Sheetlines

The journal of
THE CHARLES CLOSE SOCIETY
for the Study of Ordnance Survey Maps

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Sheetlines, 112 (August 2018), pp3-16

Stable URL: https://s3.eu-west-2.amazonaws.com/sheetlines-articles/Issue112page3.pdf

Published by
THE CHARLES CLOSE SOCIETY
for the Study of Ordnance Survey Maps
www.CharlesCloseSociety.org

Kiwi topographic maps

John L Cruickshank

The new reality of Britain ceasing to be a European country is requiring the development of new world-views and attitudes. Once Britain's membership of the EU ceases, our trading relationships will need to be re-thought, and commercial links to countries on which we turned our backs in the 1970s will need to be recreated. In parallel we perhaps need to re-examine cartographic relationships that were once important and may once again be so. New Zealand is an obvious example of a country that used to have close commercial and cartographic links to Britain, and thus seems a good place to start. On a recent visit I was able both to use some of its present-day maps, and to examine some of its superseded ones.[1]

New Zealand was 'discovered' by Captain James Cook in the eighteenth century and established as a British Colony in the nineteenth century. Gold-mining, the timber trade, and subsequently the expansion of farming, all led to British and European immigration and a rapid population growth that continues. The building of towns and settlements, with the associated clearance of native bush and the introduction of non-native plants, animals and birds, led to huge topographic change. Until the 1970s New Zealand considered itself to be very closely linked to Britain and to be a white-European country, however since Britain joined the EU the country has been actively re-evaluating its self-image and place in the world. The substantial Maori component within its society is now recognised and celebrated, while recent immigration has substantially been from many Asian and Pacific countries. As a result, Auckland in particular has become a rapidly-growing multi-cultural city whose trading links are focussed on the countries of the Pacific rim. These, and in particular China, are now the markets for New Zealand's agricultural produce, and accordingly cattle-raising and dairy farming have substantially expanded while sheep farming has contracted. As a consequence, some marginal farmland has been abandoned and is returning to bush. Accompanying this is a new recognition of the importance and value of New Zealand's native flora and fauna, with attempts to promote these, and to protect and rescue them from the effects of non-native imports. Biosecurity has thus become a major issue, and the importation of plants and animals is tightly controlled. The importance of maps for the recording, management and exploitation of all these changes is obvious.

The early history of the mapping of New Zealand was similar to that of other British colonies. The coastlines were charted by the Royal Navy and subsequently by the Royal New Zealand Navy, while survey and mapping of the interior became the responsibility of a Department of Lands and Survey. As in other

[1] I would like to thank Charlotte Middendorf and her team for showing us the magnificent topography of the Routeburn Track, Ken McDonald (formerly of the New South Wales survey) for some stimulating discussions about the maps we were using, and my son Paul for providing the excuse for our visit. While each thus made a contribution to this paper, none of them bear any responsibility for its final form.

British colonies, topographic mapping was not this department's priority. Its primary task was the recording and administration of land-grants by the Crown with the production of cadastral mapping as required for these purposes. Topographic mapping was technically difficult and expensive, and in the absence of any military or other short-term imperative it could not be funded. The Boer War provides an instance of the difficulties that might arise when a military imperative suddenly arose in such a colony, nevertheless throughout Australasia, as in much of Africa, topographic mapping remained a low priority. A geodetic triangulation of New Zealand was begun in 1909, but was not completed until 1949.[2] The first 1:63,360 topographic sheet was not produced until 1937, and it was only after the Second World War, during which both the techniques of, and equipment for, aerial survey were disseminated around the globe, that substantial progress could be made with topographic surveying and mapping.[3] An additional consequence of wartime military experience was that from 1946 a system was adopted of numbering the various Lands & Survey map series as NZMS 1 to (eventually) NZMS 347. This numbering scheme was applied not only to the then current series, but also retrospectively to some older ones. It remains a useful basis for cataloguing and carto-bibliography.[4]

Thereafter three principal phases can be recognised. The first is characterised by the use of imperial units for surveying and is exemplified by the publication of the NZMS 1 one-inch map, eventually completed in 1975. The second phase resulted from decisions in 1969 and 1970 to metricate all NZ Lands and Survey output. From 1977 the flagship publications thus became the NZMS 260 1:50,000 series and the NZMS 262 1:250,000 series. This phase was closed by the reorganisation of what had become 'the Department of Survey and Land Information' into 'Land Information New Zealand' (LINZ) in 1996, when map production was first 'rationalised' and then fully privatised. The NZMS numbering system also stopped. The third and present phase resulted from a decision by LINZ in 2007 once more to bring map production in-house. Accordingly, from 2009 publication of new 1:50,000 and 1:250,000 topographic map series of New Zealand itself and of its Pacific and other dependencies began.

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[2] For an account of the complex history of this triangulation, and much about the earlier history of the surveying of New Zealand, see LP Lee, *First Order Geodetic Triangulation of New Zealand 1909-1949, 1973-74*, Lands and Survey Technical Series No. 1, (Wellington, 1978), downloadable from: *https://www.linz.govt.nz/system/files_force/media/file-attachments/first-order-triangulation.pdf*

[3] CB Muriel Lock, *Modern Maps and Atlases*, (London, 1969), 391-7, provides a brief but uncritical history and overview of the mapping of New Zealand to that date. RB Parry & CR Perkins, *World Mapping Today*, (London, 1987), 378-384, give a similar overview account to that date and include index diagrams to the principal topographic map series then current. Both include bibliographies of further sources.

