArcGIS software package. Geographical Visualisation, techniques of Temporal mapping imagery are used to show movement over the past 10 years of the mining activities. The unique visualisation technique of the Fly Through to stimulate ones awareness to the new view, and the use of videos and sounds to provide further exploration of the mine and its processes.

1.3 Significance of the study

Interactivity is a changing arena of tools. To develop an interactive map is to try or even customise interactive techniques so they work in your project. Here we have a opportunity to present this data used in other areas but extended to be used as data for a tourist map, utilizing the capacity for interactivity and introducing a management programme to administer the quarry's data bases.

BCSC with the completion of this project will have a means of introducing the works environment in a safe and controlled manner as opposed to having tourists in the mine in mining vehicles on a wet and unstable surface. BCSC will have the ability to see how visualisation technology can be used as a presentation technique and how it will be possible to expand the type of data presented and the use of the map. Moving from a presentation field of the tourism map to a spatial information system capable of performing analysis and queries on a GIS package to the next layers of exploration.

The limestone quarry is now bordering the fringe of Geelong's sprawling urban environment. A interactive map of the BCSC operations could help bridge the gap between any community pressures that may be building due to the mine and residential development.

1.4 Objectives

The aim of this research project is to develop an interactive map associated with tourism, presenting the mining process of the quarry, with a focus on map interactivity that is suitable and available for a variety of users. Specifically, the objectives are:

To identify the users of map product(s), the user needs, and the different mining activities that can be considered in developing cartographic visualisation and interactivity tools

To develop a map based product that features appropriate geographic visualisation and interactivity components. This will be done with data from terrestrial, GPS, and Photogrammetrical surveys and photographic material. Geological data recorded via survey and documents relevant to the site will be also included. This will be presented on Microsoft's PowerPoint slides incorporating data processed via ArcGIS 9.2 GIS software, and land survey specific software LISCAD and Autodesk.

To assess the suitability of the map product. This will involve comparison with relatively similar map products, and will focus on presentation of geographic information, map performance, and data handling. It will also evaluate the computer software and hardware required to view the map, and the level of map interactivity.

1.5 Scope and Limitations of Use

This is not a study into the mine but an interactive map associated with tourism to supply relevant information to the maps users. Data that has been used and presented is actual survey data of a working mine and it was used for volumetric calculation for BCSC. The information shown here cannot be used for any other purpose other than a Tourist map. Data varying accuracies has been incorporated in the interactive map, and vertical exaggeration used in the display, the reason being to enhance some of the three dimensional (3D) images in the map

1.6 Organisation of the Dissertation

This dissertation has been organised into six chapters and includes appendices and ancillary pages. This section will provide an outline of the content of each chapter briefly.

Chapter one is the introduction to the dissertation discussing problems, significance of the study, project objectives and scope and limitation of the project.

Chapter two forms the literature review covering map users, concepts of the map, techniques used for mapping, software, aerial imagery and discussions on digital maps and issues on interactivity.

Chapter three identifies the site for the interactive map and related issues and discusses data capture, acquisition and data processing at length.

Chapter four covers the results achieved from the steps in the previous chapter and how the interactive map has been presented. Chapter Five goes on and discusses these results in detail with the focus on the presentation of the map for the user.

Chapter six discusses both the conclusions reached and future recommendations with the focus on the presentation software and visualisation used to achieve the interactive map associated with tourism.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The different sections in this chapter represent the areas of interest for the interactive map associated with tourism. The interactive map utilising visualisation and multimedia helps define the mining process and presents the mine site to the user without the user entering the working mine site. The map will be additionally used as an educational and promotional tool drawing on the map making tools contained within the tool box of GIS and multimedia. A simple search on the internet for interactive tourist maps will reveal the extents to which the tourist and business communities(both private and government), around the world have grasped this form of promotion, an created a new industry.

Initially the map users and the concept of interactivity will be discussed. Then the techniques and software used to create and present interactivity and the concept of aerial photography are outline. The different methods of presentation being a hardcopy map verus the virtual map initially and for example the various forms of maps, thematic and topographic maps. Finally the issues associated with interactive maps are discussed.

2.2 The Map Users

Maps are designed for the user and the data selected for representation by the cartographer reflects this. An interactive map associated with tourism that can be used for educational and promotional purposes requires cartographic design and construction to ensure the maximum benefit from the map by a variety of users. The student on a field trip may have a different requirements of the map to those of a new employee viewing the map as part of a safety induction overview into their new workplace. Users should be confident in using the map to develop cognition and communication.

It is the cartographers task to communicate information into the public arena (DiBiase 1990) to meet the requirements of the user. This involves the transfer of knowledge to aid the development of a mental map, with a degree of artistic input to aid this transfer by the cartographer. Kraak draws on a figure from MacEachren displaying the 3 visualization strategies as shown in the table figure below.

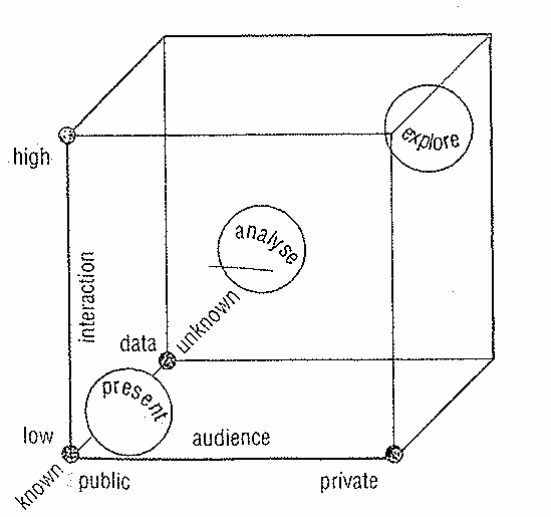

Figure 1 : MacEachren's three visualization strategies (1994) map use cube

2.3 The Map

The map will be created by the cartographer whose role has evolved with the industry around them and now incorporates a GIS toolbox and multimedia presentations with new techniques and opportunities for presentation.

This chapter will review concepts relevant to the map and associated issues. The relationship between the user and the map, the role of interactivity and visualisation and techniques that have been applied here , software and the production of aerial photography briefly. Finally the issues associated with digital maps and interactivity

2.3.1 Cartography

The map was once the domain of the cartographer. The paper map was only form of presentation a few decades ago, a static representation of information a form of visualisation none the less. Cartography is defined by Keith Clarke as "the science, art and technology of making, using, and studying maps" (KC Clark 2003 p27). Cartography has now been transformed from the representation of map data from the Land Surveyors, lithographic plans, to GIS. GIS has seen rapid technological growth that has forced a redefinition of the role of the cartographer leading to the GIS being the main source of plan output by the cartographer.

Kirsi Artimo highlights the role of the cartographer now as "the bridge between Cartographic and Geographic Information systems" (K Artimo, 1994.p57). Artimo goes on to say that cartographers now have to continue their role and provide the cartographic knowledge within the GIS as defined in the CIS (cartographic information system) that exist within the GIS. This role is confirmed by M Kraak & F Ormeling, with the idea that initially GIS would replace the cartographer through a knowledge based system within the GIS, but it has not been the case (M Kraak & F Ormeling 2003).

The blurring of roles between the GIS and cartographic professionals has occurred with the development of GIS, this does highlight the enormous capacity of GIS to deal with data input, processing, analysis and presentation utilising cartographers and their knowledge to provide good cartographic design of maps.

The table below ' Important Map Design Stages in Computer Cartography' shows the steps involved in producing digital maps. The impact of computers on map making and cartography has been dramatic. The computer is now involved in all areas of mapping and now allows cartographers to produce multiple maps from data bases in a cost effective and timely fashion "and computers are the current technology with which maps are made" (K C Clark 1995 p292).

Table 1 : Important map design stages in computer cartography.

IMPORTANT DESIGN STAGES IN COMPUTER CARTOGRAPHY	
Geocoding	Define the spatial location
Mapping	Transformed Data
Symbolisation	Data Compilation – attribute & metadata Representation of the data - temporal, dot, topographical. Design of the map – scale, layout, text Symbol selection – shape. Size, colour
Map Reading	Map use- single or multipurpose map Map interpretation Analysis

2.3.2 Interactivity

The interactive map as described by Dr F Young and Dr A Apan "is a computer assisted presentation that attempts the display of mental maps in the mind" (F Young & A Apan 2005 p4.9). Multimedia has developed a high level of interactivity in the computer map environment, it has given the user a choice of what information they will access by the use of hyperlinks, to interact with the media. The user is no longer the observer.

Hyperspace is an interactive environment developed by hypermedia for cartography to use in presentint computer maps and is linked to the creation of mental maps as mentioned above. The use of images as seen in this project has allowed the association not dissimilar to how the mind works, i.e. one thought leads to another. The image presented in the map allows further data to be associated with it via the use of hypertext and the associated electronic links This is because of the relationship it is perceived to have and this can continue into many levels of hyperspace (MP Peterson.1995) .

The map is no longer a static environment and the multimedia slide show has progressed from what was a rigid, sequential format to utilising hypermedia within the map in a non sequential manner.

2.4 The techniques used in Computer Maps

The cartographer today has a catalogue of visualisation tools to use in the production of computer generated map displays. The major concepts that are used in this project and multimedia will be covered in the following section.

2.4.1 Visualization

Visualisation is described by Cartwright Miller and Pettit, as the process of visualization which refers to computer generated imagery that is linked to creativity. "Creativity is the organisation of information into new patterns from selected images stored in the unconscious mind" (Cartwright Miller and Pettit, 2004 p26).

The concept of 'scientific visualization' (M Kraak & F Ormeling 2003), conveys geospatial information from which analysis can be derived via private visual thinking and communicated publicly via geographical visualisation to end users (DiBiase 1990). The digital map allows the user to interact on many levels and has brought to the cartographer the 3 dimensional map and animation with M Kraak & F Ormeling going on to say that "maps are no longer the products they used to be" (M Kraak & F Ormeling 2003 p1). They now have the dual role of data storage and presentation with a concept of geospatial data infrastructure (GDI). Visualisation tools are used in GIS processes and these tools are well developed to cater for effective communication (M Kraak & F Ormeling 2003).

Visualization is a collection of technologies that play a major role in cartographic representation for map presentation. Cartographic visualisation involves three technical levels and examples as follows; (B Jiang, 1996).

1) application	- Purpose of map
2) cartographic visualization tools	- Animation
	- Exploration
	-Hypermedia
3) Hardware/software devices	- Keyboard
	- Mouse
	- CPU
	- Digital camera
	- computer software

Cartographic visualisation tools vary according to the stage of scientific research , four stages of scientific research exist as follows;

1) Exploration
2) Confirmation
3) Synthesis
4) Presentation

Some exploratory acts are listed in the table below:

Table 2 : Exploratory acts of exploration

EXPLORATORY ACTS OF EXPLORATION	
BLINK	Attract attention to an object
HIGHLIGHT	Attract attention to an object
ZOOM	Zoom in for detail and out for overview
PAN	Drag the image and change its position relative to the screen
DRAG	Moving an object
CLICK	To initiate an explorative act

2.4.2 Multimedia

The involvement of multimedia in cartography to communicate ideas plays a very important part in map interactivity. Multimedia can be defined as " the various combinations Hardware/software devices of text, graphics, animation, sound and video for the purpose of improving communication" (MP Peterson.1995 p127). Interactive multimedia now allow users to interact and select what information is available with the use of Hypermedia.

Multimedia map based product is a term introduced by S. Miller and says that cartographic information will benefit greatly in utilizing multimedia. And goes onto define multimedia as " the merging of audio, video, still imagery, graphics, animation and text within a computerised environment to form an interactive, dynamic and randomly accessed whole" (Miller, S. 1995. pp30-31).

Multimedia authoring software introduces the technique of scripting and has added interactivity to presentation programs. Utilizing the integration of different media forms for communication

is a definition of an Authoring package and can be in the form of a Presentation Program , Card or Page based and Multimedia integration. It results in a sophisticated program, versatile file use formats is designed for interactivity. The scripting allows the user to choose the order in which information is viewed (MP Peterson.1995).

2.4.3 3D & Terrain Visualization

With the use of this form of visualisation a high level of realism can be achieved and bring to the user a different view of the map. The use of rotation, scaling, translation and zooming the act of exploration is greatly enhanced. The manipulation of the terrain model shown on the computer screen by the methods mentioned is important because of the nature of the viewing environment. The flat computer screen would not enable a clear view of some features because of elements i.e. a levee bank being in the way.

The digital terrain model (DTM) can be compiled from many data sources some of these are via land survey, photogrammetric techniques. A variety of professions utilise the information produced from terrain analysis i.e. Civil engineers in their design work for example. The data is generally processed into a DTM via 2 approaches as follows.

Table 3 : 2 Methods of DTM creation

DTM STYLES	
DTM APPROACH	DESCRIPTION
Triangular irregular network (TIN)	Using Delaney triangulation algorithm. Where triangles are created with the shortest lengths and angles between the 2 edges as large as possible.
Grid method	Using a regular network of points over the area, and this interpolation determines the accuracy of the modelling

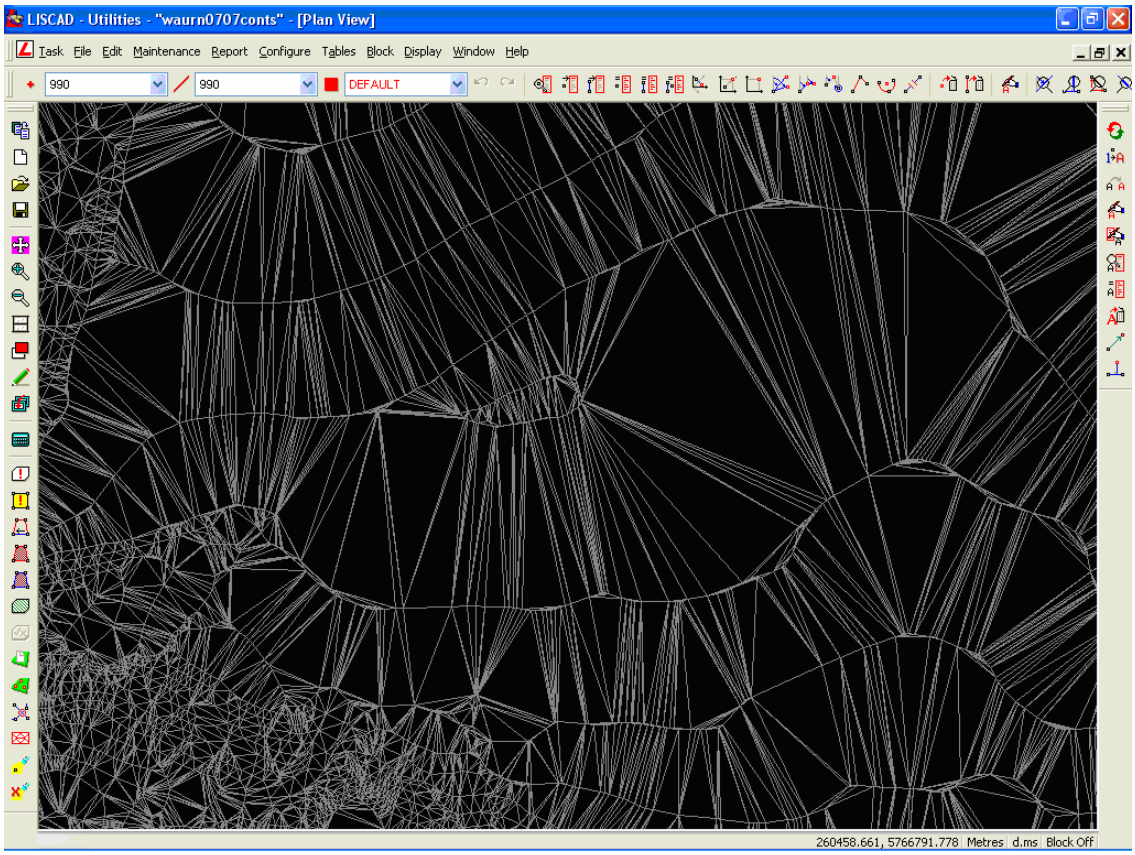

Figure 2 : Example of a TIN from LISCAD's Terrain Modelling package

The figure above shows some of the 420,000 triangles created during processing of a DTM at the BCSC Waurn Ponds site.

Within the GIS the DTM will be used to create a virtual 3D fly through animation of the mine environment.

In the case of the interactive tourist map within a working mine site that continues to alter the terrain surface from the natural surface before mining to the existing surfaces that are generated through the process of mining. What could be a better technique of terrain representation than a 3D view. In a mine you start with the natural surface: trees, grass, open paddocks then it is mined to the workable bed of limestone removing 10 metres of overburden to achieve this. Then all the limestone is removed to another 5 meters for example a constantly changing terrain. What an exciting prospect to present this data in map form utilising 3D terrain visualization incorporating animations, fly throughs and temporal mapping.

2.4.4 Animation

The animated map is used to convey geospatial information by visualisation, developed with new computer graphics. Geographical information can be interacted with to allow exploration,

discovery and decision making. Animation allows the user to visualise the appearance of the area more effectively and can be utilised to show change over time, temporal animation. With the presentation of individual frames just like in a cartoon the illusion of movement can be created and it can be associated with quantitative change and distributions of classes and categories.

Two common forms of animation are;

1) Colour Cycling - Colour change in each segment simulates movement

2) Polymorphic tweening - The shape is altered over segments to imply change and movement

Animation is both 2 and 3 dimensional . With 3D animation, a 2D drawing is manipulated and a wire fame, which consists of polygons, is created as the object is rotated. With the use of lighting angle and rendering of the polygons a solid model is formed. To simulate animation the polygons can be altered by varying light angle shape and light intensity (F. Young & A. Apan, 2005).The following table lists animation variables;

Table 4 : Animation Variables.

ANIMATION VARIABLES	DESCRIPTION
Size	- change in size to show change in value
Shape	- animation to blend the change in shape
Position	- animation shows position change over time
Speed	- animate the rate of change
Viewpoint	- to focus attention on a particular feature
Distance	- viewed as a change in scale
Scene	- to use a transition technique (fade) to one subject to another
Texture, Pattern & Shading	- use with a 3D object

Today we have access to large amounts of data, spatially referenced and with the help of efficient visualisation offered within a GIS, we can step up to the challenge of the presentation of this data.

2.5 Software

Software advances have driven the acceptance of spatial and cad computer packages to the point now where a map is rarely produced without utilising one of the many packages. The packages used in this project are briefly discussed below.

2.5.1 GIS

GIS is defined simply through the use of a spatial address the x, y and possibly z coordinate values or Geographic coordinates of latitude and longitude, which can be assigned to data, within a systems database. These values relate to a map projection of the earths surface telling users what is there (features and attributes), and where it is. Further data can be added to highlight trends, patterns, shortest routes. Spatial data separates GIS from an information system and incorporates the information system within it. Data base management is integral to both systems and enables functions like queries, problem solving and analysis.

In 1979 GIS was defined by Ken Dueker as "a special case of information system where the data base consists of observations on spatially distributed features, activities or events, which are definable in space as points, lines, or areas. A GIS manipulates data about these points, lines and areas to retrieve data for ad hoc queries and analyses" (Dueker, 1979, p106). Clarke describes a GIS as an "automated system for the capture, storage, retrieval, analysis and display of spatial data" (Clarke, 1995. p13).

With the vast array of data associated with the development of the map GIS as highlighted in Clarke's description of a GIS it is the perfect tool to create the different forms of visualisation that will be needed to form that base of the interactive map compared with the traditional paper based maps

ArcGIS desktop version 9.2, from ESRI will be the GIS software used in the data processing and the map creation. ArcGIS desktop is made up of several main components and is described in the following table

Table 5 : ArcGIS Desktop products

ArcGIS 9.2 Desktop			
PRODUCT	APPLICATIONS	PURPOSE	FUNCTIONS
Arc Reader		Map Reader	Entry Level product/ freeware View Maps Print Maps Map interactivity
Arc View	ArcMap ArcCatalog Extension modules Common user interface with other products	Map Maker	Query data Analyse spatial relationships Overlay layers
Arc Editor	Arc View functionality		Versioning, allowing multiple users to work simultaneously Disconnected editing Data creation Editing tools
ArcInfo	Arc Editor functionality ArcInfo Workstation		Full set of spatial analysis tools

For this project the 3D analyst extension will be utilized to help create the 3D models necessary to for the visualization techniques for map representation incorporating another product of ArcGIS, ArcScene.

ArcScene is a 3D visualization application that allows you to view your GIS data in three dimensions and is similar to ArcMap.

2.5.2 Survey Software

LISCAD version 8.01 from Listech is a vector based surveying and engineering software package. Its primary role has been to reduce survey data and export this data to AutoCAD for editing. Data includes terrestrial surveys of the Quarry floor used to calculate volumetric calculations and the greenfield site i.e. the original surface before mining.

Autodesk 2006 Civil 3D has been utilised to produce maps reflecting the surfaces surveyed for the volumetric surveys and presented to the client. 3D files have also been created for importation into ArcGIS for processing and map development.

2.5.3 Presentation Software

Microsoft's presentation software PowerPoint has been used to present the interactive map associated with tourism to the user. It utilises a slide presentation pack capable of a non sequential format of presentation. It has a vast array of presentation techniques that include sound, animation and interactivity. It is data and user friendly in the typical windows fashion. It is widely accepted throughout the word and people are familiar with the basic concepts of presentation within.

Nero's multimedia editing package will be utilised to finalise digital video presentations to be linked to the PowerPoint presentation creating an excellent source of information and interactivity.

2.6 Aerial Photography

As digital imagery is a major component of the interactive map it is important to provide adequate information about its origin. That is; how it is converted into a digital format, how users are presented with good coverage of their area of interest, and its location with real world coordinates. Issues associated with data file sizes and compression, and its relationship with GIS.

2.6.1 From the Plane to the Computer

The image must first be digitized to be used by the computer and this is done by scanning the aerial photo with a scanner to convert the visible features to digital files, this is termed as digital image processing.

A digital image is stored in the computer as an array of pixels, each pixel corresponds to an area on the earth's surface and this array is known as a raster. The raster is arranged in horizontal and vertical lines the rows called lines and the columns known as samples. Pixels have a digital number (DN) assigned to them. This DN represents the intensity of light reflected in a defined electro magnetic spectrum wavelength for example visible or infrared wavelengths. This enables the transformation of the aerial photo, during the digital image processing and uses the DN's to enhance the photo.

The aerial photos referred to in this study are of a natural colour and have 3 bands of data. Each of these bands or layers cover the same geographical area capturing the different wavelengths of light reflected from the earths surface. The wavelengths being red, green and blue.

The resolution of the image is affected by the scale at which the aerial photo was flown. This is determined by the altitude of the aircraft and the focal length of the camera at the time of photography and the Dots Per Inch (DPI) used to scan the photo.

The figure below is an example of an aerial photograph image. Showing fiducial points as red stars in most of the corners and halfway along the sides of the image. Other information that appears but may be difficult to see are a compass, altimeter and catalogue information of the image.

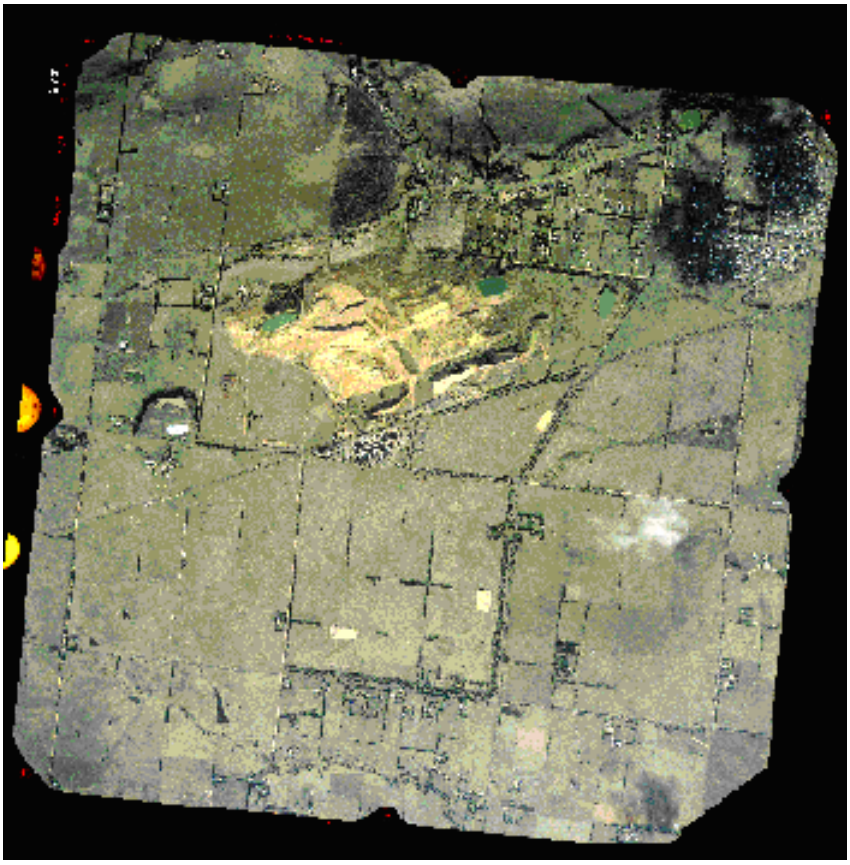

Figure 3 : Example of a aerial photo

2.6.2 Mosaics

In order, to acquire suitable coverage of the area the aircraft will repeat its flight over the area a number of times taking photos that will overlap. A mosaic will be created of these photos to create one digitized aerial photo. This processing of air photo mosaic has a number of stages with the main objective to produce seamless imagery. By stitching the individual photos together and balancing the contrast between images, to minimize the visible seam lines. The final image will be cropped from this mosaic. The reason for this is to just cover the area in question and make map files more manageable by GIS for example.

2.6.3 Image Geocoding

A very important part of digital image process is image geocoding. Errors from the raw data need to be removed to enable distances and directional measurement as well as area computations.

Image geocoding involves the Registration, Rectification and Ortho rectification of the image, each of which is described below in the table below.

Table 6 : The processes involved with image geocoding.

IMAGE GEOCODING PROCESSING	
REGISTRATION	Geometrically aligning photos to allow them to be overlaid
RECTIFICATION	Correcting raster images to correspond with real world coordinates
ORTHORECTIFICATION	Geometrically corrected image, with the scale being consistent in the image. This is done by taking into account the properties of the camera being used and the topography to produce an Orthophoto

2.6.4 Image Compression

The technique of data compression is very important. It reduces storage space requirements and also allows large image files to be transferred via portable recordable media such as compact disks (CDs) and via image web servers more conveniently. Image compression also determines the time taken to display the image due to decompression techniques. In the case of Joint Photographic Experts Group (JPEG) file format the image is viewed as the file is decompressed adding to the time taken to redraw the image. The cost of acquiring software to perform the required compression formats is also an issue. Loss of information is a critical issue and will be discussed in the following paragraphs

Compression procedures are defined by algorithms There are 2 forms of data compression as shown below;

Table 7 : Two Forms of data compression

2 FORMS OF DATA COMPRESSION	
TYPE	DESCRIPTION
Lossy	- Data may be lost when decompressed causing a reduction in quality - More suitable for images - Reduces the colour space to common colours - Transforms coding with wavelet compression technology enabling high - - compression rates
Lossless	- Reconstructs data to original state - More suitable for text

Compression ratios of data typically range from 50:1 to 20:1,. A colour image can be compressed to 2% of its original size. At a compression rate of 20:1 a 7GB image would be reduce to a file size of 350MB.

