Australian Land and Geographic Data Infrastructure

Benefits Study

by

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EXECUTIVE SUMMARY

Land and geographic data identifies the location and characteristics of natural or constructed features and boundaries on the earth. It applies to the land mass as well as aquatic, atmospheric and sub-surface environments. The natural features of the environment covered by data include land relief and contours, water resources, geology and minerals, soils, vegetation, climate, fauna and population. Major constructed features falling under the data umbrella include land ownership, government jurisdictions, and physical infrastructure relating to transport, communication, water and energy supply networks.

Data indicates the location and nature of many of the inputs required for economic, social and environmental development and is therefore a fundamental ingredient for major investment decisions. There are few areas of the economy which do not rely on it for planning, maintaining or rationalising their activities.

Overseas experience, together with recent studies of Australia's data infrastructure, point consistently to significant and broad ranging economic benefits from data usage. However, at this stage, very little information exists on how substantial these gains might be for Australia as a whole. Previous studies have been narrowly based in terms of product, geographic or institutional coverage, and their results are difficult to aggregate.

As a first step towards bridging this information gap, the Australia New Zealand Land Information Council (ANZLIC) has commissioned the Economic Studies and Strategies Unit of Price Waterhouse to more closely examine the economic gains from developing, maintaining, improving and providing access to land and geographic data infrastructure at a national level. Price Waterhouse has also been asked to determine and prioritise the steps data supplying organisations in Australia should take to maximise potential infrastructure benefits.

Extensive surveys conducted as part of the review revealed a benefit:cost ratio for data usage of approximately 4:1. This indicates that for every dollar invested in producing land and geographic data $4 of benefit was generated within the economy. For the period 1989-94, these benefits were in the order of $4.5 billion.

Benefits took the form of improved business and strategic planning, increased productivity, the development of new business opportunities, improved scheduling and co-ordination of investment projects, and improvements in the utilisation, pricing, maintenance and disposal of fixed assets. These benefits were distributed across a broad spectrum of economic activities ranging from the operation of electricity, gas, and water utilities to the development of projects involving agriculture, mining and environmental management.

Survey results also indicated that the existing infrastructure for supplying data had provided information to users at a cost far lower than alternative methods. If this infrastructure had not been in place, and users had been forced to meet their data requirements from other sources, their costs would have been approximately 6 times higher. Over the past 5 years alone, established infrastructure has saved users over $5 billion, much of which was re-invested to generate additional economic activity. The results suggest that investment in infrastructure of close to $1 billion since 1989 has been utilised effectively by data supplying agencies and has led to important cost savings for industry.

A series of case studies conducted as part of the review lent support to the scope and magnitude of these benefits and demonstrated the diverse nature of gains arising from data application.

For example, the use of improved land and geographic data by the Melton Shire Council reduced the time taken to supply local area information to industry by over 90 percent, while Sydney Electricity reduced its operating costs by over $2 million as result of applying improved data to producing maps, recording electricity usage, and lowering the risk of asset damage associated with maintenance and new construction. In Victoria, the remote sensing of tree cover had an important impact on the State Government's ability to regulate logging activity, manage wildlife-corridors, and plan for bushfire management.

The application of data to health services provision in North Sydney facilitated the more effective location of medical screening programs and investigations into the causal relationships between disease and environmental factors such as lead levels and toxic waste. Following the use of data by the NSW Police in selected jurisdictions, reductions in crime rates emerged and policing costs were cut through improved resource allocation. The Victorian Department of Education used data to rationalise its building assets and save in property maintenance costs. Finally, CRA Exploration used data to exploit new mineral deposits and greatly expand its business development capability in Australia and overseas.

If benefits of this kind are to continue, it is imperative that Government-owned data supplying agencies be given adequate budget support. From surveys and discussions with major data suppliers and users throughout Australia, Price Waterhouse estimates that the additional investment required to meet the growing demands for data usage over the next 5-10 years is in the region of 30% of existing funding levels.

A substantial proportion of this amount may come from productivity improvements within data supplying agencies (and therefore be met at no direct cost to Government) as a result of the application of new and improved technologies for data collection, storage, analysis and distribution. However, gains in productivity may not be sufficient by themselves to fully satisfy additional funding requirements. It therefore seems likely that the full retention of productivity gains by data supplying agencies will need to be supplemented by net increases in Government budgetary expenditure, if adequate data development is to be achieved

Continuing budget support will enable data suppliers to meet growing demand for sophisticated data products. It will also enable suppliers to bring existing data sets to a consistent quality. Uniformity in data quality or standard is a key determinant of both the demand for data products and the benefits which might eventually flow from their application to investment projects throughout the economy.

The task of bringing the quality of data sets to a consistent minimum level, and the resources which are needed to achieve this, should not be underestimated. Sets compiled by data supplying agencies have often been put together over extended periods of time in response to immediate user requirements, available budgetary support, and prevailing technologies. As a result, broad disparities in data quality are now a feature of Australia's land and geographic information infrastructure. Available evidence on the costs and

benefits of investing in data infrastructure indicates that any resources devoted to overcoming these problems will yield substantial net economic gains.

In order to ensure that budget funds are utilised to maximum effect, it is important that steps be taken to improve co-ordination between data supplying agencies at the Commonwealth, State and Territory level. Improved co-ordination offers the advantages of clearly prioritising data projects for Government funding and avoiding any unnecessary duplication of effort. Recent experience in Victoria involving the Office of Geographic Data Co-ordination provides a useful guide to how advances in this area might be achieved.

At the same time, continuing efforts need to be made to improve the adoption of existing standards for data transfer and, where feasible, to extend the range of standards to other areas including data collection and storage and the compilation of metadata. Standards remain central in any attempt to bring data sets to a uniform minimum quality and have a direct bearing on the resources ultimately required by data supplying agencies to maintain and expand their capability.

In line with the recent Hilmer Report on National Competition Policy, data suppliers throughout Australia must also consider the establishment of a framework for facilitating competition in data supply and ensuring that users have access to critical or essential data on fair and reasonable terms.

This should be pursued through Government-owned data suppliers improving their delivery of metadata which is an essential input for firms in the private sector wishing to become suppliers of value-added data products. It should also be pursued by establishing a set of basic conditions for access to data, which will ensure that the legitimate interests of users and suppliers are considered in establishing reasonable prices for products subject to little or no market competition.

Finally, major data supplying agencies should move towards a more formal process of performance measurement to gauge how efficiently their resources are being utilised. This could be based in the first instance on a physical indicator of labour productivity but eventually extend to cover delivery against agreed schedules, systems down-time, changes in data quality, performance against pre-determined administrative or political objectives, and benchmarking. An essential prerequisite for progress in this area will be improvements in the cost and resource attribution systems of data supplying agencies.

Drawing these points together, the development of infrastructure in the years ahead will depend on two mutually supporting strategies. The first is adequate Government funding for data maintenance and improvement. The second is an improved data policy environment. If sufficient funding for Government-owned data suppliers is provided and concerted efforts are made by suppliers and users to improve co-ordination, upgrade standards, safeguard market access to essential data, and monitor performance, Australia's infrastructure will be well placed to meet demands arising over the next 10 years.

1. INTRODUCTION AND TERMS OF REFERENCE

INTRODUCTION

Land and geographic data indicate the location and nature of many of the inputs required for economic, social and environmental development. They are a fundamental ingredient for major investment decisions and covers areas which include topography, property ownership, natural resource distribution, land use and administrative boundaries.

In Australia, the bulk of data is collected and managed by Government agencies at a local, State and Commonwealth level. National co-ordination takes place through a cooperative intergovernmental organisation - the Australia New Zealand Land Information Council (ANZLIC).

As part of its third strategic plan, covering the period 1994 to 1997, ANZLIC has identified a series of steps designed to improve the efficiency with which Australian land and geographic data is provided to users. The strategy focuses on:

- standardising fundamental data sets;
- avoiding any unnecessary duplication of effort among data supplying agencies; and
- improving data accessibility and coverage.

The strategy has emerged at an important time in the evolution of Australia's land and geographic data infrastructure which is defined to include data sets and the operating systems and institutions which support them. The past few years have seen large scale investment in upgrading data from paper-based to digitally-based formats. They have also seen an increasing reliance on input from satellite imagery and remote sensing. Improvements in technology have not only enhanced data coverage, accuracy and availability but enabled data to be combined in ways which greatly enhance their information value.

The process of reform is still in its intermediate stages. Substantial on-going investment is needed if the pace of reform is to continue and if already established programs are to be brought to completion. Such investment should be undertaken in a coordinated manner, within a policy environment dedicated to efficiency in data production and distribution. It should be guided, at least in part, by information on those data areas likely to yield the most significant overall returns to the nation.

TERMS OF REFERENCE

Overseas experience, together with recent studies on selected areas of Australia's data infrastructure, suggest that attention to each element of the ANZLIC strategy will result in substantial and broad ranging economic benefits. However, at this stage, very little data exist indicating how significant these gains might be for Australia as a whole. Previous studies have been narrowly based in terms of product, geographic or institutional coverage, and their results are difficult to aggregate.

As a first step towards bridging this information gap, ANZLIC has commissioned the Economic Studies and Strategies Unit of Price Waterhouse to more closely examine the economic gains from developing, maintaining, improving and providing access to land and geographic data infrastructure at a national level. Price Waterhouse has also been asked to determine and prioritise the steps data supplying organisations in Australia should take to maximise potential infrastructure benefits.

The Terms of Reference for the study are to:

- examine and document the costs and benefits of the land and geographic data infrastructure in Australia over the past 5 years;

- estimate the public and private sector benefits by industry segment for the next 10 years, assuming that current levels of investment continue;

- identify actions that could be taken by the public sector and private sector in Australia to increase the level of benefits over the next 10 years; and

- make recommendations on how jurisdictions within Australia can monitor benefits in a nationally consistent manner.

STUDY STRUCTURE

The study which follows is structured to capture each of these points.

Chapter 2 outlines Australia's data infrastructure characteristics, including the nature and pace of recent technological change. It identifies some of the more important issues now being faced by policy makers and briefly examines previous studies relevant to each.

Chapter 3 then describes the methodology used by Price Waterhouse to identify and compare infrastructure costs and benefits. A comparison of traditional models of cost-benefit analysis and cost-effectiveness analysis is undertaken, with the conceptual advantages and limitations of each being described. The Chapter then discusses the approach ultimately chosen by Price Waterhouse, the reasons behind its selection, and the process by which supporting statistical evidence was obtained.

Chapter 4 applies this methodology to Australia over the past 5 years, identifying cost savings by major industry sector. Estimates of how these savings might move in future are also provided. The Chapter develops the key points arising from earlier findings through a series of seven case studies.

Having established the broad economic parameters of data infrastructure in terms of costs and benefits, Chapter 5 examines possible avenues for efficiency improvements. The focus is on scope for maximising efficiency through policies which cover areas such as commercialisation and contracting-out, avoiding duplication of effort by data collection agencies, implementing equitable and efficient principles governing data pricing and access, and establishing a nationally consistent set of data standards.

Chapter 6 completes the study by dealing with how efficiency improvements might be monitored. It suggests a national performance monitoring program under which the cost, quality, coverage and timeliness of data can be assessed and compared.

ACKNOWLEDGMENTS

The study has benefited greatly from the input of major land and geographic data users and suppliers. ANZLIC and Price Waterhouse wish to thank all those involved for their assistance.

In particular, we would like to acknowledge the valuable contribution made by case study participants CRA Exploration, the Melton Shire Council, the NSW Police, Sydney Electricity, the North Sydney Area Health Service, the Australian Bureau of Agricultural and Resource Economics, and the Victorian Department of School Education.

2. LAND AND GEOGRAPHIC DATA INFRASTRUCTURE IN AUSTRALIA

Land and geographic data (LGD) may be broadly defined as information which identifies the location and characteristics of natural or constructed features and boundaries on the earth. It applies to the land mass as well as aquatic, atmospheric and sub-surface environments. Data is captured, stored, analysed, displayed and distributed using a land and geographic information system (LGIS), normally consisting of data gathering, drafting, computing, assessment, and distribution capabilities. These systems operate within a land and geographic data infrastructure (LGDI) which comprises strategic objectives, administrative processes and policies, technical standards, and organisational structures aimed at ensuring that the needs of data users are met.

DATA

i) Basic Features and Usage

The natural features of the environment covered by data include land relief and contours, water resources, geology and minerals, soils, vegetation, climate, fauna and population. Major constructed features falling under the LGD umbrella include land ownership, government jurisdictions, and physical infrastructure relating to transport, communication, water and energy supply networks.

There are few areas of the economy which do not rely either directly or indirectly on this kind of information for planning, maintaining or rationalising their activities. LGD plays a pivotal role in defining land property rights, and therefore underpins the efficient operation of most markets. It is used extensively in the management of public utilities, transport and communication projects, mineral and resource development projects, and environmental research and regulatory programs. Land administration and agricultural land use are heavily reliant on LGD as are essential services provided in the fields of defence, tourism, education, health, business, commerce and finance.

The following examples, drawn from recent experience in Victoria, demonstrate the range of activities to which data has been applied:

- accurate accounting of Government assets, in the lead-up to a disposal of properties which were either excess to requirements or capable of yielding a higher commercial return;

- the estimation of future school age populations for educational resource planning;

- the formulation of plans for maintaining roads, telecommunications and power lines, and sewer and water pipes;

- the construction and re-adjustment of electoral boundaries, based on demographic trends;

- the administration of property tax collection systems; and
- responses to calls for assistance from police and emergency services[1].

This list will expand in the years ahead as data are adapted for use in new areas such as real-time remote monitoring of vehicle speed and location for the transport industry, monitoring of traffic density patterns, determining accident and crime locations, and modelling environmental and ecological trends[2].

(ii) Collection and Distribution

At present, the bulk of data is generated within the public sector mainly to meet statutory requirements and is most frequently used as an intermediate input. For example, most NSW land data sets are generated by the Department of Conservation and Land Management predominantly for internal planning. Components are then adapted and applied, mainly by the State's publicly-owned electricity, water and gas utilities.

In order to avoid duplication of effort and to ensure data quality, Government agencies have tended to specialise. As a result, many are now sole or monopoly suppliers on an Australia-wide basis. Specialisation has allowed economies of scale to be exploited by defraying fixed costs across a substantial range of output and developing high levels of expertise through learning-by-doing.

Major Government users frequently choose to develop their own data base as a means of directly influencing data quality, coverage and scheduling. In more recent years, this has been accompanied by a shift towards commercialisation aimed at ensuring that existing data sets are compiled with closer attention to technical efficiency and cost effectiveness. However, at the present time, most data supplying agencies operate within traditional departmental structures.

While the coverage and format of most data are geared primarily to the needs of the original collecting agency, scope exists for agencies to further develop or transform data in response to the needs of users including those in the private sector. So-called `value-adding' tends to centre on the development of software to improve data formatting, coverage or distribution.

