Lake Macquarie Dredging
Benefit Cost Analysis
Sand Supply Feasibility and
Regional Impact Assessment

FINAL REPORT

For the Office of the
Lake Macquarie and Catchment Co-ordinator

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Disclaimer

The analysis presented in this report rests on a number of assumptions that have been made on the basis of available data, consultations and the consultant's judgement. The results may be sensitive to changes in these assumptions.

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EXECUTIVE SUMMARY

Lake Macquarie is the largest coastal lake in eastern Australia. It is connected to the ocean via Swansea Channel, which is in the order of 7km in length. The Channel provides access to the open ocean for day racing and cruising and to the Lake for visiting yachts. It also provides access for charter ferries to slipway services in Sydney and other locations.

There is a long history of navigation problems in the Swansea Channel arising from the continual supply of sediment from downstream sources, namely erosion of Salts Bay (due to increased wave penetration as a result of training of the entrance in the late 1800s).

Currently some community groups are concerned that up to $250 million in tourism and recreation earnings are at stake if extensive dredging is not completed. Other community groups question the need for significant investment of public moneys to service the demands of a relatively small number of vessel owners.

This study focuses on three long-term dredging options for the Swansea Channel, relative to the base case of allowing the Channel to reach its own equilibrium, with occasional maintenance dredging (able to accommodate vessels with a draught of less than 1m):

- Channel of 120m width, -3.0 m depth (maintenance of navigation access for vessels having a draught of 2.0 metres) referred to in this report as Option 1a;
- Channel of 120m width, -3.5 m depth (maintenance of navigation access for vessels having a draught of 2.5 metres) referred to in this report as Option 1b; and
- Channel of 120m width, -4.0 m depth (maintenance of navigation access for vessels having a draught of 3 metres) referred to in this report as Option 1c.

These long-term dredging options for the Swansea Channel were considered within three broad economic frameworks:

- benefit cost analysis, which considers whether the benefits to the community of dredging options outweigh the costs to the community;
- financial feasibility of dredging operations which examines the revenues and costs associated with dredging, processing and sale of sand; and
- regional economic impact assessment, which examines the additional stimulus to the Lake Macquarie economy from expenditure of visiting vessels and dredging operations.

The initial benefit cost analysis focused on the costs and benefits of dredging for navigation alone, ignoring any returns from the sale of sand. Costs related to the incremental dredging costs associated with different Channel options while benefits related to how much vessel owners and their passengers value improved access i.e. would be willing to pay (WTP) for improved access.

Estimates of these benefits required physical data on likely vessel movements associated with different dredging options relative to the base case, together with data on how much vessel owners and their passengers would be WTP for each return vessel movement. This information was not readily available.

The approach used in this study was therefore to:

- develop vessel movement scenarios for each dredging option based on extrapolation of NSW Waterways data and consultations;
- identify how large the WTP per return vessel trip through the Channel would need to be to make the navigation benefits outweigh the dredging costs;
- compare this critical WTP level, referred to as a threshold value, to WTP estimates from the literature.

The different vessel movement scenarios that were developed for each dredging option are shown in Figure ES1

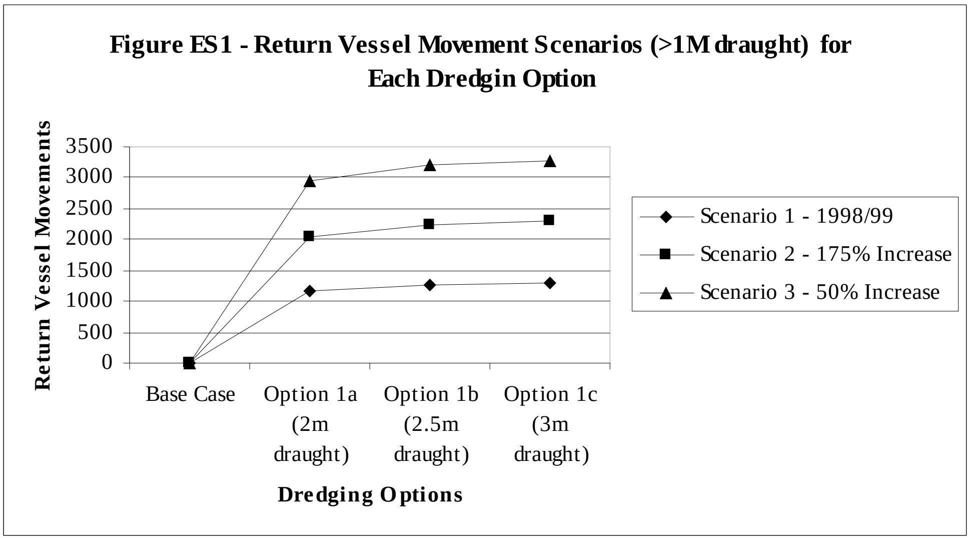


Table ES1- Critical Threshold Values For Different Annual Return Vessel Trip Scenarios

Annual Return Vessel Trips Assumptions	Threshold Values Per Return Trip @7%	Threshold Value Per Person Per Trip (Assuming 4 persons per vessel)
Dredging Option 1a		
Scenario 1 - 1998/99 levels (1175)	$558	$140
Scenario 2 - 175% increase (2057)	$319	$80
Scenario 3 - 250% increase (2939)	$223	$56
Dredging Option 1b		
Scenario 1 - 1998/99 levels (1280)	$438	$110
Scenario 2 - 175% increase (2240)	$250	$63
Scenario 3 - 250% increase (3200)	$175	$44
Dredging Option 1c		
Scenario 1 - 1998/99 levels (1306)	$290	$73
Scenario 2 - 175% increase (2286)	$166	$42
Scenario 3 - 250% increase (3265)	$116	$29

The threshold value analysis results are reported in Table ES1 and indicate that the critical WTP levels are slightly less for deeper dredging options i.e. Option 1c vis-à-vis 1b and 1c, reflecting the lower overall dredging cost (in present value terms) and the greater vessel movements that the deeper options facilitate. Hence, Option 1c is preferable to Option 1b, which is preferable to Option 1a.

However, for the options to be preferable to the base case (minimal maintenance dredging option) i.e. for the navigation benefits to exceed the incremental dredging costs, the WTP of vessel owners and passengers for improved navigation through the Channel would need to lie between:

- $116 and $223 per return trip ($29 to $59 per person per trip @7% discount rate assuming an average four person per vessel) for generous vessel movement assumptions i.e. 250% increase; and
- $290 and$558 per return trip ($73 to $140 per person per trip @7% discount rate assuming an average of four person per vessel) for 1998/99 vessel movement estimates.

Any reduction in dredging costs or additional benefits that can be obtained for each of the dredging options would reduce the critical WTP threshold. One of the potential additional benefits from the dredging alternatives is the commercial use of the sand resource.

Investigations into the commercialisation of the sand resource revealed that the resource is suitable for marketing as a fill material and sand currently recovered from nearby the study area has been sold into this lower value market. However, dredging and sale of material is not a financially feasible operation in itself and hence the private sector would not consider undertaking dredging on a commercial basis at no cost to Government. Nevertheless, once the sand is dredged it can potentially be further processed and sold into the local market at a profit.

Given that it is estimated that there are positive returns from sand processing and sale, it may be possible for the public sector to offset some of the cost of dredging by capturing **part** of the profit from sand processing. Only part of the profit may be able to be captured by the public sector since commercial operators will still require a return on their investment. Furthermore, the commercial operator is exposed to market risk regarding potential downturns in the market, additional supplies from elsewhere etc. Consequently, a commercial operator would only be willing to pay part of the estimated profit to Government in the form of a resource rent.

The most efficient method of determining this amount is to tender the opportunity to market the sand recovered from the dredging options. Competitive process will reveal the markets WTP the public sector for the sand resource.

Table ES2 - Critical Threshold Values For Different Annual Return Vessel Trip Scenarios Have Regard to Commercialisation of the Sand Resource

Annual Return Vessel Trips Assumptions	Threshold Values Per Return Trip @7%	Threshold Value Per Person Per Trip (Assuming 4 persons per vessel)
Dredging Option 1a		
Scenario 1 - 1998/99 levels (1175)	$182	$46
Scenario 2 - 175% increase (2057)	$104	$26
Scenario 3 - 250% increase (2939)	$73	$18
Dredging Option 1b		
Scenario 1 - 1998/99 levels (1280)	$142	$36
Scenario 2 - 175% increase (2240)	$81	$20
Scenario 3 - 250% increase (3200)	$57	$14
Dredging Option 1c		
Scenario 1 - 1998/99 levels (1306)	$95	$24
Scenario 2 - 175% increase (2286)	$55	$14
Scenario 3 - 250% increase (3265)	$38	$10

Regardless of whether the profit from commercialising the sand accrues to the public sector or the private sector, or is shared, it is a net benefit to society that should be included in the benefit cost analysis[1]. Including this net benefit from commercialising the sand resource has the effect of reducing the critical threshold values reported in Table ES1. These adjusted critical threshold values are reported in Table ES2.

Again the critical WTP levels are slightly less for deeper dredging options. Hence, Option 1c is preferable to Option 1b, which is preferable to Option 1a. However, for the options to be preferable to the base case (minimal maintenance dredging option) i.e. for the navigation benefits to exceed the incremental dredging costs, the WTP of vessel owners and passengers for improved navigation through the Channel would need to lie between:

[1] To include the net present values in the benefit cost analysis, royalty costs need to be excluded since they are part of the producer surplus that is redistributed. Royalty costs are not a resource cost to society.

- $38 and $73 per return trip ($10 to $18 per person per trip @7% discount rate assuming an average four person per vessel) for generous vessel movement assumptions i.e. 250% increase; and
- $95 and$182 per return trip ($24 to $46 per person per trip @7% discount rate assuming an average of four person per vessel) for 1998/99 vessel movement estimates.

No economic valuation studies were located that examined willingness to pay for improved navigation access. Consequently, the literature review provided little guidance on whether vessel owners and passengers are likely to value improved navigation at the abovementioned critical levels.

Given the ambiguity of the economic efficiency results consideration should be given to options that may reduce economic costs while having minimal impact on navigation benefits. This would include the 60m wide channel options identified in WMB Oceanics Australia (2002). While resulting in less sand production to offset dredging costs the overall net cost to society is less than that for the 120m wide channel options considered in this report while having similar navigation benefits.

Regional economic impact assessment using input-output analysis was undertaken to examine potential regional impacts associated with the dredging activity and visitation from vessels moored outside Lake Macquarie. It should be noted that such regional impacts are not benefits that are relevant in a benefit cost analysis since regional economic stimulus arise from all investments whether or not they relate to wise, economically efficient, investments.

Regional impacts were measured in terms of direct and indirect output, value-added, income and employment.

Regional economic impacts from initial dredging were estimated to be $2.2M to $5.1M in annual direct and indirect output, $1.1M to $2.5M in direct and indirect value-added, $0.2M to $0.4M in direct and indirect household income to between 4 and 8 total jobs in the region. The impacts from ongoing maintenance dredging were less than 20% of these impacts. These ongoing maintenenace dredging impacts represent less than 0.009% of the Lake Macquarie regional economy.

Regional economic impacts from projected visitation from vessels moored outside Lake Macquarie were estimated to be between $5.0M to $5.6M in annual direct and indirect output, $2.3M to $2.5M in direct and indirect value-added, $0.6M to $0.7M in direct and indirect household income to between 19 and 22 direct and indirect regional jobs. These impacts represent in the order of 0.06% of economic activity in the Lake Macquarie economy.

1. INTRODUCTION

Lake Macquarie is the largest coastal lake in eastern Australia, with a surface area of approximately 110 km^2. It is a major recreational resource offering fishing, swimmming, boating and scenic amenity.

The Lake is connected to the ocean via Swansea Channel, which is in the order of 7km in length. The Channel provides access to the open ocean for day racing and cruising and to the Lake for visiting yachts. It also provide access for charter ferries to slipway services in Sydney and other locations. A road bridge spanning the channel inhibits access of some boats. However, the bridge opens on the hour subject to a prior booking.

There is a long history of navigation problems in the Swansea Channel arising from the continual supply of sediment from downstream sources, namely erosion of Salts Bay (due to increased wave penetration as a result of training of the entrance in the late 1800s).

From year to year the nature and location of the specific navigation problems change as pulses of sediment move through the entrance, forming ever-changing shoal patterns. Currently as an interim measure, an immediate allocation of $500,000 has been committed for Channel entrance maintenance. However, longer-term options are being examined.

While from time to time reference is made to potential water quality or other environmental benefits associated with improving ocean access to the Lake, WBM Oceanics identify that there are no water quality or environmental benefits of dredging the Swansea Channel.

The navigation issue can perhaps be best summarised as follows:

" In almost every generation since the first major works in the early 1880's, there has been constant agitation for improvements, whether major or minor."

"the constant demand has been for breakwater restoration, dredging and still more dredging."

".. and the uniform reply has been lack of money to meet the cost of such works, sometimes with a variation that while proposals would improve the channel the cost could hardly be justified."

(Newcastle Morning Herald, 11 May 1972)

Currently some community groups are concerned that up to $250 million in tourism and recreation earnings are at stake if extensive dredging is not completed. Other community groups question the need for significant investment of public moneys to service the demands of a relatively small number of boat owners.

It is this very issue that is the subject of this report. Can major dredging of the Channel be justified. Do the benefits of dredging works outweigh the economic costs? What flow-on regional economic benefits might accrue to the region from improved access?

Section 2 of this report briefly outlines the conceptual economic framework for this report. Section 3 examines the navigation costs and benefits of dredging options incorporating analysis of available NSW Waterways data and the outcome of consultations with potentially affected vessel owners. Section 4 examines the feasibility of selling the dredged material and incorporates the results into the benefit cost analysis. Section 5 examines the potential regional economics impacts of improved access. Section 6 provides the conclusions to the study.

2. CONCEPTUAL FRAMEWORK

Agencies such as Lake Macquarie City Council, Wyong Shire Council and the Office of the Lake Macquarie and Catchment Co-ordinator have limited financial resources with which to carry out their charter. Choices need to be made regarding what level of funding different issues warrant.

Economic evaluation tools can provide an important input to these decisions. In economics, the aim is to allocate scarce resources, such as financial resources, to maximise economic welfare or community fulfillment. An investment is considered desirable from an economic efficiency perspective, if the benefits from an investment exceed the costs of an investment. Where there are a number of alternative investment options, the alternative that yields the greatest net benefits to the community is considered to be the most desirable from an economic efficiency perspective. The tool used by economists to evaluate investment alternatives from a community welfare (economic efficiency) perspective is ***benefit cost analysis***.

All new expenditures within a regional economy, whether or not they relate to a wise investment i.e. an economically efficient investment, will stimulate economic activity in a region. This is because expenditure in one industry sector results in flow-on expenditure in other industry sectors due to purchases of inputs to production and expenditure of employees i.e. production and consumption induced linkages. These types of effects can be considered within a regional economic impact framework that involves modelling the linkages between sectors in a regional economy and assessment of the effects of different changes in expenditure from an impacting agent e.g. increased tourist numbers. This approach is referred to as ***regional economic impact assessment***.

Financial analysis considers the costs and revenues associated with an investment (in this case production of fill sand) from the perspective of a single commercial entity. **Feasibility** is considered in the light of financial analysis results and the practicalities and commercial realities of sand extraction at the Lake's entrance.