Two common forms of image compression file types are Tagged Image File Format (TIFF) and Joint Photographic Experts Group (JPEG). These are the two formats used in image presentation in this study. They are described as follows along with further examples:

Table 8 : Compression file types

COMPRESSION FILE TYPES	
TYPE	DESCRIPTION
TIFF	- Employs both Lossless and lossy compression techniques - Commonly accepted image file format that is flexible - Uses tags with data assigned to it -These tags and data define the image
JPEG	- Widely accepted - Lossy compression format - Designed for photographic images - Loss of quality in images due to compression format
FIF	- Factual Image Format - Allows fast decompression times - Slow compression times - Breaks geometric shapes down into smaller images of smaller file size with a format created to rebuild the image
LZW	- creates coding for irregular data patterns that reoccur - Low compression rates - Lossless form of compression
RLE	- Run Length Encoding

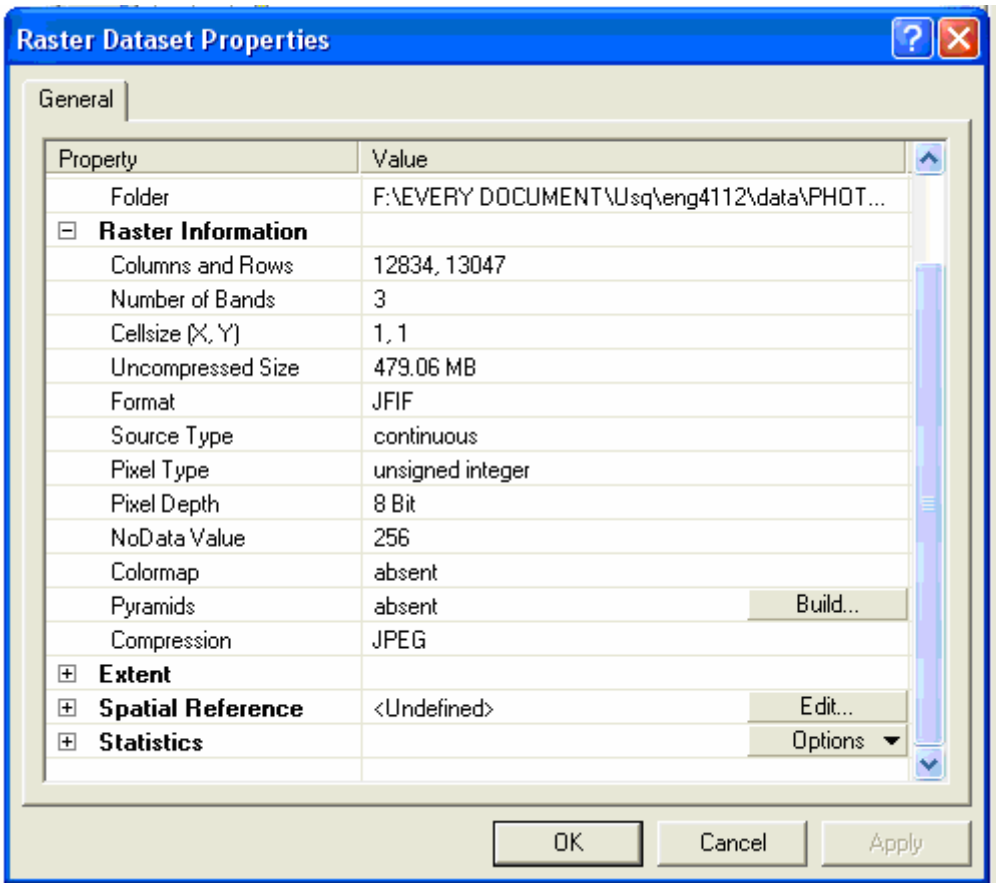

Figure 4 : Raster data set properties taken from ArcMap

The figure above shows the uncompressed file size as 479.06MB, the compressed jpeg file size is 29MB approximately 6% of its original file size

2.6.5 Digitized aerial Photos and GIS

The resultant mosaics created by aerial photography and digitization are very large in size and are at very high resolution. The cell size in these raster images can be 1 metre or less. As mentioned previously cropping is a good form of file size reduction and along with file compression this allows images to be reduced for transportation and handling. Plug ins are available to view these compressed files that when decompressed are very large files, but could still be very difficult and slow to use. Increasing the cell size, also known as the spatial resolution, is another way to reduce file size and make it more compatible with GIS. In GIS the spatial resolution is also known as the Ground Sample Distance (GSD).

Increasing the cell size in the digital image increases the amount of coverage by each pixel of the earth's surface and reduces the amount of pixels and therefore the file size. The proposed use of the of the data needs to be taken into consideration to determine the accuracy required for this and other data manipulation processes. A Concept master plan would not require the

feature definition and 1m contour interval but may need to cover a large area, therefore an increase in the cell size would be a practicable trade off to achieve a smaller file size for the raster.

Table 9 : DEM resolutions requirements

DEM RESOLUTIONS REQUIREMENTS (guide only)		
PHOTO SCALE	ACCURACY REQUIRED	CONTOURS INTERVAL ACHIEVED
1:10,000-1:15,000	1-2 metres	1-2 metre
1:20,000-1:30,000	2-5 metres	5metre
1:40,000 +	5+ metres	10 metre

2.7 Hardcopy vs Computer Display Maps

As discussed so far mapping has be revolutionised by the computer and presented the cartographer with new challenges of presentation. Visualization is well served by the dynamic arena of the digital computer maps displayed on the computer screen an the virtual map presented by the computer that has the ability to transform data and present it in a different perspective.

Conventional maps finalise the collection of information into a inflexible display when compared with the digital map. The presentation of data on a hard copy map entrenches the strict cartographic rules of scale, borders and marginalia information for presentation on a static flat viewing surface. With the virtual map that will never be printed onto the paper medium and therefore not limited to the fixed extents of the paper the presentation of data becomes a versatile medium that sometimes will disregard the tradition map production requirements. This is shown in the interactive map as views are taken from GIS and survey software displays and placed into the PowerPoint presentation for the sole purpose of diagrammatically presenting information to convey the visual message associated with the data.

2.8 Issues Associated with Animated Interactive Maps

An issue that looms over the production of animated and interactive maps is wether all the effort is worth it. Has the message been received by the map user? Jiang states “cartographic representation involves the presentation of results”(B Jiang 1996 p8). Animation and interactivity if not used correctly could distract the user from vital information or the user blink and miss it all together.

Lost in hyper space by providing to many links to external data sources most of us have experienced this feeling. By giving the user a choice of where to proceed next, without adequate control in this path presents the problem of not achieving the desired communication of results.

In the table below Mark Harrower (2003) discusses four challenges associated with animation:

Table 10 : Four challenges associated with animation

Four Challenges Associated with Animation	
Challenges	Description
Disappearance	- Animated maps change, 'blink and you may miss it'.
Attention	- With so many things happening where does the user focus their attention
Complexity	- Information overload. The power of animation lies with the possibility of presenting a lot of information to every user, some users are to inexperienced to decipher the animation.
Confidence	- Simple interfaces to allow all users confidence to interact with the display not abandon the map because of intimidation

2.9 Summary

Today we have access to large amounts of data, spatially referenced and with the help of efficient visualisation offered within a GIS we can step up to the challenge of the presentation of this data. The map users are the ones who in the end benefit from the technological advances in visualization and Map presentation as has been discussed in this chapter.

This chapter has introduced the map and its role it needs to provide for the user. The interactivity and how the mind has been link to the development of this important concept. The inclusion of the visualisation techniques aided by the different forms of multimedia, the processes involved with aerial photography, the major forms of software used in the construction of the Interactive Tourist Map Associated with Tourism. And briefly touched on issues with today's maps.

CHAPTER 3

RESEARCH METHODS

3.1 Introduction

This chapter is divided into two main sections, firstly an investigation into the site chosen for the interactive tourist map, being BCSC limestone quarry. This will cover how the mine is positioned in the area and the possible pressures that are placed on the mine by the mine's surrounding environment. The mine is an industrial site on the urban fringe of a growing suburban landscape and can benefit from an informative well designed interactive map associated with tourism to provide users with a valuable insight into the mine. Also a brief explanation of the mining process is given to understand the concepts being examined for display within the map. The geological relevance of limestone will then be covered focussing on what limestone is and what it is used for in BCSC.

In the second section of this chapter, data sources and processing of this data for the map will be discussed and how it will be utilized in the interactive tourist map presentation. It will also highlight the importance that aerial photography has with an aerial image being the base photomap of the interactive map

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3.2 The Site

The BCSC Waurn Ponds site is located approximately 7km to the south west of the Victorian regional city of Geelong with an approximate population of 785,000 . The mine site is located on the edge of the urban fringe known as Waurn Ponds with rural grazing land to the south and west. Waurn Ponds is a strong growth area of Geelong with the mine site bordering this suburb.

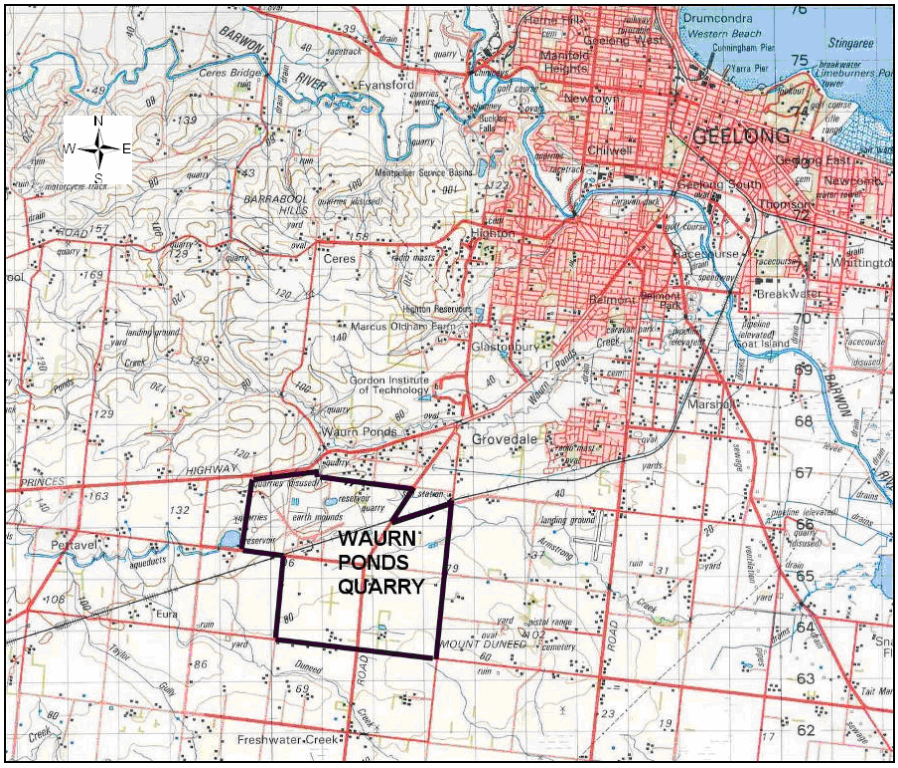

Figure 5 : Sketch showing location of Waurn Ponds site

(Source: Australia 1:100 000 Topographic Survey – Geelong Victoria. Series R652 Sheet 7721 Edition 1-AAS)

3.2.1 The Location

Blue Circle holds freehold title to all of the quarry, future quarry and buffer lands. The lands comprise 23 separate land parcels with a total area of 1146.629 Ha. Blue Circle Southern occupies a total area of approximately 1173 Ha at the Waurn Ponds site. The extractive licence covers some 800 Ha of this land. While the area of extraction is ever changing as a result of the operations at the site, presently some 96 Ha of land lays open with approximately 10 Ha being active.

The location of the mine is a concern to residents with BCSC management placing a strong emphasis on the good will of the surrounding community. Urban pressure such as a new Ring Road, formally know as the Geelong Bypass, is under discussion at the moment with a proposed route through BCSC's land.

A campaign has been launched by the Geelong City Council called 'West Connect Ring Road', to draw attention to the federal government for funding to assure the development of this large infrastructure project. Here the Geelong City Council has realised the enormous benefits this ring road will bring to the community in the form of safety by reducing traffic flows through Geelong in peak times, assisting tourist to their destinations, economic and social benefits. The Surf Coast, approximately 10 km to the south, is a rapidly developing tourist destination. The Ring Road will directly impact on the mine site as the quarry is located on the entrance to the

area that the campaign targets. Ring Road planning is at a sensitive stage with routes close to being finalised and plans being restricted from public viewing.

Noise and air pollution are also problems associated with the mine site with BCSC conscious of its close proximity to urban environments and the need to monitor output levels. Drainage and effluent and ground water contamination present with recycling and purification methods being practiced.

The closest residential properties are located north of Hams Road and these consist of small rural residential sites. Six dwellings owned by BCSC are located on the land and all are currently leased out. The photograph below shows on the right a well treed barrier that restricts the view of residents of the mine site.

Figure 6 : A view along Hams rd looking east on the north of the site

The extraction areas generally have a buffer zone of approximately 40 metres. This is composed of an inner access road, an outer 3 metre high earthen bund wall and five meters (four of which is treed) between outer roads and the bund.

Local Planning Provision in the Geelong Planning Scheme does not permit construction of dwellings within 500m of any 'active working face' of the quarry. This is to ensure residential developments, are not adversely impacted on by quarrying operations and conversely to ensure

that unreasonable limitations are not placed on the extractive operations as a result of the proximity to residential areas. At present, the closest dwelling to an active working face (not including those on Blue Circle lands) is over a kilometre away.

A joint consultative committee (the CLC) was formed between company representatives and the local community to discuss any issues that may arise. The committee was formed in early 1999.There is no doubt that any information about the mine site would be valuable to any of the mentioned matters. With the efficient form of presentation of this interactive map the information contained in the map will be available for exploration to a cross section of users.

3.2.2 The Geological View

The predominant geological feature of the area is the Barrabool Sandstone, which contains the Waurn Ponds Formation. The Waurn Ponds Formation was formed during the Oligocene Epoch (25-34 million years ago) when marine deposition of limestone beds and marls (calcium rich clays) occurred. Following the regression of the Southern Ocean to the south-east during the Miocene Epoch (12-25 million years ago) basalt flows emanating from Mt Duneed, 3 km to the south east, were extruded onto the exposed limestone plain.

The Waurn Ponds Formation is often referred to as Waurn Ponds Limestone but is actually a complex layers of clay, ironstone and limestone overlain by beds of marl and calcareous clays. The lower seven to twelve metres of the Waurn Ponds Limestone has an average calcium carbonate content of 88% to 90% and is suitable for cement manufacturing. The marl above the high-grade limestone has a lower calcium carbonate content. A proportion of this marl can be blended with the high-grade limestone to produce a cement kiln raw feed with a calcium carbonate content of 78%.

Limestone is predominately made up of a mineral called calcium calcite and the main source of the calcite is from marine animals. As a sedimentary rock, limestone here was created by deposition and compaction. Shells and the remains of sea life were deposited as the oceans receded, many millions of years ago and compacted by other layers of strata deposited. This process is known as the geological ‘lithofication’. This can be seen as you traverse the landscape of the mine with prolific remains of fossilised sea shells scattered over the exposed limestone deposits. Archaeological groups investigating the site find teeth of past marine life similar to the one shown below.

Figure 7 : Fossils found in the quarry during a volumetric audit survey. These objects date back millions of years. The tooth displayed here measures 2.5 cm.

3.2.3 The Mining Process

The quarry at the Waurn Ponds site has wealthy reserves of limestone with ongoing geological surveys plotting the future of the quarry. Large earthmoving machines known as scrapers collect limestone of different grades from the exposed limestone beds (workable bed) in the quarry.

The limestone is first uncovered from the clay and rock deposits that cover the limestone (overburden). Scrappers remove the overburden to other areas on site. Scrapers have the advantage on the overburden areas of collecting the material with minimal input from the bull dozer. The photograph below shows a scraper and bull dozer on one of the overburden beds that cover the limestone deposits. Just past the machinery the base of the mine being the bottom of the limestone deposit, the top of the mud rock and the spent area of the mine can be seen. Further in the background the reclamation process can be seen as the encroaching landfill.

Figure 8 : A Scraper and Bull Dozer travelling on overburden deposits

The overburden varies in depth and the economics of extracting the limestone come into play as the depth of the limestone increases. The overburden is used as backfill for regeneration of past mining sites.

The limestone is worked on two benches. The top bench is in the marl while the lower bench is in the high – grade limestone. Bull dozers rip the limestone beds to enable removal by scrapers The scraper enters its material collection area with its blade down and mouth to its storage bay open. The blade then directs the ripped limestone into the storage bay of the scraper for transportation to the crusher where the limestone is crushed and conveyed to the Factory by conveyor belt. Each scraper can carry $17m^3$ of material. In this form of extraction the scraper is not required to be filled by a loader, can access rough terrain, is self loading and constantly moving material to the factory or reclamation areas. This is an efficient technique as opposed to the shovel and truck method of extraction. By which large excavators load tip trucks with the material and then the material is transported by the tip trucks.

There is a five-year excavation area that covers 27 Ha. The average thickness of the workable bed is 8 metres. The total reserve of useable limestone in this area is 2,700,000 cubic metres.

The overburden thickness averages 20 metres within a range of 4 metres to 24 metres from the natural surface. The overburden to limestone ratio ranges from 0.5:1 to 2.5:1, with an average of 2.3:1 cubic metres of overburden to one tonne of limestone. About 5,400,000 cubic metres of overburden has been moved in the five-year operation.

Overburden is normally removed up to 12 months prior to limestone mining. The overburden consists of clay, sand and poor quality limestone called marl. As the overburden is removed it is placed in the eastern end of the quarry void. The overburden is compacted to match the original land surface.

Since the volume of overburden is insufficient to backfill the whole area to original topographic levels, large water reservoirs or lakes are built at regular intervals behind the westerly advancing excavation front.

3.2.4 The Factory Process

The operation here currently outputs approximately 700,000 tonnes per annum of clinker, a nodular material that is ground up with gypsum to produce Portland cement. Here at the Waurn Ponds factory a dry process kiln method is used to produce clinker.

Briefly the dry process kiln method consists of meal consisting of the materials required, including limestone to produce the clinker. The quality of limestone taken from the mine has an important impact of the recipe of the meal, used in the tumbling kiln for clinker production. Many variables influencing the quality and characteristics of the cement to be used by customers.

The raw meal is fed into the kiln via the preheater tower, where the meal is heated and all moisture removed before entering the tumbling kiln. The meal is heated in the tumbling kiln to temperatures of 1400 C – 1500 C to produce clinker. Raw meal enters the tumbling kiln from the preheater which is tilted at a angle so the meal moves down the kiln towards its end as it is heated and rotated in the tumbling kiln. The end product of this process is clinker.

3.3 Data Capture and Acquisition

The data available for the interactive map will be discussed here. Digital photographs, Video, computer, hardware and software used will also be discussed.

3.3.1 Available data

Digital ortho photos will be utilised as photo maps as the major part of the proposed visualisation techniques for inclusion in the interactive map. There are three sets of aerial photos that have been supplied since 2001, from a Photomapping consultant commissioned by BCSC through to 2007. The images were supplied with varying levels of metadata as shown below.

AutoCAD files containing georeferenced boxes to aid orthorectification of associated images and feature line work and the available images are listed in the table below:

Table 11 : Aerial images and associated data of the site

AERIAL PHOTOGRAPHY AND ASSOCIATED AUTOCAD DRAWINGS FROM PHOTOMAPPING CONSULTANT		
DATE	FILE TYPES	META DATA SUPPLIED WITH IMAGERY
2001	BlueCircle.ecw	Ortho rectified image utilizing 1-10m contours 1 : 15000 scale, 0.35 pixel resolution
	BlueCircle.ers	Header file
	Blue Circle.dxf	AutoCAD reference box for imagery AGD66
06.2005	Wau0605r.jpg	Orthorectified image
	Wau0605r.dxf	AutoCAD reference box for imagery AGD66
07.2007	Orth-wauhl07.jpg	Ortho rectified image, Scale 1: 6000
	Orth-wauhl07.tif	Ortho rectified image, Scale 1: 6000
	Wauhlo7.dwg	AutoCAD reference box for imagery GDA94
	Waun0707oc.jpg	Ortho rectified image
		Scale 1: 6000
		Site specific (cropped)
	Waun0707oc.tif	Ortho rectified image
		Scale 1: 6000
		Site specific (cropped)
	waun0707boc.dwg	AutoCAD reference box for imagery georeferenced GDA94
		Site specific (cropped)
	Waun0707.dwg	3D Feature line work from Image file, AutoCAD file
		Site specific (cropped)

The imagery supplied in 2007, Waun0707.TIF will be utilized as the major source of aerial photography in conjunction with Waun0707.DWG for the production of TIN's for raster overlays, fly throughs further animations and temporal 3D displays and photo maps. Waun0707boc.DWG will be used to geo reference Waun0707oc.TIF in ArcGIS. Line work will be taken from Waun0707.dwg for use in the 3D virtual fly through animation.

3.3.2 Terrestrial Survey Data

Data will come from a decade long client relationship between Earth Tech Engineering (ET) and BCSC. ET carries out twice yearly audits of the material removed from the mine site and material remaining in the factory area. This material is classed as overburden destined for reclamation areas and limestone of various classes destined for the milling process in the factory.

Surveyors enter the mine and collect data to map the terrain within the working quarry. Associated digital terrain models are created to calculate the volumes of materials removed. A comparison of this survey and the last audit survey give a bulk figure of material removed. When compared to geological survey DTM's the volumes of specific material removed and the amount of materials remaining can be calculated. The geology DTM's comprise of the existing natural surface, top of limestone and bottom of limestone being the top of mudstone

The past methods of data collection include topographical surveys using manual and fully Robotic total stations and real time kinematic GPS. The GPS surveys have utilized a base station and 2 rovers to collect data, auto log has also been utilized. Auto log involves the placement of a GPS rover unit on a vehicle and the vehicle is driven over the terrain to be mapped recording measurements at a defined interval. Generally after 15 – 20 metres have been covered another reading is automatically recorded. Both GPS and total station data have been used from these audit surveys, for input into LISCAD, AutoCAD and ArcGIS for the production of displays for the interactive map

The photograph below shows a Leica 530 GPS unit configured as a base station receiving and transmitting data, the unit is located on a survey control point on the northern extent of the mine. It has known Map Grid Australia 94 (MGA94 zone 55) coordinates and an Australian Height Datum (AHD) Reduced Level . The purpose of this survey was to update the existing AMG66 control network to MGA94 and to located Ground control points (GCPs) for the current aerial photo being Orth-wauhl07.TIF/JPG and for all future survey work. The date of this survey is August 2007.

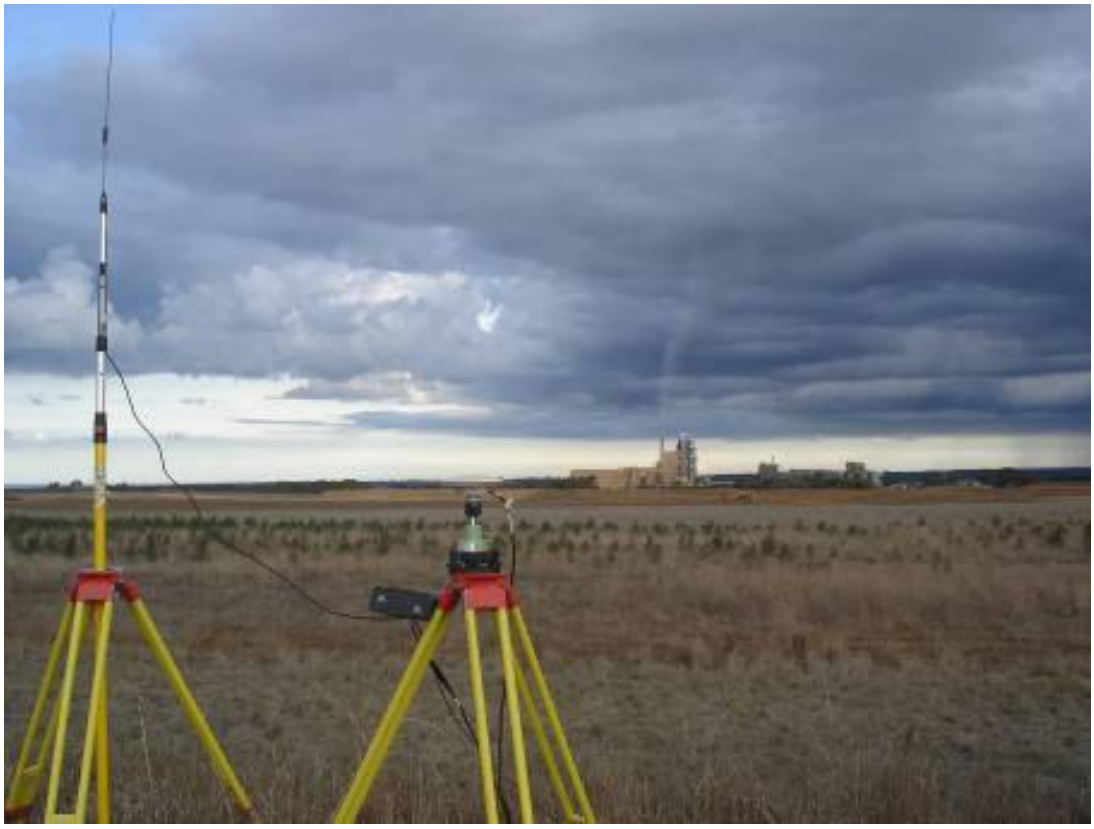

Figure 9 : GPS base station unit logging data looking south, across rehabilitation areas the quarry to the factory

Over the years of survey three different survey datum's have been used, these datum's are shown in the table below:

Table 12 : Survey datum's of terrestrial surveys

SURVEY DATUM'S OF TERRESTRIAL SURVEYS
Local Grid – arbitrary datum Horizontal and vertical datum
AMG zone 55 – Based on AGD66 and AHD levels
MGA94 zone 55 – Based on GDA94 and AHD levels

The following table lists data from the ET for possible inclusion in the interactive map:

Table 13 : Audit surveys available for use

QUARRY AUDIT SURVEYS 2002 – 2007 AVAILABLE FOR INCLUSION IN MAP		
DATE OF SURVEY	SURVEY DATUM	ET REFERENCE
31.10.2002	Local	62130
01.05.2003	Local	7703074-70
31.10.2003	Local	7703531-70
20.04.2004	Local	7704241-70
29.10.2004	AMG66	7704655-70
28.04.2005	AMG66	7705218-70
31.10.2005	AMG66	7705572-70
01.05.2006	AMG66	7706164-70
31.11.2006	AMG66	7706427-70
30.04.2007	AMG66	7707157-70

3.3.3 The Here Solution by GPS

Data is generally collected via GPS on the mine site. Recently the map projections have changed at this site as with most sites since the introduction of the Geocentric Datum of Australia 1994 (GDA 94) from the Australia Geodetic Datum 1966 (AGD66)

With extensive existing data sets on AMG66 Zone 55 a transformation of the existing data sets to the new datum has been performed and has involved a GPS survey to establish the new Datum on site incorporating previously known marks in AMG66 Zone 55. This survey has been used to establish the transformation parameters to required survey accuracies and occupy new marks to extend the survey network of marks over the site for terrestrial surveys, by theodolite. As the site was about to be flown for aerial photography, photo control points were placed over the site and located by GPS during this survey.

To establish GDA94 on site the GPS base station was established and a 'here solution' was performed. The GPS base station unit had a map projection defined in its setup parameters in this case GDA94. After collection initial readings from available satellites the unit calculates approximate MGA94 Zone 55 coordinates for its position to sub 2 meters generally with the height value to a lessor accuracy. This is known as the 'here solution'. The rover unit or units then move to known points on the MGA 94 Zone 55 map projection adjacent to the site and occupy these points and collected readings from the available satellites. After occupying a number of these points, establishing the approximate MGA94 Zone 55 values for these points

(via the here solution) transformation parameters can be calculated to enable a shift from the approximate coordinates from the 'here solution' to the known MGA94 Zone 55 values supplied by the governments survey department . This enables the calculation of sub centimetre coordinates horizontally and two centimetre accuracy for the reduced level values for survey control marks and photo control point established during this survey and provides transformation parameters for AMG66 to MGA94.