Very little information is available to indicate the potential demand for value-added products or services, or whether these could or should be supplied by Government agencies. Decisions by Government-owned data suppliers to develop value-added items appear to be made mainly on an ad-hoc basis taking both technical and budgetary constraints into consideration. While there exist substantial numbers of mainly small-medium sized firms in the private sector involved with land and geographic data, these tend (with some notable exceptions) to concentrate on the provision of supporting

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1 Tomlinson Associates, *State Government of Victoria Strategic Framework for GIS Development - GIS Strategy Report*, Melbourne, 1993, p.9.

2 *P. Zwart, Land Information - Managing a Vital Resource*, Hobart, 1994, p.17.

hardware and software or on specialised tasks such as data scanning. Few appear to possess a value-adding capability comparable to that of major Government-owned agencies.

SYSTEMS

(i) System Structure and Technologies

As indicated by ANZLIC,

"the essence of land and geographic information systems is their ability to link a multitude of land and geographic related attributes, often from many different sources and maintained by many different agencies, to a unique geographic location or area...

systems vary in sophistication and complexity, ranging from traditional manual systems using paper files, maps etc to modern computerised information systems...

spatial information systems, multi-purpose cadastre, resource information systems, facilities management systems etc are being used to describe all or part of this environment."[3]

Important tasks in the development of a land and geographic data system include:

- establishing user requirements;
- defining the scope, quantity and quality of data needed to meet user needs;
- devising schemes for data capture and validation;
- defining system boundaries, spatial referencing benchmarks, standard coding, and terminologies;
- estimating system load, testing procedures, hardware requirements and software engineering tasks; and
- assessing the cost effectiveness of system design. It is often the case that the majority of benefits can be achieved with a limited system coverage. Attempts to pursue remaining tasks can prove costly while adding little to overall infrastructure capability or user satisfaction.

In recent years, the capacity of systems to supply data has been enhanced by two major technological developments: the production of maps using (more flexible) digital technologies, and the use of computer-based systems to integrate different layers or forms of spatial information. Both shifts have provided data supplying agencies with the ability to more easily assimilate information from different areas and to generate output geared more closely to the specific needs of clients. Reform has been facilitated by dramatic increases in computer capacities, networking through high-speed electronic data transfer

3 ANZLIC, *Access to Government Land Information*, Canberra 1990, p.3.

paths available on standard telecommunication channels, and software design which is increasingly user-friendly.

Examples of where capabilities of this kind have been used include an extension in the scales and themes of land-based maps, improved response times by Government agencies to information inquiries, and the assimilation of various types of data by local governments to analyse the correlation between land use, population, and river catchments in order to optimise the use of fringe farming land for urban development.

(ii) Costs and Resources

The process of `digitisation' has been resource intensive and is still only partly complete for many of the major data sets. One of its most important aspects is the conversion of existing data from manual to electronic form. Raw data input required by computer-based technologies is extensive and must frequently be drawn from analog (ie. paper) sources. In many cases, data conversion costs can be many times the costs of associated computer hardware and software.

An extremely important feature of this process is the need to achieve a consistent level of quality for the data being used. For most supplier agencies, data input has been gathered over an extended period during which different approaches to collection and processing have applied. Upgrading areas of a data set to comply with the minimum uniform standards suitable for digitisation is a critical and resource intensive task.

On average, initial work associated with data capture and transformation has tended to account for around 70% of total costs, with the remainder being allocated to data integration and access functions. Many data suppliers in Australia are now focusing on the integration and access stages of system development, following extensive effort being directed to data collection (including digitisation) over the past 10-20 years. However, it seems unlikely that this kind of re-alignment will result in a substantially lower overall cost structure. Significant on-going costs arise in relation to maintaining basic data sets and ensuring that these are of a consistent quality.

As Richards notes with respect of Australian States:

> "Costs of implementing a comprehensive state land [and geographic] information system are high, and the pay back period quite long in comparison to some other data processing investment opportunities. While this may seem paradoxical at a time when there are almost weekly press articles reporting on the power of the silicon chip and the rapidly improving price/performance ratio of computers, the fact is that system development costs are dominated by the costs of capture and validation of the huge amount of land [and geographic] data that already exists in hard copy and graphic form.

Governments will need to take a long view in embarking on a land [and geographic] information strategy."[4]

However, while declining costs of computer hardware and software may have had a limited effect on infrastructure from the perspective of overall data coverage, they have greatly improved access to established or existing data bases. Lower software costs in particular have seen the prices for desktop mapping units decline to the point where basic digital data applications now fall within the financial range of small-medium sized enterprises. More sophisticated forms of data use, frequently involving statistical analysis, may still be beyond the reach of smaller operators.

INFRASTRUCTURE

Available technologies are capable of generating increasingly sophisticated land and geographic data and computerised systems now provide advantages which a decade ago would have been hard to envisage.

Emerging from this trend have been new challenges for data supplying agencies and for ANZLIC in attempting to establish a national framework under which efficient data production and supply can take place.

One of the most obvious challenges to have arisen in recent years relates to the fact that computer-based technologies help facilitate access to land and geographic data systems holding information about a person or property which may be considered sensitive. This includes ownership of assets, asset values, tax obligations, and commercial project proposals. In some situations, computers have `created' access to information by overcoming the previously prohibitive costs of a manual search.

Accordingly, the issue of confidentiality has assumed a prominent position. Major data suppliers have been faced with the task of striking an appropriate balance between the rights of individuals and the overall economic benefits which flow from a more open data network.

Initial work has been done by ANZLIC in this area, against a background of national concern at the effects of information technology on the privacy of individuals. Most has been aimed at educating data supplying agencies on the principles behind the protection of an individual's rights, in accordance with United Nations and OECD guidelines. The objective has been to establish a policy environment under which individual agencies may make informed decisions on a case-by-case basis.

Another important challenge has involved establishing nationally consistent land and geographic data standards and supporting this with dictionaries which classify and index data to ensure that it can be readily identified and retrieved.

To meet these needs, ANZLIC has prepared a Draft National Policy on the Transfer of Land Related Data which addresses procedures to be applied to data collected in the public interest and transferred to another party for non-commercial application. These

4 A.G. Richards, *Land Information Systems - Concepts, Costs and Benefits,* Hobart, 1980, p.4.

and other kinds of data transfers are to be facilitated by AS4270 - the Spatial Data Transfer Standard (SDTS). SDTS was developed to transfer complex topologically-structured land and geographic information in a manner consistent with limiting data degradation. The ANZLIC Draft has yet to be finalised or widely adopted.

To assist with the implementation of SDTS, ANZLIC has:

- supported the establishment of the Australasian Spatial Data Exchange Centre (with three year funding totalling $300,000) to provide technical support training for users; and

- worked towards the development of a national data dictionary, data directory, and standard to deal with a number for requirements including rural street addressing.

Nevertheless, it appears that the unimpeded transfer of data between most Government agencies is still some distance away. In order to improve access to Government data by users and private sector organisations wishing to develop a value-adding capability, more detailed descriptions of the data characteristics are required at the point of sale or distribution. This 'metadata' is essential for even simple data transformation tasks and is a necessary catalyst for wider data distribution, processing and final usage.

Important challenges have also arisen in relation to the custodial responsibilities of major data supplying agencies under a national strategy. These have been designed to clarify the responsibility of agencies in the areas of data collection, currency, storage and security. Their objective is to ensure that uniform technical standards are met and that high levels of user confidence in Australia's national infrastructure continue.

Key elements of custodianship have been identified by ANZLIC through a series of public discussion papers as well as policy guidance provided in the Draft National Policy on Data Transfer. The latter document acknowledges that in return for incurring the sometimes considerable cost of generating data and complying with national technical requirements, custodial agencies at Commonwealth, State, and Territory levels should have the ability to influence the conditions under which their data is supplied, including:

- pricing;

- licensing arrangements;

- marketing and distribution channels; and

- policies applying to sub-contracting.

Finally, agencies and authorities have faced complex challenges in establishing a suitable national economic framework under which Australia's land and geographic data infrastructure should develop.

In this respect, ANZLIC has moved to clarify a number of issues surrounding data pricing and access. Its Draft National Policy on the Transfer of Data recommends that data for *non-commercial* purposes be transferred at cost, and that data provided for other applications be distributed on terms determined by the supplying agency. `At cost' is defined to include computer processing costs, costs of consumables, distribution staff costs and associated overheads. The costs of collecting, maintaining or upgrading data are excluded. This is consistent with the economic concept of pricing at avoidable cost.

The approach is driven by the understanding that non-commercial data are normally generated as part of statutory or other obligations and are therefore created and funded in accordance with a clearly defined social need. The data would have been created irrespective of the number of additional users. Accordingly, they may be provided to all, at a price which need only cover the incremental costs of extraction and distribution.

The Council also intends to produce a discussion paper during 1994-95 defining the basic data infrastructure which Australia will need in the years ahead to meet economic, social and environmental needs.

As indicated earlier, the process of infrastructure reform in Australia is still only partly complete. Substantial additional investment in the years ahead is needed if major data projects and programs are to be brought to a successful completion. The need for on-going investment takes place at a time when Government budgets are under intense pressure. It also coincides with Treasury Department demands for quantitative evidence on two keys issues, the first being the technical merits of a proposal and the second the economic advantages of investment in land and geographic infrastructure compared with other government funding priorities. ANZLIC's paper will be directed to the first of these areas.

The priorities set through ANZLIC's proposed discussion paper will be based on the longer term *technical* requirements of users and complement work at a State level to re-evaluate the *technical* suitability of existing data sets. The paper will focus on areas in which more than one agency is involved and the need therefore arises for some form of co-ordination to ensure that technical imperatives are met.

However, the paper will leave untouched the central issue of whether further investment in infrastructure can be justified from an *economic* perspective. Ideally therefore it should be supplemented by some form of cost-benefit assessment. Cost-benefit information is needed in deciding:

- the overall budgetary assistance which land and geographic data infrastructure should receive relative to other areas competing for Government financial support; and

- if funding is tightly constrained, as appears likely, how available resources devoted to this infrastructure might be distributed.

To meet this requirement, ANZLIC has commissioned the Economic Studies and Strategies Unit of Price Waterhouse to undertake the current study.

PREVIOUS COST-BENEFIT STUDIES

Cost-benefit studies carried out recently in Australia already indicate that substantial net benefits will arise from additional infrastructure investment. The insight which they provide deserves close attention. The major studies are those by ABARE (1994), KPMG Peat Marwick (1994), Tomlinson (1993), Price Waterhouse Economic Studies and Strategies Unit (1992), Department of Defence (1992), EASAMS (1991), Western Australian Government Taskforce (1990), Price Waterhouse Urwick (1990), MWP Management Consultants (1988), and the Bureau of Transport Economics (1982)[5].

ABARE (1994) examined the economic costs and benefits of two selected applications of land and geographic data - the use of satellite imagery to map tree cover in Victoria, and the use of remotely sensed information to monitor pasture fertiliser status throughout Australia. Net gains of around $1.5 million were estimated to have flowed from the first application, where gains were measured in terms of the lower cost of satellite imagery relative to the next best alternatives of aerial photography and land surveys. For the second application, a net gain of around $66 million was estimated. In this case, benefits were measured from the perspective of remote sensing allowing farmers to identify their most efficient fertiliser distribution patterns and to replicate these in other areas of their operations to produce higher overall crop/livestock yields.

KPMG's study (1994) aimed to construct a business case for the development and co-ordination of spatial information systems within South Australia's public sector. Final results were based on experience from three projects, namely the establishment of a State asset management system, the mapping of a stormwater network, and the construction of a spatial information systems data directory. In overall terms, costs of around $1.2 million were estimated, compared with between $3.5 million and $7.0 million in benefits. The gains from improved access to data were generated from a number of sources, perhaps the most important being higher internal productivity as higher quality data reduced manpower requirements within State Government agencies.

Internal efficiencies were also the principal component of gains identified by Tomlinson Associates (1993) which examined, in considerable detail, the costs and benefits of land and geographic data use within the Victorian Government. Tomlinson estimated that overall data costs of $56 million would yield benefits of around $312 million to the State, representing a benefit:cost ratio of 5.5:1. The study covered the five key program areas of demography, land status and asset management, community health and welfare, resources and the environment, and State planning and infrastructure. Sets of results were presented for each major Government agency. Gains were generated primarily through data increasing staff productivity within agencies and providing for improvements in the utilisation, pricing, maintenance or disposal of agency assets.

Price Waterhouse Economic Studies and Strategies Unit (1992) surveyed the Public Interest Program of the Australian Surveying and Land Information Group (AUSLIG). The study

5 These studies are fully referenced in the Bibliography.

estimated total program costs to be in the order of $27 million compared with Program benefits which were estimated conservatively at $103 million. This produced a benefit:cost ratio of around 3.8:1. Net gains were measured mainly in terms of AUSLIG's low data supply costs relative to the costs of alternative sources of land information. Results were presented for each of AUSLIG's major product groups on an Australia-wide basis.

The study by Defence (1992) attempted to assess gains arising from the Royal Australian Navy's hydrographic program. A number of major benefits were identified including a reduction of shipping costs through improved navigational information, and a reduction in risk associated with accidents at sea. These benefits were unable to be quantified and therefore compared with the program's costs. However, earlier work by the Bureau of Transport Economics (1982) provided an indication of how large the benefits might be. The Bureau pointed out that the establishment a more efficient passage through the Great Barrier Reef (northeast of Mackay), in which the Naval Hydrographer played an important role, had provided a direct deep-sea route for naval and commercial shipping from Queensland to the Coral Sea. Based on savings in fuel costs alone, the benefit-cost ratio for the passage was around 2.7:1.

The EASAMS study (1991) developed a strategic framework for a geoscientific information system in South Australia. While an overall figure for net gains was difficult to determine, the study was unequivocal in its support for a more "open systems architecture" for the State's Department of Mines and Energy. Important benefits from such a system would come through substantially lower systems operating costs as data collation times were reduced and professional staff were released to concentrate on the more effective analysis and presentation of data and to generate additional geoscientific information. Mineral exploration in South Australia was expected to grow as the State's geoscientific information improved.

A Western Australian Government Taskforce (1990) found that substantial gains were likely from integrating land and geographic data held by State agencies. This integration would include steps to clarify data custodianship, the establishment of a land information directory, standard procedures for data collection, and improved marketing of data. The annual costs of integrating land information were estimated at $1.8 million and the potential annual benefits at $10.7 million - resulting in a benefit:cost ratio of 5.9:1. Benefits were likely to include an improved ability to respond to land management issues, undertake natural disaster planning, replace ageing infrastructure, avoid duplication in Government services, and improve labour productivity within data supplying agencies.

Price Waterhouse Urwick (1990) examined the economic aspects of establishing a more up to date digital mapping data base for use in NSW land information systems. In particular, the study looked at the costs and benefits of undertaking accelerated digitisation of the State's cadastral and topographic land information compared with the costs and benefits of producing the same output with established staffing and financial resources.

