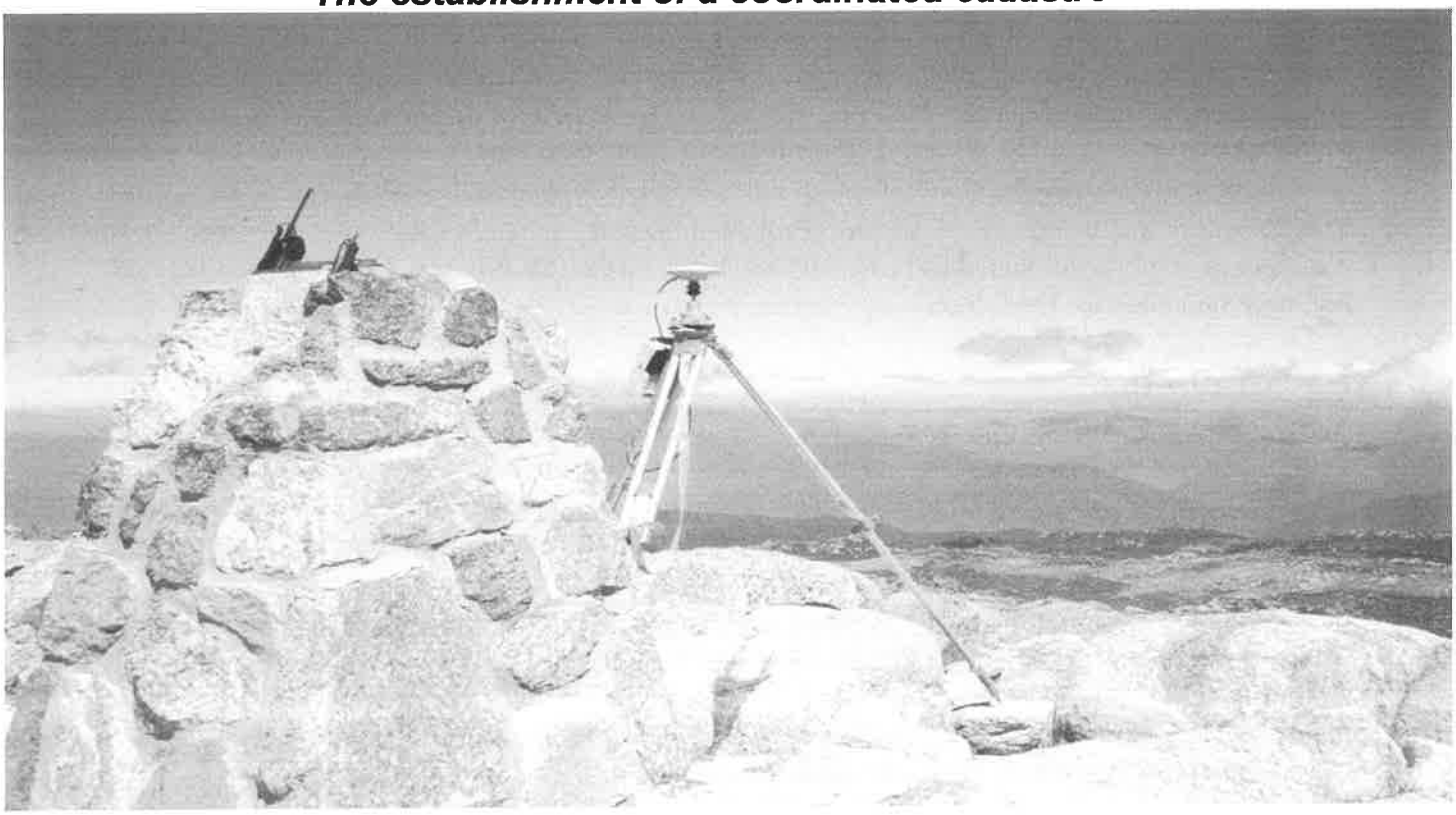
RTA

The Kosciuszko Ko-ordinated Kadastre

The establishment of a coordinated cadastre



Abstract:

This presentation to the 2004 APAS Annual Conference highlights the innovation of spatial information specialists when tested by an otherwise insurmountable problem.

The conclusions of the Coroner's Report and the subsequent Walker Enquiry into the 1997 Thredbo Disaster demanded the excision of the Kosciuszko Road and the Alpine Way from the Kosciuszko National Park. In order to achieve this, the boundaries of the 120 kilometre length of the two roads needed to be defined in a timeframe which, in itself, rejected conventional surveying techniques. It was decided that the only solution to meeting the government's deadline was to use an innovative combination of global positioning, photogrammetry and ground surveying.

The technology behind the Authority's 'Kosciuszko Ko-ordinated Kadastre' project is uniquely "spatial". There is no other industry with the skills, ability and understanding of spatial concepts necessary to be able to develop the methodology required to satisfy the demands of the community and the conclusions of the Walker Enquiry into the Thredbo Disaster. The project embraces all facets of spatial data capture, manipulation, management and presentation.

The 'Kosciuszko Ko-ordinated Kadastre' project has stretched the boundaries of conventional thinking. It is highly conceivable that the adaptation of the concepts developed through this project will significantly alter the direction of cadastral boundary definition in this State.

Introduction

The Roads and Traffic Authority (RTA) is responsible to the people of NSW for providing a cost effective, safe and accessible road network.