3.3.4 Photographic material

Photographs and digital video will be incorporated into the interactive map. This material was compiled on site over 2006 – 2007 using a Sony Digital Camera with 3X zoom lens and 32MB. Internal memory card.

Photographs have been stored in JPEG compliant format and movies in MPEG1 compliant format. The material has been downloaded from the camera and stored on computer hard drive. The JPEG file size is approximately 2 MB with an image size of 2592 pixels * 1944 pixels recorded on a fine setting using a low compression ratio and the MPG1 files vary in size with the larger files being approximately 30MB and running for 20 – 30 seconds.

3.3.5 Computer Hardware and Software

A desk top computer was used to produce the Interactive Map associated with tourism its specifications are as follows:

Table 14 : Computer hardware used for project

HARDWARE	BRAND	SIZE / SPEED
PROCESSOR	Intel Core 2 Duo	6400 @ 213GHZ
RAM		2.00GB
VIDEO CARD	NVIDIA GEFORCE 6200	256 RAM
OPERATING SYSTEM	Windows XP Service Pack 2	
PRINTER	CANNON PIXMA	IP5200

The following software packages were used to complete this study

Table 15 : Computer software used for project

SOFTWARE	PURPOSE	OTHER
ArcGIS Version 9.2 - ArcCatalog - ArcView - ArcScene	Image management File Management TIN creation 3D displays Animations	3D Analyst extension Animation extension Georeferencing extension
LISCAD version 8.01	File viewing Data formatting Data export	
AutoCAD 2006	File viewing File editing	
Nero Multimedia centre	Digital video enhancement	
PowerPoint	Interactive map presentation	Slide presentation
Microsoft Paint	Picture enhancement	
Windows Media Player	Digital Video viewer	Version 9

3.4 Data Processing

This section will discuss the processes and steps involved with the major data sources for insertion into Power point to create the interactive Map associated with tourism.

3.4.1 Photo Maps

Aerial photography will be the base of the photo maps in the interactive map and the process involved in creating the digital images and related issues to be used will be covered here.

As mentioned there are a number of images available for use in the interactive map. Various limitations do exist with regard to their use in interactive map and some of these are shown in the table below:

Table 16 : Some limitations of aerial photography

SOME LIMITATIONS OF AERIAL PHOTOGRAPHY IN THE INTERACTIVE MAP
Final File size to large
Are all the images needed (information overflow)
Limited time frame to process data – Time consuming to georeference all the images

The image that will be used to create the 3D visualization is Waun07070c.tif. The are a number reasons for this file and these are shown in the table below:

Table 17 : Aerial photography selection criteria

AERIAL PHOTOGRAPHY SELECTION CRITERIA	
REASON	DESCRIPTION
Site specific.	- Cropped from the over all orthophoto. This will reduce file size and improve display times..
File Format	- With the TIFF file format loss of quality will be negligible as discussed previously and good redraw times compared to the JPEG in ArcGIS, which has made it easier to handle.

With Aerial photos utilized in this study orthorectification by the photomapping consultant used ground control points (GCPs) and unlike images from satellites covering larger areas. Orthorectification does not generally correct images for the curvature of the earth.

Below is an image of one of the GCPs used. It must be noted that the images received from the Photomapping consultant in 2007 were not on a map projection but had been orthorectified. An insertion box on MGA 94 zone 55 map projection, was provided and is found in waun0707boc.dwg for which the image could be inserted and georeferenced in AutoCAD only. For the purpose of this study the GCPs mentioned here will have been used to geocode Waun0707oc.TIF because the insertion box does exist on the relevant map projection as mentioned. This is the reason that waun0707oc.TIF was georeferenced in ArcGIS.

GPS was used to produce horizontal and vertical coordinates on the GDA94 datum shown on the MGA94 zone 55 map projection with AHD level datum. Eight of these points over the aerial photo coverage area, are used as a reference to correct the raw image and in Geocoding or the rubbersheeting process.

Figure 10 : Image showing one of the Ground Control Points, placed on site before the aerial photography was flown

In a simplified explanation of this orthorectification process the position of each GCP is located visually in the digitized image and assigned its corresponding coordinate values as defined by the GPS survey. A DEM is created (in this case) using the level values assigned to these points as the terrain needs to be identified to eliminate distortion in the image.

The accuracy of the final product is determined at this stage. As mentioned surveyed measurements of GCPs were supplied to an accuracy of +/- 20mm allowing the contour output to be at 1 metre intervals or better and decimetre accuracy horizontally.

As vertical information was supplied with the image from the Photomapping consultant random checks have been performed on reliable areas, such as fence corners in open view, with acceptable results as shown in the 2 figures below. The first figure shows the reduced level (RL) obtained from an existing terrestrial survey at the fence corner highlighted in the red rectangle, to be 92.43. The second figure shows the RL determined from aerial photograph at approximately the same fence corner to be 92.48.

It should also be noted from these examples that the two data sets are on different map projection as shown by their respective coordinate listings in the attribute dialogue display. The first figure is on AMG66 zone 55 projection and the second figure is on MGA94 zone 55 projection. Having a number of different map projections within the data set has introduced another step in datum transformation when data needs to be overlayed and mapped.

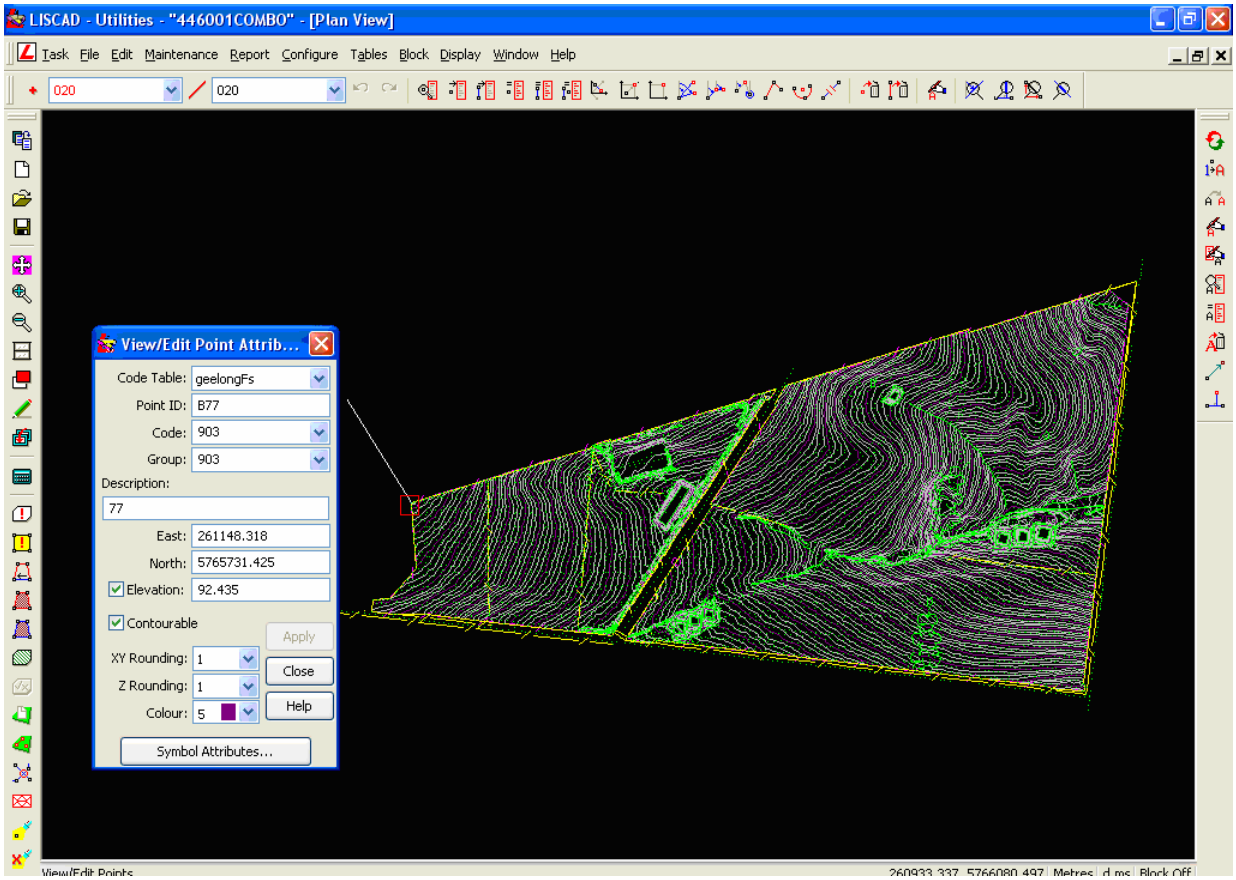

Figure 11 : Level data in terrestrial survey in LISCAD

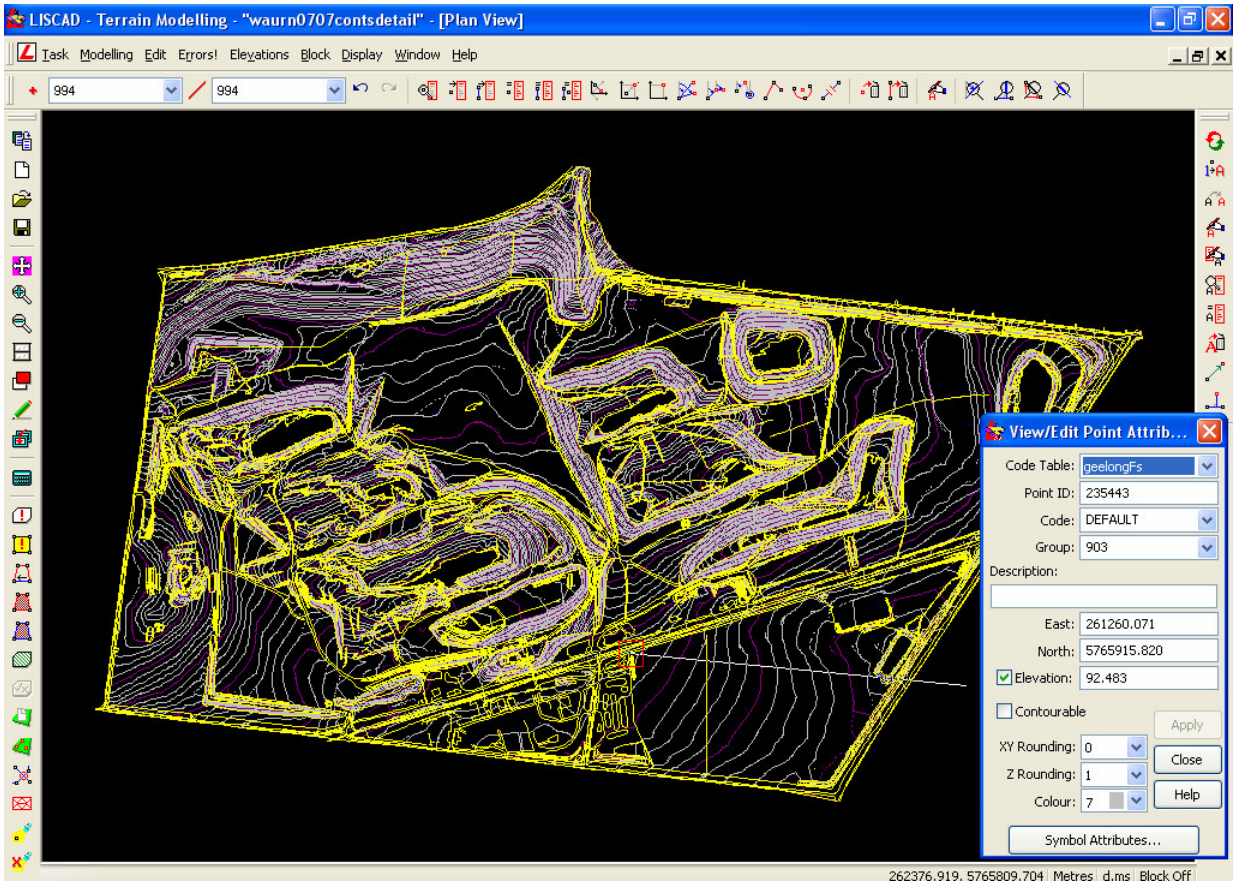

Figure 12 : Level data in Aerial Photo in LISCAD

The Blue Circle.ecw image flown in 2001 (Table 6) was based on a Digital Cadastral data base and contour interval interpolated data of 1-10 metres all containing assumed data not verified by accurate survey. The accuracy of the data input would be reflected by the deviations shown at the final stages of the transformation computation process.

In the georeferencing process errors are calculated and assessed in relation to the distance between the survey control and the visual points corresponding to these GCPs selected in the image. The error is expressed in Root Mean Square (RMS), it is a statistical measure of the size of a varying quantity. The RMS can be manipulated by improving the accuracy of locating the points in the image file, improved surveyed data for the GCPs and also by letting go of the GCPs during the process of geocoding that exceed the acceptable RMS. An acceptable RMS is approximately the intended cell size in the raster output .The image is then transformed to align itself with the GCPs.

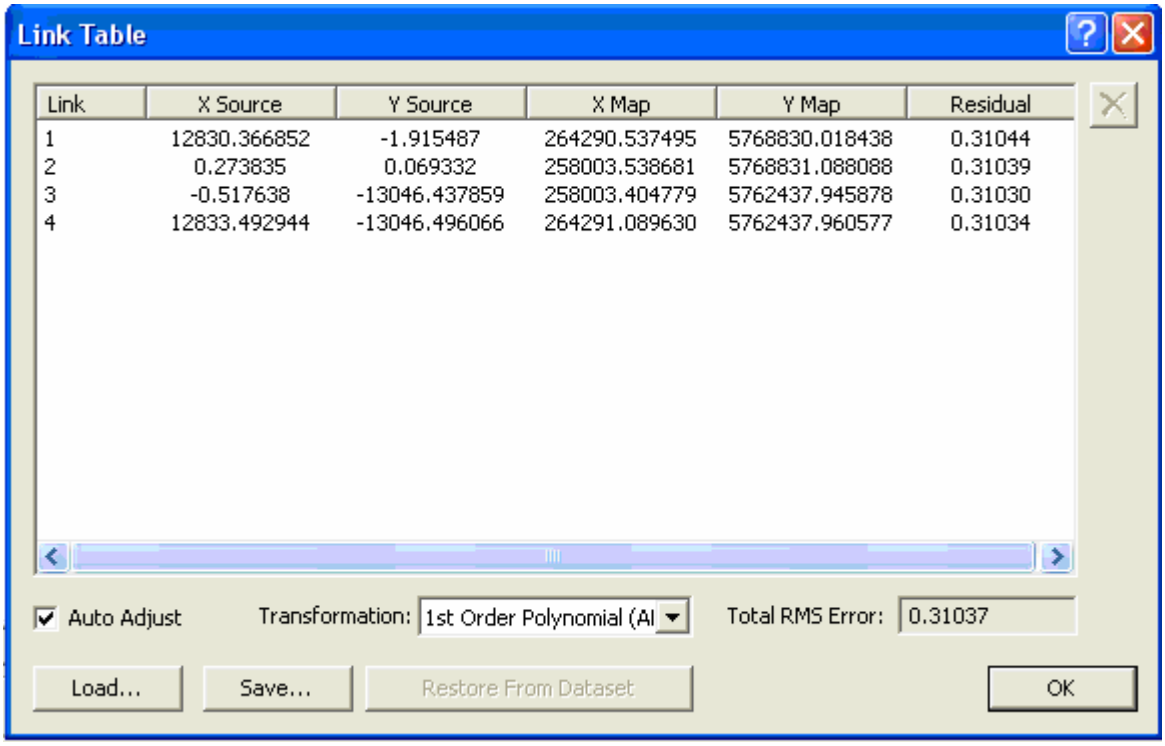

Figure 13 : Link Table from ArcView Georeference procedure

The above figure above shows 4 reference points used to georeference this particular image, taken from the corners of the insertion box supplied with the image from the photomapping consultant. This is similar to the procedure discussed and the figure above shows the results of geocoding an existing orthophoto, waun0707oc.TIF, to its projected location. No level information is required in this procedure.

The x and y source points are in this case the corners of the image and the map points are the corner of the image boxes from waurn0707boc.dwg that came with the image data. The image box supplied is on the desired datum and map projection. A small RMS error of 0.310m exists similar to the cell size in the raster. An improvement could be achieved by a more accurate selection of the source and the map points on screen or by coordinate input allowing millimetre accuracy. With this example the area is well defined and we are able to get a very good result with the minimum of reference points. Once again a determination has to be made about the required accuracy of the results and the use of this information. The results shown in the figure above are above the level of accuracy for the interactive tourist map.

The geo referenced information is then embedded in the header of the file or in a text file known as a world file. With the raster images shown the table of Aerial images of the site the BlueCircle.ers file contains the georeferenced instructions for the image.

3.4.2 : Terrestrial Audit Surveys for Temporal Mapping

The amount of useable data that exists for inclusion into the interactive map from ET's data bank is large. The audit surveys are predominantly on 2 map projections AMG66 and local grid.. 3D data will have to be created for all of the audit surveys for use within ArcScene. LISCAD will be used to export 3D Contour lines in AutoCAD format for importation into ArcGIS and modelling on the correct map projection. The final use in the interactive map for this data is in a temporal display in 3D format that will allow the user the ability to see the quarry face moving over the years.

Table 18: Audit Survey data incorporated in map

QUARRY AUDIT SURVEYS 2002 – 2007 INCORPORATED IN MAP		
DATE OF SURVEY	SURVEY DATUM	ET REFERENCE
31.10.2002	Local	62130
31.10.2003	Local	7703531-70
29.10.2004	AMG66	7704655-70
31.10.2005	AMG66	7705572-70
31.11.2006	AMG66	7706427-70
30.04.2007	AMG66	7707157-70

3.4.3 : Processing Data for 3D Visualization

The image raster and audit surveys will all be processed in ArcGIS in a similar manner. ArcGIS is used in this process to produce animations with the aid of ArcScene. All the data exists in either 2D or 3D drawing files and has been imported into ArcCatalog and utilized in ArcView and or ArcScene. Where no 3D data exists as is the case with the audit surveys from ET. AutoCAD 3D files will be exported from LISCAD. These files will contain 3D contour lines at one metre intervals and a boundary polygon of the extent of the TIN. The files will be used to create the contours to clip the new TIN's created in ArcGIS. The tables below outline the basic processing tasks and purposes associated with ArcView and ArcScene for image georeferencing, TIN creation and image draping. These tasks lead to the creation of animations and 3D surfaces for display in the interactive map.

Table 19 : ArcView Pre Processing Tasks

BASIC OUTLINE OF PROCESSING TASKS IN ArcView FOR GEOREFERENCING OF IMAGE AND TIN CREATION		
TASK	PURPOSE	DESCRIPTION
File Creation	Definition of map projection MGA94 ZONE 55	Important to establish correct projection for georeferencing
Add control data	waun0707boc.dwg added first to establish control datum	Contains the extents of Aerial photo to be inserted
Georeferencing	Aerial photo Waun0707oc.tif MGA94 ZONE 55	Use of georeferencing extension to project image. As described in chapter 3.4.1 Aerial Photography
Tin creation	Using Contour layer file extracted from Waun0707oc.dwg	Use 3D Analyst extension to create Tin. Utilise contours as hard breaklines to insure good tin formation
Insert polygon boundary to clip TIN	Use TIN boundary extent Polygon created within LISCAD and exported in AutoCAD format to be added to ArcCatalog to define projection then added to ArcView	Use 3D Analyst extension to add features to existing tin, select the relevant boundary polygon, No elevation required, use hard clip and update existing tin.
Create layer file of TIN	For use in ArcScene	

Table 20 : Basic outline of processing in ArcScene to drape aerial photograph over a TIN

BASIC OUTLINE OF PROCESSING TASKS IN ArcScene TO DRAPE AN AERIAL PHOTO OVER A TIN		
TASK	PURPOSE	DESCRIPTION
File creation	Definition of map projection	Important to establish the same projection for overlay
Add Tin layer file created in ArcView	All data sets will require this layer file for 3D visualisation In ArcScene ,set vertical exaggeration to 2, Set background colour	Creates 3D surface from relevant tin with a vertical exaggeration on the terrain of 2
Set Symbology	Use Elevation 1 for all layers	
Add Image		
Set base heights in properties of image	Obtain from height s from surface choose relevant tin	Image draped over surface 3D view of image
Add 3D text		
Create animations, save animation files and export		

For the Interactive map there is no need to produce all data sets on the same datum. The Interactive map Waun0707oc.TIF and associated files that will be processed in ArcScene will appear independent of the audit surveys and require no overlay. This will simplify data management and possible confusion about what data sets have or have not been transformed to MGA94. All audit surveys for the temporal mapping will be on AMG66 datum and this will also reduce time processing data especially when it comes to the Audit surveys with a possible of approximately10 sets of data to transform from 3 different datum's.

Table 21 : Basic outline of processing tasks in ArcScene of survey audits for temporal mapping

BASIC OUTLINE OF PROCESSING TASKS IN ArcScene OF SURVEY AUDITS FOR TEMPORAL MAPPING		
TASK	PURPOSE	DESCRIPTION
File creation	Definition of map projection	Important to establish the same projection for each audit survey for temporal display
Add Tin layer file created in ArcView	All data sets will require this layer file for 3D visualisation In ArcScene ,set vertical exaggeration to 2, Set background colour	Creates 3D surface from relevant tin with a vertical exaggeration on the terrain of 2
Set Symbology	Use Elevation 1 for all layers	Allows comparisons in level change temporal mapping
Add 3d text if required		
Create desired output format	Animation, screen view	For insertion into PowerPoint

3.4.4 Creation of Rotating Animations

The results of the above processes have been be used to develop the animations of the rotating 3D aerial photographs used in the presentation which are viewed by 'Windows Media Player. There are three animations two of which utilise Waun0707oc.tif, shown at different scales, they are quarryoverview.avi and siteoverview.avi. The process for the creation of these animations within ArcScene was as follows; a target in the centre of the proposed viewing area was created by the 'set target' function this enables the animation function to be rotated round this point at the desired elevation and aspect. This function is enabled by ticking the 'Enable Animation Rotation' box found in the 'scene properties' in the pull down menu in main tool bar under 'View'.

The file that contains the draped aerial image has been opened and the vertical exaggeration set to two to enhance the image.

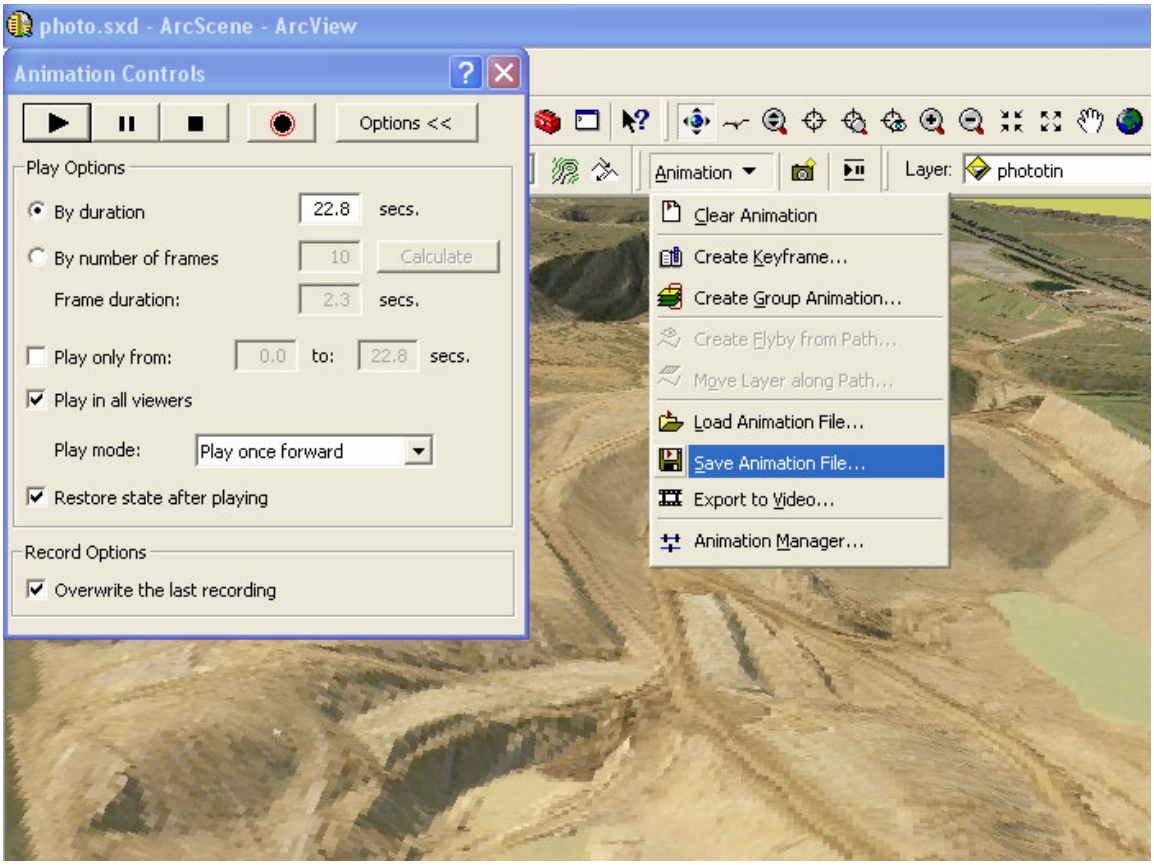

Figure 14 : View from ArcScene showing animation controls and animation pull down menu.

The 'animation control screen' needs to be displayed. To begin the display rotating around the target that was set, the mouse is depressed on the screen and dragged in the direction in which you wish to rotate the image and the speed at which you perform this determines the speed of the rotation of the display. In the animation screen the record button is clicked, shown in the above figure with the red circle around it. Once sufficient rotation has been recorded, which in this case was one complete rotation, the stop button is clicked. The animation is then saved and exported to a video file with a AVI file extension which is the capable of being played by Windows Media Player.

The third animation created by this process was geology.avi. The display utilises the three different DTM models used in the quarry which are; the natural surface, top of limestone and bottom of limestone bed all these models have been created as TIN's within ArcGIS. A separation factor of 25 metres was used between the TIN's to enable an uninterrupted view between the TIN's, with the transparency of the TIN's surface being used.

3.4.5 Creation of 3D Virtual Fly Through

The creation of the 3D virtual fly through animation involved the following processes in ArcScene. The image to be used in this animation was the Waun0707oc.tif draped over a TIN as

per the previous rotating animations. In this instance no vertical exageration was allowed to be used due to ArcScene settings. A 3D dimensional polyline was used to highlight the path of the flythrough and selected in the display for the following process to take place. The form of fly through to be created was the 'create flyby by path' as displayed in the figure below, the orientation settings menu is displayed showing an inclination in the forward view of minus2 degrees being used, setting the camera angle down 2 degrees from the horizon.