[4] See the lists and notes available at *https://gdh.auckland.ac.nz*

Figure 1. New Zealand Beaconed Trig Point (Mount Maunganui). Note that the actual trig point is a steel bolt in the inconspicuous small pillar and concrete block on the ground underneath the beacon.

My personal knowledge of the maps in imperial units is only based on a handful of second-hand sheets. [5] However the first edition of NZMS 1 sheet N168 & N169 *Palliser* published in June 1953 provides a relatively early example. What is striking about this map is the close similarity of its hand-dawn lettering and the design of its marginalia to the OS practice of the time, while the purple grid looks like a GSGS grid. [6] Nevertheless the symbol set is distinctly different, reflecting the differences in New Zealand topography. For example, there is little need in the UK for a symbol to represent mangroves, which are abundant in parts of the North Island. And indeed the annotation of road bridges with a letter to indicate the material of construction is more akin to Soviet practice. The real peculiarity of this map is in the depiction of relief. Although contours are shown in the table of conventional signs, there are none on the map itself. The only indications of relief are the spot-heights given for each trig point. Otherwise one has to guess the relief from the drainage pattern of the watercourses shown. A later example of this series is the third edition of NZMS 1 sheet S 27 *Wairau*, published in 1971. The styles of the lettering and marginalia have evolved substantially but are still reminiscent of OS practice. However on this sheet, relief is not only shown by spot-heights and 100 foot contours, emphasised at 500 foot intervals, but also by very beautiful, precise and effective hill-shading based on a north-west light. And while 100-foot contours may seem widely spaced in an English context, they are entirely suited to the very steep gradients and mountainous terrain of New Zealand's South Island. On this sheet the valley bottoms are at 1,000 feet elevation or below, while the peaks rise above 5,000 feet. Closer contours would have added nothing.

While coverage of the one-inch was still developing, a number of less solidly based maps of tourist areas were also being produced. The first edition of the

[5] However the University of Auckland has developed a Cartographic and Geospatial Resources Repository from which images of successive states of a very large number are downloadable. See *https://gdh.auckland.ac.nz* Note that the one-inch maps of the north and south islands formed separate sub-series plotted on slightly different projections.

[6] However see below.

NZMS 150 1:80,000 *Map of Tongariro National Park* published in September 1958 carries a reliability diagram indicating the source material. While about a third of the map was derived from aerial photographs, only the parts that had additionally been plane-tabled were shown with contours.[7] Well over half the map was derived from 'original maps not verified by reconnaissance'. Scattered across the map are the sort of comments that might appear on explorers' maps: 'fairly flat country scoured by watercourses', 'good climbing ground', 'shrub and grass country', 'good picnic ground'. Relief is shown by hill-shading, drawn with greater apparent confidence in the contoured areas. An inset shows a partly contoured plan of the lower Ruapehu Skiing Grounds (scale 1.4 inches to 500 yards) with a sketched indication of part of the upper ski field. This was manifestly a provisional map compiled from inadequate materials to respond to public demand for some sort of map of a popular National Park containing the only ski resort in the North Island.[8] A somewhat similar map is the NZMS 105 1:100,000 *Map of Marlborough Sounds* (second edition, September 1963). This covers a popular holiday area of sheltered marine waters enclosed by a very complex pattern of peninsulas and islands with many bays and beaches behind which 'baches' have been placed.[9] While the unstated sources for this map seem more uniform (and could perhaps include the admiralty charts), only the vaguest representation of the complex relief of the area is given by hill-shading and occasional spot-heights. These two maps represent the beginnings of an important problem for the New Zealand mapping authorities. The demand at the time for such maps is quite obvious, yet in retrospect they may well have served to accustom a newly-leisured map-using public to second-quality maps with poor relief representation.

The metric NZMS 260 (1:50,000) and 262 (1:250,000) topographic maps produced from 1977 to 1996 (with private-sector issues for a further decade), clearly built on the successes achieved with the one-inch series. They were regarded with sufficient affection by both cartographers and users (two overlapping groups) that in 2011 the New Zealand Cartographic Society published a 100-page commemorative booklet to mark their passing, including articles by different authors documenting their evolution and a definitive list of all map editions and reprints.[10] Conceptually both these series are rather like the familiar Joint Operations Graphic maps, in that they have the legend in the west and south margins, while the map itself comes to a bleeding edge at the north and

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[7] Which may suggest that the available aerial photographs were vertical, rather than overlapping obliques. Note also that much of the then contoured area forms part of a military training ground closed to the public.

[8] The Tongariro Alpine Crossing is now marketed as one of the country's 'Great Walks' and is undertaken by tens of thousands of people a year.
See *http://www.doc.govt.nz/tongariroalpinecrossing*

[9] A New Zealand 'bach' is an informal shack, usually on a beach, used as a second home. With the passage of time, some baches have however become quite substantial permanent structures.