The traditional role of spatial information specialists in the RTA, and in the public sector generally, is changing. The increasing demands that are being placed on the employees of the Roads & Traffic Authority have called for innovative ideas to be developed and implemented in very short timeframes. In an era of rapidly changing technology, the spatial information specialist must be able to recognise and adapt new methods of work for the benefit of a community with increasingly high expectations. The "Kosciuszko Ko-ordinated Kadastre" project is one example of the leadership demonstrated by spatial information specialists in the public sector.

The 'Kosciuszko Ko-ordinated Kadastre' Project applies an innovative and unique approach in the establishment of a coordinated cadastre. Its existence pushes the boundaries of acceptability and sets new standards for the future.

Background

The tragic event which is forever etched in Australian history as "The Thredbo Disaster" occurred in the early hours of Thursday 31 July 1997. Part of the hillside below the Alpine Way and above Thredbo village slipped, resulting in the destruction of two ski lodges by over 100 tonnes of rock and rubble. Only one person was to survive from the eighteen residents in the Bimbadeen Lodge and the one occupant of the Carinya Lodge.

In the resultant Coronial Enquiry, Coroner Derek Hand closely examined the role of two public authorities: the National Parks & Wildlife Service (NPWS) and the NSW Roads and Traffic Authority (RTA). The Coroner concluded: *"It appears to me that it is necessary that there be an independent assessment of the ability and appropriateness of the NPWS to retain responsibility for ... road maintenance within the parks under its care, control and management".*

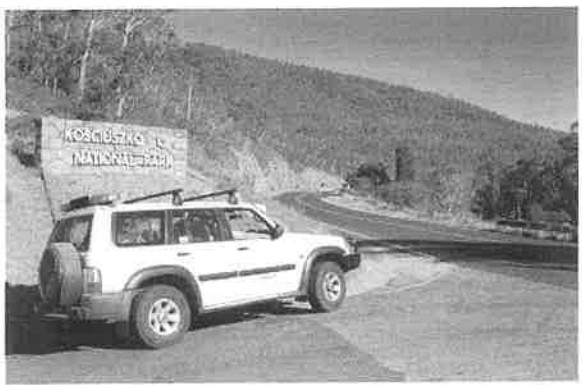
One of the recommendations of the subsequent Walker Report was to excise the Alpine Way and the Kosciuszko Road from the Kosciuszko National Park. State Cabinet consequently directed that the care, control and management of the roads should be transferred from NPWS to the RTA. To facilitate this process, the boundaries separating the formation of the Alpine Way and the Kosciuszko Road from the National Park needed to be established.

The Challenges

Both the Alpine Way and the Kosciuszko Road etch a tortuous route through Australia's highest landscape. The first of these roads extends from the National Park entrance 20 kilometres west of Jindabyne at Little Thredbo River to the quiet rural community of Khancoban, whilst the second commences at another eastern entrance to the Park, at Thredbo River, and finishes at a magnificent vista above the village at Charlotte Pass.

Alpine Way: Little Thredbo River to Khancoban

Kosciuszko Road: Thredbo River to Charlotte Pass



A simplistic, all-encompassing, statement in the Government Gazette that the road reserve would be defined as "20 metres either side of the centreline of the Alpine Way through Kosciuszko National Park" was rejected due to the lateral extent of the road formation, including cuts and fills, and definite possibility of encroachments onto the high value Ski Lodge lease areas at Thredbo and Perisher Valley.

The original deadline for the excision of the two roads from the National Park was March 2001. However this was later modified to require the plans to be ready in time for the gazettal of the excision Act, planned for March 2003. The first challenge to be met was how to define the boundaries in the timeframe allocated by State Cabinet, as it was recognised that conventional survey methods by themselves would not meet the deadline. A technical paper presented in 1997 by Paul Harcombe, then Deputy Surveyor-General of NSW, to the Institution of Surveyors National Congress in Newcastle had suggested the use of digital photogrammetry and GPS to develop a cost-effective cadastral model for low value lands in the Western Division of NSW. It was decided to adapt this concept to the Kosciuszko Project, but refine it to deliver a higher accuracy cadastre that was tied into conventionally surveyed boundaries at key locations.

The task of defining the 120 kilometre length of road boundaries was made more difficult due to the climatic and environmental conditions inherent in the 'High Country'. The ground survey required to establish permanent survey control could only be attempted in the summer months, and the photogrammetric window was even more restricted. In addition, the dense canopy of the trees

in the National Park, hiding the road formation in various locations and casting long shadows over it in others, hampered the digitising of the photogrammetric ground model.

The Project Team

People involved in this project were:

Project Sponsor	Dennis Clark, RTA Property Manager, Southern Region
Project Manager	Mark T Gordon, RTA Survey Services Manager
Photogrammetry, digitising and coordination	Chris Woodham, Photogrammetry & Geoinformation Manager Brian Myers, Photogrammetric Officer Robert Leake, Supervising Photogrammetrist
GIPSICAM	Steve Greening, Positioning Officer
Survey Control	Stewart Amery, Engineering Surveyor (GPS) Marijana Kokanovic, Survey Graduate Ray Gilmour, Senior Survey Systems Officer Peter Radley, Survey Assistant
Survey Drafting	John Dwyer, RTA Cadastral Information Manager Youngsoo Kim, CAD Drafting Administrator Richard Harding, Survey Drafting Officer, Goulburn Ewa Herden, Survey Drafting Officer, Goulburn Steve Bates, Survey Drafting Officer, Wollongong
Field Quality Control	Bill Evans, RTA Site Locations Officer
Registered Surveyor (cadastral ground survey)	Peter Burns, Peter W Burns Pty Limited, Cooma