The issue facing Government can be examined within these three broad frameworks.

3. BENEFIT COST ANALYSIS

3.1 Identification of the Base Case and Alternatives

Identification of the “base case” or “without” significant dredging scenario is required in order to facilitate the identification of the incremental economic costs and benefits of the dredging alternatives. This base case does not have to be the same as the current situation but should represent the scenario if no significant dredging is undertaken.

In this study, the base case has been defined as allowing the channel to reach its own equilibrium, with occasional minimal maintenance dredging (say $30,000 pa) to remedy specific shoaling issues. Under this option, the channel will select a preferred predominant pathway to the Lake. However, the time frame over which this will occur is uncertain. Until that time a braided system of channels is likely to exist and ongoing sediment infeed will continue to block the dominant channel, forcing selection of alternative channels that will gradually deepen as they take more of the flow. This process is likely to be repeated each time a slug of sediment moves through the Channel (WBM Oceanics Australia (2002)). Under this option it has been estimated that sedimentation would continue to affect navigation with boating access limited to vessels with a draught of less than 1m.

WBM Oceanics (2002) has identified a number of potential dredging alternatives to maintain greater navigation access through Swansea Channel. These options include:

Option 1 – re-establishing the main channel through Swansea Channel to Lake Macquarie past Marks Point. The widths of 60m and 120m were modelled. The level at the base of the dredge channel was varied from 3.0 m to 4.5m (at 0.5m intervals).

Option 2 – redirecting the channel to the west by dredging a 100m channel and building a training structure that includes gaps of various widths to facilitate flushing of Swan Bay. The level at the base of the dredge channel was varied from 3.0m to 4.5m (at 0.5m intervals).

Option 3 – dredging as for Option 1 with reclamation of the southern entrance to Swan Bay with the option of a gap to facilitate flushing of Swan Bay.

Option 4 – dredging as for Option 3 with the construction of a groyne on the southern tip of the southern entrance to Swan Bay.

Option 5 – construction of a training structure along the entrance to the western channel, postulated to result in self scouring channel together with dredging of the main entrance channel to a depth of 4m and a width of 120m.

Option 6 – removal of Elizabeth Island and other sand islands in Swansea Channel to a depth of –0.5m.

WBM Oceanics (2002) analysed these options and considered that the most cost effective solution is dredging the main channel (northwards past Marks Point) to a depth of around –0.4M AHD with a width of around 120 m. This related to one of the variants of Option 1 identified above. In accordance with advice from The Office of Lake Macquarie and Catchment Coordinator, this study evaluates the following three variants of Option 1 relative to the base case:

- 120m width, -3.0 m depth (maintenance of navigation access for vessels having a draught of 2.0 metres), referred to in this report as Option 1a;
- 120m width, -3.5 m depth (maintenance of navigation access for vessels having a draught of 2.5 metres), referred to in this report as Option 1b;

- 120m width, -4.0 m depth (maintenance of navigation access for vessels having a draught of 3 metres), referred to in this report as Option 1c.

3.2 Identification of Costs and Benefits

It is necessary to identify the incremental costs and benefits over time of the dredging alternatives compared to the base case. Costs and benefit can be examined for each affected stakeholder group. Net benefits to producers are referred to as producer's surplus and are essentially equivalent to net revenues. Net benefits to consumers are referred to as consumer's surplus. Consumers' surplus is the difference between what a person would be willing to pay for a good or service and what they have to pay.

Table 3.1 below summarises the main potential economic benefit and cost categories of dredging alternatives. The table separates costs and benefits associated with the navigation issue from those associated with the sand market. This Section of the report focuses on the costs and benefits of dredging for navigation alone while Section 4 introduces the costs and benefits associated with commercialising the sand.

Table 3.1 – Economic Costs and Benefits of Dredging Alternatives

Stakeholder	Costs	Benefits
Navigation		
Government	• Capital costs of initial channel establishment • Incremental ongoing maintenance dredging costs	
Vessel owners moored inside Lake Macquarie		• Improved access to the Ocean (producer surplus if associated with a commercial activity or consumer surplus for non-market recreation)
Vessel owners moored elsewhere		• Improved access to Lake Macquarie (consumer surplus for non-market recreation)
Sand Extraction		
Sand wholesaler	• Washing and screening costs • Contribution for road maintenance etc.	• Incremental revenue from sale of sand

* It is assumed that costs of bridge openings and delays for traffic remain constant between all alternatives including the base case. Where it is considered that this is not the case there would be additional costs to the community from the dredging options.
**Royalties payments to DLWC are not included as a cost in benefit cost analysis since they are part of redistributing producer surplus rather than a true economic cost to society. Royalty costs are, however, a relevant cost in a commercial feasibility analysis. Contributions to Council are included as a true economic cost since they aim to represent economic costs associated with road maintenance etc.
***There are currently approximately 3 cruise vessels that need to leave Lake Macquarie each year to be slipped for Surveys in Sydney. It is assumed in this analysis that even under the base case there would be tidal situations that would permit these boats to exit and enter on a sporadic basis. For example, Lake Macquarie Cruises currently needs to wait till Spring high tide to exit the Lake.

****Any increase in net revenue associated with increases in dolphin and whale watching cruises as a result of dredging options would be an additional benefit of dredging options. While some operators have expressed a view that dredging of the channel would substantially increase the prospect for whale and dolphin watching cruises, others suggested that the abundance of whales and dolphins was insufficient and that for this reason they have had to remove dolphin watching and whale watching from their advertising. Consequently, no net benefit to whale and dolphin watching is included in this analysis.

3.3 Quantification/Valuation of Cost and Benefits

3.3.1 Capital and Maintenance Costs of Dredging

The economic cost of the dredging alternatives has been estimated by WMB Oceanics Australia (2002) based on the following assumptions:

- dredging site establishment for major works ($150,000): based on recent experience;
- dredging ($5 per m3 and $1 per m3 for each additional kilometre over 1 kilometre for pumping of the dredged slurry). Total of $6 per m3 to transport to Blacksmiths Beach;
- a 20% contingency was added to capital costs;
- a 15% allowance was added to capital costs for design, investigation, survey and supervision;
- maintenance dredging quantities have been calculated based on the amount of material that would be eroded from the dredge profile per year (as predicted by the numerical model). It needs to be accepted that some variation is likely to these amounts;
- dredging site establishment for maintenance works ($150,000). This cost was spread over the expected time frame for maintenance dredging which was based on the expected annual maintenance dredging quantities; and
- discount rate on the annual series has been set at 7%. Present value of maintenance dredging has been calculated over a 25 year period.

On this basis, together with a 20% increase in estimated annual maintenance costs based on market data, the following costs of each of the dredging alternatives have be estimated.

Table 3.2 – Capital and Maintenance Costs of Dredging Options

Option	Capital Costs	Annual Maintenance	PV of Maintenance (25 years)	PV Total Cost (25 years)
Base case	$0	$30,000	$374,080	$374,080
Option 1a (120m wide, -3.0m AHD)	$1,394,000	$552,000	$6,883,000	$8,277,000
Option 1b (120m wide, -3.5m AHD)	$2,283,000	$385,000	$4,800,000	$7,083,000
Option 1c (120m wide, -4.0m AHD)	$3,171,000	$133,000	$1,658,000	$4,829,000

These cost estimates clearly indicate that deeper channel depths for the 120m wide channel incur greater up-front capital costs but have lower ongoing maintenance costs. Bringing all costs back to present values, the deeper channel depth option is cheaper overall at a cost of $4.8M. This is because the cheaper maintenance costs of this option more than offset the higher up-front capital costs.

3.3.2 Improved Access to the Ocean and Lake

One of the main economic benefit of the dredging options relate to improved navigation through the Swansea Channel. It is therefore important to obtain some physical data on the number of vessels that may benefit and how vessel movements may change under each dredging option compared to the base case or "do nothing" option.

There is no complete source of data that allows firm and accurate prediction of current and potential navigation of the Swansea Channel. It is therefore necessary to draw on available sources of data and use this to make some inferences. Sources of data used in this study include Roads and Traffic Authority and Waterways NSW data on bridge openings and vessel movements, as well as consultation with Yacht clubs/Marinas and vessel owners.

WBM Oceanics Australia's Lake Macquarie Estuary Management Study (1997), provided some annual data on bridge openings and vessel movements. This data has been updated by the Roads and Traffic Authority and reported below.

Table 3.3 – Bridge Openings and Vessel Movements

Period	No. of Openings	No. of Vessel Movements
12 months up to June 1989	1,293	2,638
1991	1,438	2,608
1992	1,444	2,764
1993	1,593	3,290
1994	1,667	3,391
1995	1,615	3,237
June 1996	1,593	2,812
1997	1,807	Not provided
1998	1,777	Not provided
1999	1,735	3,323
2000	1,774	3,875
2001	1,849	3,312
2002	1,276 (up to an including August)	2,756

* Vessel movements are only for vessels requiring bridge openings.

This data shows that the general level of vessel movements through the Channel is between 2,600 and 3,900 per annum. There is no available data on the average channel depth for each year and hence it was not possible to develop a relationship between vessel movements each year and channel depth. Furthermore, this aggregate data does not reveal any characteristics of the vessels that use the channel.

The latter issue can be partly addressed through examination of Waterways NSW data regarding vessel movements in Swansea Channel between October 1998 to November 1999. This data categorised vessels passing through the channel, at the time of bridge openings, as:

- Cruiser (C);
- Cat-Power (CP);
- Cabin Runabout (CR);
- Cat-Sail (CS);
- Motor Cruiser (MC);
- Open Runabout (OR);
- Personal Watercraft (PWC);
- Fishing Vessel (FV);
- Sailing Vessel (SV); or
- Yacht (Y).

The data was for three sizes of vessels, <8m, 8m to 10m and >10m. However, the NSW Waterways data for the year was incomplete in a number of ways:

- It only related to vessel movements reported by the RTA for which the boat registration and/or name was recognised by the NSW Waterways data base. Where NSW Waterways database did not recognise the name of the boat or the registration number provided by the RTA it was omitted from the data set[2]. Consequently, the NSW Waterways data set is for 1,498 vessel movements rather than the estimated 3,323 vessel movements of October 1998 to November 1999.

- mooring location information was not available for all the NSW Waterways data set. This data was only available where vessels were moored on NSW Waterway moorings. Where vessels were accommodated at marinas or people's houses there was no information on their location; and
- vessel draught information was not available for the complete NSW Waterways data set.

The NSW Waterways data set for vessels movements therefore represented just under half of the full years estimated vessel movements. So as not to underestimate the potential beneficiaries of the dredging options, the NSW Waterways data set was extrapolated to the estimated full year vessel movements. The results are summarised in Table 3.4.

Table 3.4 – NSW Waterways Data on Vessel Movements 1998/99

Type	Total Vessel Movements	%	Total Vessel No.	%
C	314	9%	173	9%
CAT	2	0%	2	0%
CP	29	1%	20	1%
CR	256	8%	117	6%
CS	70	2%	49	3%
FV	76	2%	16	1%
MC	1,130	34%	572	31%
OR	247	7%	170	9%
Punt	2	0%	2	0%
PWC	7	0%	7	0%
RI	18	1%	9	0%
SV	1,027	31%	621	33%
TS	4	0%	2	0%
Y	141	4%	112	6%
TOTAL	**3,323**	**100%**	**1,872**	**100%**

From this data it can be gleaned that the estimated 3,323 vessel movements were associated with 1,872 separate vessels.

The majority of vessel movements through the Swansea Channel (associated with Bridge openings) related to Motor Cruisers (and Cruisers – unspecified which has been listed separately) and Sailing Vessels. Together these categories make up 74% of vessel movements (43% and 31%, respectively).

However, not all vessel movements are potentially restricted by the shallow depths of the Swansea entrance channel that may arise under the base case or “do nothing” option i.e. less than 1m draught. In the absence of sufficient vessel draught data, it was necessary to focus on the total vessel movements associated with vessels of a **type** that are likely to be inhibited by shallow access through the Channel i.e. likely to have a draught of 1m or more.

[2] NSW Waterways data set includes vessel name as a voluntary piece of information that registered boat owners may include on their registration form and is ultimately recorded in the data base. Where RTA only obtained the name of vessels using the Channel at times of bridge openings (and not the rego) and the name was not in the NSW Waterways database, no information on the vessel could be determined and hence it was omitted from the data set.

For instance, it could be assumed that the main vessel categories that are likely to be inhibited by shallow Channel depth are motor cruisers, cruisers, sailing vessels and yachts. All other vessel types, including those that can use the Channel without the bridge being opened, are assumed to be unaffected by the various dredging options.

Based on the extrapolated NSW Waterways data for 1998/99, there were 2,612 annual vessel movements (in the order of 1,306 return trips) through the Channel from a vessel type likely to be inhibited by shallow access.

The draughts of these vessels were assumed to be in the same proportion as the limited sample of vessels that reported draughts i.e. 90% with draught of 1m to less than 2m, 8% with a draught of 2m to less than 2.5m and 2% with a draught of 2.5m to 3m.

Based on these assumptions, Table 3.6 summarises the return vessel movements (associated with vessels assumed to have a draught of 1m or more) impacted by the different dredging options.

Table 3.6 – Estimated 1998/99 Return Vessel Movements (>1M draught) for Different Dredging Options

Options	**Return Trips Per Annum**
Base Case	0
Option 1a (2m draught)	1,175
Option 1b (2.5m draught)	1,280
Option 1c (3m draught)	1,306

Major dredging of the Channel[3] was undertaken between December 1998 and May 1999. Therefore all other things being equal, vessel movement data for 1998/99 may underestimate usage of fully dredged and maintained access channel. For instance, vessel movements in the year 2000 after Channel dredging were 117% higher than in 1999. Enhanced expectations of long term ease of access due to the development and maintenance of a defined channel may result in increased usage of the Channel.

To take into account how vessel movements may increase if a distinctive channel were dredged and maintained, some consultations were undertaken with vessel owners from Lake Macquarie and Sydney. Refer to Appendix A. Up to a 250% increase in usage of the Channel was suggested from consultations. This relates to an increase over current usage levels rather than 1998/99 usage levels. However, usage levels of these two years are not dissimilar. This 250% increase in return vessel movements was applied to the above estimates of return vessel movements in 1998/99 to develop an upper limit scenario for analysis. However, it should be recognised that vessel owners may have a vested interest in overstating the benefits to themselves of the various dredging options and hence an intermediate scenario of a 175% increased in annual return vessel movements was also analysed.

Each of these three potential return vessel movement scenarios for each dredging option is summarised Table 3.7.

Table 3.7 - Return Vessel Movement Scenarios (>1M draught) for Each Dredging Option

	Vessel Movement Scenarios – Return Trips Per Annum		
Dredging Options	***Scenario 1- 1998/99 Usage Levels***	***Scenario 2 - 175% of 1998/99 Usage Levels***	***Scenario 3- 250% of 1998/99 Usage Levels***
Base Case	0	0	0
Option 1a	1,175	2,057	2,939
Option 1b	1,280	2,240	3,200
Option 1c	1,306	2,286	3,265

[3] Dredging was undertaken to a level of –3.5AHD and width of 30m.