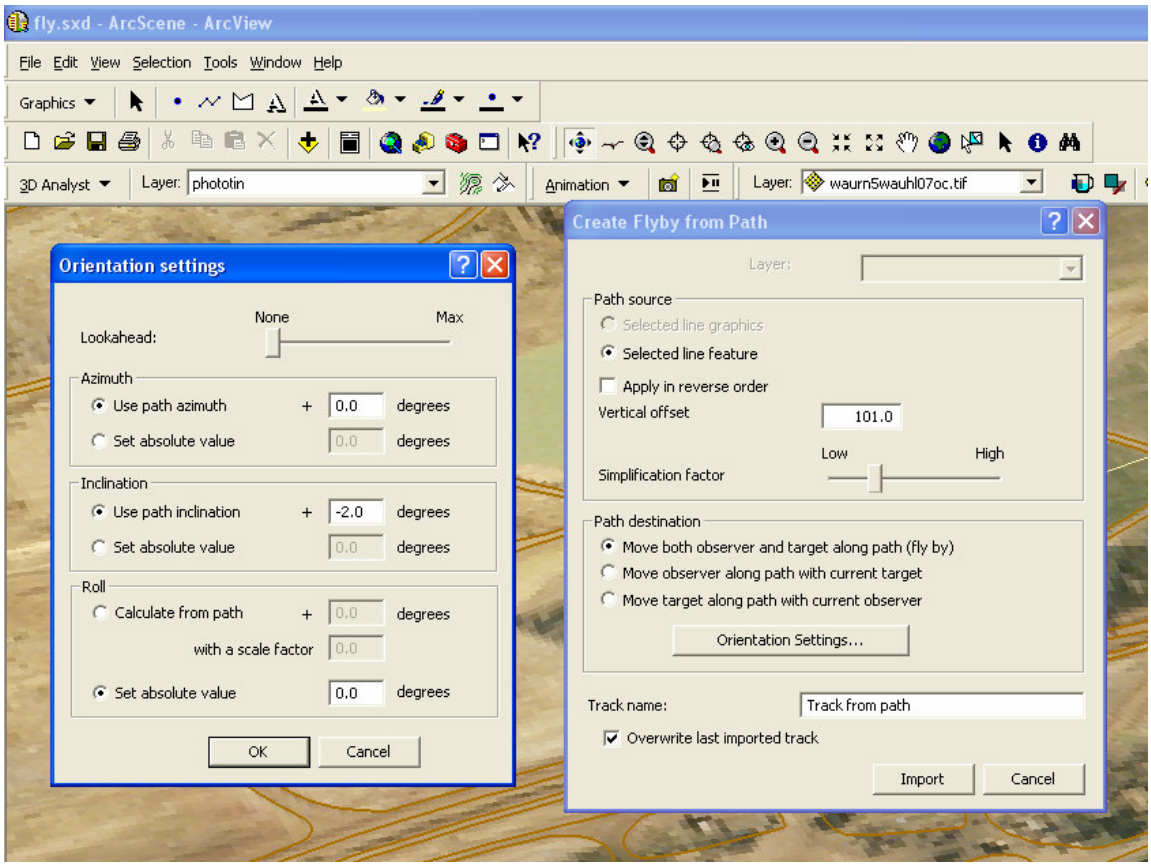

Figure 15 : View from ArcScene showing Fly through menus

In the figure above in the 'Create Flyby from Path' menu box the selected line feature has been activated a vertical offset from the line of 101 metres has been applied. Due to technical issues within ArcScene no elevations were used from the line, so and offset from zero metres had to be applied. The name of the track to be created is shown in the track name box. The import tab is clicked and the fly by has been created and now can be viewed by starting the animation. The animation is then saved and exported as with an AVI file format.

3.4.6 Multimedia Enhancement

Nero multimedia centre has been used to edit the video files recorded onsite, and animations created within ArcScene. The 'make a movie' and 'edit a movie function' within Nero will

allow the short video files created onsite to be combined, cut and edited. Text and sound will be able to be inserted providing further communication.

The figure below shows an active movie project within Nero's multimedia editing package. In the top right of the screen available media files for input into the current movie are shown. At the bottom of this screen it shows the video files that have already been added to the current movie. The black screen to the left is where the individual video files are displayed for editing as selected from the bottom of the screen. Here the video files can be cut for final video production. Once edited they are then saved and displayed once again in the bottom of the screen. The original video file can be reinserted into this area from the available media files at the top right edited to achieve a different result and saved again in the movie file being created. Here in this editing stage text and additional sound can be added. Once the editing is completed you move to the next screen for export as a single movie file. These video files will be played using windows media player

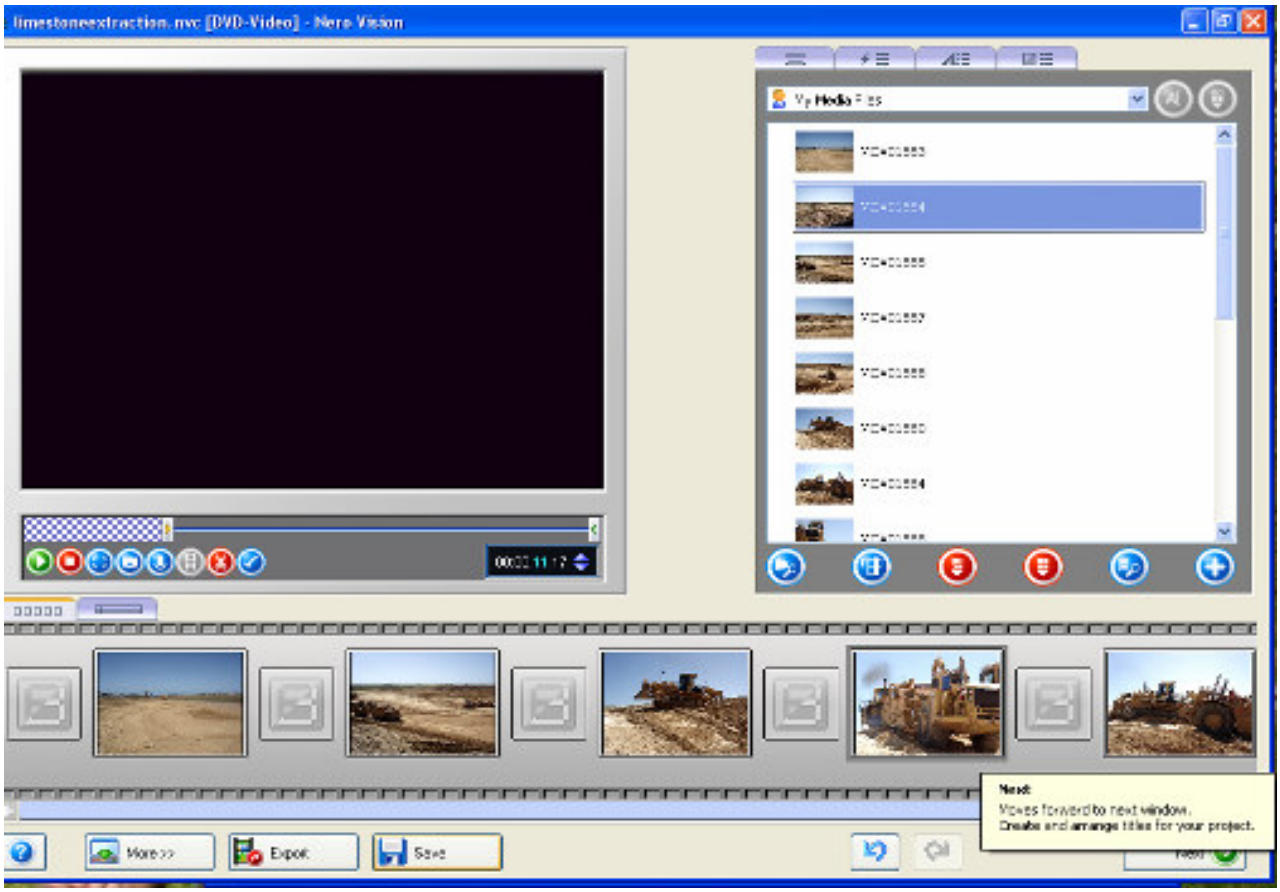

Figure 16 : Screen setup for video editing within Nero Multimedia package

3.4.7 Data Presentation In PowerPoint

The map has been presented in PowerPoint which does offer the user of the interactive map a non sequential passage through the quarry on the voyage of discovery. The basic setup of the map does revolve around the main ortho map photo (waun0707oc.tif) which has a scale in the

display of 1:15000 and does provide an overview of the Waurn Ponds site. A number of nodes appear on this screen that do direct the user to; an animation showing an image of the site rotating around a central point at a high level to gain a perspective of the whole site, an introductory sequence of slides or directly to the working quarry. In the 'working quarry map' further links to specific work areas in the working quarry or animations and a temporal map display can been activated as seen the in figure below.

Images and video files are easily attached to PowerPoint and there are a wide array of tools available for processes such as adding text, formatting colours, slide setup, transition animations and sound.

Being a presentation package the interactive map does present similar to a slide show but is well suited for a presentation to a wide group of users because of its simplicity and wide acceptance throughout the world. It can be seen from the figure below, (which is not scale correctly in this document due to the method of insertion of the figure) that tools are widely accessible. The slide transition content area on the right of the screen has many choices to suite every occasion. Further transition features are at the bottom right of the screen. These allow for the speed of transition of the slide with or without sound and the ability to control the way in which the slide transition is activated and the direction of the transition. This direction could be forward to a specific slide number, a custom slide show or another PowerPoint file, the options are prolific and limited only by the user's proficiency with the package.

Figure 17 : PowerPoint Slide no. 9 Photo Map of the Working Quarry

The cartographic concepts of map design can be implemented within this environment leading to the production of an adequate multimedia interactive map. An in depth discussion of the map and its presentation in PowerPoint will be covered in the following chapters

3.5 Summary

This chapter has introduced the Blue Circle Southern Cement Waurn Ponds site its location, some environmental and planning issues, geology, mining methods and the factory.

The second part of the chapter covers how the data was acquired and the processes that were performed to insert it into the interactive map. Aerial photo Waun0707oc.TIF has been utilized as the base photo map and waun0707.dwg has been used to create a TIN for visualization. using six audit surveys dating from 2002 to 2007 for temporal mapping. Multimedia formats are mentioned and the presentation of the map in PowerPoint is discussed.

CHAPTER 4

RESULTS

4.1 Introduction

The objective of this chapter is to present the results achieved from the processing of data as described in chapter three as part of the interactive tourist map as presented within Microsoft's PowerPoint presentation software package.

This chapter will be divided into three sections. Firstly the set up of PowerPoint to present the various forms of data that will make up the interactive map. Secondly the presentation of images and multimedia in the Interactive Map and finally the creation of a temporal map display from surfaces developed in ArcGIS.

4.2 Presentation of the interactive map

The map has been defined by the users and the proposed output format has been introduced. Data has been transformed and symbolised and placed into the map for presentation in a number of maps on different levels and then edited. The interactive map will now be presented. It has a number of different levels due to its multimedia environment which will be discussed in the following chapter.

Two different background colours have been allocated to the different sections of the map. The colours have been selected for presentation to best highlight the data and show transition from the introductory series of slide to the quarry based slides of the interactive map. The figure below shows the Title slide to the presentation and a slide associated with the quarry photo maps in a different background colour.

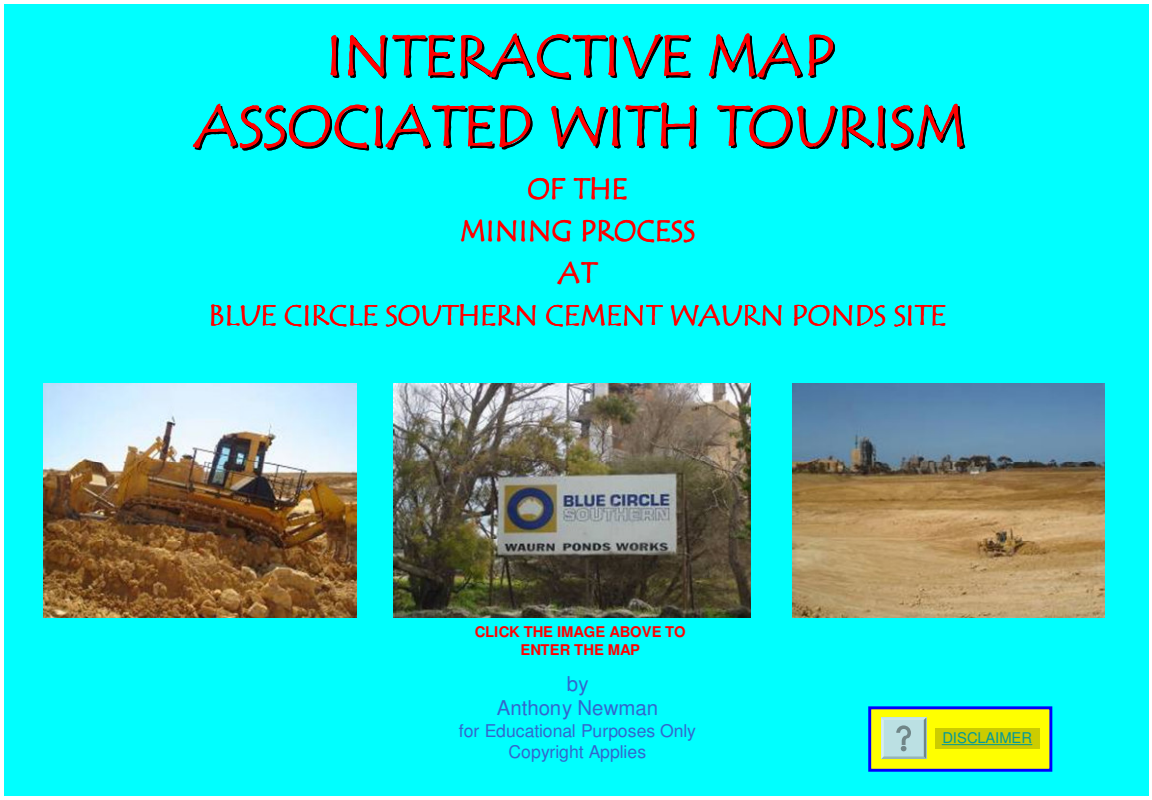

Figure 18 : PowerPoint Slide no. 1 Interactive Map Associated with Tourism

The process of the slide transition within PowerPoint has many variables associated with it but for the purpose of simplicity two transitional features have been used. The visual techniques of slide Fade and Dissolve at a fast speed have been used and as can been seen in the figure below interactive buttons allow the user to control the viewing time and direction of the slide and transition. In the case of the Temporal mapping series of slides sound has been incorporated on the slide transition.

Every slide within PowerPoint has been constructed to appear similar in its basic form; inserting the image into a similar position, the size and trying to place the north point in a consistent location. Allocating a suitable position for the scale bar when it has been utilised. Hyperlink icons vary throughout the display so specific areas have been allocated for these icons. This can be seen in figure above with only the 'Help' icon and DISCLAIMER link active. In the figure below five icons are active with the same. 'Help' icon in a similar position on both slides.

Figure 19 : PowerPoint Slide no. 9 Photo Map of Working Quarry

4.3 Images and Multimedia

The use of digital aerial images in the interactive map is the base of the tourist map. The objective was to georeference the image Waun0707oc.tif to MGA94 zone 55 map projection, utilizing a First Order Polynomial transformation with the georeferencing extension within ArcView. This was achieved with a sub metre mean root square (MRS) horizontal result.

Figure 20 : Image looking south from crusher building up to the factory

In viewing the final result the only major distortion is in the factory area where tall structures exist, the Figure above shows the tall structures in question. After georeferencing the image in ArcMap a comparison was done utilizing the georeferenced image from ArcMap and Waurn0707.dwg which contains feature line work on MGA94 zone 55 projection. This line work was taken from the aerial image by the consultants who scanned and ortho rectified the image. As it can be seen in the figure below the image and the line work show major differences.

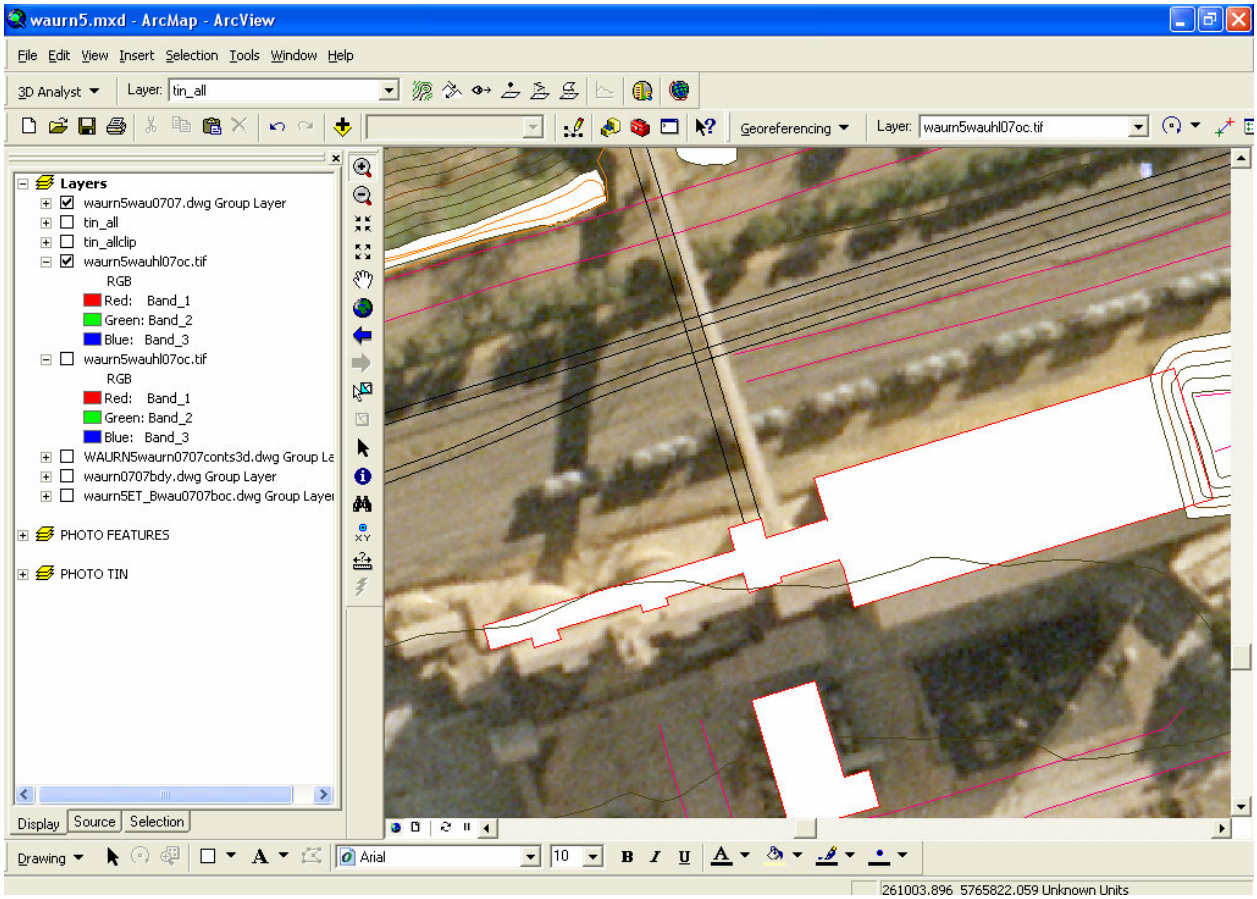

Figure 21 : Georeferenced image overlayed with feature line work in ArcView

After the processing of the aerial photo in ArcGIS the image has then been inserted into PowerPoint. No projection requirements existing within PowerPoint, the image has been inserted as a whole image and as a cropped image directly from ArcMap. The figure below is an example of the whole image 1:15,000 scale, being inserted to provide an overview of the Waurn Ponds Quarry. Figure 19 is cropped from the Waurn0707oc.tif to enhance detail at a zoomed in level 1:5000 scale.

Figure 22 : PowerPoint Slide no. 3 Photo Map of The Waurn Ponds Site

The process of orthorectification was required for the overlay of Waurn0707oc.tif onto the newly create TIN for 3D visualization with the resultant raster being very effective in communicating the rugged terrain and associated features of the Waurn Ponds site. This raster has been utilised in the production of a number of animations from ArcScene, which can be viewed on Windows Media player. Hyperlinks to these animations exist throughout the presentation with the first instance shown on the figure below, the text INTRODUCING WAURN PONDS QUARRY when clicked actives the animation siteoverview.mpg in Window Media player.

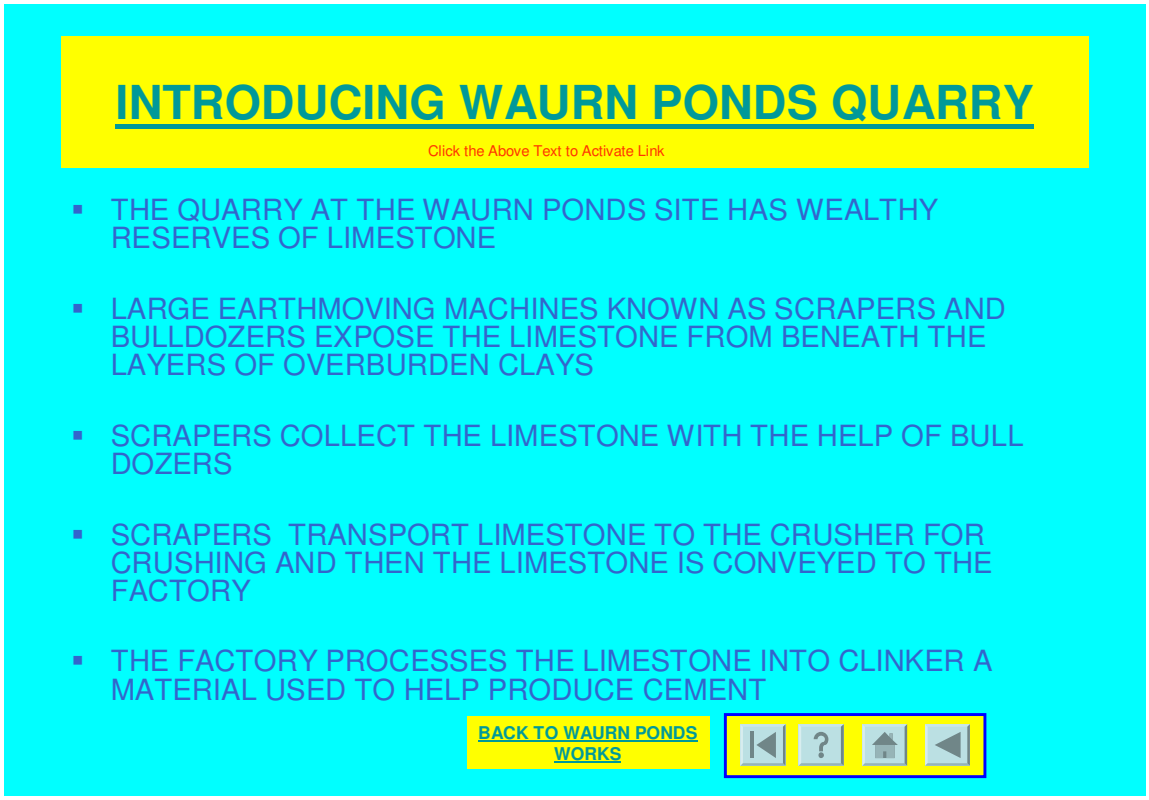

Figure 23 : PowerPoint Slide no. 8 Introducing Waurn Ponds Quarry

The animation is played as shown in figure below, 3D text has been added in ArcScene. Another two animations have been created with ArcScene. These are quarry overview.avi and flyblue.avi a 3D virtual fly through along a section of haul road.

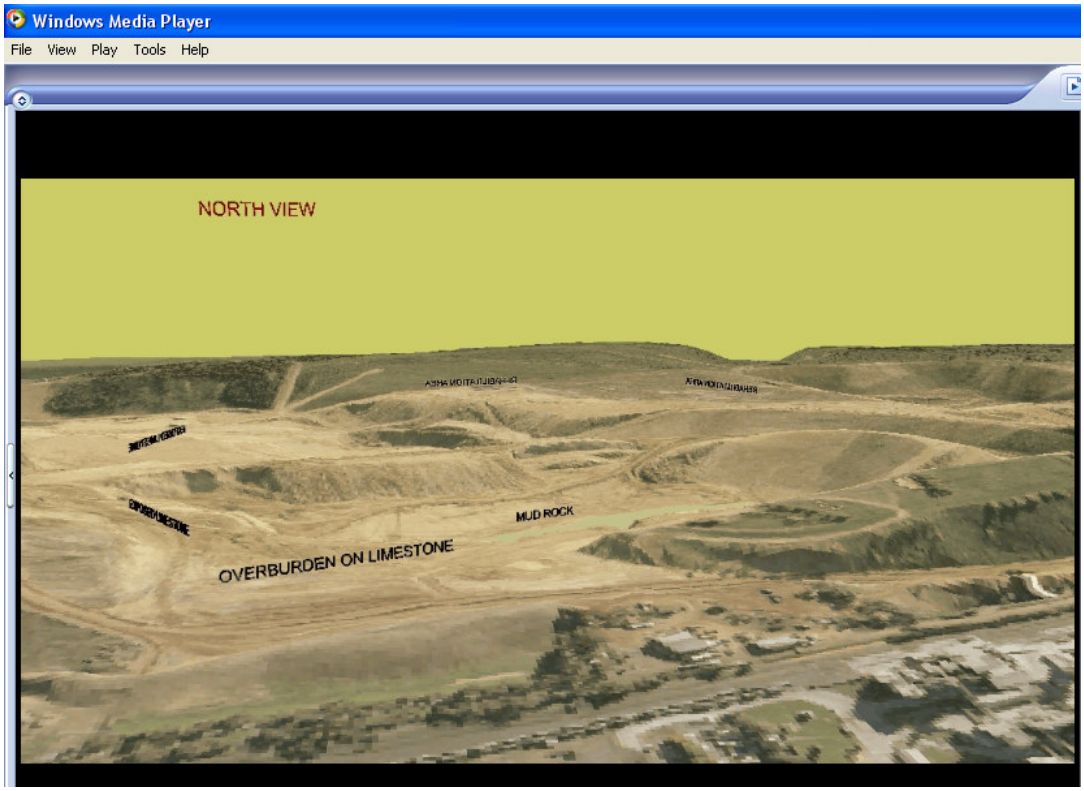

Figure 24 : View from animation quarryoverview.mpg created by ArcScene

Digital video has also been produced of major points of interest over the site and presents the user with wealth information. Photographs have been used throughout the interactive map for presentation purposes Thumbnail size photographs have been inserted on to map screens to provide icons for users to activate hyperlinks to new screens or to activate Digital video files played in Windows Media Player. Photographs are also used as displays shown in the figure below. Here thumbnails of the images with hyperlinks have been used again but when the link is activated the picture is displayed at full size.

Figure 25 : PowerPoint Slide no. 10 View of Quarry Management an Maintenance Buildings

4.4 Temporal 3D Maps

The views created within ArcScene and the 3D Analyst extension have provided a display of temporal mapping over a six year period. The TIN layers were created in ArcMap from the various TIN's from the individual audit surveys over the past six years, 2002-2007. The TIN layers created have been used in ArcScene to provide these images.

The symbology, view angle and perspective have been utilised to gain the most from the slides as they are transitioned over the six year time period and the control of the transition of the slides been provided to the user. A rapid transition through the slides gives an animation effect

An introduction was required to inform the user on what to do and what to look for in this sequence. A legend has been provided for the user to interpret the screen colours as they change as shown in the figure below.