Methodology Adopted

The process undertaken was as follows:

1. Undertake a major Control Survey using GPS techniques to encompass the lengths of the Alpine Way and Kosciuszko Road within the National Park to an accuracy of Class 'B" (SP1 Version 1.5 refers).
2. Use the major control survey to coordinate target points for photogrammetric purposes.
3. Capture both roads by aerial photography.
4. Triangulate and digitise the models produced from aerial photography, referenced to the Survey Control.
5. Coordinate the centreline of the pavement. The centreline of the road was the "master string" from which parallel "strings" 20m either side were created as the initial boundary. This boundary was then modified to accommodate the location of tops of cuttings, toes of embankments and catchdrains which needed to be contained within the final road boundaries. NPWS placed additional restrictions by stipulating that the excision was to involve the minimum area required to encompass the road formation and for future road maintenance.
6. Determine the MGA coordinates of appropriate boundary angles by examining the models and the terrain.
7. Create "plans for redefinition" at critical locations. These locations were determined to be where the roads enter and exit the Park, where the National Park boundaries needed to be precisely defined by survey.
8. Create plans of survey for specific land to be excised from Kosciuszko National Park for the purposes of the Roads Act 1993. These plans involve land:

- at Khancoban, where boundaries previously defined by Plan R314548-1603 but absorbed into Kosciuszko National Park had to be re-established.
- at Thredbo, where it was necessary to define by survey the new common boundaries between the Head Lease and the proposed road, which was in stratum in some areas. This plan also shows an amendment to the Headlease boundary.
- at Perisher, where it was necessary to define by survey the new common boundaries between the leases and the proposed road, which was in stratum as it crossed over the Ski-tube.

9. Prepare plans showing the proposed road boundaries as determined by photogrammetric means. These plans:
   - define the boundaries by a series of point numbers which are coordinated in MGA;
   - divide the roads into a series of numbered Lots for which no areas are depicted;
   - refer to the control marks defined in the major Control Survey;
   - each contain a control survey diagram of the whole route;
   - connect to the "plans for redefinition" (see point 7, above) and plans of survey (see point 8, above) at the critical locations;
   - do not show bearings and distances along the boundaries, which are defined as join lines between coordinated points;
   - do not depict a residue Lot or area for the remainder of Kosciuszko National Park.
10. Confirm the location of the boundary by field inspection with the National Parks & Wildlife Service.
11. Undertake a final field inspection of all control marks and boundary angles by GPS to confirm the road is contained within the proposed boundaries.

Problems Encountered

Major problems encountered concerned the photogrammetry and digitising procedures.

Although the original plan was for the photography to be flown on 21 December 2001, this was delayed due to adverse weather conditions to mid-January 2002. An unanticipated problem occurred when, on entering the aeroplane, the camera operator stood on the corner of the camera body, tilting the camera in its mountings. The result was that the photography, although of excellent image quality, was useless as the tilts were such (approximately 6 grads) to render the photography impossible to work with. Due to continuing vagaries of climatic conditions, the second set of photography was not acquired until late February, after desperate requests from the flying contractor to have the sun-angle requirement lowered. This resulted in extensive shadowing of the road and a number of targets being in shadow.

The second problem which arose was again a result of poor flying: the photography was flown too low. This caused severe overlap problems in the higher terrain, with the result that overlaps were very narrow, and sometimes non-existent. This, in turn, led to severe restrictions in the placement of pass points to enable triangulation to be carried out successfully.

The third problem, complicated by the late date of the photography, was that it was often difficult to digitise the pavement edges of the Alpine Way. Shadow cast across the road, particularly in areas of canopy overhang, sometimes rendered it impossible to define the road edges, and hence the centreline. Structures which were required to be located within the road boundaries were also invisible in the shadowed and canopied areas. Two innovative methods were used to overcome this problem. The RTA's asset management program had resulted in a video of both roads road using GIPSICAM technology. Simplistically, GIPSICAM (Global/Inertial PoSitioning and Image Capture Asset Mapping) involves a vehicle equipped with a GPS receiver and a video camera.

Notwithstanding the possibility of the resultant observations being up to two metres out of position, they were utilised in two small areas where it was impossible to see the road surface using photogrammetry. Secondly, where the structures could not be seen from the air due to shadow and vegetation, terrestrial orthophotography showing offsets to structure limits were used to aid the definition of road width.

Pilot Lookout on the Alpine Way, showing the density of the tree canopy:

A fourth problem was that the painted road centreline of the Alpine Way did not exist from Thredbo to Khancoban. The centreline of the road was digitised westerly from Thredbo by centring the digitising cursor (a crosshair) midway between the two digitised pavement edges on a scaled monitor display which almost exactly accommodated the cross hair between the strings. This method produced a centreline which to an accuracy of +/- 0.3 metres, which was sufficient for the project. However, this could only be used where both edges of the pavement were visible. In areas where only one pavement edge was visible, the GIPSICAM images and the associated AssetLoc program was used to create the invisible pavement edge. This program allowed the measurement of pavement width at any location and with that knowledge it was possible to construct the missing pavement edge.