[10] See *https://cartography.org.nz/resources/nzms-260-and-262*

east sides of the sheet. To allow for printing irregularities there is a small (8mm) overlap with the adjacent sheets at the bleeding edges. The sheet-lines of the 1:50,000 series generally conform to a rigid grid plan (with some exceptions at the coasts) and are numbered with a letter to indicate the column and number to indicate the row. In contrast the sheet-lines of the 1:250,000 were staggered to allow efficient coverage of the whole country with minimum wastage of paper. The 1:250,000 sheets are numbered from 1 to 18 (from north to south); there are no overlaps beyond the standard 8mm, except between the northernmost and southernmost sheets and their adjacent ones. Each 1:50,000 sheet covers an area 40 km east-west by 30 km north-south, while the basic 1:250,000 sheet covers 200 km by 150 km, although some sheets are smaller from east to west and others larger, to minimise the total number of sheets required. The 1:50,000 sheets are clear and easy to read. Relief is well shown by 20m contours and precise hill-shading, with scattered spot-heights, mostly at trig points or on hilltops. One feature that I did find surprising is that on the 1:250,000 maps relief was initially only shown by hill-shading. Contours were only added to the hill-shading on editions from the 1990s onwards. The overall style of these maps had moved well away from that of the Ordnance Survey, and there are some clear differences to suit New Zealand's needs. In particular, rural roads are named, and trig points are differentiated into those beaconed, and those not. Tree cover is divided into native forest, exotic forest, and scrub, with a separate symbol for 'burnt and fallen bush'. Some features simply reflect the realities of New Zealand geography. On the first edition (1980) of NZMS 260 T24 *Palmerston North* (1:50,000) there is a printed note beside a gap in the road climbing steeply above the Makairo Stream into the Waewaepa Range: 'Road closed bridge down'. Throughout New Zealand the rapidly eroding young rocks make road-maintenance and bridge-renewal an unending battle. The bleeding edges of these maps invited their pasting together, and I saw some huge wall maps formed this way. One, made up of sheets of the 1:50,000 map, is in the back room of the bar of the Glenorchy Hotel near the termination of the Routeburn Track. Another, at 1:250,000, is on a wall of the cafe opposite the second-hand bookshop in Omarama.

One marked difference of these maps from Ordnance Survey practice is that local government and other administrative boundaries are not shown. The explanation lies in the original nature of the Lands and Survey Department as a land registry. Thus at the time the above maps were issued, such boundaries were recorded and shown on an entirely different map, the NZMS 261 1:50,000 Cadastral Map. These plans, issued at the same time as the above maps (but on different sheet-lines), show property, local government, and survey-area boundaries plotted onto a minimal topographic base giving little more than trig points and the main roads and rivers. No indication of relief appears, even at trig points.[11]

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[11] Comments based on NZMS 261 141 *Danseys Pass* (1st ed. 1976). At the present time LINZ continues to be the national land registry, but all property surveys are now in electronic form only. For details of present procedures see: *https://www.linz.govt.nz*

A profusion of tourist and other maps, of various categories and scales, were published alongside the metric topographic maps. It is difficult to generalise about them except to say that they seem to have been simplified (or even dumbed down) derivatives of the main series, with additional tourist information and pictures in text boxes and on the reverses, plus sometimes town plans or enlargements of areas of interest as insets. Some were contoured (such as the 1:75,000 'Trackmaps' of NZMS 335), but some were not. NZMS 336-06 'Holidaymaker' 1:80,000 *Lake Taupo* has isobaths in the lake, but no contours on the land. One is left with the impression that the ordinary tourist, even one trekking for days through wild country, was not thought capable of reading a full-specification topographic map. Nevertheless they seem to have sold well, as judged by the number of surviving copies.

In very many ways the new 'NZTopo' maps published from 2009 onwards represent a fresh start. Such occasions for change can be a good thing, but my impression in this case is that some lessons learned in the production of the older series had been forgotten, perhaps because the personnel formerly concerned had been let go during the period of privatisation. Some important opportunities were also missed.