The correct measure of the benefit that accrues from improved access is how much owners and their passengers value improved navigation through the Channel. This is referred to in economics as consumers' surplus and is measured by how much vessel owners would be willing to pay (WTP) for improved navigation (whether or not the payment is actually made). Techniques that can potentially be used to elicit the WTP of vessel owners include the contingent valuation method, where vessel owners are directly asked their WTP to ensure dredging of a the Channel proceeds. Alternatively, it may be possible to examine the economic valuation literature to obtain results from studies that examined similar issues.

Because of sensitivities regarding direct questioning of vessel owners, this study utilised the latter approach.

Data sources examined included the NSW Environmental Protection Authority's ENVALUE database, New Zealand non-market valuation data base, Journal searches through ScienceDirect, Ideal, APAIS etc. and consultation with non-market valuation practitioners in NSW and Canberra.

No studies were found that directly related to willingness to pay for improved vessel navigation. However, reference was found to a number of studies relating to willingness to pay for boat recreation and general terrestrial recreation. These are summarised below.

Table 3.8 - Studies of Willingness to Pay for Recreation

Study	Year	$ per visit	Units	2001 value (AUS$)
Overseas Boating-non motorised*				
Walsh, Johnson and McKean	1990	$32 (US1993)	per day	$100
Barrier Reef Studies				
Hundloe et al	1998	$12.60	per visit	$13.90
Economic Associates	1998	$42.59	per adult day	$46.98
Sloan	1998	$69.12	per visitor day	$76.24
Terrestrial Studies				
Lockwood and Lindberg	1996	$4.80	per visit	$5.29
	1996	$19	per visit	$20.96
RAC	1992	$8.90	per visit	$10.98
Bennett	1995	$19	per visit	$21.98
Bennett	1995	$34	per visit	$39.34
Gillespie	1997	$28	per visit	$30.83
	1997	$48	per visit	$52.86
Read and Sturgess	1994	$75	per visit	$90.15
	1994	$18	per visitor day	$21.64

* This is an average of results from primary research efforts using either the contingent valuation method or the travel cost method. However, the original study has not been able to be obtained and may relate to canoeing rather than other forms of boating.

It should be noted that even the studies of WTP for non-motorised boating appear to relate to the presence/absence of canoeing opportunities rather than improved navigation access for sailing type vessels. The absence of any overly relevant WTP studies is a limitation in utilising these WTP results.

An alternative is to identify how large the WTP per return vessel trip through the Channel would need to be, for each of the vessel movement scenarios for each dredging option, to make the navigation benefits outweigh the dredging costs. This critical WTP level is referred to as a threshold value. This critical WTP threshold can then be presented to decision-makers for their judgement as to whether individual WTP is likely to be as high as these critical levels.

3.4 Calculation of Critical Threshold Values

To calculate these threshold values, it is still necessary to discount dredging costs and different willingness to pay estimates to present values. In accordance with NSW Treasury Guidelines, a 7% discount rate was used with sensitivity testing at 4% and 10%.

Table 3.9 – Critical Threshold Values For Different Annual Return Vessel Trip Scenarios Ignoring Commercialisation of the Sand Resource

Annual Return Vessel Trips Assumptions	Threshold Values @4%		Threshold Values @7%		Threshold Values @10%	
	Per Trip	Per Person	Per Trip	Per Person	Per Trip	Per Person
Dredging Option 1a						
Scenario 1 - 1998/99 levels (1175)	$536	$134	$558	$140	$582	$146
Scenario 2 - 175% increase (2057)	$306	$77	$319	$80	$332	$83
Scenario 3 - 250% increase (2939)	$214	$54	$223	$56	$233	$58
Dredging Option 1b						
Scenario 1 - 1998/99 levels (1280)	$404	$101	$438	$110	$473	$118
Scenario 2 - 175% increase (2240)	$231	$58	$250	$63	$270	$68
Scenario 3 - 250% increase (3200)	$162	$41	$175	$44	$189	$47
Dredging Option 1c						
Scenario 1 - 1998/99 levels (1306)	$245	$61	$290	$73	$339	$85
Scenario 2 - 175% increase (2286)	$140	$35	$166	$42	$194	$49
Scenario 3 - 250% increase (3265)	$98	$25	$116	$29	$136	$34

What this indicates is that the critical WTP levels are slightly less for deeper dredging options i.e. 1c vis-à-vis 1b and 1c, reflecting the lower overall dredging cost and the greater vessel movements that the deeper options facilitate. Hence, Option 1c is preferable to Option 1b, which is preferable to Option 1a. However, for the navigation benefits to exceed the incremental dredging costs, the WTP of vessel owners and passengers for improved navigation through the Channel would need to lie between:

- $116 and $223 per return trip ($29 to $59 per person per trip @7% discount rate assuming an average four person per vessel) for generous vessel movement assumptions i.e. 250% increase; and
- $290 and$558 per return trip ($73 to $140 per person per trip @7% discount rate assuming an average of four person per vessel) for 1998/99 vessel movement estimates.

Any reduction in dredging costs or additional benefits that can be obtained from each of the dredging options will reduce the critical WTP threshold. The following Section examines one of the potential additional benefits from the dredging alternatives, commercial use of the sand resource.

4. FEASIBILITY STUDY - COMMERCIAL USE OF THE SAND

4.1 Introduction

Sand resources can potentially be used for a range of construction and industrial applications. These range from high value uses for even grained sands (e.g. glass making, foundry applications, cement, etc) to low value uses for less highly sought grades. Lower value uses include construction fill.

As part of the WBM Oceanics Australia (2002) investigation, forty surface sediment grab samples were collected from the study area to gain an understanding of transport pathways and patterns of erosion and accretion. Analysis of the sand-sized fraction was undertaken for each sediment sample to determine the grain size distribution and the degree of sorting. The sediment was also subject to a visual inspection to identify the minerals present. Sampling results, along with the results of previous investigations (e.g. PWD (1976), Resource Planning (1988) and PWD (1992) are documented in WBM Oceanics Australia (2002).

Sampling results indicate that the sand resource is a clean, well sorted, quartzose marine sand, varying from light grey to white in colour. Grain size varies from fine through to coarse. Overall the resource has been classified as Medium Sand (0.25 – 0.5 mm) i.e. 50% or greater is medium sand (WBM Oceanics Australia (2002), page 4-6).

The resource is suitable for marketing as a fill material and sand currently recovered from nearby the study area has been sold into this lower value market.

4.2 Market for Fill Sand

Demand for fill sand is linked to the level of overall economic activity in the Hunter and the level of housing and infrastructure construction in particular. Very little sand is transported from this region to Sydney.

Major extractors and on-sellers report that demand is currently reasonably buoyant for fill sand with a large housing project underway and major road upgrades requiring subsurface fill.

Sand sourced from the Lake competes with product sourced from:

- Redhead (to be closed in twelve months);
- Stockton Bight (large high quality resource); and
- Hunter River (high quality resource used mainly for cement production).

Total sand sales, all grades, are estimated in the table below.

Table 4.1 - Estimated Annual Demand for Sand in the Hunter Region

Source	Tonnes recovered and sold
Stockton Bight	1,000,000
Redhead	250,000
Hunter River	250,000
Total Demand	1,500,000

Source: approximates derived with the assistance of Ian Patterson, DMR

The 1.5 million tonnes of sand supplied to the market annually is destined for the following markets (approximately):

- 10% fill (150,000 tonne);

- 20% industrial (glass making and foundry use);
- 60% concrete; and
- 10% general construction (concrete, potentially a little fill).

Belmont Sand Supply currently supplies additional fill grade material from the Lake Macquarie resource and inferior quarried crushed sandstone is also available to meet fill market needs. Total fill grade material supply is estimated to total around 200,000 to 250,000 tonne per annum.

Sand prices vary from $6/tonne for fill sand to $12/tonne for best quality bricky's sand. The Lake resource is $6/tonne fill sand at current levels of supply and demand.

4.3 Supply from Lake Dredging

Alternate dredging options will generate different sand volumes and incur different capital and operating costs. Costs of dredging and sand volumes produced for each option are summarised below.

Table 4.2 – Estimated Costs for Dredging Options

Option	Capital Costs	Volume m^3 (*tonne)	Unit Cost $/t	Operating Costs/yr	Volume/yr m^3 (*tonne)	Unit Cost $/t
Option 1 (120m wide, -3.0 AHD)	$1,394,000	147,100 (264,780)	$5.26	$552,000	68,100 (122,580)	$4.50
Option 1 (120m wide, -3.5 AHD)	$2,283,000	256,800 (462,240)	$4.94	$385,000	47,600 (85,600)	$4.49
Option 1 (120m wide, -4.0 AHD)	$3,171,000	366,500 (659,700)	$4.81	$133,000	16,500 (29,700)	$4.48

Source WMB Oceanics Australia 2002
*Based on 1 m^3 = 1.8 tonne

4.4 Net Benefits from Commercialisation of Sand

From the table it can be seen that the cost of dredging per tonne for all options is below the current market price of $6/tonne for fill sand. However, in addition to dredging costs, sand that is to be recovered for commercial purposes incurs costs associated with screening and washing, contributions for road maintenance and royalty payments. Screening and washing costs are estimated at in the order of $2.50/tonne, current contributions to Council for road maintenance are $0.20/tonne and royalty payments to DLWC are estimated at $0.10/tonne. This gives an additional cost of preparing sand for market of $2.80/tonne.

Based on these simple calculations it is evident that the private sector would not consider undertaking dredging on a commercial basis at no cost to Government. Dredging is not a financially feasible operation in itself and hence would require Government funding. This finding is supported by the fact that previous attempts by the Premiers Task Force to obtain expressions of interest to undertake the dredging at no cost to Government, were unsuccessful.

The sale schedule of the fill sand is potentially influenced by three factors, the price elasticity of demand for fill sand, site and technological constraints and the market size.

Price elasticity of demand for fill sand will influence how much the increased quantity of sand released onto the market influences price. There is little available data on price elasticity of demand for fill sand. However based on economic theory it would be expected that demand for fill sand would be elastic, meaning that the quantity demanded is highly sensitive to the market price. The consequences of this for the supplier, however, is that large increases in volume supplied to the market have little impact on market price.

Having regard to the site and typical dredging equipment, indications from market suppliers suggest that in the order of 250,000 tonnes per annum of fill sand would be all that a commercial operator could manage.

Because of the relatively low value of fill sand, the market range is likely to be influenced strongly by transport costs. As such there is a likely to be a defined geographic limit of the market for fill sand extracted from the Swansea Channel. Consequently, the total quantity demanded by the market is likely to have an upper limit related to amount of building and construction activity that is occurring within the market range. Supply of sand greater than this market limit is likely to be unsaleable.

Advice from suppliers of fill sand suggest that 250,000 tonnes per annum would not exceed the market threshold and hence would be readily saleable at $6/tonne.

Based on this assumption, fill sand market sale profiles for each dredging option are summarised in the following table.

Table 4.3 – Assumed Market Sale Profile for Each Dredging Option

Dredging Option	**Market Supply Profile (tonnes/year)**			**Total Sand Volume (tonnes)**
1A	**Year 1** 250,000	**Year 2** 137,360	**Year 3-25** 122,580	3,206,700
1b	**Year 1-2** 250,000	**Year 3** 133,600	**Year 4-25** 85,680	2,518,560
1c	**Year 1-2** 250,000	**Year 3** 219,100	**Year 7-25** 29,700	1,372,500

Based on the production profiles, costs and prices referred to above, the following net present value from marketing of the fill sand are estimated, using a 7% discount rate with sensitivity testing at 4% and 10%. The positive net present value indicates that once the sand is dredged it can potentially be further processed and sold into the local market at a gross profit. The higher gross profit being associated with the option with the greatest quantity of sand i.e. option 1a. It should be noted that the above analysis assumes that there are no additional transport costs to those included in the dredging cost estimates.

Table 4.4 – Estimated Commercial Return From Sand (Ignoring Dredging Costs)

	Discount Rate		
Dredging Option	**4%**	**7%**	**10%**
1a	$6,826,190	$5,343,117	$4,367,316
1b	$5,627,727	$4,569,977	$3,868,154
1c	$3,487,273	$3,078,260	$2,795,675

Given that there are positive returns from sand processing and sale, it may be possible for the public sector to offset some of the cost of dredging by capturing **part** of the gross profit from sand processing. Only part of the profit may be able to be captured by the public sector since commercial operators pay tax on their gross profits and will still require some return on their investment. Furthermore, the commercial operator is exposed to market risk regarding potential downturns in the market, additional supplies from elsewhere etc. Consequently, a commercial operator would only be willing to pay part of the estimated gross profit to Government in the form of a resource rent.

The most efficient method of determining this amount is to tender the opportunity to market the sand recovered from the dredging options. Competitive process will reveal the markets willingness to pay the public sector for the sand resource.

4.5 Recalculation of Critical Threshold Values

Regardless of whether the gross profit from commercialising the sand accrues to the public sector or the private sector, or is shared, it is a net benefit to society that should be included in the benefit cost analysis[4]. Including this net benefit from commercialising the sand resource has the effect of reducing the critical threshold values identified in Section 3. Revised threshold values taking account of the commercialisation value of the sand are provided in the following table.

Table 4.5 – Critical Threshold Values For Different Annual Return Vessel Trip Scenarios Incorporating the Commercialisation of the Sand Resource

Annual Return Vessel Trips Assumptions	Threshold Values @4%		Threshold Values @7%		Threshold Values @10%	
	Per Trip	Per Person	Per Trip	Per Person	Per Trip	Per Person
Dredging Option 1a						
Scenario 1 - 1998/99 levels (1175)	$167	$42	$182	$46	$198	$50
Scenario 2 - 175% increase (2057)	$96	$24	$104	$26	$113	$28
Scenario 3 - 250% increase (2939)	$67	$17	$73	$18	$79	$20
Dredging Option 1b						
Scenario 1 - 1998/99 levels (1280)	$125	$31	$142	$36	$161	$40
Scenario 2 - 175% increase (2240)	$72	$18	$81	$20	$92	$23
Scenario 3 - 250% increase (3200)	$50	$13	$57	$14	$64	$16
Dredging Option 1c						
Scenario 1 - 1998/99 levels (1306)	$76	$19	$95	$24	$118	$30
Scenario 2 - 175% increase (2286)	$43	$11	$55	$14	$67	$17
Scenario 3 - 250% increase (3265)	$30	$8	$38	$10	$47	$12

Again the critical WTP levels are less for the deeper dredging options. Hence, Option 1c is preferable to Option 1b, which is preferable to Option 1a. However, for the options to be preferable to the base case (minimal maintenance dredging option) i.e. for navigation and sand sale benefits to exceed the incremental dredging costs and sand processing costs, the WTP of vessel owners and passengers for improved navigation through the Channel would need to lie between:

- $38 and $73 per return trip ($10 to $18 per person per trip @7% discount rate assuming an average four person per vessel) for generous vessel movement assumptions i.e. 250% increase; and
- $95 and$182 per return trip ($24 to $46 per person per trip @7% discount rate assuming an average of four person per vessel) for 1998/99 vessel movement estimates.

Again the assumption made regarding vessel movements is critical to the magnitude that vessel owners and their passengers would need to value the improved navigation, for the economic benefits to outweigh the economic costs. Studies from the literature provide little guidance on whether vessel owners and passengers are likely to value improved navigation at the abovementioned critical levels.