PWU found a substantial net gain was likely from reforms, with benefit:cost ratios ranging from 9:1 to 2:1 depending upon the reform options chosen. The major benefits from an accelerated program related to: additional sales of data by existing suppliers; those suppliers being able to provide data at a lower cost than if (relatively inexperienced) users attempted to digitise their own information; digital data substantially reducing the manpower needed in the longer term to produce and apply mapping output; and, new digital data allowing users to undertake additional tasks such as more extensive environmental control and more effective maintenance of assets.

Finally, MWP (1989) found that substantial long-term benefits were likely from establishing an integrated land information system for the ACT. These would come mainly from staff savings in data-using agencies, the supply of data in a more timely manner to users, improved tax collection by Treasury, and lower costs of data transfer.

The picture emerging from the studies is that land and geographic data usage in Australia has yielded substantial net economic gains in most areas. On this basis, additional investment can be expected to produce equally substantial benefits.

Nevertheless, caution should be exercised in interpreting their results due to wide variations in the quality of statistical input and the methodologies used. Quite clearly, the studies vary in range and depth. All have been narrowly based in terms of product, geographic or institutional coverage. By relying on different methodological approaches, their results are difficult to aggregate. It is therefore important that cost-benefit work be extended to an Australia-wide level, using a single consistent methodology. This is the approach taken in the next two Chapters.

3. COST-BENEFIT METHODOLOGY

INTRODUCTION

Experience in Australia and overseas indicates that there have been two major methods used to estimate the costs and benefits of land and geographic data infrastructure. In practice, the availability of supporting statistical information has had an important bearing on the methodology eventually chosen.

The first is a traditional form of cost-benefit analysis. This has been used widely and selected on the basis of its extensive coverage of factors which contribute to the overall impact of new investment projects. However, for logistical reasons, it has been applied with greatest success to individual case studies where detailed statistical input is available. Few examples exist of cost-benefit analysis being applied to infrastructure on a national basis, due to problems of statistical collection and verification.

The second is cost effectiveness which focuses on a narrower range of determinants and, in Australia at least, has tended to be applied on few occasions. It has been adopted where a broader coverage of infrastructure is required and detailed statistical input is more difficult to obtain.

The fundamental characteristics of both approaches are briefly described below and a basic framework established for their application to land and geographic infrastructure in Australia.

COST-BENEFIT ANALYSIS

(i) Overall Framework

Cost-benefit analysis seeks to determine the net economic gain arising from a particular investment project or program. To the maximum extent possible, cost and benefit variables are measured:

- in dollar terms, to provide a consistent basis for comparison;
- across all phases of a project or program, to ensure each relevant aspect is covered;
- on an economy wide basis, given that the impact of a project or program might extend well beyond the organisations initially or directly involved; and
- with reference to intangible factors which, although frequently difficult to quantify, may significantly influence project or program participants and the broader community.

Reflecting the fact that a dollar's consumption at some point in the future is worth less than a dollar's consumption today, estimates of cost and benefits are normally adjusted to bring them to their present value. It is also standard practise to subject final estimates to

sensitivity analysis in which influential components, such as discount rates, are altered to reflect their potential impact on final results.

These results are presented as the dollar difference between benefits and costs or, its functional equivalent, the benefit:cost ratio. Where that difference is positive (or the benefit:cost ratio exceeds one) a net gain is indicated. Projects or programs falling into this category would normally be undertaken if:

- this gain was greater than the gains available from other investment opportunities;
- sufficient investment funds were available; and
- quantitative estimates were supported by available qualitative evidence.

Using this approach, the economic concept of measuring the opportunity cost of a project or program is included through a comparison of final benefit:cost ratios across investment options.

(ii) Estimating Costs

In applying cost-benefit analysis to land and geographic infrastructure, costs can normally be estimated using accounting data associated with establishing and operating data sets and systems. This applies because most systems are readily identifiable, generally confined in their costs and effects to a small number of organisations, and covered by established record-keeping procedures.

Dickinson and Calkins[6] note that the major cost categories relating the land and geographic infrastructure include:

- feasibility studies;
- hardware (computerised and non-computerised);
- software;
- hardware maintenance;
- software maintenance;
- data collection or purchase;
- data base entry and transfers;
- data base maintenance in the form of edits, updates and backups;

6 H.J. Dickinson and H.W. Calkins, 'The Economic Evaluation of Implementing a GIS', *International Journal of Geographic Information Systems*, **2**(4), 1988, p.310.

- personnel training;
- in-house development of software macros and interfaces;
- in-house support for system users;
- operating expenses in relation to staff, paper, computer disks etc.; and
- general overheads such as office space, air conditioning, access to library and reference facilities etc.

In applying these items to a cost-benefit analysis, a distinction is sometimes made between direct and indirect costs as well as fixed and variable costs. These four categories are useful in aligning cost items to normal accounting practices and to traditional concepts of economic analysis.

Direct costs are those costs which can be attributed substantially to land and geographic data projects or programs. Direct fixed costs cover items of expenditure which are needed to provide an overall data infrastructure capability and tend not to alter in the short term with shifts in project/program activity. They normally include computer hardware, other forms of equipment, software, office space, initial documentation, and the costs of shifting from one system design or structure to another.

The estimation of direct fixed costs normally requires details on the purchase, rental or leasing price of capital items, the expected life of those items, their utilisation rates for land and geographic data work, and an estimate of residual values. The expected life of capital items should account for technological obsolescence and physical wear-and-tear. However, overall estimates need not include the value of depreciation or interest on borrowed funds as adjustments for these are made through traditional discounting procedures applied to convert cost and benefit figures to their present value.

Direct variable costs are costs which change significantly with levels of project of program activity, mainly in the short term, and can be readily attributed to land and geographic data. They typically cover labour, materials, energy, repairs, maintenance, and `other' on-going expenses. Because the development of infrastructure frequently takes place on an incremental or continuing basis, direct variable costs may include a system development component.

Labour costs cover wages, salaries, and on-costs such as allowances, shift/penalty rates, overtime, annual leave loadings, long service leave, termination pay, and employer contributions to superannuation. Material costs cover externally sourced land and geographic data of any kind as well as paper, computer disks, and similar consumable items. `Other' costs include work done by subcontractors, freight and cartage, motor vehicle running expenses, workers compensation premiums and other insurance, rates, advertising and bad debts.

Indirect costs consist of costs which form part of an organisation's general activities. They are not easily attributed to particular land and geographic data projects or programs but nevertheless make some contribution to them. Normally included is an appropriate share

of the costs of an organisation's corporate executive services and corporate support in the areas of personnel management, industrial relations, training, recruitment, and the provision of library/reference services.

Where an organisation involved in supplying land and geographic data operates on a commercial basis, data costs also cover a pre-tax profit element.

(iii) Estimating Benefits

By comparison, the benefits of data usage are sometimes more difficult to identify or quantify. This is due to the potentially wide range of data applications and to data tending to have its principal impact on user organisations through productivity improvement which is not easily measured under most corporate accounting systems.

In attempting to estimate the benefits stemming from land and geographic data infrastructure, three broad categories are apparent:

- reducing costs and expanding the product and service range of data supplying agencies;

- reducing the costs and expanding the product and service range of agencies which purchase or order data (ie. data users); and

- generating benefits which extend beyond direct data suppliers and users to cover the broader community.

In terms of supplier effects, the increasingly sophisticated technologies with which land and geographic data is produced may enable supplying agencies to improve their operating efficiency and reduce costs through:

- cutting the manhours needed to collect, check, process, analyse, and distribute data;

- alleviating duplication of effort across agencies;

- replacing dull or repetitive in-house tasks; and

- improving system flexibility in terms of adjusting to individual user requirements.

User effects may be gauged by examining the contribution which land and geographic data makes to the ultimate impact of a project or program, relative to other project or program inputs which were relied upon. For example, land and geographic data may be obtained by a Water Board to improve water quality at a metropolitan beach. The individual contribution of the data to better beach conditions would depend upon the extent of water quality improvements, the value placed by the community on the changes, and the contribution which the data made relative to other project inputs such as investment capital, engineering expertise, cooperation from other government agencies, the Water Boards internal project management skills etc.

However, this is often a difficult task particularly where, as occurs in many circumstances:

- the number of other inputs to the project is substantial;

- the contribution made by data cannot always be gauged accurately by its purchase price, due to the differing charging policies of data supplying agencies; and

- the ultimate impact of a user project or program is difficult to quantify.

Accordingly, the benefits flowing to data using agencies are often measured by referring simply to intra-agency efficiency gains typically derived from:

- data being delivered in a more timely manner;

- data being able to be used without the need for elaborate transformation;

- data being geared closely to individual user requirements;

- higher levels of data accuracy; and

- improved (ie. broader or more detailed) data coverage.

The application of input of this kind may lead to better overall decision making by users in the areas of strategic planning, internal resource allocation, and project scheduling and co-ordination. Users may also exploit improved land and geographic data to raise staff productivity, lower overall staffing requirements, and better utilise, price, maintain and dispose of fixed capital assets. The processing, analysis, storage and distribution of land and geographic data within user agencies may also be enhanced. Finally, improved data from suppliers may enable users to expand into new areas of activity or to generate a higher quantity or quality of output in relation to their existing product/service range.

The activities of the Brisbane City Council illustrate these types of gains. In recent years the Council has utilised demographic data to determine the spending patterns of consumers with a view to optimising the distribution of shopping outlets within its jurisdiction. This kind of information enabled major retailing companies to plan the location of their outlets in a way which maximised consumer access to shopping facilities and enhanced overall retailer profitability. The value of market intelligence provided by the Council to firms was a fraction of the value of the gains which eventually emerged.

As far as community effects are concerned, the benefits stemming from data usage are likely to extend beyond the organisation or individual which initially purchases or receives it. The generic forms which these benefits take are difficult to categorise but may be illustrated by using the following example.

Land and geographic data is obtained by a Water Board from a State Department of Environment. The Department can produce and offer this data at a cost well below that which the Water Board would have incurred had it collected the data itself - providing the

Board with a direct cost saving. The data may be used by the Board to alleviate waste-water pollution at metropolitan beaches and therefore to satisfy the Board's statutory obligations.

However, broader community benefits also emerge. These accrue to the owners of beach-side hotels as increasing numbers of tourists are attracted to the area, to residential property owners whose houses may increase in value through being located in environmentally-friendly surrounds, to patrons of the beach whose leisure activities are enhanced by swimming in cleaner water, and to regional health authorities whose costs are reduced through fewer swimmers contracting pollution-related illnesses. This simple example demonstrates that community benefits can be both broad-ranging and substantial. They can, however, also be difficult to identify or estimate.

COST EFFECTIVENESS ANALYSIS

If a traditional cost-benefit framework is to be used the practical task of identifying and quantifying the full range of benefits arising from land and geographic data infrastructure will normally be significant. Collecting sufficient information may be particularly problematic if:

- the supplier, user and community benefits described above are considered in detail; and

- all major players within Australia's land and geographic data infrastructure are covered.

Cost effectiveness analysis provides a partial solution to the problem, mainly by narrowing benefits to a small number of indicators which might reflect or proxy the overall advantages data infrastructure provides.

A cost effectiveness approach ranks competing methods for establishing or maintaining a given capability, using relative costs as a guide. The costs associated with each method are calculated in the same way as in a traditional cost-benefit analysis. Benefits, however, are measured in terms of the difference between the costs of the already established or most preferred method and the cost of the next-best alternative. Put simply, the approach defines benefit as the cost saving arising from managers making an appropriate choice between competing methods for achieving a given objective.

The principal advantages of cost effectiveness analysis are that it may be applied in a systematic way and that measurement can sometimes take place with less extensive information.

The principal disadvantages are that:

- a comparison of competing methods normally takes place on the assumption that each method is equal in the quantity and quality of output it can generate. In the event that inequalities arise, adjusting for differences in capability may be problematic. For example, computers are frequently capable of producing land and geographic data which manual methods cannot hope to emulate, making the two approaches difficult to compare;

- important components of the overall gains arising from a project or program, such as improved organisational efficiencies and broader community benefits, may remain unidentified; and

- insufficient information is generated to compare the benefits of investment in competing data infrastructure projects or programs, or between investing in data infrastructure and other areas of the economy.

Cost effectiveness analysis is best suited to situations in which a clear commitment to the overall level and broad distribution of investment funds is already established. *Its value is greatest in determining whether already allocated funding have been, or are likely to be, utilised efficiently.*

However, in the context of land and geographic data infrastructure, four important points relating to the choice between cost effectiveness analysis and cost-benefit analysis should be noted. Each makes cost effectiveness a more desirable option than it may appear initially.

Firstly, much of the work done on land and geographic data infrastructure within Australia takes place as part of long term projects whose structures have been established for some time. Many of the resource commitments associated with these projects are on-going and leave little room for major variation. Thus, in strategically significant areas, the issue of efficiency relating to already committed funds is important.

Secondly, users of data are often in a stronger position to quantify and compare the costs of competing methods of producing data, given that comparisons are an integral part of project feasibility studies. This information forms the basis of a *cost effectiveness* approach to analysis. By comparison the efficiency gains from applying data, which form an important part of *cost-benefit* analysis, are often monitored with less precision within most organisations. Thus, the statistical input associated with a cost effectiveness approach may be relatively accurate.

Thirdly, the community benefit aspects of a cost-benefit approach are rarely open to quantitative assessment. If so, the approach offers fewer advantages over cost effectiveness than purely conceptual considerations would suggest.

Finally, some of the conceptual limitations of cost effectiveness can be overcome by supplementing *quantitative* estimates with *qualitative* information on the broader range of benefits which data might provide. Case studies provide one means by which problems of this kind may be overcome.

THE PREFERRED APPROACH

In September and October 1994, Price Waterhouse Economic Studies and Strategies Unit surveyed over 80 major suppliers of land and geographic data in Australia and over 350 major data users. Both groups were asked to provide data suitable for cost-benefit and cost-effectiveness analysis. The choice of a single method was to be decided by the quality of survey returns.

Suppliers were asked to provide information on:

- the total costs of producing land and geographic data, including system establishment and operating costs, over the past five years;

- effort directed to capturing, processing and distributing data using the major product and service categories of geodetic, ownership (cadastral), administrative areas, transport, utilities, communication, hydrography, relief and contours, geology and minerals, soils, vegetation, climate, fauna, and population;

- sales or distribution of data by the following major user categories - facilities management, transport and communications, mineral and resource development, environmental research and management, urban and regional planning, land administration, agricultural land use, defence and emergency services, tourism, education and research, and business, commerce and finance;

- areas and levels of activity over the next 10 years, under various budget scenarios, one of which was that current budgets were maintained in real (or inflation adjusted) terms;

- recent and expected technological advances and their impact on internal efficiency; and

- internal methods of performance monitoring.

Users were asked to provide information on:

- the data products and services which they acquired over the past five years;

- areas of industry activity in which data was applied;

- major sources of data - internal, external and by supplier agency type;

- major data forms - paper maps, text, digital vector, and imagery;

- data costs over the past five years;

- forms and costs of the next-best source of data supply;

- internal efficiencies arising from the use of data;

- the contribution of data to the ultimate success of projects or programs undertaken by users;

- external efficiency gains which flowed to other organisations or to individuals as a result of those projects or programs; and

- desired improvements in land and geographic data availability and coverage.