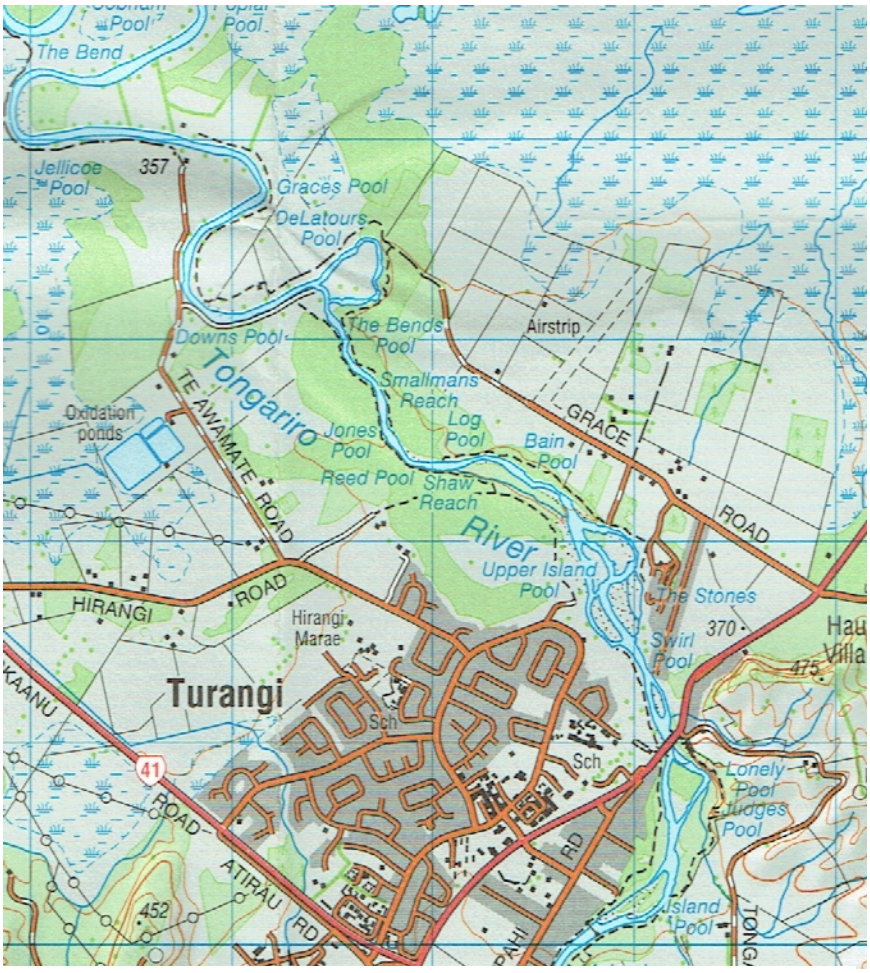

Figure 2. Extract from NZTopo50 sheet BH35 Turangi, edition 1.02 (selected change 2016).

It must be said that the content of the new maps seems good. Based on my limited sampling of a few areas, they seem to represent the ground well and to be pretty much up to date. I personally dislike the traditional NZ symbol for a single-lane road-bridge (a black line that interrupts the continuity of the road colour), but this is trivial. And while the relief is, as on the previous metric maps, shown with both contours and hill-shading, on the new maps the hill-shading is printed so faintly as to be almost imperceptible. To my mind, to be worthwhile, the hill-shading needs to be much more in-your-face. Nevertheless this too is a minor point. At Turangi (sheet NZTopo50-BH35) we encountered a footpath (shown as a vehicle track on previous editions) on the left bank of the Tongariro

River downstream of the Upper Island Pool that is now impassable due to bramble and several years of shrub overgrowth. The former track surface can be followed some considerable distance into the tangle, but no further. This drew to my attention that very slightly separate symbols are defined for 'vehicle tracks', 'foot tracks', 'closed tracks' and 'poled routes'. The symbol used looked as if the path should have been open, but it is difficult to be certain. A greater distinction between these symbols should be considered.[12] Yet despite these things I found the maps easy to read, to use and to navigate with.

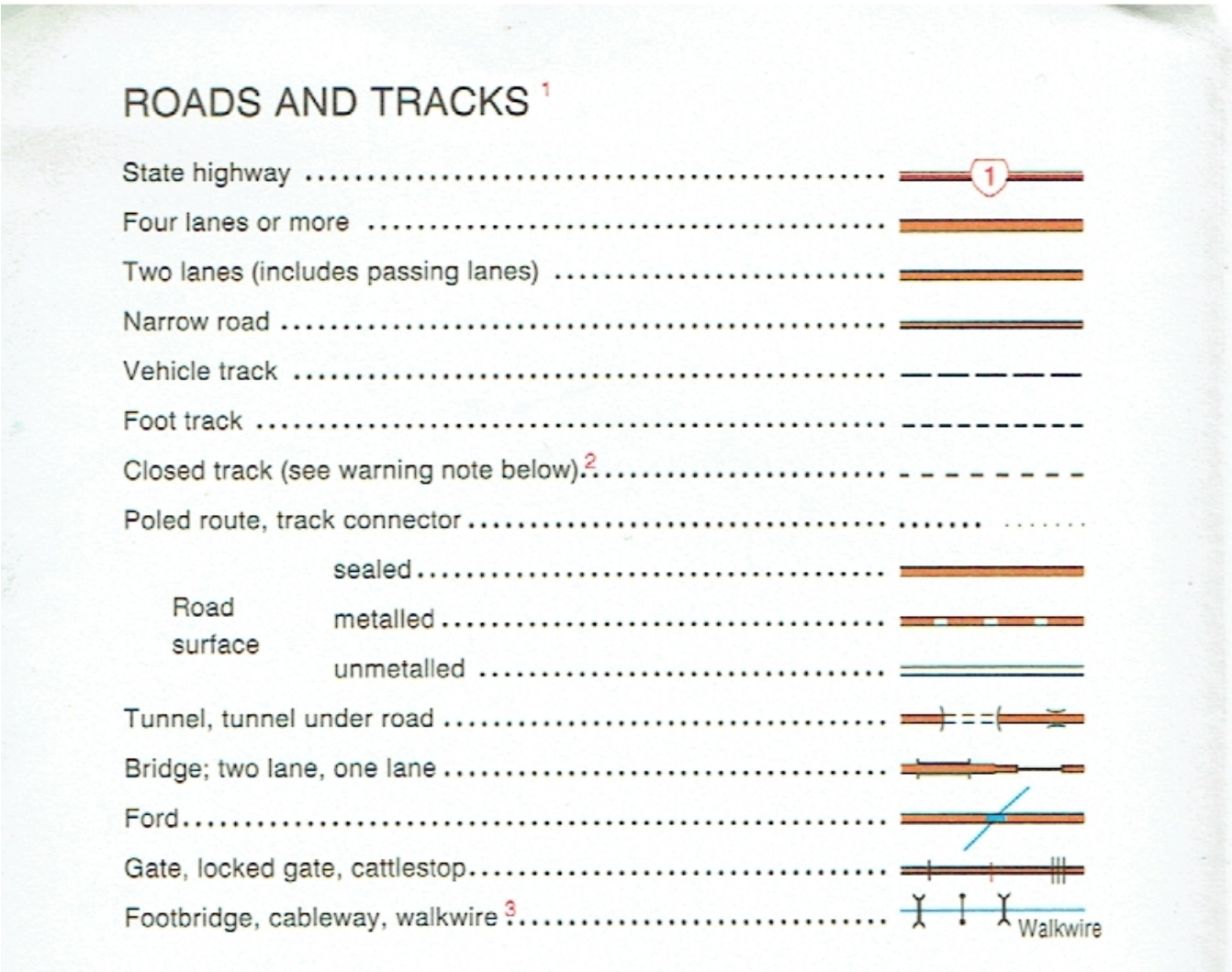

Figure 3. Extract from the Key to the NZTopo50 maps showing the classification of roads and tracks, and the symbols used for bridges