[4] To include the net present values in the benefit cost analysis, royalty costs need to be excluded since they are part of the producer surplus that is redistributed. Royalty costs are not a resource cost to society.

Given the ambiguity of the economic efficiency results some consideration should be given to dredging options that may reduce economic costs while having minimal impact on navigation benefits. This would include the 60m wide channel options identified in WMB Oceanics Australia (2002). While resulting in less sand production to offset dredging costs the overall net cost to society of these options would appear to be less than that for the 120m wide channel options while having similar navigation benefits.

4.6 Other Distributional Considerations

Regardless of the conclusions drawn about whether the benefits of dredging options outweigh the costs, there are distributional implications of adopting any Channel dredging option.

Costs incurred to dredge a distinct navigable channel in the Swansea Channel would be borne by public funds and hence either the Lake Macquarie community and/or the broader tax-paying community, depending on the source of the Government funds.

The direct benefits accrue to seafaring vessel owners and their passengers and sand producers.

However, it is potentially possible to redistribute some of these costs and benefits by for instance:

- making sand producers competitively tender for access to the sand and hence some of the benefits of commercialising the sand resource may be able to be recovered by Government;
- introducing a levy on seafaring vessel owners and their passengers which could be based on primary research into their WTP for improved access through the Channel.

4.7 Approval Process and Royalties

Removing sand from the Lake Macquarie system consistent with the options described by WBM Oceanics Australia and analysed in this report would be subject to the normal provisions of the Environmental Planning and Assessment Act. There are no new provisions in the State Environmental Planning Policy No 71 – Coastal Protection that would change the required approval process for dredging options.

DLWC waive royalty payments for sand dredging when the dredging activity is for public benefit, when the dredge material is being returned to Crown or other public land and where the activity is of a non-commercial nature. Deviations from this policy would need to be negotiated on a case-by-case basis.

5. REGIONAL ECONOMICS IMPACT ASSESSMENT

5.1 Introduction

Regional economic impact assessment is primarily concerned with the effect of an impacting agent on an economy in terms of a number of specific indicators, such as employment, income, gross regional product and gross regional output.

These indicators can be defined as follows:

- ***Gross regional output*** **-** is the gross value of business turnover;
- ***Value-added*** – is the difference between the gross value of business turnover and the costs of the inputs of raw materials, components and services bought in to produce the gross regional output;
- ***Income*** – is the wages paid to employees including imputed wages for self employed and business owners; and
- ***Employment*** – is the number of people employed (including full-time and part-time).

It should be noted that such regional impacts are not benefits that are relevant in a benefit cost analysis since regional economic stimulus arise from all investments whether or not they relate to wise, economically efficient, investments.

An impacting agent may be a change to a local economy or may be an existing activity within an economy (Powell *et al.*, 1985; Jensen and West 1986). This assessment is concerned with the impact of dredging operations and increased visitor access to a regional economy.

The economy on which the impact is measured can range from a township to the entire nation (Powell *et al.*, 1985). In selecting the appropriate economy regard needs to be had to capturing the local expenditure associated with the proposed activities but not making the economy so large that the impact of the proposal becomes trivial (Powell and Chalmers 1995). For this study, the impact of dredging and vessel access was estimated for the Lake Macquarie Local Government Area.

A range of methods that can be used to examine the regional economic impacts of an activity on an economy including economic base theory, Keynesian multipliers, econometric models, mathematical programming models and input-output models (Powell *et al.* 1985). This study used regional input-output analysis.

Input-output analysis essentially involves two steps:

- construction of an appropriate input-output table (regional transaction table) that can be used to identify the economic structure of the region and multipliers for each sector of the economy; and
- identification of the initial impact or stimulus of dredging activities and increased vessel access in a form that is compatible with the input-output equations so that the input-output multipliers and flow-on effects can then be estimated (West 1993, p 2-1).

5.2 Input Output Table and Economic Structure of the Region

For this study, a 2001 input-output table of the Lake Macquarie regional economy was developed using the Generation of Regional Input-output Tables (GRIT) procedure, developed by the University of Queensland and recognised internationally (refer to Appendix B for an overview of the GRIT procedure). The table was developed from the latest national input-output table (1996/97) and 2001 census data on *Industry of Employment for Persons Employed in Lake Macquarie LGA by Usual Residence on Census Night*. For the purpose of impact assessment, the 2001 values in the input-output table were then indexed to the year 2002 to be consistent with the revenue and expenditure data developed for dredging and increased vessel access.

A 106 sector input-output table of the Lake Macquarie economy was aggregated to 30 sectors and 6 sectors for the purpose of describing the economy. However, the full 106 sector input-output table was used in the impact assessment.

A highly aggregated 2001 input-output table for the Lake Macquarie economy is provided in Table 5.1[5]. The rows of the table indicate how the gross regional output of an industry (total) is allocated as sales to other industries, to households, to exports and other final demands (OFD - which includes stock changes, capital expenditure and government expenditure). For instance, $99,000 of the Ag/Forest/Fishing sectors $63,489,000 of output is sold to the mining sector. The corresponding column shows the sources of inputs to produce that gross regional output (total). These include purchases of intermediate inputs from other industries, the use of labour (household income), the returns to capital or Other Value Added (OVA which includes gross operating surplus, depreciation and net indirect taxes and subsidies) and goods and services imported from outside the region. The number of people (from the region and from outside the region) employed in each industry is also indicated in the final two rows. The column for the Ag/Forest/Fishing sector indicates that this sector purchases $243,000 of inputs from the mining sector and pays $6,120,000 in wages to 220 local employees.

TABLE 5.1 - AGGREGATED TRANSACTIONS TABLE: Lake Macquarie 2001, $'000

	Ag/Forest/ Fish	**Mining**	**Manufact-uring**	**Utilities**	**Building**	**Services**	**TOTAL**	**H-hold Exp**	**O.F.D**	**Exports**	**Total**
Ag/Forest/Fish	1,286	99	14,025	5	251	4,835	**20,500**	9,001	12,827	21,160	**63,489**
Mining	243	59,926	66,221	39,437	7,880	8,971	**182,679**	0	-23,587	1,455,031	**1,614,123**
Manufacturing	8,454	90,571	455,758	11,265	213,198	174,640	**953,886**	242,166	3,655	999,547	**2,199,255**
Utilities	663	26,655	52,795	29,778	1,538	54,930	**166,359**	63,010	79,865	13,155	**322,388**
Building	155	2,271	295	278	717	14,593	**18,309**	21,498	916,098	1,003	**956,908**
Services	7,067	168,499	284,834	29,653	150,770	1,252,814	**1,893,637**	1,282,366	1,653,586	634,948	**5,464,536**
TOTAL	**17,869**	**348,021**	**873,927**	**110,416**	**374,354**	**1,510,784**	**3,235,370**	**1,618,042**	**2,642,444**	**3,124,844**	**10,620,700**
H-hold Income	6,120	88,175	161,625	16,982	96,735	894,738	**1,264,375**	0	0		1,264,375
O.V.A.	24,507	954,333	526,970	164,173	335,407	2,260,447	**4,265,837**	173,554	0		**4,439,391**
Imports	14,993	223,594	636,733	30,817	150,412	798,568	**1,855,117**	676,554	0		**2,531,672**
TOTAL	**63,489**	**1,614,123**	**2,199,255**	**322,388**	**956,908**	**5,464,536**	**10,620,700**	**2,468,150**	**2,642,444**	**3,124,844**	**18,856,138**
Employment (living and working in region)	220	747	3,840	297	2,516	24,928	**32,548**				
Employment (from outside the region)	329	1,169	5,692	469	3,309	33,998	**44,964**				

From this Table, it can be seen that the value of the gross regional output for the regional economy in 2001 is estimated at $10,620M. However, it is generally considered that gross regional product (value-added) is a better measure of economic activity, as it avoids double counting associated with purchases of intermediate products.

[5] It should be noted that the input-output table is indicative only, with most uncertainty surrounding the OFD and exports columns since the derivation of these was based on residual elements being allocated in proportion to the national input output table.

Gross regional product for the Lake Macquarie economy is estimated at $5,530M including $1,264M paid to households as wages and salaries (including imputed payments to self-employed and employers) and $4,265M in Other Value Added.

The employment living and working in Lake Macquarie economy was 32,548 with average wage and salary earned being $38,847 per person.

The economic structure of the Lake Macquarie region may be ***partly*** compared with that for NSW through a comparison of Figure 5.1 and Figure 5.2. (Note that a comparison can only be made for GRP and employment). This reveals that in the Lake Macquarie economy, mining and building are of slightly greater relative importance than they are to the NSW economy, while services, manufacturing and agriculture/forestry/fishing are of slightly less relative importance. Utilities are of similar magnitude.

The economy appears to export ($3,124M) a greater value of goods and services than it imports ($2,531M). 99% of exports relate to manufacturing, mining and services with the contribution of each of these sectors to exports being 47%, 32% and 20%, respectively. The destination of imports in the local region from all sources (overseas, inter regional and interstate) are shown in aggregate in Figure 5.3 and in detail by industry in Figure C6 in Appendix C . The largest import items are for the services sector (31.5%), goods for consumption by local households (26.7%) and goods for manufacturing (25.2%).

Figure 5.1 – Summary of Aggregated Sectors: Lake Macquarie Region (2001)

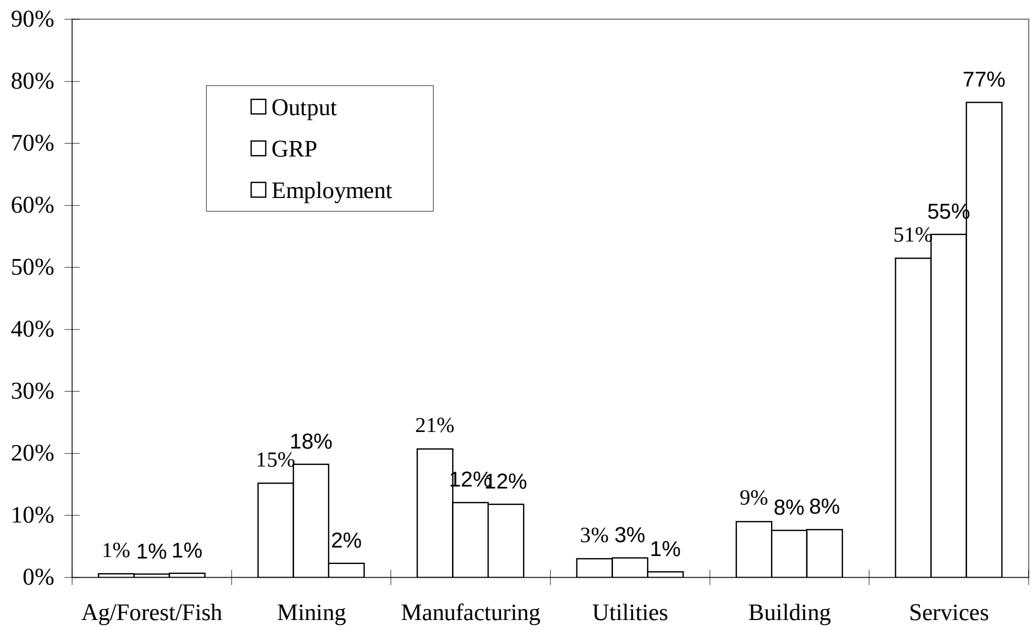
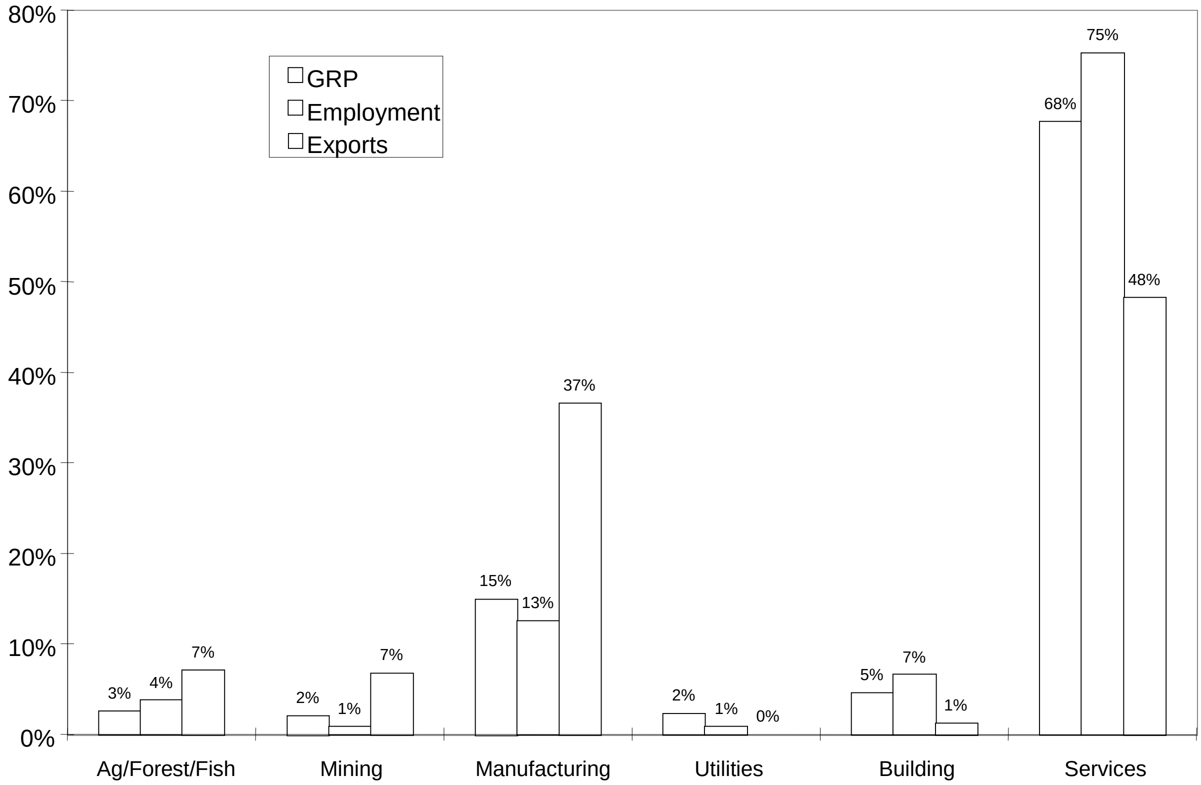
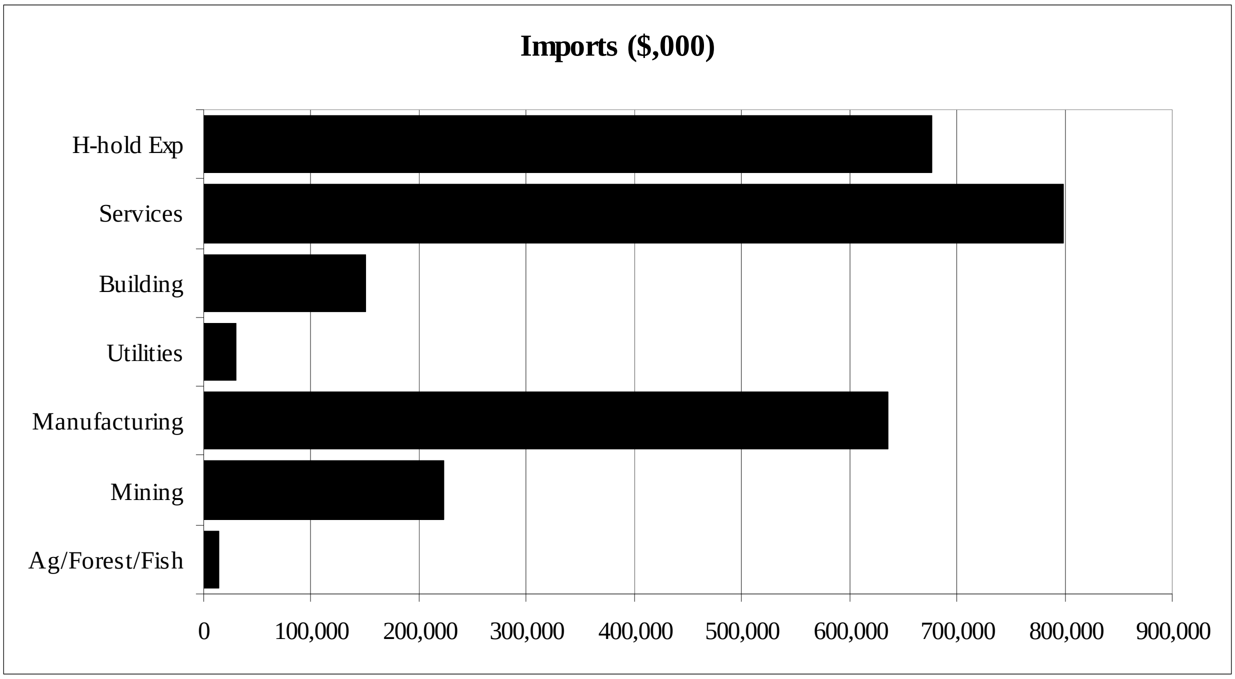


Figure 5.2 – Summary of Aggregated Sectors: NSW (1995-96)



Reference: Powell et al (1999).