Based on the information received from survey respondents it was decided to concentrate on a cost-effectiveness approach. This information provided for relatively detailed quantification of the costs of existing sources of data supply relative to the next-best alternative. While very significant information relating to broader benefits was also collected, this was mostly of a qualitative nature.

The data collected from surveys was supplemented by phone contact with principal data suppliers and users and by workshops conducted in Adelaide and Sydney during November 1994 to discuss survey results and their interpretation.

In order to further extend the information base, seven case studies were conducted to examine the costs and benefits of land and geographic data use in law enforcement (NSW Wales Police), public utility management (Sydney Electricity), local council operations (Shire of Melton - Victoria), health care (North Sydney Area Health Service), education (Victorian Department of School Education), natural resources (tree mapping in Victoria), and mining (CRA Exploration).

In this way a comprehensive picture was compiled suited to analysis on an Australia-wide basis.

4. THE COST AND BENEFITS OF DATA INFRASTRUCTURE

SUPPLIER SURVEY

The supplier survey was distributed to 82 organisations which were estimated to cover around 85% of Australia's total supplier population. Forty-one organisations, representing 50% of the total sample, furnished returns.

The organisations which did *not* respond to the survey were individually assessed and assigned to one of three groups consisting of large, medium and small suppliers determined on the basis of furnished survey returns. Each organisation was then assigned an indicative supply cost.

These figures were then pooled with the actual cost estimates from survey respondents to arrive at an indicative aggregate supply cost. An adjustment was then made to account for the initial shortfall in the coverage of the total survey sample of some 15 percent. Stratification and extrapolation procedures yielded an indicative aggregate cost figure for suppliers of all land and geographic data throughout Australia.

Table 1 sets out the relevant figures, along with present value estimates based on a discount rate of 8% recommended by the Commonwealth Department of Finance[7] for the purpose of comparing investment options.

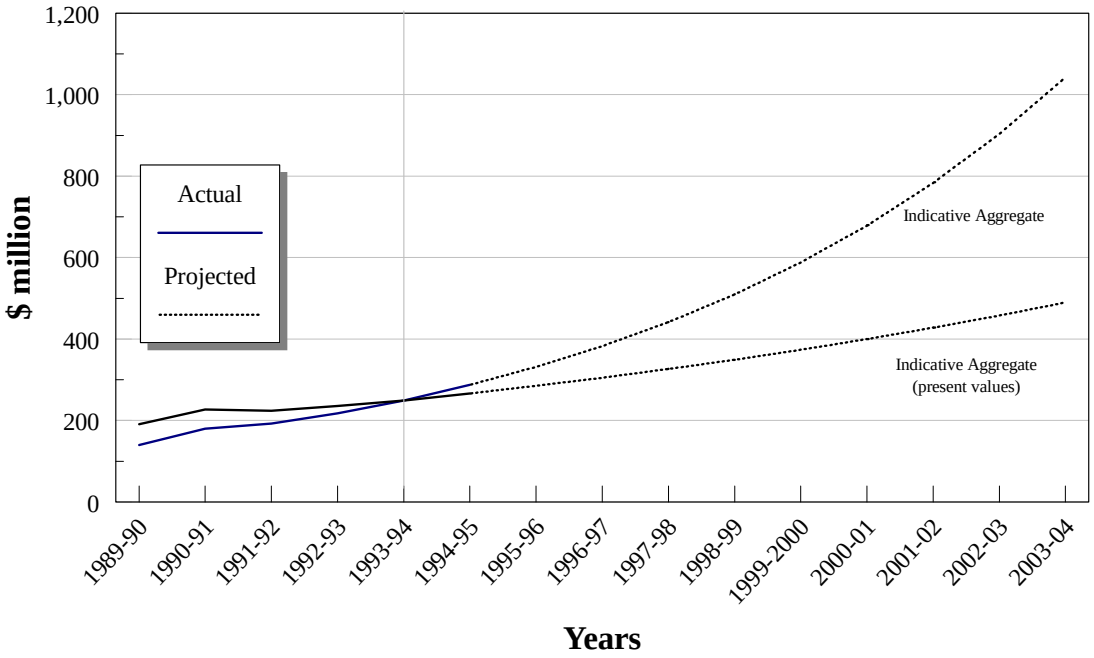
TABLE 1
THE COSTS OF LAND AND GEOGRAPHIC DATA SUPPLY
AUSTRALIA 1989-90 TO 1993-94
$ MILLION

	1989-90	1990-91	1991-92	1992-93	1993-94	**Total**
Indicative Aggregate	140.0	180.0	192.0	218.0	249.0	979.0
Indicative Aggregate (present value)	190.4	226.6	223.9	235.4	249.0	1125.3

Figure 1 sets out actual cost movements over the past 5 years and those expected over the next 10 years if growth patterns experienced between 1989 and 1994 continue. Present value figures reveal that the annual aggregate cost of data supply will, based on recent trends, reach $349 million by 1999 and $489 million by the year 2004. Corresponding cost levels prepared on a non-discounted basis are $510 million and $1,043 million.

7 Department of Finance, *Handbook of Cost-Benefit Analysis*, AGPS, Canberra, 1991.

Figure 1
Actual and Projected Aggregate Cost Movements
1989-2004



The supplier survey revealed that 63% of total costs over the period 1989-94 were allocated to *creating* land and geographic data capabilities which covered textual and spatial data products of all kinds. The remaining 37% was devoted to capability *maintenance*. Using indicative aggregates adjusted to their present value, capability creation over the past five years accounted for $708.9 million while $416.4 million was devoted to maintenance functions.

The bulk of these resources were assigned to ownership (ie. cadastral) data which accounted for approximately 26.9% of total costs identified by suppliers. This was followed by data relating to utilities (19%), data relevant to maritime navigation and bathometry (14.8%), data covering relief and contours (7.1%), and data relating to hydrography (5.3%). Details of cost distribution by *data product type* are presented in Table 2.

TABLE 2 **COST DISTRIBUTION BY PRODUCT TYPE** **AUSTRALIA 1989-94** **(% OF THE TOTAL COST OF DATA SUPPLIED)**	
Ownership (cadastral)	26.9
Utilities	19.0
Maritime navigation and bathometry	14.8
Relief and contours	7.1
Hydrography	5.3
Vegetation	4.7
Transport	4.5
Geology and Minerals	3.2
Soils	3.1
Fauna	2.3
Climate	2.0
Administrative areas	1.8
Geodetic	1.0
Communication	1.0
Population	0.5
Other	2.8

Data generated by suppliers over the 1989-94 period was distributed for use across a broad range of activities. Approximately 22% of all data (by cost) was channelled into facilities management for application by electricity, gas, water and telecommunications authorities. Approximately 14.9% was devoted to maritime navigation and surveying, 14.0% to land administration, 10.7% to environmental research and management, and 10.6% to mineral and resource development. Data distribution patterns for all major *activity groups* are detailed in Table 3.

TABLE 3 **DISTRIBUTION OF LAND AND GEOGRAPHIC DATA BY ACTIVITY** **AUSTRALIA 1989-94** **(% OF THE TOTAL COST OF DATA SUPPLIED)**	
Facilities management	21.9
Maritime navigation and surveying	14.9
Land administration	14.0
Environmental research and management	10.7
Mineral and resource development	10.6
Business/commerce/finance	6.8
Urban and regional planning	5.8
Agricultural land use	4.8
Transport and communications	3.8
Education/research	2.4
Defence/emergency services	1.5
Tourism	1.0
Other	1.8

Over 85% of survey respondents indicated that technological advances over the past five years had produced high or moderate improvements in supplier efficiency, with over 98% of respondents expecting the same or even greater advances over the next 10 years. Recent areas of technological change related mainly to data manipulation and analysis, system design and on-line data access. Areas in which future advances were expected included the integration of data bases through improved software, reduced processing times through higher overall system capacities, and improved data access through a wider use of personal computers.

Approximately 83% of survey respondents, accounting for over 95% of the total cost of data generated over the past five years, indicated that they would be able to maintain their *existing* land and geographic data products during the period 1994 to 1999 if budgets were maintained in real or inflation-adjusted terms. For the period 1999 to 2004, around 68% of respondents (representing over 85% of total costs) also indicated that their *existing* data capabilities could be maintained if real levels of budget funding were sustained. These figures indicate that in the years ahead *existing* user requirements can be met but only if continuing budgetary support is provided to data supplying agencies.

Sixty-three percent of respondents, accounting for 79% of the total cost of data generated over the past five years, indicated that the maintenance of budgets in real terms may also provide scope for *new and improved* data products to be developed over the period 1994 to 1999. Improvements in the methods by which data could be collected, stored, analysed and distributed were estimated by these respondents to produce cost savings equal to 25% of overall budget funding since 1989. If directed to extending and upgrading existing data capabilities, such savings would result in new and improved products for distribution to users with a focus on higher data quality, more extensive digital data inventories, and greater user access.

Similar patterns emerged for the period 1999 to 2004. In this case, 49% of respondents indicated that the maintenance of budgets in real terms would provide the opportunity for new and improved products to be developed. Cost savings arising from internal efficiency gains were estimated at 22% of overall budget levels between 1989 and 1994.

However, the premise underlying estimates of an expansion in existing data capabilities was that the full extent of efficiency savings could be retained by data supplying agencies and re-invested. The survey suggested that without the ability to retain the financial benefits of expected efficiency gains, suppliers would in future years be limited in their ability to expand. Suppliers could be prevented from responding to the *additional* demands of users in the decade ahead.

User demands over the next 10 years were difficult to estimate, with reasonably accurate projections being limited to the period 1994 to 1999. Supplier perceptions of these demands indicated that they could be in the order of 30% of aggregate cost levels over past five years. This equates to $337.6 million in present value terms. When asked to estimate the net addition to 1989-94 budgets which would be required to meet their organisational strategies and objectives, supplier survey respondents estimated a figure of 3.8% of the last five years budgets (based on 1993-94 present values) *provided* funding was also supplemented by the gains achieved through higher internal efficiency.

On this basis, the investment requirements of suppliers in the foreseeable future could lie in the region of 30% (ie. 25% plus 3.8%) of recent budgets assigned to supplier organisations. *The clear funding implication is that supplier organisations may not only need to retain the full extent of their efficiency gains but also receive net additional funding if Australia's data infrastructure is to develop in line with the demands placed upon it including the basic requirement of bringing data sets to a consistent minimum standard.*

If productivity gains are not retained by suppliers and net additional budget funding is not forthcoming, the ability of established data generating agencies to satisfy the growing demands of users will be jeopardised. Users will face the options of cancelling their projects or meeting their expanding data requirements through alternative and, in all probability far more expensive, supply sources.

Figures covering the period 1989-94 help to illustrate just how significant these kinds of disadvantages might be. Had established data suppliers faced a 30% reduction in their budgets over the 1989-94 period, the value of their data output would have been $338 million lower (in present value terms). Based on estimates of the cost of alternatives set down in Table 5 below, and assuming that users chose to obtain the same data output from the next-best alternative source, the costs of that data would have escalated 5.6 times, from $338 million to $1,893 million. This being the case, users would have faced a net increase in data costs of $1,555 million which for the five years 1989-94 represents 138% of the entire budget allocated to established data supplying agencies. *Thus, continuing budgetary support for Australia's existing land and geographic data infrastructure in the years ahead should produce major economic benefits by preventing a shift to far less efficient sources of supply.*

USER SURVEY

The user survey was issued to 370 organisations, with 57 responses being received. While the survey requested and obtained estimates of the value of data purchased by users between 1989 and 1994, its relatively low overall response rate meant that the total value of data obtained over the period by user organisations could not be estimated with reasonable accuracy.

Accordingly, aggregate data *usage* was assumed to equate to the aggregate cost of data *supply* which was estimated as part of the supplier survey. Usage was therefore valued in terms of the cost of production and distribution and excluded any profit margin obtained by agencies when selling to organisations throughout Australia. Profit rates could not be gauged with any accuracy from the survey information provided. However, as many of the users were also suppliers of their own data, the lack of a profit element does not detract from the survey's overall findings.

The user survey provided important insight into a number of areas. It indicated that over the past five years approximately 62% of data was generated for internal use - making many organisations providers and consumers of their own data products. The remaining 38% of data used was obtained from outside sources, of which 58% (by cost) came direct from State Government agencies, 19% from Commonwealth Government agencies, 9% from local Government agencies, and 14% from the private sector. These figures need to

be interpreted with care, given that data output from one agency frequently constituted a basic input for products generated by other data providers.

Twenty-five percent of respondents revealed that in the absence of existing or established sources of land and geographic data, their activities would have been cancelled, scaled back or substantially delayed. Over 70% of respondents indicated that this absence would have had a detrimental effect in terms of substantially raising the costs of their activities or requiring that those activities go ahead on a smaller scale. Importantly, only 4% of respondents indicated that, in the absence of existing data, their activities would have been largely unaffected.

The most commonly used *form* of land and geographic data was paper maps, followed by digital vector data, text, non-digital imagery, and digital imagery. As the process of digitisation continues it is expected that this pattern will alter and digital vector become the single most important information form. Table 4 sets out usage relativities based on survey estimates which combine the effects of data quantities and frequency of application. Usage levels are expressed in Table 4 as a multiple of the least used type of data which was digital imagery.

TABLE 4
RELATIVE DATA USAGE BY DATA FORM

Paper maps	2.02
Digital vector	1.98
Text	1.52
Non-digital imagery	1.03
Digital imagery	1.00

The survey revealed that existing sources of land and geographic data were highly cost effective relative to the next-best alternative sources of supply. For the largest single product type - ownership (cadastral) - the cost of the next-best alternative of paper maps and field surveys was 3.8 times higher than existing sources. For data on utilities the cost of the next-best alternative of paper maps was 7.1 times higher, while for all other data types the cost of the next-best alternative of paper maps and digital vector data was 6.15 times higher.

Table 5 sets out the indicative value of data (expressed in present value terms), the cost of the next-best alternative (as a multiple of the cost of existing data sources), the indicative cost savings, and the cost savings:cost ratio for each of these three major data product groups over the past five years. Insufficient data was available from the user survey to map rates of change in the cost of actual relative to alternative data sources by product group over the past five years. Accordingly, precise cost-benefit projections for individual product groups for the decade ahead are unable to be made.

TABLE 5
THE VALUE AND EXTENT OF COST SAVINGS BY MAJOR PRODUCT GROUP 1989-94

PRODUCT GROUPS	INDICATIVE COST $ MILLION (PRESENT VALUE)	COST OF NEXT-BEST ALTERNATIVE (MULTIPLE)	COST OF NEXT-BEST ALTERNATIVE $ MILLION (PRESENT VALUE)	COST SAVINGS $ MILLION (PRESENT VALUE)	COST SAVINGS: COST RATIO
Ownership (cadastral)	302.7	3.80	1150.3	847.6	2.8:1
Utilities	213.8	7.10	1518.0	1304.2	6.1:1
Other	608.8	6.15	3744.1	3135.3	5.1:1
Total	1125.3	5.62	6412.4	5287.1	4.7:1

Table 5 reveals that the weighted average multiple of the cost of the next-best alternative for all data types was 5.62. It shows that over the period 1989-94 the dollar savings arising from the presence of the existing data infrastructure was over $5 billion. The overall ratio of cost savings to actual costs was 4.7:1, where cost savings were measured in terms of the difference between the cost of data alternatives and the cost of existing or established data sources.