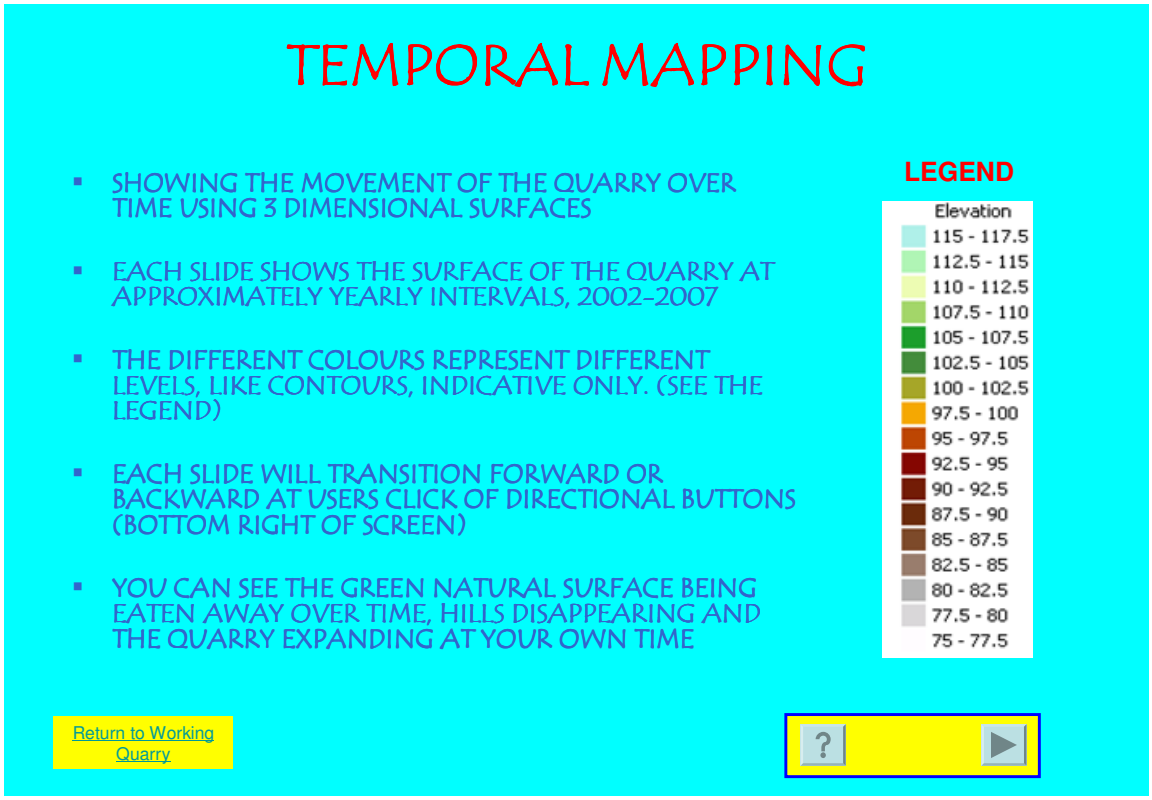

Figure 26 : PowerPoint Slide no. 18 Temporal Mapping

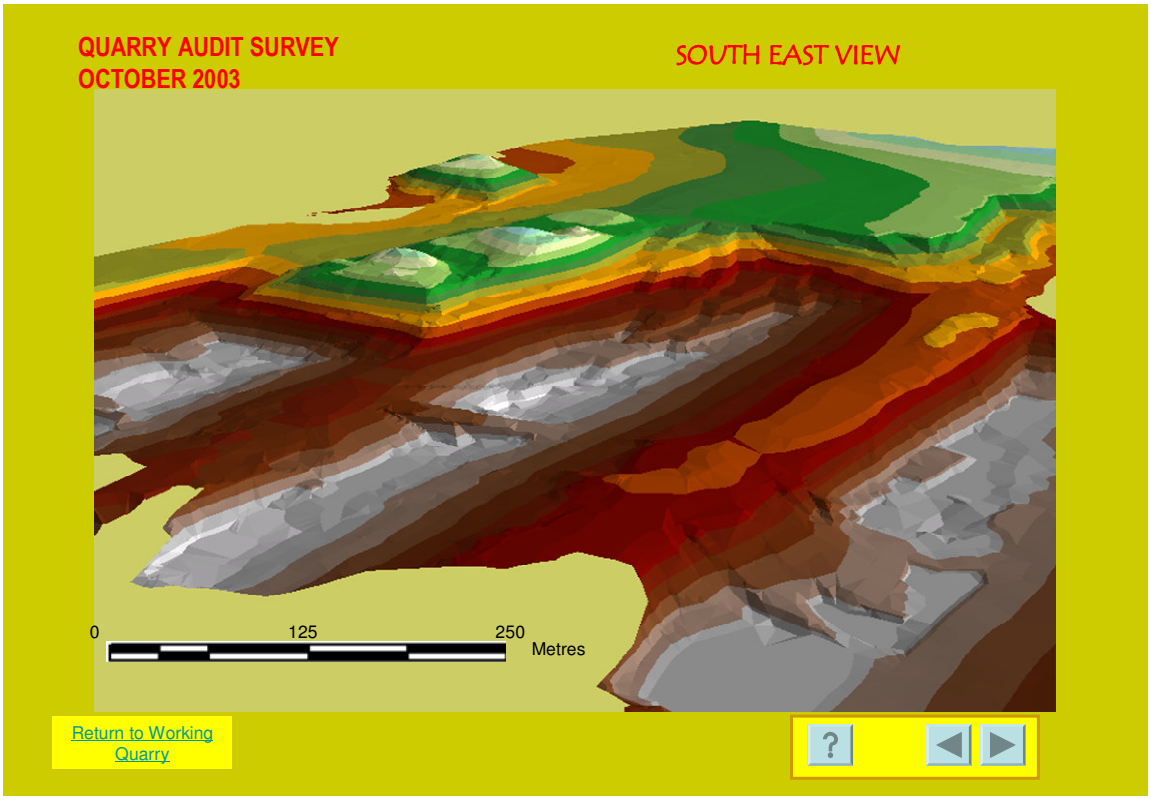

Figure 27 : PowerPoint Slide no. 20 Quarry Audit Survey October 2003

4.5 Summary

This chapter has briefly described the outputs created from the major spatial software packages. Multimedia production software has provided final digital video files culminating in the PowerPoint presentation.

It has also been mentioned that the display of maps in the computer environment presents it own challenges .The environment of the mine is harsh and dramatic in terms of topographic terrain with large mobile machinery involved in the extraction of limestone highlighting that the use of visual data needs to be effective. Further discussion of the results achieved in the interactive map will be discussed in detail in the following chapters

CHAPTER 5

DISCUSSIONS

5.1 Introduction

The aim of this chapter is to interpret and further explain the results presented in chapter 4. The suitability of the map for the intended user, the use of data and the presentation of the map in PowerPoint will be discussed in depth. Problems, discrepancies and any implications of the results will also be highlighted.

The chapter will be divided into three main sections. First the concept of the map and its design suitability for users will be explained. The second section will cover the presentation of 3D visualization data created in ArcGIS for the map. Finally, the presentation of the map in a non-sequential format in PowerPoint, the level of interactivity achieved and the comparison with other interactive maps associated with tourism are discussed. Map and text screens do overlap into other sections and this is obvious in the areas of map deign and temporal mapping. Here, for example the discussion of map design will be included in the section of temporal mapping and this will occur in a number of sections. This format will be continued throughout this chapter.

5.2 The Interpretation of the Map

In this section the explanation of the user will be highlighted to interpret the design aspects of the map. Slides have been assigned to a level of information (WE Cartwright & GJ Hunter, 1996) and interactivity to aid the interpretation of the map and each slide will be discussed individually within these levels There are five information levels within this presentation and the levels are determined by the slide content of data and their role in the non sequential staging of the interactive map associated with tourism in PowerPoint . As each slide is then discussed, common factors such as colours, text, hyperlinks, scale and images will be revisited in each discussion, this is to explain in detail the purpose of the design and presentation of each slide discussed.

5.2.1 Interpretation of Map User

The desired product was an interactive map associated with tourism and the final product has been developed to be used by a broad range of users that includes tourists with different computer skills. It has been assumed that the user will all be familiar, at a basic level, with computers and interactivity and the map developed accordingly. The desired outcome was the transfer of data to allow exploration by these groups of users to develop their mental maps to aid discovery. This was only attainable by having a good concept for the map, a well designed map with suitable techniques to capture the minds of the users. Mindful as mentioned, that the users will be of varying capabilities to access and interpret the information presented.

The map is associated with tourism and therefore the users have been defined as follows. Tourism creates the image of a business as part of the group of users we have minds associated with commerce. A tourist is associated with tourism and would be thinking about sightseeing feeding senses with food. People from all walks of life are a tourist at some time. The tourist may be from overseas, when viewing the introductory series of maps the map titled 'map of Australia' will provided a form of reference as to where Waurn Ponds is in Australia. The site that be classed as educational because of its geology and the mineral extraction processes therefore students also have been considered in the user group.

A 'help page' has been provided for users and it is accessible from every slide in the presentation. It provides a list of all the icons used throughout the presentation and a brief description of what each one performs. In addition to this added textual information to aid the user, hyperlinks on specific maps has been inserted. One example of this can been seen on photo map 'view of machines on exposed limestone bed' accessed from the 'photo map of working quarry'. Here there is a video icon action button and to make sure the video is accessed by all users the following text has been added 'Click the video icon to activate the movie to see the process in action'. In the temporal mapping display accessed from the 'photo map of working quarry' a text slide has been included to describe simply what temporal mapping involves, how the uses of colour (as defined in the legend) helps with the 3D visualization presentation, the methods of screen transition tools and some obvious changes to look for in the displays.

The other purposes of the map is the users, to gain information, and for this exchange to take place map design is a very important process and stems from who will use the map.

5.2.2 Interpretation of the Levels

The slides displayed in the presentation of the interactive map have been classified into different levels. These levels are associated by the slides purpose in the role of interactivity and information as shown below in the table,

Table 22 : Level s of interactivity and information

LEVELS OF INTERACTIVITY AND INFORMATION		
LEVEL	INTERACTIVITY	INFORMATION
One	Entry into map	Title
Two	Choice of path Ability to move further into the map	Level 3 map of greater detail Level four in controlled sequence with choices of direction but will return to level two if all slides viewed
Three	Choice of path Ability to move further into the map	To level four at the users choice User is linked back to level two only
Four	Choice of path	To level five User is linked back to level three only
Five	Detailed data	accessed via hyperlinks Ability to return to previous slide

Table 23 : Interactive Map PowerPoint slide listing

Interactive Map PowerPoint Slide Listing			
Level	**Slide Number**		**Description**
1	1	Introduction	Entry to the Map
4	2	Help Page	Assistance
2	3	Welcome to BCSC	Photo Map of Waurn Ponds BCSC Works Site 1:15,000
5	4	Map of Australia	Locality Map
5	5	Locality Map	Locality Map
5	6	Regional Map	Locality Map
5	7	BCSC Facts	Fact Sheet
5	8	Introducing Warn Ponds Quarry	Introductory text slide
3	9	Photo Map of Working Quarry	Photo Map 1:5000 scale
4	10	The Workshop	View of Quarry Management an Maintenance Buildings
4	11	The Reclamation Process	View of Overburden Dumping Site
4	12	Limestone Extraction	View of Machines on Expose Limestone Bed
4	13	Transportation of Limestone to crusher	View of Scraper on Haul Road
4	14	Overburden Cross Section	View of the Overburden and Limestone Bed
4	15	The Crushing Facility	View of the Crusher Building
4	16	From the Quarry to the Crusher Along the Haul Road	View of the Virtual Flight Path in the Working Quarry
4	17	Stages in Open Cut Mining of Limestone	Stages in Mining on text slide
5	18	Temporal Mapping	Introductory text slide
5	19	Quarry Audit Survey October 2002	3d Surface
5	20	Quarry Audit Survey October 2003	3d Surface
5	21	Quarry Audit Survey October 2004	3d Surface
5	22	Quarry Audit Survey October 2005	3d Surface
5	23	Quarry Audit Survey October 2006	3d Surface
5	24	Quarry Audit Survey April 2007	3d Surface
5	25	The End	End Slide

5.2.3 Interpretation of Level One

Level one is the title page (screen one of the PowerPoint presentation), titled 'Interactive Map Associated with Tourism' which is shown below.

Figure 28 : PowerPoint Slide no. 1 Interactive map associated with tourism

It is here that with the use of text and images the user first gets a glimpse of what the map represents. At this point a sense of anticipation must be engaged by the cartographer from the user and this is achieved by this slide. The background colour selected for this slide and for the set of slides associated with the process known in this map as the 'introduction' is cyan. The concept of the 'introduction' set of slides will be discussed later in this section. The background colour is vibrant and has links to the name of the company which operates the quarry. A subtle use of visualisation that draws recognition to the map and what it is presenting by the use of the word 'Blue' in the sign in the centre image. The cyan background also highlights the text used in the display with the red text used being vibrant and focussing ones attention. The text has also been formatted with a shadow to highlight and show creativity. It would also be possible to accentuate further the background and text colours by choosing a complex text font for example, but this would distract from the information on display and hinder exploration and discovery. The use of a larger font size, (size 40, 20, 14 an 10 have been used on this slide) is also important to establish the different levels of text and identify their importance in conveying information in a limited space.

Also this slide provides notification to the user regarding the limits for which the map can be used i.e. 'for educational purposes only' implying that it is not for commercial use or distribution. Further the information contained within is subject to the author's copyright. A disclaimer contained in a PDF document is linked to the file by activating the hyperlink when the text DISCLAIMER is clicked. The size of the text used here is small showing the low importance of the information in the presentation of the quarry. This information needs to be included to nullify any claims of negligence due to persons or organisations using this map for purposes that it is not intended for. Here the type of font used is changed as the result of the change in font size. This reduction in size made it difficult to read the Tempus San ITC style of font.. The font is now shown is Arial with a size of 14

The images that have been selected represent major icons of the site. The bull dozer on the left of the slide is perched in a rough limestone terrain and is an impressive sight in the quarry with all its power represented in its large size and by the amount of noise it generates. This noise can be heard in the digital video recorded on site and this will be discussed in later sections of this chapter. The vista across the quarry with a machine working and the factory in the background conveys an image of distance and size in both the terrain and structures on site. The image in the centre of the side describes who controls the site and where it is by the use of the sign in image It is used here as the entrance into the map and to the next level, level 2 via a hyperlink. When the mouse is held over the image a hand appears indicating that there is an active link associated with the image to access slide number three.

5.2.4 Interpretation of Level Two

Level two information incorporates the use of interactivity that gives the user the option to head in two or more directions, a non lineal progression through the presentation. Slide three of the PowerPoint presentation with the text 'Welcome to blue circle southern cement (BCSC)' at the top middle of the slide utilises aerial photography as the base of the displays.

The figure shown below is the 'Photo Map of Waurn Ponds BCSC Works Site', as shown in the title bar of the slide.

Figure 29 : PowerPoint Slide no. 3 Photo Map of Waurn Ponds BCSC Works

The map has been designed along the traditional cartographic elements and these include Title area. Although, on this slide there are two sets of text that appear to present a title, the text 'Welcome to blue circle southern cement (BCSC)' has been incorporated into the map to aid the description and purpose of this map in order to introduce the Waurn Ponds site as opposed to just the Working Quarry. The text font used at this point is the Tempus Sans ITC, size 24 to add interest and creativity to this map. The text used for the title is arial narrow size 16 and this will be the format for all future photo maps. This font takes less room because of it narrow attribute and space in this area is limited. Further cartographic elements include a north point, a scale bar an a absolute scale description, ground and border areas. A neat line was not added to the maps due to presentation limitations of PowerPoint in that the line thickness appears to be thicker on the vertical lines than the horizontal lines. This line would have been useful to cover edges that seem to be appearing around the inserted images and this may have contributed to the line thickness difficulties as just mentioned. The area outside the image known as the border has been used to place Graphical user interfaces (GUI) and hyperlinks at various levels throughout the presentation. This area has been developed along marginalia concepts to house these functional objects and develop a visual appeal about the displays It utilises the yellow background in which links and icons are placed.

From this map we have a link to the 'Working Quarry' the third level of information on the left of the map and a link to fourth level information know as the 'introduction loop' on the right. The 'introduction loop' is a route that can be chosen by the user to gain valuable background into the site as a whole. If the user decides that he or she would like to progress straight to the 'Working Quarry' a link is provided here on the left as mentioned.

The placement of these two links on the map, of these two links described has been done on purpose but is not the preferred option. The link to the 'Working Quarry' site is located in close proximity to where it is displayed an the photo map with logic suggesting to locate it in this position. It would have been preferable but not essential to have the link to the 'introduction' in this position as the map would be read from the right to left and this would encourage people to enter the 'introduction loop' before the 'Working Quarry'. It would have also been possible to place these hyperlinks on the image but these would detract from the visualisation that is provided by the image and it would also have been possible to use arrows to indicate the point of interest but again at this scale it would detract from the image. It would aid the organisation of this map if it was possible to insert a hot spot icon that did not detract from the visual display of the image. The hyperlinks and map elements on the slide have been placed to enhance and not detract form the presentation of the map and therefore a balanced perspective has been maintained.

The use of colour has been similar as per our discussion of the previous slide. The main difference here is the use of a yellow background behind the text associated with the hyperlinks, this is to highlight these links and will now occur in this fashion throughout the remainder of the presentation. A further point of explanation is the use of kilometres on the scale bar. Kilometres instead of metres were used to highlight again a sense of distance and the greater expanse which is displayed on this 1:15,000 photo map of the 'Works Site'.

5.2.5 Interpretation of Level Three

The figure below titled 'photo map of the working quarry' is an enlargement of the previous photo map shown above. The scale is 1 : 5,000 and this photo map is used to highlight the areas of interest in the 'Working Quarry' and it is reached by using the hyperlink on the left hand side of the above figure, titled 'Photo Map of Waurn Ponds BCSC Works Site'. It has been classed as level three information. It shows a greater amount of detail due to the smaller scale, this has enabled different aspects of the image to be used. Machines are visible on the exposed limestone bed, haul roads and good visual display of other work areas at this 'zoomed in' display. This will lead us to the next level being level four utilizing the icons around the photo map .

Figure 30 : PowerPoint Slide no. 9 Photo Map of Working Quarry

The most notable change here is the background colour and this is maintained throughout all the remaining maps and displays associated with the slides using images as photo maps in the 'Working Quarry'. It blends well with the aerial image when viewed on the computer screen which now displays the quarry area with exposed limestone and overburden and allows clear definition of the icons, text and photos placed on it.

The map elements continued to be displayed here. The scale is now portrayed in meters as distinct from kilometres to highlight that when compared to the above figure at 1:15,000 scale we have moved in closer to the quarry and we are seeking to extract more detail from the image. Hence the movement from level three to level four information within the map.

Arrows have now reluctantly been added to the map, to focus the users attention directly to these specific areas. With the previous photo map being an overview scaled at 1:15,000 it was obvious where the points of interest were on the photo displayed. On this photo, at 1:5000, the sites of interest need to be pointed out to the user . The thumbnail images relate to these areas and when these hyperlinks are activated a slide transition will take the display to a 'zoomed in' view of these areas. The colour white used for the arrows is the least obtrusive but most effective colour against the background of the photo map when viewed on the computer screen. The use of the arrows has been effective here because the areas of interest are located next to the perimeter of the photo map. The hyperlinks in the text boxes highlighted by the yellow background relate to other concepts and results of the mining process and not to tasks involved in the mineral extraction processes of the 'Working Quarry'. The thumbnails and text boxes have been place in strategic locations to aid the balance of the photo map.

Hypertext is used in a number of icons around the map. Colour has been used to highlight them and for creativity and in the cases of 'Working Quarry' and 'Geology Layers' they have been linked directly to level 5 data without the use of an introductory screen. It was decided that the information presented could eliminate that additional slide without detriment to the exchange of information. All these hypertext links will be discussed in detail in this section of this chapter.

A numbering system associated with each hyperlink identifying which link to activate first would present the extraction process in a structure manner . The extraction process has been identified with its own hyperlink on the top left of the figure above titled 'photo map of the working quarry'. This is a very prominent position and it would be of interest to record how many users viewed this link first to understand the mining process. It is not necessary for the link 'Stages in Mining' to be viewed first because the process has be mentioned in the 'introductory loop' in the slide titled 'introducing Waurn Ponds quarry'. It was also considered non productive to add text descriptions to the thumbnail images around the photo to aid in determining what the image was related to. For the text to be effective it would have to large enough to read in and area that would easily become congested. This may become a distraction instead of creating mental images and associations.

5.2.6 Interpretation of Level Four

Level four information represents information that has been accessed from either level two or three and it offers more detail information about the levels above but offers no way forward. It is becoming apparent the slide set up shows a standard style or template appearance. Level five information can be activated from the hyperlinks from the relevant photo maps display at this level. In the above figure of the photo map, the bull dozer icon is clicked we are transferred to a 'zoomed in' view of the same photo map image as shown above and the display scale at this level is now 1 : 1000. At this scale machines are quite distinguishable and the display is effective as can be seen in the figure below titled 'view of machines on exposed limestone bed'.

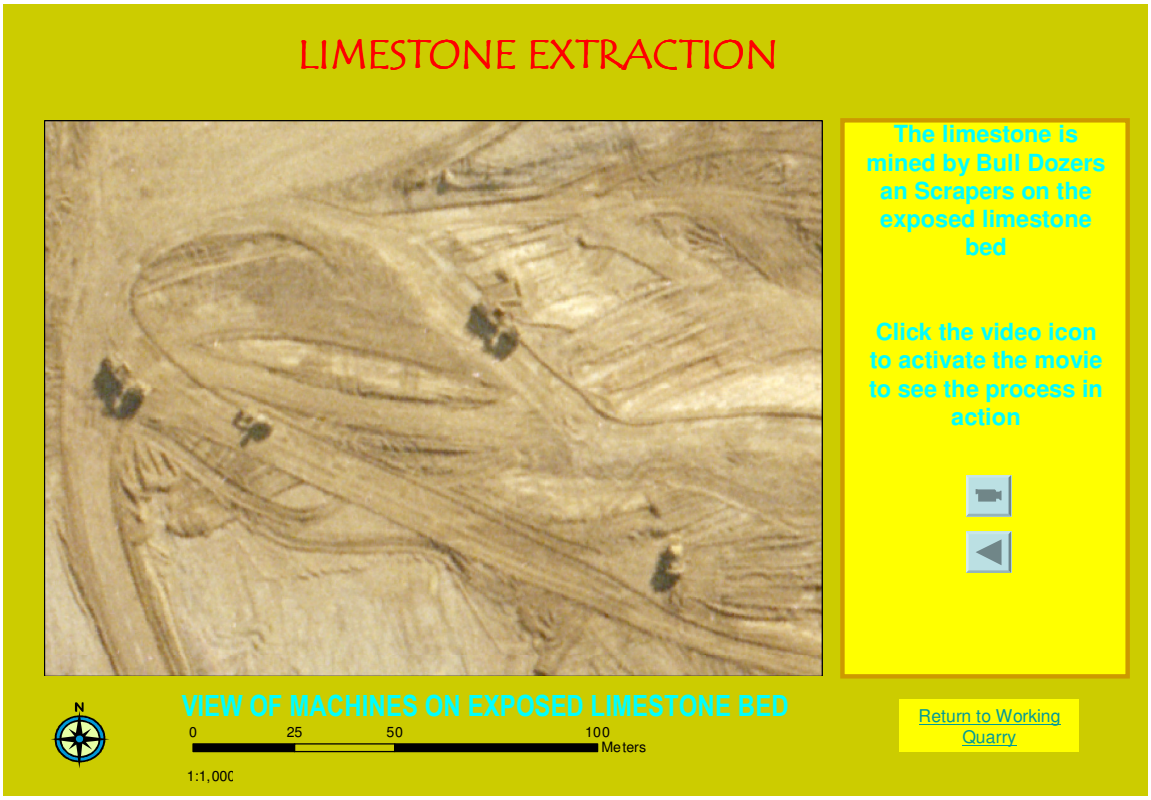

Figure 31 : PowerPoint Slide no. 12 View of Machines on Exposed Limestone Bed

As seen above the position of the photo map on the slide has been offset from the centre to allow for a text box to be inserted on the right of the image (utilising marginalia). This text box is to explain the process that takes place in the area being viewed and inform the user of what active item there is here and how to activate it. Additional text has been added to the top of the slide to highlight the process taking place here. To aid this the text is bold red with a text size of 28 in the font Tempus Sans ITC compared to 16 for the other text using the Arial font. The text has been formatted to allow creativity and will provide a static environment for the effective transfer of the relevant information. The map elements have been added to create the map structure. This photo map, as with the similar maps on this level, is an effective use of the data

supplied. If the level of enlargement was increased a noticeable change in the quality of the image would occur. The image starts to blur and the pixels become obvious.

An additional icon appears in the marginalia with the video icon. This is the go back icon which will, in this case, take the user back to the previous slide viewed. These :1000 scale level 4 slides can be accessed from two links on the 'Working Quarry' photo map The first being the thumbnail image that is directly related to the working site and available directly from the photo map, with the link back to this being the hyperlink RETURN TO WORKING QUARRY or the go back icon below the video icon. The second link is from STAGES IN MINING hyperlink directing the user to the figure shown below.

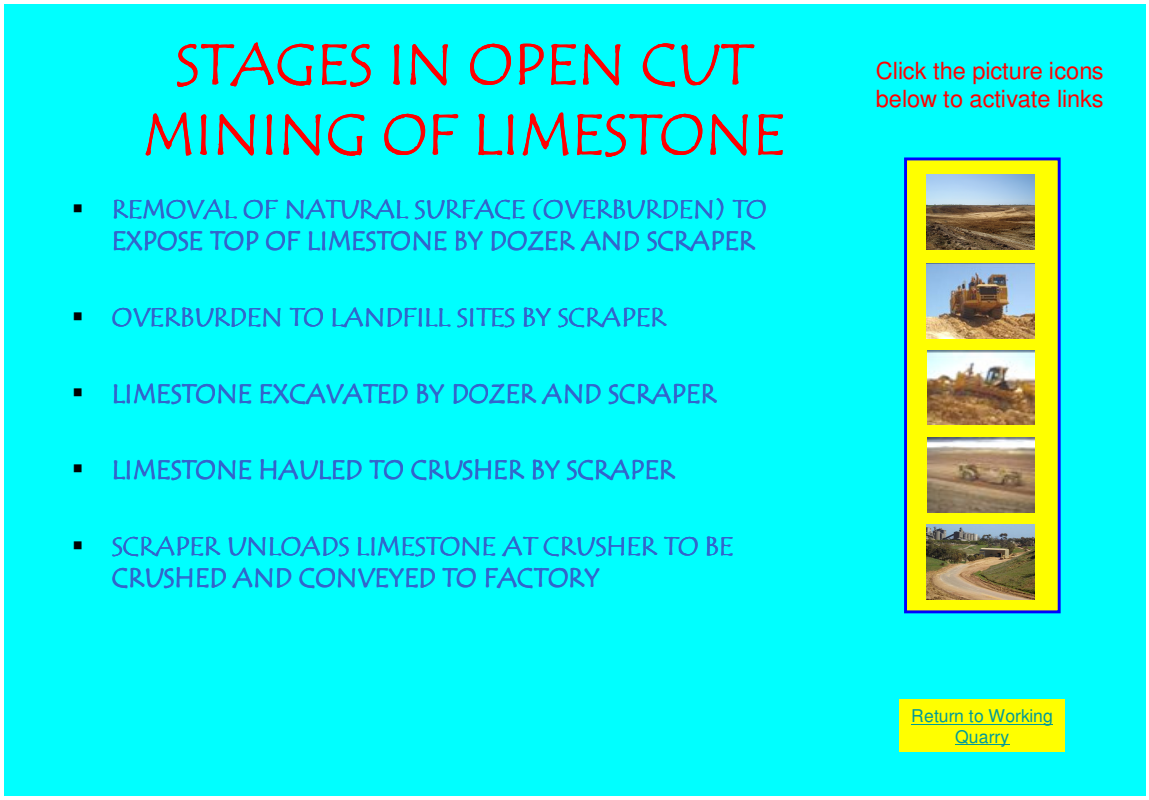

Figure 32 : PowerPoint Slide no. 17 Steps in Open Cut Mining of Limestone

From this slide the user can activate links by clicking one of the thumbnail images on the right of the slide. These images are the same images that appear on the 'Working Quarry ' photo map and the links are to the same location as in the 1 : 1000 scaled enlargement of the 'Working Quarry ' photo map. I t has been designed so that when you activate the go back icon under the video icon you will return to the last viewed slide. This is important because you will return to the figure shown above and not the 'Working Quarry ' photo map This enables the user to continue exploring the figure shown above. The hyperlink RETURN TO WORKING QUARRY allows the user to return to the 'Working Quarry ' photo map when accessed from the figure above.