Preparation of the Plans

The original intention was to refer to the final boundary plans only in an appendix to the excision Act of Parliament. This would mean that lodgment and registration of these boundary plans at LPI NSW would not be necessary. However, as the boundaries shown on the plans would be used at a later date to define the extremities of lease areas in the Park, plan registration at LPI NSW was deemed to be highly desirable.

The lodgment of the plans at LPI NSW required a number of exemptions, as the plans did not comply with the Surveyors (Practice) Regulation 2001. These exemptions were:

- The boundary angles defined by photogrammetric methods were not marked.
- Details of the photogrammetric data (film number, flying height, run, photo scale) were to be included on the Survey Control Sheet.
- MGA coordinates would uniquely define the angle points in the boundaries.
- There are no bearings and distances shown between the coordinated boundary angles.
- There are not direct bearing and distance connections from the Survey Control marks to the boundaries.

- The plans would divide the road into manageable and identifiable sections, with the result that there were up to 23 sheets in a single plan.
- A survey control diagram of the whole route would be the final sheet in each plan, as the Mark density was less than required by the Regulation.

Innovation

The "Kosciuszko Ko-ordinated Kadastre" project is the first time in New South Wales two dimensional coordinates have been used to uniquely define a cadastral boundary. This was possible on this particular project due primarily to the absence of intersecting boundaries and different ownerships. Should re-establishment of the boundaries ever be required in the future, the boundary angles can be re-established absolutely and unambiguously by GPS or by conventional methods from the survey control marks.

This project demanded the combined expertise and training of photogrammetrists, surveyors, survey drafting officers and property management specialists. There is no doubt that its uniqueness required them to think laterally and innovatively, and it demonstrated the enormous possibilities when such spatial information specialists can work together for the benefit of the community.

Liaison with Other Professionals

The Project Sponsor maintained close liaison was required with NPWS, which had a vested interest in the position of the proposed boundaries.

The expertise and advice of officers at LPI NSW was also used. In particular, David Norris, Grahame Wallis and Les Gardner recognised that this project would be the benchmark for similarly planned schemes in New South Wales and needed to ensure that the integrity of the cadastre was maintained. Terry Murray from LPI NSW also provided valuable advice in regard to the depiction of Parish boundaries, which needed to be shown on the final plans.

Close liaison was also required between the Authority and Mr Surveyor Peter Burns of Cooma, who was charged with the responsibility of completing the ground surveys at key locations throughout the project. In 1997, Peter Burns had been awarded the inaugural 'Professional of the Year" accolade from the NSW Council of Professions, specifically for his work at the site of the Thredbo Disaster that year.

Planning NSW also took an interest in the project due to its concurrent mapping of the lease areas for the Ski Resorts in the National Park. This organisation was supplied with a DXF using a GENIO input of the final boundaries, to import into its ArcView/ArcInfo software.

Adaptation to other Situations

The immediate benefit of this project is its application to roads through other large areas of government land such as State Forests. However, a wider adoption of this project is in the development of a coordinated cadastre for the whole of New South Wales. This project demonstrates that coordinates can be used as the primary evidence of the location of a boundary corner provided that a rigorous survey control network has been established.

Conclusion

The increasing demands that are being placed on the employees of the Roads & Traffic Authority have called for innovative ideas to be developed and implemented in a very short space of time. The Survey Services Section is always seeking new methods which will reduce the time between concept development and project delivery. The Authority is indeed fortunate that such a group exists.

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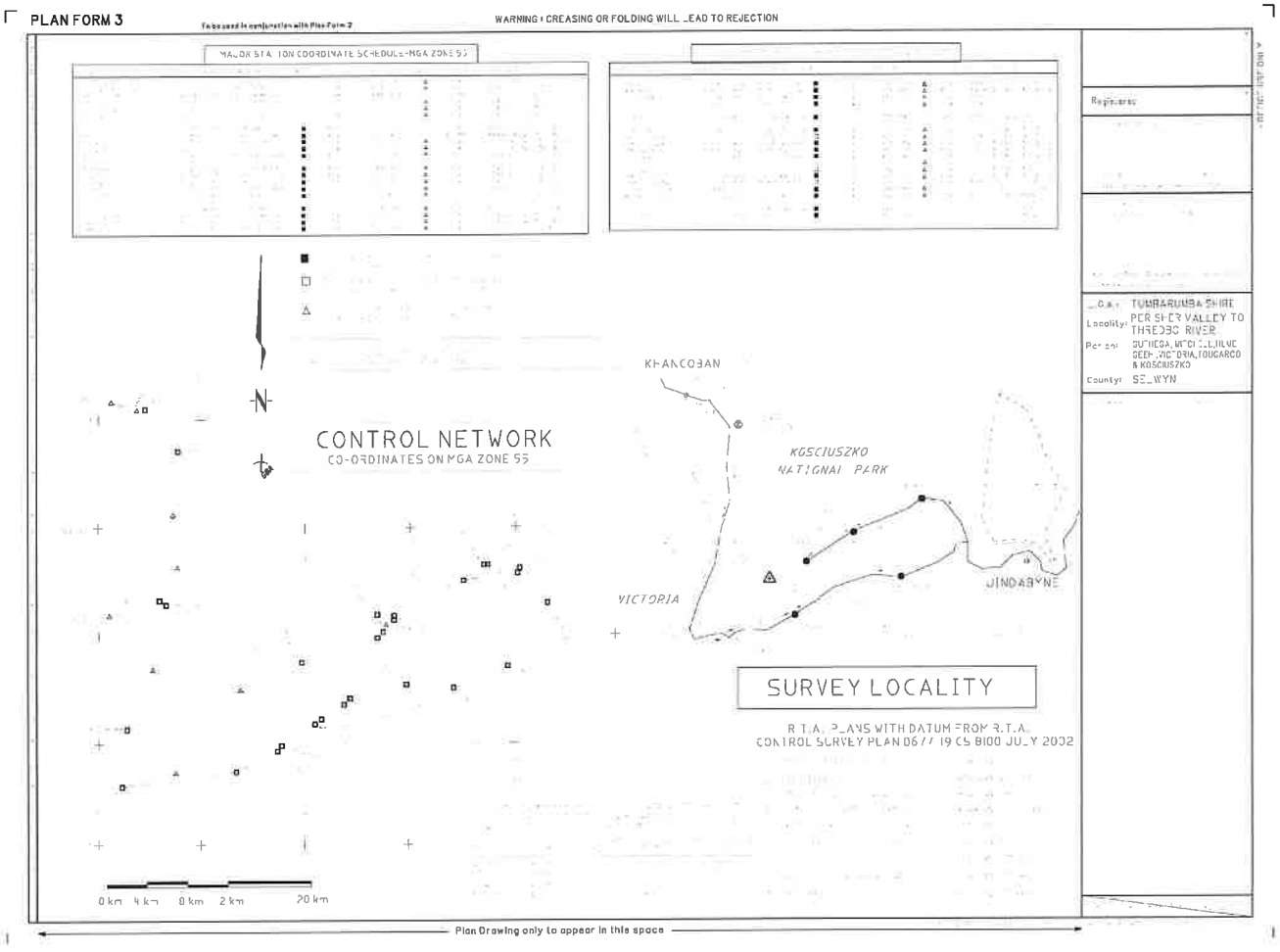
necessary to be able to develop the methodology required to satisfy the needs of the community and the conclusions of the Walker Enquiry into the Thredbo Disaster. The project embraces all facets of spatial data capture, manipulation, management and presentation.