For every dollar of expenditure on land and geographic data over the past five years, $4.70 was saved as a result of investment in efficient forms of data supply. This is comparable to the 3.8:1 cost-effectiveness ratio estimated by the Price Waterhouse Economic Studies and Strategies Unit in 1992 as part of its review of AUSLIG's Public Interest Program.

In addition to substantial cost advantages, existing sources of supply were noted by the majority of user survey respondents as offering "significant" gains over alternatives in terms of timeliness, accuracy, and ease of transformation and processing. For more than 40% of survey respondents, existing sources also provided significant gains by replacing dull or repetitive in-house tasks, promoting new product development, and facilitating improved research.

Over 65% of respondents registered improvements in their internal efficiency through the use of existing data sources, including:

- improved strategic decision making;
- increased staff productivity/lower staffing requirements;
- improved land and geographic data processing and analysis; and
- the generation of higher output quantities and quality.

Additional substantial gains in efficiency arising from data usage were also recorded through:

- the development of new areas of activity (58% of respondents);
- improved land and geographic data storage and distribution (51%);
- improved overall targeting of resources (44%);
- improved project scheduling and co-ordination (35%); and
- improved utilisation, pricing, maintenance and disposal of fixed capital assets (19%).

The majority of respondents (53%) indicated that their use of data had resulted in benefits flowing to other organisations and to the broader community. Further transformation and dissemination of land and geographic data by survey respondents reduced the need for downstream data users to digitise their own information, reduced their risk of investing in data systems, improved their decision making and facilitated better asset management. Thirty-seven percent of respondents indicated that significant benefits had flowed to the community-at-large through avenues such as improved public safety and more informed decision making by businesses.

A series of case studies conducted as part of the review and set out in the Appendix to this Chapter supports these findings on internal and external benefits which form an integral part of cost-benefit analysis. The studies reveal that data has been used to boost productivity across a broad spectrum of product and service areas in the public and private sectors. For the most part, these efficiency improvements have either assisted other businesses or led to a noticeable increase in the quality of social or physical environments.

For example, the use of improved land and geographic data by the Melton Shire Council has reduced the time taken to supply local area data by over 90 percent, while Sydney Electricity has reduced its operating costs by over $2 million as result of applying improved data to producing maps, recording electricity consumption, and lowering the risk of asset damage associated with maintenance and new construction. In Victoria, the remote sensing of tree cover has had an important impact on the State Government's ability to regulate logging activity, manage wildlife-corridors, and plan for bushfire management.

The application of data to health services provision in North Sydney has facilitated the more effective location of medical screening programs and investigations into the causal relationships between disease and environmental factors such as lead levels and toxic waste. Following the use of data by the NSW Police in selected jurisdictions, reductions in crime rates have emerged and policing costs have been cut through improved resource allocation. The Victorian Department of Education has used data to rationalise its building assets and to save on property maintenance costs. Finally, CRA Exploration has used data to develop new mineral deposits and to greatly expand its business development capability in Australia and overseas.

Bringing together the outcome of the supplier and user surveys and case studies, available evidence lends support to previous Australian analyses (outlined in Chapter 3) which on

average have produced benefit:cost ratios in the order of 4:1. Certainly, the outcomes provide no evidence to refute the commonly held view that the economic benefits of supporting Australia's land and geographic data infrastructure are many times greater than the costs. Using a benefit:cost ratio of 4:1, and taking into account (present value) costs of $1,125 million over the past five years, the value of benefits to Australia from investing in data in the period 1989-90 to 1993-94 would be approximately $4.5 billion.

APPENDIX
CASE STUDIES OF DATA COST-EFFECTIVENESS

As a means of illustrating some of the key points emerging from the analysis of cost and benefits presented in Chapter 4, this Appendix provides a series of short case studies dealing with:

- local government (Shire of Melton - Victoria);
- law enforcement (NSW Police);
- public utility management (Sydney Electricity);
- health care (North Sydney Area Health Service);
- natural resource management (tree mapping in Victoria);
- education (Victorian Department of School Education); and
- mining (CRA Exploration).

The studies were designed to cover a diverse range of data applications and to supplement the results from industry surveys. Wherever possible, quantitative and qualitative measures of costs and benefits were sought from study participants, along with an indication of how these factors might move in future. However, most of the projects covered by the studies were of a commercial or sensitive nature. Accordingly, detailed costing figures were not provided and the analysis limited mainly to qualitative issues.

(A) SHIRE OF MELTON

The Shire of Melton, located on the outskirts of Melbourne, is predominantly a user of land and geographic data purchased from outside agencies. Its interest lies with cadastral data as well as information relating to water infrastructure. While the majority of data is obtained by the Shire in digital form and used with minimal transformation, some areas are developed internally to meet specific requirements.

Data has been utilised extensively for property identification and to validate existing land records. They play a fundamental role in Shire planning and the maintenance of an accurate and up-to-date spatial and textual information base from which property values and rates can be assessed. Data on water infrastructure, including sewerage and stormwater systems, provides the basis for timely facilities management including new construction and maintenance.

The average total annual cost of data used by the Shire over the past 3 years has been in the order of $30,000. Outlays at this level are expected to continue in the short-medium term. During this period, the Shire will complement its existing data sets with aerial photography. Cost reductions arising from improved supplier efficiency are expected to

be substantial and their benefits redirected by the Shire towards developing new data capabilities and improving the quality of existing data resources.

The Shire faces few if any viable alternative sources of data supply. Had existing sources of data been unavailable over recent years, hardcopy data would have been relied upon at a cost approximately 30% above established levels. However, this figure constitutes a minimum estimate given that the quality of alternative sources was far below that of data obtained through existing supply channels. If the Shire had relied on external sources of supply for data it developed in-house, a cost premium of at least 30% would also have applied.

Significant increases in operating efficiency were reported by the Shire as a result of its usage of digitised data. The principal improvements took place in the areas of internal planning, asset management, and the development of new products and services. While aggregate benefits arising from these areas proved difficult to value, a quantitative measure of their impact on performance was obtained through estimates of a reduction from 30 minutes to 2 minutes in the time taken to handle key inquiries from the public and industry. This represents a productivity increase of some 93%.

(B) NSW POLICE

The NSW Police are currently developing a State-wide geographic information system for use by regional offices. The objectives of the program are to:

- improve internal efficiencies;
- utilise police resources more effectively through forward planning; and
- better understand issues or factors associated with crime.

The Department's Computerised Operation Policing System (COPS) currently involves several regional and district offices which have established their own data capability to monitor and help predict changes in criminal activity. Street names and numbers, local boundaries, and census data are drawn together mainly from internal textual information already held by the agency. Other types of high resolution data can be overlayed on existing maps, and large amounts of textual data have been entered into the system to provide details across a broad range of policing activities.

The typical applications of COPS include:

- the accurate location of vehicle crash sites (which proves particularly important in investigating hit and run incidents);
- tracking criminal activity by time and location, with a view to identifying patterns or trends amenable to preventative action;
- flexible and timely transfers of intelligence between policing units; and

- the generation of statistics to inform the community and neighbourhood watch members about incidents in their vicinity.

In terms of internal efficiencies, the system has enabled staffing timetables to be streamlined and matched to peak periods of demand. It has also improved patrolling techniques through more accurately gauging the location and incidence of activities such as car theft and breaking and entering. Although difficult to quantify, significant efficiencies also appear to have arisen in the area of investigatory techniques through the system helping to establish indicative correlations between a number of socio-economic patterns and illegal behaviour. From a cost perspective, the NSW Police have benefited significantly through reductions in overtime, lower response times for responding to incidents, and fewer maintenance and running expenses for motor vehicles.

The overall impact of the program on the extent of criminal activity is difficult to gauge directly. However, it should be noted that a significant reduction in crime was noticed in the Liverpool District after the development and implementation of the system in that area.

(C) SYDNEY ELECTRICITY

Sydney Electricity supplies electricity to almost 2.5 million people and faces increasing pressure from the public and private sectors to improve productivity and customer service. Information on the location and distribution of physical assets including transmission lines, cables and sub-stations is critical to achieving these performance objectives.

The corporation's Mapping Asset Program (MAP) has recently been developed to collect and analyse asset data. The project involves the conversion of over 8,000 maps to digital form and geocoding the data accurately for future reference. Many maps have not been updated in over 40 years, which makes the project both essential and costly. Approximately $3 million has been allocated for the data digitisation process.

Input for MAP has been drawn mainly from the State Government Land Information Centre which has provided layouts of roads, allotments and other geographic features. The location of electricity assets has been overlayed on this information to provide a comprehensive referencing system. Data updates are scheduled on a regular basis.

The principal uses of MAP relate to the provision of information for:

- Environmental Impact Statements;
- asset replacement and maintenance schedules;
- cable network planning, including the estimation of route lengths;
- monitoring asset performance in areas such as street lighting; and
- mapping sub-terrain structures to indicate optimal cable paths.

The efficiency gains from the Program stem from an ability to segment data for use in individual applications, reproduce and record data more easily, upgrade mapping production methods, digitally read and record electricity meters from a remote location, and reduce the risk of asset damage as a result of maintenance or new construction. Sydney Electricity has estimated that to date the value of these gains has been in the order of $2 million. Such gains will be on-going and in the medium to long term are expected to substantially outweigh MAP's establishment costs.

(D) NORTH SYDNEY HEALTH SERVICES

The North Sydney Area Public Health Unit has been applying land and geographic data technology to map specific diseases within its jurisdiction since 1991. Its activities are expected to influence the overall system of health management within the North Sydney area which covers approximately 700,000 people.

Data covered by the system relate to infectious and other diseases, cancer, land use, environmental quality, general demography, hospital separation, education, and statistics collected from General Medical Practitioners in the North Sydney area. This information is collected and analysed for the purpose of:

- determining causal relationships between disease and environmental factors such as lead levels and toxic waste;

- establishing the most effective site for the location of medical screening programs for conditions such as breast cancer;

- monitoring the demands placed on nursing homes and other community medical facilities;

- planning emergency services networks; and

- investigating food-borne disease outbreaks.

Recent developments in data-related technologies have substantially improved the Unit's internal efficiency through reducing data processing times, providing a more extensive range of information for use in public education programs, and facilitating more comprehensive strategic planning. Cost savings of around $10,000 per year have applied, the majority of which have been re-invested to further upgrade data capabilities without the need for additional direct budget funding.

The benefits flowing to organisations and individuals as a result of the Unit's activities are estimated to be substantially higher than this figure as a result of a more direct targeting of the causes of disease, the adoption of similar systems by other health authorities, the use of the Unit's data output by other Government agencies, and a strengthening in the General Practitioner Sentinel Surveillance Program.

(E) TREE MAPPING IN VICTORIA

In July 1994 the Australian Bureau of Agricultural and Resource Economics (ABARE) released the results of a study on the costs and benefits of mapping tree cover in Victoria.

Tree coverage had become an important issue for the State's Department of Conservation and Natural Resources (DCNR), as a result of the perception that of a wide-spread decline in Victoria's timber resources and the absence of accurate data on existing timber stocks. However, uncertainty surrounded the question of whether such resources could be measured in a cost efficient manner. While satellite imagery emerged as the preferred monitoring mechanism on technical grounds, little information was available on whether the cost of its further application could be justified from an economic perspective.

ABARE estimated that the costs of remote sensing of tree cover in Victoria over the period 1990-91 to 1993-94 to be in the order of $394,000 expressed in terms of 1990-91 present values. This figure covered equipment and building requirements, data processing and data acquisition. The benefits to emerge either directly or indirectly from use of the data related primarily to:

- planning by DCNR and other Government agencies as part of their forest management and re-afforestation responsibilities. In particular, satellite imagery allowed agencies to monitor the effectiveness of an existing permit system designed to control land clearance and restore tree cover following logging operations;

- DCNR's other obligations covering the management of wild-life corridors consisting of tree belts which linked significant areas of fauna habitat; and

- bushfire management involving the location and operation of remote automatic weather stations, the collection of data on the effects of fire according to crop and pasture type, and the identification of areas prone to the highest bushfire risks.

These benefits proved difficult to value. However, the advantages of adopting satellite imagery over the next-best alternative of aerial photography could be gauged and provided an indication of the cost savings associated with the choice of a satellite option. Over the period 1990-91 to 1993-94, these savings were estimated by the Bureau at around $1.49 million (in present value terms).

(F) VICTORIAN DEPARTMENT OF SCHOOL EDUCATION

An important function of the Victorian Department of School Education is to recommend sites for new public schools and to assess the position of schools proposed for closure. The State has over 2,000 schools with a floor space totalling around 5 million square metres. This involves projecting the demand for school facilities several years into the future so that capital works programs can be planned and co-ordinated. In the initial stages of the project attention has been directed primarily to geographic areas with a high population growth.

Over the past few years, the Department has approached its planning functions through the use of a spatial data system comprising desk-top mapping units and extensive data

input covering demographic trends, property ownership patterns, local Government development, and logistical information on facility locations and capacities drawn from within the Department and other areas of Government. The system integrates this information and provides statistical and other read-out suitable for planning decisions. System establishment costs were around $37,000.

It is expected that these costs will be recouped by the Department many times over as result of reductions in planning staff (from four to possibly one person), better internal planning, shorter lead times to develop building proposals, and more efficient building maintenance. Had the Department been forced to rely on hard-copy maps rather than a spatial data system to carry-out planning functions, its data costs would have increased by at least 100 percent.

(G) CRA EXPLORATION

CRA Exploration collects and processes vast amounts of minerals-related information for use by company geologists and strategic planners around the world.

The land and geographic data types utilised by the company includes drillholes, geochemistry, geology, geophysics, mineral occurrences, geological structures, land tenements, and topography including homesteads, water resources and pastoral leases. In addition, CRA Exploration holds over 20,000 internal company reports and a range of publicly available information drawn from books, magazines and journals.

Over the past two years, CRA Exploration has introduced a personal computer (PC) based Image Based Information System (IBIS) which allows for extensive data integration and the ready transfer of information to other areas of the company including geologists working in the field. Based on off-the-shelf hardware and software adapted to meet specific company requirements, this desk-top mapping capability makes extensive use of data digitised internally from textual records as well as information obtained from Government agencies such as the Australian Surveying and Land Information Group (AUSLIG) and the Australian Geological Survey Organisation (AGSO). CRA Exploration has pioneered the transfer of geological information using CD-ROM.