The following maps are similar to the photo map shown as PowerPoint slide no. 12 and need not be discussed, they include 'view of overburden dumping site' and 'view of scraper on haul road'. The figure below shows the photo map titled 'view of quarry management an maintenance buildings' thumbnail images have been used as hyperlinks that activate a picture viewer to show enlargements of these photos. All the map elements and background colours remain constant in these slides.

Figure 33 : PowerPoint Slide no. 10 View of Quarry Management an Maintenance Buildings

In the figure below a photograph has been inserted into the slide with text used to convey the meaning of the photograph .This photograph provides a good cross section view of the overburden bed sitting on the limestone bed. There was a video mpg file of the scraper and bulldozer working on the overburden but this was very similar to the previous video display for the extraction of limestone and it would prove to be repetitive. The photo was utilized because it displays the concept of the overburden layer sitting on the limestone bed.

Figure 34 : PowerPoint Slide no. 14 View of the overburden and limestone beds

PowerPoint slide no. 13 is a similar form of slide display showing the crusher building from a good angle high above the haul road. With this image there is a hypermedia link to display a video file of how the scrapers enter the drive through into the building. Once in position the floor beneath the scraper retracts to expose the a hopper bin from which a conveyor runs to the crushing equipment, beneath the scraper. The scraper releases the limestone it has in its storage compartment onto the conveyor and once empty after the limestone has been dumped the scraper moves out of the building and back to the 'Working Quarry'.

The use of the still images in this fashion is effective as they display a large amount of information, i.e. the view of the Crusher Building (not shown here) and this initiates many questions by the user. The main concern about the use of still images is the amount of carefully selected text and the phrasing of this text that will need to be included with the image to adequately describe it in a confined space similar to what is shown on the slide below. The slide shown below from PowerPoint would not allow Tabs to be inserted to highlight the points being made and to present order in the text box. No north point or scale has been shown in both of the slide images discussed.

PowerPoint slide no. 13 'From the Quarry to the Crusher Along the Haul Road' is scaled photo map at 1:5000 and is similar to slide no. 9 'Photo Map of the Working Quarry' is at the same scale. The template set up for the map is the same as that of the similar level four maps at 1 : 1000 scale. This photo map has been produced to highlight to the user the path of the 3D virtual fly through that follows the route taken by the scrapers from the quarry to the Crusher and terminates on a high point past the crusher building.

The maps involved with the 'Introduction loop' (as mentioned at the beginning of 5.2.4) will now be discussed here. The first map in this series is the 'Map of Australia'. The text in the title is of font Tempus Sans ITC size 32 and red in colour to highlight the map. It is a simple map of Australia to inform any uses that the Quarry is located in Australia near Melbourne. Some overseas tourist may need the location confirmed.

The text 'Melbourne' appears in red and is size 18, the only other piece of text not mentioned is 'Australia' placed in the centre of the continent it is green in colour and of size 16. The purpose of the text format here is to highlight 'Melbourne' as the place of interest. Here minimal text has been used to aid the transition time of this series. The colour of the land mass of Australia is fawn and as we transition through the slides in the 'Introduction loop'. The colour of the land mass will move to light green then to green to accentuate the change of the areas being viewed and trend from the stark colour of the full extent of the 'Map of Australia' towards the deep rich colours associated with the mine site and in this case the interactive maps 'home'.

The set of three map slides in this series will start the full extent view of Australia zoom into the map of part of Victoria. Map number two in this series has the title of 'Regional Locality Map' in font Tempus Sans ITC size 32 shown in red. The text of Melbourne is now green with a font size of 16 with text for the city of Geelong now appearing with the characteristics that the text Melbourne had in the previous map i.e. red and font size 18 the descriptive text on this map in font Arial size 18 and black in colour. I have found the font Tempus Sans ITC confusing to read when you wish to convey the message simply and clearly and when other traditional font styles are used in the same display. This is highlighted in slides numbered 6 and 8 where again l have chosen to use the Arial font.

The next map as shown below has the title of 'Locality Map' (slide 6), font Tempus Sans ITC size 32 shown in red has been used. The transition of place name text has continued with Waurn Ponds now appearing on the map with a font colour of red and size of 18. The two Locality maps have had descriptive text place on the slide over the land map area as previously discussed and the map element shown on these maps is a north point. These maps have been used as sketches to allow a rapid and simple interpretation of the site's location by the user. The background colour for these maps has been cyan to associate them with the Waurn Ponds Site overall view of the project.

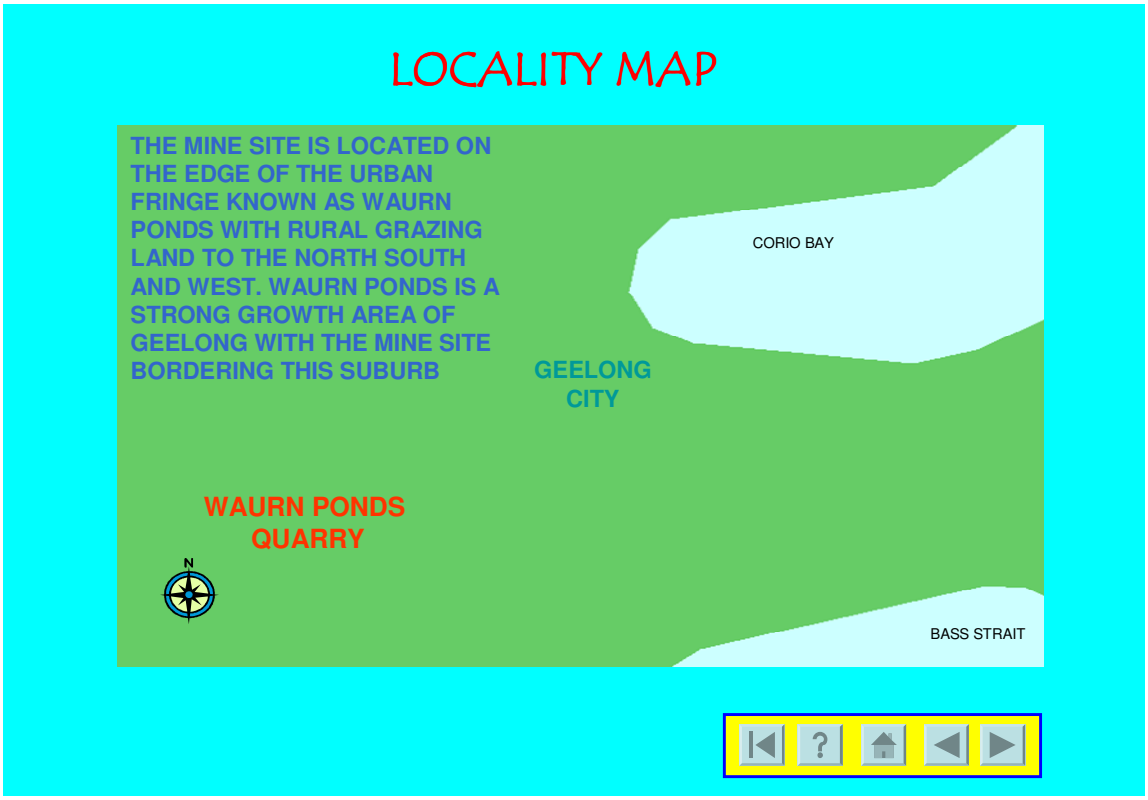

Figure 35 : view of PowerPoint slide no. 6 Locality Map

Slide 7 is a short Facts sheet for the Quarry. It uses font Tempus Sans ITC size 32 shown in red in the title and the same font in navy blue size 18 to present the bulleted facts. From the last slide the user is forced; to return to the 'HOME' slide known as 'photo map of Waurn ponds BCSC works site' or to go to the slide no. 1, or to return back one slide. The RETURN TO WAURN PONDS WORK is available here to transition with. Even though the home icon is linked to the same slide this reassures users of where to go. Slide 8 the last in this 'Introductory Loop' has reverted back to the Arial font. This is because the text at the top of the slide used as the title is a hypertext to a digital video file displayed in the Arial font size 32 with the bulleted descriptive text Arial 24 being navy blue.

5.2.7 Interpretation of Level Five

Level 5 is the detailed data involved in presenting the facts with no hyperspace links forward. All the discovery will take place here for one example the animation video files. Once this data has been viewed the user will return to the slide from where the link was activate. This level is the storage bank for the map.

The majority of data in this level will be discussed in the following sections of this chapter.

5.3 Interpretation of 3D Visualization Created for the Map

The amount of good data available for use on this project has been of great help in the final presentation of the data. There are sources of data that do go untouched and would be invaluable additions to this project. The data processed for this project has allowed for the development of 3 dimensional surfaces with aerial photographs draped over these surfaces and animation created in ArcScene and for the use of similar surfaces for temporal mapping. Video Images collected onsite have allowed for the editing of short digital videos which have proved to be a good source of information on the mining extraction processes.

5.3.1 Interpretation of Animated Rotation 3D Maps

There have been four animations created for inclusion into the interactive tourist map. The first animation to mention is siteoverviewtxt2.mpg which runs for 59 seconds. This animation is activated via an action setting located in slide 8 via a hypertext link at the top of the slide 'INTRODUCING WAURN PONDS QUARRY', text has been used to inform the user to activate the link. It uses the aerial photo that has been used throughout the presentation, in this animation, which rotates around the centre of the image, the image has been draped over the TIN surface in ArcScene and utilised the heights in the TIN to create a 3D image of the aerial photo.

This is a impressive form of 3D visualisation well suited to the terrain of the mine site because of the dramatic changes in terrain. To add to the effect the surface has had a vertical exaggeration of 2 applied to it. Black 3D text was added in ArcScene, describing the past, present and future mine locations over the site. Black colour was used for the text because it was visible on the landscape but it did not jump out as a brilliant colour does. when viewed from behind and the illumination used had no effect on the black text especially since the scene rotated creating shade movements. This text has been place over the site and orientated in different directions to enable viewing from a number of angles and from different distances the height of the text has been adjusted accordingly. The terrain of the mine has been used to hide the text from different viewing angles, once described as a problem of 3D visualisation on computer screens of the terrain blocking the users view it has now been used to hide text when not in use. A problem with the 3D text is it can be viewed from behind but it is illegible and a distraction. The word 'NORTH' was added above the horizon and placed far enough away so that as it rotated in the animation it moved behind the camera out of view on the way around and becomes visible when the animation looks to the north.

This animation was created to give the user an idea of the extent of the site and highlight the mine locations. The AVI animation file that was create by ArcScene was imported into Nero movie editing software for further text to be added to aid the visual explanation of the animation, it was saved here in a MPG format. The text was added in yellow and starts at the beginning of the animation and runs for 14 seconds. This text lays in a flat perspective as it scrolls across the screen, and it is know as 'floor text'. The benefit of this text is that it lays low and does not affect the view of the user, although having text scroll across the screen is distracting, this style of text is used in other animations and digital video. A voice over would have a more effective form of multimedia to use instead of the text in all instances of these animations.

Quarry overview.mpg was created by the same process as stated above. The same aerial image was used with a 'zoomed in' view to focus on the 'Working Quarry' site with the centroid point for the rotation being the centre of the 'Working Quarry'. The animation was used to highlight

the different areas of work in the quarry. Black 3D text has been added to describe such area as 'Mudrock' being the bottom of the limestone bed, exposed limestone and overburden are all terms that are used in the quarry. The yellow floor text, 'view of working quarry within the mine site' was added in Nero and this text sequence scrolls across the screen in 8 seconds, commencing just after the start of the animation, which runs for 1 minute and 12 seconds approximately the time it takes for the image to do a complete 360 degree rotation. The speed of the rotation is determined manually when the animation is created, and it has taken a number of attempts to achieve the desired speed in the rotation. This speed of the rotation does determine the amount of time users get to view the terrain and text.

The next animation is that of the three DTM models that are used to calculate volumetric figures. This is shown as 'Geology Layers' in the 'photomap of the working quarry' slide number 9 in the hypertext link 'Geology Layers'. The media player is activate and the animation geologytxt.mpg plays. Once again descriptive text has been added in Nero, and this text is floor text to aid with the view of the lower model. This runs for 16 seconds and the animation for 1 minute and 3 seconds. The animation is allowed to rotate for approximately 250 degrees. The text added from Nero start at the beginning and by the time it finishes the 3D text becomes legible (from ArcScene) so the user is not trying to read two sources of text at once.

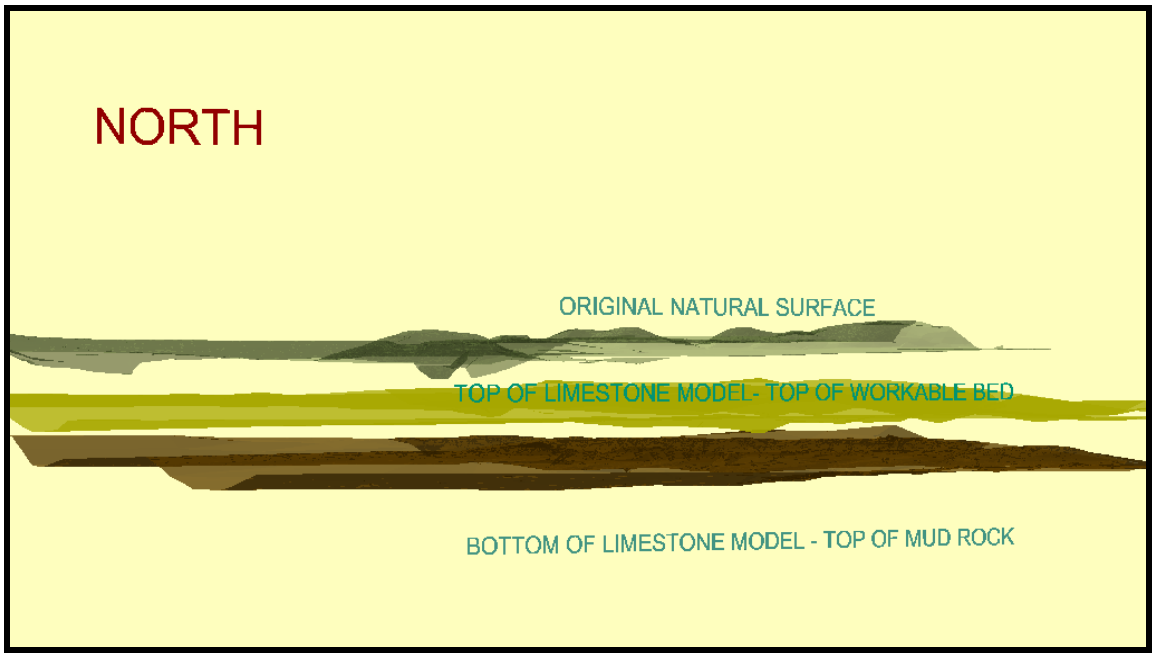

Figure 36 : View from geologytxt.mpg

The figure above highlights the used of a light background, so the space can be seen through the different models. The layers have been colour coordinated to give the best results with the illumination used, with so many variable with lighting in this animation due to the rotation and the shade cast by the layers sitting over each other. A transparency level has been added to each of the layers to aid visualisation, it becomes possible to see through the different layers. a separation factor has also been used to highlight the concept of the different models overlaying each other and the purpose of open cut mining. These views have been enhance in a most of the

animations to impress upon the user about the concepts being displayed, this data is not intended for any design or concept planning which may rely on accurate presented information.

5.3.2 Interpretation of Virtual 3D Fly Through

A useful tool to have for 3D visualisation. In the production of this animation l found that it did not function well a from a high elevation when trying to gain an overall impression of the site, the sitet was to small and when you flew low over a large area you became disorientated. So the image of creating the view of what the scraper driver sees as he heads from the quarry to the crusher building through the cuttings was desirable. A main concern here was the terrain as shown by the 3D image and the cells becoming visible on a close fly through as displayed in this animation. This is a basic fly through in terms of the landscape features. This was the first time that line work had be used in the display , it is shown here predominately as edge of track. Line work was not utilised in the interactive map because if would have detracted from the aerial images. The site consist predominately of natural surface which was adequately defined by the 3D visualisation techniques used in the map.

It would have been desirable to build a model up of the crusher building to fly by. Also in the aerial photo used to highlight this area from the aerial photo at 1: 000 view, accessed from 'photomap of the working quarry' you can clearly see the scraper on the haul road . It would have enhanced the visualisation to pass a scraper model on the haul road. The use of the blue background for the sky, and managing to keep the fly through low beneath the natural surface terrain to create this visualisation was effective. The fly through follows a path created in ArcScene and it was supposed to utilise the elevation changes but l had difficulty in performing this after the success of my first attempt.

5.3.3 Interpretation of 3D Temporal Mapping

The slide titled 'temporal mapping' is the text screen at the beginning of the temporal mapping display in PowerPoint, and it has been design to simply make the user aware of what the following display is and how to get the most from it. Basically a help page for users. It has been designed to simply convey the minium amount of information to ensure the user gets the basic information from the temporal mapping display. The background is consistent with the other maps directly related to the quarry and text has been designed to be non obtrusive but legible The slide has been designed to be low key introduction to highlight the visualization that will follow.

The inclusion of this text slide in the temporal mapping display does show the importance that has been place on this 3D visualization and temporal mapping technique in the interactive map. The temporal map sequence has proved to be an effected display of the data collected form the Audit surveys that otherwise would be laying dormant on a computer back up system. This mapping display has reinvented the data and highlights the power of GIS in data visualization

The next figure is the first map of the temporal mapping display with the title of 'quarry audit survey October 2002' . All the maps that appear in the temporal map display are based on the same map template, and this map will be the only one discussed here. It is important throughout this display that the only movement perceived is that of the of the 3D surface that has been generated from ArcScene. With the transfer of the image from ArcScene to PowerPoint and because it was not an animation with a AVI export function, the display was 'copied to a clip board'. This process is found in ArcScene in the 'edit' pull down menu and was the desired export format This will be explained further in section 5.4. The map was copied from the clip

board and pasted in PowerPoint and this was the same procedure used for the six maps of the display and was adequate for the presentation in the interactive map.

As can been seen in the figure below the use of colour has been an important visualization tool. Problems have arisen with the different minimum and varied levels in the data sets. The difficulties encountered in adjusting these in ArcScene have not been resolved. Therefore the color schemes assigned to the TIN from the different audit data sets have not used the same minimum level value to generate the colour schemes used in the 3D displays and in the production of the legend throughout the temporal mapping display. The results in showing movement in the colour scheme where no change in the level value has actually occurred. It was assessed and decided to be acceptable for the use in an interactive map associated with tourism. The main purpose of the temporal display is to highlight movement overtime and the this mapping display does achieve this.

The slide design used the background colour that associates the map with the series of maps generated from 'photo map of working quarry' . The map elements shown are the scale bar and the use of text to indicate that the view direction is to indicate that the view is to the south east. Absolute definition of scale has been omitted here as it was difficult to accurately determine. As a means of measuring distance was required to judge the distance moved over a period of time the scale bar was included and the accuracy determined as acceptable for an interactive map associated with tourism. The viewers perspective has been chosen to highlight the movement in the quarry, the illumination azimuth, altitude and contrast could be adjusted as the display is dark but the colours shown are satisfactory and the text used is as described previously in section 5.2.5 . The placement of the navigation icon was important and this is discussed further in section 5.4.

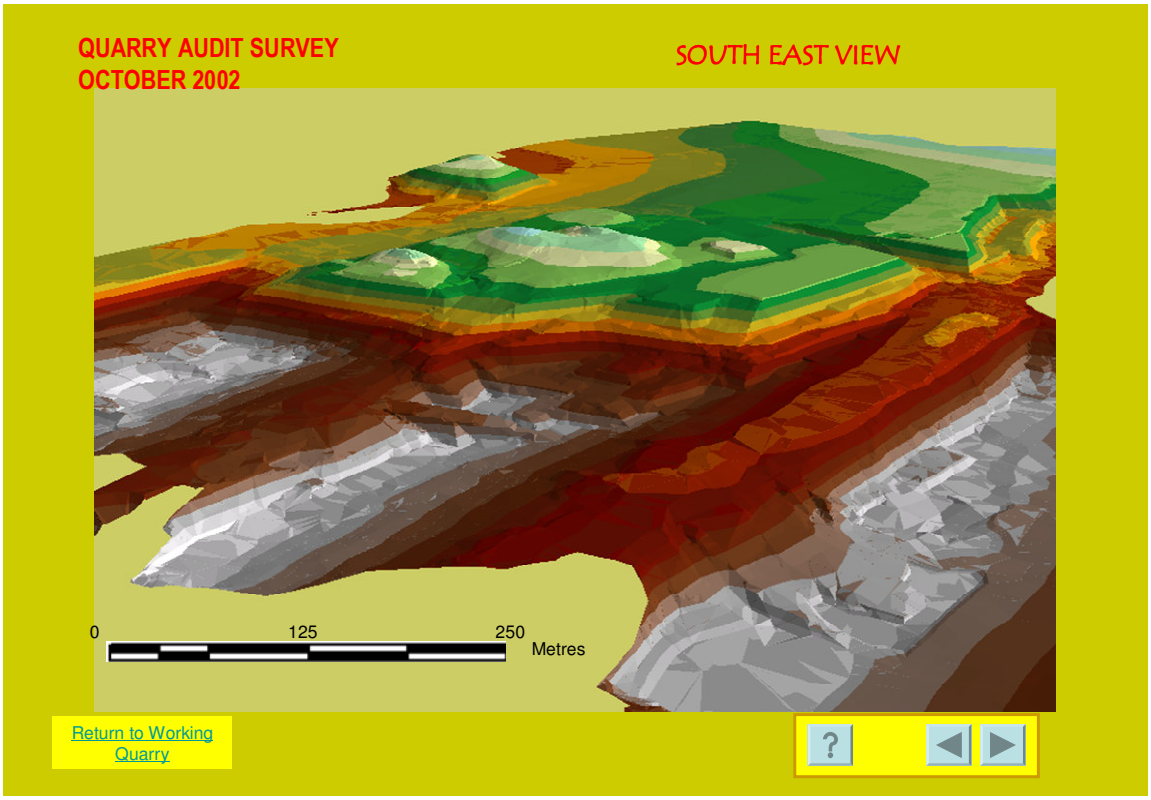

Figure 37 : PowerPoint slide no.19 Quarry Audit Survey October 2002

5.4 Interpretation of the Presentation in PowerPoint

The following section will explain the non sequential format that has been adopted for the interactive map display interactivity. Finally it gives an over all assessment of the PowerPoint and a comparison with other interactive maps associated with tourism including web based interactive maps.

5.4.1 Interpretation of the Interactive Map

Power point has been the base of the of the presentation of the interactive map to the user. As power point is widely known for its effective sequential slide show presentations, its use to develop a non sequential presentation has added to the process of interactivity and is to the benefit of the users by utilising the multimedia. A non sequential approach allows the user to make their own decision about what direction they will follow in their discovery within a multimedia map environment.

The forms of multimedia used in the display include text, aerial photos and still photos, video, animation, and sound. The main form of media use has been the aerial photo that has formed

the base map for 8 maps. Initially the scale of 1:15,000 was use to display the overall site at Waurn Ponds let the user develop some broad mental images of what was here and how the 'working quarry' was situated within the site. Then the user was offered to explore and further interact with the map by transferring to other slides.

The next level map of the aerial photo uses a scale of 1:5,000 which shows the working quarry, this can been compared to other interactive displays the have the ability to zoom in real time. Here the focus is on the quarry and details now emerge of what is available for the user to interact with and nothing is left to chance as the points of interest have been highlighted to the user. This is a main objective of the map to provide the relevant information to the user, information that is related to the mining process utilising the effective display of data in the map.

As the user interacts with this map, their actions take them to another scaled view of the aerial photograph to acquire further information the scale now is 1:1,000 and the limits of the aerial image have been met as the quality of the image would deteriorate considerably if zoomed to another level. At this scale the user is able to visualise the quarry to a certain extent by the use of the aerial photo and the user can then active the links to view animations, video displays in a media player and interact with this presentation format for example utilising the controls on the media to replay the video an manipulate the sound. It is impressive to see the level of information that can be obtained from viewing the map on a computer screen as opposed to walking the site which is not as easily done as by this method.

There is a total of 25 slides in the presentation with 8 slides being part of the introduction to the BCSC Waurn Ponds site (cyan colour) and 17 slides, including the end slide being part of the Working Quarry (light olivenite colour) level of the display, two slides, 17 and 18 have a cyan background in the 'Working Quarry' . In the previous section of 5.2 a level value was defined for information in the multimedia presentation, this same level value system can be used here to define the non sequential approach in this presentation.

Level 1 is the slide that the user is made to view being the introductory slide that allows the user to enter the site or visit the help screen via the help icon. If the visitor goes to the 'HELP PAGE' which is defined as level 5 information it the information in the figure below is displayed.

Figure 38 : View of PowerPoint slide no. 2 'Help Page'

Most users would, choose to enter the site by clicking the image in the centre and would proceed to slide number three the first photo map in the display and the level two information. Here the user has the opportunity to proceed to further introductory slides numbered four to eight. The user is required to activate one of the icons shown on the bottom right hand corner to proceed from slide four to five. When the user reaches slide number eight (shown in the figure below), the user can activate the hypertext at the top of the screen to activate an animation, that will display a rotating 3D visualization of an aerial photograph that has been draped over a TIN. This gives an overview of the site with text to explain areas of the Waurn Ponds site. After this has completed the user may return to slide three and proceed forward to revisit the 'photo map of Waurn ponds BCSC works site' or utilise the directional icons at the bottom right hand corner of the screen. These icons are shown in the figure above and there positions remain consistent throughout the presentation although icons disappear and reappear which controls the path of the user, when required this helps the user to move in the correct direction and not get lost. PowerPoint provides it own slide transition icons that are embed into the lower left hand of the display which cannot be turned off unless you turn of the pointer function, as the slide show is being viewed. If this action is taken the view of the mouse is also removed from the screen, which is not practical. The wheel on the mouse when rolled allows the user to scroll through the slide show in a sequential format which is detrimental to the presentation.