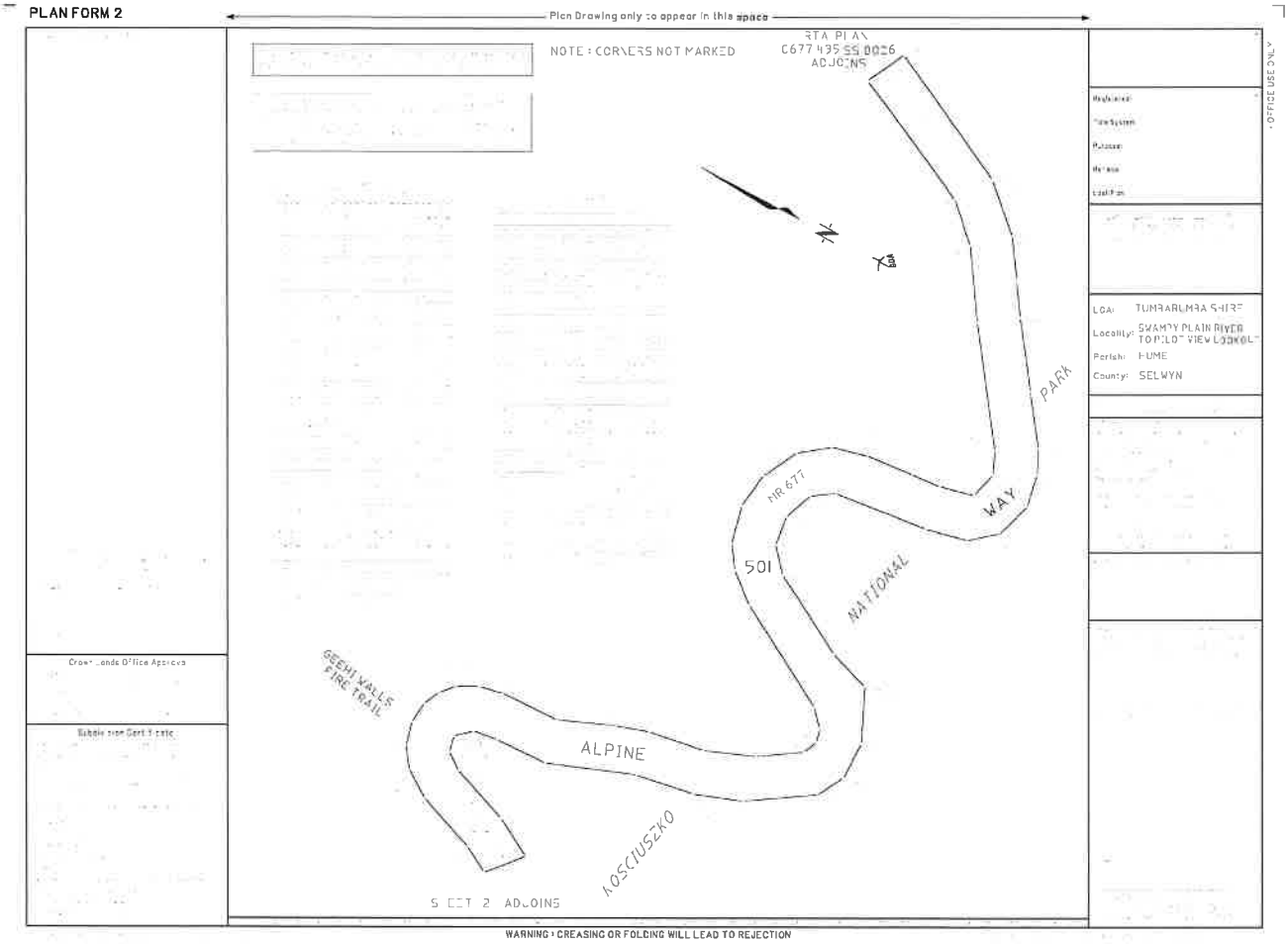
The 'Kosciuszko Ko-ordinated Kadastre' project has stretched the boundaries of conventional thinking. The concepts developed through this project will obviously lead to other applications which will further test the minds of spatial information specialists. The Roads & Traffic Authority is confident that we will be equal to the task.