Figure 5.3 – Distribution of Imports to the Lake Macquarie Economy by Destination Sector



Figures C1 to C8 in Appendix C, provide a more expansive sectoral distribution of gross regional output, employment, household income, gross regional product, exports, imports, productivity and average wages and salaries and can be used to provide some more detail in the description of the economic structure of the economy.

In terms of gross regional output and gross regional product the coal mining, business services, retail trade and building and constructions sectors are the most significant industry sectors in the regional economy. In terms of employment, retail trade is the highest employer followed by personal/other services, education, business services and building and construction (predominantly residential). The high ranking of the retail sector reflects its labour intensive nature. In terms of total wages to households the retail trade business services, health and education as well as building and construction are important contributors. On an individual sector level (106 sectors) coal mining is second in importance to retail trade reflecting higher than average wage. The majority of exports from the region are from the coal mining sector while imports are more spread out, with major importers being coal mining, metal manufacturing, retail and wholesale trade and business services. At an individual sector level the residential building and basic non-ferrous metal manufacturing sectors are significant importers.

As indicated in Figure C7, in Appendix C, the coal mining sector is one of the most productive sectors of the economy (as measured through Gross Regional Product per employee) and has one of the highest average wages of all the economy sectors. Refer to Figure C8 in Appendix C.

5.3 Multipliers

The multipliers for each sector of the economy and any particular final demand expenditure pattern can also be derived from the input-output table for the Lake Macquaire economy.

The calculation of multipliers from the input-output table is based on the following underlying assumptions:

- “there is a fixed input structure in each industry, described by fixed technological coefficients....;
- all products of an industry are identical or are made in fixed proportions to each other;
- each industry exhibits constant returns to scale in production;
- unlimited labour and capital are available at fixed prices.....; and
- there are no other constraints, such as the balance of payments or the actions of government, on the response of each industry to a stimulus.” (ABS 1995, p 24).

Multipliers therefore do not take account of economies of scale, unused capacity or technological change since they describe average effects rather than marginal effects (ABS 1995).

Multipliers indicate the total impact of changes in demand for the output of any one industry on all industries in an economy (ABS 1995). Conventional gross regional output, employment, gross regional product and income multipliers show the gross regional output, employment, gross regional product and income responses to an initial gross regional output stimulus (Jensen and West 1986).

Components of the conventional gross regional output multiplier are as follows:

Initial Effect - which is the initial output stimulus, usually a $1 change in output from a particular industry (Powell and Chalmers 1995; ABS 1995).

First round effects - the amount of output from all intermediate sectors of the economy required to produce the initial $1 change in output from the particular industry (Powell and Chalmers 1995; ABS 1995).

Industrial support effects - the subsequent or induced extra output from intermediate sectors arising from the first round effects(Powell and Chalmers 1995; ABS 1995).

Production induced effects - the sum of the first round effects and industrial support effects i.e. the total amount of output from all industries in the economy required to produce the initial $1 change in output (Powell and Chalmers 1995; ABS 1995).

Consumption induced effects - the spending by households of the extra income they derive from the production of the extra $1 of output and production induced effects. This spending in turn generates further production by industries (Powell and Chalmers 1995; ABS 1995).

The *simple multiplier* is the initial effect plus the production induced effects.

The *total multiplier* is the sum of the initial effect plus the production-induced effect and consumption induced effect.

Conventional employment, gross regional product and income multipliers have similar components to the gross regional output multiplier, however, through conversion using the respective coefficients show the employment, gross regional product and income responses to an initial gross regional output stimulus (Jensen and West 1986).

For employment, gross regional product and income it is also possible to derive relationships between the initial or own sector effect and flow-on effects. For example, the flow-on income effects from an initial income effect or the flow-on employment effects from an initial employment effect etc. These own sector relationships are referred to as ratio multipliers, although they are not technically multipliers because there is no direct line of causation between the elements of the multiplier. For instance, it is not the initial change in income that leads to income flow-on effects, both are the result of an output stimulus (Jensen and West 1986).

A description of the different ratio multipliers is given below.

Type 1A Ratio Multiplier = $\frac{\text{Initial + First Round Effects}}{\text{Initial Effects}}$

Type 1B Ratio Multiplier = $\frac{\text{Initial + Production Induced Effects}}{\text{Initial Effects}}$

Type 11A Ratio Multiplier = $\frac{\text{Initial + Production Induced + Consumption Induced Effects}}{\text{Initial Effects}}$

Type 11B Ratio Multiplier = $\frac{\text{Flow-on Effects}}{\text{Initial Effects}}$

(Centre for Farm Planning and Land Management 1989, p.207)

Type 11A ratio multipliers are used in Section 5.5 to estimate the total regional economic impact of the dredging options and additional vessel tourists on the Lake Macquarie economy.

5.4 Direct Impacts

For the purposes of this study, a variety of direct impacts on the Lake Macquarie economy were examined, that is:

- expenditure associated with dredging; and
- expenditure associated with potential visits from vessels moored outside the economy.

Aggregate costs of dredging have been provided by WBM Oceanics Pty Ltd. For the purpose of estimating regional impacts it has been assumed that the expenditure pattern in the region and employment ratios for dredging are the same as for the Lake Macquarie input-output sector in which sand dredging operations are included i.e. *Other Mining*.

For regional expenditure associated with potential visits from vessels moored outside the economy, visiting or potential visiting vessels were interviewed to ascertain likely expenditure levels in the region per visit. Estimates were then made of the total likely visits from outside the region, and hence regional expenditure, under the dredging options, compared to the base case of only minimal maintenance dredging.

5.5 Total Impact of Dredging

Using input-output analysis, with its fixed input structure in each industry, results in the regional impacts being directly proportional to the cost of dredging. The direct and indirect output, value-added, income and employment effects from initial dredging and ongoing maintenance dredging are summarised in the following tables.

Table 5.2 – Regional Economic Impacts Associated with Initial Dredging

	Direct	**Production-induced**	**Consumption-induced**	**Flow-on**	**Total**
Output ($)					
Option 1a	$1,394,000	$676,090	$158,916	$835,006	$2,229,006
Option 1b	$2,283,000	$1,107,255	$260,262	$1,367,517	$3,650,517
Option 1c	$3,171,000	$1,537,935	$361,494	$1,899,429	$5,070,429
Type 11A Ratio Multiplier	1.00	0.49	0.11	0.60	1.60
Value-added ($)					
Option 1a	$719,304	$299,710	$78,064	$377,774	$1,097,078
Option 1b	$1,178,028	$490,845	$127,848	$618,693	$1,796,721
Option 1c	$1,636,236	$681,765	$177,576	$859,341	$2,495,577
Type 11A Ratio Multiplier	1.00	1.14	0.34	1.48	2.48
Income ($)					
Option 1a	$66,117	$75,572	$22,282	$97,854	$163,971
Option 1b	$108,283	$123,767	$36,491	$160,258	$268,541
Option 1c	$150,401	$171,908	$50,685	$222,593	$372,993
Type 11A Ratio Multiplier	1.00	0.42	0.11	0.53	1.53
Employment (no.)					
Option 1a	1.42	1.70	0.59	2.29	3.72
Option 1b	2.33	2.79	0.97	3.76	6.09
Option 1c	3.23	3.87	1.35	5.22	8.45
Type 11A Ratio Multiplier	1.00	1.20	0.42	1.61	2.61

Table 5.3 – Regional Economic Impacts Associated with Annual Dredging

	Direct	Production-induced	Consumption-induced	Flow-on	Total
Output ($)					
Option 1a	$552,000	$267,720	$62,928	$330,648	$882,648
Option 1b	$385,000	$186,725	$43,890	$230,615	$615,615
Option 1c	$133,000	$64,505	$15,162	$79,667	$212,667
Type 11A Ratio Multiplier	1.00	0.49	0.11	0.60	1.60
Value-added ($)					
Option 1a	$284,832	$118,680	$30,912	$149,592	$434,424
Option 1b	$198,660	$82,775	$21,560	$104,335	$302,995
Option 1c	$68,628	$28,595	$7,448	$36,043	$104,671
Type 11A Ratio Multiplier	1.00	1.14	0.34	1.48	2.48
Income ($)					
Option 1a	$26,181	$29,925	$8,823	$38,748	$64,930
Option 1b	$18,261	$20,872	$6,154	$27,026	$45,286
Option 1c	$6,308	$7,210	$2,126	$9,336	$15,644
Type 11A Ratio Multiplier	1.00	0.42	0.11	0.53	1.53
Employment (no.)					
Option 1a	0.56	0.67	0.24	0.91	1.47
Option 1b	0.39	0.47	0.16	0.63	1.03
Option 1c	0.14	0.16	0.06	0.22	0.35
Type 11A Ratio Multiplier	1.00	1.20	0.42	1.61	2.61

Regional economic impacts from initial dredging were estimated to be $2.2M to $5.1M in annual direct and indirect output, $1.1M to $2.5M in direct and indirect value-added, $0.2M to $0.4M in direct and indirect household income to between 4 and 8 total jobs in the region. The impacts from ongoing maintenance dredging were less than 20% of these impacts. These ongoing maintenance dredging impacts represent less than 0.009% of the Lake Macquarie regional economy.

The main sectors of the Lake Macquarie region that would be impacted by dredging would include the petroleum manufacturing sector, agricultural machinery, wholesale trade, road transport and other property services.

5.5 Total Impacts of Visitors to the Region

Claims have been made of a potential $250M a year tourist industry that is in jeopardy due to channel shallowness. However, the main potential regional economic impacts associated with the dredging options relates to regional expenditure from vessels visiting the Lake region. There is considered to be no other regional tourism benefits since dredging will have no impact on water quality or fish stocks in the Lake (WBM Oceanics Pty Ltd 2002).

Analysis of extrapolated 1998/99 NSW Waterways data indicated 404 vessel movements associated with vessels with outside moorings (most of which are of a vessel type whose access would be limited under the assumed base case dredging scenario), 1,177 vessel movements associated with vessels with Lake Macquarie moorings and 1,742 vessel movements associated with vessels with no specified mooring location. For the purpose of this analysis, movements associated with vessels with no specified mooring location were assumed to be distributed between Lake Macquarie and outside moorings in the same ratio as for vessel movements where mooring locations were known.

These assumptions resulted in there being an estimated 848 vessel movements, 424 return trips, in 1998/99 from vessels moored outside Lake Macquarie. These vessel movements would be unlikely under the base case scenario of minimal dredging.

As part of the consultation strategy, five owners of boats with a draught of greater than 1 meter, moored outside Lake Macquarie, were located and interviewed. Four of these were from RMYC Broken Bay and one from Newcastle Cruising Yacht Club. This small sample[6] accounted for 16 to 17 return trips per annum.

If the Channel enabled uninhibited travel, in total the respondents indicated that usage would increase to between 35 and 39 trips. This increase in usage represents a percentage increase of in the order of 205% to 243% for vessels moored outside the Lake.

If it is assumed that the estimated 424 return trips in 1998/99 from vessels moored outside the Lake are of a type likely to be inhibited by shallow access:

- all have a draught of 1m or over;
- would increase visitation by 250% under the various dredging options;
- have draughts in the same proportion as the sample of vessels that reported draughts i.e. 90% with draught of 1m to less than 2m, 8% with a draught of 2m to less than 2.5m and 2% with a draught of 2.5m to 3m;

then the visitation pattern under each dredging options can be summarised as follows.

Table 5.5 – Estimated Incremental Vessel Visits To the Region Under Different Dredging Options

Option	Return Visits Per Annum
Base Case	0
1998/99	424
Option 1a	954
Option 1b	1,039
Option 1c	1,060

From the small sample taken, the average length of stay was estimated as 7 days with the average number of people on board being 5. Expenditure per trip is summarised below.

Table 5.6 – Expenditure per Vessel Trip to Lake Macquarie

Expenditure Item	Per Trip
Mooring Cost	$201
Restaurants	$1,940
Beverages	$646
Food	$279
Taxis	$100
Fuel	$280
Entertainment	$286
Batteries, Boating Equipment, Parts	$210
Total	**$3,942**

To estimate the direct and indirect regional economic impacts associated with this visitor expenditure profile it was necessary to allocate expenditure groupings across the appropriate sectors in the input-output model of the Lake Macquarie economy and make adjustments for imports, taxes and margins. The taxes and margins were estimated using national accounts information and imports were calculated using location quotients for the Lake Macquarie region.

Estimates of annual incremental regional economic impacts of regional visitation associated each dredging option are provided in Table 5.7.

[6] It should be noted that this sample was not random since the population was not known.