[12] The status of footpaths and other rights of access in New Zealand is complex and not always certain. See *New Zealand Outdoor Access Code (Walking Access Rights and Responsibilities)* published by the New Zealand Walking Access Commission (June 2010). Also *www.walkingaccess.govt.nz*

However, the new NZTopo maps are a standard size, which for the 1:50,000 series covers only 24km east-west by 36km north-south, while the 1:250,00 sheets cover an area exactly matching that of five sheets in each direction, i.e. 25 of the larger-scale sheets in total. These dimensions are substantially smaller than those of the earlier metric series. Furthermore at both scales the sheet-lines form a rigid grid pattern with no overlaps and only a very few adjustments to cope with awkwardly positioned offshore islands. The numbering scheme of the 1:50,000 series uses letters to identify each row, with numbers to identify the position of the sheet within that row. This reverses the scheme used for the earlier metric maps. The small sheet-size means that it takes three passes through the alphabet to identify all the rows, so each row requires a two-letter identifier. The nomenclature is further complicated by a decision not to begin at the beginning of the alphabet, but to begin towards the end of A, so the southernmost rows have identifiers beginning with D. I have not tried to count the number of 1:50,000 sheets, but at 1:250,000 there are 31 sheets now instead of only 18 previously. This rigid scheme, of small sheets with fixed correspondences of sheets at one scale to those of another, looks for all the world like the scheme adopted by the Ordnance Survey in the 1890s for its New Series. The OS maps of that scheme later became known as the small sheet series, which reached its zenith and downfall around 1904. The scheme produced a most elegant pattern of sheet-lines that no doubt delights map-librarians and the mathematically minded to this day. It also rendered Ordnance Survey maps almost unsaleable in competition with Bartholomew's better designed product. At around the time that Charles Close became Director-General of the Ordnance Survey it was realised in Britain that what both retailers and users wanted was large-sheet maps with overlaps as necessary to cover areas of likely interest. No retailer or user wants small coastal sheets covering only headlands and a few uninhabited skerries. No purchaser wants to spend his money on land maps covering large areas of sea. And the only way of reducing the number of places shown irritatingly close to the edge of a sheet is to enlarge the size of the sheets. More recently the commercial failures of both the Provisional Edition and the Second Series of the Ordnance Survey 1:25,000 maps were due to the same problem. Sales and public awareness of the scale improved dramatically when the sheet-lines were rethought and the sheet-sizes enlarged to create the Explorer Series maps.

There are, of course, examples of successful topographic map-series using small sheet-sizes, however the criteria for judging that success are not usually or directly commercial. An obvious example is provided by the Soviet topographic coverage of the world. Particularly in temperate latitudes, the Soviet sheets are very small indeed. However in peace-time the Soviet sheets were only issued in minimal numbers with a requirement that they be returned after use. Although combined sheets had been printed and issued before and during the Great Patriotic War, after that war all Soviet officers and sergeants were taught, as part of their basic topographic training, a method of pasting together up to six

topographic sheets to make a more useful size map.[13] In essence, the Soviet maps were conceived as tiles, to be pasted up into larger sheets at will. Despite previous practice in country pubs and cafes, the current New Zealand map-reading booklet makes no mention of pasting sheets together.[14] In Germany the series sheets are small and the sheet-lines form a rigid framework, but since the Kaisers' time standard practice there has been to produce a multitude of combined sheets for military, administrative, tourist and many other purposes. Again, the series sheets are treated as tiles. In France the IGN has moved decisively in favour of large sheet sizes and flexible sheet-lines, and has abandoned the 1:50,000 scale with its time-honoured rigid small-sheet structure altogether.

A policy has been adopted that all LINZ data, including the maps, should be free to download under a Creative Commons licence. To a mapaholic this sounds like manna from heaven. Yet there are some problems with this policy. From their publication date in 2009 onwards, the entirety of the latest revision of each sheet, whether at 1:50,000 or at 1:250,0000, has been available to download from the LINZ website as a TIFF file. The file sizes vary quite substantially depending on how much sea is shown, but sheets without any sea occupy about 70MB. Even with a good internet connection this takes 2-3 minutes to download. In this form you get not only the map but also the full marginalia including the integral cover panel, just as you would with the printed map. If one had a printer of adequate size one could print the map out, however my printer can only handle A3 paper, and so in practice I can't get the maps to print at scale. Alternatively you can download each sheet as a GeoTIF file of the spatial area only, giving greater functionality, but an even larger file size (138MB for each sheet) and correspondingly longer download time. Because of this, LINZ recommend the use of their free 'LDS' (LINZ Data Service) system which allows one to use the full range of their data without downloading more than necessary. This seems however to be principally targeted at land surveyors and local authority users, rather than leisure users or travellers.[15] The conclusion has to be that not only are the present NZTopo sheet sizes too small for convenient use as paper maps, they are too large for convenient electronic use. Indeed it looks as if the sheet size was