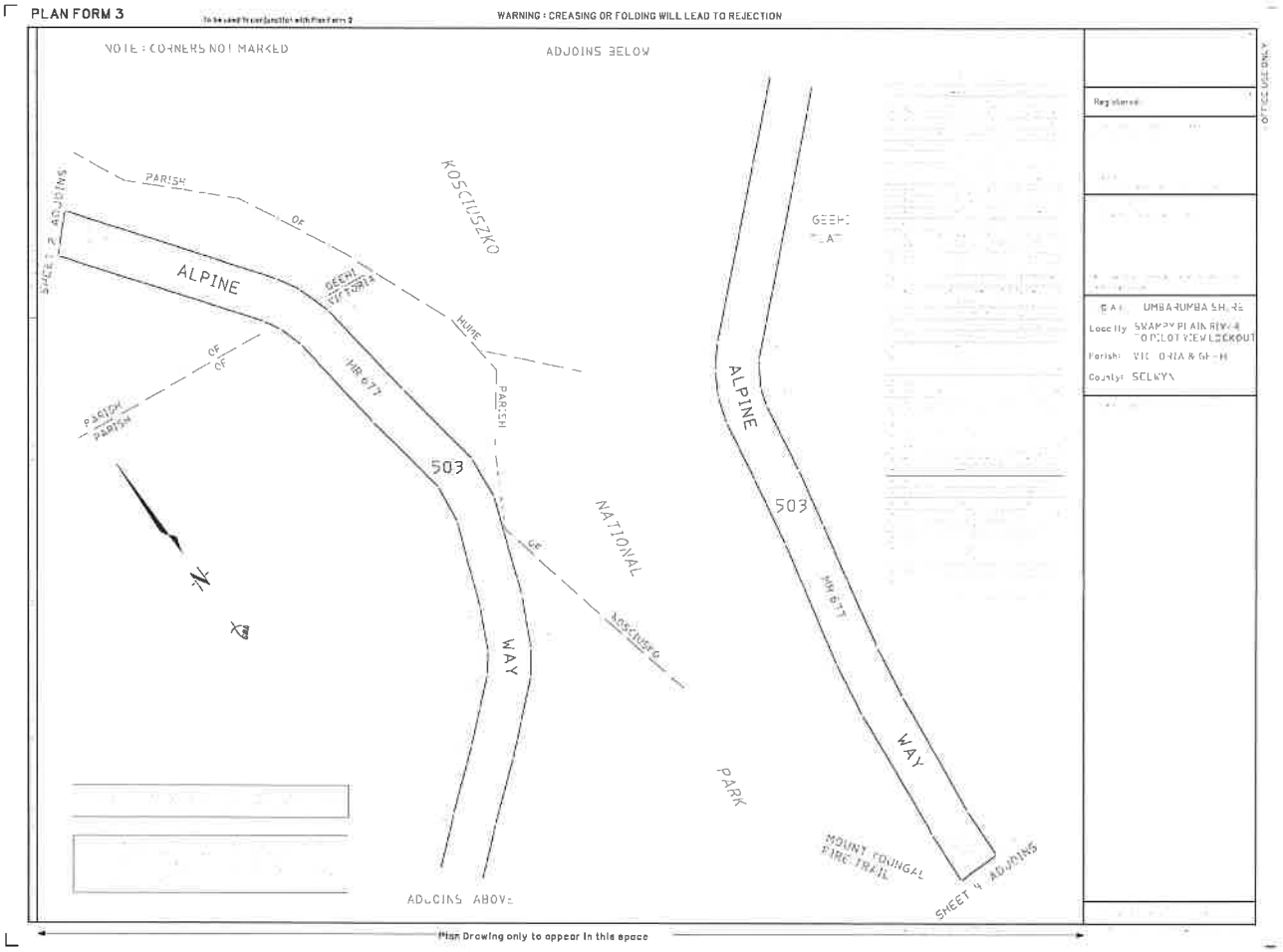
Undertaking the GPS Survey Control: (1) Marijana Kokanovic on Kosciuszko Road (2) Ray Gilmour, Stewart Amery and Peter Radley experience difficult radio reception at a Photo Control Point at Scammells Lookout, Kosciuszko Road (note canopy shadows over the road in the background):