By facilitating the integration of data sets with greatly improved levels of accuracy and cost-effectiveness, the system has resulted in:

- less duplication of effort in the collection of information;

- desk-top planning of surveys and other work which would normally have required costly and time consuming field trips;

- an improved analysis of survey findings by bringing together data in a way which allows the link between factors such as mineral locations, geological structures, and topography to be identified;

- an enhanced ability to undertake environmental protection studies and to meet environmental safeguards;

- an enhanced ability to monitor the activities of competing mineral exploration firms by, for example, analysing changes in land ownership;

- more effective presentations of the company's position to indigenous peoples, graziers and rural producers, Government departments and sub-contractors; and

- better decision-making in relation to strategic investments where timing can prove critical in gaining access to mineral deposits.

CRA Exploration estimates that the system has improved productivity relating to data analysis and interpretation by over 1000 percent in some cases. As a result, some support staff have been released from traditional drafting tasks and utilised in higher productivity areas relating to electronic data processing.

Additional gains in efficiency have been achieved by the company through the purchase of specialised digital data from external sources which utilise the latest geographic information technologies. One example of this involves the procurement of geochemical data on stream sediments at a cost of around $50. Had CRA been required to generate this data itself, the cost would have been in the order of $40 million.

5. IMPROVING INFRASTRUCTURE BENEFITS

The actions which might potentially be taken by the public or private sectors to improve the future benefits of land and geographic data infrastructure in Australia centre on:

- ensuring that adequate investment is directed to completing existing infrastructure projects as well as to meeting the future requirements of data users;

- seeking to maximise funding levels and efficient resource use through closer co-ordination between data suppliers and users, particularly on Government funding issues; and

- establishing a policy environment which promotes efficiency in data collection, processing and distribution.

Chapters 3 and 4 have addressed the first of these points by providing an indication of the benefits of infrastructure investment. This evidence might be used by supplier agencies in seeking budget support for their activities. However, within a budget context, there remains the issues of how on-going data programs impact on funding requirements, how data supplying agencies might best co-ordinate to present their views to Government, and how to ensure that once overall budget parameters have set, best use is made of available resources through policies pertaining to commercialisation, contracting-out, duplication of effort, competition, standards, and pricing. Chapter 5 takes up these points.

Comprehensive coverage of each point lies beyond the scope of a single study. Nevertheless, substantial progress may be made by more clearly identifying the nature of the issues involved and singling out those areas in which policy intervention may make a substantial positive contribution.

The sections which follow take this approach. Comments are made based on the results of supplier and user surveys in which organisations were asked to provide qualitative feedback on priorities for data infrastructure development. They have also been formulated from the results of two workshops held during November 1994 to discuss infrastructure policy options.

FUNDING ON-GOING REQUIREMENTS

In assessing the funding levels required by data supply agencies it is important to note that resources be provided on a regular basis to bring data sets to a consistent quality. Uniformity in data quality or standard is a key determinant of both the demand for data products and the benefits which might eventually flow from their application to investment projects throughout the economy.

The task of bringing the quality of data sets to a consistent minimum level, and the resources which are needed to achieve this, should not be underestimated. Sets compiled by data supplying agencies have often been put together over extended periods of time in response to immediate user requirements, available budgetary support, and prevailing technologies. As a result, broad disparities in data quality are now a feature of Australia's land and geographic information infrastructure.

The pressures to overcome this problem are already substantial and can only become more intense and costly to rectify in the years ahead. Rapid shifts in physical and man-made geographic features, the growing demands of data users for products which integrate information from a range of different areas (and therefore require high levels of data compatibility), and technology-related changes in the accuracy of data collection techniques have all combined to make disparities in quality less acceptable to the data supplier and user community.

The provision of adequate budgetary resources for data maintenance and enhancement remains the only viable means of overcoming the problem. If data sets are to meet the increasing demands of users, there remains little option other than provide funding adequate for the task.

CO-ORDINATION OF FUNDING PROPOSALS

One means for improving funding prospects is through improved co-ordination between data supplying agencies. Perhaps the most important questions relating to this kind are co-ordination are:

- what practical constraints do suppliers of data face in attempting to attract budget funding?

- are the statutory and other obligations of these agencies sufficiently well defined to identify data funding priorities (ie. to single-out data products in most need of development in terms of meeting user demand)?

- could the process of identifying priority products be improved through closer liaison between users and suppliers, particularly within States and Territories? and

- how might this kind of liaison be affected?

In answer to these questions, it is apparent that the ability of data supplying agencies at a State and Commonwealth level to influence the level and direction of funding available for data infrastructure is heavily constrained by at least three factors.

The first is that in important areas, such as mineral development, funding patterns may be determined at least in part by competition between States to attract additional economic investment. The availability of land and geographic data may often be an important ingredient for investment projects and one factor taken into account by firms in determining project location. Political imperatives can dictate that this data be provided to meet broader Government industry development objectives, with data supplying agencies having little say on whether funding conflicts with their already established or planned data priorities.

The second is that if intra-Government transfers of data take place at avoidable cost they may offer little scope for revenue generation. At the same time, while sales of commercial

or value-added data to the private sector normally occur under arrangements which allow for higher prices to be pursued, this area of the data product market is small in size and undeveloped. Moreover, major users of commercial data frequently demonstrate a high sensitivity to price rises. Both factors combine to limit the scope for supplying agencies to generate their own revenue and profit.

The third is that, with the possible exception of natural disasters, there are few occasions on which land and geographic data assumes a political profile higher than other areas of Government activity such as housing, transport, health care and social welfare. Although data is an essential ingredient for the smooth operation of public and private sectors of the economy, it rarely attracts the attention which is often required to compete successfully for Government resources.

Despite the constraints faced by data suppliers on each of these fronts, scope may still exist for Government-owned data supplying agencies to attract additional resources.

One potentially important means of making full use of any opportunity and improving funding prospects is through a closer cross-agency co-ordination of funding priorities. This issue is particularly important at a State and Territory level where custodial responsibilities (and associated funding mechanisms) are perhaps less clearly delineated than at a Commonwealth level where high levels of specialisation tend to apply and scope for duplication of effort is limited.

In a Government budget context, the advantages of improved co-ordination and consensus are that funding applications may:

- be more easily justified and understood;
- attract a wider spread of support from stake-holders including private sector data users;
- facilitate high levels of supplier specialisation and efficiency; and
- offer important administrative advantages in terms of project implementation and post-funding accountability.

Existing administrative structures provide the scope for improvements to be made. An important factor in the allocation of State Government funding for land and geographic data infrastructure within Australia is the statutory and other obligations of major Government-owned data suppliers. These include Departments and agencies with responsibility for land management and mapping, public works, housing, the environment, regional development, agriculture, minerals, energy, and marine resources. While these obligations are ultimately a reflection of the specific demands of data users, which include other areas of Government and the private sector, they are for the most part broadly specified and open to interpretation at a bureaucratic level. At least some scope therefore exists for shifting funds between different areas of data activity on a State-wide or Territory-wide basis.

With these points in mind, the establishment of clear land and geographic data funding priorities within and between supplying agencies appears to be in the early stages of development. Further improvements seem possible. In Victoria, Queensland, Western Australia, Tasmania and the Northern Territory considerable advances have been made in recent years, through inter-departmental co-ordination or joint action in constructing applications for central budget funding. In South Australia, arrangements appear less formal or closely knit, although mechanisms for consensus building and prioritisation have been used in response to State Treasury demands for greater objectivity in funding allocation. Elsewhere, co-ordinating mechanisms are ad-hoc or incomplete.

From discussions with a broad range of data users and suppliers, Price Waterhouse believes that the ability of land and geographic data suppliers to *attract and utilise* Government funding could be enhanced if more focused mechanisms for co-ordination were in place in a number of States and Territories. A model which might be used for work in this area is that of Victoria where the Office of Geographic Data Co-ordination (OGDC) has assumed a leading role with responsibility for creating and administering policy and standards.

The Office has been instrumental in identifying a core of 20 high-priority data products from a group of 61 products and 280 data sets. Selection was based in part on a comprehensive cost-benefit analysis undertaken in 1992 by Tomlinson Associates. In conjunction with Melbourne Water, the Office has created a separate corporation known as Geographic Data Victoria (GDV) with the aim of maintaining and upgrading the State's cadastral data base which constitutes a core element of all State data requirements. GDV will operate along commercial lines and package and market cadastral, topographic and road centreline data sets used within the State. Importantly, the overall priorities set by OGDC are recognised as a key ingredient in the State's budgetary process and serve to influence the budget proposals put forward by individual departments and agencies.

To complete a model of this kind, a mechanism may be needed for identifying and properly reflecting the views of users. Because a number of major suppliers are also users of their own data products, this kind of mechanism already exists in a number of areas. However, it suffers from two important shortcomings. Firstly, coverage is incomplete by failing to deal with the opinions of organisations oriented heavily towards a usage function, including many in the private sector. Secondly, the mechanism fails to bring together within a single forum the positions of different users, from which competing points of view can be compared and an overall list of priorities established which is suitable for Government budgetary decision making. For both these reasons, a user committee in each State or Territory may be needed which could meet separately and/or in conjunction with a committee of suppliers. The composition and powers of these committees are most appropriately determined on a case-by-case basis.

It should be noted that closer co-ordination may necessitate more detailed intra-agency systems for cost attribution. During the course of the inquiries conducted by Price Waterhouse, it became apparent that few agencies had cost allocation systems capable of isolating the resources being devoted to producing land and geographic data. More accurate data costing would greatly facilitate the estimation of future funding requirements and the monitoring of funding outcomes.

EFFICIENCY

Key questions relating to the efficiency with which data are supplied include:

- have policies of commercialisation and contracting-out been applied effectively to Government agencies and do these policies extend far enough?

- to what extent does there exist an appropriate degree of duplication of effort amongst Government agencies at a local, State and Commonwealth level and how might this be kept to a minimum?

- does substantial scope exist for commercial data products to be developed and offered to users in a more effective manner through competition between Government-owned suppliers and firms in the private sector?

- are existing technical standards for data collection and transfer satisfactory?

- how should data be priced? and

- are sufficient regulatory safeguards in place to ensure that positions of monopoly data supply are not abused?

(a) Commercialisation and Corporatisation

Taking each of these questions in turn, commercial principles of operation represent a potentially important means of injecting innovation and accountability into Government agencies which are sometimes subject to few if any external competitive pressures.

Driven by the financial policies of Treasury Departments, commercial methods of operation are now well established throughout Australia in relation to the supply of electricity, gas, water, urban transport, railways, ports, postal services, shipping, and airports. Co-incidentally, substantial land and geographic data generation takes place within many of these areas, just one example being the NSW Department of Water Resources which is now subject to corporatisation. While more commercialised frameworks for operation have been designed with overall agency structures in mind, their influence is expected to filter-down to agency land and geographic data activities and to exert a potentially important influence over data costing and pricing policies.

In its Report on Government Trading Enterprises (GTEs), the Steering Committee on National Performance[8] noted that as a result of Government-owned entities shifting to a more commercial style:

> "Financial results have continued to improve with increasing real revenue and sales margins. GTEs have taken the opportunity to reduce real debt but have also passed on some of the benefits to customers through lower prices, and to Governments in the form of higher dividend payments."

[8] Steering Committee on National Performance Monitoring of Government Trading Enterprises, *Government Trading Enterprises Performance Indicators 1987-88 to 1992-93*, Melbourne, 1994, p.1.

"These improvements have been underpinned by gains in operational performance. Labour productivity has increased sharply ....."

This suggests that a more widespread application of commercial operating practices to include Australia's *larger and more specialised land and geographic data suppliers* warrants close consideration. Nevertheless, Price Waterhouse would advocate that any move by data suppliers in the direction of commercialisation be undertaken incrementally and with reference to the experience of other relevant organisations. There are three reasons for this.

Firstly, data suppliers must frequently respond to the needs of users as part of Community Service Obligations (CSOs). CSOs involve activities which lie outside the capacity or interests of privately-owned data providers. They frequently require close co-ordination with policy makers and considerable flexibility (on the part of suppliers) in allocating resources between commercial and non-commercial projects. In some cases, the supply of CSOs might best occur within a department operating in line with normal Government management structures and procedures.

Secondly, data agencies falling outside the umbrella of commercialisation or corporatisation remain subject to scrutiny through State Audit Offices, Parliamentary Committees, and program reviews initiated by Treasury Departments as part of the budget process. These approaches do not necessarily provide the on-going pressures to improve performance which characterise more commercialised environments. Nevertheless, they appear reasonably well placed to encourage efficiency in data generating agencies operating under traditional departmental structures.

Thirdly, from an economic perspective, the market for land and geographic is in some respects `immature'. Currently, most data is transferred between Government agencies under uniform terms and conditions which appear satisfactory to all concerned and provide minimal scope for competition and innovation based on variations in price or quality. At the same time, the scale of production of value-added output is limited. While commercialisation and corporatisation may assist in levelling the playing-field between Government-owned and privately-owned sellers and improve efficiency (through competition between the two), their overall impact on revenue could be small. Under these circumstances, and in the short-medium term at least, the benefits arising from improved competition need to be weighed carefully against the costs to Government agencies of re-structuring their operations to comply with commercial requirements.

At this early stage, it would seem appropriate to await the outcome of moves already in place to develop a more commercial approach to data supply, before a concerted effort is made to identify and define the need for broadly based changes across the Australian land and geographic data community. The New South Wales Public Works Department and Geographic Data Victoria are just two examples of organisations which are currently moving towards a commercialised approach and could help to clarify the issues involved. Their experience over the next 12-18 months may provide a useful foundation for wider debate on commercialisation and corporatisation. ANZLIC and AURISA are two organisations which could facilitate the process of public discussion.

(b) Contracting-Out

In a similar vein to commercialisation, contracting-out represents one means by which efficiency can be bolstered. It provides the potential for significant cost savings through reducing:

- the in-house resources needed by data supply agencies to address peak demand for their products; and

- the need to maintain specialist skills in activities which are undertaken on a limited or irregular basis.

Available evidence suggests that contracting-out is already used extensively by data suppliers for scanning and survey work and to provide specialist information technology (IT) support relating to systems integration and development. Resultant cost savings appear substantial.

However, important constraints apply in the degree to which contracting-out might usefully be pursued. The task of data interpretation, involving the matching and integration of various information sources, remains a core activity for most supply agencies. It requires direct and on-going input from those involved in constructing original or base data sets, through tight cross-referencing. This process is not easily done outside the Government agency responsible for base data creation, particularly where tight project schedules apply and the cost of correcting faulty work is high. In addition, it is sometimes necessary to maintain designated tasks in-house to preserve a capability for responding to shifts in user demand.

Price Waterhouse believes that existing approaches to contracting-out are satisfactory, although it would emphasise the continuing need for this efficiency option to be exploited wherever practicable.

(c) Duplication of Effort

Anecdotal evidence suggests that unnecessary duplication of effort between data supplying agencies has declined in recent years. However, little accurate information is available on the rate of decline or the degree of duplication which remains. Moreover, few details are available on whether further improvements can be affected and how substantial resultant costs and benefits might be.