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[13] See IA Bubnov, AI Kremp, & SI Folimonov, *Voennaya Topografiya*, (Moscow: Ministry of the Armed Forces of the USSR, 1947), pp 169-170. The same instructions appeared in successive editions of this official text until the end of the Soviet Union: IA Bubnov et al., *Voennaya Topografiya*, (Moscow: Ministry of Defence of the USSR, 1977), pp 186-188; and also AA Psarev, AH Kovalenko, AM Kuprin, BI Pirnak, *Voennaya Topografiya*, (Moscow: Military Publishers, 1986), pp 299-301. Even before the war, directions for pasting two sheets together had been given in the 1933 edition: IA Bubnov, IS Kaliuzhniy, IP Onishchenko, GF Gapochko, AA Sergeev & SI Folimonov, *Voennaya Topografiya*, (Moscow: State Military Publishers, 1933), pp 141-142.

[14] *Topo50 Map Reading Guide*, (LINZ, n.d.), downloadable from *https://www.linz.govt.nz/land/maps/topographic-maps* Yet note that the bleeding edges of the earlier metric map series (NZMS 260 and 262) had positively encouraged the possibility of paste-ups.

[15] All these facilities are available at *https://www.linz.govt.nz/*

chosen as an awkward compromise between the two requirements, satisfying neither.

The effects of this small-sheet scheme on sales of the paper NZTopo maps should have been predicted. It has been exacerbated by marketing errors that also repeat mistakes made long ago in Britain. Retailers are provided with a stand for the maps that provides slots for many adjacent map sheets, and they seem to be required to stock not only the local map but also a large number of surrounding sheets. Many of these prove to be dead stock. Accordingly very few retailers are prepared to stock the NZTopo maps, and some that once did so (like the busy i-Site in the centre of Rotorua) have ceased to do so. Time and again I was informed that the only shops that would stock these maps were out-of-town hunting-shooting-&-fishing stores. And in such a shop in a mall on the outskirts of Rotorua the staff seemed surprised that anyone should want to buy these maps. Furthermore, even retailers who stock the 1:50,000 maps seldom stock the 1:250,000 sheets, which are clearly seen as unsaleable.

This is because the 1:250,000 map has a direct competitor. A firm called 'Kiwimaps' produces a 1:250,000 'topographic' map of the country, available both as 18 individual sheets, or in spiral-bound atlas form.[16] The representation of relief is by hill-shading, which to my mind renders the 'topographic' descriptor questionable. Nevertheless the maps present an attractively clear image of all settlements, the road and trail systems and significant topographic features. The sheet-lines have been carefully thought out, with a result that is not unlike the sheet diagram for the old NZMS 362, but with extensive overlaps. This has been enabled in part by switching some sheets from landscape to portrait format. The underlying data derives from LINZ, but the country roads are both named and indexed, campsite and motorhome information has been added, as has much tourist information and the routes of the New Zealand Cycle Trails.[17] All place-names are categorised and indexed on the reverse. The maps are even advertised as suitable for joining together, and a 19th sheet of 'water only' is available for squaring up the edges of such a paste-up. The sheets cost $2 more than the NZTopo250 sheets, but you get more map for your money. For a motorist or cyclist it is a far more useful map than the LINZ one. Furthermore it is available, and prominently displayed, at every small newsagent, bookseller and stationery shop throughout the country, even in backwoods settlements. This brings forcefully to mind the despair at Ordnance Survey when the Bartholomew maps were available at every railway bookstall while the OS product had to be ordered in advance at a post office, or from an agent in London, Edinburgh or Dublin.

The 1:50,000 maps do not have a direct competitor, but the Department of Conservation (DOC), which is a government body with protean responsibilities for both land management and tourism across much of rural New Zealand, has developed close links with two linked private-sector mapping companies who

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[16] *http://www.kiwimaps.com/*

[17] New Zealanders remain deeply attached to their motor homes for holidays and travel. Knowledge of the locations of 'Motorhome Dump Stations' is essential for their use.

have cherry-picked the routes of the DOC's 'Great Walks' along with many other trail routes. They now dominate a market that was once the focus of many NZMS tourist maps by providing waterproof maps based on LINZ data, but printed at an enlarged scale and sold at a premium price through DOC offices. These companies also provide mapping support for many other DOC activities.[18]

In Britain we are accustomed to National Grid references derived from Ordnance Survey maps appearing in all sorts of contexts. These include not only local and national administrative and planning documents, but also a wide range of geographical, geological, archaeological, historical, ecological and other academic documents and publications. In the seventy years or so since the system was first presented to the British public grid references have provided a stable and reliable means of identifying precise locations that continues in use in the age of GPS and similar technologies. This stability has been lacking in New Zealand, and as a result there seems little familiarity with the potential uses of a grid reference system, or the importance of using a grid system in a country-wide way. The primary problem is that each stage of the topographical mapping of the country has been associated with a different grid system, and each has been incompatible with all the others. The point was brought home to me by a geology book. Jocelyn Thornton's *Field Guide to New Zealand Geology*[19] is the sort of book that cries out for some grid references. It describes the find-sites of many, many rocks and minerals throughout New Zealand, and their origins and inter-relationships. Yet the find-sites are described using all sorts of transient landmarks, including the courses of public roads that have since been improved and realigned, disused mine access tracks with landmarks along them, and old mine entrances. all of which can be (and probably have been) effaced by land-slips and other forms of erosion, or by regrowth of bush, or by redevelopment for other purposes. No grid references are recorded for her museum specimens, and none are given in her book.