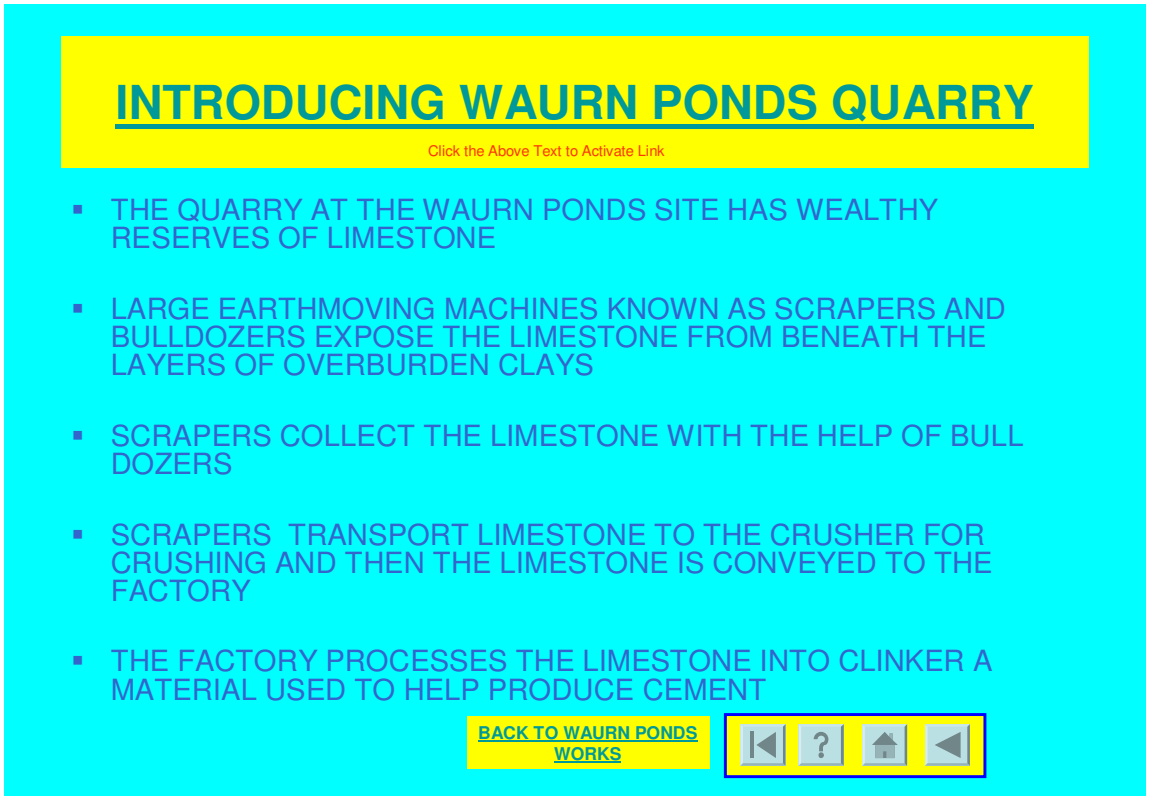

Figure 39 : PowerPoint slide no. 8 Introducing Waurn Ponds Quarry

From slide three the user would proceed to slide number nine with the title of 'photo map of working quarry' by activating the hypertext on the left hand side of the screen on slide number three the user is transferred to side number nine. On arrival at this photo map classed as level three information, the user can activate any of the icons located around the border to move into a level 4 view of the map which would then allow them access to level 5 data or return the 'working quarry' before or after viewing the level 5 data. There are possible ten hyperlinks to activated around the map. The user at this point has the opportunity to also activate the directional icons at the bottom right of the screen with the only icon missing here being the proceed to the 'next slide' icon. The user is directed to investigate the map and once that has been completed they would use the direction icon that would link them to the end of the slide show if they wished or revisit previous maps.

5.4.2 Interpretation of Similar Map Products

No comparison has been able to be made with Interactive Maps associated with tourism that have been presented in PowerPoint. The only comparison that l have been able to make is with the interactive maps presented on the internet and comparisons with software such as ArcGIS that are used to produce the data for presentation. With a comparison to these products the interactive map that has been created in PowerPoint for the purpose of this project can be scrutinised and the results discussed.

PowerPoint is a friendly environment in which to construct an interactive map, it is widely available and does offer the concepts required to present a simple interactive map that is

associated with tourism. User are familiar with PowerPoint and this is worthy of pointing out because users are happy to interact with PowerPoint. PowerPoint allows the efficient packing of its presentations onto CD's with a simple export feature the does package the presentation. It is available to users that don't have PowerPoint by means of a PowerPoint viewer.

A possible problem of interactive maps and some that are seen on the internet, that is the maps are to complex and the user exhausted by the time they have found what they want and give up. The confidence of the user plays an important part in the use of the interactive map. The user can be presented with and interface that is different to what they have experience before, marginalia areas that require this box to be tick for that layer to be displayed, numbers presented as ratio's that alter as the screen moves and funny icons that should mean something. If the user decides not to interact with the presentation because of these issues then the map has failed.

The issue of the time it takes for maps and images to appear on the screen via the internet or a presentation package does limit the performance of the map. The internet based map does have these problems redraw times can be long and then not reappear as a technical problem has developed and the map is gone needing to be recreated. There may be a cost involved in getting the map on the internet and issues of the accuracy of this information or copyright , advertising, security while on the internet. PowerPoint has allow the insertion of a number of images, movie files and the file size when packaged for CD s approximately 600mb but it allows the presentation of these images and maps in a timely and effective manner with non of the above mentioned issues.

The PowerPoint presentation has been very limited when you do compare it to the products that are viewed on the internet and GIS like ArcGIS. The GUI that exist on these other forms of map presentation systems is advantageous for the transfer of information and increased interaction between the map to the map user. Maps offered over the internet have the ability to be accessed by a large group of users who do enjoy the experience, and that is a goal of mapping and certainly in the tourism field. The inability to actively zoom into the map and out again and pan around the screen has resulted in the interactive map that has been presented here, but it does allow users of many levels to interact and gain knowledge from the experience.

In the comparison of the two types of maps the presentation for this project and tourist maps offered on the internet they utilise similar design aspects. The interactive maps offer the introduction level to the user in the first instance, offer help and directions on how to use the map. As you enter into the map site an overview is presented for the site and hyperlinks are then offered for links to more detail maps or other web sites and tourism operators offering their products and services. The interactive map in this project was design as a stand alone map that would not offer links to the internet because of the group of users being focused on and to highlight the simple nature of the mining process and the interactive map produced. The access to information and interactivity cannot be understated on the internet and the risk of disappearing into hyperspace is real.

5.5 Summary

This chapter has discussed in detail the map and the relationship of the map to the user It has interpreted the map design and discussed this in depth and the purpose in using the different type of multimedia present in a particular format in map for the benefit of the users. The media used to present the interactive map has also been interpreted, highlighting the reasons it was used and the effectiveness of the presentation. It has also explained the use of 3D visualisation techniques as produced from GIS.

And finally a comparison between this presentation and interactive maps associated with tourism that available over the internet and advance interactive environments of GIS. This highlighted the benefits and disadvantages of having to present data in the PowerPoint package.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

In this chapter the final conclusions and recommendations drawn from the analysis of the final results of this project will be discussed referring to the presentation of the of the selected data the tools and techniques used for the benefit of the map user. Further recommendations will also be discussed here.

6.2 Conclusions

The identification of the user and their needs in this project, was a major issue in defining the design and production of the map. This then reflected what data needed to be incorporated in the map and what visualisation tools would be used to aid the transfer of knowledge to help develop mental maps in the mind of the user.

The user of the map has been defined by the specific words in title of the project aims, 'associated with tourism' and this definition has allowed the development of an interactive map that presents to the user the opportunity to access this information by the use interactivity and 3D visualisation. The stages in the extraction of the materials have been well incorporated in the map using these techniques. With the removal and transfer of overburden the extraction of limestone and haulage to the crusher building the mining process has been is completed. The level of description has been focused to enable the process to be presented in a simple manner that will be well understood by users while employing multimedia and advanced levels of 3D visualisation techniques.

It has been established that the data processing techniques employed in this project to create the 3D visualization images, which have been discussed at length, have developed a level of visualisation to satisfy the user. The use of spatial information some of which has a high level of accuracy has been reinvented for the presentation. GIS has been the main instrument for the production of the rotating animation of the site a virtual 3D fly through. These animations run for approximately 60 seconds and this does not reflect the time and level of data processing to achieve these results, this is the benefit of having access to the GIS that has given cartography the ability to transform this data for presentation in the interactive map associated with tourism.

The interactive map presentation that has been achieved using PowerPoint and has provided valuable lessons in the use of visualisation and multimedia the combination being a powerful display of mapping concepts one of which is shown in the temporal mapping display. The use of the multimedia 3D visualisation and the movement controls been allocated to the user. When visualisation is used correctly it allows for the effective transfer of information from the map to the user. The lessons can be well used in the future for a wide variety of mapping projects not just maps associated with tourism areas.

Advances in computer hardware and software has lead the way for this form of interactivity to be expected in society today. As mentioned the computer used to create this presentation is a standard machine in today's computer environment. Look back only ten years the Pentium

processor was only beginning to be considered the minium requirement for computing. RAM, video cards for advance graphics an unknown requirement by the average computer users and a costly item to acquire. Today advanced gaming software requires this and it is widely available. Computer software has developed along side of hardware and it is not for this project to discuss wether hardware developments were driven by software developments or software was driven by hardware developments. It does highlight that computers have reached into our lives and made the production of interactive maps an informative experience that user and cartographers are comfortable to use.

The map is a story waiting to be told, it presents information in a logical format to the user. The user can choose what information is to be included in the story by using the links placed in the map for them. The communication of information via traditional cartographic values and modern hypermedia has created interactivity that has realized the potential of the data processed to produce this information.

6.3 Recommendations for Practical Applications

This interactive map associated with tourism can be utilised in educational tours of the Waurn Ponds Quarry of visiting school groups by Blue Circle Southern Cement. Currently groups are guided over the quarry specifically to areas where fossils are generally found. These areas are located away from the working limestone and overburden sites so the exposure to the mining process is limited. These groups are from high schools and university students studying the geology formations in the quarry.

As mentioned it could be used to provide information to interested groups in the local area about mine activities. It may also introduce BCSC management to the powerful mapping and presentation capabilities of GIS and the relevance it has in effective planning of the mine. The quarry is planning future sites to mine over their extensive land holdings. Geology reports have been finalise and mapped, all this data has the ability to be used by GIS to further extent current digital terrain models and associated visualisation for promotional and management presentations.

This presentation could initiate the start an information system for the public about the Waurn Ponds mine site and BCSC operations here. An interactive map presented at a kiosk onsite with guided tours then linked to specific areas of the quarry and factory. Local tourism businesses and promotional groups could incorporate this map or a prototype into advertising campaigns highlighting the Geelong region which is the gateway to the ‘Great Ocean Road’ a well known tourist destination.

6.4 Recommendations for Future Research

The map produced in this project has the potential to introduce a number of interested groups to GIS and its value for mapping and presentation. It has the potential to allow investigations into areas of GIS that were not used in this project i.e. the powerful data base that can be used to associate data for potential queries, searches and analysis.

Any further presentations into the 3D visualisation tools of the GIS need to be comprehensively research and training provided to actively explore the product. Hardware needs to be updated in a timely fashion to enable the use of high end software processing demands. Data sources are becoming more accurate and available to mapping professionals and there is a need to have the current data set for inclusion into any data base.

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APPENDIX A

Project Specification

University of southern Queensland

FACULTY OF ENGINEERING AND SURVEYING

ENG 4111/4112 Research project
PROJECT SPECIICATION

For: Anthony Newman

Topic: Interactive maps for tourism areas

Supervisor: DR. ARMANDO A. APAN

Enrolment: ENG 4111-S1, X, 2007
ENG 4112-S2, X, 2007

Project aim: To develop an interactive map associated with tourism, highlighting the mining process of the specific site with a focus on map interactivity.

PROGRAMME: Issue A, 20.03.2007

1) Conduct literature review on the concepts, techniques, and application of interactive maps, including their potential for tourism.
2) Research the proposed site and its relationship / relevance to tourist activities for inclusion on the interactive map.
3) Using a suitable software, determine the suitable visualization and presentation techniques and data requirements.
4) Acquire and pre-process the spatial datasets needed for the study.
5) Analyse the data, its relevance for the interactive map and format for use in the presentation software.
6) Develop and produce the final map product.
7) Assess the suitability of the output interactive map for tourism.
8) Write, revise and submit the final dissertation.

AGREED:

(Student) (Supervisors)

29/4/07 29/03/07

Co-examiner

USQ project spec revA.doc

APPENDIX B

Risk Assessment

As professionals working in both the office and outside environments work safe work practices need to be observed at all times. EarthTech Engineering has strict health and safety policies to adhere to at all levels. The following pages of Job Safety and environment Analysis forms to be completed when visiting sites, relevant pages for this site have been included only.

At BCSC all visitors must conform to health and safety regulations with access to the site restricted if not accompanied by a BCSC employee at all times. All contractors working onsite must undertake a BCSC training induction programme to familiarise themselves with the site and conditions to be allowed to work that allow work in a safe manner. All vehicles in the mine site must be cleared to enter the Quarry from the Quarry manager with a BCSC two way radio to be carried at all times.. A flashing light must be attached to the roof of the vehicle at all times while working in the quarry. When driving on haul roads used by large mobile earthmoving machines generally travelling at speed with heavy loads, right of way is given at all times and the direction of travel is as per movements in the mine at that time.

JSEA (Job Safety/ Environmental Analysis)

Doc. Reference: SHE-F-018
Last Modified: 6 January 2005

Contract/ Location:	Contract/ Project Number:	Principal Contractor:	ABN No.:
Client:	JSEA Type: ☐ Preliminary ☐ Implement ☐ Revision	Sub-Contractor:	ABN No.:
Task:		JSEA Implementation Date:	

SAFETY

Step No:	BASIC JOB STEP	POTENTIAL ACCIDENT OR HAZARD	RISK CATEGORY (Refer to Risk Matrix)			RISK CONTROL MEASURE (SAFETY: H – Top Priority, Implement Immediately L - Low Priority, Implement as soon as practicable)
			LIKELIHOOD	SEVERITY	RATING	
1						

JSEA (Job Safety/ Environmental Analysis)

Doc. Reference: SHE-F-018
Last Modified: 6 January 2005

Table 1: Safety Hazard/ Environmental Impact Risk Matrix

Risk Factor Method						Severity			Likelihood
		Severity				Safety Hazards	Environmental Impacts	Financial Loss	
Likelihood	1	2	3	4	5	1 - No potential for injury, illness, or incident. First Aid.	1 - Minor environmental incident with no legislative breach (Minor NCR)	Minimum. <$10,000	1 - Very Unlikely (Once per 5 years)
	2	4	6	8	10	2 - Potential for minor injury, illness, or incident. MTI	2 - Potential complaints from local residents, no legislative breach (Minor Impact)	Minor. $10K to $50K	2 – Unlikely (Annual, not > 5 times in 5 years)
	3	6	9	12	15	3 - Potential for a recordable injury, illness, or incident. LTI	3 - Potential for lost time/ Complaints from local authorities for legislative breach (Moderate Impact)	Moderate $50K to $150K	3 – Likely (Monthly, not >12 times per year)
	4	8	12	16	20	4 - Potential for major incident, or major injury or illness causing short term disability .	4 - Minor legislative breach with potential for prosecution (Major Impact)	Major $150K to $1M	4 - Very Likely (weekly, not >4 times / month)
	5	10	15	20	25	5 - Potential for major incident, or major injury or illness causing a fatality or long term disability.	5 - Potential for major environmental pollution incident with high clean up and/ or prosecution costs (Catastrophe)	Huge >$1M	5 – Certain (Daily or several times a week)

Risk Level			
Low	Medium	High	

Note: Risk Calculator (SHE 018A) may be used as an alternative to the above risk matrix.

High: URGENT – correction required as soon as possible consideration should be given to not commencing work until corrective action taken.

Medium: Plan to reduce risk as soon as possible e.g. within one to two weeks

Low: Risk should be eliminated or reduced when time permits

JSEA Compliance Assessment Criteria	Yes / No	Comments	Revisions		
			No.	Date	Reason for Revision
Is the JSEA task specific, not covering too many related operations?					
Is the task broken down into a logical sequence of events?					
Are there enough 'steps' to adequately cover all aspects of the task?					
Are all 'credible' hazards identified?					
Is the 'Likelihood' & 'Severity' score appropriate to each hazard?					
Are the 'Control' measures adequate for each identified hazard?					
Is there a 'Control' measure for each individual identified hazard?					
Are Certificates of Competency/ licences recorded where required?					
Are Environmental hazards & controls adequately identified?					
Name of Person Assessing JSEA:	**Date:**	**Signature**			

INTERACTIVE MAP ASSOCIATED WITH TOURISM

OF THE MINING PROCESS AT BLUE CIRCLE SOUTHERN CEMENT WAURN PONDS SITE

CLICK THE IMAGE ABOVE TO ENTER THE MAP

by
Anthony Newman

? DISCLAIMER

HELP PAGE

Click for help

Click to go back one slide

Click to go forward one slide

Click to return to the start - INTERACTIVE MAP ASSOCIATED WITH TOURISM

Click to go to The End

Click to activate a video-close media player at end of video to return to last screen viewed

Click to return home - PHOTO MAP OF WAURN PONDS BCSC WORKS SITE

CLICK TO ENTER THE WORKING QUARRY

Click to activate hyperlink

Click to activate hyperlink

WELCOME TO BLUE CIRCLE SOUTHERN CEMENT (BSCS)

CLICK TO ENTER THE WORKING QUARRY

CLICK TO ENTER INTRODUCTION TO WAURN PONDS WORKS SITE

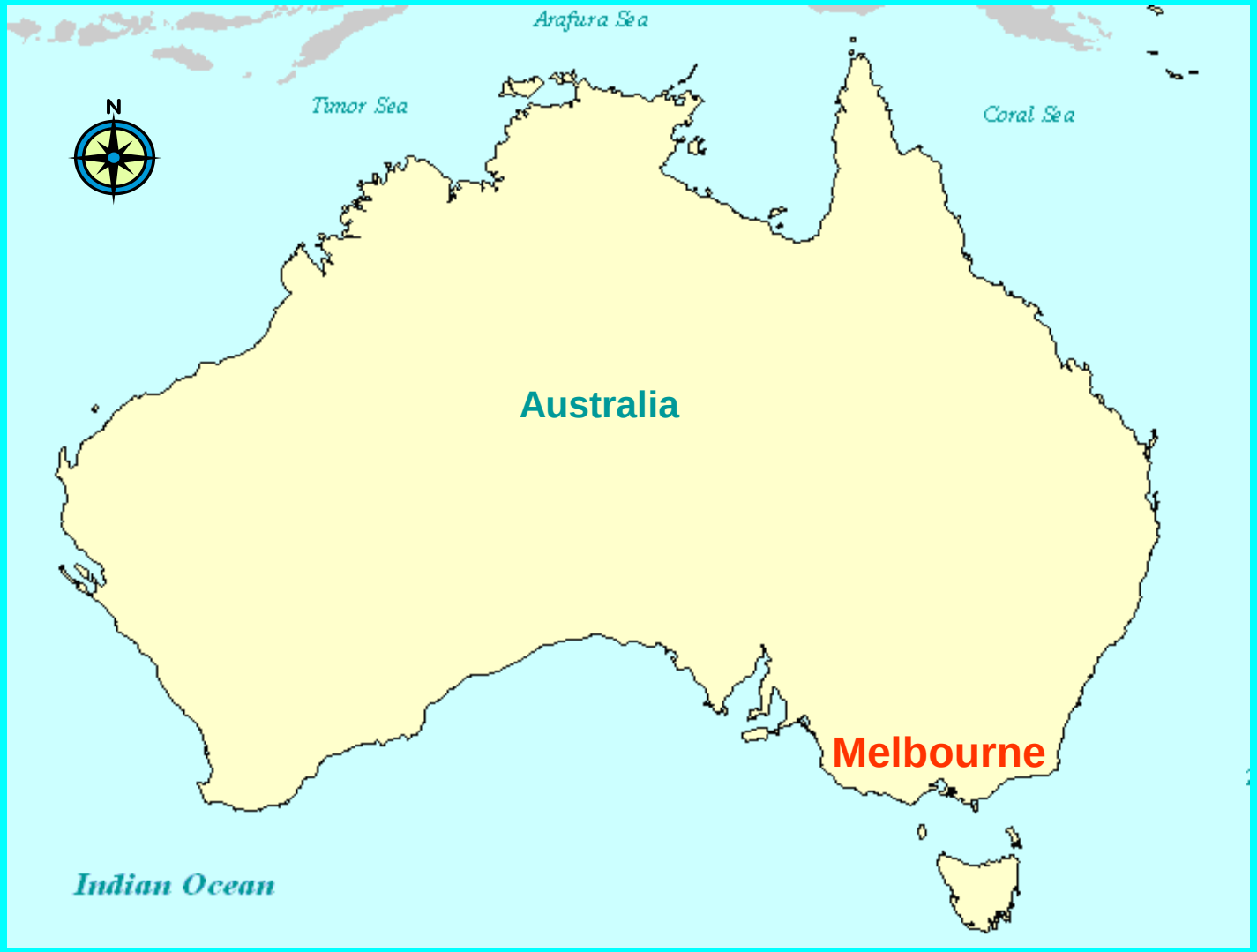
N

PHOTO MAP OF WAURN PONDS BCSC WORKS SITE

0 0.25 0.5 0.75 1 Kilometers

Scale1:15,000

MAP OF AUSTRALIA



REGIONAL MAP

THE BCSC SITE IS NEAR GEELONG, WHICH HAS AN APPROXIMATE POPULATION OF 785,000, IS LOCATED TO THE SOUTH WEST OF THE VICTORIAN REGIONAL CITY

LOCALITY MAP

THE MINE SITE IS LOCATED ON THE EDGE OF THE URBAN FRINGE KNOWN AS WAURN PONDS WITH RURAL GRAZING LAND TO THE NORTH SOUTH AND WEST. WAURN PONDS IS A STRONG GROWTH AREA OF GEELONG WITH THE MINE SITE BORDERING THIS SUBURB

BCSC FACTS

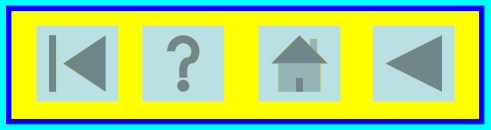
- THE QUARRY AT THE WAURN PONDS SITE HAS WEALTHY RESERVES OF LIMESTONE
- LARGE EARTHMOVING MACHINES KNOWN AS SCRAPERS AND BULLDOZERS EXPOSE THE LIMESTONE FROM BENEATH THE LAYERS OF OVERBURDEN
- SCRAPERS COLLECT THE LIMESTONE WITH THE HELP OF BULLDOZERS
- SCRAPERS TRANSPORT LIMESTONE TO THE CRUSHER FOR CRUSHING AND THEN THE LIMESTONE IS CONVEYED TO THE FACTORY
- THE FACTORY PROCESSES THE LIMESTONE INTO CLINKER A MATERIAL USED TO HELP PRODUCE CEMENT

INTRODUCING WAURN PONDS QUARRY

Click the Above Text to Activate Link

- THE QUARRY AT THE WAURN PONDS SITE HAS WEALTHY RESERVES OF LIMESTONE
- LARGE EARTHMOVING MACHINES KNOWN AS SCRAPERS AND BULLDOZERS EXPOSE THE LIMESTONE FROM BENEATH THE LAYERS OF OVERBURDEN CLAYS
- SCRAPERS COLLECT THE LIMESTONE WITH THE HELP OF BULL DOZERS
- SCRAPERS TRANSPORT LIMESTONE TO THE CRUSHER FOR CRUSHING AND THEN THE LIMESTONE IS CONVEYED TO THE FACTORY
- THE FACTORY PROCESSES THE LIMESTONE INTO CLINKER A MATERIAL USED TO HELP PRODUCE CEMENT

BACK TO WAURN PONDS WORKS



STAGES IN MINING

TEMPORAL MAPPING

WORKING QUARRY

GEOLOGY LAYERS

PHOTO MAP OF WORKING QUARRY

N

0 50 100 200 300 400 Meters

1:5,000

THE WORKSHOP

Click the picture icons below to enlarge the picture





VIEW OF QUARRY MANAGEMENT AN MAINTENANCE BUILDINGS

N

0 25 50 100 Meters

1:1,000

[Return to Working Quarry]

THE RECLAMATION PROCESS

Overburden that covers the limestone is placed here by Scrapers to backfill past mining areas

Click the video icon to activate the movie to see the process in action

VIEW OF OVERBURDEN DUMPING SITE

N

0 25 50 100 Meters

1:1,000

Return to Working Quarry

LIMESTONE EXTRACTION

The limestone is mined by Bull Dozers an Scrapers on the exposed limestone bed

Click the video icon to activate the movie to see the process in action

VIEW OF MACHINES ON EXPOSED LIMESTONE BED

N

0 25 50 100 Meters

1:1,000

Return to Working Quarry

TRANSPORTATION OF LIMESTONE TO CRUSHER

Scrapers haul limestone from the quarry to the Crusher via a network of haul roads

Click the video icon to see the animation of the virtual fly through along the haul road

VIEW OF SCRAPER ON HAUL ROAD

N

0 25 50 100 Meters

1:1,000

Return to Working Quarry

OVERBURDEN CROSS SECTION

VIEW OF THE OVERBURDEN AND LIMESTONE BED

A GOOD EXAMPLE OF THE AMOUNT OF CLAY OVERBURNDEN THAT COVERS THE LIMESTONE BED

THE MACHINES SHOWN HERE ARE SITTING ON THE EXPOSED LIMESTONE BED

TO THE LEFT OF THE MACHINES YOU CAN SEE THE OVERBURDEN BANK START TO RISE UP FROM THE LIMESTONE TO THE TOP WHERE THE NATURAL SURFACE IS

ALL THIS CLAY WILL BE REMOVED TO ACESS THE LIMESTONE IN THE FUTURE

Return to Working Quarry

THE CRUSHING FACILITY

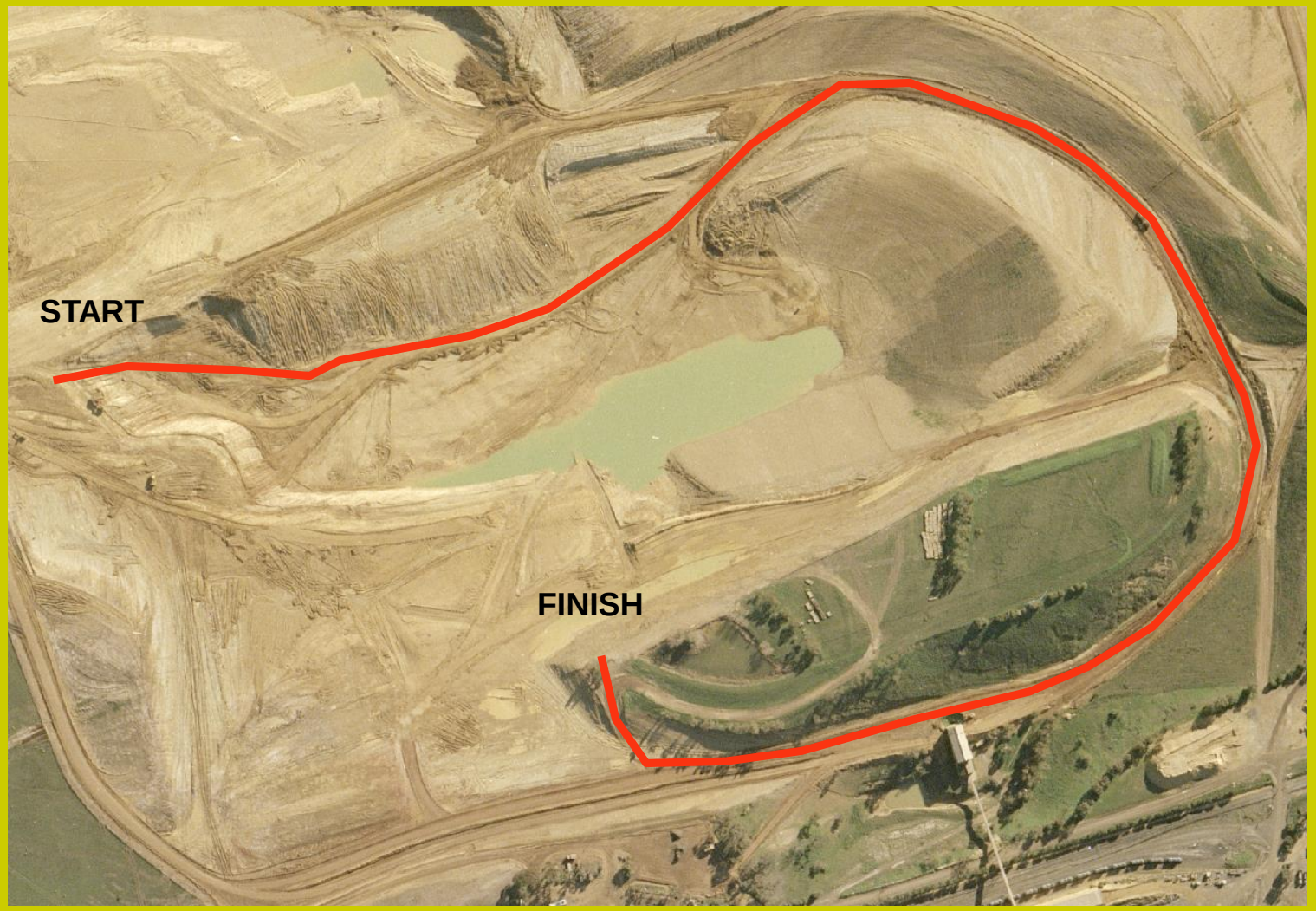
VIEW OF CRUSHER BUILDING WITH THE HAUL ROAD IN THE FOREGROUND AND FACTORY IN THE BACKGROUND