A recent decline in unnecessary duplication appears attributable to the wider availability of digitised data sets, greater accessibility of computer-based technologies, improved data transfer standards, and a clearer definition of the custodial responsibilities of major suppliers. The limits to its reduction have arisen as a result of agencies differing in their data requirements with respect to delivery times, data coverage and data quality.

In line with the comments made above in relation to funding levels, Price Waterhouse believes that the greatest single opportunity for minimising remaining duplication of effort

is through closer co-ordination and consensus building between State agencies. In this case, the emphasis would be on refining custodial boundaries.

For practical purposes, moves of this kind are indivisible from funding decisions. This is due to the system of custodianship relying on agencies receiving funds sufficient to meet not only their individual data needs and portfolio obligations but also the data requirements of a potential large number of `dependant' external organisations. Again, Victoria's approach to the problem of co-ordination, focusing around the OGDC, provides a useful model on which improvements might be based.

(d) Competition

A final means by which efficiency might be improved relates to competition in the supply of value-added data products. At this stage, there exist few privately-owned providers in this segment of the market. Value-adding is undertaken by a small proportion of final users, to maintain the confidentiality of their projects and as means of establishing an in-house capability for data interpretation which might complement other aspects of project management. However, very few firms act as *specialist or dedicated developers and brokers of elaborately transformed data* which might operate in open competition with Government agencies. In the longer term, the absence of such competition could result in excessively high data prices and the absence of extensive product innovation.

The efficiency arguments for government agencies becoming involved in the supply of value-added data products centre on those agencies:

- having high levels of technical expertise;
- having a scale and scope of operation which allows for economies to be exploited;
- placing competitive pressures on private sector suppliers which might otherwise have become monopolists; and
- exploiting close synergies between generating commercial and non-commercial data products.

The arguments against government agency involvement, and in favour of a greater private-sector presence, are that:

- Government agencies may not comply with the tax and other obligations placed on privately-owned competitors and therefore enjoy an unfair competitive advantage;
- value-added products lie outside Government agencies' statutory obligations and therefore do not warrant public funding on the basis of existing social priorities;
- the production of commercial items can be divorced from non-commercial production with no significant losses in efficiency (ie. substantial synergies do not exist); and

- private firms operate in a more competitive and therefore cost-efficient economic environment by being subject to profit and other imperatives.

In reality, a competitive and efficient market for value-added products would probably require active participation from both Government-owned and privately-owned data providers. The principal reason for this is that, in the short-medium term at least, active participation by both types of organisation is necessary to generate supplier numbers sufficient to produce reasonable competitive pressures.

Currently, the major impediment to achieving effective competition lies with the barriers to entry faced by private firms, including:

- difficulty in attracting adequately skilled employees;
- the cost disadvantage associated with an initially smaller scale and scope of operation; and
- limited access to metadata.

While there is little that can done to overcome the scale disadvantages or lack of technical expertise that these providers may face in attempting to establish a market niche, corrective action might be taken in respect of access to metadata which is an essential input for most aspects of value-adding. Metadata is produced by Government agencies as part of their production of basic or primitive data sets. It describes the technical characteristics of those sets in terms of coverage, accuracy, and technical attributes. In effect, the meshing of data or other forms of (value-adding) transformation cannot be undertaken without metadata being made available.

Data of this kind is contained within Government agencies but *not always compiled in a form suitable for external distribution*. As a result, private sector agencies attempting to value-add face the complex and time consuming task of bridging information gaps which their publicly-owned competitor(s) can avoid. Price Waterhouse believes that in many cases this constitutes, or could constitute, an insurmountable barrier to market entry. If so, improved access to metadata may be regarded as a necessary but not sufficient condition for viable competition to emerge.

A lack of metadata is an obstacle which is open to direct Government action. In developing the overall policy environment for data infrastructure, improving public access to it should be given a high priority.

(e) Standards

Standards provide the basis on which data is collected, stored and transferred and therefore assume a position of fundamental importance. They remain central in any attempt to bring data sets to a uniform minimum quality and therefore have a direct bearing on the resources required by data supplying agencies to maintain and expand their capabilities.

At present Australian standards are limited to the area of data transfer in which considerable work has been undertaken in recent years. But their application has been piecemeal as a result of:

- introduction part-way through major data development projects;
- complexity;
- differences of interpretation involving basic definitions; and
- the absence of supporting metadata.

Although a number of organisations have agreed to the principles associated with standard data exchange formats, few have taken the opportunity of making full use of the capability which exists currently within the industry.

The most effective way of dealing with this matter may be through utilising *existing vehicles*, notably the Australasian Spatial Data Exchange Centre (AUSDEC) and Spatial Data Transfer Standard (SDTS - now AS4270). Taken together these two instruments are capable of addressing many of the generic impediments to a broader development and application of transfer standards throughout Australia at all levels of the existing infrastructure.

The use of both instruments would avoid unnecessary duplication of resources through the creation of new institutional arrangements. It may also help to stimulate debate on broader policy issues by focusing on a standard which is well known to most players within the industry and of considerable strategic importance in the evolution of a more sophisticated national data network. The formation of AUSDEC by ANZLIC appears to have created a unique opportunity for data agencies to become familiar with and embrace SDTS. Moves in this direction can only help to facilitate the transfer of spatial data in a concise and quality assured manner.

The development of standards in the remaining areas of collection and storage and in the production of metadata has yet to begin. In the longer term, these standards will be necessary as the market for data matures resulting in more extensive inter-agency data transfers and the emergence of larger numbers of private sector suppliers with a value-adding capability. However, care is required to ensure that any standards are simple, easily administered and introduced in a manner which reflects the lessons learnt from experience with SDTS. Progress towards this might be achieved on three fronts.

Firstly, in the initial stages of development, voluntary guidelines rather than formal standards might be appropriate to support the process of change. These would provide scope for suppliers to minimise their exposure to compliance costs, at least until some of the more complex issues had been refined and full scale implementation was possible. Secondly, standards could be designed around data product specifications, leaving the methods by which data was compiled in the hands of individual suppliers. In this way, the focus would remain on the final quality of the data and suppling agencies would enjoy a high degree of flexibility in dealing with how quality requirements could be met. Thirdly, existing (consensus-based) institutions such as ANZLIC should be used to co-ordinate development work particularly during the initial stages. In this way, administration costs can be kept to a minimum.

(f) Data Pricing

Where Government agencies supply commercial data, the issue arises of how this should be priced. While a single prescription which might be applied in all circumstances is difficult to identify, a number of general principles are apparent which should guide data supplying agencies.

Land and geographic data has classic "public good" characteristics in the sense that it is *non-rivalrous*. Once a data product is produced, consumption by one person will not reduce the availability of similar data to other parties. This has important implications in that the price mechanism is not required to ration consumption in order to balance forces of supply and demand.

However, while price signals may not be relevant to consumption decisions, they may still be necessary for resource allocation and investment decisions dealing with how much data should be produced and what inputs should be directed to the task. For public goods supplied by agencies subject to commercial principles of operation, explicit price signals (reflected in profitability or hurdle rates return) play an important role in guiding investment/resource decisions. For public goods which are not supplied under commercial principles but instead are delivered as a public service, market prices play no useful role from a production or consumption point of view[9].

The relevant approaches to pricing Government land and geographic data are now reasonably well established, and have been determined on the basis of two separate data groups or classes.

The first group covers basic or `primitive' data defined as information compiled by an agency *at least cost* as part of its core function for government. It is a public good for which access is required by third parties. Pricing should therefore be at the avoidable cost of extraction and distribution in order to maximise usage and ensure the highest possible levels of social benefit. Charging avoidable cost to third parties for such data seems to be accepted by some jurisdictions and is included in ANZLIC policy stipulating that non-commercial data[10] is to be transferred `at cost' in a manner determined by its custodian.

The second group covers value-added or elaborately transformed data. In this case, the usually accepted principle to be applied where the supplier is a monopolist is for data to be priced at full cost recovery. Where keen and effective competition applies, pricing at what the market will bear is appropriate.

9 Shadow prices may still be used internally by government in order to assist in production and investment decisions. Market prices, however, are not relied on for product decisions in the case of these "pure public goods".

10 "Commercial" is defined in terms of the intended use of the data; specifically "to make the data available to a third party; to sell the data to a third party; to sell products derived from the data; to use the data to gain a competitive or business advantage; or, to use the data to derive income or gain a financial return".

Where there is competition in the supply of the particular transformed information, regulatory issues do not arise. The pricing of that commercial (and competitive) product will be subject to efficient market outcomes. Where value-added information is supplied by an agency as a monopolist some form of regulation may be justified. One option is for prices to be subject to oversight by the new Australian Competition Commission to ensure that there are no monopoly rents earned and that appropriate profits and returns are embodied in sales prices. However, as discussed below, in the section dealing with data access, regulation may be undertaken at either a Commonwealth or State level.

(g) Data Access

The supply of basic or primitive data which cannot be readily duplicated by others effectively takes place through a natural monopoly where the minimum optimum scale of production is so large that there is room in a given market for only one agency who can efficiently provide the product. To the extent that the supply of primitive data (including metadata) can only be efficiently provided by one entity, the public good aspects of the data itself require access provisions.

Access rights and rules have been recognised clearly in recent National Competition Policy reforms proposed as part of the Hilmer Review. While much of the focus of the Review has been on the natural monopoly components of telecommunications and energy supply networks, the same general principles enunciated by Hilmer may be applied to the provision of critical or essential land and geographic information. To the extent that this data has natural monopoly characteristics, access rights and rules may need to be introduced which are over and above those articulated as part of existing ANZLIC policy.

Primitive land and geographic data and metadata is likely to fall within the requirements for an access regime under the new National Competition Policy arrangements due to:

- their natural monopoly characteristics;

- the strategic position of suppliers, in as much as access to the data is required by downstream users wishing to compete in the market for value-added products; and

- those suppliers competing or being in potential position to compete in the provision of value-added products and therefore having an incentive to inhibit access by competitors.

The principle to be applied in this case is that third parties be provided with access on `fair and reasonable' terms. Ideally, access regimes should operate in a "non-proscriptive manner, seeking to facilitate voluntary agreement between parties, and where such agreement cannot be reached, providing an arbitration mechanism to settle the issues in dispute"[11]. This contrasts with current arrangements under Part IV of the Trade Practices

11 National Competition Policy - Draft Legislative Package.

Act where access can be enforced under the anti-competitive provisions of Section 46 dealing with abuse of market power. A non-proscriptive approach avoids many of the complications associated with formal bureaucratic or legal proceedings.

This being the case, two options for a non-proscriptive access regime are available. The first is created by relevant Minister(s) on the recommendation of the proposed Australian Competition Council. This option involves determining what, if any, of the land and geographic data created is `essential' and whether the public interest would be served by establishing an access regime to permit effective competition in a downstream market. The public interest test would consider, *inter alia*, the significance of data to the national economy, the nature of the activities involved, and the expected impact of effective competition on national competitiveness. Based on information currently available, it is reasonable to expect that primitive land and geographic data and metadata will satisfy the public interest test.

The second option is for an access regime to be established by data supplying agencies themselves, through ANZLIC or by other means. The advantage of this approach is that it gives data suppliers greater influence over how the scheme might operate and obviates the need for a regime constructed by Government(s). However, should an approach of this kind be pursued it would need to meet three conditions.

To begin, basic principles of competition would need to be applied in which the interests of potential users of essential data and the `legitimate interests' of suppliers were taken into account when reaching a decision on whether data pricing and access took place on `fair and reasonable' terms. In view of the public good characteristics of land and geographic data the `legitimate interests' defence available to suppliers seems limited as a means of restricting access or pricing data above competitive levels.

Next, at least some oversight by a Government regulatory agency would be required to ensure that the industry's regulatory approach met appropriate standards. Where data supply involved cross-border transactions, the relevant agency for oversight of this kind would be the Australian Competition Commission. Where transactions fell clearly within a single State or Territory, oversight by the Commission or by relevant State bodies such as the NSW Prices Tribunal or Victorial Regulator General would be appropriate.

Finally, in the event of a dispute between parties under an industry program, either the Commission or a State Tribunal/Regulator may be needed to perform the function of arbitrator.

CONCLUSION AND RECOMMENDATIONS

The above points make clear that in future the Australian land and geographic data community may need to take action on a number of fronts to attract adequate resources and to ensure those resources are assigned and used to maximum effect. Closer co-ordination between suppliers and users at all levels of data infrastructure will be required.

As means of achieving these objectives, Price Waterhouse recommends that:

- Government-owned data suppliers throughout Australia, working individually and through ANZLIC, make use of the cost-benefit and cost-effectiveness data provided in Chapter 4 to help attract adequate budget funding including resources necessary to raise the quality of existing data sets to a consistent minimum standard;

- major Government-owned data suppliers in each State and Territory give consideration to improving levels of co-operation with a view to more clearly establishing Government funding priorities within their individual jurisdictions and reducing unnecessary duplications of effort. Recent experience in Victoria involving the Office of Geographic Data Co-ordination (OGDC) provides a useful guide to how reforms of this kind should proceed. Any efforts to co-ordinate the activities of major Government-owned suppliers should be supplemented by more formal mechanisms for regular consultation with major data users;

- continuing efforts be directed to expanding the application of the Spatial Data Transfer Standard (AS4270). As part of this process, data suppliers should make greater use of the Australasian Spatial Data Exchange Centre (AUSDEC). If needed, additional funding should be provided to support the Centre's activities;

- ANZLIC co-ordinate the national development of standards in the areas of data collection and storage and the preparation of metadata. These standards should be based on data product specifications. Initial work in the area should be directed to the establishment of voluntary guidelines, and take direct account of the difficulties faced by suppliers in implementing the data transfer standard AS4270;

- the potential efficiency advantages of contracting-out work to the private sector be explicitly mentioned in the mission statements of Government-owned data suppliers. Scope for contracting-out should be examined by these suppliers at regular intervals with a view to identifying additional contracting opportunities;

- Government-owned data supplying agencies at all levels develop, as a matter of priority, means for improving the delivery of metadata to external users. Such metadata should be prepared in accordance with any prevailing guidelines or standards and provide users with information comparable to that held by the supplying agencies themselves. Metadata should be provided in a form which facilitates its timely transfer and be presented in a way which can be readily understood. It should be priced at the avoidable cost of extraction and distribution;

- Government-owned data supplying agencies at all levels develop, as a matter of priority, internal cost attribution systems capable of identifying the resources devoted to collecting, storing, analysing and distributing land and geographic data;

- Government-owned data supplying agencies be guided in their pricing of data by the following commonly accepted principles: basic or primitive data be sold at the avoidable cost of extraction and distribution; and, value-added or elaborately transformed data be sold to achieve full cost recovery where the supplier is not subject to reasonable levels of market competition, and at the prevailing market price where reasonably strong competition exists;

- working through ANZLIC, the Australian land and geographic data community give consideration to establishing its own provisions for ensuring access on fair and reasonable terms to data supplied by monopolists. Such provisions should rest on voluntary agreement between parties and comply with the minimum requirements set down by the proposed Australian Competition Commission. Basic principles of competition should be applied in which the legitimate interests of data users and data suppliers are considered. The opportunity for independent arbitration in the event of dispute should be available; and

- any national decisions on the desirability (or otherwise) of commercialisation or corporatisation of major Government-owned data suppliers be considered after the initial experience of organisations like Geographic Data Victoria become apparent. Broader debate on the commercialisation/corporatisation issue should be encouraged and facilitated by ANZLIC and AURISA.