Table 5.7 - Regional Economics Impacts Associated with Incremental Annual Visits for Each Dredging Option

	Direct	Production-induced	Consumption-induced	Flow-on	Total
Output ($)					
Option 1a	$2,910,281	$1,487,154	$596,608	$2,086,672	$4,996,953
Option 1b	$3,169,583	$1,619,657	$649,765	$2,272,591	$5,442,174
Option 1c	$3,233,646	$1,652,393	$662,897	$2,318,524	$5,552,170
Value-added ($)					
Option 1a	$1,296,450	$692,304	$294,294	$986,599	$2,283,049
Option 1b	$1,411,962	$753,988	$320,515	$1,074,503	$2,486,465
Option 1c	$1,440,500	$769,227	$326,994	$1,096,221	$2,536,721
Income ($)					
Option 1a	$365,388	$168,079	$84,039	$252,118	$617,507
Option 1b	$397,944	$183,054	$91,527	$274,581	$672,525
Option 1c	$405,987	$186,754	$93,377	$280,131	$686,118
Employment (no.)					
Option 1a	13	4	2	6	19
Option 1b	15	4	2	7	21
Option 1c	15	4	2	7	22

* Flow-on = production induced + consumption induced
Total = direct + flow-on

Regional economic impacts from projected visitation from vessels moored outside Lake Macquarie were estimated to be between $5.0M to $5.6M in annual direct and indirect output, $2.3M to $2.5M in direct and indirect value-added, $0.6M to $0.7M in direct and indirect household income to between 19 and 22 direct and indirect regional jobs. These impacts represent in the order of 0.06% of economic activity in the Lake Macquarie economy.

These estimates are based on the following Type 11A ratio multipliers generated from the Input Output Table for the visitor expenditure profile.

Table 5.8– Type 11A Ratio Multipliers for Visitor Regional Expenditure

Multipliers	Direct	Production-induced	Consumption-induced	Flow-on	Total
Output	1.00	0.51	0.21	0.72	1.72
Income	1.00	0.46	0.23	0.69	1.69
Employment	1.00	0.28	0.17	0.45	1.45
Value-added	1.00	0.53	0.23	0.76	1.76

The main sectors impacted included accommodation, cafes and restaurants, wholesale and retail trade and road transport.

6. CONCLUSIONS

This study examined the economics of long term dredging options for the Swansea Channel within three broad economic frameworks:

- benefit cost analysis, which considers whether the benefits of dredging options outweigh the costs;
- financial feasibility of dredging operations which examines the revenues and costs associated with dredging, processing and sale of sand; and
- regional economic impact assessment, which examines the additional stimulus to the Lake Macquarie economy from expenditure of visiting vessels and dredging operations.

The initial benefit cost analysis focused on the costs and benefits of dredging for navigation. Costs relate to the incremental dredging costs associated with different Channel options while benefits relate to how much vessel owners and their passengers value improved access i.e. would be willing to pay (WTP) for improved access. Estimates of navigation benefits requires physical data on likely vessel movements relative to the base case together with data on how much vessel owners and their passengers would be WTP for each vessel movement. Neither of this benefit data was readily available.

The approach used in this study was therefore to:

- develop vessel movement scenarios for each dredging option based on extrapolated NSW Waterways data and consultations;
- identify how large the WTP per return vessel trip through the Channel would need to be to make the navigation benefits outweigh the dredging costs;
- compare this critical WTP level, referred to as a threshold value, to WTP estimates from the literature.

The analysis indicated that the critical WTP levels are slightly less for deeper dredging options i.e. option 1c vis-à-vis 1b and 1c, reflecting the lower overall dredging cost and the greater vessel movements that the deeper options facilitate. Hence, Option 1c is preferable to Option 1b, which is preferable to Option 1a. However, for the options to be preferable to the base case (minimal maintenance dredging option) i.e. for the navigation benefits to exceed the incremental dredging costs, the WTP of vessel owners and passengers for improved navigation through the Channel would need to lie between:

- $116 and $223 per return trip ($29 to $59 per person per trip @7% discount rate assuming an average four person per vessel) for generous vessel movement assumptions i.e. 250% increase; and
- $290 and$558 per return trip ($73 to $140 per person per trip @7% discount rate assuming an average of four person per vessel) for 1998/99 vessel movement estimates.

Any reduction in dredging costs or additional benefits that can be obtained from each of the dredging options will reduce the critical WTP threshold. One of the potential additional benefits from the dredging alternatives is the commercial use of the sand resource.

Investigations into the commercialisation of the sand resource revealed that the resource is suitable for marketing as a fill material and sand currently recovered from nearby the study area has been sold into this lower value market. However, dredging and sale of material is not a financially feasible operation in itself and hence the private sector would not consider undertaking dredging on a commercial basis at no cost to Government. Nevertheless, once the sand is dredged it can potentially be further processed and sold into the local market at a profit.

Given that it is estimated that there are positive returns from sand processing and sale, it may be possible for the public sector to offset some of the cost of dredging by capturing **part** of the profit from sand processing. Only part of the profit may be able to be captured by the public sector since commercial operators will still require a return on investment. Furthermore, the commercial operator is exposed to market risk regarding potential downturns in the market, additional supplies from elsewhere etc. Consequently, a commercial operator would only be willing to pay part of the estimated profit to Government in the form of a resource rent.

The most efficient method of determining this amount is to tender the opportunity to market the sand recovered from the dredging options. Competitive process will reveal the markets WTP the public sector for the sand resource.

Regardless of whether the profit from commercialising the sand accrues to the public sector or the private sector, or is shared, it is a net benefit to society that should be included in the benefit cost analysis[7]. Including this net benefit from commercialising the sand resource has the effect of reducing the critical threshold values reported above.

Again the critical WTP levels are slightly less for deeper dredging options. Hence, Option 1c is preferable to Option 1b, which is preferable to Option 1a. However, for the options to be preferable to the base case (minimal maintenance dredging option) i.e. for navigation and sand sale benefits to exceed the incremental dredging costs and sand processing costs, the WTP of vessel owners and passengers for improved navigation through the Channel would need to lie between:

- $38 and $73 per return trip ($10 to $18 per person per trip @7% discount rate assuming an average four person per vessel) for generous vessel movement assumptions i.e. 250% increase; and
- $95 and$182 per return trip ($24 to $46 per person per trip @7% discount rate assuming an average of four person per vessel) for 1998/99 vessel movement estimates.

A review of the economic valuation literature revealed no relevant studies that would help in indicating whether or not vessel owners are likely to value the improved navigation benefits from dredging options at the critical levels.

Given the ambiguity of the economic efficiency results consideration should be given to options that may reduce economic costs while having minimal impact on navigation benefits. This would include the 60m wide channel options identified in WMB Oceanics Australia (2002). While resulting in less sand production to offset dredging costs the overall net cost to society is less than that for the 120m wide channel options considered in this report while having similar navigation benefits.

Regional economic impact assessment using input-output analysis was undertaken to examine potential regional impacts associated with the dredging activity and increased visitation from vessels moored outside Lake Macquarie. It should be noted that such regional impacts are not benefits that are relevant in a benefit cost analysis since regional economic stimulus arise from all investments whether or not they relate to wise, economically efficent, investments.

Regional impacts were measured in terms of direct and indirect output, value-added, income and employment.

Regional economic impacts from initial dredging were estimated to be $2.2M to $5.1M in annual direct and indirect output, $1.1M to $2.5M in direct and indirect value-added, $0.2M to $0.4M in direct and indirect household income to between 4 and 8 total jobs in the region. The impacts from

[7] To include the net present values in the benefit cost analysis, royalty costs need to be excluded since they are part of the producer surplus that is redistributed. Royalty costs are not a resource cost to society.

ongoing maintenance dredging were less than 20% of these impacts. These ongoing maintenance dredging impacts represent less than 0.009% of the Lake Macquarie regional economy.

Regional economic impacts from projected visitation from vessels moored outside Lake Macquarie were estimated to be between $5.0M to $5.6M in annual direct and indirect output, $2.3M to $2.5M in direct and indirect value-added, $0.6M to $0.7M in direct and indirect household income to between 19 and 22 direct and indirect regional jobs. These impacts represent in the order of 0.06% of economic activity in the Lake Macquarie economy.

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Appendix A - Study Consultation

Introduction

In order to complete an informed cost benefit analysis of Lake dredging options it was necessary to consult with current and potential users of the Channel.

A study consultation strategy was designed and executed that included face-to-face and telephone interviews and attendance at the Cruising Yacht Club Division meeting. Stakeholder groups interviewed include:

- Stakeholders within Lake Macquarie:
  - Marina operators, sailing clubs and private boat owners who moor in Lake Macquarie;
  - Charter boat operators who operate businesses in Lake Macquarie; and
  - Other stakeholders affected by channel siltation (e.g. Chamber of Commerce).

- Stakeholders outside Lake Macquarie:
  - Marina operators, sailing clubs and private boat owners.

.
The consultation questionnaire is included as an appendix.

Stakeholders within Lake Macquarie

Private Boat Owners >1 M

Some 49 interviews were completed with private boat owners who operate their boats in Lake Macquarie. Table A1 summarises the split of interviews completed.

Table A1 Private Boat Owners Interviewed (draught >1M)

Moored: Marina/Club/Private	**Total**
Lake Macquarie Yacht Club members	19
Marks Point Marina	1
Marmong Cove Marina	4
Not Stated	1
Private	20
Wangi Amateur Sailing Club	4
Total	**49**

Characteristics of the Swansea Channel Restricting Movement

Consultation with this group of stakeholders revealed the following issues with the current status of the channel. The source of the comment is included as a bracket:

- 50% of crossings require assistance from another vessel (Lake Macquarie Yacht Club);
- Use restricted to daylight hours (private);
- Regular groundings with assistance required to get free (private);
- Dog leg plus drop off is dangerous to navigate (private);
- Stress and damage to equipment including water pumps, keel and rigging (private);
- Two boats cannot pass in the channel (private);
- Need three people on the boom, just not safe (private);
- Anything over 1.8 m drought has to be pulled over (private);

- Going offshore is just too hard (private);
- Currently loosing tourism and recreation dollars because of fearsome reputation (Lake Macquarie Yacht Club);
- Many times coastal sailors say they won't come in as they have heard that Waterways has to tow them in - not true but that's what is said (private);
- Shallow water in channel makes the requirement of a high tide during daylight hours essential (private); and
- People are getting older and have more time to enjoy sailing holidays. Easy sail is from either Port Stephens or Sydney to Lake Macquarie with many facilities. Improve the channel and people will make Lake Macquarie a long term holiday destination (private).

Perceived Benefits of Dredging the Channel

The following perceived benefits of dredging the channel were offered by stakeholders. The consultants make no judgment on their validity:

- Cleaner water for swimming because of flushing and less sea lice;
- water temp currently 25 degrees. Sea life can't survive - remember when there were sea urchins on the sand flats, the water's too warm and too full of "nutrients" choking such sea life;
- Don't want Lake Macquarie to end up like Tuggerah Lakes - pungent odour and poor fishing;
- Grandson enjoy, children enjoy as used to;
- Flushing of the lake which would result in fish entering to breed, prawns able to leave the lake;
- Boats would be able to stop at Lake Macquarie and give revenue to local businesses;
- Help with sale of deep draughted boats;
- Better tourism which enhances the economy of Lake Macquarie;
- Deeper keel boats would be able to navigate more safely and not need the services of the Coastal Patrol to pull their vessels off sand bar in the channel; and
- Reappearance of dolphins in the Lake if channel were deeper and wider.

Estimates of Current and Post Dredging Usage

The number of return trips through the Swansea Channel for this sample was between 211 and 228 trips per year.

If the channel enabled uninhibited travel, the usage would increase to between 727 and 780 trips.

The increase in usage represents a percentage increase of between 245 percent and 242 percent.

Clubs/Marinas

Representatives from the following clubs and marinas were interviewed:
- Lake Macquarie Yacht Club
- Marks Point Marina
- Marmong Cove Marina
- Wangi Amateur Sailing Club
- Pelican Marina
- Royal Motor Yacht Club

Comments on difficulties with the channel and perceived benefits of dredging are consistent with those received from private boat operators. The cruising division of the Lake Macquarie Yacht club commented that they attempt to organise a cruising event once per year. Most recently a 100 boat event was organised and only three boats were able to negotiate the channel due to depth of water.

Charter Boat Operators

Charter boat operators of surveyed included:
- B&L Fishing Cruises;
- Lake Macquarie Cruises; and
- Cruise Cat Pty Ltd.

Reasons supplied by charter boat operators for additional visitation as a result of dredging included:
- Dolphins used to visit the lake and now the channel is too shallow to let them in. A potential dolphin watch business has been stopped
- Boat surveys and slippage are hard to secure locally and the trip to Sydney through the channel is difficult
- Current "prop dredging" is expensive and risks damaging the vessel

Chambers of Commerce

- Important that the channel is open to develop and promote water events
- The Chamber will plan events such as game fishing and considered that with channel open there will be additional fish stocks in the Lake. Boats will visit from Port Stephens and Newcastle.
- Heritage boats afloat – have boats come from Port Hacking and Coffs Harbour. Invite for a three-day event each year at Easter.
- Annual summer migration of Sydney cruise boats would visit Lake Macquarie as the trip can be done in daylight hours.

- Tourism from visiting yachts would increase. Visiting boats expend on mooring costs, berthing, food, restaurants, beverages, entertainment, fuel, fishing tackle, boat repairs etc. An open channel is critical for development in Lake Macquarie. Access leads to the place being a tourism destination.

Council(is this the tourism people if so put in brackets)

With the channel not dredged opportunities of capturing boats from Sydney are lost, boats travel through to Newcastle to the new marina. People truck yachts into Lake Macquarie because of the channel. The Council found it difficult to estimate increased patronage from the yachting fraternity.

Royal Volunteer Coastal Patrol

Shoaling, low tide 1.3 metres, vessels get caught and they have to drag the boats off, get sand in the motors. Dredging the channel would alleviate a lot of problems. The patrol estimate that two vessels every 3-4 hours require assistance. A lot of boats won't come to the Lake because of shoaling and dog leg. Dangerous for boats to pass as the channel is too narrow.

Boat Sales and Servicing

The industry commented that it would sell bigger boats and would be more activity servicing more boats. It might also achieve fewer repairs.

Other Affected Stakeholders

In addition to stakeholders within the boating fraternity and those involved directly in promoting tourism within the Lake Macquarie area, a number of individuals who considered themselves affected stakeholders, were interviewed. The following comments and suggestions were made:

Sand flats can't breath any more - Sea grass dead due to silt and soil and lack of flushing;
Sand islands are eroding back into the channel as the tide goes out; and
Lack of knowledge about the channel is a deterrent to both local and visitor use.

Stakeholders Outside of Lake Macquarie

A total of five owners of boats with a draught of greater than one metre and which are moored outside of Lake Macquarie were surveyed.

Marina	***Number***
RMYC Broken Bay	4
Newcastle Cruising Yacht Club	1
Total	**5**

Without local knowledge visiting boats find entering Lake Macquarie complicated particularly given the hair pin 'dog leg' turn at Swan Bay.

The number of return trips through the Swansea Channel for this sample was between 16 and 17 trips per year.

If the channel enabled uninhibited travel, the usage would increase to between 35 and 39 trips.

The increase in usage represents a percentage increase of between 119% percent and 129% percent.

The average length of stay is seven days and the average number of people on board was five.

Average visitor expenditure is estimated in the table below.

Average Expenditure per Boat per Day

Expenditure Item	**Per Day**
Mooring Cost	28.67
Restaurants	277.20
Beverages	92.32
Food	39.88
Taxis	14.29
Expenditure Item	**Per Trip**
Fuel	280.00
Entertainment	285.71
Batteries, Boating Equipment, Parts	210.00

Boat owners who do not visit the Lake indicated a willingness to visit if the "famed" hairpin were removed. Specific comments included:

- Silted and horseshoe bend - used to go straight through (RMYC Broken Bay)
- Not a racing destination - impractical to finish a race off shore, LMYC highly regarded great spot for families (CYC Australia Royal Squadron)
- Difficult to get 40 boats in and out at one time with tide, channel, bridge etc (Royal Sydney Yacht Squadron)

The channel hampers visiting yachts.