Final Control Survey Plan

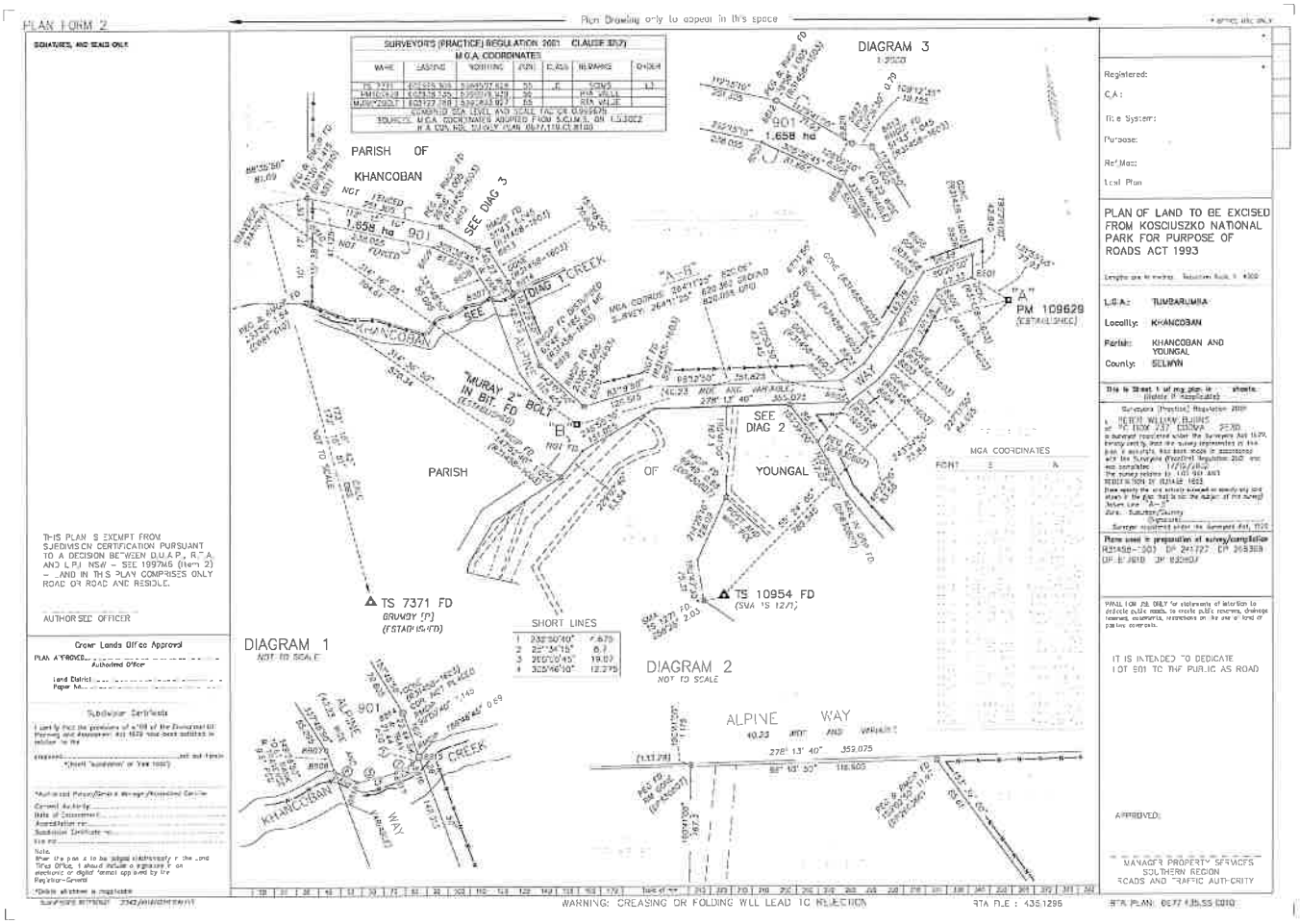


Examples of coordinated cadastre plan sheets

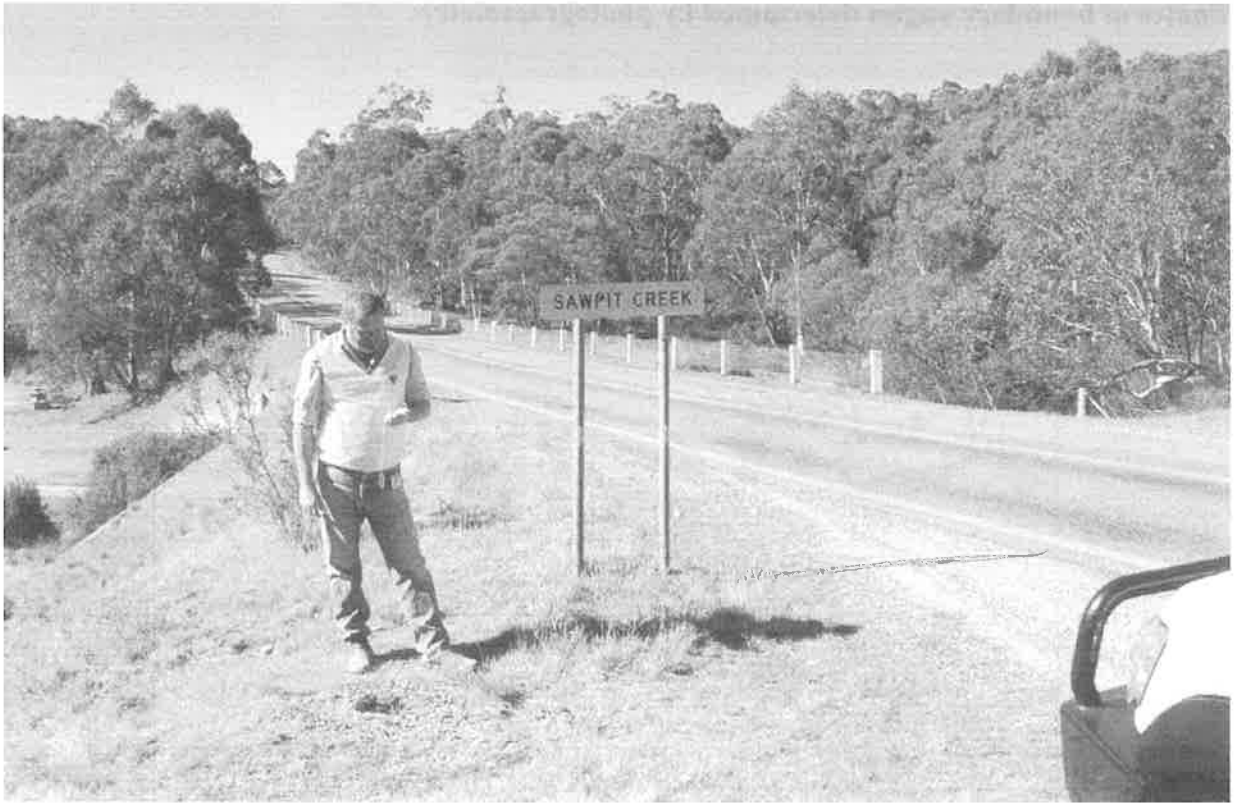




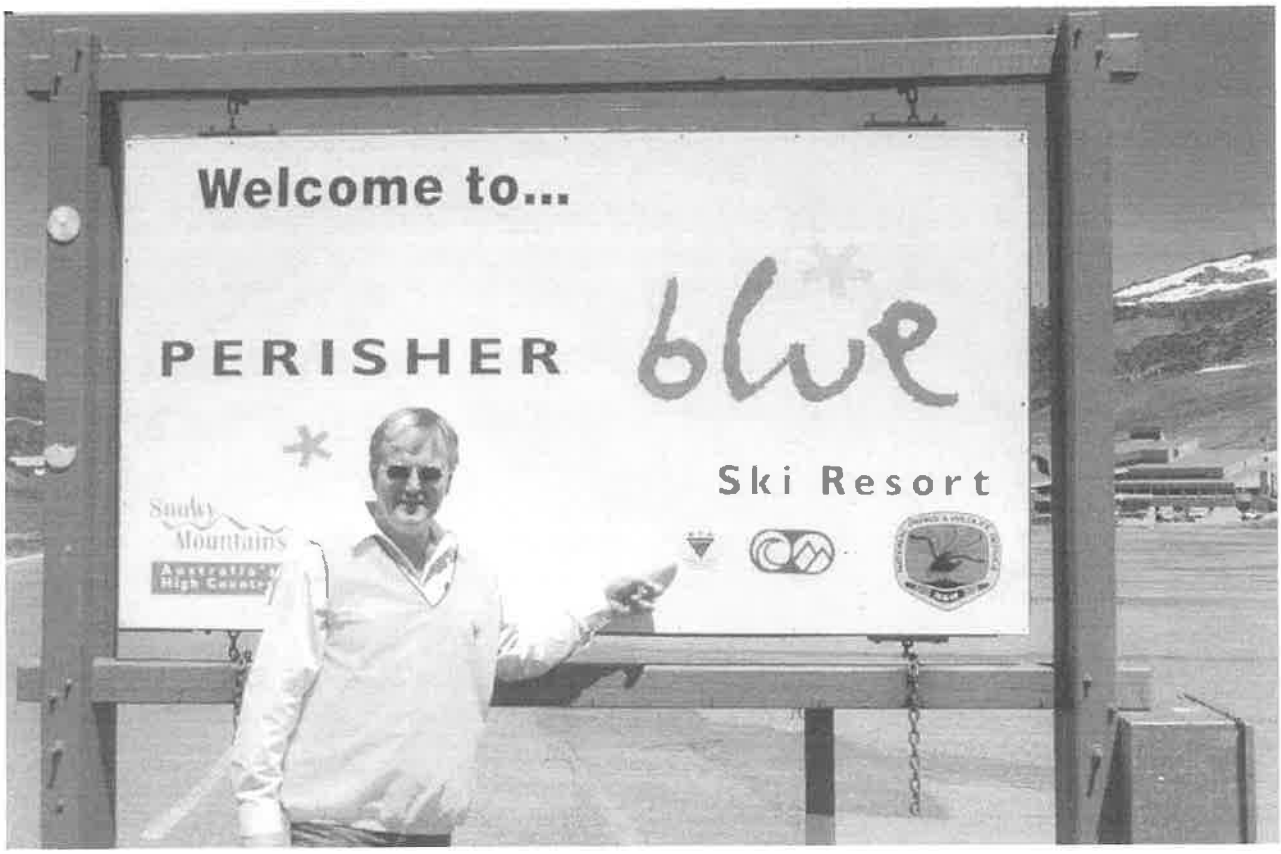
Redefinition Plan (ground survey) by Mr Surveyor Peter Burns at Khancoban, showing coordinates of boundary angles determined by photogrammetry:



Reconnaissance Survey: Bill Evans confirming coordinates of survey control marks and boundary angles. Sawpit Creek, Kosciuszko Road:



The NSW Roads & Traffic Authority makes its "Mark" on Perisher Blue and the future of the coordinated cadastre in New South Wales:


Welcome to...
PERISHER
blue
Ski Resort
Snowy Mountains
Australia's High Country