6. MONITORING INFRASTRUCTURE BENEFITS

One means of assisting to ensure that additional infrastructure investment is well directed and applied is through monitoring the effects of infrastructure changes over time. The Study's Terms of Reference calls for advice on how jurisdictions within Australia can monitor benefits in a nationally consistent way.

Effective monitoring entails the development of indicators which are:

- meaningful to Government;
- open to aggregation across individual jurisdictions;
- capable of providing feedback at regular intervals (of say 12-18 months);
- readily understood; and
- able to be implemented at reasonable cost.

The importance and potential benefits of developing a monitoring system of this kind should not be underestimated. In recent work undertaken by the Toowoomba City Council, it was estimated that an 8 step/3 day data process could be reduced to a 3 step/5 minute process by having access to the appropriate land related information and more sophisticated computer software. Monitoring systems often help to identify these kinds of opportunities and to provide feedback on their ultimate effects.

UNDERLYING PHILOSOPHY

Recent Australian experience in monitoring the performance of Government Trading Enterprises (GTEs) at a State and Commonwealth level provides a useful guide to the approach which might be adopted in tailoring a program to the needs of land and geographic data suppliers and users.

The Steering Committee on National Performance Monitoring of GTEs[12] which was established at the 1991 Special Premiers Conference, notes that:

- while many caveats may be attached to performance comparisons, at least they raise the very important question of why performance differences exist. In addressing the question of why, ways of improving efficiency and effectiveness may be found;
- agencies have differing corporate objectives, structures and operating environments. Each performs a different range of activities, and is subject to different legislative constraints. These factors all impact on data comparability and suggest that key indicators should be industry specific and subject to on-going refinement; and

[12] Steering Committee on National Performance Monitoring of Government Trading Enterprises, *Government Trading Enterprises Performance Indicators 1987-88 to 1992-93*, Melbourne, 1994, pp.iii-iv.

- an ad-hoc collection of information on benefits may need to give way to a more systematic methods. These may necessitate not only the step-by-step development of measurement indicators but caution in interpreting initial results.

EXISTING APPROACHES

The survey of data suppliers conducted as part of the current study showed that around 85% of respondents monitored their performance in generating land and geographic data by relying on direct feedback from clients on quality, reliability, timeliness, and responsiveness. Numbers of clients and compliance with Government objectives were the next most popular forms of monitoring.

In overall terms, the surveys and workshops conducted as part of the study revealed that relatively little effort had gone into devising systematic and detailed performance monitoring programs. In particular, quantitative measures of performance appeared to be relatively underdeveloped and, with a small number of exceptions, few steps had been taken towards comparing and examining differences in performance across supplier agencies.

A BASIC FRAMEWORK

With these points in mind, an appropriate set of indicators for land and geographic data infrastructure would encompass measures for capturing more efficient performance by data suppliers in terms of:

- a better mix of resources being directed to data collection, analysis, and distribution;
- reduced duplication of effort;
- expansion in the quantity, quality or range of data offered to users; and
- success in meeting pre-determined policy objectives.

Overlaid on this structure would be a series of measures designed to capture the benefits which would eventually flow to users and to the broader community.

SUPPLIER PERFORMANCE

As indicated in Chapter 3, the efficiency with which inputs are selected and combined by data suppliers are normally gauged through two avenues.

The first focuses on the difference between the cost of data from existing sources of supply and the cost of data available from the next-best alternative supply source. However, in seeking to monitor performance on regular basis, this approach may not be feasible. The experience gained by Price Waterhouse in surveying major data suppliers throughout Australia suggests that estimating the total cost of alternatives can only be done

in terms of general approximates. This being the case, the task of measuring what may be small or marginal changes in cost over a 12-18 month period appears incapable of yielding reliable or accurate results. If relative changes in the cost of alternative data is to be gauged, the task might best be left to major studies conducted at longer intervals of perhaps 3-5 years which would allow definite patterns to be detected.

The second focuses on the gains in efficiency which take place within a data supplying agency when investment in new technologies and processes occurs. These gains might include fewer staff needed to complete a task, less duplication of effort, and improved flexibility in responding to user needs.

In theory at least, efficiency of this kind may be gauged through a mix of financial and non-financial indicators.

Financial measures typically include:

- return on assets;
- sales margin;
- return on equity;
- the dividend to equity ratio;
- the debt to equity ratio;
- the ratio of total liability to equity; and
- interest cover.

However, while these indicators have been applied widely to public utilities and other GTEs within Australia, they are not well suited the current structure of land and geographic data supply. Financial indicators are complex, often requiring detailed valuations of fixed and other assets. Perhaps more importantly, the measures are designed for fully commercialised, corporatised or privatised organisations operating under a well established profit imperative. The measures are therefore inappropriate to existing land and geographic supply networks in which data is provided mainly by Government agencies operating within traditional departmental environments. While the shift of Government-owned suppliers towards more commercially-oriented models of operation is underway in some areas, overall change is incremental and will take some time to develop to the stage where financial indicators are of any relevance.

Non-financial indicators offer more positive prospects and may extend to all major facets of infrastructure including data collection, analysis, storage and distribution.

Perhaps the broadest measure of non-financial efficiency is productivity. Here, two options are available. The first involves a `partial' productivity measure which typically looks at the contribution to data output made by employees. In this case input might best be gauged by figures on manhours worked by the data agencies own employees as well as sub-contractors. Output measures would need to be determined on a case-by-case basis taking the particular characteristics of the data into account.

As a general rule, Price Waterhouse would advocate that output and labour inputs be gauged using physical quantities rather than dollar values. Dollar estimates are frequently open to distortion through changes or variations in costing techniques and differing approaches to data pricing.

The second measure, known as total factor productivity, extends beyond labour's contribution to output to also cover the contribution made by fixed capital such as computer hardware and software. The conceptual advantage of this approach is that it overcomes the problem of relying on the efficiency of labour to indicate the overall efficiency of an agency when employees may have benefited from improvements in the quality or quality of the plant and equipment at their disposal. Its disadvantage is that capital inputs are frequently difficult to quantify.

Over time, productivity measures might be supplemented by additional measures aimed at gauging the outcome of supplier activity. These will vary according to the type of land and geographic data being provided and reflect the methods and practices used in their development. However, some generic areas which could be covered include:

- comparisons of actual delivery against agreed schedules;
- systems malfunctions and down-time;
- improvements in data quality; and
- performance against pre-determined administrative or political strategies guiding the longer-term development of a data capability.

Irrespective of the approach to measuring efficiency which might eventually be adopted, the development of indicators obviously requires a method of internal resource attribution which is capable of assigning inputs on a project or product/service basis.

The impression gained by Price Waterhouse during the course of its enquiries is that suitable attribution systems do not currently exist in most agencies but could be established within a relatively short period of time. This being the case, the role of performance measurement in signalling levels and changes in efficiency levels may take time to emerge as 2-3 years of statistical collection is normally required to refine measurement techniques and identify clear trends. An immediate start to establishing a suitable measurement framework will be necessary if the benefits of performance monitoring are to emerge at an early stage.

If applied across a broad spectrum of supplying agencies, productivity and other forms of efficiency measurement will facilitate benchmarking under which the performance of suppliers can be compared. Benchmarking offers suppliers the opportunity to compare their performance against others. It also provides an avenue for overcoming problems of interpretation which arise when internal rates of efficiency growth are high but suspicion exists that this may have been caused by improvements occurring from a relatively low base. Emphasis in this process is on identifying the driving forces behind better performance rather setting strict performance targets.

Cross-agency comparisons are more easily facilitated where similarities exist in the technical characteristics of data products/services, scales of operation, and market and administrative environments. However, data suppliers may choose to compare aspects of their operations against leading organisations in other industries where similar generic functions are being performed.

Benchmarking would only be required for non-commercial data in which supplying agencies are not subject to competitive pressures or formal regulation. Again, a system of resource attribution must be in place to ensure that a distinction between commercial/non-commercial activities can be affected. This is an area in which agreement on definition between participating agencies will be required.

USER AND COMMUNITY BENEFITS

Price Waterhouse believes that the benefits flowing to data users and the broader community are best gauged through major cost-benefit studies at a 3-5 year interval. As indicated in Chapter 3, these benefits are rarely open to detailed quantitative analysis and rely instead on qualitative judgements where changes can only be identified over the medium-long term. The current study establishes a framework through which these benefits may be addressed.

CONCLUSIONS AND RECOMMENDATIONS

Drawing together the above points, Price Waterhouse recommends that major data supplying agencies move towards a more formal process of performance measurement based in the first instance on a physical indicator of labour productivity but eventually extending to cover delivery against agreed schedules, systems down-time, changes in data quality, performance against pre-determined administrative or political objectives, and benchmarking.

An essential prerequisite for progress in this area will be improvements in the cost and resource attribution systems of data supplying agencies. Prior to performance measurement being upgraded, it will also be necessary for suitable measures of output to be determined for each major data product group.

More detailed work on an overall performance measurement framework, including output indicators, should be undertaken in a co-ordinated manner and could be pursued on a national basis. ANZLIC may provide the most appropriate forum for this to be done.

By comparison, the introduction of improved cost and resource attribution systems is perhaps best undertaken at an individual State or Territory level, given the frequent need to tailor such systems to the individual requirements of supplier agencies. Reasonably accurate cost and resource management will be increasingly important if Government-owned suppliers in States and Territories are to join together in identifying and determining the value of data funding priorities as well as ensuring that most efficient use is made of monies allocated by Treasuries for developing land and geographic data infrastructure. Perhaps the most effective means for facilitating the development of these systems is the creation of supplier co-ordination groups along the lines recommended in Chapter 5. The efficient and effective operation of groups of this kind requires that each participating agency has a reasonable idea of its own resource position.

APPENDIX 1

ATTENDANCE AND OUTCOMES OF WORKSHOPS

ATTENDANCE AND OUTCOME OF WORKSHOP ADELAIDE 21 NOVEMBER 1994

Attendance

Jim Jones	SA Engineering and Water Supply Department
Jeff Laubsch	SA Department of Mines and Energy
Peter Brooke-Smith	SA Department of Housing and Urban Development
Allan Barnes	SA Department of Environment and Natural Resources
Andrew Johnson	SA Department of Primary Industries
Rob Bourke	Price Waterhouse

Outcome

1. Survey results indicating technology-related cost savings of around 25-30 percent over recent years appear reasonable.

2. The objectives of Government-owned data supplying agencies could be met if these savings were retained and budgets were increased by around 10 percent in real terms. Many agencies appear to have moved beyond the stage of initial data capture and transformation which normally accounts for around 70 percent of total system costs. Attention is now focusing on data integration and access whose development costs are high but perhaps less so than earlier activities. However, overall costs will remain substantial due to a continuing need to update and upgrade established data sets.

3. Competition between Government agencies and private firms is, and might continue to be, restricted due to:

- Government agencies enjoying significant advantages in terms of economies of scale and scope; and

- difficulty in private firms gaining full access to metadata relating to Government-generated data sets. Access problems may be one factor which could prevent private firms from engaging in the types of technical interpretation which underpin the development of value-added land and geographic data products and services.

4. Most Government agencies consider ANZLIC pricing guidelines when determining the sales price of their data sets. However, pricing aimed at full cost recovery is not making a major contribution to agency budgets due to the limited scope of value-adding activities. Most agencies appear undecided on how far their value-adding activities could or should expand.

5. Contracting-out by Government agencies centres on scanning which can be undertaken very effectively by outside firms. However, tasks involving technical interpretation are not always within the capability of outside organisations due to the frequent need for interpretation to be carried-out with close referral to original records.

6. Existing standards, including SDTS, are sometimes too complicated. They have often been introduced part way through the system development process and have therefore been costly to implement. Improved metadata would make standards more applicable. The establishment of standards is not always done with adequate representation from stakeholders.

7. Duplication of effort among Government agencies is difficult to measure.

8. Little detailed consideration has been given to how the performance of Government data agencies might be measured.

ATTENDANCE AND OUTCOME OF WORKSHOP SYDNEY 24 NOVEMBER 1994

Attendance

Phillip Rudd	NT Department of Lands, Housing and Local Government
Ray Eklund	Telecom
Gary Field	Melbourne City Council
Brian Wright	VIC Department of Energy and Minerals
Andrew Burke	WA Department of Land Administration
Ashley Mahar	TAS Department of Environment and Land Management
Robert Twin	TAS Department of Environment and Land Management
Stuart Murray	NSW Department of Conservation and Land Management
Jim Mitchell	NSW Department of Conservation and Land Management
Neil Bennett	NSW Department of Water Resources
Ron Lucas	NSW Department of Minerals and Energy
Paul Baxter	Price Waterhouse
Rob Bourke	Price Waterhouse
Bruce Douglas	Price Waterhouse Urwick

Outcome

1. Productivity gains within major Government-owned data supplying agencies over recent years have been substantial , although some agencies have been unable to retain the full financial benefits of these improvements. Higher productivity in data supply has led to improved efficiency in other areas of Government through flow-on effects.

2. Over recent years a heavy emphasis has been placed on digitisation and on bringing data sets to a consistent standard. The costs of updating data are substantial and on-going. The value of data to users can decline rapidly if updating is neglected.

3. More comprehensive coverage of local Government data by major State Government agencies is planned for the future.

4. These agencies are beginning to take a more pro-active role in developing value-added data products and services including the development of collaborative business agreements with users. However, clear parameters have still be established by most agencies in relation to how far a pro-active approach should be pursued.

5. A common approach to the pricing of value-added data across most Government agencies has still to emerge.

6. Victoria, South Australia, Tasmania, Western Australia, Queensland and the Northern Territory have established reasonably close co-operation between Government-owned data supplying agencies for the purpose of establishing funding priorities and improving data quality and accessibility. Elsewhere, co-ordination is less well developed. Substantial improvements in co-ordination have been made within Victoria in recent years.

7. Very little detailed consideration has been given to monitoring the performance of data supplying agencies, with the exception of agencies such as the NSW Department of Water Resources.

8. Contracting-out is used extensively by Government-owned data suppliers, particularly in the areas of information technology and surveying. This approach is working satisfactorily. Innovative approaches to contracting-out are being developed by a number of organisations including the Melbourne City Council.

9. The high cost of data upgrades remains a major stumbling block to the introduction and implementation of data standards. Standards are not critical when data supply is restricted to a small number of suppliers and users who are able to negotiate their own requirements. Little information exists on the efficiency gains which arise from the implementation of standards.

10. ANZLIC provides a useful vehicle for promoting reforms designed to improve the efficiency and effectiveness of data supply. Closer co-ordination between ANZLIC, ICSM and major individual data suppliers and users would help to facilitate the reform process.

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