Appendix B – the GRIT System for Generating Input-Output Tables

"The GRIT system was designed to:

- combine the benefits of survey based tables (accuracy and understanding of the economic structure) with those of non-survey tables (speed and low cost);
- enable the tables to be compiled from other recently compiled tables;
- allow tables to be constructed for any region for which certain minimum amounts of data were available;
- develop regional tables from national tables using available region-specific data;
- produce tables consistent with the national tables in terms of sector classification and accounting conventions;
- proceed in a number of clearly defined stages; and
- provide for the possibility of ready updates of the tables.

The resultant GRIT procedure has a number of well-defined steps. Of particular significance are those that involve the analyst incorporating region-specific data and information specific to the objectives of the study. The analyst has to be satisfied about the accuracy of the information used for the important sectors; in this case the national parks sectors. The method allows the analyst to allocate available research resources to improving the data for those sectors of the economy that are most important for the study. It also means that the method should be used by an analyst who is familiar with the economy being modelled, or at least someone with that familiarity should be consulted.

An important characteristic of GRIT-produced tables relates to their accuracy. In the past, survey-based tables involved gathering data for every cell in the table, thereby building up a table with considerable accuracy. A fundamental principle of the GRIT method is that not all cells in the table are equally important. Some are not important because they are of very small value and, therefore, have no possibility of having a significant effect on the estimates of multipliers and economic impacts. Others are not important because of the lack of linkages that relate to the particular sectors that are being studied. Therefore, the GRIT procedure involves determining those sectors and, in some cases, cells that are of particular significance for the analysis. These represent the main targets for the allocation of research resources in data gathering. For the remainder of the table, the aim is for it to be 'holistically' accurate (Jensen 1980). That means a generally accurate representation of the economy is provided by the table, but does not guarantee the accuracy of any particular cell. A summary of the steps involved in the GRIT process is shown in Table 12" (Powell and Chalmers 1995, p13-14)

Table 12 - The GRIT Method

Phase	Step	Action
PHASE 1		ADJUSTMENTS TO NATIONAL TABLE
	1	Selection of national input-output table. (109-sector table with direct allocation of all imports, in basic values)
	2	Adjustment of national table for updating.
	3	Adjustment for international trade.
PHASE II		ADJUSTMENTS FOR REGIONAL IMPORTS
		(*Steps 4-14 apply to each region for which input-output tables are required*)
	4	Calculation of ‘non-existent’ sectors.
	5	Calculation of remaining imports.
PHASE III		DEFINITION OF REGIONAL SECTORS
	6	Insertion of disaggregated superior data.
	7	Aggregation of sectors.
	8	Insertion of aggregated superior data.
PHASE IV		DERIVATION OF PROTOTYPE TRANSACTIONS TABLES
	9	Derivation of transactions values.
	10	Adjustments to complete the prototype tables.
	11	Derivation of inverses and multipliers for prototype tables.
PHASE V		DERIVATION OF FINAL TRANSACTIONS TABLES
	12	Final superior data insertions and other adjustments.
	13	Derivation of final transactions tables.
	14	Derivation of inverses and multipliers for final tables.

Source: Table 2 in Bayne and West (1988)

Appendix C – Graphs Describing the Lake Macquarie Regional Economy

Figure C1 – Sectoral Distribution of Gross Regional Output ($,000)

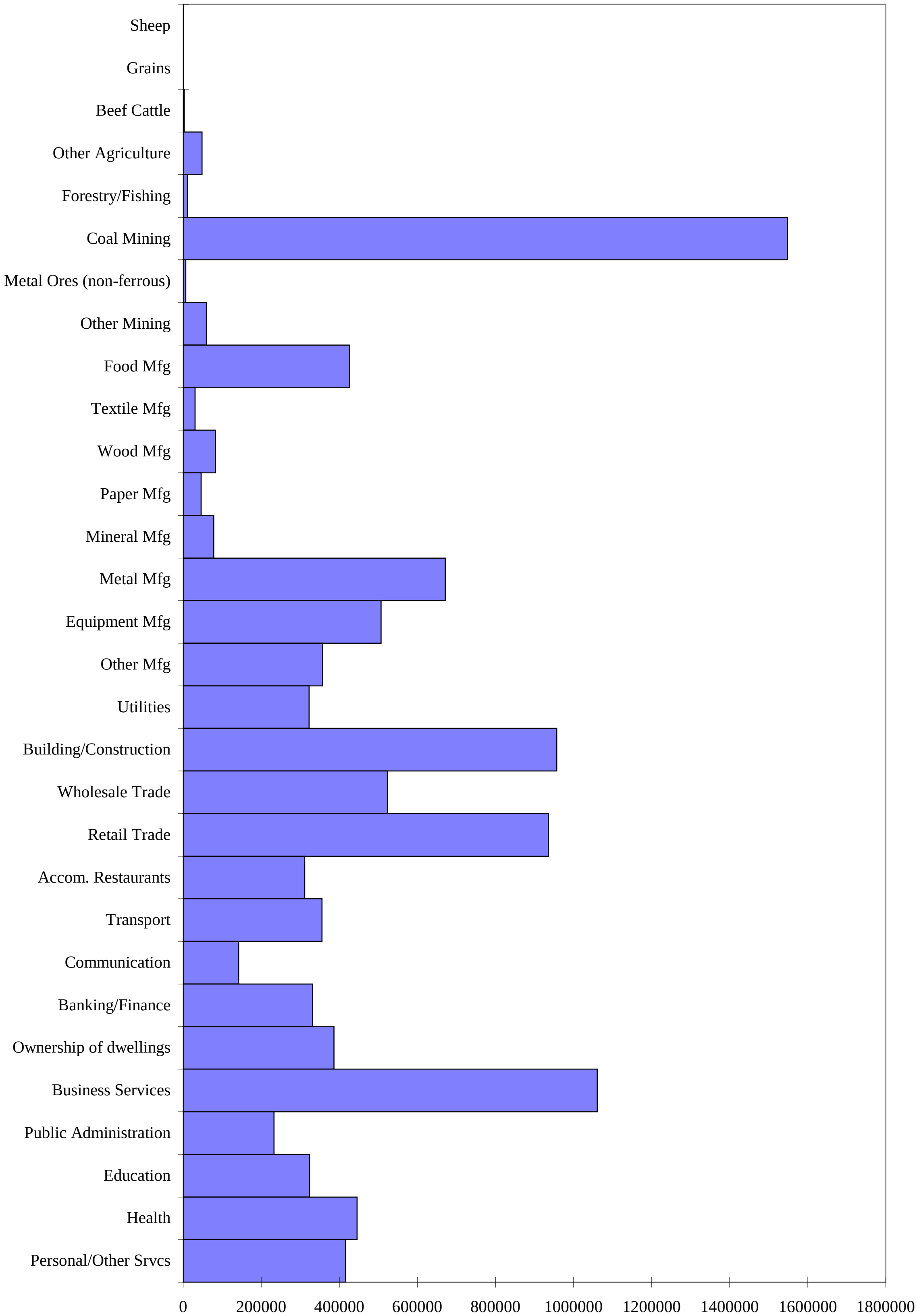

Figure C2 - Sectoral Distribution of Gross Regional Product ($,000)

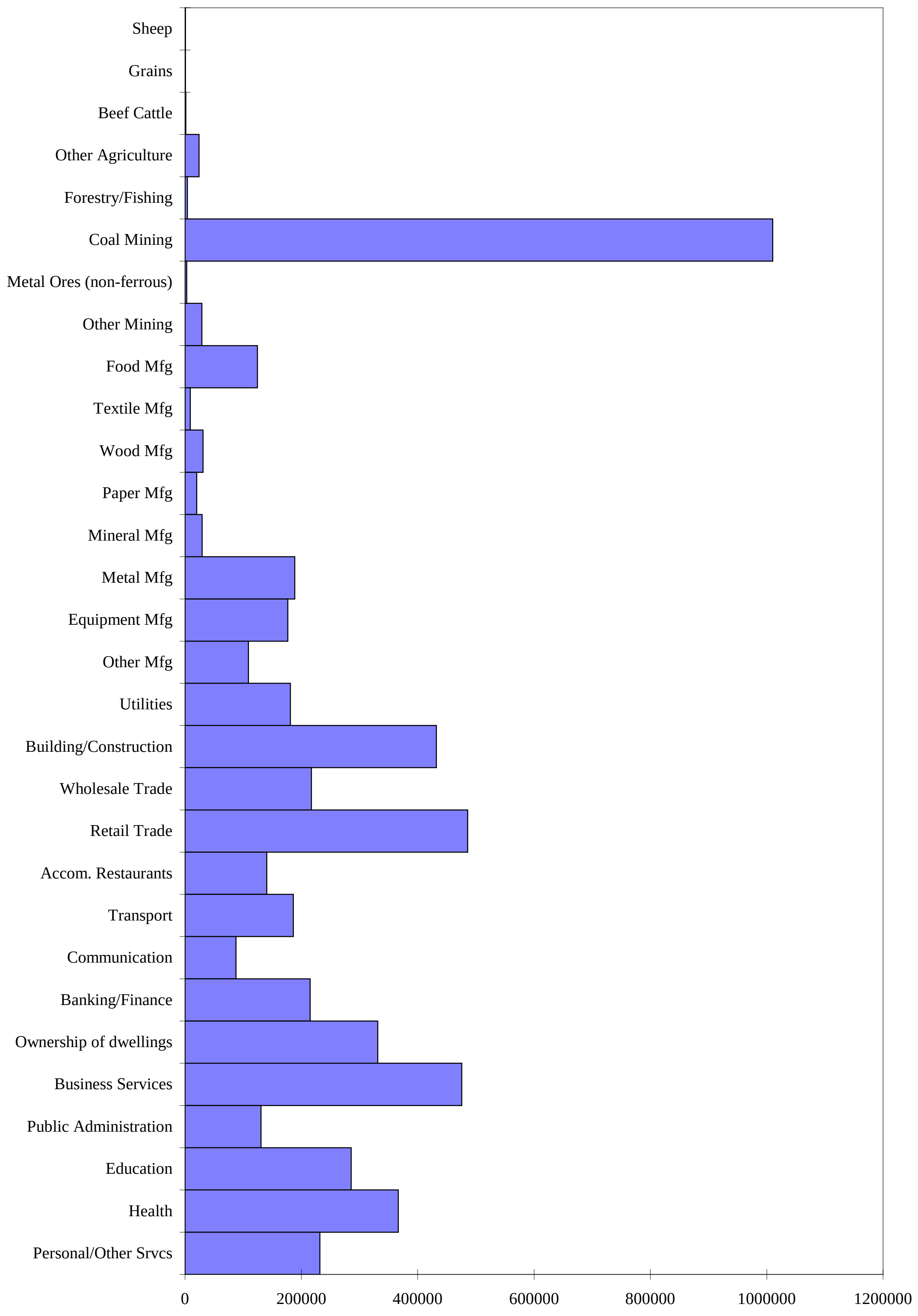

Figure C3 – Sectoral Distribution of Income ($,000)

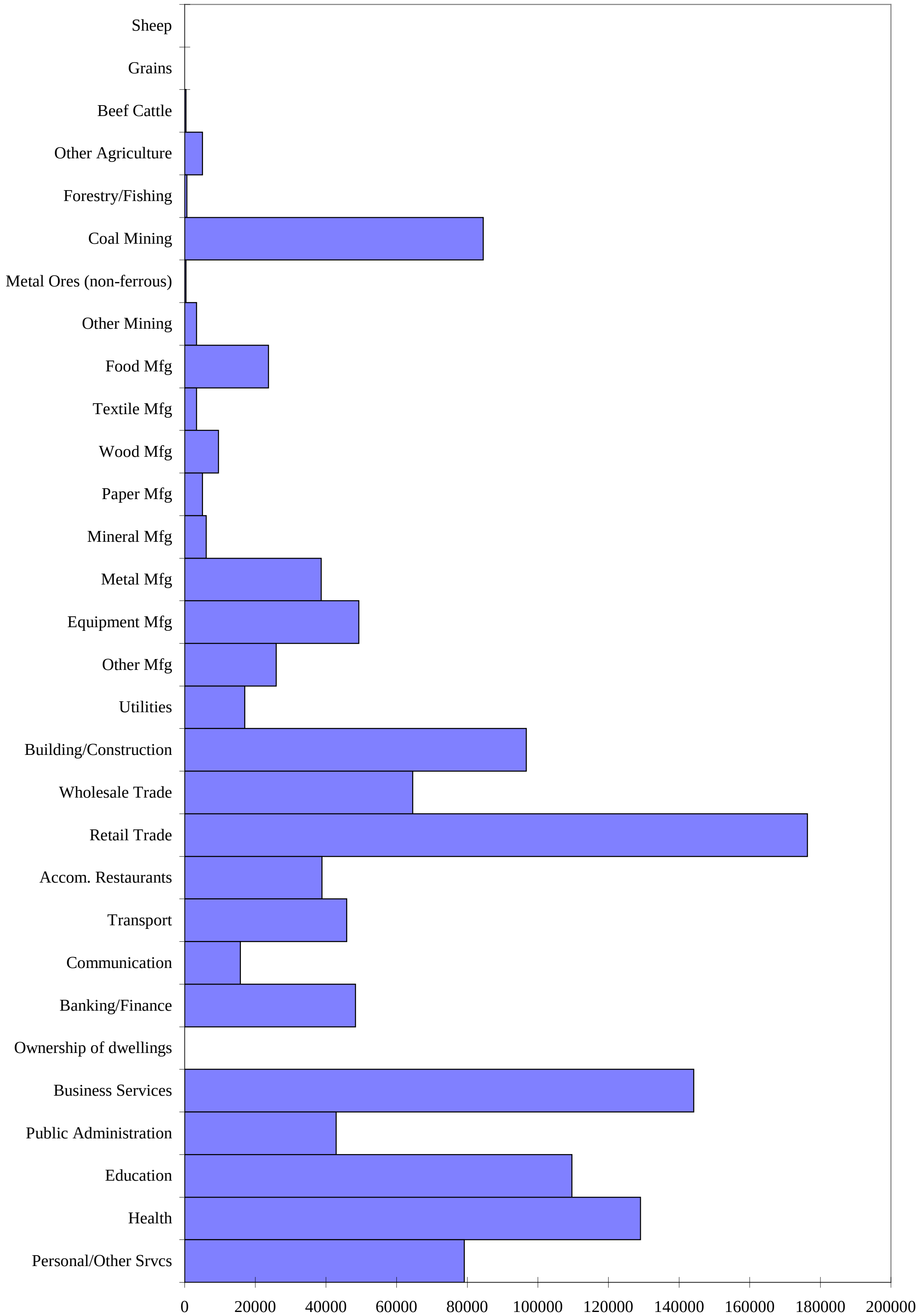

Figure C4 – Sectoral Distribution of Employment (No's)