The Scraper enters the building drive through drops its load of limestone in the hopper beneath and heads backs to the quarry

Click the video icon to activate the movie to see the process in action

Return to Working Quarry

FROM THE QUARRY TO THE CRUSHER ALONG THE HAUL ROAD



Scrapers haul 17m³ of limestone with each trip to the Crusher with a top speed of 51.5 km/h

Click the video icon to activate the animation to see the virtual 3D fly through

VIEW OF THE VIRTUAL FLIGHT PATH IN THE WORKING QUARRY

N

0 25 50 100 Meters

1:1,000

Return to Working Quarry

STAGES IN OPEN CUT MINING OF LIMESTONE

- REMOVAL OF NATURAL SURFACE (OVERBURDEN) TO EXPOSE TOP OF LIMESTONE BY DOZER AND SCRAPER
- OVERBURDEN TO LANDFILL SITES BY SCRAPER
- LIMESTONE EXCAVATED BY DOZER AND SCRAPER
- LIMESTONE HAULED TO CRUSHER BY SCRAPER
- SCRAPER UNLOADS LIMESTONE AT CRUSHER TO BE CRUSHED AND CONVEYED TO FACTORY

Click the picture icons below to activate links



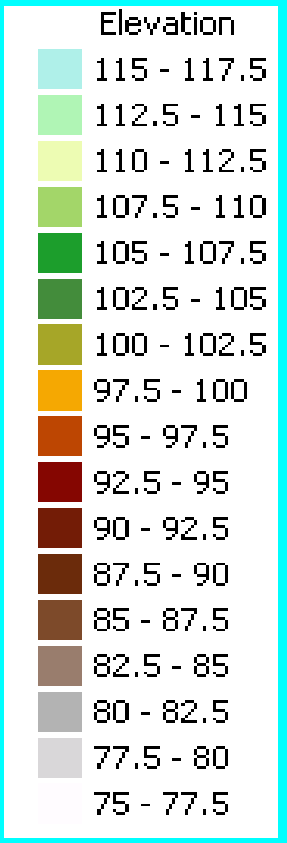


Return to Working Quarry

TEMPORAL MAPPING

- SHOWING THE MOVEMENT OF THE QUARRY OVER TIME USING 3 DIMENSIONAL SURFACES
- EACH SLIDE SHOWS THE SURFACE OF THE QUARRY AT APPROXIMATELY YEARLY INTERVALS, 2002-2007
- THE DIFFERENT COLOURS REPRESENT DIFFERENT LEVELS, LIKE CONTOURS, INDICATIVE ONLY. (SEE THE LEGEND)
- EACH SLIDE WILL TRANSITION FORWARD OR BACKWARD AT USERS CLICK OF DIRECTIONAL BUTTONS (BOTTOM RIGHT OF SCREEN)
- YOU CAN SEE THE GREEN NATURAL SURFACE BEING EATEN AWAY OVER TIME, HILLS DISAPPEARING AND THE QUARRY EXPANDING AT YOUR OWN TIME

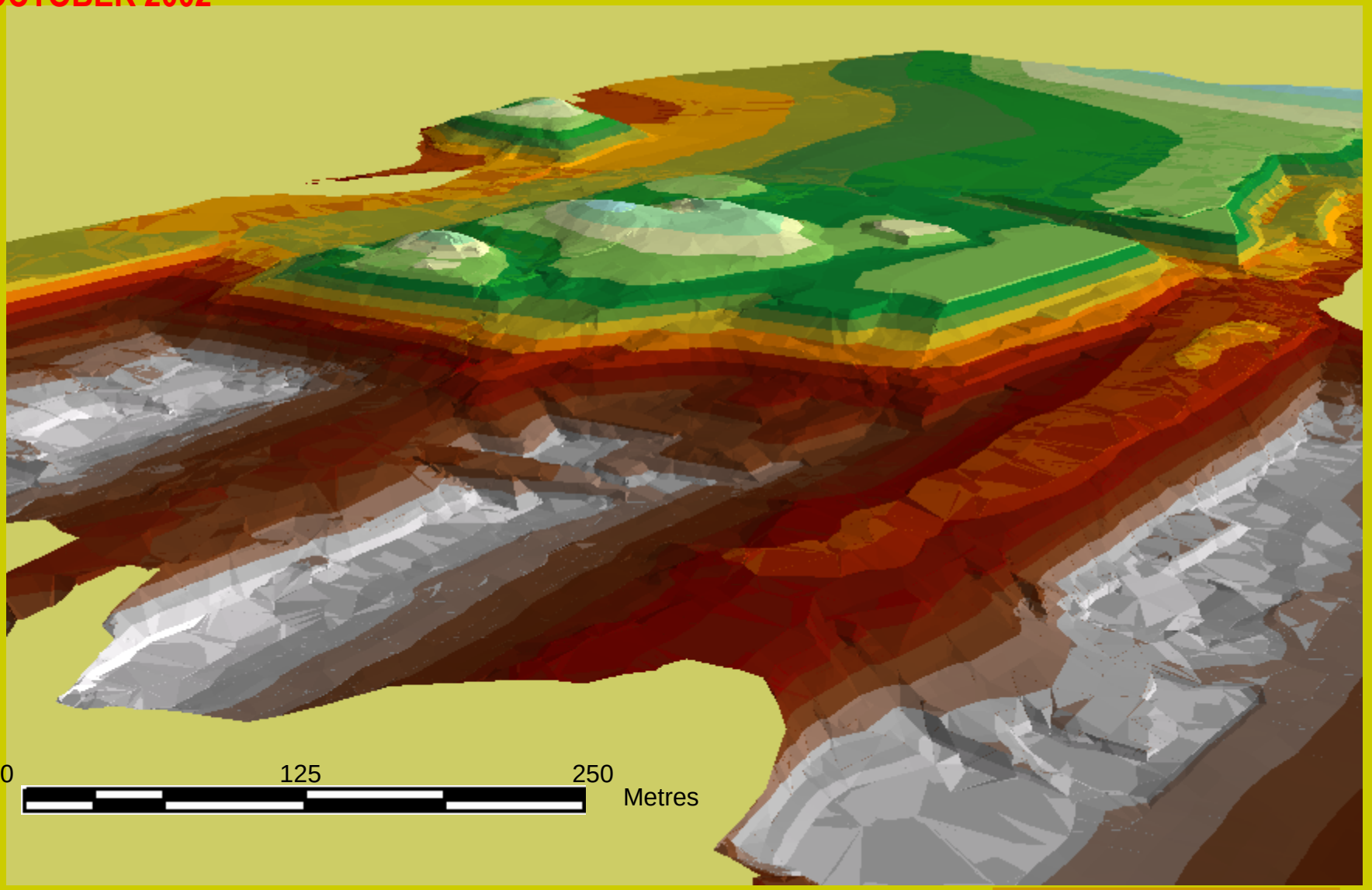
LEGEND



Return to Working Quarry

QUARRY AUDIT SURVEY
OCTOBER 2002

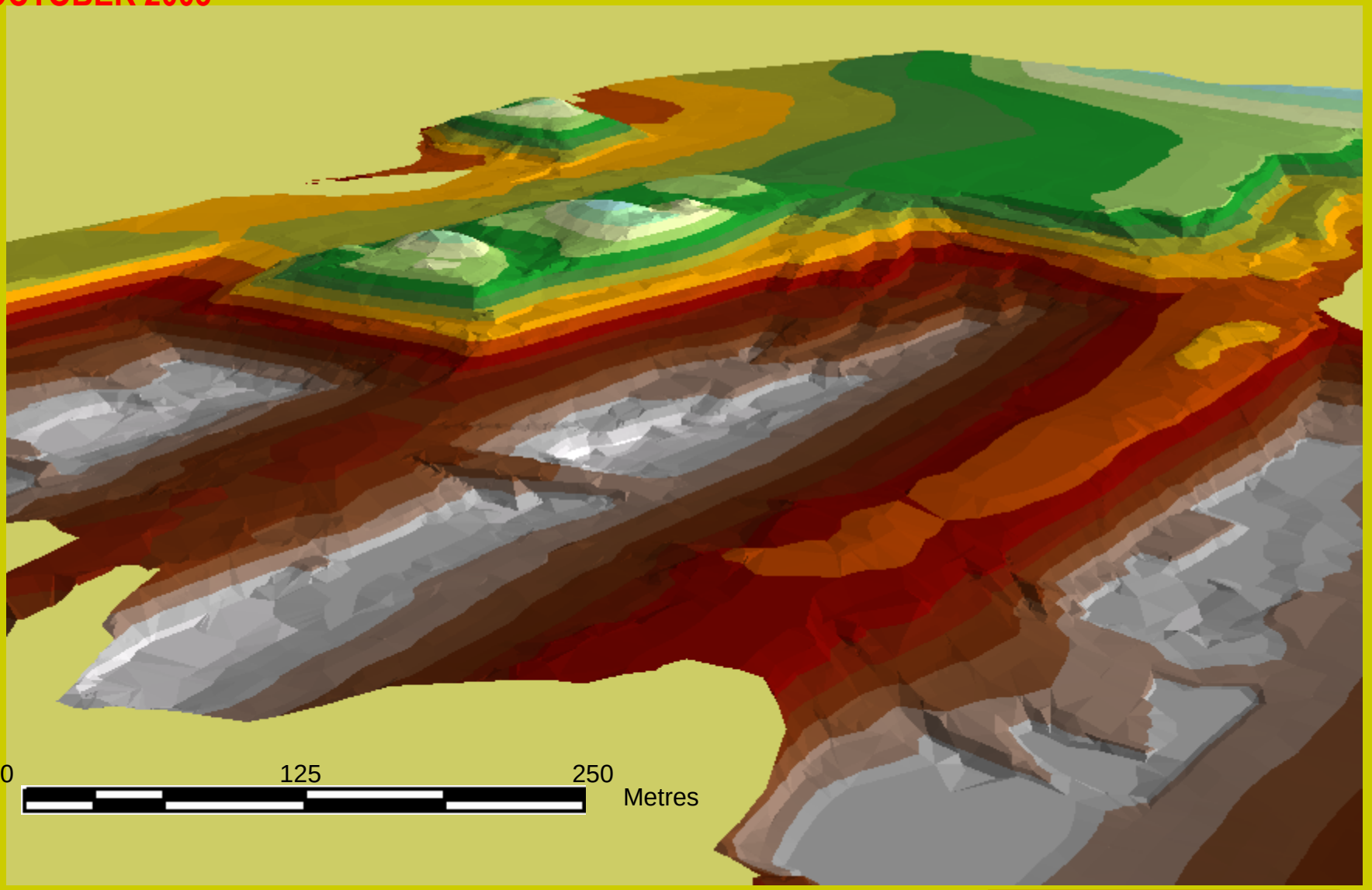
SOUTH EAST VIEW



Return to Working Quarry

QUARRY AUDIT SURVEY
OCTOBER 2003

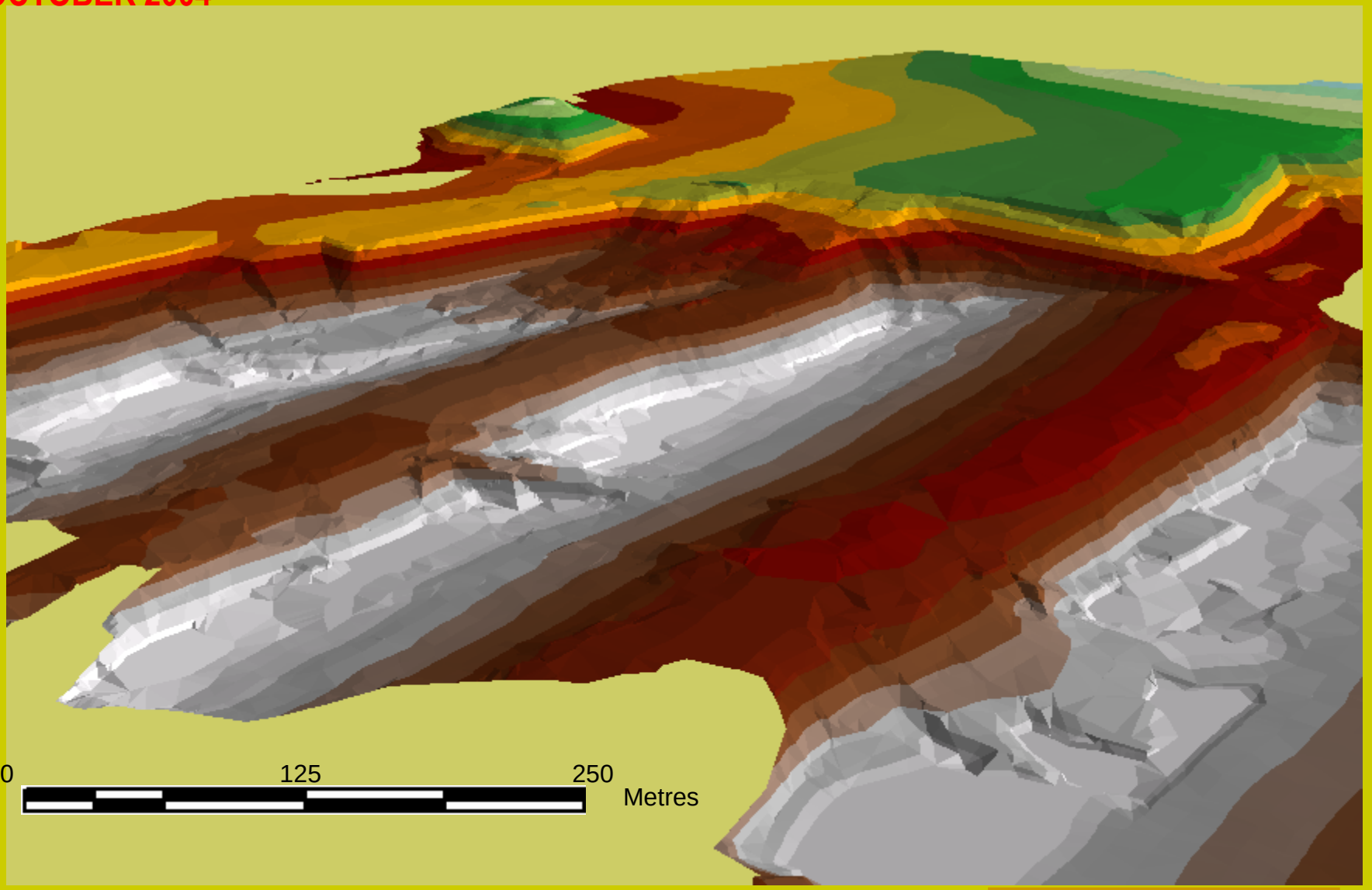
SOUTH EAST VIEW



Return to Working Quarry

QUARRY AUDIT SURVEY
OCTOBER 2004

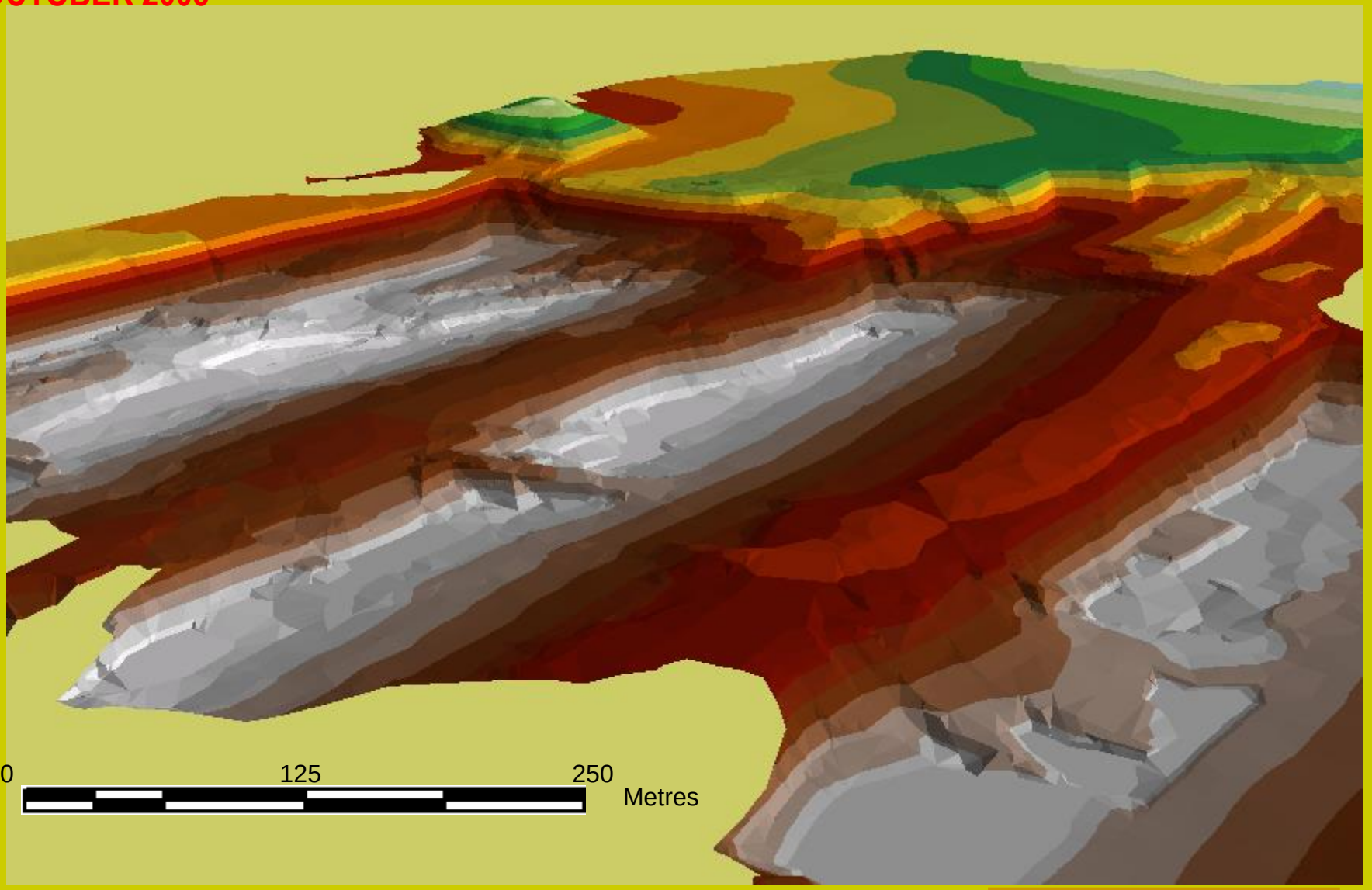
SOUTH EAST VIEW



Return to Working Quarry

QUARRY AUDIT SURVEY
OCTOBER 2005

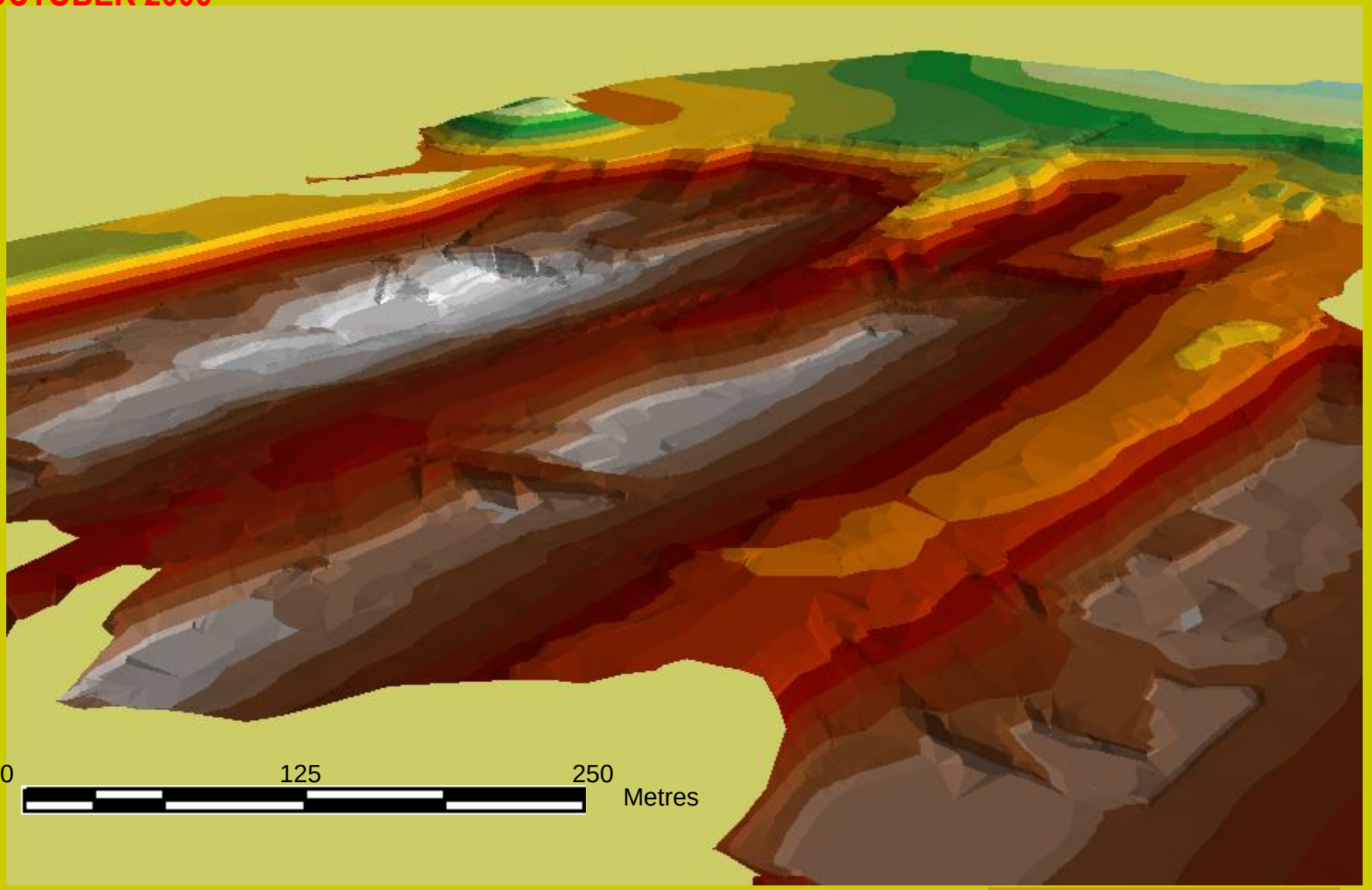
SOUTH EAST VIEW



Return to Working Quarry

QUARRY AUDIT SURVEY
OCTOBER 2006

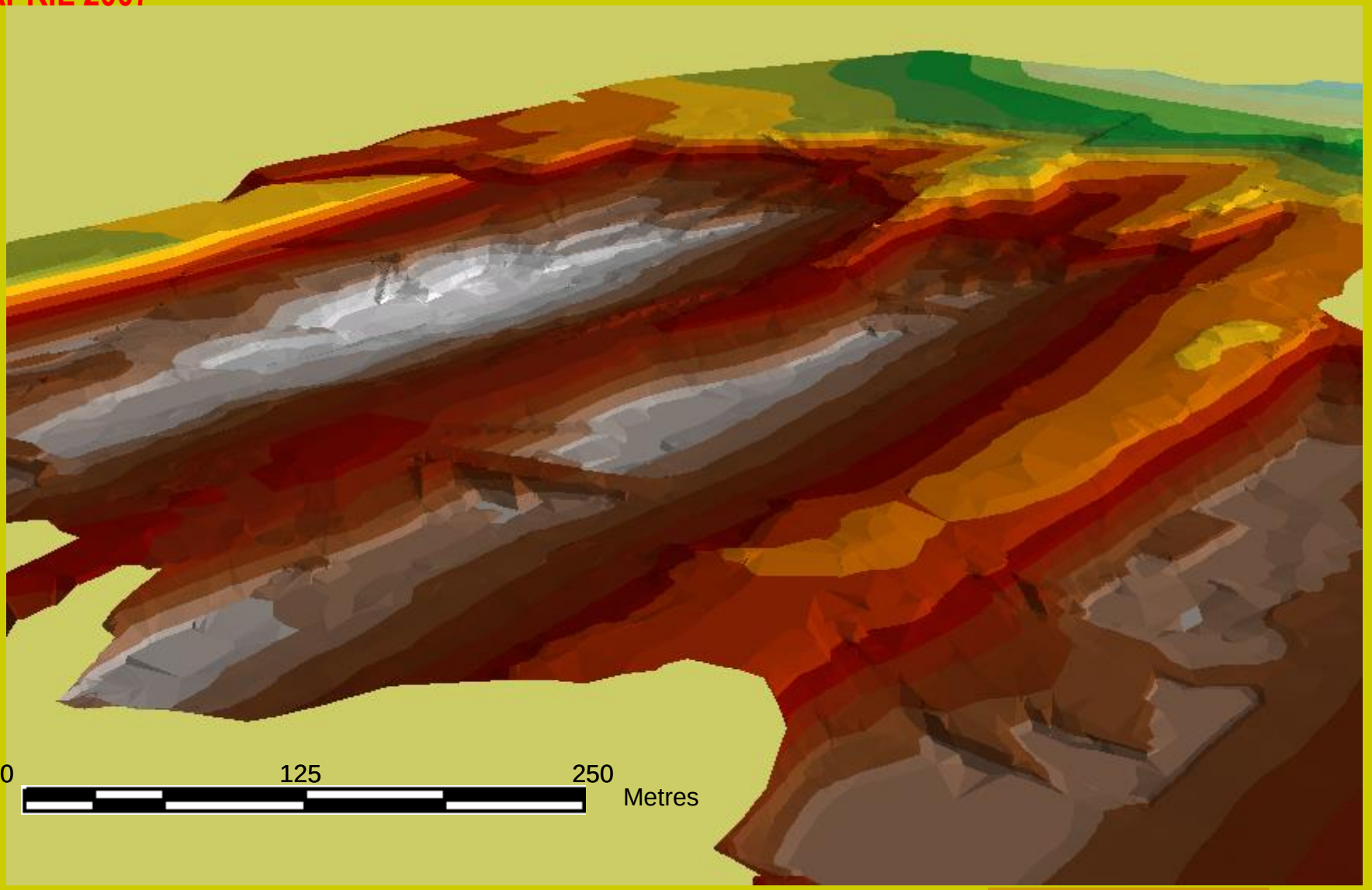
SOUTH EAST VIEW



Return to Working Quarry

QUARRY AUDIT SURVEY
APRIL 2007

SOUTH EAST VIEW



Return to Working Quarry