The NZMS imperial maps were constructed using two different transverse Mercator projections, one for each major island. Corresponding transverse Mercator grids were printed on the maps, but the coordinate values were given in thousands of yards, very much as had been the case on the OS Fifth edition one-inch maps of the 1930s. In New Zealand the yard grids were retained throughout the currency of the one-inch maps, and thus into the 1990s. However the metric maps produced from 1977 onwards were plotted on the New Zealand Map Grid Projection, a minimum error conformal projection. The grid was the New Zealand Map Grid, showing coordinates in metres in terms of the Geodetic Datum 1949, based on the International (Hayford) Spheroid.[20] Use of this projection and grid

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[18] See *https://geographx.co.nz* and *http://www.newtopo.co.nz*

[19] Now published by Penguin: 1st edition 1985, with eight reprints, 2nd edition 2003, with three further reprints.

[20] For details of what these terms mean and their implications see: *https://www.linz.govt.nz/data/geodetic-system* See also the book *Where in the World are we? A Technical Guide to Datums and Projections in New Zealand*, Version 2, (Government of South Australia and LINZ, no date), downloadable from the same website.

was unique to New Zealand, and while it covered the whole country it was incompatible with WGS84. Furthermore the 1949 datum applied only to horizontal position and did not provide a height standard. By the end of the twentieth century accumulated errors in the geodetic net combined with strains due to tectonic change in the shape of the country meant that a new datum became required. Therefore the current NZTopo maps have been plotted on a single New Zealand Transverse Mercator 2000 projection based on a new NZ2000 datum, which closely approximates to WGS84. The maps are printed with a corresponding Transverse Mercator grid.[21]

In principle, this grid should be entirely suitable for the full range of military and civilian purposes. However there is a problem that has been rolled over from the older map series. The instructions for the use of the grid are printed in the margin in a box of familiar design. On the old NZMS metric maps this box directed the user to ignore the smaller grid figures at the sheet corners 'which are for finding full coordinates'. The user was then instructed to give a six-figure map reference preceded by the sheet number. Furthermore the instructions given on the 1:250,000 maps differed from those on the 1:50,000 in that one gave a six-figure reference to the nearest 1000 metres while the other gave one to 100 metres. As a result quite different six-figure references were to be quoted for the same point. Effectively the user was directed to use a local grid system dependant on the particular sheet and scale being used, rather than the full national grid. The instruction panels on the current NZTopo sheets have been slightly modified, in that a full national reference to the nearest metre is quoted for the sample point, before giving exactly the same the directions for producing a sheet- and scale-dependant six-figure reference. There are plenty of short-range navigational and similar purposes for which such a local grid system can work satisfactorily. But as a national reference and recording system for general and academic use in an age of GPS devices, a scheme of sheet- and scale-dependant local grids is utterly useless and perverse, the more so as the sheet-lines of the paper maps need to be revised in the near future. Gridded maps were developed for artillery use during the First World War. It was rapidly appreciated then that sheet- and scale-dependant grids caused great difficulties, such that both sides progressively unified their grids to cover larger areas as that war progressed. By 1918 the Germans had unified their Western Front grids, while unification of all the Allied grids was scheduled for 1919, although implementation was aborted following the armistice.[22] That a century later LINZ is still promoting the use of local grids seems almost disrespectful to the knowledge and experience of the ANZACs of 1914-18, who have recently been the subject of major exhibitions in the museums of both Wellington and Auckland. The value and use of the full form of the NZTM2000 grid should be appreciated, publicised and (most importantly)

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[21] For descriptions of the calculations necessary to transform grid values from one system to another see *Where in the World are we? A Technical Guide to Datums and Projections in New Zealand*, op. cit.

[22] Peter Chasseaud, 'German Maps and Survey on the Western Front, 1914-1918', *The Cartographic Journal* 38 (2001), 119-134.

promoted by LINZ outside the cartographic community, very much as Ordnance Survey did with the British National Grid seventy years ago.