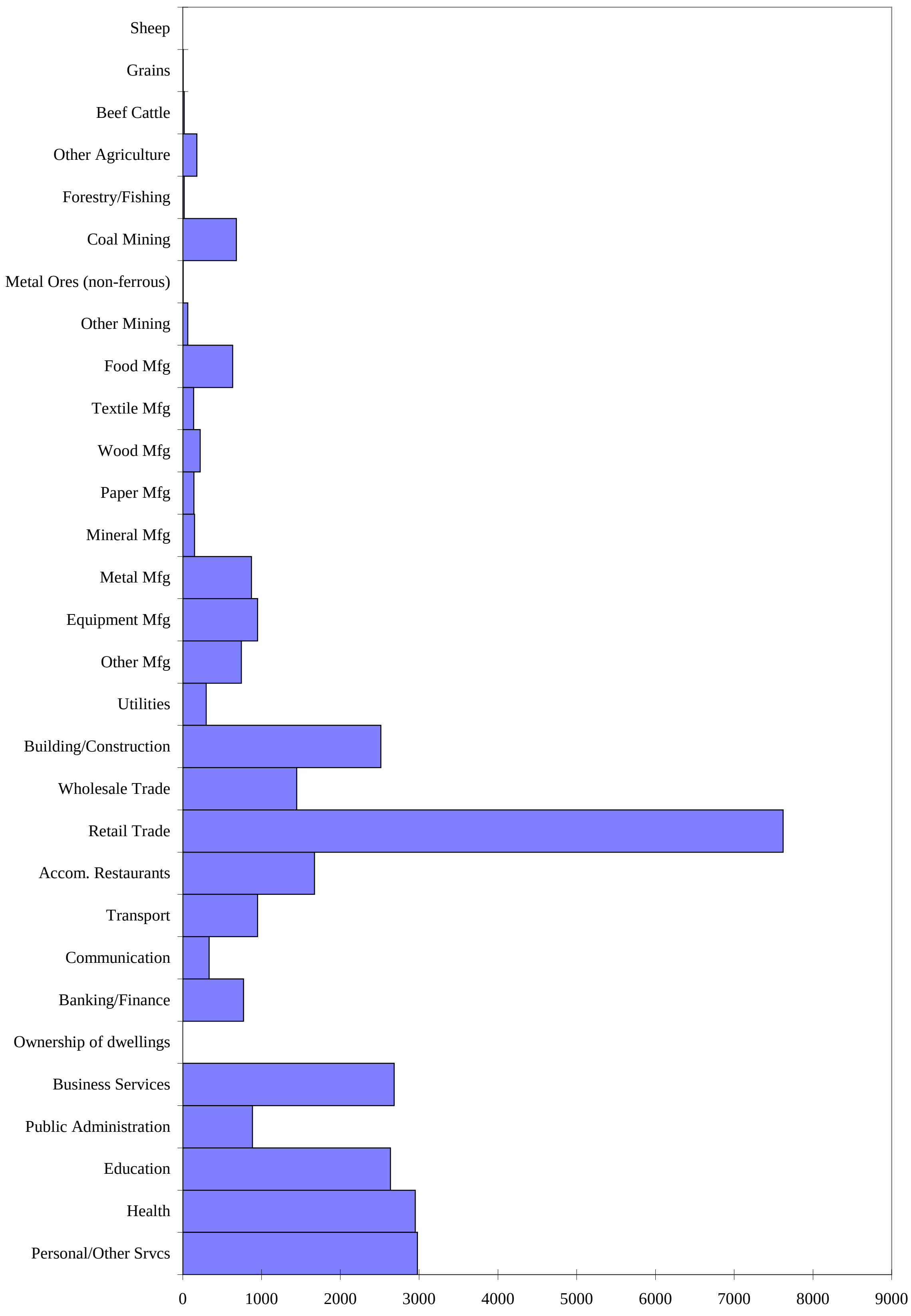

Figure C5 – Sectoral Distribution of Exports ($,000)

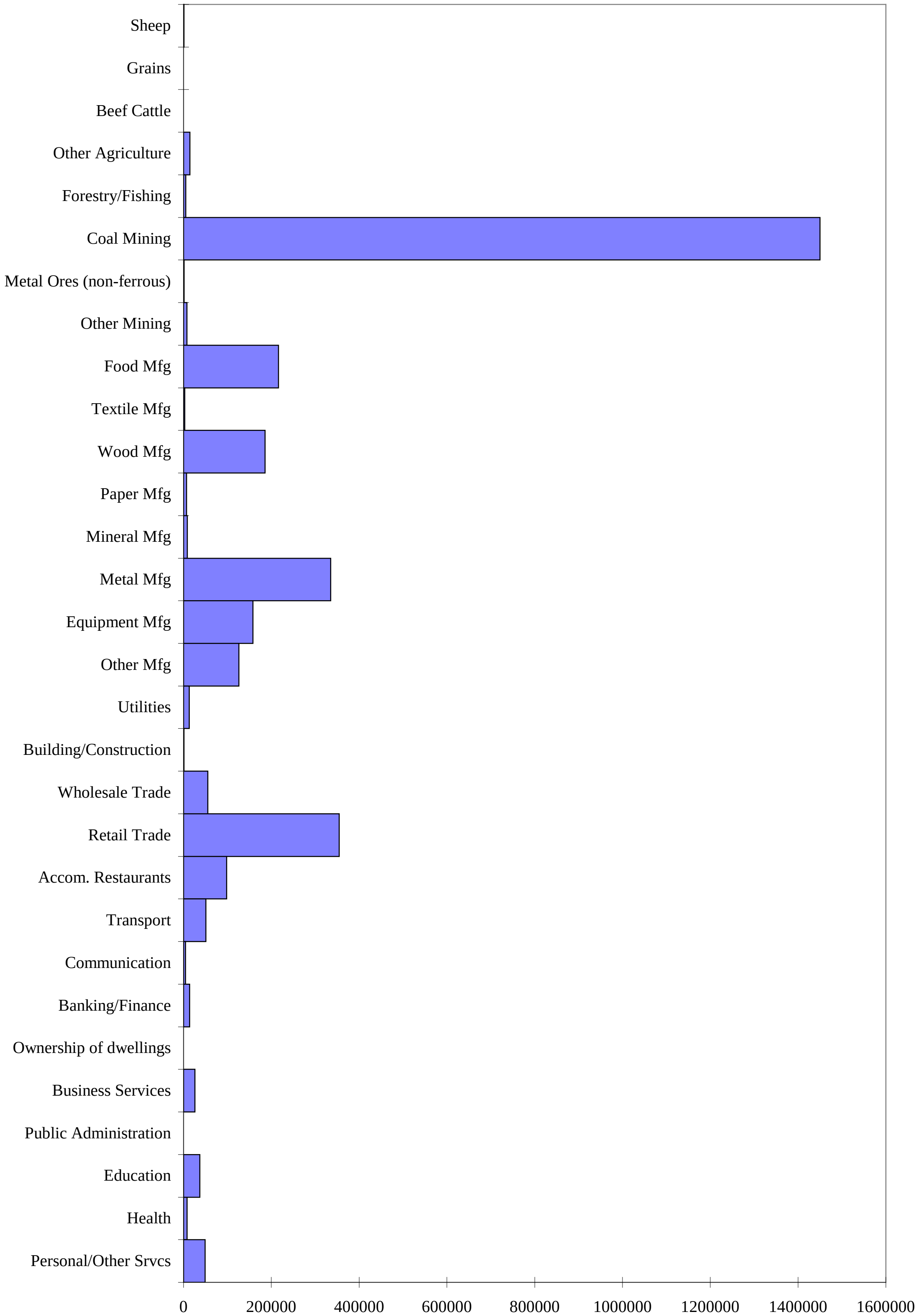

Figure C6 – Sectoral Distribution of Imports ($,000)

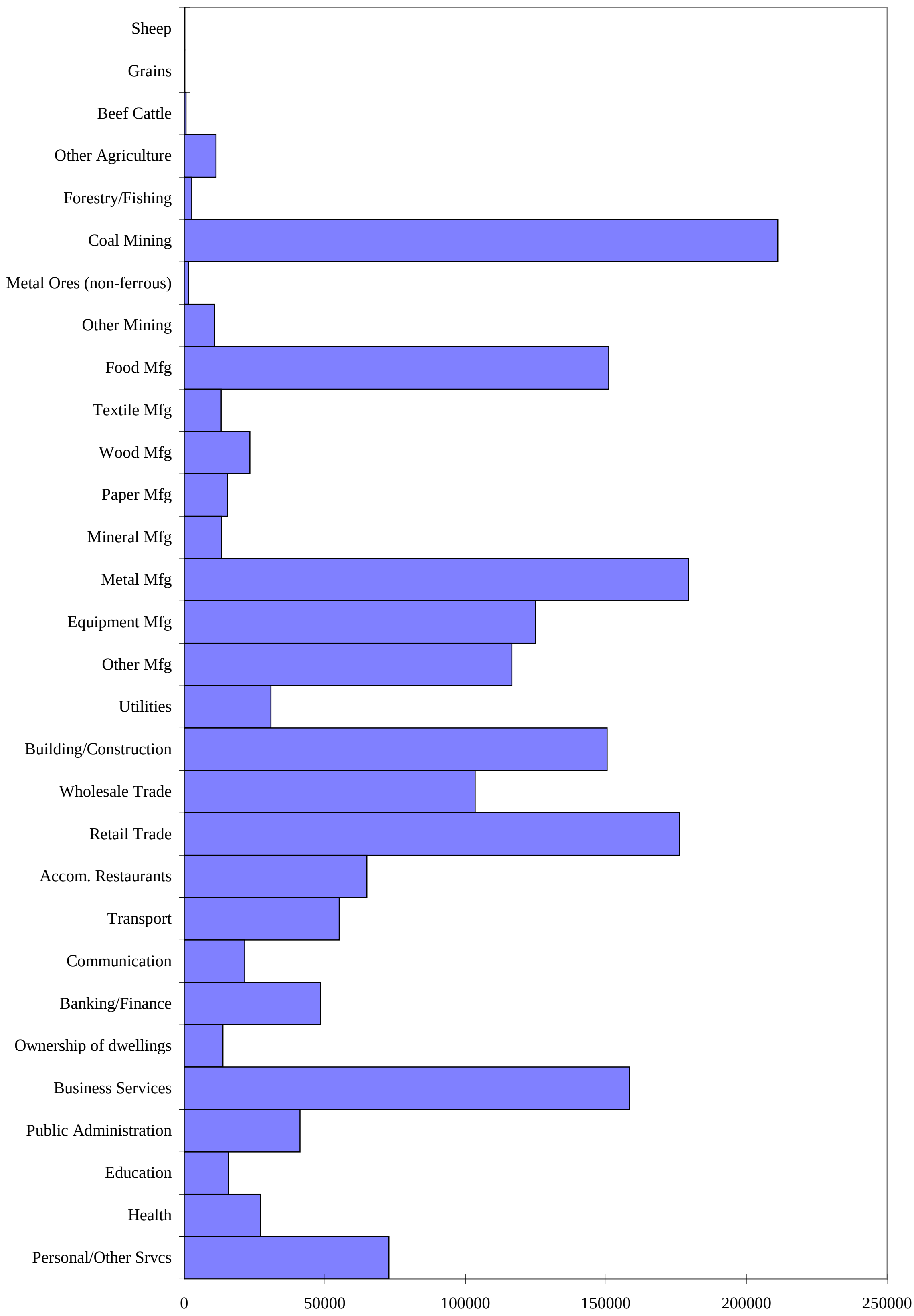

Figure C7 – Sectoral Distribution of Productivity (GRP ($,000)/person)

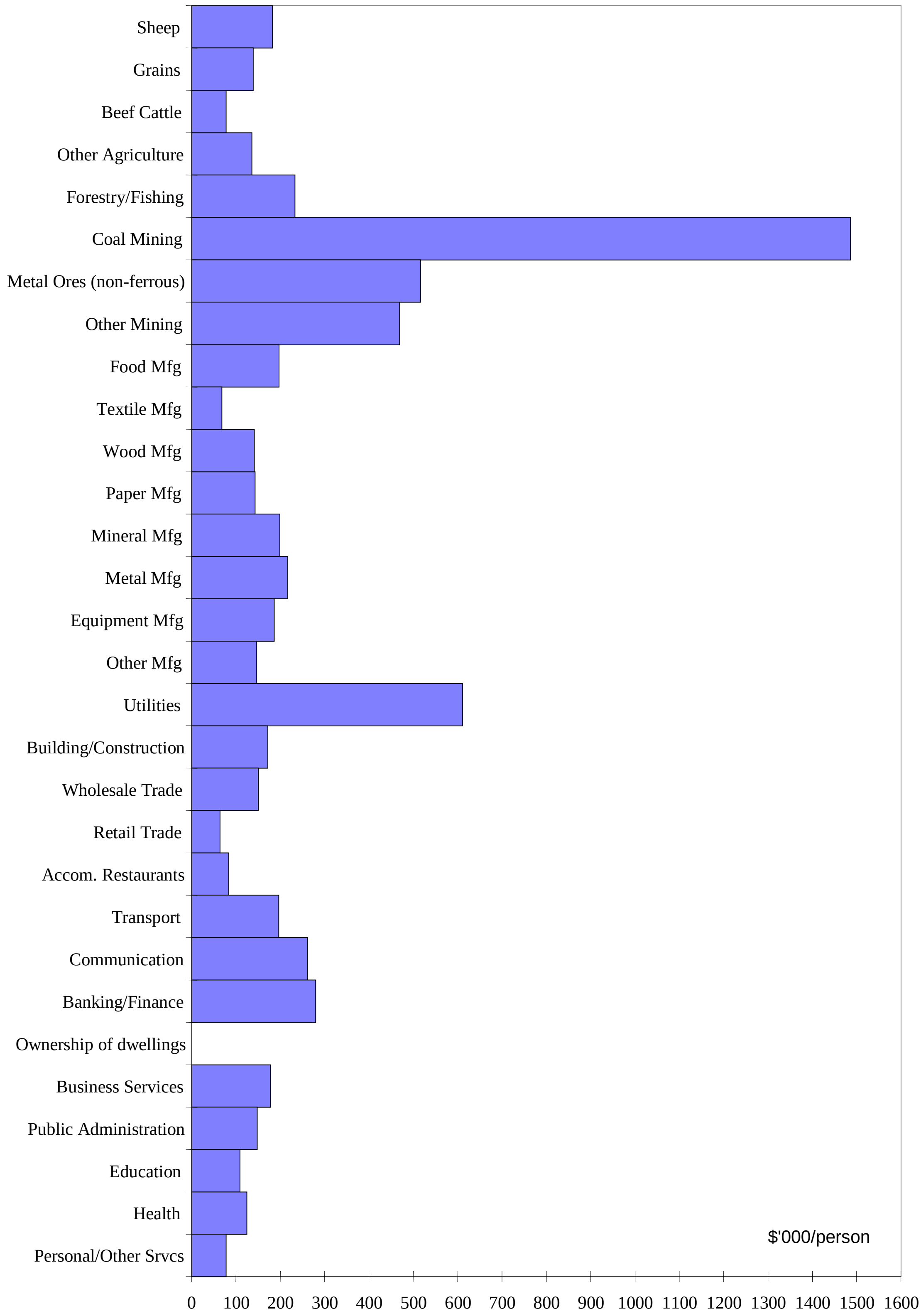

Figure C8 – Sectoral Distribution of Average Wages and Salaries