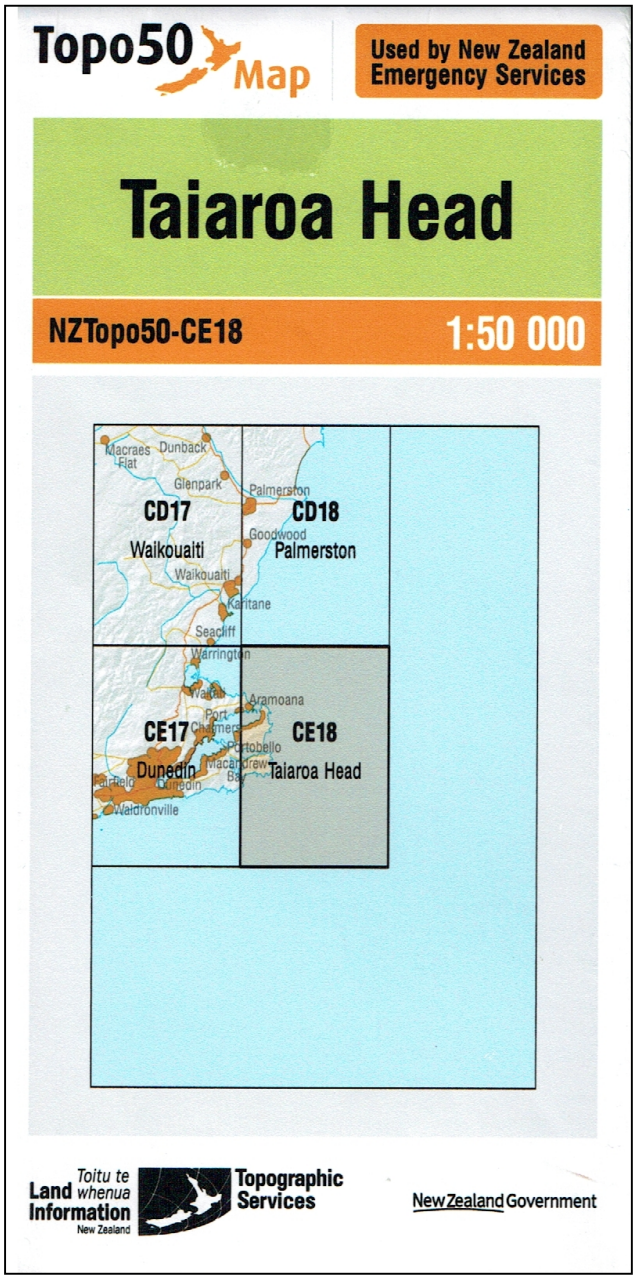

Figure 4. Cover panel from NZTopo50 sheet CE18 Taiaroa Head, edition 1.02 (selected change 2015). Note the small land area covered by this sheet. Note also that the black colour is more intense than it should be, with loss of white line definition in the logo at the bottom of the image; it looks as if there has been a double impression of the black plate in this printing. This suggests that lithography is being used to print these maps rather than any more recent technology.

I commented above on the poor height representation on some New Zealand maps. But for LINZ and its predecessors the establishment of a consistent system of height measurement has been a continuing nightmare. That the 1949 Datum could not provide a height standard was one effect of this. Tide gauges were set up at 13 harbours around the coasts, and levelling traverses were measured outwards from them. Although traverses from some of these centres eventually met, it became clear that for gravitational reasons sea levels differed around New Zealand and measurements derived from different tide gauges could not be equated. Furthermore several of the tide stations turned out to be in tectonically active areas, such that their positions have been disturbed by earthquakes. The harbour at Wellington itself provides one example. Large areas of what is now dry land rose from below sea level in that harbour in the nineteenth century. The international airport is built on one of these, which is now high above the water. Even more immediate is the example of the Christchurch tide gauge which was at Lyttelton Harbour at the epicentre of the 2011 earthquakes. The solution adopted for the 2000 Datum was to relate all heights to the ellipsoid, the theoretical shape of the earth used for satellite navigation systems, however sea level in New Zealand differs substantially, although variably, from the zero height above the ellipsoid. Accordingly LINZ then had to publish the New Zealand Geoid 2005 (with updated versions in 2009 and 2016), to allow ellipsoidal heights to be converted to more useful heights above sea-level. All of which might explain a certain caution in previous years before publishing absolute values for heights alongside matching contours, particularly across an area the size of an old

1:250,000 sheet. And of course, it seems not unlikely that further adjustments to the height system will before long be needed.

Nevertheless, while solutions have now been devised for the problems of defining and presenting height data, some even more intractable problems for LINZ remain. For as the woman in the DOC i-Site in Queenstown put it: 'only the Brits buy the maps'. In Britain several generations have now been taught that to get out of one's car without some sort of map to hand (even if only on a phone screen) is reckless and foolhardy. Going for a walk in rough country without a map would be universally condemned. Yet Kiwis indulge in an astonishing range of outdoor pursuits, in some very wild country indeed, without maps. They will set off up a trail without anything more than a descriptive leaflet picked up from an i-Site, perhaps augmented by a verbal description by a staff member there.[23] In part this reflects the efforts of DOC, and other sponsors of tracks and trails, to maintain them and to provide signage to prevent any wrong turns. But it also reflects an undervaluation of the present NZTopo maps by the public (who have presumably paid for their making), and also a lack of appreciation of the additional context that a map can add to a day's activity, even when navigation proves straightforward. Overcoming these entrenched public attitudes is now the real challenge facing LINZ. It has taken Ordnance Survey well over a century of continuing effort to educate (or perhaps brainwash) the British public in the value and use of their products. That effort has taken many forms, in schools and in school examination boards, in university research and teaching, in Scouts and other youth organisations, in various adult outdoor-pursuit contexts, and in the aggressive retail marketing of OS products from the 1920s onwards. Branding one series as 'the Popular Edition' and another as 'the New Popular Edition' was part of this, as likewise are the present marketing labels: 'Explorer Map' and 'Landranger Map'. LINZ has a long way to go in this, particularly since it is having to develop its own brand from scratch rather than being able to build on a foundation of the old NZMS brands. The fact that its relief representation is at last reliable, and thus far better than that of any i-Site leaflet, should (in the short term) be a major selling point. In the longer run, closer cooperation with DOC would seem desirable. And yes, the immediate recasting and relaunching of both the present NZTopo map series as 'Large Sheet Series', with the addition of more tourist information, would seem an essential part of this marketing and education effort. Indeed, it looks to me as if the 1:250,000 map cannot survive without such a transformation.

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[23] This was made starkly clear to us when we set off from Kaueranga to climb the Pinnacles (773 metres). The DOC i-Site there was able to show us copies of the NZTopo maps, but had run out of sales copies except for those of distant areas. We, and by the look of it everyone else who went up that day, had to make do with a booklet giving brief descriptions of a large number of local trails with thumbnail sketches of their locations.